1.1.3

SYLLABI-UG

HAVING EMPLOYABILITY, ENTREPRENEURSHIP AND SKILL DEVELOPMENT

2016

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16BC102**
TITLE OF THE COURSE : **ORGANIC CHEMISTRY, DRUG SYNTHESIS AND TOXICOLOGY**
L: T/A: P: C : **3: 1: 0: 4**

COURSE OBJECTIVES: This course will provide the basics in Organic chemistry and drug development. They will gain a basic knowledge of methods used in drug discovery and basic toxicology.

COURSE OUTCOMES: Students will recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism. They will understand the basics in drug design and toxicology.

MODULE 1 **10Hrs**

Introduction: IUPAC nomenclature of organic compounds, Inductive effect, resonance and hyperconjugation, Reactive intermediates: carbocations, carbanions, carbines and free radicals.

Aliphatic and Aromatic Hydrocarbons: General characteristics of alkanes, alkenes and alkynes, substitution and bond opening reactions: Wurtz & Kolbe reaction for alkane, Hydrogenation with Merkownikoff's rule and ozonolysis of alkenes. Organometallic compounds - definition, examples and synthetic applications of Grignard Reagents. Baeyer strain theory. Sachse-Mohr theory. Boat and chair forms of cycloalkane. Axial and equatorial bonds. Benzene structure, Aromaticity, Huckel's rule, orienting influence of substituent on group addition.

MODULE 2 **10Hrs**

Mechanisms: Substitution of alkyl halides via SN1 and SN2, elimination via E1 and E2.

Alcohols: Definition and classification. Monohydric alcohols – general properties; distinguishing reactions of primary, secondary and tertiary alcohols – Lucas Test, Victor Meyer Test and Oxidation reactions. Acidity of phenol, Kolbe & Reimer-Tiemann reactions.

Acids and Aldehydes: Definition and examples. General properties, acid strength, esterification of acid, oxidation of alcohols to aldehydes and ketones. Keto-enol tautomerism, Perkin reaction, Claisen and aldol condensation, Cannizzaro reaction and reduction.

MODULE 3 **10Hrs**

Stereochemistry: Stereoisomerism: Optical isomerism: Molecular dissymmetry, Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism in alkenes and ring compounds. Structure and properties of malic and fumaric acid, E-Z system of specifying geometrical isomer, examples of chirality in the biological world.

Amines: Classification. Isomerism. Distinguishing reaction of 1°, 2° and 3° amines. pKb values of amines. Effect of substituents on the basic strength of amines. Some biologically important amines.

Heterocyclic Compounds, Terpenes and Alkalolds: Structure, formulae and occurrence of furan, thiophene, pyrrole, imidazole, pyridine and indole. Aromaticity of furan, thiophene, pyrrole and pyridine. Isoprene rule, biological importance and occurrence of terpenes & alkaloids. Phytochemicals- Introduction and uses.

MODULE 4 **10Hrs**

Organic synthesis and Drug Design: Retro-synthetic planning and synthetic execution, retron and synthon. Michael addition, Diels Alder reaction, Organo-lithium and epoxide-based reactions to create synthones, Reaction of diazonium salts coupling reactions, ethyl acetoacetate and its synthetic application, increasing C-atoms by n units, selective removal of C-atoms. Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug-receptor interaction Principles of Drug Design, Traditional analog (QSAR) and mechanism based approaches, Computer Aided Drug Designing (CADD) and molecular modeling. Synthesis of aspirin, anthraquinone, sulfanilamide, paludrine, acetaminophen (paracetamol) and pentothal**.**

MODULE 5 **10Hrs**

Toxicology: Toxins, venom, poison with examples, Dose Response curves, bioavailability, biosorption, IC50, LD50, ED50, Genotoxicity, Xenobiotics, Role of Cytochrome P450, Various mechanisms of Detoxification. Whole animal studies, Perfusion studies, Metabolic cage, Tissue culture, Common cell lines used for studying diseases.

REFERENCES BOOKS

1. Organic Chemistry-Morrison and Boyd. Prentice-Hall of India
2. Organic Chemistry-Solomons and Fryhle. Wiley & Sons.
3. A Guidebook to Mechanism in Organic Chemistry-Sykes. Longman Publishers.
4. Advanced Organic chemistry-Bahl and Bahl. S. Chand Publishing House.
5. A textbook of Modern Toxicology – Hodgeson. Wiley & Sons.
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publisher

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16BC201**
TITLE OF THE COURSE : **PHYSICO-ANALYTICAL TECHNIQUES**
L: T/A: P: C : **3: 1: 0: 4**

COURSE OBJECTIVES:
1. To create general understanding about fundamentals of biomolecules, their structure and function.
2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES:
1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **11Hrs**

Spectroscopy: Wave particle duality, the electromagnetic spectrum, Lambert-Beer's law, Absorbance, extinction coefficient, Chromic shifts, auxochromes. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscope; assay of biomolecules. Principle, Schematics and Application of Luminometry, Flame photometry and AAS. IR spectroscopy, equation, vibrational modes of various bonds, applications in the identification of common functional groups in biomolecules.

MODULE 2 **11Hrs**

Techniques for structure determination

X-Ray Diffraction: crystal planes, Braggs Equation, Diffractometer, Applications in crystal characterization. NMR: principle and applications in structure elucidation of biomolecules.

Techniques in Medical Applications

NMR based techniques – Magnetic Resonance Imaging and Diffusion tensor imaging – brief idea, X-ray based technique: CAT scan and radioactivity based technique: PET scan

Chromatography

Distribution coefficient, Adsorption, partition, Retention factor. Types: Planar and columnar, S-L, L-L, G-S and G-L. Paper, thin layer, gel permeation, ion exchange, hydrophobic and affinity chromatography with applications, Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules. Brief idea about HPLC (C8 and C18) and FPLC.

MODULE 3 **10Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis, Applications. Gel electrophoresis: - Types of gels, Procedure, Column & slab gels. Detection, Recovery & characterization of macromolecules (molecular weight determination and subMODULE enumeration). Principle and application of SDS-PAGE, IEF, peptide mapping, OFGE, Application in molecular biology and genomics.

Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

MODULE 4 **10Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography. Applications of isotopes in biochemistry with reference to studies in metabolism, Principles of tracer techniques, it's advantages and limitations,

MODULE 5 **10Hrs**

Centrifugation: Basic principles, Mathematics & theory: RCF, Sedimentation coefficient, Svedberg constant, nomogram. Preparative centrifugation: Differential & density gradient centrifugation, Applications**.** Analytical centrifugation: - Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Electrochemistry: Potentiometry, potentiometer schematics and use as pH meter, Conductance, specific and equivalent conductance, Conductivity meter.

REFERENCE BOOKS

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Principles and Techniques of practical Biochemistry – Wilson and Walker. Camridge.
4. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
5. Immunology – Kuby. Freeman Publishers.
6. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER/YEAR : **IV SEM / II YEAR**
COURSE CODE : **16BC202**
TITLE OF THE COURSE : **PHYSIOLOGY OF LIVING SYSTEMS.**
L: T/A: P: C : **3: 1: 0: 4**

COURSE OBJECTIVES:

1. To provide the basic knowledge about the nutrition and significance of nutrients.
2. To provide the basics about the functioning of different organ systems of the human body

COURSE OUTCOME:

1. Students will be able to integrate the functioning of different organ systems in the human body.
2. Students will be able to understand and analyze the significance of balanced nutrition in human physiology.

MODULE 1 **11Hrs**

Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods. Nitrogen balance, BUN, NPN, Calorific value of foods, bomb calorimeter. Respiratory quotient, BMR, SDA and factors affecting them. Role of protein, lipid and carbohydrates as fuel molecules, Protein sparing effect of carbohydrates. Dietary fiber. Essential fatty acids and their biological importance**.** Food fortification & food supplementation, Minerals and vitamins.

Skeletal system: Tissues- introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodelling and regulation by hormones.

MODULE 2 **11Hrs**

Hematology and respiration: Blood components and their functions, blood groups: the ABO system, rhesus system, blood clotting factors, intrinsic and extrinsic pathways for blood clotting. Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxy hemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.

Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

MODULE 3 **10Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Structure and function of liver and Gall bladder, LFT.

Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

MODULE 4 **10Hrs**

Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and non-myelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

MODULE 5 **10Hrs**

Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

REFERENCES BOOKS

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16BC301**
TITLE OF THE COURSE : **ENZYME TECHNOLOGY AND PROTEIN CHEMISTRY**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVES:

1. Learning about enzyme properties along with enzyme and inhibition kinetics.
2. Knowledge of enzyme assay and drawing enzyme assisted reaction plots.
3. Brief idea about the various coenzymes.
4. Introduction to Protein structure understanding with various examples.
5. Studying analytical techniques to characterize proteins including brief introduction to proteomics.

COURSE OUTCOMES:

1. They will have a working knowledge of the active site of the enzyme and how it helps in reactions.
2. Students will be equipped with adequate knowledge on drawing various plots to understand the nature of enzyme and inhibitor.
3. Students will know the classification and function of various proteins along with their structural hierarchy.
4. They will also be able to analyze results obtained after protein characterization.

MODULE 1 **9 Hrs**

INTRODUCTION: Classification & nomenclature of enzymes, Active site: Lock & key, induced fit model and strain/TS theory- lysozyme and chymotrypsin as examples, Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientation effect, Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogen phosphorylase) enzymes, MODULEs-Katal & IU. Effect of physical and chemical parameters on enzyme activity with examples.

MODULE 2 **9 Hrs**

ENZYME KINETICS: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km. Bisubstrate reactions – brief introduction.

ENZYME ASSAY AND PURIFICATION: Enzyme assay, Specific activity. Enzyme isolation and purification, criteria for enzyme purity. Isoenzymes and clinical applications, Biotechnological applications, enzyme biosensors.

MODULE 3 **9 Hrs**

VITAMINS AND COENZYMES

Structure and reaction mechanisms of vitamins – fat-soluble: A, D, E & K; water-soluble: Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, cobalamine and ascorbic acid.

MODULE 4 **9 Hrs**

PROTEINS

Classification based on composition, shape and function, assay techniques. Peptide bond, Ramachandran Plot, Structural organization: primary, secondary, tertiary and quaternary structures, Hemoglobin, Immunoglobulin, Collagen, myosin and Keratin structures. Denaturation and melting temperature, Hofmeister series. Protein synthesis.

MODULE 5 **9 Hrs**

INTRODUCTORY PROTEOMICS: Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography. Sequence determination by Sanger and Edman methods. Mass spectroscopy of proteins: mass determination, Hydropathy plot, Protein Expression, Vectors and hosts, downstream processing.

REFERENCES BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16BC371**
TITLE OF THE COURSE : **ENZYMOLOGY AND RECOMBINANT PROTEIN PURIFICATION**
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. To introduce students to various practical aspects of enzymology; and give them hands on learning in function and kinetics of enzyme and their role as catalyst and regulator of cell metabolism.
2. Serve as foundation for more advanced enzymology courses.
3. To equip the students with protocols in genetic engineering

COURSE OUTCOMES:

1. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation, expression and purification of recombinant protein

Practicals:

1. Isolation of enzymes from biological source and activity determination
2. Determination of kinetic constants through LB plot.
3. Effect of temperature and Arrhenius constant.
4. Effect of enzyme dilution
5. Effect of substrate concentration
6. Effect of pH
7. Effect of activator
8. Effect of inhibitor
9. Immobilization of enzyme using calcium alginate.
10. Preparation of competent cells and transformation
11. Protein purification by Ni- NTA Affinity chromatogram
12. SDS-PAGE of purified protein
13. Protein concentration determination from spectrophotometry
14. Purification of protease from plant by ammonium sulphate fractionation
15. Protease assay through FC method

REFERENCES BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
   Protein Protocols Handbook – Walker. Humana Press.
2. Protein Purification Applications – Roe. Oxford University Press.
3. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC303**
TITLE OF THE COURSE : **CHEMISTRY AND METABOLISM OF LIPIDS AND NUCLEIC ACIDS**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVE:
1. Introduction to structure and classification of lipids.
2. Learning about the various reactions in which lipids are broken down by living systems to generate energy.
3. Learning about nucleic acid structures and properties along with synthesis and breakdown.

COURSE OUTCOME:
1. Students will have an idea about the various lipid molecules and how they behave in contact with water.
2. They will be aware of the importance of lipid in energy storage.
3. Students will able to comprehend the synthesis and breakdown of RNA/DNA and the enzymes that assist in the process.

MODULE- 1 **9 Hrs**

LIPID CHEMISTRY

Classification of lipids. Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids. Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid. DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids).

MODULE- 2 **9 Hrs**

ARACHIDONIC ACID DERIVATIVES: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3. Lipoproteins & GPI-linked proteins: Types and functions. Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model. Steroids - Function of hopnoids, cholesterol, androgen and estrogens. Lipid peroxidation and its role as a stress marker.

MODULE- 3 **9 Hrs**

LIPID METABOLISM: The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation, Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

MODULE- 4 **9 Hrs**

NUCLEIC ACIDS: Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides. DNA: Biological role, structure, polymorphism, denaturation, renaturation and Tm. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins. RNA: Types, secondary structure and biological role of various RNA

MODULE- 5 **9 Hrs**

NUCLEIC ACID METABOLISM: Metabolism of purine and pyrimidine nucleotides. Hyperuricemia & other inborn errors.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC372**
TITLE OF THE COURSE : **ESTIMATION OF BIOMOLECULES**
L: T/A: P: C : **0: 0: 6: 3**

COURSE OBJECTIVE:
To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME:
Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

PRACTICALS:
[1] Qualitative analysis of
a. carbohydrates,
b. amino acids,
c. proteins,
d. lipids and
e. Preparation of solid derivatives of monosaccharides – osazone crystal.
[2] Estimation of amino acids by formal titration.
[3] Estimation of ascorbic acid from biological samples by titrimetric method.
[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

REFERENCE BOOKS
1. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
2. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
3. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
4. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN272
TITLE OF THE COURSE : MOLECULAR GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. Introduction and usage of the different instruments in a basic molecular genetics' lab.
2. Different methods of isolation and study of the genetic material (DNA).

COURSE OUTCOMES:
1. Students will appreciate the methods of DNA isolation and its manipulations and its potential applications.
2. Student will also be able to make connections with the different techniques and its usage in identifying and
understanding genetic diseases.

Experiments
1) Instrumentation:
- Centrifuge
- Ultra centrifuge
- pH meter
- Electrophoretic MODULE
- Spectrophotometer/colorimeter

2) Extraction of DNA from:
- Plants (Cauliflower/Coconut endosperm/any)
- Animal tissue (Liver Tissue/any)

3) Paper Chromatography for Separation of:
- Leaf pigments
- Drosophila eye pigments
- Amino acids

4) Electrophoresis
- Agarose gel electrophoresis

5) Mutations:
- Study of examples of mutations: Sickle cell Anaemia Missense mutation and Thalassemia frame shift mutation.
- Induction of Mutation in *Drosophila* and detection of sex linked lethal by Muller 5 stock

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN302
TITLE OF THE COURSE : APPLIED GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To get a glimpse of the role of genetics application
2. Understand and integrate biology and computation

COURSE OUTCOMES:
1. Industrial and agricultural application of genetics
2. Development of key skill such as bioinformatics**.**

MODULE - 1 GENETIC RESOURCES AND BIODIVERSITY
9Hrs
Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centers of Diversity, Vavilovian Centers of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.
MODULE - 2 INTRODUCTION TO PLANT TISSUE CULTURE
9Hrs
Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.
MODULE - 3 HETEROSIS IN ANIMALS AND PLANTS
9Hrs
Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis-Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques- intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.
MODULE - 4 GENETICS IN MEDICINE & INDUSTRY
9Hrs
Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying.
MODULE – 5 BIOINFORMATICS
9Hrs Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics. **TEXT BOOKS**
1. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
2. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.

REFERENCE BOOKS
1. Singh B. D. Biotechnology. Kalyani Publication. 2002.

2. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
3. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
4. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
5. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
6. Phundan Singh , Elements of Plant Breeding. 2nd Edition. Kalyani Pulications. 2001
7. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.
8. Brown, T. A. Genetics: A Molecular Approach (2nd Ed.), Garland Science, New York. 2002.
9. Baxevanis and Bff Oluellette. Bioinformatics : A practical guide to the analysis of genes and proteins, Ad Wiley Interscince – new York. 2001.
10. Stephen Misener and Stephan A. Krawetz. Bioinformatics: Methods and protocol. Humana press, New Jersey. 2000
11. Des Higgins and Willie Tylore. Bioinformatics: sequence, structure and databanks, Oxford University press. 2000.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN371

TITLE OF THE COURSE : GENETIC ENGINEERING PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. Introduction to instruments and isolation methods of the genetic materials.
2. Further study of quantification and manipulating of the genetic material with extra-chromosomal genetic material from other sources.

COURSE OUTCOMES:
1. Students will understand how genetic material from different sources can work together in genetic engineering.
2. Student with competitive approach can use this Multidisciplinary approach to think innovative concepts.

1. INSTRUMENTATION:
UV Transilluminator
PCR

2. VECTORS:
pBR 322 and Cosmid,
YAC,
Ti plasmid - Binary vector,
SV 40 (any one type)

3. TRANSGENIC ORGANISMS:
Plants-Bt cotton and Animals-Knock out Mouse

4. EXPERIMENTS:
Quantification of DNA by DPA method
Quantification of RNA by Orcinol method
Agarose Gel Electrophoresis of DNA

5. DEMONSTRATIONS:
Isolation of Plasmid DNA
Restriction Enzyme digestion
Ligation of DNA fragment
Transformation- α complementation

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN372
TITLE OF THE COURSE : APPLIED GENETICS, GENOMICS AND PROTEOMICS PRACTICALS
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVES:
1. To understand the tissue culture techniques for genetic manipulation of plants/crops.
2. Use different genomic and proteomic approaches to genetics.

COURSE OUTCOMES:
1. Broaden horizon on the potential applications of plant and animal genome and proteome.
2. Hands on skills on the usage of bioinformatics tools to study genomic and proteomic data.

APPLIED GENETICS
1. Tissue culture techniques:

- Sterilization
- Explants preparation
- Media Composition and preparation
- Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
- Synthetic seed preparation

2.Study of different techniques in plant hybridization
3. Study of pollen fertility

4. Study of diagnostic kits - WIDAL & VDRL

5. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.

6. Study of hybrid animals - Poultry, dairy, fishery.

7. Homology sequence analysis using Blast and Fasta.

GENOMICS AND PROTEOMICS:
1) Physical mapping by Restriction mapping of plasmid DNA
2) Genetic mapping by RFLP analysis
3) RAPD analysis
4) DNA fingerprinting analysis: Parentage detection

5) Homogenization, fractionation and separation of enzymes/ proteins in plants and animals by SDS- PAGE method

6) Protein database study SCOP, DALIDD, CATH

SEMESTER/YEAR : III SEM / II YEAR

COURSE CODE : 16MB201

TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY, MICROBIAL GENETICS AND INSTRUMENTATION

L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:

1. Learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics.

2. To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype.

COURSE OUTCOMES:

1. To understand the complexity of microbial structures, genetics and metabolism.

2. Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment

MODULE 1: BIOMOLECULES AND ENZYMES 10Hrs

A brief account of the properties, classification and importance of carbohydrates, lipids and proteins. Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes.

MODULE 2: METABOLISM AND BIOENERGETICS-I 11Hrs

Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP, shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H. Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: METABOLISM AND BIOENERGETICS-II 11Hrs

Bacterial photosynthesis and Fermentation: Definition, Photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid. Bioenergetics: Free energy, ATP and its production, other high energy compounds, Oxidation –Reduction reactions.

MODULE 4: MICROBIAL GENETICS 10Hrs

Basics of Genetics: Mendelian Principles of genetics (Monohybrid, Dihybrid and Test cross), Morphology of Prokaryotic and Eukaryotic genetic material. Chemical basis of heredity: Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment). Properties of genetic code and Wobble hypothesis. Transformation, Conjugation and Transduction. Transposons in recombination. Extra chromosomal genetic elements and their importance. Molecular basis of mutations: Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.

MODULE 5: INSTRUMENTATION 10Hrs

Centrifugation: Basic principles, Low-speed and High-speed centrifuges, ultracentrifugation,

Applications. Chromatography: Paper, Thin layer, Column chromatography, HPLC

Electrophoresis: Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, SDS-PAGE

Spectrophotometer: Principles of Spectroscopy, UV Visible spectroscopy, NMR spectroscopy.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec

2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.

3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.

4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.

5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.

6. Freifelder, D. 2002. Microbial Genetics, Narosa Publishing House, New Delhi.

7. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 2008. Principles of Genetics. Eight edition. Wiley Publications.

8. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.

9. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.

10. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.

11. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.

Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.

12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.

13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : IV SEM / II YEAR

COURSE CODE : 16MB202

TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY

L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:

1. To examine basic techniques used in molecular microbiology.

2. To adapt molecular and biotechnological techniques to research and industry for the welfare of mankind.

COURSE OUTCOMES:

1. Determine which technique(s) is appropriate in solving a specific experimental problem.

2. Describe the applications of molecular biology in areas such as transgenic plants and animals, vaccines and therapeutic agents.

MODULE 1: INTRODUCTION TO NUCLEIC ACIDS AND REPLICATION
11Hrs

Structure of bases – A, T, G, C and U. Definition of nucleosides and nucleotides,Watson and Crick model of DNA, Types of DNA (A, B and Z), Types of RNA and their functions. Modes of replication- Conservative, Semi conservative (Messelson and Stahl experiment) and Dispersive. Methods of DNA replication (Rolling circle and Linear), and mechanism of Prokaryotic DNA replication.

MODULE 2: GENE EXPRESSION AND REGULATION 11Hrs

Central dogma, Transcription- mechanism, post transcriptional modification. Translation - mechanisms, post translational modification in prokaryotes. The operon concept, induction, repression catabolic repression and attenuation. The lac operon and trp operon.

MODULE 3: RECOMBINANT DNA TECHNOLOGY 10Hrs

History and fundamentals of r-DNA technology, Tools for r-DNA technology Enzymes: DNA manipulative enzymes, Restriction enzymes, Ligases and other DNA modifying enzymes

Gene cloning vectors: Salient features, Plasmids- properties, types pBR322, bacteriophages- λ and M 13, Cosmids-properties, Bacterial Artificial Chromosomes (BAC's),Yeast Artificial Chromosomes (YAC's), Agrobacterium tumifaciens, SV 40.

MODULE 4: TOOLS IN rDNA TECHNOLOGY 10Hrs

Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). Cutting of DNA molecules. Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters.

Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment.

MODULE 5: SCREENING, SELECTION AND APPLICATIONS 10Hrs

Insertional inactivation, in situ colony/DNA hybridization, Polymerase chain reaction, blotting techniques and immunological techniques.

Applications of Genetic Engineering: a) Medicine: Gene therapy b) Agriculture: nif gene cloning

Potential hazards and safe guards of genetic engineering.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec

2. Brown, T.A. 2010. Gene Cloning and DNA Analysis – an Introduction. Sixth edition.

Wiley Blackwell.

3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth

Edition. The Addison Wesley Longman, Inc England.

4. Cooper, G.M. 2013. The Cell – A Molecular Approach. 6th edition. Sinauer Associates.

5. Karp, G. 2008. Cell and Molecular Biology. 5th edition. McGraw Hill Book Company,

New York.

6. Nelson, D.L. and Cox, M.M. 2007. Lehninger's Principles of Biochemistry. Fourth

edition. Macmillan Press/Worth Publishers. New Delhi.

7. Palmer, T. and Bonner, P.L. 2007. Biochemistry, Biotechnology and Clinical Chemistry.

Second edition. Wood head Publishing co.

8. Prescott, L.M. Harley, J.P. and Klein, D.A. 2011. Microbiology. Eight edition. WCB –

McGrawHill, New York.

9. Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene manipulation and

Genomics. Seventh edition. Blackwell Publishing.

10. Singh, B.D. 2008. Biotechnology – Expanding Horizons. Kalyani Publishers.

11. Watson, J. D. Recombinant DNA, Scientific American Books, New York.

12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levne, M., and Losick, R. 2004. Molecular

Biology of the Gene. Fifth Edition. Pearson Education

SEMESTER/YEAR : V SEM / III YEAR

COURSE CODE : 16MB322

TITLE OF THE COURSE : DAIRY MICROBIOLOGY (ELECTIVES)

L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To provide in-depth knowledge in various MODULE operations and basic concepts in dairy processing.

2. To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products

COURSE OUTCOMES:

1. Enables students about additional knowledge on microbiological analysis on organisms relevant for dairy products.

2. Knowledge of the most important spoilage and pathogens in dairy products has also been obtained.

MODULE 1: MICROBIOLOGY AND FERMENTATION IN MILK 9hrs

Physical and chemical properties of milk. Types of microorganisms in milk (bacteria, fungi and yeast). Source of microbial contamination of milk- Milk producing animal, Milking environment, utensils, equipment, water, personnel and packing material. Souring, lactic acid fermentation, colour and flavour fermentation, gassy fermentation, proteolysis and lipolysis.

MODULE 2: MILK BORNE INFECTIONS 9hrs

Introduction, Tuberculosis, Brucellosis, Listeriosis, Anthrax, Q fever, Cow pox, Foot and Mouth diseases. Preventive and Control Measures.

MODULE 3: MILK AND MILK PRODUCTS 9hrs

Dairy starter cultures, Fermented Dairy products – curd, lassi, yogurt, flavoured milk, cheese, condensed milks, acidophilus milk, kefir and milk powders.

MODULE 4: MICROBIOLOGICAL ANALYSIS OF MILK 9hrs

Rapid platform tests- organoleptic, clot on boiling, lactometer, titratable acidity, alcohol test, DMC, sedimentation tests and pH. Standard plate count, reductase test- MBRT, Resazurin test, Methylene blue test.

MODULE 5: MILK PROCESSING 9hrs

Collection, transport of Milk, Cold Storage,Pasteurization, sterilization, dehydration, and preservation of milk quality, Indian standards of grading milk. General account on milk adulteration: effects and detection.

REFERENCE BOOKS

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.

2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited,

New Delhi

3. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.

4. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw- Hill Publishing Company

Limited, New Delhi.

5. Varnam A.H and Evans M.G Food borne Pathogens, Wolfe Publishing House, London.

SEMESTER/YEAR : VI SEM / III YEAR

COURSE CODE : 16MB372

TITLE OF THE COURSE : IMMUNOLOGY, MEDICAL MICROBIOLOGY AND MICROBIAL FERMENTATION

L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVES:

1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES:

1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.

1. Isolation of normal microflora from skin and oral cavity

2. Snyders test for dental caries detection

3. Blood grouping and Rh typing

4. Dot ELISA

5. Precipitation reactions: Ouchtlerlony Double Diffusion, Radial Immune Diffusion, Rocket

Immuno electrophoresis

6. Antibiotic sensitivity test

7. Determination of effectiveness of antiseptics by thumb impression method

8. Identification of different types of blood cells

9. Production and determination of amylase activity

10. Preparation of wine

11. Study of different types of fermenters (Models/ Charts)

12. Cell immobilization techniques (yeast cells)

13. Sterility assays of pharamaceutical products

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT102
TITLE OF THE COURSE : PRINCIPLES OF MICROBIOLOGY AND BIOSTATISTICS L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about classification and diversity of microorganisms and familiarize the students with the cultivation of microorganisms and sterilization techniques.
2. To impart the basic concepts in biostatistics.

COURSE OUTCOMES: 1. Student will be aware of basic microbiological and sterilization techniques.
2. Student will have sufficient understanding of statistical methods used in biological sciences for data handling.

MODULE 1

10Hrs

Historical perspectives of microbiology: Introduction – microbial origin,

Contributions and discoveries, Germ theory, Scope of Microbiology. Concept of Sterilization - Definition of sterilization, disinfection, Sanitization, antisepsis and fumigation. Physical, Chemical and radiation methods of sterilization, and their applications.

MODULE 2

11Hrs

Classification of Microbes: Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of molecular classification of microorganisms Systematics of bacteria, Nutritional types (Definition and examples). Classification on the basis of oxygen requirement. General Account of Viruses and Bacteria; Bacteria-Ultra structure of a bacterial cell (both Gram positive and Gram negative) endospore and capsule.

MODULE 3

11Hrs

Microbes in Extreme Environment; Nature, special features of the thermophiles, methanogens and halophiles, Archaea; photosynthetic bacteria, Cyanobacteria, some Archaea living in extreme conditions like cold, and space (Extremophiles). Pathogenic Microorganisms; A. Plant viruses- CAMV, Animal Viruses-Hepatitis B, Bacterial virus- lambda phage B. The common bacterial, fungal and viral diseases of human beings (Name of the disease, causative pathogen, parts affected).

MODULE 4

10Hrs

Biostatistics: Importance and Applications; Tabulation and classification of Data - Frequency distribution and graphical distribution of Data; Measures of Central Tendencies - Mean, Median, Mode and their properties; Measures of Dispersion - Mean Deviation, Variance, Standard Deviation and Coefficient of Variation;

MODULE 5

10Hrs

Hypothesis testing - Student T and Chi Square test; Probability and distribution - Concepts and problems on probability, Binomial, Poisson, normal distribution and their application.

REFERENCE BOOKS

1. Microbiology-Pelczar, Chan, Krieg Tata McGraw Hill Publications (2000)
2. Microbiology- Concepts and applications by Paul A. Ketchum Wiley Publications (2001)
3. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications (2003)
4. Microbiology –Ronald M. Atlas (1990)
5. Introductory Biotechnology-R.B Singh C.B.D India (1990)
6. Microbiology by L M Prescott, Mc Graw Hill
7. General Microbiology –C.B. Powar, H.F. Daginawala, Himalayan Publishing House (2001)
8. Fundamental of Biostatistics by Khan and Khanum, Ukaaz Publications (1994)
9. Statistics for Biologists by RC Campbell, Cambridge University Press (1989)
10. Biostatistics by Wayne W Daniel, Wiley 10th Edition (2014)

COURSE CODE : 16BT271
TITLE OF THE COURSE : BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES L: T/A: P: C : 0: 0: 4: 2

Course Objectives: 1. To make students learn quantitative and qualitative methods for study of biomolecules.

Course Outcomes: 1. Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

1. Preparation of Buffers-Citrate and Phosphate.
2. Estimation of reducing sugars by DNS method.
3. Estimation of reducing sugars by Somogyi-Nelson Method.
4. **Estimation of Amino acids by Ninhydrin method.**
5. **Estimation of Protein by Biuret method.**
6. **Estimation of protein using Lowry's method.**
7. Preparation of crude amylase extract from biological source
8. **Assay of amylase enzyme activity using starch as a substrate**. (2 MODULEs)
9. **Separation of Amino acids by Paper Chromatography.**
10. **Separation of amino acids/sugars by Thin layer chromatography**

COURSE CODE : 16BT272
TITLE OF THE COURSE : TECHNIQUES IN MOLECULAR BIOLOGY L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To skill students for isolation and quantitation of DNA and proteins from different sources.

COURSE OUTCOMES: 1. Student will be able to isolate and analyze DNA from different sources using appropriate buffers and partially purify proteins using common protocols.

1. **Estimation of DNA and RNA by UV-Vis Spectroscopy/Colorimetric method**.
2. **Partial purification of protein from plant source by Ammonium sulphate precipitation and its estimation.**
3. **Partial purification of protein from animal source by organic solvent (acetone) and its estimation**.
4. **Isolation of genomic DNA from plant source and its analysis using agarose gel electrophoresis.**
5. **Isolation of genomics DNA from animal/bacterial source and its analysis using agarose gel electrophoresis.**
6. Column Chromatography (Demo)
7. Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16BT301**
TITLE OF THE COURSE : **PRINCIPLES OF IMMUNOLOGY AND BASICS OF ANIMAL BIOTECHNOLOGY**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVES:
1. To equip the students with cells and organs of immune system and immunological techniques.
2. To provide basic understanding on animal cell culture and applications of animal biotechnology in modern research.

COURSE OUTCOMES:
1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge on animal biotechnology and its application.

MODULE 1

09Hrs

Elements of Immune System: History and scope of Immunology, Innate and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Interleukins and Interferons – brief introduction and their important functions. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE 2

09Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting antigenicity, antigen processing and presentation, antigen processing cells

(APCs); Major Histocompatibility Complex (MHC) – MHC I and II, Antibodies – structure, types and functions of Immunoglobulins

MODULE 3

09Hrs

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence.

Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

MODULE 4

09Hrs

Animal Cell Culture: Introduction, history and scope of Animal Biotechnology, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK)

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT371
TITLE OF THE COURSE : IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To acquaint the student with the important techniques in immunology and animal biotechnology.

COURSE OUTCOMES: 1. Student will be well equipped with immunological techniques utilized for diagnostic assays.
2. Students will be skilled to set up primary cell culture and perform cell count and cell viability assay.

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Preparation of media for animal cell culture
7. Isolation of liver parenchyma cells by mechanical method and set up primary culture
8. Determination of the concentration of viable cells in a suspension by

Haemocytometer counting (trypan blue)

9. Isolation of cells by explant method and Sub-culturing
10. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

COURSE CODE : 16BT321
TITLE OF THE COURSE : ENVIRONMENTAL BIOTECHNOLOGY L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To impart basic knowledge in environmental science, environmental issues and the management.
2. To familiarize the significant techniques in biotechnology that contribute to environment protection.

COURSE OUTCOMES:

1. Student will be well acquainted with the role of various environmental pollutants, and environment monitoring techniques.
2. Students will be familiarized with the waste water treatment, bioremediation and bioleaching.

MODULE 1

10Hrs

Sources of Energy: Renewable and non-renewable sources of energy, Conventional fuels and their environmental impact, Modern fuels and their environmental impact, methanogenic bacteria, microbial hydrogen production, biogas production, conversion of sugar to alcohol, gasohol, biofuels.

MODULE 2

10Hrs

Waste management: Treatment of municipal solid waste and industrial effluents, preliminary treatment, primary treatment – sedimentation, secondary treatment – aerated lagoons, activated sludge, batch reactor, trickling filter, rotating biological contractor, packed bed process, pond treatment system – aerobic, anaerobic and facultative, tertiary treatment – solid, nitrogen, phosphorus removal and disinfection.

MODULE 3

09Hrs

Bioremediation: Bioremediation techniques – *in situ* and *ex situ*, bioremediation of soil and water contaminated with oil spills, heavy metals and detergents, Phytoremediation, degradation of pesticides and toxic chemicals by microorganisms - aromatic and chlorinated hydrocarbons, petroleum products, genetically modified organisms in bioremediation

MODULE 4

07Hrs

Bioleaching: Microbes used in leaching, mechanism, leaching process, some case studies related to bioleaching.

MODULE 5

09Hrs

Environment monitoring: Bioindicators (Terrestrial & Aquatic), Biosensors of pollution

Novel methods for environment protection: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products.

REFERENCE BOOKS

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
2. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
3. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
4. SK Agarwal (2005) Advanced Environmental

Biotechnology, APH publishing corporation.
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd

COURSE CODE : 16BT322
TITLE OF THE COURSE : INDUSTRIAL BIOTECHNOLOGY L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
2. To familiarize students with downstream processing and production of important microbial products.

COURSE OUTCOMES: 1. Student will be aware of fermentation process, types

of fermentation media and strategies for isolation of industrially important strains.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.

MODULE 1

09Hrs

Screening and Selection of strains: Introduction, basics of fermentation technology, Isolation and screening of microorganisms, maintenance of strains, strain improvement – mutant selection, recombinant DNA method

MODULE 2

10Hrs

Fermentation Media, Fermentors and Fermentation: Fermentation media – natural and synthetic, media sterilization, Types of Fermentors – Basic design, Airlift, tower and bubble cap fermentor; Immobilized cells and enzyme fermentor; Types of Fermentation -Solid state, submerged, Batch, Fed-batch and Continuous.

MODULE 3

08Hrs

Downstream Processing: Solid-liquid separation (Filtration, flocculation, centrifugation, sedimentation),

MODULE 4

08hrs

Downstream processing for release of intracellular products – physical, enzymatic, chemical, concentration and purification of products.

MODULE 5

10Hrs

Production of Microbial Products: Production of wine, beer, citric acid, penicillin, glutamic acid, Vitamin B12, Amylase, insulin, fermented foods (Yoghurt, cheese), Single Cell Protein (SCP)

REFERENCE BOOKS

1. Glazer and Nikaido (1995), Microbial Biotechnology, WH Freeman and Co.
2. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
3. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
4. Nduka Okafor (2007) Modern Industrial Microbiology and Biotechnology, CRC Press
5. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier

6. LEJR Casida (2007) Industrial Microbiology, New Age International Publishers
7. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR :

VI SEM / III YEAR COURSE CODE : 16BT302
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To acquaint the student with the significant component of biotechnology - Recombinant DNA technology.

2. To impart knowledge on important tools, techniques, protocols for genetic engineering.

COURSE OUTCOMES:

1. Student will be well equipped with the scientific understanding of the fundamental requirement of recombinant DNA technology

2. Student will gain optimum knowledge of application of recombinant DNA techniques in today's Life science Research.

MODULE- 1

09Hrs

Tools for Genetic Engineering: Introduction to Recombinant DNA technology, DNA manipulative and Modifying enzymes – Restriction enzymes, DNA ligases, Alkaline phosphatases, polynucleotide kinase, exonuclease, DNase I, DNA polymerase and Klenow fragment, RNA dependent DNA polymerase, terminal nucleotide transferase.

MODULE- 2

09Hrs

Vectors – Basic features, Cloning vectors -Prokaryotic (pBR322, pUC18, Lambda phage, m13, cosmids), Eukaryotic vectors (YAC, shuttle vectors, Ti plasmid, Binary vectors, SV40, Retroviral and Vaccinia viral vectors) Expression vectors in Prokaryotes and Eukaryotes – Basic features, role of promoters. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion

MODULE- 3

09Hrs

Techniques in Recombinant DNA technology: Hybridization – Southern, Northern, Western, DNA Sequencing (Sanger's di-deoxy method), Basics of New Generation Sequencing, PCR, Real Time PCR, Construction of genomic library, cDNA library.

MODULE- 4

09Hrs

Selection and Screening of Recombinants: Identification and selection of transformed cells, Direct methods – insertional inactivation, blue-white selection, plaque formation, complementation of mutation, Indirect methods – colony hybridization, immunochemical detection, Use of selectable marker genes in eukaryotes for expression, Expression of cloned genes

MODULE- 5

09Hrs

Microarray, Yeast two hybrid system, *In vitro* Mutagenesis. Applications of r-DNA technology: Production of Insulin, Recombinant Vaccines, hGH, Role in gene therapy, GM crops, Ethics and Biosafety involved.

REFERENCE BOOKS

1. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
2. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
3. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication.
5. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

COURSE CODE **: 16BT372**
TITLE OF THE COURSE **: GENETIC ENGINEERING AND PLANT TISSUE CULTURE** **L: T/A: P: C : 0: 0: 6: 3**

COURSE OBJECTIVES: 1. To skill students for basic techniques required to establish plant tissue culture
2. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. Student should be able to prepare and sterilize culture media and establish callus growth.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation.

1. Preparation of competent cells
2. Transformation of Plasmid DNA in competent cells and screening of transformants
3. Isolation of plasmid DNA and analysis using gel electrophoresis
4. Restriction digestion and ligation
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus
10. Production of synthetic seeds.

2019

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19BY2301**					
TITLE OF THE COURSE	**ANIMAL PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	II/I	**19BS1207**	**BASIC BIOCHEMISTRY**

COURSE OBJECTIVES:

- To provide the basic knowledge about the nutrition and significance of nutrients.
- To provide the basics about the functioning of different organ systems of the human body

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to integrate the functioning of different organ systems in the human body.	L2 & L3
CO2	Students will be able to understand and analyze the significance of balanced nutrition in human physiology.	L4

COURSE CONTENT:	
MODULE 1	**11Hrs**
Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods, BUN, NPN, Calorific value of foods, bomb calorimeter. Respiratory quotient, BMR, SDA and factors affecting them. Dietary fiber. Essential fatty acids, essential amino acids and their biological importance**.** Minerals and vitamins, Food fortification & food supplementation. **Digestion:** Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Function of liver and Gall bladder, Liver Function Test. **Muscle:** Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles	
MODULE 2	**11Hrs**
Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxyhemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. **Reproduction:** Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.	

MODULE 3	**11Hrs**
Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis **Neurobiology:** Structure of Neurons, Physiological properties of Nerve fibers, brief account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and non-myelinated nerve fibers. Nernst's and Goldman Equation. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.	
MODULE 4	**11Hrs**
Hematology : Blood components and their functions, blood groups: the ABO system, rhesus system, intrinsic and extrinsic pathways for blood clotting. **Cardiovascular System:** Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias. **Skeletal system:** Tissues- introduction. Extracellular matrix and its components, Bone- ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodelling and regulation by hormones.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier. 4th Ed 27
2. Human Physiology – Chatterjee. Sapna Publishers. 3rd Ed
3. Fundamentals of Biochemistry - Deb. Central Publishers. 1st Ed
4. Medical Biochemistry – Chatterjee and Shindey. 7th Ed
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19BY3571**					
TITLE OF THE COURSE	**ESTIMATIONS OF BIOMOLECULES - I – LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**NA**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To make students learn qualitative methods for study of biomolecules.

- To train the students to differentiate the normal level and abnormal level of biomolecules in different body fluids.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 The student will be able to learn the procedures and safety precautions while handling the biomolecules. L2 & L3

CO2 Students will be able to correlate the normal and abnormal level of biomolecules with medical conditions. L4

EXPERIMENTS/PRACTICALS:
1. Qualitative analysis of Monosaccharides (Glucose, Fructose)
2. Qualitative analysis of Disaccharides (Lactose, Maltose, Sucrose)
3. Qualitative analysis of Carbohydrates Polysaccharides (Starch)
4. Preparation of solid derivatives of saccharides – osazone crystal.
5. Qualitative analysis of amino acids (tryptophan, tyrosine, cysteine, methionine, arginine, proline and histidine).
6. Lipids (solubility, acrolein test)
7. Determination of iodine number of a fat sample.

TEXT BOOKS:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed

2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	**VI**
YEAR	**III**
COURSE CODE	**19BY3601**
TITLE OF THE COURSE	**LIPID METABOLISM AND MOLECULAR PHYSIOLOGY**

SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	II/I	**19BS1207**	**BASIC BIOCHEMISTRY**

COURSE OBJECTIVES:

- Introduction to structure and classification of lipids.
- Learning about the various reactions in which lipids are broken down by living systems to generate energy.
- Introduction to hormones and their functionality. Brief idea about cell cycle and programmed cell death.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will have an idea about the various lipid molecules and how they behave in contact with water. L2 & L3

CO1 They will be aware of the importance of lipid in energy storage. L3

CO3 Students will have an idea as to how hormones control the physiology of an organism via signaling mechanisms. L4

CO4 They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease. L4

COURSE CONTENT:	
MODULE 1	**11Hrs**
Classification of lipids. Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids. Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid. DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids).	
MODULE 2	**11Hrs**
The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation, Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.	
MODULE 3	**11Hrs**
Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms. Signal transduction - G-protein as cellular transducer, adenylate cyclase system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade. Functions of pancreatic, adrenal, pituitary and GIT hormones. Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.	
MODULE 4	**11Hrs**
Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Apoptosis: Caspases, structure, function and activation. Factors initiating apoptosis and steps leading to cell death. Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Biochemistry – Harper. Lange Publications, 2nd Ed
3. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
4. Biochemistry with medical correlation – Devlin. Wiley & Sons.
5. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
6. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
7. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
8. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
9. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19BY3671**					
TITLE OF THE COURSE	**ESTIMATIONS OF BIOMOLECULES - II– LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**NA**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	V/III	**19BY3571**	**ESTIMATIONS OF BIOMOLECULES - I – LAB**

COURSE OBJECTIVES:

- To make students learn qualitative methods for study of biomolecules.

- To train the students to differentiate the normal level and abnormal level of biomolecules in different body fluids.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will be able to learn the procedures and safety precautions while handling the biomolecules.	L2 & L3
CO2	Students will learn how to quantitate biomolecules and estimate the concentrations using standard graphs.	L3
CO3	Students will be able to correlate the normal and abnormal level of biomolecules with medical conditions.	L4

EXPERIMENTS/PRACTICALS:

1. Estimation of reducing sugars by DNS method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of protein by Lowry's method
4. Estimation of DNA by DPA method.
5. Estimation of RNA by Orcinol method.
6. Determination of free amino acid content in germinating seeds.
7. Determination of Vitamin C content in lemon juice
8. Estimation of starch in plant tissues.

TEXT BOOKS:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19BS2472**					
TITLE OF THE COURSE	**rDNA TECHNOLOGY-LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To prepare students for successful career in industry and research institutes.
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.
- To enable students to work in a team with multidisciplinary approach.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Account for structure formation of and function of DNA, RNA and proteins	L1
CO2	Describe gene cloning, restriction endonucleases, PCR use modern gene technologies are used to elucidate genetic issues	L2
CO3	Critically analyse, evaluate and compile received results	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Instrumentation:
a) UV Transilluminator
b) PCR

2. Vectors:
a) pBR 322 and Cosmid
b) YAC
c) Ti plasmid - Binary vector
d) SV 40 (any one type)

3. Experiments:
a) Spectrophotometric quantification of DNA and RNA.
b) Quantification of DNA using Agarose Gel Electrophoresis.
c) Construction of restriction maps and problem solving.

4. Demonstrations:
a) Isolation of Plasmid DNA
b) Restriction Enzyme digestion
c) Ligation of DNA fragment
d) Transformation- α complementation

REFERENCES:

1. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics. Blackwell Publishing MA. USA. 2006.
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.
3. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz. Wiley-Blackwell Publishing. UK. 2012.
4. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ , ASM Press. USA. 2017.

SEMESTER	**V**				
YEAR	**III**				
COURSE CODE	**19GN3571**				
TITLE OF THE COURSE	**DEVELOPMENTAL BIOLOGY AND HUMAN GENETICS-LAB**				
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours
	0	**0**	**4**	**0**	**-**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce students to experiments in Developmental biology & genetic analysis.
- The course is designed to teach the utility of set of experimental methods in a problem-oriented manner.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 On completion of this course, students should be able to:

To elaborate concepts of developmental biology and human genetics with ease to run experiments L3

CO2 To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in the subject. L4

List of Laboratory/Practical Experiments activities to be conducted (if any):

1. Dissection and mounting of Imaginal discs of *Drosophila melanogaster*.
1. Induction of Chromosome Puffing with Heat Shock in *Drosphila virilis*.
3. Study the developing embryo in chicken (*Gallus gallusdomesticus*).
4. Preparation of Human Metaphase Chromosomes.
5. Identification of inactivated X chromosome as Barr body.
6. Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
7. Preparation of Pedigree chart of some common phenotypic characters of human.

REFERENCES

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC.New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin. R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19GN3601**					
TITLE OF THE COURSE	**APPLIED GENETICS AND GENOMICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To go through basic and specialized knowledge and understanding the aspects of genetics that might be applied to research and industry.
- To take the students through the basics of genomics and disease gene mapping.
- To teach various approaches to genomics that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Student will be able to understand various modes of inheritance as well as mapping of monogenic and polygenic traits. L2

CO2 The students should be endowed with strong theoretical knowledge of genomics. L2

CO3 In conjunction with the practical in applied genetics, the students should be able to take up biological research as well as find placement in the relevant biotech industry. L3

COURSE CONTENT:	
MODULE 1 GENETIC RESOURCES AND BIODIVERSITY	**8Hrs**
Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, Centres of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation	
MODULE 2 HETEROSIS IN ANIMALS AND PLANTS	**15Hrs**
Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry.	
MODULE 3 PROKARYOTIC AND EUKARYOTIC GENOMES	**5Hrs**
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.	
MODULE 4 GENOMICS AND PROTEOMICS	**10Hrs**

Genome size, Sequence complexity, Introns and Exons, Genome annotation, traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, gene ontology, overview of comparative genomics. Organization of human genome and Human Genome Project. Isolation of Chromosomes, chromosome micro dissection, Retrofitting. Introduction to Proteomics – The Proteome, Mining proteomes, Bridging Genomics and Proteomics. Proteomics and the new biology. Application of Genome and proteome analysis in disease mapping and drug development	
MODULE 5 BIOINFORMATICS	**5Hrs**
Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Sequence Alignments and BLAST.	

TEXT BOOK:

1. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt/ Academic press. 2000.
2. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
3. Singh B. D. Biotechnology. Kalyani Publication. 2002.
4. T.A. Brown, Genomes, Bios, 2002.
5. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
6. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
7. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003
8. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1st edition, Academic Press, San Diego, 1996.

SEMESTER	**VI**
YEAR	**III**
COURSE CODE	**19GN3671**

TITLE OF THE COURSE	APPLIED GENETICS AND GENOMICS-LAB					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Exploring how concepts in Genetics can be understood by applying in animal and plants models.
- Getting foundations in plant tissue culture, and understand its commercial relevance.
- Getting basic exposure to key bioinformatic approaches.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 An experience in plant tissue culture techniques will help in finding jobs at Agro-based industries. L1

CO2 Students will get insight as how sequential variations across species impacts disease susceptibility, evolution, and organism complexity. L2

List of Laboratory/Practical Experiments activities to be conducted (if any):

APPLIED GENETICS

1. Tissue culture techniques:
   A. Sterilization
   B. Explants preparation
   C. Media Composition and preparation
   D. Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
2. Synthetic seed preparation

3. Study of pollen fertility
4. Study of diagnostic kits - WIDAL & VDRL
GENOMICS 1. Genetic mapping by RFLP analysis.
2. RAPD analysis.
3. Homology sequence analysis using Blast and Fasta.
4. Protein database study SCOP2, PDB, DALIDD etc.

REFERENCES

1. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
2. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
3. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
4. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**19BS1171**					
TITLE OF THE COURSE	**TECHNIQUES IN CELL BIOLOGY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	**-**	**28**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

- To equip students with the basic techniques used in cell biology
- To facilitate the study of cell size, cell count, stages in cell division, staining of cells

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Able to perform staining of cells	L3
CO2	Identify stages of mitosis and meiosis	L3
CO3	Be well versed with the use of simple and compound microscope	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast

Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of Barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila.

TEXT BOOKS:

1. Dr. Renu Gupta , Dr. Seema Makhija , Dr. Ravi Toteja. Cell Biology : Practical Manual. Prestige Publishers, 2018.

REFERENCES:

1. Amit Gupta and Bipin Kumar Sati. Practical laboratory manual- CELL BIOLOGY. LAP Lambert Academic Publishing, 2019.

2. Alberts et al., (2002). Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**19BS1172**					
TITLE OF THE COURSE	**VOLUMETRIC ESTIMATIONS - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Students will learn about good laboratory practices, various glassware used in the chemistry laboratory and the methods to calibrate them.
- Students will be introduced to various volumetric titrations such as acid-base, redox and Idometric etc.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them. L1

CO2 Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given. L3

List of Laboratory/Practical Experiments activities to be conducted (if any):	
1	Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.)
2	Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3	Estimation of potassium permanganate using standard sodium oxalate solution.
4	Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5	Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6	Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7	Estimation of free alkali present in different soaps/detergents
8	Estimation of carbonate and bicarbonate in a given mixture.
9	Determination of percentage of manganese dioxide in pyrolusite ore.
10	Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**19BS1206**					
TITLE OF THE COURSE	**ANALYTICAL TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To familiarize students with basic concepts principles and application of cutting-edge techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will receive adequate knowledge of basic techniques like Potentiometry & Chromatography	L3
CO2	Students will acquire knowledge of high end biotechniques like Mass spectroscopy & NMR	L3
CO3	Students will have a basic understanding of biomedical equipments	L4
CO4	Students will have an idea of working and analysis of CAT scanner and PET scanner general used in hospitals.	L3

COURSE CONTENT:	
MODULE 1	**11Hrs**
Spectroscopy: Properties of light, Electromagnetic spectrum and their interaction with matter and types, electronic transitions, Chromic shifts, concepts of chromophore and auxochrome with their applications. -Beer Lambert's law, Determination of Absorbance and extinction coefficients for biomolecules. Principle, schematics and applications of Colorimeter and UV-Vis Spectroscopy; Assay of biomolecules (carbohydrates, proteins and nucleic acids). Luminometry. Basics of IR spectroscopy including frequencies and vibrations. Centrifugation: Basic principles, theory and types of centrifugation -Preparative and analytical with their applications in biology.	
MODULE 2	**11Hrs**
Chromatography General principles of chromatography and its types (planar and column). Types of matrices used for separation of biomolecules. Paper, thin layer, gel permeation, ion exchange, adsorption and affinity chromatography with applications. Brief idea about HPLC and GC – working principle and instrumentation of packed columns.	
MODULE 3	**11Hrs**
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Vertical (PAGE) and Horizontal (Agarose) electrophoresis and its applications. Detection (by staining and UV), Recovery (homogenization and electro elution) & characterization of macromolecules (molecular weight and pI determination). Principle and application of Isoelectric focusing (IEF) and 2D PAGE. Application in proteomics and genomics.	
MODULE 4	**11Hrs**

Electro-Analytical Techniques: Strong and weak electrolytes, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- , Standard electrode potentials. Reference electrodes: Calomel and Glass. Basics of pH metry, potentiometry and conductometry. Cyclic Voltametry – basic concepts. Radiochemical Techniques : Tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique) and Autoradiography.

TEXT BOOKS:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19MB3501**					
TITLE OF THE COURSE	**APPLIED MICROBIOLOGY – I (Immunology, Medical Microbiology and Industrial Microbiology)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
- To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans. L3

CO2 It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology. L3

COURSE CONTENT:	
MODULE 1	**11Hrs**
ELEMENTS OF IMMUNE SYSTEM Types of immunity (innate and adaptive). Structure, Functions and Properties of: Immune cells and Immune organs. Immune responses- Humoral and cell mediated immunity. Components of Immune response- Antigen, Antibody (Structure, Types, Functions and Properties of antibodies), Major Histocompatibility Complex (Types and functions), Complement system – Components, function and activation pathways. Hypersensitivity reactions (Definition and types). Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications.	
MODULE 2	**11Hrs**
MEDICAL MICROBIOLOGY Normal flora of skin, oral cavity and other body regions. Relationship between normal pathogens and host. **Disease types** (Epidemiology, etiology, pathogenesis and prophylaxis): **Bacteria**–*Salmonella typhi* and *Mycobacterium tuberculosis*. **Fungi–** *Tricophyton spp.* and *Candida albicans.* **Viruses –**Hepatitis and HIV. **Protozoa** – *Leishmania donovani* and *Entamoeba histolytica.* **Antimicrobial agents:** Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. **Vaccines:** Types and its immunization schedule.	

MODULE 3	11Hrs
INDUSTRIAL MICROBIOLOGY Isolation, Screening (Primary and Secondary), Enrichment, Preservation of microbes. Strain improvement of industrially important microorganisms. Culture collection centers in India and worldwide. **Fermenters**: Design, Construction and Components of a typical fermenter and types of fermenter (stirred tank fermenter, submerged, fixed bed and fluidized bed bioreactors). **Upstream Processing:** Factors influencing product formation (Nutrients, pH, temperature, dissolved oxygen, foaming and aeration). **Downstream processing:** Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying, purification and concentration of products.	
MODULE 4	**11Hrs**
FOOD TECHNOLOGY **Food Microbiology:** Intrinsic and extrinsic factors in food affecting microorganisms; natural flora and source of contamination of foods in general. Food hazards, significance of food borne diseases, types food intoxication (*Clostridium botulinum, Aspergillus spp,* Polio and *Entamoeba histolytica*). **Food Preservation:** Physical methods of food preservation: temperature (low, high, canning, drying), Irradiation, Hydrostatic pressure, microwave processing and aseptic packaging, chemical methods of food preservation (salt, sugar, organic acids, nitrite and nitrates, antibiotics and bacteriocin). **Industrial production**: Organic acids (Citric acid), Alcohol (wine), Antibiotics (penicillin), Vaccines (Hepatitis B) and hormones (human insulin). Market potential. General concepts and importance of IPR.	

TEXT BOOKS:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
6. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchill Livingstone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.

10. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
11. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
12. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
13. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
14. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
15. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
16. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000. Robinson. Dairy Microbiology Vol I and II.
17. John G. Essentials of Food Microbiology. Arnold International Students Edition.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19MB3571**					
TITLE OF THE COURSE	**APPLIED MICROBIOLOGY – I LAB (Immunology, Medical Microbiology and Industrial Microbiology)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. L4

List of Laboratory/Practical Experiments activities to be conducted (if any):
1. Identification of different types of blood cells
2. Precipitation reactions: A) Ouchtlerlony Double Diffusion B) Radial Immune Diffusion
3. Agglutination Reaction: Blood grouping and Rh typing
4. Isolation of normal microflora from skin and oral cavity
5. Snyder's test for dental caries detection
6. Antibiotic sensitivity test
7. Production and determination of amylase activity
8. Cell immobilization techniques (yeast cells)
9. Sterility assays of pharmaceutical products
10. Preparation of wine

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam.(2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
3. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

4. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.

5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.

6. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.

7. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi

8. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.

9. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.

10. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.

11. Maheshwari, D. K. (2002). *Practical Microbiology*. S. Chand Publishing.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19MB3601**					
TITLE OF THE COURSE	**APPLIED MICROBIOLOGY – II (Agricultural and Environmental Microbiology)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To observe importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
- Explains the geochemically and environmentally significant processes include the activities of microorganisms and the environmental factors controlling and limiting microbialactivities.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts. L2

CO2 Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them. L3

COURSE CONTENT:	
MODULE 1	**11Hrs**
PART A: AGRICULTURAL MICROBIOLOGY **BIOFERTILIZERS AND BIOLOGICAL CONTROL** Types of Biofertilizers, Mass cultivation of biofertilizers- *Rhizobium*, *Azotobacter,* VAM and Azolla. **Bio-fertilizers**: Mode of application of biofertilizers. Advantages and limitations. **Bio-inoculants-** Mechanisms of biological control, Mass production and field applications of *Bacillus thuringiensis*, *Trichoderma spp*. and Nuclear Polyhedrosis Virus. Advantages and limitations. Marketing - Carrier and Legal clearances.	
MODULE 2	**11Hrs**

PLANT PATHOLOGY

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases.

Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences (hypersensitive response (HR), SAR and ISR, phytoalexins, pathogenesis related (PR) proteins, Plantibodies.

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism).

Study of different plant diseases- Bacteria –Blight of rice, Fungi – Rust of Wheat, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

MODULE 3	**11Hrs**

PART B- ENVIRONMENTAL MICROBIOLOGY

AEROBIOLOGY AND SOIL MICROBIOLOGY

Aerobiology: Significance of microorganisms in air, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Impingers and Filtration. Control of Air borne microorganisms – Dust control, Filtration, Fumigation and UV light exposure.

Soil Microbiology: Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism). General account of bioleaching, biodegradation and bioremediation.

MODULE 4	**11Hrs**

AQUATIC AND WASTE WATER MICROBIOLOGY

Aquatic Microbiology: Zonation of water system (Fresh and Marine), Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients). Water Pollution: Sources and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique.

Municipal treatment of water: Sedimentation, Filtration and Disinfection.**Waste water Microbiology**: Characteristics of sewage (physical, chemical and biological), Concept of BOD and COD. **Sewage Treatment**: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production.

TEXT BOOKS:

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Introductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbarao N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
9. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
10. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
11. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science
12. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
15. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
16. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishers, 1981.
17. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
18. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
19. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**19BS2301**					
TITLE OF THE COURSE	**BIOSTATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Recognize the importance of data collection and its role in determining scope of inference.
- Interpret statistical results correctly, effectively, and in context.
- Understand and critique data-based claims and appreciate the power of data.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation. L1

CO2 Select from, use, and interpret results of, the principal methods of statistical inference and design. L2

CO3 Communicate the results of statistical analyses accurately and effectively. L2

COURSE CONTENT:	
MODULE 1	**13Hrs**

MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.	
MODULE 2	**13Hrs**
PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions. Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.	

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19MB3671**					
TITLE OF THE COURSE	**APPLIED MICROBIOLOGY – II (Agricultural and Environmental Microbiology)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation and enumeration of bacteria, fungi and Actinomycetes from rhizosphere soil.
2. Examination of Bacteroides from legume root nodules.
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms.
4. Demonstration of fungal contaminants in ground nut by standard blotter method.
5. Effect of seed borne fungi on seed germination and seed vigor.
6. Isolation and enumeration of air borne microorganism by petriplate exposure method.
7. Estimation of dissolved oxygen in water.
8. Determination of Biological Oxygen Demand.
9. Standard water quality analysis by MPN test.
10. Estimation of total solids in sewage.

REFERENCES:

1. Maheshwari, D. K. (2002). Practical Microbiology. S. Chand Publishing.
2. Pepper, I. L., Gerba, C. P., & Brendecke, J. W. (1995). Environmental microbiology: a laboratory manual. Academic Press.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja.
4. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
5. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19BS2471**					
TITLE OF THE COURSE	**TECHNIQUES IN MOLECULAR BIOLOGY-LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4-	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES:
• Laboratory exercises to give student skills in a range of DNA manipulation and routine laboratory techniques
• To safely carry out a range of laboratory techniques used for isolation, purification and manipulation of biomolecules e.g. DNA and protein isolation, qualification and visualizations.
• To instill the ability to demonstrate knowledge and understanding of the molecular machinery of living cells.
• Use basic laboratory skills and apparatus to obtain reproducible data from molecular biology experiments.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will have ability to conduct basic molecular techniques work in a laboratory.	L3
CO2	Analyze, interpret, and participate in reporting to their peers on the results of their laboratory experiments.	L3
CO3	Implement experimental protocols, and demonstrate ability to plan and carry out simple investigations.	L4
CO4	Participate in and report orally on team work investigations of problem-based assignments.	L3

COURSE CONTENT: Laboratory/Practical Experiments		
1	Extraction of DNA and RNA from Plants (Cauliflower /Coconut endosperm / any other source) (2 units)	8 Hrs (4x2)
2	Extraction of DNA and RNA from : Animal tissue (Liver Tissue/ any other source) (2 units)	8 Hrs (4 x 2)
3	Quality check of DNA and RNA by Agarose gel electrophoresis (2 units)	8 Hrs\ (4 x 2)
4	Partial purification of protein from plant source by Ammonium sulphate precipitation and its qualitative analysis. (2 Units)	8 Hrs (4 x 2)
5	Partial purification of protein from animal source by organic solvent (acetone) and its qualitative analysis. (2 Units)	8 Hrs (4 x 2)
6	Paper Chromatography for separation of - Leaf Pigments and Amino acids.	4 hrs
7	Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)	4 hrs

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS:

1. Essential Molecular Biology, Volume I : 001 Practical Approach Series by Terry Brown .

REFERENCES:

1. Wilson and Walkers Principles and Techniques of Biochemistry and Molecular Biology, 8th Edition.

2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.

3. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam.(2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
3. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)
4. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
6. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
7. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
8. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
9. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
10. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
11. Maheshwari, D. K. (2002). *Practical Microbiology*. S. Chand Publishing.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19BS3501**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**0**	**0**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	After completion of the course students will able to understand the concept and scientific writing.	L2
CO2	They will be able to draft suitable and effective reports and scientific journal papers.	L3

COURSE CONTENT:

MODULE 1 : STRUCTURE OF SCIENTIFIC WRITING	13Hrs
Basics of writing: English grammar in the current context of writing: nouns and pronouns; adjectives; verbs; adverbs; prepositions; conjunctions, articles; order of words; sentence structure, clauses, punctuation, vocabulary; idioms; figures of speech; active vs. passive voice, etc.; writing skills: paragraph construction; common mistakes while writing, better sentences, story writing; precise writing. Differences in structure between reviews and papers**;** composition of an abstract, title, introduction, methods, results and discussion; preparing figures and figure legends, citations; importance of engaging the reader, telling a story with right emphasis on important results; avoiding plagiarism; adapting to different journal requirements; critique published articles. **Constructing arguments:** Recognition of the argument in a passage, graphical representation and paraphrasing, critically analysis of an argument. Practice using published articles.	
MODULE 2: SCIENTIFIC COMMUNICATION	**13Hrs**
Composing professional emails and; preparing an effective resume. **Effective oral presentations:** essential principles of a good talk, importance of engaging the audience, telling a story with right emphasis on important results; preparing effective presentations: preparing images, graphs and tables, appropriate use of color and font size; talks for different audiences. **Research proposal writing:** Defining scientific problem, hypothesis, specific aims, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. **Other modes of scientific communication:** Short accounts of scientific discoveries for the layman; social media and science communication; use of social media to transmit a scientific discovery, the importance of engaging with the community, communicating scientific knowledge to the community.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS:

1. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
2. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers. New York: Mcgraw-Hill., 2097. Print.
3. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: Phadake Prakashan.
4. Chand, S. (1973). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19CY3601**					
TITLE OF THE COURSE	**INORGANIC AND ORGANOMETALLIC CHEMISTRY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make students understand about co-ordination compounds their synthesis, reactions and applications
- To impart knowledge about organometallic compounds.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get the knowledge co-ordination compounds.	L1
CO2	Students will gain knowledge organo-metallic compounds.	L2

COURSE CONTENT:	
MODULE 1	**11Hrs**
CO-ORDINATION COMPOUNDS Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra,penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel-based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of [CoF6]3-, [Fe(CN)6]4Spectral properties of [Ti(H2O)6]3+, [Co(H2O)6]3+Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.	
MODULE 2	**11Hrs**
REACTION MECHANISM IN TRANSITION METAL COMPLEXES Energy profile of a reaction inert and labile complexes, kinetics of octahedral substitution and mechanistic aspects. Acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism and evidence in its favour. Substitution reactions of square planar complexes - Trans effect and applications of trans effect, substitution reactions of tetrahedral complexes, isomerization and racemisation reactions of coordination compounds. Electron transfer reaction- inner sphere and outer sphere reactions, complementary and non-complementary reactions.	
MODULE 3	**11Hrs**

MAGNETIC PROPERTIES OF TRANSITION METAL COMPLEXES Types of magnetic behaviour, orbital contributions, spin orbital coupling, spin cross over system, methods of determining magnetic susceptibility, diamagnetic corrections, ferro and antiferro magnetic coupling, super paramagnetisam. spin-only formula. Electron Spectra of Transition Metal Complexes Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for d1 and d9 states, discussion of the electronic spectrum of [Ti(H2O)6]3+ complex ion.	
MODULE 4	**11Hrs**
ORGANOMETALLIC COMPOUNDS Ligands, classification (hapticity). Synthesis and structure of K[PtCl3(η2-C2H4)] Metal carbonyls – Cr(CO)6, Mn2(CO)10; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na2Ca, EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene, hydrogenation, decarbonylation reaction, Rh-catalyst reaction, Zigler natta reaction, Hack reaction and Suzuki coupling reaction.	

TEXT BOOKS :

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

REFERENCES :

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER **V**
YEAR III
COURSE CODE **19CY3671**
TITLE OF THE COURSE **INORGANIC CHEMISTRY**

SCHEME OF Instruction

Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
4	**0**	**-**	**-**	**44**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make the students to learn about various inorganic experiments.
- To make the students to learn about estimation of different elements present in various compounds.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level

COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonate as an internal indicator.
2. Estimation of calcium in lime stone.

3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na2CO3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5^{th} Edition, A.J. Hannford
1. , A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Fransicisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

REFERENCES :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **19BS1171**
TITLE OF THE COURSE : **TECHNIQUES IN CELL BIOLOGY - LAB**
L : T : P : S/P : C : **0 : 0 : 4 : 0 : 2**

COURSE OBJECTIVES:
1. To equip students with the basic techniques used in cell biology
2. To facilitate the study of cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES:
1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

PRACTICALS:
1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

REFERENCES:
1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.

4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College

2020

SEMESTER	I					
YEAR	I					
COURSE CODE	20BC1171					
TITLE OF THE COURSE	BASIC BIOCHEMISTRY PRACTICAL					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**NA**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To familiarize the students with good lab practise how to make buffers.
- To create general understanding about detection of biomolecules.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be familiarized with handling laboratory equipment like weighing balance, pH meter and potentiometer and learn the importance and preparation of buffers.	L2
CO2	They will have an understanding of biomolecule composition of edible materials	L3

EXPERIMENTS/PRACTICALS:

1. Calculation and preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Potentiometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Potentiometric titration of amino acid against NaOH and HCl
5. Estimation of proteins milk.
6. Estimation of carbohydrates in vegetables (Potatoes etc)
7. Estimation of lipids in milk/vegetables (avocadoes etc)
8. Estimation of iodine number of edible oils
9. Estimation of ascorbic acid in fruits by titrimetric method.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20BC2301**					
TITLE OF THE COURSE	**HUMAN PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	**20BC1101**	**BASIC BIOCHEMISTRY**

COURSE OBJECTIVES:

1. To illustrate the general human physiology in terms of nutrition and energy synthesis.

2. To have an insight into the cellular to organ level differentiation and their related biochemical concepts

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will understand the mechanism of action of the energy generation machinery and the organs associated with it.	L2 & L3
CO2	The cell to organ system to organism architecture will be better understood.	L4

COURSE CONTENT:	
MODULE 1	**12Hrs**
Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Respiratory quotient, BMR, SDA and factors affecting them. Role of carbohydrates, protein, lipid and as fuel molecules. **Hematology:** Blood components and their functions, blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. **Respiration:** Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions.	
MODULE 2	**12Hrs**
Biochemistry **Cardiovascular System:** Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction and congestive heart failure. **Skeletal system:** Tissues - introduction. Extracellular matrix and its components, Bone- ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodeling and regulation by hormones **Muscle:** Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.	
MODULE 3	**12Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. **Excretion:** Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis. **Reproduction:** Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.	
MODULE 4	**12Hrs**
Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and nonmyelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.	

TEXT BOOKS:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20BC2371**					
TITLE OF THE COURSE	**CLINICAL BIOCHEMISTRY -LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

1. To provide an advanced understanding and applied knowledge of clinical biochemistry using biological samples (Urine or Blood).

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.	L3

EXPERIMENTS/PRACTICALS:
1. Qualitative analysis of normal components of urine.
2. Qualitative analysis of abnormal components of urine.
3. Estimation of Glucose estimation by Miller's method /DNS method.
4. Protein/DNA by UV absorption spectroscopy.
5. Estimation of Protein by Folin - Ciocalteu method.
6. Estimation of Iron by Wong's method.
7. Estimation of Phosphate by Fiske – Subbarow's method.
8. Estimation of Creatinine by Jaffe's method.

TEXT BOOKS:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn. (2076), Tata-McGrawHill.
Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER	**IV**				
YEAR	**II**				
COURSE CODE	**20BC2401**				
TITLE OF THE COURSE	**ENZYMOLOGY AND PROTEIN CHEMISTRY**				
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours
	4	**0**	**0**	**0**	**48**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	**19BS1207**	**BASIC BIOCHEMISTRY**

COURSE OBJECTIVES:

1. To have a comprehensive understanding about the enzymes present in different systems, and their structure and functions.
2. To enhance the knowledge of kinetics, active sites and mechanism of action of different classes of enzymes from different biological systems.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Will be able to understand the biological significance of enzymes, their critical roles in different systems and their efficiency in biological reactions.	L2 & L3
CO1	Will be able to apply skills/knowledge to calculate different kinetic parameter of enzymes and also the will be equipped with information about the enzyme technologies and enzymatic assays and their medicinal/industrial applications.	L4

COURSE CONTENT:	
MODULE 1	**11Hrs**
Introduction, classification & nomenclature of enzymes; Active site, Lock & key model, induced fit model and strain/TS theory-taking lysozyme and chymotrypsin as examples; Enzyme specificity- bond, group, absolute and stereo-chemical specificity; Enzyme catalysis: Proximity & Orientation effect; Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogen phosphorylase) enzymes, MODULEs-Katal & IU; Effect of physical and chemical parameters on enzyme activity with examples.	
MODULE 2	**11Hrs**
Enzyme Kinetics: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots; Importance of Kcat / Km. Bisubstrate reactions – brief introduction. **Enzyme Assay and Purification:** Enzyme assay, Specific activity; Enzyme isolation and purification, criteria for enzyme purity; Isoenzymes; Coenzymes and their significance. Clinical and Industrial applications of enzymes.	

MODULE 3	11Hrs
Classification based on composition, shape and function; Peptide bond; Ramachandran Plot; Structural organization: primary, secondary, tertiary and quaternary structures; Structure of Haemoglobin, Immunoglobulin, Collagen, myosin and Keratin; Denaturation of proteins and melting temperature; Hofmeister series; Protein assays and quantification methods; Peptide synthesis.	
MODULE 4	**11Hrs**
Protein purification & Proteomics: Vectors and hosts, downstream processing; Protein Expression; Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography; Sequence determination by Sanger and Edman degradation methods; Protein fragmentation and Peptide purification; Derivatization of peptides and mass spectroscopy of peptides; mass determination; Applications of proteomics.	

TEXT BOOKS:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20BC2471**					
TITLE OF THE COURSE	**ENZYMOLOGY -LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**40**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES:

1. To train the students to design the enzymatic assays and learn the calculation of kinetic parameters of the enzymes.

2. To learn isolation, handling and quantification of enzymes from biological samples and to train them to carry out enzymatic assays and interpret the results.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to interpret the kinetic parameters of the enzymes and assay results.	L3
CO2	Students will be able to design and carry out the enzymatic assays and will gain the practical knowledge about the mechanism of action of different enzymes.	L4

EXPERIMENTS/PRACTICALS:
1. Introduction to enzymology Lab and product curve determination
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve.
3. Determination of kinetic constants through LB plot
4. Effect of pH on enzyme activity
5. Effect of temperature on enzyme activity
6. Determination of Arrhenius constant
7. Effect of enzyme dilution on enzyme activity
8. Effect of activators and inhibitors on enzyme activity
9. Immobilization of enzyme using calcium alginate.

TEXT BOOKS:

1. Practical enzymology – Hans Bisswanger, Wiley-VCH, 2019, 3 rd Ed

2. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001, 1st Ed
3. Principles and Techniques of Practical Biochemistry – Wilson, Wilson and Walker, Cambridge University Press 2000, revised Ed
4. Introduction to practical Biochemistry, Plummer, Tata McGraw-Hill Education 2001, 2nd Ed
5. Basics of Enzyme Immobilization – Alka Dwevedi, Springer International Publishing, 2016, 1 st Ed.

SEMESTER I
YEAR I
COURSE CODE 20GN1171
TITLE OF THE COURSE BASIC GENETICS PRACTICAL

SCHEME OF Instruction

Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

Table 1

20BS3602	PROJECT

COURSE OBJECTIVES:

- To differentiate between the various stages of meiosis in animal and plant cells.
- To gain insight as to the different genetic interactions and their effect on phenotype.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will gain skills to process tissue into slides and distinguish various meiotic stages. L3

CO2 Students will be capable to analyse and identify gene interactions, predict crosses and understand its role in inheritance. L4

List of Laboratory/Practical Experiments activities to be conducted (if any):

8. Temporary squash preparation of : Grasshopper Testes, Onion flower bud
9. Observation of meiotic stages in permanent slides
10. Blood Typing
11. Sex differentiation in Drosophila
12. Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
13. Genetic problems on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage
14. Study of : (a) Flower color in
14. *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl.

REFERENCES

6. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
7. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC.New York.
8. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
9. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
10. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER III
YEAR II
COURSE CODE 20GN2371
TITLE OF THE COURSE BASIC HUMAN GENETICS AND GENETIC ENGINEERING-Lab

SCHEME OF Instruction

Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To prepare students for successful career in industry and research institutes.

- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Proficient in preparing human chromosomes for karyotyping analysis. L3

CO2 Describe gene cloning, restriction endonucleases, use modern gene technologies are used to elucidate genetic issues L4

CO3 Critically analyse, evaluate and compile received results L3

List of Laboratory/Practical Experiments activities to be conducted (if any):

1. Preparation of Human Metaphase Chromosomes
2. Identification of inactivated X chromosome as Barr body.
3. Resolution and molecular weight estimation of fragmented DNA using agarose gel electrophoresis.
4. Preparation of Pedigree chart of some common phenotypic characters of human.
5. Molecular cloning. Demonstrations:
   i. Plasmid DNA isolation
   ii. Restriction Digestion
   iii. DNA ligation
   iv. Preparation of competent cells and Transformation.

REFERENCES

1. Jocelyn, E. K., Elliot, S. G., Stephen, T. K. (2009), Lewin's Gene X. Jones & Barlett.
2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlet India Pvt. Ltd.
3. Freshney, R.I. (2011). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. Wiley online library.
4. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics. Blackwell Publishing MA. USA. 2006.
5. 2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.

TEXT BOOKS:

SEMESTER II
YEAR I
COURSE CODE 20GN1201
TITLE OF THE COURSE FUNDAMENTALS OF CYTOGENETICS

SCHEME OF Instruction

Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects	Ho

Total Hours	Credits
4 0 0 0 48	**4**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

SEMESTER IV
YEAR II
COURSE CODE 20GN2401
TITLE OF THE COURSE APPLIED GENETICS

SCHEME OF Instruction

Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects	Ho

Total Hours	Credits
4 0 0 0 48	**4**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

1. To go through basic and specialized knowledge and understanding the aspects of genetic essential to applying concepts in Genetics.
2. To take the students through the basics of applied genetics and disease gene mapping.
3. To teach various techniques that students can apply in their future career in biological resea as well as in industry.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level

CO1 Applied Genetics deals with the application of Genetics in Molecular Biology, Developme Biology, Medicine, Pharmaceutical Industries, Medical Sciences, Agriculture and Horticulture ba industries etc. L3

CO2 Students will have a deeper understanding of several facets of applied genetics. L3 CO3 Students will be equipped to pursue a fitting career in academia or industry. L4

COURSE CONTENT:

MODULE 1 GENETIC RESOURCES AND BIODIVERSITY 8Hrs

Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBF IBPGR). Genetic Erosion, biodiversity, centres of Diversity, Vavilovian Centres of Diversity, Law Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.

MODULE 2 INTRODUCTION TO TISSUE CULTURE 7Hrs

Types of cell culture media for plants and animals; Preparation and sterilization of cell culture medi

ANIMAL CELL CULTURES TECHNIQUES: History of animal cell culture; Different tissue cult techniques; Types of primary culture; Chicken embryo, fibroblast culture; Secondary cult Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture; estimatio cell number;, Characterization and maintenance of cell lines, Cryopreservation; Application of an cell culture for in vitro testing of drugs.

PLANT CELL CULTURES TECHNIQUES: Embryo, Anther and Ovary cultures, Shoot and Root Meris cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tis Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.

MODULE 3 HETEROSIS IN ANIMALS AND PLANTS 15Hrs

Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cr breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreed Production of breeds: crossing of inbred lines for commercial production. Breeding strategies improvement of livestock for milk, meat, wool production. Breeding strategies for improvemen Poultry.

Introduction to plants breeding: Estimation of heterosis - Heterobeltosis, Economic heterosis, Stand heterosis. Hybridization techniques- intergeneric and interspecific hybridization. Identification hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.

MODULE 4 GENETICS IN MEDICAL & INDUSTRIAL BIOTECHNOLOGY 10Hrs

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepa B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphi DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, M satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life cry

MODULE 5 BIOINFORMATICS 10Hrs

Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Pro Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications bioinformatics.

REFERENCES:

1. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 20
2. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
3. Singh B. D. Biotechnology. Kalyani Publication. 2002.
4. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 19
5. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge Univer Press. 2002.
6. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
7. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
8. Animal cell culture Techniques by Ian Freshney, Wiley-Liss.
9. Animal Cell Culture – Practical Approach BY Ed. John R.W. Masters, 3rd Edition, Oxford Univer Press.
10. Animal Cell Culture Techniques BY Ed. Martin Clynes,. Springer

YEAR	**II**					
COURSE CODE	**20GN2471**					
TITLE OF THE COURSE	**APPLIED GENETICS -LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- Experiments will give emphasis on current methods and applications of genetic manipulation in plants and crops.
- Through the use of transgenics, one can produce plants with desired traits and even increased yields.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 After being introduced to the topics students will cover 'methods available for plant transformation through Agrobacterium mediated. L3

CO2 Students will also study about the role of precise genome modification in crops, role of vectors and markers in gene expressions. L3

CO3 The students are expected to read, research and discuss papers related to the topic L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Tissue culture techniques:
   - Sterilization
   - Explants preparation
   - Media Composition and preparation
   - Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
2. Synthetic seed preparation
3. Study of different techniques in plant hybridization
4. Study of pollen fertility
5. Study of diagnostic kits - WIDAL & VDRL

6. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.
7. Study of hybrid animals - Poultry, dairy, fishery.
8. Homology sequence analysis using Blast and Fasta.

REFERENCES

1. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
2. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
3. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
4. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.

SEMESTER	I					
YEAR	I					
COURSE CODE	20MB1171					
TITLE OF THE COURSE	BASIC TECHNIQUES IN MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To enable students to understand the microbial structure, microbial growth pattern and techniques to measure cell size.
- To help them understand the isolation of various microorganisms from different sources.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students are aware of microbial diversity and isolation techniques. L1

CO2 Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields. L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Study of basic instruments in Microbiology laboratory (2 Units)
   a) Autoclave
   b) Hot air oven
   c) Incubator
   d) pH meter
   e) High speed centrifuge
   f) Colorimeter / Spectrophotometer
   g) Anaerobic jar
   h) Bacterial Filters
   i) Laminar air flow

2. Preparation of culture media:
   a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
   b) Selective media (EMB agar and McConkey agar),
   c) Enriched media (Blood agar).

3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air.

4. Methods of pure culture techniques
   a) Pour plate technique
   b) Spread plate technique
   c) Streak plate technique

5. Transfer of media and inoculum
6. a) Slant culture technique
   b) Broth culture technique
   c) Stab culture technique

7. Microscopic examination of bacterial smear
   a) Simple staining
   b) Gram's staining
   c) Capsule staining
   d) Endospore staining

8. Isolation and identification of fungi (Lactophenol cotton blue mount)

9. Micrometry: Microscopic measurement of bacterial cell (Bacillus), yeast (Saccharomyces).

10. Microscopic observation of temporary slides
    a. Algae: Chlamydomonas and Spirulina
    b. Fungi: Rhizopus, Aspergillus, Penicillium, Yeast and Fusarium
    c. Protozoa: Amoeba, Paramecium and Plasmodium

11. Study of growth curve of bacteria by turbidimetric method

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec

2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.

3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.

4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.

5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER	III					
YEAR	II					
COURSE CODE	20MB2371					
TITLE OF THE COURSE	IMMUNOLOGY AND MEDICAL MICROBIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Identification of different types of blood cells

2. Precipitation reactions: a. Ouchtlerlony Double Diffusion b. Radial Immune Diffusion
3. Agglutination Reaction: a. Blood grouping and Rh typing
4. Isolation of normal microflora from skin and oral cavity
5. Snyder's test for dental caries detection
6. Antibiotic sensitivity test
7. Dot ELISA
8. Determination of effectiveness of antiseptics by thumb impression method.

REFERENCES:

12. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.

13. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.

14. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

15. Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.

16. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.

17. Maheshwari, D. K. (2002). *Practical Microbiology*. S. Chand Publishing.

SEMESTER	IV					
YEAR	II					
COURSE CODE	20MB2401					
TITLE OF THE COURSE	INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
- To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES:

CO No.Outcomes Bloom's Taxonomy Level

CO1 It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology. L3

CO2 It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products. L4

COURSE CONTENT:	
MODULE 1	**12Hrs**
INTRODUCTION TO INDUSTRIAL MICROBIOLOGY Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement - Mutation, recombination- gene regulation and genetic manipulation. Preservation: Industrially important microbes. Culture collection centers. Basic components and design of Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, Continuous, chemostat, Turbidostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	
MODULE 2	**12Hrs**
INDUSTRIAL BIOPROCESSING Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; inoculum preparation and inoculum development. Downstream processing: Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization. Productions and Applications: Alcohol production, organic acids (citric acid), enzymes: amylases- (Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing. Production economics and IPR.	
MODULE 3	**12Hrs**
FOOD MICROBIOLOGY Principles and methods of food preservation by Physical, Chemical and food Additives, Biopreservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – Clostridium. Virus- Hepatitis A, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods (Fermented Vegetables, Beverages, Bread, and Idli). Single cell Protein, Probiotics, Prebiotics and Synbiotics; Neutraceuticals, Quorn). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	

MODULE 4	12Hrs

DAIRY MICROBIOLOGY

Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage. Principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: Yogurt, acidophilus milk, fat rich products (Cream and butter) and cheese. Biosensors in Food Industry; Food fortification.

TEXT BOOKS:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
1. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2 nd Edition Aditya Books (P) Ltd, New Delhi.
1. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology-An Introduction, Blackwell Science. Delhi
1. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
1. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
1. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
1. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited.
1. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
1. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
1. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2 nd Edition. CRC press. 2001.
1. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
1. John G. Essentials of Food Microbiology. Arnold International Students Edition.
1. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
1. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

YEAR	II					
COURSE CODE	20MB2471					
TITLE OF THE COURSE	INDUSTRIAL AND FOOD MICROBIOLOGY - LAB					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To apply techniques to industrial microbiology; biochemical and fermentation mechanisms.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce basic fermentation techniques employed in Microbial industries.	L3
CO2	Course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of microorganisms from fruits.
2. Isolation of microorganisms from vegetables.
3. Production and determination of amylase activity.
4. Preparation of wine.
5. Study of different types of fermenters (Models/ Charts).
6. Cell immobilization techniques (yeast cells).
7. Determination of quality of raw milk by methylene blue reduction test.
8. Estimation of lactic acid from different diary product.
9. Production of alcohol from different sources and estimation by specific gravity method.

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
5. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BT1171
TITLE OF THE COURSE : TECHNIQUES IN CELL
BIOLOGYL: T/A: P: C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES

1. To familiarize the students with the concepts of microscopy, basic staining procedures to enable them to get hands on experience
2. To make the students understand how to measure cell size and identify different blood cells

COURSE OUTCOMES

1. Students will understand the basic concepts of microscopy, get clear picture of concept they study in theory like mitosis and an inactivated X- chromosome
2. Students will understand how to measure cell size and identify different blood cells

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora*

crassa,Caenorhabditis elegans, Arabidopsis thaliana, Drosophila.

REFERENCES

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BT1201
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGYL: T/A: P: C : 4 : 0 : 0 : 0 :4

COURSE OBJECTIVES:

1. To provide basic understanding on Immune system: Cells and organs of the immune system and its fundamentals.
2. To give basic framework and knowledge on structure and functions of antibodies, , antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response and to equip the students with knowledge on immunological techniques, vaccines

COURSE OUTCOMES:

1. Student will be acquainted with the basic understanding of immune system in its entirety and student will be competent with basic knowledge of the structure and basic working of antibodies, functions of antibodies and their antigen specificity
2. Student will have basic understanding of immunological techniques involving antibodies and vaccines as disease preventive agents

TOTAL HOURS: 48

MODULE I: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM 1

2 Hrs

Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell)

branches of immunity. Immunological memory.

MODULE II: ANTIGENS AND ANTIBODIES

12 Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE III: IMMUNE RESPONSES 1

2 Hrs

Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES

12Hrs

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinant vaccines – Peptide and DNA Vaccines.

REFERENCES:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York:
   W. H. Freeman & Company; 2006.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. Kuby Immunology 7th edition. macmillan Publishers 2014.
4. Kuby Immunology, 8th Edition | macmillan Publishers 2019.
5. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. https://doi.org/10.1201/9781315533247
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BT1271**
TITLE OF THE COURSE : **IMMUNO-TECHNIQUES –**
PRACTICALL: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
2. To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES:

1. Student will be familiarized with immunological techniques utilized for diagnostic assays.
2. Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.

1. Blood group identification and Rh Typing
2. Precipitation Reactions –
    I. Radial Immuno Diffusion
    II. Ouchterlony double diffusion
    III. Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
7. Study of different cells in whole blood using Giemsa/Leishman stain.

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
3. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20BT2301**					
TITLE OF THE COURSE	**PRINCIPLES OF RECOMBINANT DNA TECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To give foundation of tools, vehicles used in cloning DNA.
- To impart basic principles of various vectors used in rDNA technology, their uses and limitations.
- To inculcate good fundamental knowledge in basics of gene cloning, including detection methods for screening the recombinants.
- To provide basic principles of analysis techniques employed in characterize the cloned recombinant DNA and to promote scope of application of rDNA technology.

- Principles of techniques to characterize cloned DNA, applications of rDNA technology.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the basic paradigm of rDNA technology and various enzymatic tools, vectors and their utility.	L2
CO2	The sound in knowledge of steps involved in basic gene cloning	L1
CO3	A comprehensive knowledge on the various applications and scope of recombinant DNA technology.	L3

COURSE CONTENT:	
MODULE 1: INTODUCTION TO rDNA TECHNOLOGY	**12Hrs**
History and fundamentals of r-DNA technology. Molecular tools for gene cloning: Nucleases -Endo and Exonucleases – Nomenclature, Types and characteristic features. Modification of cut ends. DNA ligases and DNA Recombinases. DNA Modifying Enzymes - Alkaline phosphatase, Polynucleotide kinase, DNase, RNase, DNA polymerase and Klenow fragment, terminal nucleotidyl transferase, RNA dependent DNA Polymerase.	
MODULE 2: VEHICLES FOR CLONING	**12Hrs**
Properties of an ideal vector. Types: Cloning and expression vectors. Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages -Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.* For higher plants: Integrative DNA transfer- Agrobacterium vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV) For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes	
MODULE 3: GENE ISOLATION AND TRANSFER	**12Hrs**
Isolation of passenger DNA. Cutting of DNA molecules - Physical methods, chemical and enzymatic methods. Joining of DNA molecules-Homopolymer tails, Linkers, Adapters. Transformation. Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.	
MODULE 4: CHARACTERIZATION OF CLONED DNA	**12Hrs**

Electrophoresis: AGE and SDS-PAGE. Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes. **Application of rDNA technology:** Expression vectors (E coli/eukaryotic), Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS :

1. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
2. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
3. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publications.

REFERENCES :

1. Glick and Pasternak (2010) Molecular Biotechnology (4th Ed.), Wiley, Washington DC
2. Howe, C. (2007). Contents. In Gene Cloning and Manipulation (pp. V-Vi). Cambridge: Cambridge University Press.
3. Primrose, Twyman and Old (2002). Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA, Genomes, 3rd ed. Garland Science 2006
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**20BT2371**

TITLE OF THE COURSE	TECHNIQUES IN RECOMBINANT DNA TECHNOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- Understand basic instrumentation and vectors used in routine cloning experiments
- To integrate the theoretical/conceptual principles with experiments
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.
- To enable students to work in a team with multidisciplinary approach.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Be able to gain fundamental working knowledge of basic principles of gene cloning.	L1
CO2	Critically analyse, evaluate and compile received results	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Extraction of DNA from plant/bacteria and animal sources (2 Units)
2. Separation of DNA on agarose gel electrophoresis , Visualization of DNA (2 units)
3. Quantification of DNA by spectrophotometry or DPA method
4. Preparation of competent cells
5. Transformation of bacterial competent cells with plasmid DNA
6. Plasmid extraction
7. Linearization of plasmid DNA

TEXT BOOKS :

1. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.
2. Biotechnology A Laboratory Course by Becker JM, Caldwell GA, Zachgo EA. Second edition. Elsevier. 1996.

REFERENCES :

1. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
2. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz. Wiley-Blackwell Publishing. UK. 2012.
3. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ, ASM Press. USA. 2017.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20BT2401**					
TITLE OF THE COURSE	**PRINCIPLES OF ANIMAL AND PLANT BIOTECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4		**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

- To acquaint the students with the basic concepts of animal and plant cell culture set up and conditions.
- To familiarize the students with knowledge on various ways to produce transgenic plants and animals with novel traits.
- To equip the student's wide area of important applications of animal biotechnology

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Have understanding of basic fundamentals of animal Biotechnology and its uses	L3
CO2	Have understanding of basic fundamentals of plant cell culture conditions, media formulations, techniques and its uses.	L3
CO3	The students will learn the fundamentals of culturing animal and plant cells & tissues and the modes to change and improve genetic traits of animal and plants.	L4
CO4	Will be equipped with the wide area of applications of biotechnology in modern world.	L3

COURSE CONTENT:	
MODULE 1 BASICS OF ANIMAL TISSUE CULTURE	**12Hrs**
Basics of animal tissue culture, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF. Stem Cell Types and its characteristics. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK).	
MODULE 2 APPLICATION OF ANIMAL BIOTECHNOLOGY	**11Hrs**

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep). Basics of Tissue Engineering. Biosafety and Good Lab practices.	
MODULE 3 BASICS OF PLANT TISSUE CULTURE	**11Hrs**
Introduction to Plant Tissue Culture: Aseptic techniques, sterilization methods - (Steam and Dry), media and explant sterilization techniques, post sterilization care of the instruments, contaminants, components of tissue culture media, growth hormones (auxin and cytokinin), Tissue and Organ Culture: Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, callus culture, cell culture, protoplast culture and fusion, organogenesis and somatic embryogenesis, Soma clonal Variants.	
MODULE 4	**11Hrs**
Genetic Transformation Techniques: Transgenic plants- Agrobacterium mediated (Ti and Ri plasmid), physical and chemical methods of gene transfer. GM technology and Plant Trait improvement: GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops. Bt cotton, Bt brinjal, Golden Rice. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Edible vaccines, secondary metabolites (in-vitro production).	

TEXT BOOKS :

1. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Son

Prerequisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	-	-	-

COURSE OBJECTIVES :

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20BT2471**					
TITLE OF THE COURSE	**TECHNIQUES IN ANIMAL AND PLANT BIOTECHNOLOGY- LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			4	**-**	**36**	**2**

- To acquaint the student with the fundamental practical knowledge of the laboratory set up.
- To acquaint the student with basic techniques to use cell culture.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The course will help in making the students learn basic knowledge of the plant and animal tissue culture laboratory.	L3
CO2	The course will help in making the students learn basic techniques for plant and animal tissue culture.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Introduction to instruments and laboratory set up for animal biotechnology
2. Preparation of media for animal cell culture

3. Isolation of liver parenchyma cells by mechanical method and set up primary culture.
4. Determination of the concentration of viable cells in a suspension by Hemocytometer counting (trypan blue)
5. Plant tissue culture laboratory organization and instruments.
6. Preparation of plant tissue culture media – MS media
7. Aseptic techniques and surface sterilization of explants
8. Establishment of callus culture, subculture of callus
9. Production of synthetic seeds.

TEXT BOOKS :

1 John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons

2 Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications

3 HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing

4 S. Chand Practical book of biotechnology and plant tissue culture, S Chand & Company

REFERENCES :

1. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

2. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	20CY1171					
TITLE OF THE COURSE	**VOLUMETRIC ESTIMATIONS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
		0	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES:

- Students will learn about good laboratory practices, various glassware used in thechemistry laboratory and the methods to calibrate them.
- Students will be introduced to various volumetric titrations such as acid-base, redox andidometric etc.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.	L1
CO2	Students will be able to use the principles of titration experiments to estimate carbonate,nitrogen, chlorine etc. from the various matrices given.	L3

COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Good laboratory practices and calibration of glassware (pipette, burette and standardvolumetric flasks etc.)

2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basicparts and preparation of a standard solution.

3. Estimation of potassium permanganate using standard sodium oxalate solution.

4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroinindicator.

5. Estimation of ferrous sulphate using standard potassium dichromate solution usingexternal indicator.

6. Estimation of ferrous and ferric iron in a given mixture using standard potassiumdichromate solution.

7. Estimation of free alkali present in different soaps/detergents

8. Estimation of carbonate and bicarbonate in a given mixture.

9. Determination of percentage of manganese dioxide in pyrolusite ore.

10. Estimation of water of crystallization in Mohr's salt by titrating with KMnO4.

TEXT BOOKS :

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).

2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

REFERENCES :

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).

2. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20CY1201**					
TITLE OF THE COURSE	**ADVANCED CHEMISTRY - II**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To impart knowledge of advanced chemistry topics such as *s* & *p* block elements, liquid andsolutions, thermodynamics and aliphatic organic compounds.
- To make students to understand about liquid state of matter, different properties of liquids,laws governing liquids and colligative properties and their applications.
- To make the students to know about the salient features of alkali and alkaline earth metals andalso the chemistry behind p-block elements.
- To make students understand fundamental concepts of thermodynamics, thermodynamic laws,heat engine, efficiency, entropy etc.
- To give knowledge about aromatic organic compounds & alkyl halides, their properties,
  synthesis, reactions and important applications.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will be familiar with the basic knowledge of the liquids and solutions and their applications in analytical chemistry. Students will develop the ability of effectively solving practical problems of analytical chemistry of non-aqueous solutions. L1

CO2 Students will learn the descriptive chemistry of representative elements of s- and p-block elements and recognize the differences in their reactivity, chemical and physical properties

L3

CO3 Students will get the knowledge of different concepts of thermodynamics, thermodynamic laws, heat engines, efficiency, entropy etc.

CO4 Students will gain knowledge about aromatic organic compounds and alkyl halides theirproperties, synthesis methods, reactions and applications in different fields.

L2

COURSE CONTENT:	
MODULE 1	**12Hrs**

s & p BLOCK ELEMENTS

Hydrogen: Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and para hydrogen, Industrial production of hydrogen by chemically assisted electrolysis and Steam reforming. Heavy water: Physical properties (with comparison to light water), Applications.

Hydrates: Chemical nature and their stability.

s-block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density,

melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.p – block elements: Halides of boron, relative strength of BF_3, BCl_3 & BBr_3 as Lewis acids, diborane-preparation, structure & bonding.

Halogens: Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF_3, IF_5 & IF_7.

Noble gases: Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

MODULE 2: LIQUIDS AND SOLUTIONS	**12Hrs**

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids- Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.

MODULE 3: THERMODYNAMICS – I	**12Hrs**

First law of thermodynamics: Review of terms, Exact and inexact differentials, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).
Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Numerical problems. Spontaneous and non-spontaneous processes.
Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity.
Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.
Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency. Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes.

MODULE 4 : AROMATIC HYDROCARBONS & ORGANIC HALOGEN COMPOUNDS	**12Hrs**

Aromatic Hydrocarbons: General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.
Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction.Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and
phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, cis- and trans-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.
Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups,(ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.
Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

TEXT BOOKS :

Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998

1. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
2. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

REFERENCES :

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20CY1271**					
TITLE OF THE COURSE	**SYNTHESIS AND ANALYSIS OF ORGANIC COMPOUNDS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**44**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- Students will determine various physical properties like density, specific gravity, molar mass,and transition temperature of some of the organic compounds.
- Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organicdyes.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.

L1

CO2 The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. The students will be sell versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

L3

COURSE CONTENT:
List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Determination of transition temperature of a salt hydrate by thermometric method.
5. Determination of distribution coefficient of benzoic acid between water and toluene.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar mass of PVA.
9. Determination of percentage of sodium chloride by miscibility temperature method.
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G.Fransicisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J.
   Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CY2301**					
TITLE OF THE COURSE	**ADVANCED CHEMISTRY - III**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To make students understand about advanced concepts of solid state of matter, phase rule, thermodynamics and chemical kinetics.
- To impart knowledge about different organic compounds such as alcohols, aldehydes, ketones, phenols and carboxylic acids; to make them understand about their properties, synthesis, reactions and important applications.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will get the knowledge of different concepts of solid state of matter, phase rule thermodynamics and chemical kinetics. L1

CO2 Students will gain knowledge about different organic compounds such as alcohols, aldehydes, ketones, phenols and carboxylic acids; they get to know about their properties, synthesis methods, reactions and applications in different fields. L3

COURSE CONTENT:	
MODULE 1 : PHYSICAL CHEMISTRY – I	**12Hrs**

Phase Equilibria: Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems.

Solid state: Crystalline state, Laws of crystallography. Symmetry elements in cubic systems, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation. Problems Liquid Crystals-Types (Smectic, Nematic and Cholestric) with examples. Applications. Superconducting solids-High temperature superconductors. Applications.

MODULE 2 : PHYSICAL CHEMISTRY – II	**12Hrs**

Chemical Kinetics -2: Theories of reaction rates: Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis). Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Thermodynamics – 2: Free energy, Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation (derivation). Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G = -RT \ln kp$. Problems. Derivation Clausius-Clapeyron equation. Its applications to ΔTb and ΔTf determination (thermodynamic derivation not required). Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.

MODULE 3 : ORGANIC CHEMISTRY – I	**12Hrs**

Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Pondorff-Verley reaction); (ii) From acids and esters (by reduction with $LiAlH_4$). Reactions of alcohols: Comparison of the reactivity of 1°, 2° and 3° alcohols - Lucas test, oxidation with $K_2Cr_2O_7$.

Aldehydes and Ketones: Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Addition of HCN - mechanism. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalyzed acetal formation. Wittig reaction (no mechanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α-Hydrogen, enolate ion. Keto- enol tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanism of both), cross aldol reaction (practical crossed aldol reactions). Claisen- Schmidt reaction (nomechanism).

MODULE 4 : ORGANIC CHEMISTRY – II	12Hrs
Phenols: Nomenclature, classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO2 group and electron donating –CH3 group on acidity of phenols at o-, m-, p- positions, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin (ii) methyl salicylate (iii) salol (iv) salicyl salicylic acid. Carboxylic Acids and Their Derivatives: Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidity of carboxylic acids Acidic strength (pKa values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (Comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids; benzoic and p-nitrobenzoicacid; benzoic acid and p-aminobenzoic acid). Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Nucleophilic substitution at the carboxylic carbon- General mechanism. Relative reactivity of acid derivatives.	

TEXT BOOKS :

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H.
3. Langford, Oxford Univ. Press 2002.
4. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
5. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

REFERENCES :

1. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
2. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20CY2371**					
TITLE OF THE COURSE	**SEMI-MICRO QUALITATIVE ANALYSIS OF BINARY SALT MIXTURES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**44**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To make students familiar with the semi-micro qualitative analysis technique.
- To make students understand about paper chromatographic techniques and its application in separating different inorganic radicals.
- To give knowledge about solvent extraction technique and its application in ion separation.

COURSE OUTCOMES :

CO No.Outcomes Bloom's Taxonomy Level

CO1 Students will be well versed with the semi-micro qualitative analysis techniques and its application in analyzing binary salt mixture. L1

CO2 Students will gain knowledge about separating different ions through paper chromatographic technique. L3

CO3 Students understand about separation of ions through solvent extraction technique. L2

COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixture of salts with no interfering radicals). (7 Units)
2. Separation of metal ions (Cu2+, Co2+, Ni2+, Fe2+) using paper chromatography and calculation of Rf values. (2 Units)
3. Separation of ions by solvent extraction technique. (2 Units)

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5^{th} Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G.Fransicisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J.

a. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.

5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

REFERENCES :

1. Vogel's Text Book of Practical Organic Chemistry, 5^{th} Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C.Publication.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20BS1201**					
TITLE OF THE COURSE	**BIOINFORMATICS AND BIOSTATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.
- To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.
- To give holistic view for understanding the scientific validation and biomodelling.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be aware of various applied and allied scientifically domains to innovative and creative think.	L2

CO2	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO3	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:	
MODULE 1	**12Hrs**
Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). **Introduction to networks:** LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. Concepts on encryption of data. **Relational Databases Management (RDMS):** Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).	
MODULE 2	**12Hrs**
Bioinformatics (Genomics): Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.	
MODULE 3	**12Hrs**
Bioinformatics (Proteomics): Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis. Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.	
MODULE 4	**12Hrs**
Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods	

and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20BT1271**					
TITLE OF THE COURSE	**IMMUNO-TECHNIQUES – LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**-**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
- To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be familiarized with immunological techniques utilized for diagnostic assays.	L2

CO2	Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.	L2
CO3	Principle of ELISA and working of dotELISA. ELISA as a quantitative tool to measure specific analytes.	L3
CO4	Know the principles behind hemagglutination vs Immunoprecipitation techniques and correlate differentiate between soluble to insoluble(particulate) antigen concepts	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Blood group identification and Rh Typing
2. Precipitation Reactions – I. Radial Immuno Diffusion II. Ouchterlony double diffusion III. Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
7. Study of different cells in whole blood using Giemsa/Leishman stain.

TEXT BOOKS :

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.

REFERENCES :

1. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20BS1202**					
TITLE OF THE COURSE	**COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**24**	**2**

Perquisite Courses (if any)

#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To create general interest in applied domain towards using computers for biological applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be aware of the computer tools and applications which can be implemented in biological sciences.	L2
CO2	Students will be empowered for better prospects leading to project design and execution.	L2

COURSE CONTENT:	
MODULE 1 History and Generations of Computers	**4Hrs**
Evolution, Generations of computers (I, II, III, IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline, Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.	
MODULE 2 Categories of Computers and Operating Systems	**4Hrs**
The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.	
MODULE 3	**8Hrs**
Data processing & presentation: Introduction, Office Automation Software (Open Source Software). **Computer viruses and Internet Searches:** An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.	
MODULE 4 Algorithms, Flowcharts, Programming concepts & Bioinformatics	**8Hrs**
Algorithms: Concepts & definitions, converting algorithms to flowchart; Coding:	

flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.

REFERENCES:

1. Computer Fundamentals, 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora, P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

YEAR	**II**					
COURSE CODE	**20BS2401**					
TITLE OF THE COURSE	**GENOMICS AND PROTEOMICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To go through basic and specialized knowledge and understanding the aspects of genomics and proteomics is essential to understanding Genetics and its architecture.
- To take the students through foundations in genomics and disease gene mapping.
- To teach various approaches to investigating genomics and proteomics that students can apply in their future career in biological research as well as in industry.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be able to understand how genomes are organised and contemplate on the mapping of monogenic and polygenic traits.	L2
CO2	Students should be endowed with strong theoretical knowledge of genomics.	L3
CO3	In conjunction with the practical in bioinformatics, the students should be able to take up biological research as well as find placement in the relevant biotech industry.	L3

COURSE CONTENT:	
MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION	**8Hrs**
Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: Arabidopsis, rice, yeast, Drosophila, C. elegans and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.	
MODULE 2 GENOME MAPPING TECHNIQUES	**8Hrs**
Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.	
MODULE 3 HUMAN GENOME PROJECT	**8Hrs**
History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.	
MODULE 4 COMPARATIVE GENOMICS	**5Hrs**
Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.	
MODULE 5 PROTEIN PROFILING	5Hrs
Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modelling. Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.	

REFERENCES

1. T.A. Brown, Genomes, Bios, 2002.
2. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
3. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
4. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
5. Hawley and Mori, The Human Genome, Academic, 1999.
6. Lewis, Human Genetics, WCB, 1999.
7. Liebler, Introduction to Proteomics, Humana, 2002.

YEAR	**II**					
COURSE CODE	**20BS2402**					
TITLE OF THE COURSE	**BIOETHICS AND IPR**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the students to the concepts of biosafety regulatory frameworks concerning genetically modified organisms at national and International levels
- To give elementary essential concepts of Bioethics, IPR and patent laws.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student should develop basic understanding of the concepts of Biosafety, regulations concerning GMOs IPR and patent laws.	L2
CO2	This course should generate interest for avenues for pursuing higher studies and careers in these areas.	L2
CO3	General knowledge should create awareness necessary for higher studies in biotechnological fields.	L2

COURSE CONTENT:	
MODULE 1 : BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA	**8Hrs**
Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).	
MODULE 2 BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL	**6Hrs**
Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-	

Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.	
MODULE 3 BIOETHICS	**4Hrs**
What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.	
MODULE 4 INTELLECTUAL PROPERTY RIGHTS	**3Hrs**
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal Implications-Biodiversity and farmer rights.	
MODULE 5 PATENTS AND PATENT LAWS	5Hrs
Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents. The Indian Scenario", Universities Press (1998)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights. Research, Design, and Commercialisation", CRC Press, Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local CommMODULEies [Paperback], Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montegomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International.

TITLE OF THE COURSE	BIOANALYTICAL TECHNIQUES					
YEAR	I					
COURSE CODE	**20BC1201**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences.
- To give holistic view for understanding the screening, isolation, separation and characterization of molecules.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.	L3
CO2	Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.	L3
CO3	Students will have a basic understanding of biomedical equipments	L4
CO4	Students will be empowered for better prospects leading to project design and execution.	L3

COURSE CONTENT:

MODULE 1	**12Hrs**
Spectroscopy: Wave particle duality, the concepts of electromagnetic spectrum, Concepts of Absorbance and Emission Spectroscopy, Beer-Lambert's law, application and its limitations. Extinction coefficient, Concepts of chromophore/auxochrome and Chromic shifts. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscopy. Assay of biomolecules (Carbohydrates and Proteins). Principle, schematics and application of Luminometry, Tubidometry, Klett Photometry, Flame photometry and IR spectroscopy.	
MODULE 2	**12Hrs**
Chromatography History and principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (Rf & Rt concepts). Types: Planar and columnar, S-L, L- L, G-S, G-L and G-G. Paper and thin layer chromatography, types and their application in separation of biomolecules. Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules using gel permeation, ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).	
MODULE 3	**12Hrs**
Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Cellulose acetate electrophoresis, High voltage electrophoresis and their Applications. Gel electrophoresis - Types of gels, Procedure, for gel making. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration). Principle and application of Poly acralamide Gel Electrophoresis (PAGE), Iso-electric focussing (IEF) and 2D-PAGE, Submerged agarose gel electrophoresis (SAGE). Application of electrophoresis in molecular biology (genomics, transcriptomics and proteomics).	
MODULE 4	**12Hrs**
Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations. **Centrifugation:** Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules. **Immunological techniques:** Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.	

TEXT BOOKS :

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.

2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications

.

REFERENCES:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.

2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.

3. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.

4. Immunology – Kuby. Freeman Publishers.

5. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	II					
YEAR	I					
COURSE CODE	20BC1271					
TITLE OF THE COURSE	BIOANALYTICAL SEPARATIONS					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
		0	**4**	**0**	**NA**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To make students learn quantitative and qualitative methods for study of biomolecules.
- To provide hands-on training to physico-chemical methods.
- To give insights on isolation, separation and characterization of biomolecules.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**

CO1	Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic and chromatographic techniques.	L2
CO2	Students will have a complete understanding on methods to analyse biomolecules.	L3
CO3	Students will be empowered for better prospects leading to project design and execution.	L4

EXPERIMENTS/PRACTICAL:
1. Determination of extinction coefficient using colorimetry.
2. Determination of lambda maximum of biomolecules using UV spectroscopy.
3. Estimation of protein by Lowry method or Estimation of sugar by Miller method.
4. Estimation of pKa of amino acid (glycine).
5. Determination of density & viscosity of given unknown solution.
6. Circular Paper chromatography for amino acid/ sugars and Rf calculations.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
5. Handbook of Analytical Techniques - Gunzler and Williams. Wiley & Sons.
6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**20BC2301**

TITLE OF THE COURSE	HUMAN PHYSIOLOGY					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I/I	**20BC1101**	**BASIC BIOCHEMISTRY**

COURSE OBJECTIVES:

1. To illustrate the general human physiology in terms of nutrition and energy synthesis.
2. To have an insight into the cellular to organ level differentiation and their related biochemical concepts

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The student will understand the mechanism of action of the energy generation machinery and the organs associated with it.	L2 & L3
CO2	The cell to organ system to organism architecture will be better understood.	L4

COURSE CONTENT:	
MODULE 1	**12Hrs**
Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Respiratory quotient, BMR, SDA and factors affecting them. Role of carbohydrates, protein, lipid and as fuel molecules. **Hematology:** Blood components and their functions, blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance. **Respiration:** Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions.	
MODULE 2	**12Hrs**
Biochemistry **Cardiovascular System:** Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle. Blood pressure and its regulation.	

Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction and congestive heart failure.

Skeletal system: Tissues - introduction. Extracellular matrix and its components, Bone- ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodeling and regulation by hormones

Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

MODULE 3	**12Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins.

Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

MODULE 4	**12Hrs**

Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and nonmyelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

TEXT BOOKS:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.

2. Human Physiology – Chatterjee. Sapna Publishers.

3. Fundamentals of Biochemistry - Deb. Central Publishers.

4. Medical Biochemistry – Chatterjee and Shindey.

5. Biochemistry – Das. Central Publishers.

6. Biochemistry –Jain. Himalaya Publications.

7. Principles of Nutrition – Swaminathan. Himalaya Publications.

8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **16BT101**
TITLE OF THE COURSE : **ESSENTIALS OF CELL BIOLOGY**
L: T/A: P: C : **3: 1: 0: 4**

COURSEOBJECTIVES:
1. To equip students with the basic understanding of structures and functions of basic organelles ofprokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSEOUTCOMES:
1. Students should have basic knowledge on the structure and functions of cellularorganelles.
2. Students should be able to understand the concept of cell cycle, its control and different stages in cell division.

MODULE 1 10Hrs

Cell as a basic unit of living organisms. Discovery of cell and Cell Theory; Chemical components of a cell, catalysis and use of energy by cells, Comparison between plant and animal cells. Cell Wall and membrane structure; Cell wall; Plasma membrane – structure and functions of plasma membrane; Modifications of plasma membrane and intracellular junctions.

MODULE 2 10Hrs

Structure and functions of cellular organelles - Mitochondria, Chloroplast, ER, Golgi complex and Ribosome.

MODULE 3 10Hrs

Structure and functions of - Cytoskeleton, Centriole, Protoplasm, Cell motility; Structure and functions of cilia, and Flagella, Types-Amoeboid, Ciliary and Flagellar movements.

MODULE 4 11Hrs

Nucleus and chromosomes; Structure and functions of nuclear membrane, nuclear pore complex, Nucleolus and Chromatin. Chromosomes-Discovery, morphology and structural

Organization- Centromere, Secondary constriction, Telomere, Chromomere, Euchromatin and Heterochromatin, chemical composition and karyotype. Ultra-structure- Single-stranded and multi-stranded hypotheses, folded fiber and nucleoside models. Special types of chromosome: Salivary gland and Lampbrushchromosomes.

MODULE 5 11Hrs

Cell division and Programmed Cell Death; a) Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division. b) Mitosis: Significance of Mitosis, Breakdown of nuclear envelope, spindle fibers, Kinetochore, Anaphase movements. c) Meiosis: Types of meiosis, the first and second meiotic division, synaptonemal

complex. d) Programmed cell death (Apoptosis): intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.

REFERENCE BOOKS

1. Molecular Biology of Cell-Bruce Albert's et.al, Garland publications (2005).
2. Cell Biology &Molecular Biology EDP Robertis & EMF Robertis, Saunder College (2001).
3. Cell Biology C.B. Powar, Himalaya Publication (2004).
4. Cell Biology by David E Sadava, Jones and Bartlett Publications (1993).
5. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).
6. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).

COURSE CODE : 16BT171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic techniques used in cell biologyto study – cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES: 1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use ofsimple and compound microscope.

1. **Microscopic measurements using micrometry** – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
2. Cell division: Study of mitosis using onion root tips.
3. Cell division: Study of and Meiosis in grasshopper testes/onion flower buds
4. Chromosomes: Mounting of polytenechromosomes
5. Preparation of Buccal smear for study of barr bodies.
6. Karyotype analysis-Man and onion Man-Normal and Abnormal-Down and Turner's syndromes.
7. **Blood cell count byHemocytometer**.
8. **Blood smear-differential staining.**
9. Vital Staining ofmitochondria.
10. Isolation of chloroplast from spinach leaves.

COURSE CODE : 16BT172

TITLE OF THE COURSE : MICROBIAL TECHNIQUES

L: T/A: P: C : 0: 0: 4: 2

COURSEOBJECTIVES: 1. To make the students aware of basic microbiological techniques.

COURSEOUTCOMES: 1. Student will be trained in basic sterilization and microbiological techniques.

1. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
2. **Common instruments** usedina microbiology Lab: **Principles and operations** - Incubators & Shakers Centrifuge pH meter Colorimeter Spectrophotometer
3. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa)
4. Sampling and quantification of microorganisms in air, soil and water.
5. Isolation of bacteria - Streak plate, spread plate, pour plate, serial dilution (2 units)
6. **Biochemical tests – IMViC**, starch hydrolysis, catalase & gelatin liquefaction (3 units)
7. **Antibiotic sensitivity test**-paper disc method
8. Study of Rhizobium from root nodules of legumes.
9. Microscopic study of phytoplankton & zooplanktons.

SEMESTER/YEAR : III SEM / II YEAR

COURSE CODE : 16BT201

TITLE OF THE COURSE : BASIC PRINCIPLES OF BIOCHEMISTRY AND BIOPHYSICS

L: T/A: P: C : 3: 1: 0: 4

COURSEOBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.

2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSEOUTCOMES:

1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 10Hrs

Carbohydrates: Structure, properties and classification with examples – Monosaccharides, Disaccharides, polysaccharides (storage and structural, homo and hetero polysaccharides). Lipids: Structure, properties and classification and functions – Phospholipids, sphingolipids and glycolipids.

MODULE 2 10Hrs

Classification and properties of amino acids, titration curve of amino acid, concept of zwitter ion, pKa and pI. Proteins: Classification based on structure and function, structural organization of proteins – Primary, secondary (alpha helix and beta sheet), tertiary and quaternary structure. Nucleic Acids: Nucleic acids and their components – Nitrogenous bases (purines and pyrimidines), nucleosides and nucleotides, formation of phosphodiester bond.

MODULE 3 11Hrs

Enzymes: Introduction, classification, co-enzymes and co-factors, enzyme kinetics (Michelis- Menten equation), factors influencing enzyme activity- Substrate, enzyme, temperature and pH, Inhibition mechanisms (competitive and non-competitive). Vitamins and Hormones: Water Soluble and fat-soluble vitamins, Dietary source, Clinical relevance. Functions of Steroid hormones (testosterone and estrogen), Glucocorticoid hormones (cortisol and mineralocorticoid), pituitary hormones (MSH and FSH). Examples of Plant Hormones (Auxins, Cytokinins and Gibberllins).

MODULE 4 10Hrs

Scope of Biophysics, pH and Buffer concepts. **Principles and applications of Chromatography (Paper, thin layer, column, GLC and HPLC); Centrifugation (differential,densitygradient,Ultra centrifugation);**

MODULE 5 11Hrs

Principles and applications of **Spectroscopy (UV, Visible, X-Ray crystallography, NMR, IR, Fluorescence and Atomic; Absorption)**; and Electrophoresis. Isotopes: Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

REFERENCE BOOKS

1. Lehninger's Principles of Biochemistry- W H Freeman (2008)
2. Biochemistry-Lubert Stryer Freeman International Edition (2002).
3. Biochemistry-Keshav Trehan Wiley Eastern Publications (1987).
4. Fundamentals of Biochemistry J.L. Jain S. Chand and company (2007).
5. Biochemistry by U Satyanarayana and Chakrapani, Elsevier Inc. (2013).
6. Biochemistry by Voet and Voet, Wiley Publishing (2010).
7. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi(2008).
8. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
9. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John
10. Walker, Cambridge University Press(2005).
11. Biophysics – An introduction by Ronald Glaser, Springer (2012).

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To provide comprehensive understanding molecular processes in the cell required for its growth and maintenance of genetic material.
2. To equip with fundamental understanding of the underlying mechanisms in regulation of gene expression.

COURSE OUTCOMES: 1. Student will be well versed with mechanisms in the expression, regulation and maintenance of genetic information, within a biological system.
2. Student will be able to critically think in the field of application

of molecular biology.

MODULE 1 10Hrs

Molecular basis of life: Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Structure and function of DNA and RNA: Structure of DNA. Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA. Recombination: Transformation, Conjugation and Transduction; Holliday model of recombination. Extra nuclear Genomes: Mitochondria and chloroplasts.

MODULE 2 11Hrs

MODULE 4. DNA Replication: Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. Causes of DNA damages, mechanisms of repair– photo-reactivation, excision repair, mismatch repair, SOS repair.

MODULE 3 10Hrs

Transcription in Prokaryotes and Eukaryotes: RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of EukaryoticmRNA.

MODULE 4

10Hrs

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes. Post translational modification of Proteins.

MODULE 5

11Hrs

Regulation of Gene Expression: Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons Regulation of Gene expression in Eukaryotes – galactose metabolism in yeast. Role of cis and trans elements in regulation of gene expression. Mobile Genetic Elements: Insertional elements, transposons in Bacteria, Maize and Drosophila.

REFERENCE BOOKS

1. Cell& Molecular Biology by Gerald Karp, 3rd Edition, John Wiley& Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

DAYANANDA SAGAR UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

BSc - Syllabus as per Choice Based Credit System Guidelines.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 19BT2301
TITLE OF THE COURSE: IMMUNOLOGY

L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:

1. To provide basic understanding on Immune system: Cells and organs of the immune systemandits fundamentals.
2. Toequipthestudentswithknowledgeonimmunologicaltechniques.

COURSE OUTCOMES:

1. Student will be acquainted with the basic understanding of immune system in its entirety and
2. To enable critical thinking about its protective role in infectious diseases and their control.

Total Hours: 44

MODULE I: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM 11Hrs

Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, HumoralandCellmediatedImmunity.Cellsandorgansofimmunesystemand their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cellsBasicoutlineorschemeofclonalselection inthehumoral(Bcell)andcellular(Tcell) branchesofimmunity. Immunological memory.

MODULE II: ANTIGENS AND ANTIBODIES 11Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

Module III: IMMUNE RESPONSES 11Hrs

Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC Iand II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendriticcells; cytokines (interleukins and interferons) Primary and secondary Immune response.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 11 hrs

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinantvaccines– Peptideand DNAVaccines.

REFERENCES:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman& Company; 2006.
2. Kuby Immunology 7thedition. macmillan Publishers 2014.
3. Kuby Immunology, 8th Edition| macmillan Publishers 2019.
4. RoittIM(2001)EssentialsofImmunology,BlackwellScientificPublishers,London.
5. Murphy,K.,Weaver,C.,Weaver,C.,2016.Janeway'sImmunobiology.W.W.Norton&

Company. https://doi.org/10.1201/9781315533247

6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J.,2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. CVaman Rao(2007) Immunology(2nd Ed), Narosa Publishing.

SEMESTER/YEAR : III SEM / II YEAR

COURSE CODE : 19BT2371

TITLE OF THE COURSE: IMMUNO-TECHNIQUES –LAB

L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Toacquaintthestudentwiththeimportanttechniquesinimmunology.

COURSE OUTCOMES:

1. Student will be well equipped with immunological techniques utilized for diagnostic assays.

PRACTICALS

1. Blood groupidentificationand Rh Typing
2. Precipitation Reactions–
   I. Radial ImmunoDiffusion
   II. Ouchterlony doublediffusion
   III. Rocket ImmunoElectrophoresis
3. Dot ELISA
4. Serumseparationandquantificationofserumproteins
5. Introductiontoinstrumentsandlaboratorysetupforanimalbiotechnology
6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypanblue)

7. Studyofdifferent cellsinwholebloodusingGiemsa/Leishman stain.

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay,F.C.,Westwood,O.M.R.,2002.PracticalImmunology,4thedition.ed.Wiley-Blackwell, Malden,MA.
3. LabManualinBiochemistry,ImmunologyandBiotechnologybyNigam,Arti-AbeBooks." McGraw-Hill Education (India) (2008)

SEMESTER/YEAR	**: V SEM / III YEAR**
COURSE CODE	**: 19BT3501**
TITLE OF THE	**: ANIMAL AND PLANT BIOTECHNOLOGY**

COURSE OBJECTIVES:

[1] Toacquaintthestudentswiththebasicconceptsofanimalandplantcellculture set upand conditions.

[2] To familiarize the students with knowledge on various ways to produce transgenic plants and animals withnoveltraits.

[3] To equip the student's wide area of important applications of animal biotechnology.

COURSE OUTCOMES:

[1] Will learn about basic animal and plant cell culture conditions, media formulations, techniquesanditsuses.

[2] The students will learn the fundamentals of culturing animal and plant cells & tissuesandthe modestochangeandimprovegenetictraitsofanimalandplants.

[3] Willbeequipped withthewideareaofapplicationsofbiotechnologyinmodern world.

TOTAL HOURS: 44

MODULE 1: BASICS OF ANIMAL TISSUE CULTURE 11 Hrs

Basics of animal tissue culture, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF. Stem Cell Types and its characteristics. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines(Hela, CHO, BHK).

MODULE 2: APPLICATION OF ANIMAL BIOTECHNOLOGY 11Hrs

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells –expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals
– techniques and applications (examples of mice and sheep). Basics of Tissue Engineering. Biosafety and Good Labpractices.

MODULE 3: BASICS OF PLANT TISSUE CULTURE 11hrs

Introduction to Plant Tissue Culture: Aseptic techniques, sterilization methods - (Steam and Dry), media and explant sterilization techniques, post sterilization care of the instruments, contaminants, components of tissue culture media, growth hormones (auxin and cytokinin), Tissue and Organ Culture: Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, callus culture, cell culture, protoplast culture and fusion, organogenesis and somatic embryogenesis, Soma clonalVariants.

MODULE 4: APPLICATIONS OF PLANT TISSUE CULTURE 11hrs

Genetic Transformation Techniques: Transgenic plants- Agrobacterium mediated (Ti and Ri plasmid), physical and chemical methods of gene transfer.
GM technology and Plant Trait improvement: GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops. Bt cotton, Btbrinjal,Golden Rice. Application of tissue culture for crop improvement in agriculture, horticulture and forestry. Edible vaccines, secondary metabolites (in-vitro production).

REFERENCES:

1. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
2. RIanFreshney(2010)CultureofAnimalCells(6thEd),Wiley-Blackwell
3. JohnDavis(2011)AnimalCellCultureEssentialMethods,Wiley&Sons
4. SatyanarayanaU(2008)Biotechnology, BooksandAlliedLtd.
5. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing.
6. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
7. SantoshNagarandMadhavAadhi(2010)PracticalBookofBiotechnologyand
8. Plant Tissue Culture, SChand Publications

9. BDSingh(2014)Biotechnology:Expandinghorizons,KalyaniPublishers.

SEMESTER/YEAR : V SEM / III YEAR

COURSE CODE : 19BT3571

TITLE OF THE COURSE : TECHNIQUES IN CELL CULTURE-

L: T : P: S/P : : 0 : 0 : 4 : 0 : 2

COURSE

[1] To acquaint the student with the fundamental practical knowledge of the laboratory set up and techniques to use cell culture.

COURSE OUTCOMES:

[1] The course will help in makingthe students learn basic techniquesforplant and animal tissueculture.

1. Introductiontoinstrumentsandlaboratorysetupforanimalbiotechnology
2. Preparationof media foranimal cellculture
3. Isolation of liver parenchyma cells by mechanical method and set up primary culture.
4. Determination of the concentration of viable cells in a suspension by Hemocytometercounting(trypanblue)
5. Planttissueculturelaboratoryorganizationandinstruments.
6. Preparationofplant tissueculture media –MS media
7. Asepticteechniquesandsurfacesterilizationofexplants
8. Establishmentofcallusculture, subcultureofcallus
9. Productionofsynthetic seeds.

REFERENCES

1. RIanFreshney(2010)CultureofAnimalCells(6thEd),Wiley-Blackwell.
2. JohnDavis(2011)AnimalCellCultureEssentialMethods,Wiley&Sons

SEMESTER/YEAR : VI SEM / III YEAR

COURSE CODE :19BT3671

TITLE OF THE COURSE : BASIC FERMENTATION TECHNIQUES-LAB

L: T : P: S/P : : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

[1] Toimpart basic understandingofprinciples, and keyconcepts relevant to industrialbiotechnology.

[2] To familiarize students with downstream processing and production of important microbialproducts.

COURSE OUTCOMES:

[1] Studentwillbeawareoffermentationprocess,typesoffermentationmediaand strategiesforisolationofIndustriallyimportant strains.

[2] Thecoursewillenablethestudenttoapplytheknowledgeinvariousaspectsof fermentation orindustrial biotechnologyprocesses.

EXPERIMENTS:

1. Studyoffermenter(Demonstrationusingvideoormodelor Industrialvisit)
2. Isolation of Amylase producing microorganisms and production of Amylase using solid statefermentation
3. Estimation of Amylaseactivity
4. Preparation of wine (Grapes/ Ginger/ Pomegranate). Estimation of alcohol by specific gravitymethod.
5. Immobilization of yeast by calcium alginate gel entrapment and assay for enzyme-Invertase andCatalase.
6. Screening ofantibiotics producingmicroorganisms.
7. Algalandfungalculture – Spirulina, YeastandAspergillus.
8. ProductionandEstimationofcitricacidfrom Aspergillusculture.
9. Productionand Estimation oflacticacid.

SEMESTER	**II**
YEAR	**I**
COURSE CODE	**19BS1274**
TITLE OF THE COURSE	**BASIC TECHNIQUES IN MICROBIOLOGY - LAB**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	-	**4**	-	-	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To equip students with basic microbiological techniques
- To understand working principles of instruments
- To understand microbial structure, functions and their environment

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Enable students to isolate, culture and identify microorganisms	L2
CO2	Educate students about principles and applications of instruments used in microbiological techniques	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Study of basic instruments in Microbiology laboratory (2 Units) Autoclave, Hot air oven, Incubator, pH meter, High speed centrifuge, Colorimeter / Spectrophotometer, Anaerobic jar, Bacterial Filters, Laminar air flow
2. Microscopic examination of bacterial smear a) Gram's staining b) Capsule staining d) Endospore staining
3. Preparation of culture media and transfer of media: a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA) b) Selective media (EMB agar and McConkey agar), c) Enriched media (Blood agar). Slant culture technique, Broth culture technique, Stab culture technique
4. Methods of pure culture techniques a) Pour plate technique b) Spread plate technique c) Streak plate technique
5. Microscopic observation of temporary slides a. Algae: *Chlamydomonas* and *Spirulina* b. Fungi: *Rhizopus, Aspergillus*, *Penicillium*, Yeast and *Fusarium* c. Protozoa: *Amoeba, Paramecium* and *Plasmodium*

REFERENCES:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. 5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**19BS1275**					
TITLE OF THE COURSE	**BIO-ANALYTICAL CHEMISTRY - LAB**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
		0	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To create general understanding about practical concepts of techniques used to detect and assay biomolecules.
- To familiarize students with laboratory equipment, use.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have a general idea about acid-base and amino-acid titration.	L2
CO2	Students will be familiar with the use and applications of viscometer and pH meter.	L3
CO3	Students will be able to detect and resolve bio-molecular mixtures based on their physical and chemical properties	L4

EXPERIMENTS/PRACTICAL:
1. pH metric titrations of HCl-NaOH / Acetic acid-NaOH.

2. Determination of pI of amino acid (glycine).
3. Determination of density & viscosity of given unknown liquid.
4. Determination of density & surface tension of given unknown liquid.
5. Circular paper chromatography of amino acids / carbohydrates.
6. Ascending/Descending paper chromatography of amino acids / carbohydrates.
7. Separation of amino acid by TLC.
8. Column chromatography of pigments on adsorbent.
9. Paper electrophoresis for separation of biomolecules (Demo).

TEXT BOOKS:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**19BS2472**					
TITLE OF THE COURSE	**rDNA TECHNOLOGY-LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**4**	**0**	**-**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To prepare students for successful career in industry and research institutes.
- To develop the ability amongst the students to apply modern genetic engineering techniques in industry and research.
- To enable students to work in a team with multidisciplinary approach.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Account for structure formation of and function of DNA, RNA and proteins	L1
CO2	Describe gene cloning, restriction endonucleases, PCR use modern gene technologies are used to elucidate genetic issues	L2
CO3	Critically analyse, evaluate and compile received results	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Instrumentation:

a) UV Transilluminator
b) PCR

2. Vectors:

a) pBR 322 and Cosmid

b) YAC

c) Ti plasmid - Binary vector
d) SV 40 (any one type)

3. Experiments:

a) Spectrophotometric quantification of DNA and RNA.

b) Quantification of DNA using Agarose Gel Electrophoresis.

c) Construction of restriction maps and problem solving.

4. Demonstrations:

a) Isolation of Plasmid DNA

b) Restriction Enzyme digestion

c) Ligation of DNA fragment

d) Transformation- α complementation

REFERENCES:

1. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics. Blackwell Publishing MA. USA. 2006.
2. Recombinant DNA: A Short Course by JD Watson, J. Tooze and DT Kurtz. Scientific American books. USA. 1983.
3. From Genes to Genomes: Concepts and Applications of DNA Technology by JW Dale and M Schantz. Wiley-Blackwell Publishing. UK. 2012.
4. Molecular Biotechnology: Principles & Applications of Recombinant DNA Glick BR and Pasternak JJ , ASM Press. USA. 2017.

1.1.3

SYLLABI-PG

HAVING EMPLOYABILITY, ENTREPRENEURSHIP AND SKILL DEVELOPMENT

SEMESTER/YEAR: I SEM
COURSE CODE: 17MBC171
TITLE OF THE COURSE: BIOCHEMICAL ESTIMATIONS
L: T/A: P: C: 0:0:8:4

1. Estimation of lactose in milk by DNS
2. Estimation of sugars in fruits
3. Estimation of proteins by Lowry's method
4. Estimation of inorganic phosphate in peas by Fiske-Subbarow method
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by Orcinol method.
7. Estimation of total sugars in plants by anthrone method.
8. Determination of saponification number of oil/fat.

References:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
5. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990).
6. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.
7. Biophysical chemistry by Upadhyay and Upadhyay.

SEMESTER/YEAR: I SEM
COURSE CODE: 17MBC172
TITLE OF THE COURSE: BIOPHYSICAL CHEMISTRY
L: T/A: P: C: 0:0:8:4

1. pH calculation and Buffer preparations - problems
2. Determination of absorption spectra, molar extinction coefficient & λmax of proteins & nucleic acids.
3. Determination of pKa of amino acid through pHmetric titration.
4. Determination of weak acid concentration by conductometric titration
5. Separation of amino acids by ascending & circular chromatography.
6. Separation of amino acids by 2-D chromatography
7. Separation of carbohydrates/amino acids by TLC.
8. SDS-PAGE of proteins.

References:

1. Biochemical Calculations, Irwin H.Segel (1976) 2nd Ed. John Wiley and Sons.
2. Modern Experimental Biochemistry R.F.Boyer [Ed.] (1986) Addition Wesley.
3. Analytical Biochemistry; D.J.Holme and H. Pick, Longman (1983).
4. Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 6th Ed. (2005) Cambridge University Press.

SEMESTER/YEAR	**: II SEM**
COURSE CODE	**: 17MBC201**
TITLE OF THE COURSE	**: METABOLISM OF CARBOHYDRATES AND LIPIDS**
L: T/A: P: C	**: 4: 1: 0: 5**
	52 hours

Module 1:

Carbohydrate metabolism: anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, Kreb's cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle-utilisation of TAG in germinating seeds. Glucuronic acid pathway-synthesis of L-Ascorbic acid in plants. Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins

Module 2: 13h

Lipid metabolism: Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, energetics of β-oxidation scheme, peroxisomal β-oxidation, branched chain fatty acids by α- oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, shpingolipid storage disorders.

Module 3: 13h

Cholesterol: structure, brief idea of synthesis and metabolism, normal and abnormal levels in the body.

Isoprenoid metabolism, insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL. Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism, obesity, atherosclerosis and hypercholesterolemia, synthesis of prostaglandins and related compounds, Non steroidal anti inflammatory drugs (NSAIDs)

Module 4: 13h

Metabolic disorders: Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves,

and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria.

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation. Introduction to metabolomics.

References

1 Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(1999).
2 Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper IRL Oxford University Press(1995).
3 Photosynthesis, D.O. Hall and K. K. Rao, 6th Ed. Cambridge University Press (1999).
4 Hawk's Physiological Chemistry, 14th Ed , Oser, Tata-McGraHill (1976).
5 Biochemistry of Foods, Eskin, Elsevier (2012).
6 Text Book of Biochemistry with Clinical correlations; 6th Ed. Thomas M. Devlin, Wiley-Liss (2012).
7 Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
8 Biochemistry; David Rawn, Panima Publishers (2012).
9 Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D.Bender , K.M. Botham , P. J. Kennelly,
10 P. A. Weil (2015) Biochemistry; 7th Ed. J.M.Berg, J.L.Tymoczko, L.Stryer , W.H.Freeman &Company.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **17MBC202**
TITLE OF THE COURSE : **IMMUNOLOGY AND CANCER BIOLOGY**
L: T/A: P: C : **4: 1: 0: 5**

52 hours

Module 1: **13h**

Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity.
Innate immunity: Different lines and layers of defense, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.

Module 2: 13h

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins, genetic recombination of heavy and light chains.
Immuno techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA & ELISA. Immuno-electrophoresis, Immuno-florescence and immuno-staining techniques in electron microscopy.
Antigen recognition by T cells: T_H, T_C and T_{Reg} cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen. 5h

Module 3: 13h

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self recognition. 3h
Failures of Host Defense Mechanisms: How do pathogens evade the immune system, inherited immunodeficiency diseases, acquired immune deficiency syndrome. Autoimmune responses. Vaccines. Allergy and Hypersensitivity: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases. 3h
Transplantation and Network theory: Transplant rejection, immunosuppressents. Immuno-surveillance, idiotopes and immune network theory. 3h

Module 4: 13h

Hallmarks of cancer, tumor viruses, oncogenes, growth receptors and signaling, tumor suppressor genes, p53 and pRB-functions and regulation. Apoptosis – components of pro- and anti-apoptotic pathways. Tumorogenesis- differentiation, immortalization, genomic integrity, angiogenesis and metastasis. Rational design of cancer therapeutics.

References:

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology , 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L.Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007)
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013)
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).
8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57–70 (2000)
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC204
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5
52 hours

Module I: 13h

Criteria for classification of microroganisms, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Chemotaxonomy, Numerical taxonomy and Molecular taxonomy. Brief account of Bergey's manual of bacteriology.

Bacteria: Ultra structure of bacterial cell: Shapes and size, chemical composition and characterization of cell wall.

Viruses: General Properties of viruses, classification and replication of bacteriophages. Viroids and Prions.

Ultrastructure, classification and reproduction in algae, fungi and protozoa

Module II: 13h

Microscopy: Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Microbial Techniques: Cultivation of microorganisms, culture media, Pure culture techniques, Stains and staining techniques: Simple, Negative, Gram's, Acid fast and structural staining techniques.

Microbial Control: Concepts of sterilization and disinfection. Physical and chemical methods of sterilization.

Module III : 13h

Microbial growth, growth curve and factors affecting growth (Physical and chemical).

Bacterial photosynthesis, photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Role of microorganisms in nitrogen fixation.

Breakdown of carbohydrates –EMP (Glycolysis), HMP shunt (pentose phosphate pathway) and ED, TCA, ETS (oxidative phosphorylation), anaerobic respiration.

Fermentative modes in microorganisms – alcoholic, lactic acid (hetero and homo lactic acid fermentation).

Overview and importance of secondary metabolites - antibiotics

Module IV: 13h

Host pathogen interactions, defense mechanisms of pathogens, human pathogens and diseases; virus (chickenpox, measles, mumps, hepatitis B), bacteria (tetanus, TB, cholera, typhoid, anthrax), protozoa (amebiasis, malaria, toxoplasmosis), fungi (mycoses). General characteristics of antimicrobial drugs and their mode of action, antibiotic resistance and multi-drug resistant strains.

References:

1. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers

2. Stainer R.T., Ingraham J.L., Wheelis M.L. and Painter, P.R., (1987).General Microbiology; Macmillan, 5th. Edition
3. Pelczar Jr. M.J.; Chan E.C.S. and Krieg N.R. (1986). Microbiology, Mc Graw Hill, Fifth Edition
4. Glazer A N and Nikiado H , Freeman (1995).Microbial Biotechnology and Fundamentals of Applied Microbiology.
5. Introductory Microbiology by Heritage Pub Heritage
6. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y
7. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2 Edition, Milan Publishing Co.
8. Brock T.D. and Madigan M.T). (1992)Biology of Microorganisms 6 Edn. Prentice Hall, Eagle wood cliffs N.j.
9. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T. (1994). Bergey‟s Manual of the Systemic Bacteriology 9 Edn. William and Wilkins, Baltimore.
10. Dubey.R.C Microbiology. (2001). First edition. Chand & Company.

SEMESTER/YE	**: II SEM**
AR COURSE	**: 17MBC205**
CODE	**: BIOINFORMATICS**
TITLE OF THE COURSE	
L: T/A: P: C	**: 2: 0: 0:2**

26 hours
8h

Module I:

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant

Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Programming Languages: Introduction to programming languages - C and PERL

Module II: 10h

Data management - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF-PIR, SWISSPROT

Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,

Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

Module III : 8h

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics;

Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking – Autodoc

References:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC271
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND MICROBIAL TECHNIQUES L: T/A: P: C : 0: 0: 8:4

1. Estimation of glucose in blood by Folin-Wu / glucose oxidase method
2. Estimation of uric acid in blood by Caraway's method
3. Estimation of creatinine in serum and urine by Jaffe's method
4. Estimation of urea in serum and urine by urease method
5. Estimation of haemoglobin by Wong's method
6. Estimation of ketone bodies in urine
7. Estimation of reducing sugars in urine
8. Estimation of serum cholesterol by Zack's method.
9. Isolation and Identification of microorganisms from air, water and soil.
10. Microbial culture techniques- Streak Plate, Spread Plate and Pour plate.
11. Staining techniques – Simple staining and Grams staining.

References:

1. Hawk's Physiological Chemistry, 14th Ed (ed. Oser) , Tata-McGrawHill (1976).
2. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).
3. Practical Clinical Biochemistry, ed. Harold Varley, 4th Ed. CBS Publishers (1988).
4. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
5. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC371
TITLE OF THE COURSE: MOLECULAR BIOLOGY & IMMUNO TECHNIQUES
L: T/A: P: C : 0: 0: 8: 4

Isolation and Estimation of DNA by colorimetric/spectrophotometric method
Estimation of RNA by colorimetric/spectrophotometric method
Isolation of plant/animal genomic DNA, and analysis by agarose gel electrophoresis
Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency
Study of conjugation in *E. coli*
Serum Separation from whole blood and isolation of immunoglobulins from serum.
Study of different cells in whole blood using Giemsa/Leishman stain.
Blood grouping
ELISA/Dot ELISA
Radial Immunodiffusion/Ouchterlony Double Diffusion
Rocket Immuno Electrophoresis
WIDAL/RPR Test

References:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6^{th} Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4^{th} edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC302
TITLE OF THE COURSE : METABOLISM OF NITROGEN COMPOUNDS
L: T/A: P: C : 4: 1: 0: 5
52 hours

Module I: Bioenergetics 13 hrs

Reduction Potential, Biological redox couplers, Sequence and structure of mitochondrial electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores.

Module II: Nucleotide Metabolism 13 hrs

Nitrogen Cycle, nitrogen fixation, *nif* genes. Structure of nucleoside and nucleotide; Synthesis and degradation of purine and pyrimidine nucleotides and their regulation. Disorders: SCID, gout, Lesch-Nyhan syndrome, oroticaciduria and xanthinuria.
Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.

Module III: Nitrogen metabolism 13 hrs

General metabolic reaction of amino acids– transamination, deamination, oxidative and non- oxidative deamination, glucose – alanine cycle. Urea cycle and its regulation. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.

Module IV: Amino acid metabolism 13 hrs

Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism. Regulation of amino acid metabolism.

References

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC372
TITLE OF THE COURSE : PROTEIN BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

1. Extraction of phosphatase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

2. Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

3. Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation
4. Criteria of purification of phosphatase visualized through SDS-PAGE

5. Extraction of esterase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

6. Extraction of esterase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

7. Criteria of purification of esterase – chromatography of purified samples – ion exchange/gel permeation

8. Criteria of purification of esterase visualized through SDS-PAGE

9. Concepts of Isoelectric Focusing (Demonstration)

Reference Books:

1. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
2. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC471
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY & BIOTECHNOLOGY L: T/A: P: C : 4: 1: 0: 5

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC421
TITLE OF THE COURSE : FOOD BIOCHEMISTRY AND NUTRITION
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: Basics on Food Biochemistry 13h

Carbohydrates: Occurrence and physiological functions, factors influencing metabolism. Lipids: Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA-sources and physiological functions.

Proteins: Concepts of essential and non-essential amino acids- their role in growth and development. Physiological functions of proteins. Requirements, nitrogen balance concept. Methods for evaluating protein quality.
Regulation of food intake: role of hunger and satiety centers, effect of nutrients.

Module II: Basics on Nutrition 13h

Body composition: Methods of studying body composition. Nutritional disorders and effect on body composition- protein energy mal nutrition, renal failure and thyroid related disorders. Food borne allergens, toxins and adulterants.
Energy metabolism: Basal and resting metabolism- influencing factors. Methods to determine energy requirements and expenditure.

Module III: Nutraceuticals 13h

Nutraceuticals: Definition, example and use of nutraceuticals in traditional health sciences; their role in preventing /controlling diseases.
Prebiotics and probiotics: Usefulness of probiotics and prebiotics in gastro intestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.
Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. (with examples)
Development of nutraceutical and functional foods: Standards for health claims, Regulatory bodies (FSSAI). Process of developing - preclinical & clinical studies.

Module IV: Designer Foods and Nutrigenomics 13h

Functional Foods - Natural and synthetic, use of excipients. Characteristics of drugs action: pharmacokinetics, route and form of excretion. Drug abuse and drug resistance Drug- nutrient interactions – effect of drugs on ingestion, digestion, absorption and metabolism of nutrients, effect on nutritional status, effect on organ function, drug dosage and efficacy.

Nutrigenomics - definition, concepts and theories. Genetic materials, gene expression and inheritance. Molecular mechanisms of genetic variations linked to diet- role of diet, macro and micro nutrients. Role of animal foods. Evolution of human diseases.

References:

1. Swaminathian (1990). Food and Nutrition, Himalaya Publishers.
2. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
4. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
8. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC422
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND BIOENGINEERING
L: T/A: P: C : 4: 1: 0: 5
52 hours

Module I 13 h

Precision, accuracy and sensitivity. Brief introduction to carbohydrate, fat and protein metabolism (overview). Metabolic disorders: Diabetes Mellitus, Atherosclerosis, Renal failure and muscular dystrophies. Detection of these diseases through blood, liver and kidney functional tests. Role of isozymes. Clinical laboratory functioning - Laboratory information systems, Lab accreditation processes

Module II 13 h

Drug discovery and development, including animal studies, tissue culture studies, safety, efficacy, randomization procedures, Preclinical Safety, Assessment of pharmacokinetics in early phase drug evaluation, Metabolism studies: in vitro and in vivo tests Pre clinical studies, Phase 0, Phase I, Phase II, Phase III, Phase IV, single blind and double blind studies. Regulation and quality assurance.

Module III 13 h

Introduction to bioengineering, Quantitative and qualitative Models for biology: models used to understand DNA, proteins and lipids. Estimates; estimation of size for bacterial cells and mammalian cells including fibroblasts and intestinal cells. Relative time.

Module IV 13 h

Complexity in biological systems, Simple mathematical models for diffusion kinetics and gene expression, transformation of energy in cells - metabolism of fuels and generation of proton motive force leading to ATP synthesis. Brief idea of Systems Biology.

References:

1. Donald Voet, Judith G Voet, Biochemistry, 4th Edition, John Wiley and Sons
2. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia; Physical biology of the Cell, 2nd edition, garland Science Publication, 2012.
3. Handbook for applicants and reviewers of Clinical trials of new drugs in India; CDSCO. ICMR, 2017.
4. The Drug development Process; US Food and Drug Administration URL: https://www.fda.gov/ForPatients/Approvals/Drugs/default.html

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5101**					
TITLE OF THE COURSE	**FUNDAMENTALS OF CHEMISTRY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To reintroduce the students to the fundamentals and application of current chemical and scientific theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
- To make the students to understand the interdisciplinary nature of chemistry and to integrate knowledge of various branches of chemistry with other higher biological courses.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will acquire a foundation of chemistry of sufficient breadth and depth to enable them to understand and critically interpret the primary concepts in chemistry.	L2

CO2	Students will familiarize with the basic concepts related to chemical bonding, electrochemistry, thermodynamics, chemical kinetics, stereochemistry, reaction mechanism and their interdisciplinary role in thorough understanding of higher biological courses	L3

COURSE CONTENT:	
MODULE 1 General Chemistry	**13 Hrs**
Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.	
MODULE 2 Physical Chemistry	**13 Hrs**
Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation. Thermodynamics: First & second laws of thermodynamics, enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential. Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis.	
MODULE 3 Organic Chemistry - I	**13 Hrs**
Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.	

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.	
MODULE 4 Organic Chemistry - II	**13 Hrs**
Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5102**					
TITLE OF THE COURSE	**BIOMOLECULES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To create in depth understanding about fundamentals of biomolecules, their structure and significance.
- To know about the structural and functional classification of biomolecules

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be able to draw structures of biomolecules and comprehend their properties based on the structures.	L2
CO2	They will have a better understanding of metabolism of these biomolecules in second and third semesters.	L3

COURSE CONTENT:	
MODULE 1 CARBOHYDRATES	**13 Hrs**
Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides. **Complex Carbohydrates:** Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.	
MODULE 2 AMINO ACID AND PROTEINS	**13 Hrs**
Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination –amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent. **Secondary structure**: α-, PP-, 310 and π-helix, β pleated sheet, β and bend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains	
MODULE 3 PROTEIN CONFORMATION AND FOLDING	**13 Hrs**
Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.	

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition. **Protein folding:** Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins-protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

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MODULE 4 LIPIDS AND NUCLEIC ACID	**13 Hr**

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation. **Nucleic acids:** Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.
List of Laboratory/Practical Experiments activities to be conducted (if any) :
1 No
2 No

TEXT BOOKS:

1.Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5103**					
TITLE OF THE COURSE	**MOLECULAR GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Laying foundation in genetics with classical Mendelian and Non-Mendelian genetics.
- Understanding central principles and fundamental mechanisms for the organization, replication, expression, variation, and evolution of the genetic material.
- Theoretical knowledge about modern molecular genetic methods and tools.
- Insights into how molecular genetics contributes to progress in areas like medical genetics, cancer, and population genetics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will exhibit a comprehensive knowledge base in Molecular Genetics.	L2
CO2	The course will emphasize commonalities between different types of organisms, and will therefore be useful	L3

	for students with many different types of specializations or interests.	
CO3	A main theme of the course is to understand molecular genetics as an experimental discipline, and to appreciate how knowledge in the field is based on experimental evidence.	L3
CO4	Students will appreciate the interplay between genotype and phenotype and how it affects complex disease traits.	L4

COURSE CONTENT:

MODULE 1 Concepts in Genetics and Genomics	**13 Hrs**

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2 Molecular Mechanisms of Recombination	**13 Hrs**

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific

recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA	
MODULE 3 Molecular Basis of Mutation and Transposable Genetic Elements.	**13 Hrs**
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. **Transposons and Molecular mechanism of transposition:**Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis	
MODULE 4 Sex Determination and Cancer Genetics	**13 Hrs**
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). **Medical Molecular Genetics:** Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1No
2No

TEXT BOOKS:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5104**					
TITLE OF THE COURSE	**GENERAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To deliberate existing theories about the origin of life, microbial evolution and systematics
- To understand basic techniques, morphological, biochemical and cultural characteristics
- To study the applications of microbes with respect to various

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students are equipped with strong grounding in fundamental aspects of the basic microbiology.	L1
CO2	Enable to understand the diversity of microbial, structure, function and their environment	L2
CO3	To apply the importance of microbes in different fields and enable students to employ the knowledge	L3

COURSE CONTENT:

MODULE 1: History and Systematics of Microorganisms **13Hrs**

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques **13Hrs**

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope,

Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification

techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.
MODULE 3: Applied Microbiology-I **13Hrs**
Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveria bassiana*. Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.
MODULE 4: Applied Microbiology-II **13Hrs**
Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals. **Industrial Microbiology**: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS :

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company.

4 Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.

5 Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1 Edward Alcamo. Microbiology. Cliffs Notes 1996.

2 Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.

3 Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.

4 Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5105**					
TITLE OF THE COURSE	**BIOINFORMATICS – I (PROTEOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand proteins at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating proteomic targets

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L2
CO2	They will have an understanding of composition of inorganic materials.	L3

COURSE CONTENT:

MODULE 1	**13 Hrs**

History, scope, definitions and basic concepts in bioinformatics and its relation with molecularbiology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introductionto networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2	**13 Hrs**

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling- principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5106**					
TITLE OF THE COURSE	**BIOSTATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To demonstrate the significance of statistical analysis in biology.
- To understand basic definitions, usage of proper mathematical calculations to analyse the biological data

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be able to execute and understand proteins at a virtual platform which will enable them for pharmaco-proteomic studies	L3

COURSE CONTENT:

MODULE 1 Measures of Central Tendencies, Dispersion And Correlation	**13 Hrs**
Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance	
MODULE 2 Probability Distributions and Testing of Hypothesis	**13 rs**
obability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5171**					
TITLE OF THE COURSE	**ANALYSIS OF BIOMOLECULES - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To familiarize the students with good lab practice and laboratory instruments.
- To create in depth understanding about detection of biomolecules.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L3
CO2	They will have an understanding of composition of inorganic materials.	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Estimation of lactose in milk by Miller's method

2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

TEXT BOOKS:

1. 1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**21MSC5172**					
TITLE OF THE COURSE	**TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To equip students with the basic microbiological techniques
- To gain insight to different genetic interactions and their effect on phenotype
- To understand the role of allele frequency in evolution and genetic diversity

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand microbial structure, functions and their environment	L3
CO2	Students will be capable to recognise various gene interactions, predict crosses and decipher the role of alleles in inheritance.	L3
CO3	Ability to calculate allele frequency and its role in genetic diversity.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1.	Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2.	Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3.	Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4.	Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus* and *Puccinia*.
5.	Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria and Rivularia.*
6.	Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7.	Study of mitosis in onion root tips
8.	Study of *Drosophila* mutant types.
9.	Mounting of polytene chromosomes – in *Drosophila.*
10.	Preparation of buccal smear to study Barr bodies.

TEXT BOOKS :

1. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

REFERENCES :

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5201**					
TITLE OF THE COURSE	**METABOLISM – I**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- Learning structure and reactions of carbohydrates and amino acids used in metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown carbohydrates and amino acids for release of energy.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to draw structure of mono, di and polysaccharides and amino acids. They will have an in depth idea about the role these biomolecules play in energy storage and usage.	L3
CO2	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems.	L3

COURSE CONTENT:	
MODULE 1 Carbohydrate metabolism	**13 Hrs**
Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle- scheme; Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins.	
MODULE 2 Disorders of Carbohydrate metabolism	**13 Hrs**
Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves, and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria.Introduction to metabolomics.	
MODULE 3 Amino acids and peptides	**13 Hrs**
General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Synthesis of porphyrin rings and their breakdown into billirubin. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.	
MODULE 4 Metabolism of standard amino acids	**13 Hrs**

Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(2099).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5202**					
TITLE OF THE COURSE	**HUMAN PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To give a detailed idea about various physiological systems in human beings.
- To make the students understand the biochemical reactions and physical process that underline biological systems

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be equipped with knowledge about several physiological processes.	L3
CO2	The student will be aware of the biochemical basis of human physiology	L3

COURSE CONTENT:

MODULE 1	**13 Hrs**

Tissue level of organization

Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues.

The muscular system

Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism.

MODULE 2	**13 Hrs**

Nervous system: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin

Endocrine system: Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by

parathyroid hormone, calcitonin and vitamin D.

MODULE 3	**13 Hrs**

Cardiovascular system: Functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center.

Respiratory system: Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.	
MODULE 4	**13 Hrs**
Digestive system: Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food **The urinary system:** Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)
2. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (2097).
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (2095).
6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).
7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (2097)
8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (2098)
9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (2091).
10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (2083).
11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (2086).
12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5201**					
TITLE OF THE COURSE	**MOLECULAR BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To introduce the basic concepts of central dogma of molecular biology
- To provide in-depth knowledge of DNA replication and repair mechanisms with proteins involved in these processes.
- To give substantial knowledge on the processes involved in gene expression and its regulation in prokaryotes and eukaryotes.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will understand the key events of central dogma comprising mechanism of replication, transcription and translation.	L1
CO2	Student will understand the molecular mechanisms of expression, regulation, and maintenance of genetic information, within a biological system.	L2
CO3	Student will be able to critically think in the field of application of molecular biology.	L3

COURSE CONTENT:

MODULE 1: DNA replication and repair	**13Hrs**

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA.C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene expression – Transcription	**13Hrs**

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases,

Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination- Rho dependent and Rho independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, elongation and termination.

Post transcriptional modifications of mRNA (5' cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene expression- Translation	**13Hrs**

Protein synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly,

mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in eukaryotes.

Protein targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.	
MODULE 4: Regulation of gene expression in prokaryotes and eukaryotes.	**13Hrs**
Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage. **Regulation of eukaryotic gene expression**: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, post-transcriptional control. **Gene Silencing:** transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS :

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition)
2. James D. Watson. Molecular Biology of the Gene (7th Edition)
3. Benjamin A Pierce. Genetics A conceptual approach (5th Edition)
4. Robert Weaver. Molecular Biology. (4th Edition)
5. Nancy L Craig. Molecular Biology: Principles of Genome Function.

REFERENCES :

1. Pukkila P J., 2001. Molecular Biology: The Central Dogma. (https://doi.org/10.1038/npg.els.0000812)
2. Mejía-Almonte, C., Busby, S. J. W., Wade, J. T., van Helden, J., Arkin, A. P., Stormo, G. D., … Collado-Vides, J. (2020). Redefining fundamental concepts of transcription initiation in bacteria. Nature Reviews Genetics. (doi:10.1038/s41576-020-0254-8)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5202**					
TITLE OF THE COURSE	**ANALYTICAL TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES :

- To create detailed understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To acquaint students with concepts, principles and advanced application of cuttingedge techniques.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will receive adequate knowledge of high-end techniques like Microarray, Mass spectroscopy & NMR	L3
CO2	Students will be able to have a basic understanding of techniques used in drug discovery.	L3

COURSE CONTENT:

MODULE 1	**13 Hrs**
Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **Structural elucidation:** CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.	
MODULE 2	**13 Hrs**
Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques. **Mass spectrometry:** principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips.	
MODULE 3	**13 Hrs**
Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC **Radioactivity:** Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.	
	13 Hrs
MODULE 4	
Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.	

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5203**					
TITLE OF THE COURSE	**BIOINFORMATICS – II (GENOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand genes at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating genomic targets

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to execute and understand genes at a virtual platform which will enable them for pharmaco-genomic studies	L2

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs	
MODULE 2	**13 Hrs**
Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank	

libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files. General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5204**					
TITLE OF THE COURSE	**EVOLUTION AND DEVELOPMENTAL BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Demonstration of how the lives originate from the a-biotic factors in the universe and learn the dynamics of different populations, their interactions with the ecosystems, intricacies and integration of the ecosystems with the populations.
- Understanding of the mechanisms of cell metamorphosis into different cell types, tissues, organs and life

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Have an enhanced skills and knowledge of origin of life, evolution, and development	L2
CO2	Be able to critically analyse the basic concepts and fundamentals of the course and integrate the related fields and pursue this area in the future.	L3

COURSE CONTENT:	
MODULE 1 Ecology and Evolution	**13 Hrs**
Ecology: Introduction, biotic and abiotic factors, Biomes **Population ecology:** Dynamics of population, Population growth-Exponential model Logistic growth model **Community ecology**: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure-Contrasting views **Ecosystems:** Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems **Evolution:** Introduction, Early ideas of evolution, Darwinian view of life. **Speciation and Evolutionary Rates:** The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change. **Natural selection:** Stabilizing, directional, and disruptive selection. **Microevolutionary and Macroevolutionary phenomena:** insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny	
MODULE 2 Developmental Biology	**13 Hrs**
Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5271**					
TITLE OF THE COURSE	**CLINICAL BIOCHEMISTRY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To give a practical idea about various physiological systems in human beings
- To make the students understand the biochemical reactions that underline biological systems and the reactions used to detect them

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be equipped with practical knowledge about several physiological processes and their detection techniques	L3
CO2	The student will be aware of discrepancies in biomolecular levels and thereby detect diseases.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Estimation of sugar from blood and urine
2. Estimation of Hemoglobin in blood by Wong's method
3. Estimation of blood albumin: globulin ratio
4. Estimation of blood cholesterol by Zak and Zlatkis method
5. Estimation of uric acid in urine by Caraway's method
6. Estimation of creatinine in urine by Jaffe's method
7. Estimation of urea in urine by Nessler's reagent
8. Estimation of bilirubin in urine
9. Titratable acidity of urine
10. Serum SGOT/SGPT assay

TEXT BOOKS:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(2076), Tata-McGrawHill.
5. Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5271**					
TITLE OF THE COURSE	**BIO-ANALYTICAL TECHNIQUES - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Practical exposure for biomolecules and their quantification using standard estimations and spectroscopy
- Biophysical equipments will be explored for the analysis of biomolecules

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have hands on practical exposure for quantitation of biomolecules using modern techniques and equipments	L3

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3 Isolation of total RNA from biological source and its analysis
4 Study of conjugation in *E. coli.*
5 Study of mutation in *E. coli* by Physical method (UV).

6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

TEXT BOOKS:

1. 1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5301**					
TITLE OF THE COURSE	**METABOLISM II**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role electron transport chain plays in connecting fuel breakdown and metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown lipids and nucleic acids for release of energy

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to comprehend the integration of metabolism, oxidative phosphorylation and ATP production.	L3
CO2	They will have an in-depth idea about the role lipids play in energy storage and usage.	L3
CO3	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by nitrogen bases and fat to fuel to living systems.	L3

COURSE CONTENT:	
MODULE 1 Bioenergetics	**13 Hrs**
Reduction Potential, Biological redox couplers, Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H^+ pumping by bacteriorhodopsin.	

MODULE 2 Nucleotide Metabolism	13 Hrs
Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.	
MODULE 3 Lipid metabolism	**13 Hrs**
Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, scheme and energetics of β-oxidation, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders.	
	13 Hrs
MODULE 4 Cholesterol and Circulating lipids	
Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds, Non steroidal anti-inflammatory drugs (NSAIDs).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed
4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5302**					
TITLE OF THE COURSE	**ENZYMOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning about enzyme properties and coenzymes
- Knowledge of enzyme assay, enzyme kinetics and drawing enzyme assisted reaction plots.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Brief idea about regulation of enzyme activity along with enzyme Inhibition.	L3
CO2	Studying active site structure and catalysis.	L3

COURSE CONTENT:

MODULE 1 Introduction to Enzymes	**13 Hrs**
Introduction to enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes. **Coenzymes**: The mechanistic role of the following coenzymes in enzyme catalysed reactions – nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B	
MODULE 2 Enzyme Kinetics	**13 Hrs**
Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. **Kinetic data evaluation**: linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy	
MODULE 3 Enzyme Inhibition	**13 Hrs**
Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation	
	13 Hrs
MODULE 4 The investigation of active site structure	
The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labelling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies.	

Enzyme catalysis**:** Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin), sulphydryl enzymes (alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase).

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (2099).
4. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2080).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (2076).

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**20MBC5321**
TITLE OF THE COURSE	**IMMUNOLOGY**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.	L2
CO2	Student will gain fundamental knowledge about the consequences of immune system failure. They will also gain insights about the spread of cancer and its therapeutics	L3

COURSE CONTENT:

MODULE 1 Introduction and Innate Immunity	10 Hrs
Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. **Innate immunity**: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous.Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.	
MODULE 2 Antigen Antibody interactions	**10 Hrs**
Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins. **Antigen recognition by T cells**: T_H, T_C and T_{Reg} cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.	
MODULE 3 Lymphocyte development and inflammation	**10 Hrs**
Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition. **Transplantation and Network theory**: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory	
	10 Hrs
MODULE 4 Pathoimmunology & immunotechniques	
Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis **Immuno-techniques**: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flow cytometry.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No

2. No

TEXT BOOKS :

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).

2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).

3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).

4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).

5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).

6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).

7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).

REFERENCE PAPERS

8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57– 70 (2000).

9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5322**					
TITLE OF THE COURSE	**MOLECULAR PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have an idea as to how hormones control the physiology of an organism via signallingmechanisms.	L3
CO2	They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.	L3

COURSE CONTENT:	
MODULE 1 Endocrine signaling	**10 Hrs**
Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine / serotonin); Ion– channel (ACh); Tyrosine kinase (RTK), [insulin] and Intrinsic enzyme / cytokine, receptors.	

Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+}, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.	
MODULE 2 Nerve signalling and neurotransmitters	**10 Hrs**
Nerve signaling: Morphology of a neuron. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential. Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate/GABA) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).	
MODULE 3 Nuclear signaling and Cell Cycle	**10 Hrs**
Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. **Cell Cycle**: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation. **Stem Cells**: Embryonic and adult stem cells; unique properties, and potential applications.	
	10 Hrs
MODULE 4 Apoptosis and Cancer	
Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments. **Cancer:** Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases and JAK-STAT pathways). Concept of tumor suppressors.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey,(1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5323**					
TITLE OF THE COURSE	**GENETIC ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To understand how DNA can be manipulated using different enzymes.
- Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
- Diverse methods to visualise modified genetic materials.
- Applications of genetic engineering.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L3
CO3	Students will also learn various applications where genetic engineering can be used	L3

COURSE CONTENT:	
MODULE 1 Basic Concepts	**10 Hrs**
DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors;	

Homopolymeric tailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.

MODULE 2 Cloning and expression vectors	**10 Hrs**
Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
MODULE 3 Cloning strategies and study of protein-DNA interactions	**10 Hrs**
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
	10 Hrs
MODULE 4 Sequencing, PCR and its applications	
Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform). PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition,

S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5324**					
TITLE OF THE COURSE	**MEMBRANE BIOCHEMISTRY AND NANO SCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role lipids play in maintaining plasma membranes and techniques to isolate and study membranes.
- Learning about nanotechnology and its application in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have a theoretical knowledge about isolating plasma membranes and studying its components to draw conclusions about the multitude of role played by membranes.	L3
CO2	They will have an in-depth idea about nanotechnological solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:	
MODULE 1 Lipid properties	**10 Hrs**
Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolpin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.	

MODULE 2 Membrane topology	**10 Hrs**
Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Erythrocyte ghosts; Classification of membrane proteins based on membrane-protein interaction. Techniques for determination of membrane protein topology: Biophysical methods: X-ray crystallography, Freeze-fracture electron microscopy, Lateral and rotational diffusion of integral membrane proteins. Fluorescence photobleaching recovery (FRAP). Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.	
MODULE 3 Nanoscience	**10 Hrs**
Definition of Nanoscale, Scientific revolution-Atomic Structure and atomic size. Nanoparticles – properties, emergence and challengs of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nanotoxicology.	
	10 Hrs
MODULE 4 Nanobiotechnology	
Synthesis of nanoparticles and nanostructures – bottom-top and top-bottom approaches, Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, synthesis and functionalization of Graphene, electronic application of Graphene. Applications of nanoscience in biological systems - drug targeting, drug delivery and biomedicine, Bionics and Biomimicry. Scanning Tunneling microscope, Atomic force Microscopy, Zetasizer.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural nanomaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5325**					
TITLE OF THE COURSE	**PHYTOCHEMICALS AND MICROBIAL SECONDARY METABOLITES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learning the role of phytochemicals and microbial metabolites.
- Learning the qualitative and quantitative with its application in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have a theoretical knowledge about isolation and characterization of phytochemicals and microbial metabolites, this enables the student to draw conclusions about the multitude of role played by phytobioactives.	L3
CO2	They will have an in-depth idea about phytochemical and microbial metabolites solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:	
MODULE 1 Introduction to Phytochemicals	**10 Hrs**
Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level. Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, concentration and evaporation techniques, lyophilisation.	
MODULE 2 Methods to analyse Phytochemicals	**10 Hrs**
Techniques for quantitative and structural analysis of plant secondary metabolites: Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry. Application of UV/Visible, IR, 1H and 13C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).	
MODULE 3 Microbial metabolites	**10 Hrs**

Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process. Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application. Lactic acid: Nutrient media, production process recovery and purification. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.	
	10 Hrs
MODULE 4 Special Microbial Metabolites	
Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine). **Health care products**: Industrial production and recovery: Penicillin and Streptomycin. **I P R**: Patents: Patent regulations of processes, products and microorganisms.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
3 No
4 No

TEXT BOOKS :

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology II Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IV Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher.
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5371**					
TITLE OF THE COURSE	**ENZYMOLOGY AND PROTEIN PURIFICATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- Learn about the nature of enzymes and their mode of action along with the analytical techniques of protein purification.
- To learn isolation and purification of enzymes with classical examples.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn enzymology and analytical techniques which can be used to understand biomolecules specific to proteins.	L3

CO2	It will also enable them to learn protein chemistry techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation and assay of phosphatase; effect of dilution
2. Effect of substrate on phosphatase
3. Effect of Temperature & pH on phosphatase
4. Inhibition kinetics of phosphatase by L-B plot
5. Extraction of phosphatase from plants and stepwise purification through organic acid
6. precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
7. Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
8. Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation.
9. Criteria of purification of phosphatase visualized through SDS-PAGE.
10. Concepts of Isoelectric Focusing (Demonstration)

TEXT BOOKS:

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)

2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)

3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)

4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).

5. Biochemical Calculations, Irwin H. Segel (2076) 2nd Ed. John Wiley and Sons.

6. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith

Wilson and John Walker (2012).

7. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21MBC5372**					
TITLE OF THE COURSE	**GENETIC ENGINEERING & IMMUNO TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES:

- Learn molecular techniques to modify DNA, introduce foreign DNA in *E.coli* host and express proteins.
- To learn immune techniques used as diagnostic tools.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach diagnostic immune techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. PCR amplification and analysis by agarose gel electrophoresis.
2. Preparation of plasmid DNA from E. coli.
3. Restriction digestion and Restriction mapping
4. Ligation
5. Preparation of competent E. coli. cells
6. Transformation in E. coli.
7. Induction of protein expression and analysis by SDS-PAGE
8. Serum Separation from whole blood and isolation of immunoglobulins from serum.
9. Study of different cells in whole blood using Giemsa/Leishman stain.
10. Blood grouping
11. ELISA/Dot ELISA
12. Radial Immunodiffusion/Ouchterlony Double Diffusion
13. Rocket Immuno Electrophoresis
14. WIDAL/RPR Test

TEXT BOOKS:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.

7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.

8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London

9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21MSC5301**					
TITLE OF THE COURSE	**CLINICAL RESEARCH**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

- To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
- To equip students with the proper designing and planning of clinical trial.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L2
CO2	Students will gain the concepts of designing and monitoring of clinical trial studies.	L3

COURSE CONTENT:	
MODULE 1 Concepts of Clinical Research	**13 Hrs**
General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd).* maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50} & ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.	
MODULE 2 Regulatory Perspectives of Clinical Research	**13 Hrs**
Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration. Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator,	

Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	**III**
YEAR	**II**
COURSE CODE	**21MSC5302**
TITLE OF THE COURSE	**SCIENTIFIC WRITING AND IPR**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
		-	-

COURSE OBJECTIVES:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.	L2
CO2	They will also get an idea about patent laws and will know how to file a patent	L3

COURSE CONTENT:

MODULE 1 Scientific writing	**13 Hrs**
Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism. Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.	
MODULE 2 Intellectual Property Rights	**13 Hrs**
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights. Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Right Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)

5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

M.Sc. – BIOCHEMISTRY SYLLABUS

SEMESTER – IV

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5303**					
TITLE OF THE COURSE	**RESEARCH METHODOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2		**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Students understand research terminology one that can be used to carry out different approaches to research

2. To be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge of research processes (reading, evaluating and developing)	L2
CO2	Compare and contrast qualitative and quantitative research	L4

COURSE CONTENT:	
MODULE I	**13Hrs**
Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.	

MODULE II:	**13Hrs**
Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimentaland sample designs. Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20MSC5401**					
TITLE OF THE COURSE	**PROJECT WORK**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**36**	**-**	**18**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations

2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB101
TITLE OF THE COURSE : BACTERIOLOGY AND VIROLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: HISTORY AND SYSTEMATICS OF MICROORGANISMS 13HOURS

History and development of Microbiology: Scope and Applications of Microbiology, discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germtheory of diseases. Contributions of Louis Pasteur and Robert Koch. Microbial Systematics:

Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization.

Techniques in taxonomy: Chemotaxonomy, Numerical Taxonomy, Molecular taxonomy, Serology and Phage typing. Concepts and Applications of Bergey's manual of systematic anddeterminative bacteriology.

MODULE 2: BACTERIOLOGY 13HOURS

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time;Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of micrororganisms based on environmental and nutritional requirements.

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement;flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly Hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. Reproduction in bacteria.

MODULE 3: SPECIAL MICROBIAL FORMS 13HOURS

Ultrastructure, classification. cultivation, reproduction and importance of Archaebacteria, Myxobacteria, Sheathed, budding and appendaged bacteria, Spirochaete, Rickettsia, Chlamydiae,

Mycoplasma, Actinomycetes, Cyanobacteria.

MODULE IV: VIROLOGY **13HOURS**

History of Virology, General properties of viruses, ICTV and classification of viruses, Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), general replication of viruses. Cultivation, purification and assay of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV). (Ultra-structure, replication and importance).

General Account and Importance of Viriods and Prions.

REFERENCES:

1. Addison Wiesley, New York. Holt J.G., Kreg N.R., Sneath PHA, Staley J.T and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994.
2. Balows, A., H.G., Dworkin, M., Harder, W and Schleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
3. Breiman, L., Friedman, J.H., Olsen, R.A and Stone. C.J. Classification and Regression Trees.
4. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
5. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
6. Edward Alcamo. Microbiology. Cliffs Notes. 1996.
7. Eldowney, S.Hardmen, D.J and Waite, S. Pollution. Ecology and Biotreatment. Longman Scientific Technical. 1993.
8. Flint L.W.,Enquist, V.R., Racaniello and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2000.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
10. Johri, B.N. Extremophiles. Springer Verlag., New York. 2002.
11. McKinney, R. Environment Microbiology. Principles and applications. Science Publishers. 2004.
12. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
13. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition. Pub.1986.
14. Nigel Dimmock N, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
15. Schlegel,H.G. General Microbiology, Cambridge University Pres.
16. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
17. Salle, A.J. Principles of Microbiology, 2ndedition., 1997, Mc Graw Hill.1997.

18. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.
19. Dubey, R.C. Microbiology 1st Edition. Chand and company
20. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
21. Pelczar, M.J., Chan, E.C.S., and Kreig N.R. Microbiology Tata McGraw-Hill Pub.1986.
22. Breiman, L., Friedman, J.H., Olsen, R.A. and Stone. C.J. Classification and Regression Trees.
23. Felsentein, J. Numerical Taxonomy, NATO ASI series, Springer-Verlag, New York. 1961
24. Edward Alcamo. Microbiology. Cliffs Notes 1996.
25. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
26. Ec. Eldowney, S. Hardmen, D.J., and Waite, S. Pollution: Ecology and Biotreatment. Longman Scientific Technical. 1993.
27. Jacquelyn G. Black, Larry M and Lewis. Microbiology: Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
28. S.J. Flint L.W. Enquist, V.R. Racaniello and A.M. Skalka. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2004
29. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
30. Balows, A., H.G., Dworkin, M., Harder, W.,andSchleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
31. Madigan and John M Martinko, Paul V. DunlP, David P. andClark Benjamin Cummings Brock Biology of Microorganisms (12th edition), 2008.
32. H.G. Schlegel. General Microbiology., Cambridge University Pres
33. Johri B.N. Extremophiles. Springer V erlag., New York. 2002.
34. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
35. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997
36. *Addison Wiesley*, New York. Holt JG, Kreg NR, Sneath PHA, Staley JT and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994
37. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB102
TITLE OF THE COURSE : EUKARYOTIC MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: PHYCOLOGY — 13 HOURS

Comparative study of Eukaryotic and Prokaryotic cells and its significance**.** General characteristics of Algae, occurrence, thallus organization, classification, ultra structure of cell, vegetative, asexual and sexual reproduction. Algal life cycles- Haplontic, Diplontic,Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

MODULE 2: MYCOLOGY — 13 HOURS

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, fungal spores – dormancy and dispersal.

Type studies: Aspergillus, Yeast, Pythium, Rhizopus, Fusarium, Puccinia and Agaricus (Classification, Ultrastructure, reproduction, lifecycle, importance)

MODULE 3: FUNGAL PHYSIOLOGY & REPRODUCTION — 13 HOURS

Reproduction (asexual and sexual). Fungal growth (yeast cell cycle and growth of hyphae); mechanism of growth in Fungi; measurement and kinetics of growth, nutritional and environmental requirements. Fungal life cycles, mating system and genetic exchange, sex hormones in fungi; physiological specialization, phylogeny of fungi. Saprotrophic, parasitic, aquatic, endophytic, keratinophilic, coprophilous and mutualistic fungi. Economic importance of fungi.

MODULE 4: PROTOZOOLOGY — 13HOURS

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Trichomonas,Paramecium, Amoeba, Entamoeba* and *Plasmodium.* Cultivation of protozoa.

REFERENCES:

1. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
2. D.K. Maheshwari. Industrial Exploitation of Microorganisms. I.K. International Publishing House Ltd.NewDelhi.. (2009)
3. JIS Khattar.. Algal Biology and Biotechnology. I.K. International Publishing House Ltd.NewDelhi,(2009)
4. K R Sridhar. Frontiers in Fungal Ecology, Diversity and Metabolites. I.K. International Publishing House Ltd.NewDelhi.(2009)
5. Marjorie Cowan, Kathleen Park Talaro. Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.(2009)
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
7. M.K.Sateesh. Comprehensive Biotechnology (Microbiology and Biostatistics). New Age International Publishers, New Delhi-110 002, India. (2007).
8. R.C. Kuhad. Lignocellulose Biotechnology: Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi.(2006)
10. A.V.S.S. Sambamurty. A Textbook of Algae. I.K. International Publishing. (2005).
11. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford(2005).
12. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications.(2002).
13. Alexopoulos, C. J. and Mims, C.W.. Introduction to Mycology, Wiley.(2001)
14. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora A.. Recent Advances in the Exploitations of Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2001)
15. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora, ABiofertilizers- Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2000).
16. Becker, E.W. Microalgae: Biotechnology and Microbiology, CambridgeUniversity Press.(1994)
17. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (1994).
18. Janet R Stein Phycological methods. Cambridge university press. (1975).
19. Chapman, V.J. and chapman, D.J. The Algae. English language book society & MacMillan(1973).

SEMESTER/YEAR : **I SEM**
COURSE CODE : **17MMB103**
TITLE OF THE COURSE : **MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY**
L: T/A: P: C : **4: 1: 0: 5**

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: BIOMOLECULES **13 HOURS**

Carbohydrates: Structure of mono, di and polysaccharides, asymmetric centre in sugars, dextro and leavo-rotatory, anomers, epimers, reducing and non-reducing sugars. Oligo saccharides – starch, glycogen and chitin. Complex carbohydrate.

Amino acids and Proteins: Structure of amino acids, classification of amino acids, amino acids as acids and bases, peptide linkage, Classification of proteins, Structural organisation of proteins (primary, secondary, tertiary and quaternary) N-terminal and C-terminaldetermination.

Lipids: Structure of saturated, unsaturated fatty acids, phospholipids**,** glycolipids and steroids; structure and function of fat soluble vitamins A, D, E and K.

Nucleic acid: Structure of Nucleotides, Nucleosides and Bases, Nucleotide Coenzymes (NAD, Coenzymes A);

MODULE 3: METABOLISM **13 HOURS**

Photosynthesis: Photosynthetic pigments, light reactions in eukaryotes, cyanobacteria,green and purple bacteria, process of photosynthesis with special reference to microorganisms.

Fermentation: Alcohol fermentation, Lactic acid: Homo and Heterolactic fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Briefaccount of porphyrins.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. **Bioluminescenc**e – mechanism and significance.

MODULE III: BIOENERGETICS **13 HOURS**

Introduction, Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Energy production in aerobic and anaerobic organisms: Structure of bacterial and mitochondrial ATPase, Substrate level phosphorylation; Electron transport chain and Oxidative phosphorylation: generation and maintaince of PMF, inhibitors and un-couplers of electron transport system, phosphorylation potential and its importance.

MODULE IV: METABOLITE TRANSPORT AND ENZYMOLOGY 13 HOURS

Metabolite transport: Facilitated diffusion mechanosensitive channels, ATP- binding cassette transport family, chemiosmotic driven transport, ion ingredients, specific transportsystem: ATP-linked ion motive pumps, histidine permease, iron, phosphorous transferase system.
Microbial stress responses: oxidative, thermal and heat shock response.

Enzymes: Definition, classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit, isozymes, enzymes kinetics; Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters. Principles and mechanism of reversible and irreversible enzyme inhibition, Ribozymes and abzyme.

REFERENCES:

1. Berg Jeremy, Tymoczko John, Stryer Lubert. *Biochemistry* 4th Ed, W. H. Freeman, New York. 2001.
2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H. *Outlines of Biochemistry* 5th Ed , John Wiley and Sons, New Delhi.1987.
3. Dawes Edwin A. *Quantitative Problems in Biochemistry*, Churchill Livingston,Edinburgh.1972.
4. Hall D. D. and Rao K. K. *Photosynthesis* 5th Ed., Cambridge University Press.
5. Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London.1996.
6. Lehninger. Principles of Biochemistry, 3rd edition by Nelson & Cox (Worth) pub.2000.
7. Linda Sherwood and Chris Woolverto. Prescott's Microbiology, **8th Edition**McGraw-Hill.2011.
8. Metzler David E. *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California. 2001.
9. Moat Albert G. and Foster John W. *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.1988.
10. Nelson D. L. and Cox M. M. *Lehninger's Principles of Biochemistry*, Fourth edition, W.H. Freeman & Co. New York. 2005.
11. Palmer Trevor. *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England. 2001
12. Segel Irvin H. *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York. 1997.
13. Stanier R. Y., Adelberg E. A., Ingraham J. L.*General Microbiology*, 4th edition, Mac Millan Press, London.
14. Voet Donald and Voet Judith G. *Biochemistry*, 2nd Ed.. John Wiley and sons New York. 1995.
15. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.1983.

16. White David. *Physiology and Biochemistry of Prokaryotes.* 2nd Ed. Oxford University Press, New York. 2000.
17. Zubay Geoffrey. *Biochemistry*, 4th Ed., W. C. Brown, New York.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB104
TITLE OF THE COURSE : MICROBIAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: MICROBIAL TECHNIQUES 13 HOURS

Microscopy: History and development of microscopes, Principles and concepts of microscopy, Working principles of compound, dark filed, phase contrast, fluorescent, confocal, interference, polarizing, electron microscopy (TEM and SEM) and atomic force microscope; micrometry.

Stains and Staining techniques: Principles, protocols and applications of stains and staining techniques. Simple, differential and vital staining techniques.

Control of microorganisms: Terminologies, principles and applications of sterilization. Physical and chemical methods of control of microorganisms

Pure Culture Techniques: Isolation of pure cultures; serial dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics ofcultures, fatty acid analysis, Fluorescent in situ hybridization (GISH) genomic in situ hybridization (GISH)

MODULE 2: MICROBIAL CULTURE AND GROWTH TECHNIQUES 13 HOURS

Microbial culture media: Culture media, requirements, types, preparation and uses of different microbial culture media. .

Microbial Growth Measurements: Microbial growth; Concept, growth type, measurement of microbial growth-cell number, turbidity and biomass, determination of microbial growth curve, Continuous and synchronous culture, balanced and unbalanced growth, dioxy-growthcurve, aerobic and anaerobic growth.

Microbial culture preservation: Concept, types of microbial culture preservation, type culture collections. Advantages and limitations of culture preservation techniques.

Microbial Safety measures: Concept, safety measures in handling microbiological samplesand microorganisms.

MODULE 3: CHROMATOGRAPHY AND ELECTROPHORESIS 13 HOURS

pH and Buffers: Preparation of buffers, Henderson and Hesselbach equation, pka and pkb, pH measurements, electrodes and its types, viscometer and osmometer in relation to molecular size and shape, membrane filtration techniques, Dialysis and its applications.

Chromatography: Introduction, Principle types and application of: paper, thin layer, gel permeation, affinity, ion-exchange chromatography, adsorption chromatography, High pressure liquid chromatography and Gas chromatography.

Electrophoresis: Basic principle and application of Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and native PAGE, Agarose gel electrophoresis, capillary electrophoresis, immune electrophoresis, isoelectric focusing, 2D electrophoresis.

MODULE 4: SPECTROSCOPY AND RADIOISOTOPES 13 HOURS

Spectroscopy and Spectrophotometry: Electromagnetic spectrum, Beer- Lamberts law, Principle and application of UV/VS spectroscopy, IR spectroscopy, ESR and NMR spectroscopy, Fluorescence spectroscopy, Atomic absorption spectroscopy, Raman spectroscopy, Mass spectroscopy, circular dichroism, XRD, Microarray.

Radio-isotopes detection and measurements: Nature and types of radiations, stable andunstable isotopes, labelling of biological samples, tracer technique, detection and measurement of radioactivity by Dosimetry, Ionisation chamber, GM counter, Photographic method, Scintillation counter, Autoradiography. Handling methods and safety, non-radioactive labelling.

REFERENCES:

1. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
2. Ackerman, E. I. Biophysical Science. Prentice Hall Inc. NJ, USA. 1962
3. Alonso, A., and Arrondo, J.L.R. Advanced Techniques in Biophysics.Springer,UK.2006
4. An Introduction to Practical Biochemistry: Plummer D. T.
5. Analytical Chemistry: Christion G. D.
6. Arora, M. P. Biophysics. Himalaya Publishing House, New Delhi. 2007
7. Biochemical Techniques theory and practice : White R
8. Biophysical techniques : Principles and techniques Upadhaya and Upadhaya
9. Das, D. Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.1991.
10. Edward, A.L. Radiation Biophysics. Academic Press, NY, USA.1997.
11. Gupta A. Instrumentation and Bio-Analytical Techniques. Pragati Prakashan,Meerut.2009.
12. Hoope, W. et.al. Biophysics. Springer Verlag, Berlin.1983.
13. Narayanan, P. Essentials of Biophysics. New Age International (P) Ltd. Publishers,New Delhi.2002.
14. Nuclear Magnetic Resonance: Williams
15. Roy, R.N. A Textbook of Biophysics. New Central Book Agency (P) Ltd.Calcutta.1996.
16. Srivastava, P.K. Elementary Biophysics. An Introduction. Narosa PublishingHouse, New Delhi.2006.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **17MMB171**

TITLE OF THE COURSE : **GENERAL MICROBIOLOGY AND EUKARYOTIC MICROBIOLOGY**

L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources: Serial dilution and Pure culture techniques.
3. Staining- simple, differential, acid fast, endo spore, capsule, flagella, vital, cell wall and nuclear staining.
4. Determination of bacterial motility by hanging drop method.
5. Determination of microbial size by micrometry
6. Enumeration of microorganisms by haemocytometer.
7. Determination of bacterial growth curve by turbidometry and plate count.
8. Isolation of bacteriophages from sewage.
9. Isolation and identification of fungi from soil: Dilution plate method, Warcup method, stamping method.
10. Isolation of fungi from plant material: Epibiotic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
11. Growth measurement of fungi- linear and biomass.
12. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast,Mucor, Rhizopus, Agaricus, Puccinia,*
13. Isolation and identification of microscopic algae from soil and water
14. Study of algae (permanent slides): Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria, Rivularia,
15. Isolation and identification of protozoans from soil and water.
16. Study of Protozoa (permanent slides): Euglena, Plasmodium, Paramecium, Amoeba,

SEMESTER/YEAR : **I SEM**
COURSE CODE : **17MMB172**

TITLE OF THE COURSE : **MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY**
L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Biochemical tests for identification of bacteria:
   Catalase, Oxidase, IMViC, Gelatin hydrolysis, Hydrogen sulfide production in TSIA , Coagulase, Nitrate Reduction test, Sugar Fermentation test, Casein hydrolysis and Starch hydrolysis. Identification of bacteria by API system. (6 units)
2. Preparation of standard buffers and determination of pH of a solution.
3. Qualitative analysis of proteins.
4. Qualitative analysis of carbohydrates.
5. Quantitative estimation of glucose by DNS method
6. Quantitative estimation of reducing sugars by Benedict's method.
7. Quantitative estimation of protein by Lowry's/ Bradford method.
8. Quantitative estimation of amino acids by ninhydrin method.
9. Study of enzyme kinetics, Km and Vmax of amylase.
10. Separation of amino acids by paper / thin layer chromatography.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB203

TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: SOIL MICROBIOLOGY 13HOURS

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (The rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health; Isolation of soil viruses; Genetic exchange between communities; Biogeochemical cycles-Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE 2: AQUATIC BIOLOGY AND SEWAGE TREATMENT 13 HOURS

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE 3: AEROBIOLOGY 13 HOURS

Aerobiology: Air spora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Green house effect, Ozone depletion , UV radiation and Acid rain. Aeroallergens and Allergies: Causes andtests for detection of aero allergens.

MODULE 4: BIOLEACHING AND BIODEGRADATION 13HOURS

Bioleaching- Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution**.**

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose and lignin paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water 'insitu' remediation- Engineering developments - Construted wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

REFERENCES:

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **17MMB204**

TITLE OF THE COURSE : **FOOD AND DAIRY MICROBIOLOGY**
L: T/A: P: C : **4: 1: 0: 5**

TOTAL HOURS: 52 HOURS

MODULE 1: SCOPE OF FOOD MICROBIOLOGY AND FOOD PRESERVATION 13 HOURS

Scope of food microbiology: Development of food microbiology as a science, scope of food microbiology. Food as a substrate for microorganisms; intrinsic and extrinsic factors affecting the growth of microbes. microorganisms in food and their source.
Principles of Food preservation: Principles of preservation (Asepsis, Removal, Anaerobic conditions). Methods of food preservation (High temperature, Low temperature, irradiation, Drying and Food Additives), Chemical method of Food preservation (Class I and Class II Preservatives). D, Z and F values; Biopreservation, Food Packaging and benefits.

MODULE 2: PRINCIPLES OF FOOD SPOILAGE AND ILLNESS 13 HOURS

Microbial spoilage of food: Causes and sources of food spoilage, Spoilage of Vegetables, fruits, cereals, sugar products, meat and meat products, fish, poultry, canned products and miscellaneous foods. Methods for microbial examination of foods: indicator organisms,direct examination, cultural techniques, enumeration methods and molecular methods.

Foodborne Illness: Food borne Infections and Intoxications. Bacteria –*Clostridium, Bacillus, Brucella, Escherichia, Listeria, Campylobacter, Staphylococci, Salmonella, Shigella, Yersinia*. Virus- Hepatitis A and E, rota viruses, toxigenic algae, Rickettsia, Various parasites, Sea toxicants; Poisoning by chemicals; Mycotoxins (Aflotoxins, Ochratoxins, Fuminosins, Trichothecenes, Zealenone, Ergot alkaloids); Recent methods in detection of food pathogens.

MODULE 3: FERMENTED FOODS AND FOOD REGULATIONS 13 HOURS

Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread, Idli, Nutritional and therapeutic importance, Single cell Protein (Bacteria, Yeast, Algae); Probiotics and Synbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production).

Food Sanitation and Food control Agencies: HACCP, Employees Health standards, GMP, Plant sanitation, Waste treatment, Disposal, Criteria of microbiological quality control. Food control agencies and their regulations.

MODULE 4: DAIRY MICROBIOLOGY: 13 HOURS

Nutritional level of milk, microbial flora of milk, sources of milk contamination

Bacteriology of milk: Incidence and characterization of pathogenic microorganisms in milk, bacteriological aspects of pasteurization, sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant bacteria in milk and their role in milk spoilage; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

Microbiology of dairy products: Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making. Quality standards of milk products.

Advances in Food and Dairy Microbiology: Biosensors in Food Industry; Genetically modified foods; Food fortification; Food parks.

REFERENCES

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. Mc Graw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van Nostrand Rheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8HOURS

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.
Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10HOURS

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.
Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt
Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,
Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8HOURS

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **17MMB271**

TITLE OF THE COURSE : **MICROBIAL GENETICS AND MOLECULAR BIOLOGY**
L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Quantification of DNA by colorimetry/ spectrophotometry
2. Quantification of RNA by colorimetry/ spectrophotometry
3. Conjugation in *E. Coli*
4. Transformation in *E.coli*
5. Antibiotic resitant mutant isolation by gradient plate technique
6. Isolation and electrophoretic analysis of genomic DNA
7. Isolation and electrophoretic analysis of plasmid DNA 8. Isolation and electrophoretic analysis of RNA
9. Identification of lytic and lysogenic cycles in bacteriophage
10. Induction and assay of β -galactosidase
11. Study of replica plating techniques.
12. Mutagenesis: Identification and isolation of fungal mutants [physical (UV)].
13. Genetics problems.
14. Protoplast fusion (Demonstration)

SEMESTER/YEAR : **II SEM**
COURSE CODE : **17MMB272**

TITLE OF THE COURSE : **ENVIRONMENTAL, FOOD AND DAIRY MICROBIOLOGY**

L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Quantification of microorganisms in air.
2. Study of microbial interactions in soil (antagonism)
3. Detection and Estimation of Protein and Polysaccharide in Biofilm.
4. Isolation and characterization of Iron, Manganese and Methanogenic bacteria.
5. Detection of Metal tolerance in microorganisms.
6. Isolation of xenobiotic degrading organisms and estimation of chloride
7. Detection of coliform in water (MPN test)
8. Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
9. Study of Bacteriocin.
10. Study of antimicrobial activity of chemical preservative.
11. Quality test of Fermented Food.
12. Production and estimation of lactic acid by *Lactobacillus* sp.
13. Isolation of food poisoning bacteria from contaminated foods and dairy products
14. Detection of Aflotoxin production (*Aspergillus flavus)*
15. Quality test of milk – Platform and Dye reduction test

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB301

TITLE OF THE COURSE : MEDICAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours: 52 Hours

Module 1: Host Microbe Relationship and Epidemiology 13hours

Normal microbial flora of human body and its significance, tissue tropism.Contamination, Infection and Disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infections, nosocomial infections and non-infectious diseases.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxins.G protein signalling, spreading, tissue damage and antiphagocytic factors.Specific and non specific host defense.Quorum sensing.

Epidemiology-Diseases in population, epidemiological studies,epidemics of emerging and re-emerging diseases,reservoirs of infection, modes of disease transmission, herd Immunity and public health organizations.

Module 2- Bacterial, Fungal and protozoan diseases 13hours

Study of diseases - Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following

Bacterial diseases: *Streptococcus, Staphylococcus, Shigella, Salmonella, Neisseria, Corynebacteria, Vibrio, Yersinia, Haemophilus, Helicobacter, Mycobacterium, Spirochetes-Treponema, Chlamydiae, Mycoplasma.*

Protozoan and Helminthic diseases- *E. histolytica*, *Plasmodium*, *Leishmania,Filaria* and tape worm.

Fungal diseases- Dermatomycosis, Subcutaneous mycosis, Systemic mycosis and Opportunistic mycoses.

Module 3- Viral diseases13hours Etiology, Epidemiology, Pathogenicity, Diagnosis, and Prophylaxis of the following.Viral Diseases- Pox virus, Herpes virus, Varicella-zoster, Adenovirus, Picornavirus, Orthomyxoviruses (influenza), Paramyxovirus (mumps and Measels), Rhabdovirus, Hepatitis viruses, Oncogenic virus, Retrovirus, Arbovirus.
Prion infection.

Module 4- Antimicrobial Prophylaxis and Diagnostic Microbiology. 13hours

Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and antiprotozoans. Methods of testing

drug sensitivity, antibiotic assay in body fluids, drug resistance – causes, mechanism and prevention.Probiotics as therapeutic agents.Brief account of vaccine- Conventional vaccines, Subunit vaccines and DNA vaccines. Immunization schedules. Passive prophylactic measures and Interferons. Principles and applications of Immunological and PCR based diagnostic methods.

Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.

References-

1. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
2. Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virologya text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical micrbiology. Vol2, practical medical microbiology, Churchill Livingstone.
9. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
14. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
15. Warren Levinson (2000) Medical Microbiology and Immunolog: Examination and Board Review 8th Edition. McGraw Hill.
16. Warren Levinson (2000) Medical Microbiologyandimmunolog examination and board review (8th edition) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB302

TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Immune System 13hours

Innate,adaptive, humoral and cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and monoclonal, Complement system – component, properties and functions. Complement pathwaysand biological significance.

Module II: Immune Responses 13hours

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B & T cell development and regulation, B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

Module III: Immune-Mediated Diseases and Transplantation 13hours

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis. Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, xenotransplantation, tolerance.

Module IV: Immunological Techniques and Vaccines 13hours

Immunoprecipitation; Agglutination; Immunoelectrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA Western blotting; Hybridomas and their production.

Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines-live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. novel vaccines-subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abbas &Lichtman&Pillai (2014) Cellular and Molecular immunology,8th edition, Elsevier publisher
2. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
3. C.VamanRao.(2012), An Introduction to Immunology. 2nd edition , Narosa publishing house
4. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
5. K.M.Pavri. 1996, Challenge of AIDS, 2nd edition, National Book Trust, India.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. NY .

SEMESTER/YEAR : **III SEM**
COURSE CODE : **17MMB303**

TITLE OF THE COURSE : **INDUSTRIAL MICROBIOLOGY**
L: T/A: P: C : **4: 1: 0: 5**

Total Credit Hours – 52 hours

Module I: Introduction to Industrial Microbiology **13hours**

Concepts and scope of microbes in industry.Modern era of industrial fermentation technology. Pre-requisite of industrial microorganisms: Screening, isolation, identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process **13hours**

Basic components, design and scale-up of fermenters – Typical fermentor. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Microbial growth in batch fermentor and chemostat.Other types like surface, submerged and solid state fermentation.Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing **13hours**

Upstream processing: Formulation of fermentation media, rheology of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. Effluent treatment.

Module IV: Industrial Bioprocessing **13hours**

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product:

Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin). Applications of genetic engineering in industrial bioprocessing.

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

REFERENCES:

1. Bailey and Ollis (1996) "Biochemical Engineering Fundamentals", McGraw Hill(2nd Ed.).
2. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
3. Dubey, R.C. (2006) "A Textbook of Biotechnology" S.Chand and Co. Ltd.
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication
7. Satyanarayana, U (2005). "Biotechnology" Books and Allied (P) Ltd. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
8. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology-An Introduction, Blackwell Science. Delhi
10. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.

SEMESTER/YEAR : **III SEM**
COURSE CODE : **17MMB322**

TITLE OF THE COURSE : **APPLIED MICROBIOLOGY**
L: T/A: P: C : **4: 1: 0: 5**

(Departmental Elective - 2)

Total credit hours: 52hours

Module 1: Food and Dairy Microbiology **13 hours**

Food as a substrate for microorganisms, spoilage of fruits, vegetables, meats and dairy products.Food preservation, examination, standards for food and milk production. Microbial and Fermented foods- fermented vegetables, meats, beverage and dairy products. Probiotics, prebiotics, synbiotics and nutraceuticals.Quality control and their regulation, HACCP.

Module 2- Environmental Microbiology **13hours**

Aerobiology- Significance of microorganisms in air, air spora in different layers of atmosphere, bioaerosol. Microbiology of indoor and outdoor environment. Air samplers and control of air borne microorganisms.

Aquatic Microbiology- Natural waters, microbial flora of aquatic environment, pollution and water borne diseases. Municipal treatment of drinking and waste water. Water quality assays and public health.

SoilMicrobiology-Soil profile, soil microorganisms, microbial interactions in soil. Bioaccumulation, biomagnification biodegradation and bioremediation,.Bioleaching of Minerals.

Module 3: Industrial and Agricultural Microbiology **13hours**

Industrial Microbiology – Industrially important microorganisms, preservation and strain improvement, design and types of fermenters, upstream and downstream processing, production of beverages, antibiotics, organic acids, and enzymes .

Agricultural Microbiology- Concepts and scope of agricultural microbiology, biofertilizers and biopesticides. Plant diseases, plant defence mechanisms and disease control.

Module 4- Clinical Microbiology and Microbial Biotechnology **13hours**

Clinical Microbiology- Disease epidemics, Role of Microbiologist in diagnostic laboratory, General concepts for specimen collection, handling, processing, laboratory safety and infection control. Disease diagnosis - Microscopic examination, growth and biochemical characteristics, rapid methods of identification.

Microbial Biotechnology: Introduction to microbial biotechnology, applications of microbial biotechnology in the field of medicine, industry, agriculture and environment.

References

1. Alexander M (2000) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009
4. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
5. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
6. Credric A. Mims (2004) Medical Microbiology 3rd edition Mostly Inc.
7. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
8. Fritz H. Kayser (2005) .medical microbiology, TR hiemeVerlag.
9. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
10. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. James M.J Martin, J. Loessner and David, A.G. (2006) Modern food microbiology (7thEds)
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Microbiology by MJ PelczarJr, ECS Chan, NR Krieg 5th edition, Pub: Tata Megra Hill Publising Co Ltd.
15. Norman G Marriott, (1995). Principles of Food Sanitation, 4th Edition, (Chapman and Hall Food Science Book). Aspen Publishers Inc.
16. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
17. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
18. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
19. T.J Montville and K Wikowski, Ic: M.P., Doyle, L.R. Beuchat and T.J., Montville, (Eds). 1997. Fundamentals and Frontiers. ASM Press, Washington DC.

SEMESTER/YEAR : **III SEM**
COURSE CODE : **17MMB371**

TITLE OF THE COURSE : **MEDICAL MICROBIOLOGY AND IMMUNOLOGY**
L: T/A: P: C : **0: 0: 8: 4**

(PRACTICALS)

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Effect of antiseptics on normal microbial flora of hands.
3. Dental caries susceptibility assay by Snyder's agar test
4. Isolation and identification of fungal infections (skin, nail and hair sample).
5. Isolation and identification of nosocomial pathogens
6. Study of blood smear by Giemsa's/ Leishman's staining technique.
7. Study of *M. tuberculosis* by Ziehl-Neelsen (acid fast) staining .
8. Determination of MIC - T- test, Checker board method.
9. Drug susceptibility assay for susceptibility and resistance of antibiotics by Kirby-Bauer method.
10. Isolation of lymphocytes from peripheral blood
11. Serum separation and serological reactions:
    a. Agglutination - Blood grouping and Rh typing
    b. Precipitation reactions:
        i. Ouchtlerlony Double Diffusion,
        ii. Radial Immune Diffusion
        iii. Rocket Immuno electrophoresis
12. Enzyme linked immunosorbant assay / Dot ELISA
13. Purification of IgG by column chromatography
14. WIDAL Test.
15. VDRL Test (RPR).

SEMESTER/YEAR : **III SEM**
COURSE CODE : **17MMB372**

TITLE OF THE COURSE : **INDUSTRIAL MICROBIOLOGY**
L: T/A: P: C : **0: 0: 8: 4**

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production and estimation of amylase from microbial sources.
4. Production of organic acids(lactic acid and citric acid) from microbes.
5. Immobilization technique: whole cell or enzyme- sodium alginate gel method.6. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.7. Laboratory scale production of wine.
8. Estimation of alcohol from different sources by specific gravity method.
9. Alcoholic fermentation and determination of total acidity and non-reducing sugars
10. Detection and quantification of pigment from microbes: Melanin.
11. Detection and quantification siderophore produced by *Pseudomonas* spp.
12. Microbial assay of vitamin B12 and Glutamic acid
13. Sterility tests for pharmaceutical products

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB401

TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND HYTOPATHOLOGYL:
T/A: P: C : 4:1: 0:5

Total Credit Hours – 52 hours

Module I: Plant-Microbe Interactions 13hours

Distribution of microorganisms in soil, Soil fertility evaluation and improvement.Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum). Concepts of Siderophores and VAM with suitable examples.Application of nitrogen fixing genes in rDNA technology in agriculture research.

Module II: Bioinoculants And Biological Control 13hours

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, ~~phos~~phate solubilising microorganisms, Azolla. Carrier-based inoculants – production, applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes Pseudomonas fluroscence, Bacillus thuringiensis, Trichodermaharzianum, Trichodermaviridae, Nuclear Polyhedrosis Virus. Production, applications and limitations.

Module III: Host Pathogen Interaction And Defense Mechanism 13hours

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Kochs' postulates. Parasitism and disease development: Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant – Mechanical forces, Microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defenses (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, plantibodies

Module IV: Plant Diseases And Their Management 13hours

Plant diseases- Red rust of tea and Algal Leaf Spot (Algae), Grain and head smut of Sorghum, tikka disease of ground nuts, red rot of sugarcane and wilt of tomato (Fungi), Root knot of mulberry and lesion nematode disease (Nematode). Tobacco mosaic disease and Papaya

ring spot (Virus), Sandal Spike Disease and grassy shoot of sugarcane (Mycoplasma), Bacterial blight of Paddy, Citrus canker and fire blight of apple (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept.Diagnosis of plant diseases, regulatory, farming education and awareness.

References

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.

17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB421

TITLE OF THE COURSE : CLINICAL MICROBIOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 1)

Total Credit hours: 52 hours

Module 1- Host Pathogen interaction and disease epidemics 13hours

Normal microbial flora of human body and its significance, infection and disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infectious and Non infectious diseases.Emerging and remerging pathogens.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxin. Epidemiology-Diseases in population, epidemiological studies, reservoirs of infection, modes of disease transmission, herd immunity and public health organizations.

Module 2: Infectious Diseases of Human Organ Systems 13hours

Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following diseases of the skin and eyes, urogenital diseases, disease of respiratory systems, oral & gastrointestinal diseases and wound infections. Cardiovascular, lymphatic diseases,zoonoses and vector transmission of human disease.Air, food and waterborne disease transmission. Immunization, Antimicrobial chemotherapy and drug resistance.

Module-3- Hospital acquired Infections (Nosocomial Infections) 13hours

Common types of hospital infection, diagnosis and control of hospital infection. Prevention of common hospital acquired infections, maintenance of hospital, surroundings and intravascular & indwelling devices. Role of the healthcare staff in infection control, restrictions in hospitals.Needle Stick Injury, vaccination of healthcare workers.Biosafety in biological laboratories.

Module 4- Diagnosis and Biomedical waste management. 13hours

Collection, transport, processing and storage of biological specimens.Care and handling of pathogens, biological materials and disposal.Laboratory Diagnosis of Infectious Diseases-bacterial, parasitic, viral and fungal diseases. Principles and applications of microscopic, microbiological, biochemical, immunological and molecular diagnostic methods.Recent advancements in disease diagnosis – scanning techniques and rapid identification systems.Regulations and accreditation of medical laboratories.Biomedical Waste, classification, types and treatment.

References-

1. Ananthanarayan and Panikar, Textbook of Microbiology for Nurses, University Press.
2. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virology a text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
9. Mackie amdMcCarthey (1996) Medical Microbiology. Vol2, practical medical microbiology, Churchill Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. R Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
14. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
15. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
16. Warren Levinson (2000) Medical Microbiology and immunolog examination and board review (8th edition) McGraw Hill.
17. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review 8th Edition. McGraw Hill.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB422

TITLE OF THE COURSE : MICROBIAL BIOTECHNOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 2)

Total Credit Hours – 52 hours

Module 1: History and Advancements in Microbial Biotechnology 13 hours

Introduction to microbial biotechnology, principle, applications, economics and milestones in microbial technology.Manipulation of gene expression in prokaryotes – use of strong and regulatable promoters, fusion proteins, unidirectional tandem gene arrays. Recombinant protein production in eukaryotes – *S. cerevisiae* expression systems, Baculo virus expression vector system, mammalian cell expression vectors. Directed mutagenesis and protein engineering.

Module 2: Applications of Microbial Biotechnology –I 13 hours

Molecular Diagnostics: Immunological diagnostics, monoclonal antibodies, DNA diagnostic systems – diagnosis of Malaria, *Trypanosomacruzi*, molecular diagnosis of genetic diseases – Sickle cell anemia.

Microbial Production of Therapeutic Agents: Interferons, human growth hormone, antibody production in *E. coli*. Vaccines: peptide vaccines, vector vaccines. Antibiotics: Polyketide antibiotics. Single cell proteins.

Module 3: Applications of Microbial Biotechnology –II 13 hours

Biosynthesis of biopolymers: Xanthan gum, animal adhesive biopolymers, rubber, polyhydroxyalkonates. Bioremediation and Biomass utilization: Degradation of xenobiotics, utilization of starch and cellulose. Plant growth promotion: Nitrogen fixation, nitrogenase, nodulation, biocontrol: siderophores, ice nucleation and antifreeze proteins. Microbial insecticides: *B. thuringiensis* and *Baculoviruses.* Brief account on transgenic plants, transgenic animals and human gene therapy

Module 4: Nanotechnology, Bioethics and Biosafety 13 hours

Introduction, tools of nanosciences, synthesis of nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles.

Introduction to Bioethics and biosafety, yeast genome project: its ethical, legal and social implications. Biosafety guidelines and regulations for Genetically Modified Microroganismss, GLP and GMP.Labelling of GM products.Ethics and safety of GM food.

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops.WileyDreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation Publications.(6th Ed.).Black well publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, set. OUP.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB471

TITLE OF THE COURSE : AGRICULTURE MICROBIOLOGY AND PHYTOPATHOLOGY
L: T/A: P: C : 0:0: 8:4

(PRACTICALS)

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation and enumeration of bacteria and fungi from rhizosphere soil.
3. Examination of bacteriodes from legume root nodules
4. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
5. Isolation of phosphate solubilising bacteria and fungi-plate method.
6. Isolation of bioinoculants: *Bacillus thuringiensis, Bauveriabassiana, Trichoderma, Pseudomonas*.
7. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
8. Seed health testing by standard moist blotter (SBM).
9. Effect of seed borne fungi on seed germination and seed vigour.
10. Effect of fungicides on fungal spore germination inhibition.
11. Mass multiplication techniques of Azolla.
12. Isolation and identification of Nostoc in Azolla (from paddy field).
13. Estimation of total phenols in diseased and healthy plant tissues.
14. Sample collection and Identification of following disease:
    Tobacco mosaic disease, Sandal spike, Bacterial blight of paddy, Red rust of tea and Mango, Grain and Head smut of Sorghum, Wilt of Tomato, Root Knot of Mulberry, tikka disease of ground nuts and red rot of sugarcane.
15. Quality control assessment of biofertilizers (vialibity and shelf life).
16. Study of liquid and solid carrier material.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB471

TITLE OF THE COURSE : AGRICULTURE MICROBIOLOGY AND PHYTOPATHOLOGYL: T/A: P: C : 0:0: 8:4

(PRACTICALS)

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation and enumeration of bacteria and fungi from rhizosphere soil.
3. Examination of bacteriodes from legume root nodules
4. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms 5. Isolation of phosphate solubilising bacteria and fungi-plate method.
6. Isolation of bioinoculants: *Bacillus thuringiensis, Bauveriabassiana, Trichoderma,Pseudomonas*.
7. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement ofroot and shoot length).
8. Seed health testing by standard moist blotter (SBM).
9. Effect of seed borne fungi on seed germination and seed vigour.
10. Effect of fungicides on fungal spore germination inhibition.
11. Mass multiplication techniques of Azolla.
12. Isolation and identification of Nostoc in Azolla (from paddy field).
13. Estimation of total phenols in diseased and healthy plant tissues. 14. Sample collection and Identification of following disease:

Tobacco mosaic disease, Sandal spike, Bacterial blight of paddy, Red rust of tea and Mango, Grain and Head smut of Sorghum, Wilt of Tomato, Root Knot of Mulberry, tikka disease of ground nuts and red rot of sugarcane.

15. Quality control assessment of biofertilizers (vialibity and shelf life).
16. Study of liquid and solid carrier material.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MMB5201**					
TITLE OF THE COURSE	**PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To understand microbial diversity, classification, structure of different groups of microbes and their functions
- To strengthen the knowledge on cell and cellular organisation of prokaryotic and eukaryotic systems
- To know about the economic importance

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Enable students to relate the principles in classifying microbes	L3
CO2	Apply the knowledge in identifying different microorganisms and to study their life cycles	L3
CO3	Elucidate the role of beneficial and harmful effects	L5

COURSE CONTENT:

MODULE 1: BIOLOGY OF VIRUS	**13Hrs**
Difference between prokaryotic and eukaryotic microorganisms. Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages - structural organization and life cycle - lytic, lysogenic.Application of viruses. Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV), (Ultra-structure, replication and importance). Viral related agents - viroid and prion.	
MODULE 2: BIOLOGY OF BACTERIA	**13Hrs**
Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur globules), endospores and exospores. Reproduction in bacteria. Special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae, Archaebacteria and extremophiles. **Microbial growth and nutrition**: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of microorganisms based on environmental and nutritional requirements.	
MODULE 3: BIOLOGY OF FUNGI & PROTOZOA	**13Hrs**
General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, Sex and mating in fungi fungal spores – dormancy and dispersal. Type studies: *Aspergillus*, *Saccharomyces*, *Pythium*, *Rhizopus*, *Fusarium*, *Puccinia* and *Agaricus* (Classification, Ultrastructure, reproduction, lifecycle, importance). General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Amoeba, Entamoeba*and *Plasmodium*. Cultivation of protozoa.	

MODULE 4: BIOLOGY OF ALGAE	13Hrs
General characteristics of Algae, occurrence, thallus organization, classification, ultra-structure of cell, vegetative, asexual and sexual reproduction.Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra*. Symbiotic algae: Lichens. Economic importance of algae.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Sambamurty, A.V.S.S.. A Textbook of Algae. I.K. International Publishing. (2005).
2. Alexopoulos, C. J. and Mims, C.W. Introduction to Mycology, Wiley.(2001)
3. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
4. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press. 2005
2. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MMB5202**					
TITLE OF THE COURSE	**MICROBIAL PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**0**	**0**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics
- To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the complexity of microbial structures, genetics and metabolism.	L2
CO2	Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment	L4

COURSE CONTENT:

MODULE 1 : MICROBIAL METABOLISM	**13Hrs**

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins.

Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Methanogenesis.

Fermentation: Alcohol fermentation, Lactic acid: Homo- and Heterolactic acid fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones.

Bioluminescence – mechanism and significance.

MODULE 2: ENZYMOLOGY	**13Hrs**

Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups.Effect of temperature, pH and substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action

Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters, hyperbolic and LB plot. Regulation of enzymes: Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive. Ribozymes and abzyme.

MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS	**13Hrs**

Introduction: Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain.

Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation, structure of bacterial ATPase.

Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria. **Anaerobic respiration**: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria.	
MODULE 4 : MICROBIAL CELL MEMBRANE PHYSIOLOGY	**13Hrs**
Metabolite transport: Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in transport, different permeases in E. coli. Transport of aminoacids and inorganic ions in microorganisms (Bacteria and fungi) and their mechanisms. **Stress physiology:** Osmotic stress and osmoregulation by glutamate and disaccharide trehalose, Osmotic Control of Gene Expression. Aerobic to anaerobic transitions in facultative microorganisms (E. coli); Oxidative stress - superoxide dismutase and catalase, Regulation of the Oxidative Stress Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress, stringent Control.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No

TEXT BOOKS :

1. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York.
2. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge
3. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.

4 Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.

REFERENCES :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.

2. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.

YEAR	**I**					
COURSE CODE	**20MMB5271**					
TITLE OF THE COURSE	**PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**0**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To make students learn and identify microbes based on biochemical tests
- To estimate biomolecules by quantitative and qualitative methods

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be equipped with microbial isolation and identification techniques	L2
CO2	Knowledge of estimating biomolecules and enzyme kinetic studies will be imparted.	L1

List of Laboratory/Practical Experiments activities to be conducted (if any):	
1.	Isolation and culturing of fungi (yeasts and molds) by Dilution plate method, Warcup method implant and impression.
2.	Anaerobic culturing methods – anaerobic jar and its use, thioglycollate media culturing.
3.	Isolation and identification of microscopic algae from soil and water.
4.	Isolation and identification of protozoa from soil and water.

5.	Biochemical test: Catalase, Oxidase, IMViC, starch, casein and Gelatin hydrolysis, Hydrogen sulfide production in TSIA, Identification of bacteria by API methods.
6.	Growth measurement of bacteria (turbidity method) and fungi (Linear method).
7.	Estimation of DNA and RNA.
8.	Estimation of proteins
9.	Estimation of enzyme activity – amylase and protease.
10.	Enzyme kinetics – K_m and V_{max} of amylase

TEXT BOOKS :

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Caldwell. D.R. (2095). Microbial Physiology and metabolism, Brown Publishers.

REFERENCES :

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5301**					
TITLE OF THE COURSE	**IMMUNOLOGY AND MEDICAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MMB5201	PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY

COURSE OBJECTIVES :

1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.	L3
CO2	To introduce the classes of antibiotics and the resistant mechanisms encoded in bacteria and to neutralise these antimicrobial agents.	L3
CO3	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L4
CO4		L3
CO5		L2

COURSE CONTENT:	
MODULE 1: Immune System and Immune Responses	**13Hrs**
Innate, adaptive, humoral and cellular immunity. Primary and secondary immune responses. Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Immunoglobulin genes: organization and assembly. Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. T-cell receptor; B and T cell activation. Antigen processing, antigen presentation, Complement system – pathways, component,	

properties and functions. Immune response to cancer. Hypersensitivity reactions - types (I, II, III, and IV).	
MODULE 2: Autoimmune Disorders, Transplantation and Pathogenic Diseases	**13Hrs**
Autoimmune diseases- Insulin dependent Diabetic mellitus, Rheumatoid arthritis, Myasthenia gravis and their treatment. **Tissue transplantation-** Graft versus host reaction and rejection, xenotransplantation, tolerance. **Host Microbe Relationship-** Normal microbial flora of human body and its significance. Koch's Postulates. Mode of entry of pathogen into human host. Infections and its types- nosocomial infections and non-infectious diseases. Immune response to infectious diseases; viral, bacterial, fungal and protozoal infections (Hepatitis, HIV, *Mycobacterium tuberculosis, Salmonella typhi, Tricophyton* spp., *Candida albicans, Plasmodium vivax*, *Entamoeba histolytica*).	
MODULE 3: Immunological Techniques and Diagnostic Microbiology	**13Hrs**
Techniques- Immunoprecipitation; Agglutination; Immuno-electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA, Western blotting; Tissue typing methods for tissue and organ transplantations. Polyclonal and monoclonal antibodies. Hybridomas and their production. **Diagnostic Microbiology**: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.	
MODULE 4: Vaccines and Antimicrobial Prophylaxis	**13Hrs**
Vaccines: Active and passive immunization, Immunization protocol. Conventional vaccines, live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. Novel vaccines subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, Small pox, DPT, Polio, Measles, Hepatitis-B. **Antimicrobial Prophylaxis**: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and anti-protozoans-causes, mechanism and prevention. Probiotics as therapeutic agents.	

TEXT BOOKS :

REFERENCES:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (2097) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5302**					
TITLE OF THE COURSE	**INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.

2. To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.	L3

CO2	It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments.	L2
CO3	To gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.	L4
CO4		
CO5		

COURSE CONTENT:	
MODULE I: Introduction to Industrial Microbiology	**13Hrs**
Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement - mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers. Basic components and design of typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.	
MODULE II: Industrial Bioprocessing	**13Hrs**
Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. **Downstream processing:** Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. **Productions and Applications**: Alcohol production, organic acids (citric acid), enzymes: amylases-(Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing.	

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.	
MODULE III: Scope of Food Microbiology and Food Preservation	**13Hrs**
Scope and Development of food microbiology. Food as a substrate for microorganisms; Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – *Clostridium.* Virus- *Hepatitis A*, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,). Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread and Idli. Nutritional and therapeutic importance: Single cell Protein, Probiotics and Symbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.	
MODULE IV: Dairy Microbiology	**13Hrs**
Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading. Microbiology of dairy products: cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products. Biosensors in Food Industry; Genetically modified foods; Food fortification.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES:

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 2096
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 2079.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5321**					
TITLE OF THE COURSE	**ENVIRONMENTAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course makes students understand distribution of microorganisms in nature, their habitat and interaction with other organisms.

2. The course enables the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have fundamental understanding of the distribution and habitat of microorganisms in nature.	L3

CO2	They can apply the knowledge in studying microbial diversity in various environmental niches.	L4
CO3	Students are aware of the role of microorganisms in the environment.	L2
CO4	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
CO5	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:

MODULE I: Soil Microbiology	**10Hrs**

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide-reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE II: Aquatic Biology and Sewage Treatment	**10Hrs**

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE III: Aerobiology	**10Hrs**
Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens	
MODULE IV: Bioleaching and Biodegradation	**10Hrs**
Bioleaching: Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution. **Biodegradation:** Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin, paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water '*in-situ*' remediation- Engineering developments - Constructed wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES:

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5322**					
TITLE OF THE COURSE	**AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.

2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be equipped with knowledge about the importance of microorganisms in agricultural field.	L3

CO2	They can understand how to employ microorganisms to enhance agricultural productivity.	L4
CO3	The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.	L2
CO4	They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms.	L1
CO5	The course helps them to apply knowledge in employing microbes in various fields.	L4

COURSE CONTENT:	
MODULE I: Plant-Microbe Interactions	**10Hrs**
Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation:Symbiotic nitrogen fixation, (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation *Azotobacter,Azospirillum*). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.	
MODULE II: Bioinoculants and Biological Control	**10Hrs**
Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- *Rhizobium, Azotobacter, Azospirillum*, Cyanobacteria,Phosphate solubilizing microorganisms and *Azolla*. Carrier-based inoculants–production,applications and limitations. **Biopesticides**: Types and mechanism of application of different varieties. Examples includes *Pseudomonas fluroscence, Bacillus thuringiensis*, *Trichoderma harzianum, Trichoderma viridae,* Nuclear Polyhedrosis Virus. Production, applications and limitations.	

MODULE III: Host Pathogen Interaction and Defense Mechanism	10Hrs
Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators. **Defense Mechanisms:** Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defences (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.	
MODULE IV: Plant Diseases and Their Management	**10Hrs**
Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria). **Plant disease control:** Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, farming education and awareness.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition.
   ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised
    Edition: 2006
13. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5323**					
TITLE OF THE COURSE	**GENETIC ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5201	MOLECULAR BIOLOGY

COURSE OBJECTIVES :

1. To understand how DNA can be manipulated using different enzymes.
2. Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
3. Diverse methods to visualise modified genetic materials.
4. Applications of genetic engineering.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3

CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L4
CO3	Students will also learn various applications where genetic engineering can be used.	L2

COURSE CONTENT:	
Module I: Basic Concepts	**10Hrs**
DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.	
Module II: Cloning and expression vectors	**10Hrs**
Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
Module III: Cloning strategies and study of protein-DNA interactions	**10Hrs**
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	

Module IV: Sequencing, PCR and its applications	**10Hrs**
Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform). PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5324**					
TITLE OF THE COURSE	**AQUATIC MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the diversity of microorganisms in aquatic environments, ecology and biogeochemistry.
2. To know the importance of aquatic microbes and to derive their utility in various fields.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of this course, student will be able to understand microbial diversity in aquatic environments.	L2
CO2	Students understand the role of aquatic microorganisms in biogeochemical cycles.	L3

CO3	Students will have a better knowledge about the application of aquatic microorganisms in various fields	L4
CO4		
CO5		

COURSE CONTENT:	
MODULE I: Aquatic Environment	**10Hrs**
Aquatic environment and distribution of microorganisms. Major environmental conditions influencing microflora in aquatic environment. Aquatic ecosystem- fresh water (ponds, lakes, stream), marine (estuaries, mangroves, deep sea, hydrothermal vents). Microbes in atmospheric water, surface water, stored water, groundwater, mineral water, spring water, well water. Nutrients in aquatic environments and food chain. Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients).	
MODULE II: Marine Microbiology	**10Hrs**
Marine environment–properties of seawater, chemical and physical factors of marine environment-Ecology of coastal, shallow and deep sea microorganism - significance of marine microflora. Diversity of microorganism - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association. Water zonations- upwelling and downwelling, ocean currents. Benthic microorganisms. Marine microflora and biofouling. Barophilic and Barophiles, Halophilic archaebacteria and extremozymes. Sea food contamination. Bioluminescence.	
MODULE III: Aquatic Microflora and Water Treatment	**10Hrs**
Introduction to Water cycle. Techniques for the study of aquatic microorganisms. Role and importance of aquatic microbial ecosystem. Microbial consortia. Surface attachment and biofilm development. Antibacterial and bioactive compounds from aquatic microorganisms.	

Waste Water Treatment: Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.	
MODULE IV: Water Pollution and Diseases	**10Hrs**
Water pollution, microbial changes induced by inorganic and organic pollutants. Metals as pollutants. Algal blooms. Biological and chemical control of algal blooms. Formation of biofilm. Algal toxicity. Biomagnifications. Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection. Water borne diseases (Waterborne diseases *Travellers'* Diarrhea, *Giardia, Salmonella, Escherichia coli*, *Cholera* and *Hepatitis* A) and control measures.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Elements of microbiology- Pelczar, Reid and Chan
2. Aquatic microbiology-Rheinheiner
3. Microbiology-Prescott, M.J, Harley, J. P. and Klein, D. A.
4. Gerhard Rheinheimer Aquatic Microbiology, John Wiley and sons, ISBN 0471718033.

5. Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment and Freshwater Microbiology: John Wiley, John Wiley and sons David C. Sigee ISBN-9780471485285.
6. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for Environmental microbiology. CRC press.
8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press
9. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
10. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
13. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5325**					
TITLE OF THE COURSE	**SOIL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To observe importance of soil and soil microorganisms, life cycles in the nature, for plants growing.
2. Explains geochemical significant processes of the microbial activities and the soil factors controlling and limiting microbial activities.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To understand the fundamental concepts and techniques in soil microbial diversity	L2
CO2	Basic and applied concepts environmental problems and available solutions towards them.	L3
CO3	To make use of how microorganisms may be utilised in soil microbiology and in agriculture.	L4
CO4		
CO5		

COURSE CONTENT:	
MODULE I: Microbes and Soil Fertility	**10Hrs**
Soil profile, Soil morphology, Biotic and abiotic interactions; Habitat and niche; Soil as an environment for microorganisms. Role of microbes in soil fertility. Microbial interactions in soil - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition. Soil pathogens and soil microflora and human health. Isolation of soil viruses; Genetic exchange between the communities.	
MODULE II: Diversity and Distribution of Microorganisms	**10Hrs**
Rhizosphere, Mycorrhizosphere, Actinorhizae, spermosphere, rhizoplane; symbiotic association in root nodules. Methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM.Roles of microbes in biogeochemical cycles: Carbon, nitrogen, phosphorus, sulphur. Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.	
MODULE III: Biofertilizer and Biopesticides	**10Hrs**
Biological nitrogen fixation - types (symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*);mechanism, microorganisms and factors affecting; Genetic engineering of BNF. Biofertilizer - types, production, applications and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, Phosphate solubilising microorganisms, *Azolla, Frankia* and VAM. Biopesticides – viral, bacterial and fungal- Types and applications (*Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma* and Nuclear Polyhedrosis Virus).	
MODULE IV: Soil Pollution and Biodegradation	**10Hrs**
Soil pollution: Nature and sources of pollutants: Industrial, agricultural and municipal wastes, fertilizers, pesticides, radio nucleotides, fossil fuels, acid rains	

and oil spills. Heavy metals toxicity. Soil erosion - control methods, soil acidification, monitoring and control of soil pollution. **Biodegradation**: Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Effect of pesticides on soil microflora. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology - Applications in Agricultural and Environmental Management*. Marcel Dekker.
5. The Nature and Properties of Soil, Brady.
6. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
7. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3 Edn. Academi Press.
8. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
9. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
10. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.
11. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
12. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.

13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
15. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5326**					
TITLE OF THE COURSE	**PHARMACEUTICAL MICROBIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	20MSC5104	GENERAL MICROBIOLOGY

COURSE OBJECTIVES :

1. To make students understand the applications of microorganisms in production of pharmaceutically active compounds.

2. To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of this course, student will be able to Identify different antimicrobial agents, antibiotics produced by them and it's mode of action.	L2
CO2	Basic and applied concepts clinical problems and available solutions towards them.	L3
CO3	Process involved in drug discovery and development and regulatory guidelines in pharmaceuticals product production.	L4

COURSE CONTENT:	
MODULE I: Antibiotics	**10Hrs**
Antibiotics and Synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives. Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Microbial resistance.	
MODULE II: Mechanism of Action of Antibiotics	**10Hrs**
Inhibition of cell wall synthesis, nucleic acid and protein synthesis. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene therapy. Mode of action of non–antibiotic antimicrobial agents; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones. Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.	
MODULE III: Microbial formulation and Applications of Microbial Enzymes	**10Hrs**
Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Any two). Vaccine: Synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines. Secondary metabolites from microorganisms. Database for Drug designing; Preclinical, clinical trials and Toxicology (LD50 and ED50).	
MODULE IV: Regulatory Aspects in Pharmaceuticals	**10Hrs**
Design and layout of sterile product manufacturing unit. Designing of Microbiology laboratory, Biosafety levels in setting up lab and safety measures. Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; legislative perspectives; GMP and GLP in pharmaceuticals; Quality	

control through WHO; ICH process. GCP Guidelines. Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation. Food & nutraceuticals inIndia. Intellectual property rights.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

REFERENCES

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013).Wiley Blackwell.
4. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
6. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
7. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.
8.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5371**					
TITLE OF THE COURSE	**IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.
- To impart basic understanding of principles, and key concepts relevant to industrial microbiology.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**

CO1	To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.	L3
CO2	The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology.	L3

List of Laboratory/Practical Experiments activities to be conducted:
1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Dental caries susceptibility assay by Snyder's agar test.
3. Serological reactions: 4. Agglutination - Blood grouping and Rh typing 5. Precipitation reactions: i. Ouchtlerlony Double Diffusion, ii. Radial Immune Diffusion.
6. Assay for susceptibility and resistance of antibiotics by Kirby Bauer method.
7. Isolation of lymphocytes from peripheral blood.
8. Identification of different types of blood cells.
9. Production and estimation of amylase from microbial sources
10. Production of organic acids (lactic acid and citric acid) from microbes.
11. Detection and quantification siderophore produced by *Pseudomonas spp.*
12.Study of different types of fermenters (Models/ Charts)
13.Immobilization technique: whole cell or enzyme- sodium alginate gel methods

REFERENCES:

REFERENCES

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.

2. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
3. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
6. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
10. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
11. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
12. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MMB5372**					
TITLE OF THE COURSE	**PRACTICAL BASED ELECTIVE-I**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**-**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- The course will help in making the students learn techniques to study microbial interactions and their impact in nature.
- The course imparts practical knowledge in screening the microorganisms for their employment in various fields.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students have fundamental practical knowledge of the techniques to study microbial interactions and their role in environment.	L3
CO2	Students will learn many techniques to study the impact of microorganisms in different applied microbiological studies.	L3
CO3		L4

List of Laboratory/Practical Experiments activities to be conducted:	
2.	Study of microbial interactions in soil (antagonism).
3.	Isolation of cellulose and pectin degrading microbes.
4.	Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) –(3 Units)
5.	Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
6.	Effect of seed borne fungi on seed germination and seed vigour.
7.	Estimation of total phenols in diseased and healthy plant tissues.
8.	Isolation of Plasmid DNA
9.	Demonstration-Restriction Enzyme digestion
10.	Demonstration- Ligation of DNA fragment

REFERENCES:

1. Nicholl DST. An Introduction to Genetic Engineering. Cambridge University Press, 2002.
2. Sandhya M. Genetic Engineering: Principles and Practice. MacMillan India. 2008.
3. Primrose SB and RM Twyman. Principles of Gene Manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
4. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
5. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
6. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
7. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20MSC5401**					
TITLE OF THE COURSE	**PROJECT WORK**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**36**	**-**	**18**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	I	-	-

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations

2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares	L5

	students for productive careers and lifelong learning.	

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT104

TITLE OF THE COURSE : BIOMOLECULES AND ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CHEMISTRY OF CARBOHYDRATES AND LIPIDS 13H

Chemical basis of life: Macromolecules- monomers and polymers, Acid Base balance and its maintenance, Water- properties, pH, ionization and hydrophobicity and thermodynamics.
Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans.
Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, lipoproteins. Lipid micelles, liposomes & their applications.

MODULE II CHEMISTRY OF PROTEINS AND NUCLEIC ACIDS 13H

Proteins: Amino acids and peptides. Primary, secondary, tertiary and quaternary structures, Ramachandran plot. Collagen structure, models of protein folding, experimental techniques to study protein folding (X-ray Crystallography, Fluorescence spectroscopy), roles of chaperones and chaperonins. Concepts of protein sequencing and protease mapping.
Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Higher order structures of DNA (bends, cruciform, G-quadraplexes). Denaturation and renaturation studies and their applications.

MODULE III ENZYMES AND BASIC ENZYME KINETIC CONCEPTS 13H

Enzymes: Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.Enzyme Kinetics: Basic chemical kinetics, rate of reaction, order of reaction, zero order and first order reactions. Derivation of Michaelis-Menten equation, Significance of Km, Vmax and Kcat. Derivation of Lineweaver-burk plot, basic concepts of Scatchard Plot, Eadie-Hofstee Plot, Hanes-Woolf plot and their relevance.

MODULE IV ENZYME CATALYSIS AND REGULATION 13H

Mechanism of Enzyme catalysis: Mechanism of enzyme catalysis - Acid-Base catalysis, covalent catalysis, metal ion catalysis and entropy effect. Example of enzyme catalysis mechanism – chymotrypsin and transaminases.
Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots.
Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

REFERENCES:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
3. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
4. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
5. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
6. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
7. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT171

TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY AND GENETICS
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Hemocytometer: Counting of cells
3. Study of mitosis by using onion root tips
4. Study of meiosis –Grasshopper testis
5. Mounting of Barr bodies
6. Study of Karyotyping in onion, humans (normal and abnormal)
7. Study of mutation in E. coli by Physical method (UV) (2 units)
8. Study of Drosophila mutant types.
9. Mounting of polytene chromosomes – in Drosophila
10. Study of normal and abnormal cellular cell structure and their pathological significance (through permanent slides)
11. Isolation of nucleus/mitochondria and determination of its purity
12. Concept of Multiple Alleles in Humans (Blood group)
13. Solving Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance)

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT172

TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND BIOCHEMISTRY
L: T/A: P: C: 0: 0: 8: 4

1. Determination of pI of amino acid by titration method.
2. Estimation of glucose by Dinitrosalicyclic acid (DNSA).
3. Estimation of protein by Lowry's/Bradford method.
4. Estimation of inorganic phosphate by Fiske-Subbarow method
5. Determination of saponification number and acid value of the given fat samples. (2 unit)
6. Sterilization techniques and Preparation of media
7. Isolation of microorganisms from Soil/Air/Water
8. Pure Culture Techniques – serial dilution, streaking, pour plate, spread plate
9. Staining techniques in microbiology - simple staining, negative staining, Gram staining,spore staining, capsule staining
10. Biochemical tests: Starch hydrolysis, Catalase, Gelatin Liquefaction, IMViC
11. Determination of microbial growth by turbidometric method.
12. Identification of algae, fungi and protozoa (Permanent slides): *Spirulina, Nostoc, Aspergillus, Penicillium, Paramecium* and *Amoeba.*

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT201

TITLE OF THE COURSE : BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I SPECTROSCOPY TECHNIQUES 13H

Theory and application of UV, Visible and Raman Spectroscopy, Circular Dichroism *and optical rotatory dispersion*; Fluorescence; Nuclear magnetic resonance, *Electron spin resonance*, Mass spectrometry (GC-MS, LC-MS, ICP-MS, MALDI-TOF), Atomic absorption and atomic emission spectroscopy.

MODULE II SEPARATION TECHNIQUES – CHROMATOGRAPHY AND ELECTROPHORESIS 13H

Chromatography: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity Chromatography; HPLC and FPLC; Dialysis, Criteria of protein purity.
Electrophoresis: Theory and application of Polyacrylamide gel electrophoresis and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

MODULE III SEPARATION TECHNIQUE – CENTRIFUGATION 13H

Basic principles (RCF, Sedimentation coefficient); Types of centrifuge - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

MODULE IV RADIOISOTOPY, MICROSCOPY AND CELL SORTERS 13H

Radioisotope Techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay, Units of radioactivity. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters, autoradiography, radioimmunoassay.

Microscopy: Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy and Atomic Force Microscopy

Cell Analysis: Florescent activated cell sorter (FACS) and Coulter counter.

REFERENCES:

1. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
2. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, HimalayaPublishing House (2010)
3. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson andJohn Walker, Cambridge University Press (2005).
4. Biophysics – An introduction by Ronald Glaser, Springer (2012).
5. An introduction to practical biochemistry 1987.third edition by D T Plummer. pp. 332.McGraw-Hill (UK).
6. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4 edition Pub WH Freeman Co.
7. T.G. Cooper; the Tools of Biochemistry. Wiley Intersciences, 1977.
8. Protein purification techniques – A practical Approach (2001) Simon Roe, 2nd Edtion, Oxford University press

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT204

TITLE OF THE COURSE : ENVIRONMENTAL AND MEDICAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I WASTE WATER AND SOLID WASTE MANAGEMENT 13H

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II APPLICATION OF BIOTECHNOLOGY IN ENVIRONMENTAL MANAGEMENT 13H

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III BIOLOGY OF HUMAN DISEASES 13H

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B) Bacteria (Typhoid, STD) Fungi (Aspergillosis, Cryptococcosis) and Protozoa (Malaraia, Amoebiasis)

Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalassemia and Diabetes

MODULE IV MOLECULAR THERAPEUTICS AND NANOBIOTECHNOLOGY 13H

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials.

REFERENCES:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Devlin, Thomas M. (2001) Textbook of Biochemistry: With Clinical Correlations (5th Ed.); John Wiley & Sons, Inc.

SEMESTER/YEAR : II SEM

COURSE CODE : 17MBT205

TITLE OF THE COURSE : BIOINFORMATICS

L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8H

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10H

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER, Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acidsand protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8H

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.

5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.)John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professionalpublishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. NucleicAcids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular BiologistShould Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT271

TITLE OF THE COURSE : BIOPHYSICAL AND IMMUNOLOGICAL TECHNIQUESL: T/A: P: C : 0: 0: 8: 4

(PRACTICAL)

1. Isolation of enzyme and estimation of its activity (Urease/Amylase/AcidPhosphatase/esterase) - any one
2. Determination of kinetic properties of amylase/acid phosphatase/urease/esterase (2units).
3. Partial purification of the enzyme by salting out/acetone and dialysis (2 units)
4. To perform SDS-PAGE and check the purity of the isolated enzyme (2 units).
5. Immobilization of the purified enzyme and its assay.
6. To separate amino acids/ lipids using paper chromatography/Thin LayerChromatography
7. Serum Separation from whole blood and precipitation of immunoglobulins fromserum.
8. Study of different cells in whole blood using Giemsa/Leishman stain.
9. Blood grouping

10. ELISA/Dot ELISA
11. Radial Immunodiffusion/Ouchterlony Double Diffusion
12. Rocket Immuno Electrophoresis
13. WIDAL/RPR Test

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT272

TITLE OF THE COURSE : MOLECULAR BIOLOGY, MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

L: T/A: P: C : 0: 0: 8: 4

1. Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation plant/animal genomic DNA, and analysis by agarose gel electrophoresis (2units)
4. Preparation of competent cells and transformation by calcium chloride method andcalculation of transformation efficiency (2 units)
5. Study of conjugation in *E.coli*
6. Gel filtration chromatography: Sephadex/Sepharose. (Demo)
7. Estimation of SGPT/SGOT in serum samples.
8. Estimation of serum cholesterol by Zak's method.
9. Demonstration of PCR technique.
10. Determination of DO, BOD and COD of water sample (2 units)
11. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
12. Potable water quality assessment-MPN

SEMESTER/YEAR : III SEM

COURSE CODE : 17MBT321

TITLE OF THE COURSE : METABOLISM OF BIOMOLECULESL: T/A: P: C : 4: 1: 0: 5

Total Hours - 52

Module I Bioenergetics and Oxidative phosphorylation **13h** Bioenergetics: laws of thermodynamics, enthalpy, entropy, and the free energy change, standard free energy change. Biochemical energetic group transfer reactions of ATP,functions of ATP, phosphate group transfer potential of ATP and other high energyphosphate donors. Oxidative phosphorylation: Mechanism of proton pumping. Protonmotive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism. Couplingof electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation,mitochondrial specific transport systems and energy charge. Uncouplers, inhibitors andionophores.

Module II Carbohydrate Metabolism **13h**

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation.

Gluconeogenesis pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway,Cori's cycle.

Glycogen and starch: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms. Regulation of blood glucose level, disorders of carbohydrate metabolism.

Module III: Amino acid and nucleotide metabolism

13h General metabolic reaction of amino acids– transamination, glucose – alanine cycle,oxidative deamination (glutamate dehydrogenase), minor pathways of amino aciddegradation – transdeamination, amino acid oxidase, and non – oxidative deamination.

Ureacycle, its regulation and significance. Biosynthesis and degradation of essential amino acids(with emphasis on aromatic amino acids). Disorders of amino acid metabolism (PKU,Alkaptonuria).

Biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage), regulation of biosynthesis. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyan syndrome, inhibitors of nucleotide synthesis.

Module IV: Lipid Metabolism

13h

Oxidation of fatty acids: even and odd numbered, unsaturated and branched chain fatty acids. Alternate routes for fatty acid oxidation. Degradation of triacylglycerols and phospholipids. Energetic of β-oxidation. Metabolism of ketone bodies; their formation, oxidation and clinical significance. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

Cholesterol biosynthesis, catabolism and regulation. Transport of cholesterol -LDL receptor pathway. Lipoproteinemias, fatty liver, hypercholesterolemia. Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL.

Reference Books:

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
2. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
3. Biochemistry; David Rawn, Panima Publishers, (1989).
4. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan
5. Publications (2012).
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
8. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
9. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
10. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.

SEMESTER/YEAR : III SEM

COURSE CODE : 17MBT371

TITLE OF THE COURSE : GENETIC ENGINEERING-L

T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

SEMESTER/YEAR : III SEM

COURSE CODE : 17MBT372

TITLE OF THE COURSE : PLANT & ANIMAL BIOTECHNOLOGY

L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Preparation of plant tissue culture media
2. Organ culture (Shoot tip, nodal and leaf culture)
3. Callus culture: Initiation and regeneration.
4. Isolation and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants

7. Study of VAM, isolation of spores, arbuscles and vesicles from roots
8. VAM culture
9. Animal cell culture: Preparation of (serum and non-serum supplemented) media.
10. Primary culture of fibroblast cells/liver cells/testis-leydig cells
11. Assessment of viability and counting using trypan blue exclusion method
12. Determination of the concentration of viable cells in a suspension by haemocytometer counting (trypan blue)
13. Isolation of cells by explant method and Sub-culturing

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT421

TITLE OF THE COURSE : APPLIED BIOTECHNOLOGYL: T/A: P: C : 4:1:0:5

Total hours: 52

Module I Bioprocess Engineering

13h

Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation process, Industrially important products: Ethanol, citric acid, penicillin, amylase, SCP, fermented foods

Module II Plant Biotechnology

13h

Basics of Plant tissue culture, initiating plant tissue culture, Aseptic techniques, Componentsof tissue culture media, use of growth regulators (auxins, cytokinin, gibberellins), Micro- propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, edible vaccines.

Module III Animal

Biotechnology

13h

Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGFand erythropoietin, Primary and Secondary Cell Culture, stem cells and tissue engineering, transgenic animals, therapeutic and pharmaceutical products,

Module IV Environmental Biotechnology

13h Air, water, soil pollution, Bio-indicators, waste water management and treatment,bioremediation and biodegradation

IPR, patenting of biotech products, Bioethics, ethical issues related to consumption of GMcrops, ethical implication of Human Genome Project

References:

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
6. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts andApplications (2nd Ed) IK International Publishing House
7. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IKPublishing House
8. Glazer and Nikaido (1995), Microbial Biotecnology, WH Freeman and Co.
9. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
10. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
11. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
12. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and IbhPublishing
13. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), OxfordPublishing.
14. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice HallIndia Learning Pvt Ltd.

SEMESTER/YEAR **: I SEM**

COURSE CODE **: 20MSC5101**

TITLE OF THE COURSE **: FUNDAMENTALS OF CHEMISTRY**

L: T: P: S/P : C **:4: 0: 0: 0 : 4**

Total Hours: 52

MODULE 1: General Chemistry **13Hrs**

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation. VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin& cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry **13Hrs**

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.

Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.

Chemical Kinetics: Rate of reaction, order&molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I **13Hrs**

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II **13Hrs**

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

14. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
15. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
16. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
17. Organic Mechanisms, Peter Sykes, Longman, (2077).
18. Inorganic Biochemistry. G.L. Eicharn, Elsevier
19. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
20. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
21. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
22. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
23. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
24. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
25. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
26. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5102

TITLE OF THE COURSE : BIOMOLECULES

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson &Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5103

TITLE OF THE COURSE : MOLECULAR GENETICS

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendeliangenetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2: Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation:

Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals. Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

8. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
9. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
10. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
11. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
12. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
13. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
14. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveria bassiana*.

Medical Microbiology: pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and

Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases: Malaria and Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and JayaramPanicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2099.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2096.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2099.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. McGraw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2ndedition., 2097, McGraw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : **I SEM**

COURSE CODE : **20MSC5105**

TITLE OF THE COURSE : **BIOINFORMATICS – I (PROTEOMICS)**

L: T: P: S/P : C : **2: 0: 0: 0 : 2**

Total Hours: 26

MODULE 1: **13 hrs**

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) & UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: **13 hrs**

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB), Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling- principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *abintio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5106

TITLE OF THE COURSE : BIOSTATISTICS

L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: Measures of Central Tendencies, Dispersion and Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2: Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 McGraw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM

COURSE CODE : 20MSC5171

TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB

L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

3. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
4. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR **: II SEM**

COURSE CODE **: 20MSC5201**

TITLE OF THE COURSE **: MOLECULAR BIOLOGY**

L: T: P: S/P : C **: 4: 0: 0: 0 : 4**

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4: Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

8. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
9. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
10. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 2093.

11. David Rawn J (2089)Biochemistry, Neil Patterson Publishers.
12. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
13. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
14. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
15. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
16. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
17. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
18. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MSC5202

TITLE OF THE COURSE : ANALYTICAL TECHNIQUES

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: 13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper &agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: **13hrs**

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: **13hrs**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : **II SEM**
COURSE CODE : 20**MSC5203**
TITLE OF THE COURSE : **BIOINFORMATICS – II (GENOMICS)**
L: T: P: S/P : C : **2: 0: 0: 0 : 2**

Total Hours: 26 Hours

MODULE 1: **13 hrs**

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: **13 hrs**

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

10. Concepts of Ecology, Edward.J.Kormondy
11. Ecology and environmental science, S.V.S. Rana
12. Cell biology, Genetics, Molecular biology, evolution and ecology
13. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
14. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
15. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
16. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
17. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
18. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM

COURSE CODE : 20MSC5271

TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB

L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis

4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

SEMESTER/YEAR : III SEM
COURSE CODE : 20MSC5301
TITLE OF THE COURSE : CLINICAL RESEARCH
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical trial.

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical research studies.

Total Hours: 26 Hrs

MODULE I: Concepts of Clinical Research 13 Hrs

General introduction, routes of drugs administration, Dose,threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under*

the curve (AUC) of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd).* maximum tolerated dose (MTD).Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity.Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50}& ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research 13Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.

7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR	**: III SEM**
COURSE CODE	**: 20MSC5302**
TITLE OF THE COURSE	**: SCIENTIFIC WRITING AND IPR**
L: T: P: S/P : C	**: 2: 0: 0: 0 : 2**

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing: 13 Hrs

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.

Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights 13 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.

Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20MSC5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: **10Hrs**

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: **10Hrs**

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: **10Hrs**

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: **10Hrs**

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi

4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.

7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications

8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MBT5201

TITLE OF THE COURSE : GENETIC ENGINEERING

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Basic Concepts 13hrs

DNA Structure and properties; Enzymes in genetic engineering - Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Recombinases, CRISPR – cas system for gene and genome editing, Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization.

MODULE II: Cloning and expression vectors 13hrs

Plasmids; Bacteriophages; M13 mp vectors; pUC20 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

MODULE III: Cloning Strategies and study of protein-DNA interactions 13hrs

Gene transfer in host cells (transformation, electroporation, transfection, microprojectile, liposome – mediated, gene gun), construction and screening of genomic and cDNA libraries; construction of microarrays –cDNA arrays and oligo arrays; techniques for DNA – protein interactions - electrophoretic mobility shift assay; DNaseIfootprinting; methyl interference assay, chromatin immunoprecipitation; phage display, principle of Surface Plasmon Resonance (SPR) and its application to study protein-protein interactions.

MODULE IV: Sequencing, PCR and its applications 13hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MBT5202

TITLE OF THE COURSE : ADVANCED CELL BIOLOGY

L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Cell types, cell cycle and its control 13hrs

Cell types**:** Structure of prokaryotic and eukaryotic cells, ultrastructure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle**:** Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks* and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways, cell senescence.

MODULE II: Membrane transport 13hrs

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport,

co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na^+/K^+ Pump, Ca^{2+} Pump. ABC transporter and Multidrug resistant protein.

MODULE III: Cytoskeleton and Cell-cell interactions 13hrs

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV: Cell Signaling and Antioxidant defense system 13hrs

Cell signaling:Principles of cell signaling,intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions.(Ca^{2+}Cyclic modulators –cAMP, cGMP, IP3, 2AG, Nitric Oxide).Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

REFERENCES:

1. Alberts et al., (2002).Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (2080). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (2096). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007).Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

SEMESTER/YEAR : II SEM

COURSE CODE : 20MBT5271

TITLE OF THE COURSE : CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB

L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Counting of cells: Hemocytometer
3. Study of meiosis –Grasshopper testis/onion flower buds
4. Vital staining of mitochondria.
5. Preparation of competent *E. coli*. cells
6. Transformation plasmid in E. coli and screening of transformants.
7. Isolation of plasmid DNA from *E. coli* (mini-prep) and its analysis.
8. Amplification of DNA using PCR and analysis by agarose gel electrophoresis.
9. Restriction digestion of vector/DNA and its analysis.
10. Ligation of DNA fragments and its analysis.

REFERENCES:

1. Cell biology, Genetics, Molecular biology, evolution and ecology

SEMESTER/YEAR : III SEM/2nd year
COURSE CODE : 20MBT5301
TITLE OF THE COURSE : IMMUNOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

1. Impart fundamental concepts of Immune system and its workings.
2. Instill basic understanding of MHC, TCR, antibodies, antigens, T cells, specific immune response; application of antibodies as reagents.
3. To instill principles of vaccines as disease preventive agents; principles of hypersensitivity and autoimmune disorders.

Course Outcomes:

1. Students will develop a clear basic understanding of the fundamentals ofmammalian immune system as our defense against pathogens as well as the conceptof vaccines as protective agents.
2. Enable sufficient knowledge in application of antibodies as analytical tools.
3. Equip thestudents with sufficient basic knowledge necessary to understand concepts in research methodologies and in other Biotechnology courses, they study.

Total hours: 52 Hrs

MODULE I: **Immune System** **13 Hrs**

Innate immunity Vs adaptive immunity, cell mediated and humoral immunity, immune cells (T cells B cells, NK cells, Macrophages, DCs, granulocytes, mast cells, Inflammation concept, lymphoid organs. Basic outline of negative and positive T and B cell selection, self MHC restriction during the developmental lymphoid cells. T-cell sub-sets. Complement activation, Classic, and alternative pathway and biological function.

MODULE II: Antigens and Antibodies **13 Hrs**

Antigens- Immunogenecity versus Antigenicity, Factors that influence immunogenicity. Concept of epitopes.

Immunoglobulins: Basic structure of Immunoglobulins -Fine structure of Immunoglobulins - Immunoglobulin domains-variable region and constant region domains. isotopic, allotypic and idiotypic variation. Immunoglobulin classes, functions of Ig class. Organization and expression of Immunoglobulin Light and Heavy chain genes- generation of antibody diversity, scheme of T-cell receptor diversity. Class switching.

MODULE III:Immune Responses **13 Hrs.**

Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. Concept of antigen specific receptor. T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; APC; cytokines. Lymphocyte migration, homing and trafficking; and chemokines; B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing. Clonal selection theory, Primary and secondary immune responses. Immune response to infections, autoimmune diseases. Immune response to infectious diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis; hypersensitivity reactions

MODULE IV: Immunological techniques and vaccines **13 Hrs.**

Concept of polyclonal vs monoclonal antibodies. Immunofluorescence ELISA, Western blotting. Flow Cytometry. Fractionation of leukocytes under density gradient.; Hybridomas and their production. Active & Passive immunization, Role of vaccines in prevention of diseases, Types of vaccines (Heat inactivated vaccines; Attenuated vaccines; Recombinant vaccines; Subunit vaccines)

REFERENCES

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. Kuby Immunology 7th edition. Macmillan Publishers 2014.
3. Kuby Immunology, 8th Edition | Macmillan Publishers 2020.
4. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
5. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. https://doi.org/10.1201/9781315533247
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

SEMESTER/YEAR **: III SEM/2nd Year**
COURSE CODE **: 20MBT5302**
TITLE OF THE COURSE: **: INDUSTRIAL BIOTECHNOLOGY**
L: T: P: S/P : C **: 4: 0: 0: 0 : 4**

Course Objectives:

- To help students achieve knowledge in principles and concepts relevant to industrial biotechnology.
- To familiarize the students with upstream and downstream processing, types of fermenters and production of important microbial products.

Course Outcomes:

- Students will be updated with the current methods of fermentation process, modern fermenters and strategies for isolation of industrially important strains.
- Student will be able to apply the knowledge in their future with respect to industrial biotechnology processes.

Total hours: 52 Hrs

MODULE I: Microbial growth, development and maintenance 13 Hrs

Microbial growth and death kinetics (particularly with reference to industrially useful microorganisms). Screening, Isolation. Identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres.

MODULE III: Bioreactors and Fermentation 13 Hrs

Scope and importance of fermentation in industrial Biotechnology, Basic components, design and scale-up of fermenters – Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Conditions regulating fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Types of fermentation - batch fermentation and chemostat, submerged and solid substrate fermentation.

MODULE IV: Upstream Processing and downstream processing 13Hrs

Formulation of fermentation media. Rheology of fermentation media. Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid- Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

Module V: Industrial Bioprocessing **13Hrs**

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product: Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin).

REFERENCES:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.) Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5371
TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY AND IMMUNOTECHNIQUES-LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:

1. To equip students with techniques for industrial production.
2. To learn immune techniques used as diagnostic tools.

Course Outcomes:

1. This course will enable students to learn techniques which can be used in industrial production.

2. It will also teach diagnostic immune techniques routinely used in medical laboratories

PRACTICALS

1. ELISA/Dot ELISA
2. Radial Immunodiffusion/Ouchterlony Double Diffusion
3. Rocket Immuno Electrophoresis
4. Demonstration of a fermenter and its types.
5. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilization.
6. Production of organic acids (citric acid) from microbes
7. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
8. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
9. Laboratory scale production of wine/beer.
10. Estimation of alcohol by specific gravity method and determination of total acidity and non-reducing sugars (2 units)
11. Sterility tests for pharmaceutical products
12. Production of amylase by solid substrate fermentation.
13. Production of yoghurt and estimation of lactic acid at different time intervals.

REFERENCES:

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
3. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER/YEAR : III SEM

COURSE CODE : 20MBT5372

TITLE OF THE COURSE : ELECTIVE BASED PRACTICAL- II

L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives

1. The course will help in making the students learn basic techniques for understanding genetic concepts and detecting human genetic diseases.
2. The course imparts practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

Course Outcome:

1. Students will have fundamental practical knowledge of the techniques for understanding genetic diseases
3. Students will acquire practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

PRACTICALS

1. Karyotyping of normal/abnormal chromosome set
2. Restriction digestion and Restriction mapping
3. Identification of inactivated X- chromosome as Barr body.
4. Demonstration of PCR technique.
5. Estimation of SGPT/SGOT in serum samples.
6. Estimation of serum cholesterol by Zak's method.
7. Determination of Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) (3 units)
8. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
9. Potable water quality assessment-MPN

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
4. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

5. Ronald L Dooste- Theory and Practical of water and waste water treatment.

SEMESTER/YEAR: **III SEM**
COURSE CODE: **20MBT5321**
TITLE OF THE COURSE: **PLANT BIOTECHNOLOGY**
L: T: P: S/P : C **: 3: 0: 0: 0 : 3**

Course Objectives:

- To equip the students with fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- To familiarize the students with knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Course Outcomes:

- The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Total hours: 40 Hrs

MODULE I: Plant Tissue Culture **10 Hrs**

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, Organogenesis; Micropropagation; Somatic embryogenesis and its applications; Somaclonal variation; Anther culture for haploid production and its applications in plant breeding;

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids. Cell cultures for secondary metabolite production

MODULE II: Genetic Transformation Techniques for plants **10Hrs**

Agrobacterium-plant interaction; organization of Ti and Ri plasmids; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated transformation; Cointegrate and binary vectors and their utility; viral based vectors. Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; stability of transgene; Transplastomic technology; Marker-free methodologies; Gene editing by TALLEN and Crispr techniques

MODULE III: GM Technology and Plant Trait improvement **10 Hrs**

GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops

Concept of bio factories; Production of pharmaceutical proteins Plantibodies, vaccines and industrial enzymes in plants. Metabolic engineering for oil improvement, Crop improvement and fortification of agricultural crops–Bt cotton, Bt brinjal, transgenic sweet potato and Golden rice. Ethical, regulatory and environmental issues associated with GM crops and GM food;

MODULE IV: Molecular Breeding: Molecular Mapping & Marker Assisted Selection

10 Hrs

Molecular markers: RFLP, RAPD, SCAR, STS, AFLP, and SNP markers; Construction of genetic and physical map; Quantitative and qualitative characters. MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; QTL mapping and cloning. Application of Molecular Markers: Genotyping tools as plant variety protection, hybrid purity tests.

REFERENCES

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR : **III SEM**
COURSE CODE : **20MBT5322**
TITLE OF THE COURSE : **ANIMAL BIOTECHNOLOGY**
L: T: P: S/P : C : **3: 0: 0: 0 : 3**

Course Objectives:

1. To acquaint the students with the basic concepts of animal cell culture set up and conditions.
2. To Equip the students with fundamentals of gene transfer methods for mammalian cells and animal transgenics followed by important applications of animal biotechnology

Course Outcome:

1. Will learn about basic animal cell culture conditions and its uses.
2. Be able to describe techniques and problems both technical and ethical in animal cloning.
3. Will be equipped with the wide area of applications of biotechnology in modern world.

Total hours: **40 Hrs**

MODULE I: Basics of Animal Tissue Culture **10 Hrs**

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Methods of sterilization, Detection of Mycoplasma and viral contaminants, types of culture media, composition, preparation. Serum and protein free defined media. Role of CO_2, Serum, supplements, Culture and maintenance of primary and established cell lines. Biology of cultured cells: Culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity.

Module II: Stem Cells **10 Hrs**

Stem cells – Adult, embryonic, Induced pluripotent stem cells. Stem cells from adult organs-Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals **10 Hrs**

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF-technology for livestock and humans. Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Animal and human cloning- ethical and social issues.

Module IV Applications of Animal Biotechnology **10 Hrs**

Disease resistant, recombinant vaccines for poultry, livestock pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, interleukins, interferons, Cell culture-based vaccines.

Biosafety: The Cartagena protocol on biosafety. Good manufacturing practice and Good lab practices (GMP and GLP).

REFERENCES:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEYVCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5323
TITLE OF THE COURSE :PRINCIPLES OF ENZYMOLOGY AND METABOLISM
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives

1. To impart basic concepts of metabolisms of carbohydrates, amino acids, nucleotides and lipids, Oxidative phosphorylation and generation of ATP.
2. To equip students with basic understandings of concept of enzymology.

Course Outcomes

1. Students will be equipped with the basic concepts of metabolism of biological fuels in biological systems and oxidative phosphorylation process involved in ATP synthesis.
2. Gain sufficient knowledge on the role of enzymes and the nature of their action in metabolism.

Total hours: 40 Hrs

MODULE I: Enzymes and basic enzyme kinetic concepts 10 Hrs

Basic Concepts of Enzymes: factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.

Enzyme Kinetics: Basic chemical kinetics, rate of reaction, Significance of Km, Vmax and Kcat, basic concepts of Lineweaver-burk plot and its relevance.

Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots. Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

MODULE II: Carbohydrate and amino acid metabolism 10 Hrs

Carbohydrate metabolism; Introduction, glycolytic pathway. Gluconeogenesis pathway. Role of LDH. TCA cycle. HMP pathway, Cori's cycle. Brief scheme of glycogen metabolism. Pasteur

effect, fermentative pathways in microorganisms. Amino acid metabolism: General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – trans deamination, amino acid oxidase, and non – oxidative deamination. Urea cycle, Biosynthesis and degradation of essential amino acids. Disorders of amino acid metabolism (PKU, Alkaptonuria).

MODULE III: Nucleotide and Lipid metabolism **10 Hrs**

Nucleotide metabolism: biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage). Degradation of purine and pyrimidines, and disorders associated with their metabolism.

Lipid Metabolism: Oxidation of fatty acids: beta oxidation. Cholesterol biosynthesis. Scheme of transport of cholesterol -LDL receptor pathway. Lipoproteinemia, fatty liver, hypercholesterolemia. Biological functions, and metabolic fate of VLDL, LDL and HDL.

MODULE IV: Oxidative phosphorylation **10 Hrs**

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1- ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, Uncouplers, inhibitors, and ionophores.

REFERENCES

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, 2nd edition, 2008, East-West Press Edition, Horwood Publishing limited.
3. Enzyme kinetics and mechanisms. TAYLOR (Kenneth B). 2009, Kluwer Academic Press
4. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999).
5. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).

6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (1976).
9. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH. Freeman Co.
10. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
11. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
12. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
13. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5324
TITLE OF THE COURSE : HEALTH AND ENVIRONMENTAL BIOTECHNOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To impart basic knowledge in environmental science, issues and biotechnological applications in waste management.
2. To familiarize students with basic concepts involving health and disease, infectious disease.
3. To give conceptual knowledge of the principles behind molecular therapeutics and nanobiotechnology.

Course outcomes:

1. Students will be equipped with basic foundation of Biotechnological applications to environmental and medical problems.
2. Students will gain basic knowledge in application of nanobiotechnology to molecular therapeutics

Total Hours: 40 Hrs

MODULE I: Waste Water and Solid Waste Management 10 Hrs

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II: Application of Biotechnology in Environmental Management 10 Hrs

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III: Biology of Human Diseases 10 Hrs

Evaluation of organ functions: liver, kidney, cardiac function tests with the significant serum biomarkers. Infectious (communicable) diseases: Cause, Symptoms and treatment/prevention- Bacterial infections (Typhoid), Viral infections(H1N1), STDs. Pregnancy and infections. Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Lesch- Nyhan syndrome, Gout, , Beta Thalassemia and Diabetes.

MODULE IV: Molecular Therapeutics and Nanobiotechnology 10 Hrs

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials

REFERENCES

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008

2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House

3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House

4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).

5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.

6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5325
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.

2. To aware students the concepts to make them capable to propose appropriate methods for analysis of given sample type with respect to purpose of analysis

Course Outcomes:

1. Students will be equipped to infer the basic concepts of genomics, transcriptomics and proteomics.
2. List and discuss the use of genomics and proteomics in human health.
3. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

Total hours: 40 Hrs

MODULE I: Genome Organization, structure and mapping 10 Hrs

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Recognition of coding and non-coding sequences and gene annotation. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques.

Module II: Genome sequencing and analysis 10 Hrs

Genome sequencing. Clone contig method, Next Gen Sequencing, Genome sequencing projects of E. coli., yeast, and human genome project. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Genome sequence data bases, expressed sequenced tags (ESTs), Genome sequence analysis. determining gene location in genome sequence, Promoter prediction methods

Module III: Proteomics 10 Hrs

Protein analysis (includes measurement of concentration, amino-acid composition, N terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Mass Spectroscopy, Concept of MudPIT (Multidimensional Protein Identification Technology), Protein-protein interactions, proteome databases.

Module IV: Functional and comparative Genomics 10 Hrs

Transcriptome analysis-transcripts of a tissue; Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria. Introduction to metabolomics, lipidomics, metagenomics, systems biology, Pharmacogenetics and drug development

REFERENCES

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry
2. 2nd Edition. Wiley 2006 2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5326
TITLE OF THE COURSE : Human Genetic Diseases
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To help students in understanding the genetic basis of different diseases.
2. To familiarise students with basics of cytogenetic analysis

Course Outcomes:

1. Students will grasp the concepts of genetic basis of different diseases.
2. Students will understand the basics of cytogenetic analysis.

Total hours: 40 Hrs

Module I: Genetic factors in common diseases 10 Hrs

Genetic susceptibility to common diseases. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery, diseases, Alzheimer's disease, Congenital abnormalities, Huntington's disorder, Neurofibromatosis, Cystic fibrosis, Duchenne Muscular Dystrophy (DMD), Becker muscular dystrophy, Hemophilia A and B. Trinucleotide Repeat Expansion mutations and their remediation.

Module II: Biochemical genetics and pharmacogenetics 10 Hrs

Biochemical genetics: Inborn errors of metabolism, molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Mucopolysaccharide and Galactosemia, Albinism

Pharmacogenetics: Definition, drug metabolism, Genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, Evolutionary origin of

variation in drug responses, Pharmacogenomics, Molecular detection of diseases after human genome project, Drug discovery.

Module III: Cellular and molecular cytogenetic technologies **10 Hrs**

Cell lines, Cell and tissue culture practices, harvesting of cells for chromosomal analysis, Conventional and specialized staining protocols, Imaging in cytogenetic practices, Chromosome jumping and walking, Chromosome instability and fragile sites.

Module IV: Diagnosis of prenatal and haematopoietic disorders **10 Hrs**

Prenatal diagnosis: Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Genetic counselling, Chromosomal diagnostics in hematopoietic disorders: Myeloid disorders, AML, CML and lymphoid leukaemia, lymphoblastic lymphoma and their chromosomal changes, Chromosome changes in benign and malignant tumors, Cytogenetics of breast cancer.

REFERENCES

1. Peter Sudbery 2002. Human Molecular Genetics (Second Edition), Prentice Hall.
2. Tom Strachan & Andrew P.Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons
3. M.A. Jobling, M.E. Hurles & C. Tyler-Smith, 2004. Human Evolutionary Genetics-Origins, Peoples & Disease, Garland Science.
4. Jorge J.Yunis, 1977. Molecular Structure of Human Chromosomes, Academic Press.
5. Elaine Johansen Mange & Arthur P. Mange, 1995. Basic Human Genetics (Second Edition), Sinauer Associates, Inc.
6. Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.
7. Margarlet J.Barch, Turid Knutsen & Jack L.Spurbeck, 1997. The AGT Cytogenetics Laboratory Manual (3rd Edition), Lippincott-Raven.
8. K.C. Sawant 2003. Concise Encyclopedia of Human Genetics, Dominant Pub. & Distributors
9. Amita Sarkar, 2001. Human Genetics, Dominant publishers and Distributors.
10. Michael Baraitser & Robin Winter, 1983. A Colour Atlas of Clinical Genetics, Wolfe Medical Publications Ltd.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5103**					
TITLE OF THE COURSE	**MOLECULAR GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
	-	-	-

COURSE OBJECTIVES :

- To understand the functions and structures of nucleic acids and proteins.
- To understand the concepts of transcription, translation, control of gene expression, mutations, DNA repair and DNA recombination

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	In-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms	L3

CO2	At the end student will gain an understanding of chemical and molecular processes that occur in and between cells	L3
CO3	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L4
CO4	Explain the principles of cloning and genetic manipulation and their application in genetic analysis	L3
CO5	Discuss the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms	L2

COURSE CONTENT:

MODULE 1	**13Hrs**

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes

MODULE 2	**13Hrs**

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein

in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DN	
MODULE 3	**13Hrs**
Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders. **Transposons and Molecular mechanism of transposition:**Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesi	
MODULE 4	**13Hrs**
Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA). **Medical Molecular Genetics:** Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Comp
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc p
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cu Pearson Education.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5201**					
TITLE OF THE COURSE	**FUNDAMENTALS OF HUMAN GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To be updated with the knowledge on the basics of human genetics and genetic causes for human diseases.
- To study the genetic techniques as to gain the knowledge in the field of basic human genetics.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The fundamentals of human genetics will help to students in obtaining basic knowledge of human genetics and its importance.	L3

CO2	Students will have an idea on identifying the pattern of inheritance and genetic cause for the disease	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
Introduction to Genetics: Mendel and his experiments, Law of segregation and independent assortment; Chromosomal basis of segregation and independent assortment. Allelic variation and gene function, Dominance relationships, basis of dominant and recessive mutations; Multiple allelism, allelic series.	
MODULE 2	**13Hrs**
History and Scope of Human Genetics: Origin of Human Genetics, Present and future prospectus of Human Genetics, Pedigrees-gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits-Autosomal inheritance-dominant and recessive; Sex-linked inheritance-dominant and recessive; Sex-limited and sex-influenced traits; Y-linked; Mitochondrial inheritance, Errors in transmission (Mutation), Classification of Genetic Disorders, Medical Applications of Chromosomes, Drawing of a pedigree, Consanguinity.	
MODULE 3	**13Hrs**
Human Cytogenetics: Review of cellular division mitosis and meiosis, Human Chromosomes, Chromosomal aberrations, Techniques in human chromosome analysis, Human karyotype: banding, nomenclature of banding, Pathology of human chromosomes, Nomenclature of aberrant karyotypes, Common chromosomal disorders and Mendelian disorders: Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies, disorders of structural aberrations.	

MODULE 4	13Hrs
Complex traits: Characteristics and structure of genes, Single gene disorders, Multifactorial disorders. Polygenic inheritance of continuous (quantitative) traits, Dysmorphology, Polygenic inheritance of discontinuous (dichotomous) traits-threshold model, liability and recurrence risk, Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling.

Oxford University Press, Oxford.

8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

R	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5202**					
TITLE OF THE COURSE	**HUMAN BIOCHEMICAL AND IMMUNOGENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To understand the genetics of biochemical disorders especially inborn errors of metabolism.

- To study the genetics of immune system and immunodeficiency diseases.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get an idea of how genetically inherited diseases are associated with biochemical pathways.	L3
CO2	This course will help to understand the importance of genes in gaining immunity	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; Effects of multiple gene loci on protein structure; Molecular structure, biosynthesis and genetics of the ABH antigens, Rh antigens and MN antigens. Quantitative and qualitative variation of enzymes; Haemoglobin variants; Hemoglobin and Hemoglobinopathies, Effects of Single Amino Acid Substitutions: Sickle cell Anaemia, Genetics of steroid and insulin receptors.	
MODULE 2	**13Hrs**
Inborn errors of metabolism: Disorders of aminoacid metabolism (Alkaptonuria, Phenylketonuria, Maple Syrup Urine Disease), Disorders of Carbohydrate Metabolism (Galactosemia, Hereditary Fructose Intolerance), Glycogen storage diseases (affecting liver and muscle), Lysosomal Storage Disorders (Tay-Sachs Disease), Disorders of Lipoprotein and lipid metabolism-Hyper Lipoproteinemia, FH; Disorders of Purine metabolism Lesch Nyhan syndrome; Disorders of Pyrmidine metabolism-Orotic Aciduria, Disorders of copper metabolism (Menkes and Wilson diseases).	

MODULE 3	**13Hrs**
Introduction to immune system: Innate and adaptive immunity, Phagocytes, the complement system, natural killer cells; The adaptive immune system: Cellular immune system, humoral immune system; Genetic basis of structure and diversity; Immunoglobulin molecules and genetic basis of antibody diversity. Organization of immunoglobulin genes, mechanism of gene rearrangements, class switching, regulation of immunoglobulin genes.	
MODULE 4	**13Hrs**
Regulatory mechanisms of immune system: The Major Histocompatability complex (MHC), Organization of HLA complex, Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism. Immunodeficiency diseases-Agamma-globulinemia, Severe combined immuno-deficiency, Ataxia telangiectasia, Wiskott-Aldrich syndrome. Hypersensitive reactions, Cytokine-related diseases, Immunesystem in human health, Immune response to infectious diseases and malignancy, Concept of immunotherapy, Vaccines, Transplantation immunology.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling. Oxford University Press, Oxford.
8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MHG5271**					
TITLE OF THE COURSE	**PRACTICALS IN HUMAN CYTOGENETICS, BIOCHEMICAL AND IMMUNOGENETICS**					
	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits

SCHEME OF Instruction	**0**	**0**	**6**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To increase students learning ability by conducting praticals of human cytogenetics, on biochemical genetics including errors in metabolism.
- To familiarize students with the various immunological techniques including antigen-antibody interactions, quantitation of antigens or antibody, agglutination reactions etc.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After this course students would have practical knowledge of various human cytogenetic, biochemical and immunological techniques.	L4
CO2	Completion of this practical course, student will have the hands on training experience, which will help to carry out such practical experiments as well as research in future	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Barr body identification from buccal cells

2. Karyotyping:

a) Setting up of Human leukocyte culture

b) Harvesting and metaphase plate preparations

c) Preparation of G-banded chromosomes and observation

3. Problems on patterns of Inheritance in Human: Pedigree analysis; Autosomal patterns, X and Y linked patterns.

cose estimation from Blood/Urine.

5. Sickling test to identify sickle shaped RBC's.

6. Determination of Red Blood Cell (RBC) and White Blood Cell (WBC) count by using hemocytometer.

7. Blood smear preparation and differential leukocyte count.

8. ABO-Blood grouping and Rh typing.

9. Single/Double Immunodiffussion assay for quantitation of antigens/antibody.

10. Determination of lymphocyte viability by Trypan blue dye exclusion test.

TEXT BOOKS :

1. 1 Wilson & Walker (2000). Practical biochemistry. Principle and techniques, Cambridge.
2. Grifith's et al. (2004). An introduction to genetic analysis, Freeman
3. Rooney, D.E. and Czepulkowski, B.H. (1992). Human Cytogenetics: A Practical Approach. IRL Press, Vol. 1&2, 2nded.
4. Stoddart, M.J. (2011). Mammalian Cell Viability: Methods and Protocols. Humana Press, New York.
5. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nded.
6. Freshney, R.I. (2010). Animal Cell Culture: A Practical Approach. IRL Press, Oxford, 2nded.
7. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5301**					
TITLE OF THE COURSE	**MEDICAL AND CANCER GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- This course will provide up-to-date information about various applications of genetics to human health.
- The objective of the course is to understand how genetics contributes to predisposition and progression of cancer.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have an idea on different types of genetic disorders, mapping of disease genes to specific locations on chromosomes, analyses of the molecular mechanisms through which genes cause disease.	L1

CO2	This course will familiarize the students with current concepts in cancer genetics and genomics.	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
INTRODUCTION TO MEDICAL GENETICS Scope of Medical Genetics: Practical applications of medical genetics, Impact of genetics condition on families, Types of human genetic diseases. Nomenclature of mutations, from genotype to phenotype: loss of function mutations, gain of function mutations. Identifying Human Disease Genes, monogenic and polygenic disorders.	
MODULE 2	**13Hrs**
GENETIC DISORDERS OF HUMAN Genetic disorders of Skin: Psoriasis, hereditary hemorrhagic telenglectsia, multiple neurofibromatosis, blooms syndrome. Skeletal system: Marfan's syndrome, brachydactyly, syndactyly, polydachyly, spina bifida and anencephaly, Rheumatoid arthritis, Osteogenesis imperfecta. Muscle: muscular dystrophies, Myotonia. Eye: Glaucoma, retinoblastoma. Jaws: Hare lip and palate. Ears: Deafness. Alimentary system: Hypertrophic pyloric stenosis. Respiratory system: Cystic fibrosis. Cardio vascular system: congenital heart disease, coronary heart diseases and Hypertension. Central nervous system: The ataxias and familial spastic paraplegia. Kidney and urinogenital tract: Cystinosis, polycystic kidney disease. Endocrine system: diabetes.	
MODULE 3	**13Hrs**
AN OVERVIEW OF CANCER GENETICS The genetic basis of cancer, Characteristics of cancer cells, Difference between normal and cancer cells, Contact inhibition, Malignancy as a loss of normal cellular affinities,	

Differential gene expression in normal vs transformed cells, Molecular changes in proto-oncogenes, tumor suppressor genes-Knudson's Hypothesis.

MODULE 4	**13Hrs**

TYPES OF HUMAN CANCER

Inherited versus sporadic cancers. Retinoblastoma, Lung cancer, Colon cancer, Brain cancer, Breast cancer, Prostrate cancer, cervical and esophageal cancers. Epstein Barr virus and its relationship to Burkett's lymphoma, Papilloma virus and cervical carcinoma. Genetic predisposition to sporadic cancer. Cancer prevention, diagnosis and treatment

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. 1. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
2. RA Weinberg (2012) Biology of Cancer, Garland, Taylor and Francis Group Publication, 2nd Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.
4. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication.
5. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
6. Gardner, A. and Davies, T. (2009) Human Genetics-Scion Publishing, 2nd edition.
7. Tobias, E.S. , Connor, J.M. and Ferguson-Smith, M. (2011) Essential Medical Genetics, Wiley-Blackwell publications, 6th edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5302**					
TITLE OF THE COURSE	**GENETIC SCREENING, COUNSELING AND DISEASE MANAGEMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**52**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- The primary objective of the course is to educate students in the fundamental concepts of medical genetics and counselling in order to become competent, insightful, knowledgeable, sensitive and passionate genetic counsellors.
- To provide intensive practical knowledge of Genetic Counseling, screening and disease management.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will prepare the student with in-depth knowledge of genetic counseling, diverse fieldwork and innovative learning	L2

	experiences to develop motivated genetic counselors to meet the needs of an expanding landscape in genetics and genomics.	
CO2	Student will understand the genetic mechanisms play a fundamental role in the pathogenesis and treatment of diseases and in the maintenance of health.	L3

COURSE CONTENT:	
MODULE 1	**13Hrs**
INTRODUCTION TO GENETIC COUNSELING Scope of genetic counseling, methods of genetic counseling, educating the counselee, presenting the risks and options and guiding. Information gathering and construction of pedigrees; Medical Genetic evaluation (Basic components of Medical History, Past medical history, social & family history). Components of Genetic Counselling: Physical examination (General and dysmorphology examination, Documentation), Legal and ethical considerations; Patterns of inheritance, risk assessment and counselling in common Mendelian and multifactor syndromes. Reproductive failures, consanguinity.	
MODULE 2	**13Hrs**
METHODS IN GENETIC SCREENING Scope of genetic screening, Prenatal and Post natal screening. Population screening for genetic diseases, family screening. Prenatal screening methods-Noninvasive methods (Ultrasound, Endoscopy, MRI, Maternal Serum Screening for Down's syndrome & Neural tube defect, Fetal Blood Sampling, etc.) Invasive methods; Amniocentesis, Chorionic Villi Sampling. Ethical issues in prenatal screening & diagnosis. Post-natal screening- chromosomal abnormalities, cytogenetic and molecular methods.	
MODULE 3	**13Hrs**
POPULATION SCREENING	

Newborn screening: PKU, Galactosemia, SCA & Congenital Hypothyroidism. Population carrier screening: Alzheimer's, HD & FHCL, Disease susceptibility for complex diseases – CAD & T2DM, Thalassemia's, Cystic Fibrosis, DMD, Fragile– X syndrome, Hemophilia. Presymptomatic and predispositional testing. Markers for disease diagnosis and prognosis: Genetic markers; Protein/enzyme markers and antibodies

MODULE 4	**13Hrs**

MANAGEMENT OF GENETIC DISORDERS **13 HRS**

Conventional methods for treatment of genetic diseases: Diet replacement, dietary avoidance, protein/enzyme substitution- Enzyme replacement therapy; substrate reduction therapy, Recombinant gene products for therapy. Gene therapy; Somatic cell gene therapy vs Germ line gene therapy; Gene transfer methods for therapy, Viral vectors, physical and chemical methods; Limitations of gene therapy Surgical interventions- Organ transplantation, bone marrow transplant. Immunotherapy: Approaches in immune therapy -use of Monoclonal antibodies, NK cells, Dendritic cells, B-lymphocytes and vaccines. Genomic medicine: Pharmacogenetics: G6PD & CYP2D6, benefits of Pharmacogenomics- personalized medicine.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Snustad, D P., and Michael J. Simmons. (2012) Principles of genetics. Hoboken, NJ: Wiley.
2. K Park (2011) Park's Textbook of Preventive and Social Medicine, Banarsidas Bhanot Publication, 21st Edition.
3. Peter Turnpenny and Sian Ellard (Eds) (2012) Emery's Elements of Medical Genetics, Elsevier, 14th Edition.

4. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
5. Jean-Marie Saudubray, Georges van den Berghe, John H. Walter, (Eds.) (2012), Inborn Metabolic Diseases: Diagnosis and Treatment, Springer, 5th Edition.
6. DL Rimoin, RE Pyeritz, B Korf (2013), Emery and Rimoin's Principles and Practice of Medical Genetics, Elsevier Science Publication, 6th Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5321**					
TITLE OF THE COURSE	**HUMAN POPULATION GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To make student understand the forces that have an impact on levels of genetic variations in natural and/or experimental populations for both qualitative and quantitative traits.
- To make the students familiar with different types of DNA markers and the range of tools for their detection to enable advanced studies on molecular population genetics.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	This course will give students exposure towards understanding population health and disease susceptibility.	L3
CO2	This course will be helpful to the students to conceptualize the existence of genetic variation and speciation.	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
INTRODUCTION TO POPULATION GENETICS Mendelian Population and scope of population genetics. Gene and genotype frequencies, mating patterns, Hardy-Weinberg principle, heterozygotes, extension of H-W principle to multiple alleles, sex-linked alleles. Non-random matings, inbreeding and assortative matings, inbreeding coefficient. Factors that change allelic frequencies.	
MODULE 2	**10Hrs**
GENETIC MAPPING OF MENDELIAN TRAITS Identifying recombinants and non-recombinants in pedigrees. Genetic and physical map distances, Basics of genetic variation, Genetic markers-SNP, CNV, Indels, VNTR, STR, Microsatellite, Two-point mapping- LOD score analysis, Multipoint mapping, Homozygosity map.	
MODULE 3	**10Hrs**
GENETIC VARIATION AND INHERITANCE OF COMPLEX TRAITS: Tag markers and Haplotypes, Linkage disequilibrium, Fixation index; Quantitative Genetic analysis; Broad-Sense Heritability and Narrow-Sense Heritability. Testing gene mutations for alleles: complementation test, intragenic complementation Genotypes &	

phenotypes: Effect of the environment on phenotype development, Penetrance and expressivity, Visible, sterile and lethal mutations, Gene interactions and modifying genes, Pleiotropy.

MODULE 4	**10Hrs**

GENETIC POLYMORPHISMS AMONG POPULATIONS

Genetic polymorphism, transient and stable and factors responsible for stable polymorphism. DNA markers and populations differences. Application of population genetics. Role of population genetics in genetic counselling. Genetic origin and evolution of human races. Genetic Demography, age and gender specific death and birth rates, intrinsic rate of natural increase. Index of opportunity for natural selection.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Hamilton M.B. (2009). Population Genetics. Wiley-Blackwell, UK.
2. Hedrick P.W.(2011). Genetics of Populations. Jones and Bartlett Publishers, Massachusetts.
3. Jobling, M., Hollox, E., Hurles, M., Kivisild, T. and Tyler-Smith, C. (2013). Human Evolutionary Genetics. Garland Science.
4. Nielsen, R. and Slatkin, M. (2013). An Introduction to Population Genetics: Theory and Applications. Sinauer Associates, Inc.
5. Relethford, J.H. (2012). Human Population Genetics. John Wiley & Sons.
6. Snusted, D.P., Simmons, M. J. (2010). Principles of Genetics. John Wiley & Sons, New York.
7. Knight, J.C. (2009). Human Genetic Diversity –Functional consequences for Health and Disease. Oxford University Press, USA.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5322**					
TITLE OF THE COURSE	**DEVELOPMENTAL AND REPRODUCTIVE GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- The goal of the course is to explore how genetic differences between individuals lead to behavioral differences between individuals.
- Provide an overview of reproductive disorders, types of infertility, and genetic causes for infertility.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completing the course students will be able to develop knowledge on hereditary mechanisms and processes relevant for the nervous system and behavior.	L3

CO2	Students will learn about genetic causes behind infertility, methods available for genetic testing, diagnosis, and reproductive options.	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
EARLY DEVELOPMENT Gametogenesis and differentiation: Oogenesis and spermatogenesis, Hormonal regulations. Fertilization and development: Molecular events of fertilization, activation of sperm motility, gamete fusion, Role of calcium during egg activation, Genetics of multicellularity cleavage, Molecular events.	
MODULE 2	**10Hrs**
BASIC CONCEPTS OF DEVELOPMENT Potency, commitment, specification, induction, competence, determination and differentiation; Morphogenetic gradients, pattern formation, cell fate and cell lineages; Mosaic versus regulative development; Genomic imprinting. Genomic imprinting; later phases of embryonic development; phenocopies and malformations; the development of structure and birth defects in humans; sex differentiation and its errors.	
MODULE 3	**10Hrs**
REPRODUCTIVE SYSTEMS AND DISORDERS Male and female reproductive systems: Gonads and differentiation of sexual characters; hormonal regulation of sexual differentiation; Reproductive Disorders: Genetic and environmental susceptibility for reproductive disorders, endometriosis, polycystic ovarian disorder, pseudohermaphroditism; true hermaphroditism; gonadal disgenesis, testicular feminization.	

MODULE 4	**10Hrs**

GENETICS OF INFERTILITY AND ASSISTED REPRODUCTIVE TECHNIQUES

Genetic basis of male infertility, genetic basis of female infertility; Abnormal gametes and infertility, Spontaneous abortions and still birth (etiology, pathogenesis, genetic characteristics, diagnosis and management), Reproductive technologies; Assisted reproductive techniques (ARTs), IVF, artificial insemination, cryo-preservation of oocyte, sperm & embryo, in vitro fertilization, embryo transfer, intra-cytoplasm sperm injection, ethical issues, prenatal diagnosis, pre-implantation genetic diagnosis (PGD), Genetic technologies used in PGD,

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Plomin, R., DeFries, J.C., McClearn, G.E. & McGuffin, P. (2008). Behavioral Genetics (5th Ed.). Worth Publishers, NY.
2. Knopik, Neiderhiser,DeFries and Plomin. Behavioral Genetics. Worth, 2017, 7th Ed.
3. Mazzocco, M.M. & Ross, J.L (2007; Eds). Neurogenetic Developmental Disorders. MIT Press, Boston, MA.
4. Kim, YK (2009; Ed). Handbook of Behavioral Genetics. Springer, NY, NY.
5. Anholt, R. & MacKay, T. (2010). Principles of Behavioral Genetics. Elsevier Press, San Diego, CA.
6. Moody (2007). Principles of developmental biology, Elsevier.
7. Singh and Pal (2007). Human Embryology, 8th Edition, McMillan.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5323**					
TITLE OF THE COURSE	**CLINICAL GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To provide students with increased knowledge about the genetic causes and inheritance of genetic disorders.
- This course is designed to provide an overview of human genetic diseases associated with blood, muscle, brain and Eye.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completing the course students will have acquired knowledge about the cause and inheritance of genetic disorders in humans.	L1

CO2	Students will have knowledge of genetic disorders, congenital anomalies and malformations and molecular mechanisms underlying these diseases.	L4

COURSE CONTENT:	
MODULE 1	**10Hrs**
GENETIC BASIS OF SYNDROMES AND DISORDERS Monogenic diseases: Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome. Polygenic diseases: Hyperlipidemia, Atherosclerosis, Diabetes mellitus. Genomic syndrome: Neurofibromatosis I syndrome. Genomic imprinting Syndromes: Prader-Willi & Angelman syndromes, Beckwith-Wiedeman Syndrome	
MODULE 2	**10Hrs**
CONGENITAL ABNORMALITIES AND DYSMORPHIC SYNDROMES Numerical (Down's Syndrome, Fragile-X syndrome, Edward's syndrome), Microdeletions (DiGeorge Syndrome, Prader Willi and Angelman Syndrome, Retinoblastoma), Breakage syndromes (Ataxia Telengiectasia, Fanconi Anemia)	
MODULE 3	**10Hrs**
DISORDERS OF BLOOD, MUSCLE AND EYE Disorders of Haemopoitic systems. Overview of Blood cell types and haemoglobin. Hemoglobinopathies, Thalassemias, Hemophilias. Disorders of muscle: Dystrophies (Duchenne Muscular dytstrophy and Becker Muscular Dystrophy), Myotonias, Myopathies. Disorders of eye: Retinitis pigmentosa, Cataracts, Colour blindness.	
MODULE 4	**10Hrs**
MITOCHONDRIAL AND NEUROGENETIC DISORDERS	

Mitochondrial disorders: Kearns-Sayre syndrome, Pearson's syndrome, and progressive external ophthalmoplegia, MELAS syndrome, Leber's hereditary optic neuropathy, Defects in nuclear genes leading to dysfunction of mitochondrial proteins (Friedreich's ataxia). Neurogenetic disorders:Charcot-Marie tooth syndrome, Spino-muscular atrophy, Alzheimer's disease.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Cassidy, S.B. and Allanson, J.E. (2010). Management of Genetic Syndromes. Wiley-Blackwell, 3rd ed.

2. Gardner, R.J.M., Sutherland, G.R. and Shaffer, L.G. (2011). Chromosome Abnormalities and Genetic Counselling. Oxford University Press, 4th ed.

3. Gunder, L.M.and Sudbury, S.A.M. (2011). Essentials of Medical Genetics for Health Professionals. Jones and Bartlett Learning.

4. Hudgins, L., Toriello, H.V. Enns, G.M. and Hoyme, H.E. (Eds.) (2014). Signs and Symptons of Genetic Conditions: A Handbook. Oxford University Press, London, 1st ed., p.560.

5. Jorde, L.B., Carey, J.C. and Bamshad, M.J. (2010). Medical Genetics. Mosby, 4th ed.

6. Korf, B.R. and Irons, H.B. (2013). Human Genetics and Genomics. John Wiley and Sons, Hoboken, 4th ed.

7. Roderick R. McInnes and Huntington F. Willard (2007).Thompson& Thompson Genetics in Medicine

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5324**					
TITLE OF THE COURSE	**APPLIED HUMAN GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To understand applications of human genetics in drug therapy optimization and patient care.
- To enrich the current knowledge with nutritional genomics and genomic medicine.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will have the knowledge of recent trends in human genetics and its applications.	L1
CO2	This course will enhance the in-depth understanding of genomic medicine and Nutrigenomics concepts and cultivating empathy towards patients with genetic conditions	L4

COURSE CONTENT:

MODULE 1	**10Hrs**

APPLICATIONS OF HUMAN GENETICS

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects.

MODULE 2	**10Hrs**

PHARMACOGENOMICS

Introduction to pharmacogenomics. Genetic polymorphism of CYP isoenzymes and drug transporters. New pharmacological classes of drugs (antibodies, antisense RNAs, siRNAs, aptamers). Personalized medicine and drug prescription. Development of new innovative molecularly-targeted cancer therapeutics; Examples of drugs related to the pharmacogenomics application in clinical practice: a) Pharmacodynamics- and pharmacogenomics-guided warfarin dosing in individual patients; b) Pharmacological assessment of tamoxifen-paroxetine interaction and pharmacogenomics of tamoxifen in oncology; c) Thiopurine drugs and pharmacogenomics of TPMT enzyme in guiding dosage schemes; d) Pharmacogenomics of antidepressant and psychotropic drugs.

MODULE 3	**10Hrs**

NEUTRIGENOMICS

Introduction to nutrigenomics and personalized nutrition. 'Omics' technologies used in nutrition. Nutritional Epidemiology and Study Design. Genetic variation and nutrient response. Food Intolerances. Consumer genetics and personalized nutrition- Keeping genetic information safe. Genetic determinants of eating behaviours. Functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.

MODULE 4	**10Hrs**

CHARACTERIZATION OF COMPLEX DISEASE TRAITS
Scaling the human genome: UCSC genome browser, RegulomeDB database, ENCODE-ChIA-PET database, Dual Luciferase Reporter (DLR) assay. Estimating DNA-protein interactions: Chromatin Immunoprecipitation (ChIP) assay, Electrophoretic mobility Shift Assay (EMSA) and affinity pull down assays, 3D view of the Genome: Chromatin Conformation Capture (3C) and Hi-ChIP assays.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. QI L.Gene-Diet Interactions in Complex Disease (2012): Current Findings and Relevance for Public Health, Curr Nutr Rep: 1: 222-227
2. TUCKER K.L.,SMITH C.E.,LAI C.Q.,ORDOVAS J.M (2013).Quantifying diet for nutrigenomic studies, Annual review of nutrition: 33: 349-371.
3. PETERS L.L.,ROBLEDO R.F.,BULT C.J.,CHURCHILL G.A.,PAIGEN B.J.,SVENSON K.L.(2007). The mouse as a model for human biology: a resource guide for complex trait analysis, Nature reviews Genetics 8: 58-69.
4. FRAZER K.A.,MURRAY S.S.,SCHORK N.J.,TOPOL E.J.(2009). Human genetic variation and its contribution to complex traits, Nature reviews Genetics: 10: 241-251.
5. DAVID L.A.,MAURICE C.F.,CARMODY R.N.,GOOTENBERG D.B.,BUTTON J.E.,WOLFE B.E.et al. (2013) Diet rapidly and reproducibly alters the human gut microbiome, Nature
6. LUCA F.,PERRY G.H.,DI RIENZO A. (2010) Evolutionary adaptations to dietary changes, Annual review of nutrition: 30: 291-314.
7. Raffaele DE Caterina, J. Alfredo Martinez and Martin Kohlmeier (2020). Principles of Nutrigenetics and Nutrigenomics, Elsevier.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5325**					
TITLE OF THE COURSE	**GENETICS IN TOXICOLOGY AND FORENSIC SCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**40**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To Lay foundation in forensic genetics that can be applied to assess problems concerning various types of DNA markers and analyses.
- Study and understand different experiments employed in forensic genetics and Toxicology.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	At the end of the course student will able to understand genetic toxicology and methods applied in forensic genetics.	L1
CO2	Student will have the current knowledge of genetics in forensic applications.	L4

COURSE CONTENT:

MODULE 1	**10Hrs**

INTRODUCTION TO GENETIC TOXICOLOGY

Origin of genetic toxicology; historical prospective of genetic toxicology; fundamentals of genetic toxicity; mechanism of induction of chromosomal alterations and sister chromatid exchanges; mutagens-chemical, physical, biological, environmental and food; antimutagens. Mechanisms of gene mutations; germinal mutations and human genetic diseases; mutations and cancers; genetic toxicology and congenital malformations; consequences of genotoxic effects in humans.

MODULE 2	**10Hrs**

EVALUATION OF GENO TOXICITY **10 HRS**

Functional genomics: cDNA/gene, cloning; site-directed mutagenesis; Mammalian tissue culture, Methods for generation of transgenic animals/ knock-in, knockout models (microinjection, ES cell transformation); E Numutagenesis; PFGE, Automated DNA sequencing. In vitro gene mutation – bacterial reverse mutation assay (Ames test), mammalian cell Hprt mutation; In vivo gene mutation - Rodent lymphocyte Hprt mutation assay.

MODULE 3	**10Hrs**

INTRODUCTION TO FORENSIC GENETICS

Forensic Biology: Definition and scope Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. DNA Profiling: Introduction, History of DNA Typing, DNA variations, DNA typing systems- RFLP analysis, PCR amplifications, sequence polymorphism. Analysis of SNP, Y-STR, Mitochondrial DNA, Ancient DNA typing. DNA Statistics: frequency estimate calculations, interpretations, allele frequency determination, Paternity/Maternity index, Sibling index, Probability of match. Human Genome Project, DNA Forensic Databases.

MODULE 4	**10Hrs**

FORENSIC SIGNIFICANCE OF DNA PROFILING
Applications in disputed paternity cases, child swapping, missing person's identity- civil immigration, legal perspectives- legal standards for admissibility of DNA profiling, procedural and ethical concerns, status of development of DNA profiling in India and abroad. New and future technologies: DNA chips, SNPs and limitations of DNA profiling.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

1. Goodwin, Linacre, and Hadi (2010) An Introduction to Forensic Genetics, 2nd Edition, Wiley [Paperback]
2. Butler, J.M. (2005) Forensic DNA Typing, 2nd Edition, Elsevier.
3. Baird, M.L. Analysis of Forensic DNA Samples by Single Locus VNTR ProbesForensic DNA TechnologyMark Farley, James Harrington, editorsLewis, 1991.
4. Principles of Genetic Toxicology (2013) by D. Brusick Second Edition, Springer2. Genetic Toxicology Testing - A Laboratory Manual edited (2016) by Ray Proudlock Elsevier-Academic Press3. Genetic Toxicology: An Agricultural Perspective edited by Raymond F. Fleck, Plenum Press4.
5. Transgenic plants as sensors of environmental pollution genotoxicity (2008) Kovachuk and Kovalchuk. Sensors 8(3), 1539-15585.
6. Toxicology of Herbal Products edited by Olavi Pelkonen, Pierre Duez, Pia Maarit Vuorela, Heikki Vuorela.
7. Rudin N, Inman K (2001). An Introduction to Forensic DNA Analysis, CRC Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5371**					
TITLE OF THE COURSE	**LABORATORY EXERCISE IN MEDICAL AND CANCER GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To increase students learning ability by conducting practical's including isolation of DNA/RNA from blood sample, amplification of gene through PCR, Sequencing of PCR products and analysis.
- To familiarize students with the various methods involved in mutation analysis, genotype-phenotype correlation and disease pathway analysis.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After this course students would have practical knowledge of genotyping/genome analysis methods.	L4
CO2	On completion of this practical course, student will have the hands on training experience in the field of Molecular genetic testing.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Isolation of DNA from peripheral Blood.
2. Isolation of RNA from whole blood.
3. Quantity and Quality check for Genomic DNA and RNA by using agarose gel electrophoresis and spectrophotometric method.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
5. Primer designing by using bioinformatics tools for genes to be amplified through PCR.
6. PCR amplification of gene fragments by using specific primers.
7. Agarose gel electrophoresis to resolve PCR products and purification of PCR products.
8. Demonstration of sanger method of sequencing and analysis of mutations by using exon sequences of the gene.
9. Use of databases and bioinformatics tools for protein-structures, gene ontologies, protein-interactions and disease pathway analysis.

TEXT BOOKS :

1. Kary B Mullis, Francois Ferre (1994), PCR-The Polymerase Chain Reaction, Birkhauser Boston Edn.
2. LB Jorde, JC Carey and MJ Bamshad (2009) Medical Genetics, Elsevier Publication
3. R. Durbin (1998) Biological sequence analysis; Cambridge University Press, 1998.
4. T Strachan and AP Read (2011), Human Molecular Genetics, Garland Science/Taylor and Francis Group Publication, 4th Edition.
5. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.
6. L Buckingham (2011) Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, FA Davis Company Publication, 2nd Edition.
7. P George, GP Patrinos and WJ Ansorge (2010) Molecular Diagnostics, Academic Press, Elsevier Publication, 2nd Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MHG5372**					
TITLE OF THE COURSE	**LABORATORY EXERCISES IN GENETIC SCREENING AND ANALYSIS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**0**	**6**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- Students will Explore knowledge in genetic counseling, screening and genetic testing methods by having case studies.
- Train the student to understand how to gather family history by pedigree construction, analysis and prediction of genetic risk.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	At the end of the course Students will be able to perform genetic counseling effectively.	L4
CO2	Students will get case based practical knowledge to understand genetic counseling screening and genome analysis methods.	L2

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Preparation of pedigree on case based study.
2. Case based genetic counseling, problems on Genetic counseling and risk assessment.
3. Demonstration of comet Assay to detect DNA damage.
4. Applications and usage of databases like, OMIM, NCBI, Ensemble, UCSC Genome browser, Emboss, PDB.
4. Genotyping by using RFLP markers.
5. Genotyping using VNTR markers.
6. Quantitative PCR (qPCR) for estimation of gene copy or transcript expression level.
7. Demonstration of data analysis in genomics, transcriptomics (mRNA and miRNA analysis), and metagenomics.
8. Case studies in clinically relevant databases and SNP databases.
9. Maternal serum testing for prenatal diagnosis.
10. Identification of chromosomal abnormalities in relation to cancers using banding technique.

TEXT BOOKS :

1. Peter S Harper (2010), Practical Genetic Counselling Elsevier, 7th Edition.
2. R.J. McKinlay Gardner, Grant R Sutherland, and Lisa G. Shaffer (2011), Chromosome abnormalities and Genetic counselling, Oxford University Press, 4th Edition.
3. Jones KL and Smith DW : Smith's Recognizable patterns of Human malformations (7th Edition, 2013): Elsevier Health Sciences
4. Young I: Introduction to Risk Calculation in Genetic Counseling (3rd Edition,2006) Oxford University Press.
5. Knowles, Richard V. (2001) Solving problems in genetics, New York: Springer
6. S Heim, F Mitelman (2011) Cancer Cytogenetics: Chromosomal and Molecular Genetic Aberrations of Tumor Cells, John Willey and Sons Publications.
7. Griffiths, Anthony J., et al. (2015) Introduction to genetic analysis, New York, NY: W.H. Freeman & Company.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Physicochemical principles: Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pK_a, pK_b, pOH, preparation of buffers, Henderson-Hasselbach equation and numerical problems associated with buffer preparation. **8h**

Bonding: VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll. **5h**

Module 2: **13h**

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernsts' equation. **5h**

Thermodynamics**:** First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential. **5h**

Chemical kinetics**:** Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, Activated complex theory, catalysis **3h**

Module 3: **13h**

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids. **8h**

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions. **5h**

Module 4: **13h**

Reaction Mechanism: S_N1, S_N2 E1 & E2 reactions, aromaticity, mechanistic study of reactions important for biology, E1, E2, S_N1 and S_N2 attack – metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. **8h**
Heterocyclic compounds: Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins. **5h**

References:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(1996).

2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (1992)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

4. Organic Mechanisms, Peter Sykes, Longman, (1977).

5. Inorganic Biochemistry. G.L. Eicharn, Elsevier

6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co

7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (1964).

8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).

9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).

11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).

12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).

13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York(1995).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC102
TITLE OF THE COURSE : BIOMOLECULES
L: T/A: P: C : 4: 1: 0: 5 52 hours

Module 1: 13h

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides, sugar derivatives. Glycosidic linkages in disaccharides, glycosides. **4h**

Complex Carbohydrates: Homopolysachharides and heteropolysachharides-starch, glycogen, cellulose chitin, glycosaminoglycans and peptidoglycans. Blood group determinants, therapeutics of cardiotonic steroids. Structure determination and sequence analysis of carbohydrates. Glycoprotiens and Glycolipids - O and N linked oligosaccharides, Proteoglycans, Lectins, lipo-polysaccharides and trehalose mycolates. **9h**

Module 2: 13h

Amino acids and peptides: Standard amino acids- structure and classification. Enantiomeric, ampholytic, UV absorption and ionic properties, amino acid derivatives in proteins and specialized roles of amino acids. Peptide bond, naturally occurring peptides-vasopressin, endorphins and glutathione, Merrifield's solid phase synthesis of peptides. **5h**

Structural organization of proteins

Primary structure determination **-** End group analysis, cleavage of Disulfide bond, sequencing methods, separation, purification and characterization of polypeptide chains, amino acid composition analysis, fragmentation of peptides by enzymes and chemicals, sequence determination and ordering the peptide fragments, assignment of disulfide bond position, Modern methods of peptide sequencing; Mass spectrometric and Recombinant DNA Technology methods. **8h**

Module 3: 13h

Secondary structure*:* Peptide bond geometry, conformational map, Chou and Fasman algorithm, α-helix and other helices, β pleated sheet, Beta bend and triple helical cable, secondary structure of fibrous proteins: α-keratin, silk fibroin and collagen, super secondary structures

Tertiary structure*:* Non covalent and covalent interactions stabilizing the 3D structure. Tertiary structure of lysozyme, myoglobin and ribonuclease, denaturation of proteins

***Quaternary structure**:* Cross linking agents to determine subunit composition. Hemoglobin Structure and mechanism of oxygen binding cooperativity. Molecular basis of Sickle-cell anemia

***Protein folding**:* Protein renaturation experiment by Anfinsen, folding accessory proteins- protein disulfide isomerases and molecular chaperones, Levinthol paradox, events during protein folding, conformational diseases: Amyloid, Alzheimer's and Prion diseases. **10h**

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of fatty acids, acylglycerols, phospholipids, plasmalogens, sphingolipids and sterols. **3h**

Module 4: 13h

Lipids: Biological importance of Prostaglandins and related compounds, lipid peroxidation and antioxidants. **3h**

Nucleic acids: Nucleosides, nucleotides and polynucleotides. secondary and tertiary structure of DNA, Cloverleaf model of t-RNA , unusual bases of nucleic acids, Isolation and purification of DNA and RNA, properties of nucleic acids in solution, melting temperature of DNA-T_m; factors affecting T_m. Maxim and Gilbert method and Sanger's dideoxy method of DNA sequencing, rapid sequencing methods. Oligonucleotide synthesis by phosphoramidite method, DNA chip and SELEX (systematic evolution of bio ligands by evolutionary enrichment). **10h**

References:

1. Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).

2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).

4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).

5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).

6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).

7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and Lubert Stryer, W H Freeman and Co. (2006).

8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC103
TITLE OF THE COURSE : BIOANALYTICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5 52 hours

Module 1: **13h**

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **8h**

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules. **5h**

Module 2: **13h**

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, Western, Northern and Southern blotting techniques, 2D gel electrophoresis. **6h**

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips **7h**

Module 3: **13h**

Chromatography : partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapathite chromatography, special chromatographic techniques for nucleic acids, FPLC **10h**

Radioactivity: Disintegration of radionucleides, half life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography. **3h**

Module 4: **13h**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications. **5h**

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property. **8h**

References

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).

2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)

4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)

5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)

6. Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III

Elsevier (2008).

7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC104
TITLE OF THE COURSE : HUMAN PHYSIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Tissue level of organization: Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues. **8h**

The muscular system: Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism. **5h**

Module 2: **13h**

Nervous system: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin **8h**

Endocrine system: Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D. **5h**

Module 3: **13h**

Cardiovascular system: functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary

circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center. **8h**

Respiratory system: Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O_2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods. **5h**

Module 4: **13h**

Digestive system: Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food **7h**

The urinary system: Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones. **6h**

References

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)

2. Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).

3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (1997).

4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (1995).

6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).

7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (1997)

8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (1998)

9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (1991).

10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (1983).

11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (1986).

12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC105
TITLE OF THE COURSE : BIOSTATISTICS
L: T/A: P: C : 2:0:0:2

26 hours

Module I: 13h

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.
Measures of Central tendency: Arithmetic mean, mode & median.
Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error
Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.
Sampling methods and their significance.

Module II: 13h

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.
Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

References:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC171
TITLE OF THE COURSE : BIOCHEMICAL ESTIMATIONS
L: T/A: P: C : 0:0:8:4

1. Estimation of lactose in milk by DNS
2. Estimation of sugars in fruits
3. Estimation of proteins by Lowry's method
4. Estimation of inorganic phosphate in peas by Fiske-Subbarow method
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by Orcinol method.
7. Estimation of total sugars in plants by anthrone method.
8. Determination of saponification number of oil/fat

.

References:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).

2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).

3. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).

4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),

5. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990).

6. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

7. Biophysical chemistry by Upadhyay and Upadhyay.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC172
TITLE OF THE COURSE : BIOPHYSICAL CHEMISTRY
L: T/A: P: C : 0:0:8:4

1. pH calculation and Buffer preparations - problems
2. Determination of absorption spectra, molar extinction coefficient & λ_{max} of proteins & nucleic acids.
3. Determination of pK_a of amino acid through pHmetric titration.
4. Determination of weak acid concentration by conductometric titration
5. Separation of amino acids by ascending & circular chromatography.
6. Separation of amino acids by 2-D chromatography
7. Separation of carbohydrates/amino acids by TLC.
8. SDS-PAGE of proteins.

References:

1. Biochemical Calculations, Irwin H.Segel (1976) 2nd Ed. John Wiley and Sons.

2. Modern Experimental Biochemistry R.F.Boyer [Ed.] (1986) Addition Wesley.

3. Analytical Biochemistry; D.J.Holme and H. Pick, Longman (1983).

4. Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 6th Ed. (2005) Cambridge University Press.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC201
TITLE OF THE COURSE : METABOLISM OF CARBOHYDRATES AND LIPIDS
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Carbohydrate metabolism: anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, Kreb's cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle-utilisation of TAG in germinating seeds. Glucuronic acid pathway-synthesis of L-Ascorbic acid in plants. Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins **13h**

Module 2: **13h**

Lipid metabolism: Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, energetics of β-oxidation scheme, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, shpingolipid storage disorders**.** **13h**

Module 3: **13h**

Cholesterol: structure, brief idea of synthesis and metabolism, normal and abnormal levels in the body. **2h**

Isoprenoid metabolism, insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL. Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism, obesity, atherosclerosis and hypercholesterolemia, synthesis of prostaglandins and related compounds, Non steroidal anti inflammatory drugs (NSAIDs) **11h**

Module 4: **13h**

Metabolic disorders: Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves,

and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria. **8h**

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation. Introduction to metabolomics. **5h**

References

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(1999).

2. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper IRL Oxford University Press(1995).

3. Photosynthesis, D.O. Hall and K. K. Rao, 6th Ed. Cambridge University Press (1999).

4. Hawk's Physiological Chemistry, 14th Ed , Oser, Tata-McGraHill (1976).

5. Biochemistry of Foods, Eskin, Elsevier (2012).

6. Text Book of Biochemistry with Clinical correlations; 6th Ed. Thomas M. Devlin, Wiley- Liss (2012).

7. Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).

8. Biochemistry; David Rawn, Panima Publishers (2012).

9. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D.Bender , K.M. Botham ,

P. J. Kennelly, P. A. Weil (2015)

10. Biochemistry; 7th Ed. J.M.Berg, J.L.Tymoczko, L.Stryer , W.H.Freeman &Company (2012)

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC202
TITLE OF THE COURSE : IMMUNOLOGY AND CANCER BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. **3h**

Innate immunity: Different lines and layers of defense, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils. **10h**

Module 2: **13h**

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins, genetic recombination of heavy and light chains. **5h**

Immuno techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA & ELISA. Immuno-electrophoresis, Immuno-florescence and immuno-staining techniques in electron microscopy. **3h**

Antigen recognition by T cells: T_H, T_C and T_{Reg} cells**,** T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen. **5h**

Module 3: **13h**

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self recognition. **3h**

Failures of Host Defense Mechanisms: How do pathogens evade the immune system, inherited immunodeficiency diseases, acquired immune deficiency syndrome. Autoimmune responses. Vaccines. **4h**

Allergy and Hypersensitivity: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases. **3h**

Transplantation and Network theory: Transplant rejection, immunosuppressents. Immuno-surveillance, idiotopes and immune network theory. **3h**

Module 4: **13h**

Hallmarks of cancer, tumor viruses, oncogenes, growth receptors and signaling, tumor suppressor genes, p53 and pRB-functions and regulation. Apoptosis – components of pro- and anti-apoptotic pathways. Tumorogenesis- differentiation, immortalization, genomic integrity, angiogenesis and metastasis. Rational design of cancer therapeutics. **13h**

References:

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology , 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L.Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007)
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013)
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).
8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57–70 (2000)
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC203
TITLE OF THE COURSE : ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Introduction to Enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes. **7h**

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions –nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B. **6h**

Module 2: **13h**

Enzyme Kinetics: Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. **5h**

Kinetic data evaluation; linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy. **8h**

Module 3: **13h**

Enzyme Inhibition: Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. **5h**

Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation - reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation. **8h**

Module 4: **13h**

The investigation of active site structure: The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labeling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies. **7h**

Enzyme catalysis: Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin) , sulphydryl enzymes(alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase). **6h**

References:

1. Enzymes- Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010)
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999)
4. Fundamentals of Enzyme Kinetics,Bowden, Portland Press (2004)
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H.. Freeman & Companys (1980).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000)
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons(1976).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC204
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: **13h**

Criteria for classification of microroganisms, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Chemotaxonomy, Numerical taxonomy and Molecular taxonomy. Brief account of Bergey's manual of bacteriology.

Bacteria: Ultra structure of bacterial cell: Shapes and size, chemical composition and characterization of cell wall.

Viruses: General Properties of viruses, classification and replication of bacteriophages. Viroids and Prions.

Ultrastructure, classification and reproduction in algae, fungi and protozoa

Module II: **13h**

Microscopy: Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Microbial Techniques: Cultivation of microorganisms, culture media, Pure culture techniques, Stains and staining techniques: Simple, Negative, Gram's, Acid fast and structural staining techniques.

Microbial Control: Concepts of sterilization and disinfection. Physical and chemical methods of sterilization.

Module III : **13h**

Microbial growth, growth curve and factors affecting growth (Physical and chemical).

Bacterial photosynthesis, photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Role of microorganisms in nitrogen fixation.

Breakdown of carbohydrates –EMP (Glycolysis), HMP shunt (pentose phosphate pathway) and ED, TCA, ETS (oxidative phosphorylation), anaerobic respiration.

Fermentative modes in microorganisms – alcoholic, lactic acid (hetero and homo lactic acid fermentation).

Overview and importance of secondary metabolites - antibiotics

Module IV: **13h**

Host pathogen interactions, defense mechanisms of pathogens, human pathogens and diseases; virus (chickenpox, measles, mumps, hepatitis B), bacteria (tetanus, TB, cholera, typhoid, anthrax), protozoa (amebiasis, malaria, toxoplasmosis), fungi (mycoses). General characteristics of antimicrobial drugs and their mode of action, antibiotic resistance and multi-drug resistant strains.

References:

1. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers
2. Stainer R.T., Ingraham J.L., Wheelis M.L. and Painter, P.R., (1987).General Microbiology; Macmillan, 5th. Edition
3. Pelczar Jr. M.J.; Chan E.C.S. and Krieg N.R. (1986). Microbiology, Mc Graw Hill, Fifth Edition
4. Glazer A N and Nikiado H , Freeman (1995).Microbial Biotechnology and Fundamentals of Applied Microbiology.
5. Introductory Microbiology by Heritage Pub Heritage
6. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y
7. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2 Edition, Milan Publishing Co.
8. Brock T.D. and Madigan M.T). (1992)Biology of Microorganisms 6 Edn. Prentice Hall, Eagle wood cliffs N.j.
9. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T. (1994). Bergey‟s Manual of the Systemic Bacteriology 9 Edn. William and Wilkins, Baltimore.
10. Dubey.R.C Microbiology. (2001). First edition. Chand & Company.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0:2

26 hours

Module I: **8h**

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant

Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Programming Languages: Introduction to programming languages - C and PERL

Module II: **10h**

Data management - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT

Structural databases - protein data Bank (PDB) & UniProt

Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,

Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

Module III : **8h**

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics;

Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models

Threading, structure evaluation and validation and *ab intio* Modeling

Applications - Molecular docking - Autodoc

References:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC271
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND MICROBIAL TECHNIQUES
L: T/A: P: C : 0: 0: 8:4

1. Estimation of glucose in blood by Folin-Wu / glucose oxidase method
2. Estimation of uric acid in blood by Caraway's method
3. Estimation of creatinine in serum and urine by Jaffe's method
4. Estimation of urea in serum and urine by urease method
5. Estimation of haemoglobin by Wong's method
6. Estimation of ketone bodies in urine
7. Estimation of reducing sugars in urine
8. Estimation of serum cholesterol by Zack's method.
9. Isolation and Identification of microorganisms from air, water and soil.
10. Microbial culture techniques- Streak Plate, Spread Plate and Pour plate.
11. Staining techniques – Simple staining and Grams staining.

References:

1. Hawk's Physiological Chemistry, 14th Ed (ed. Oser) , Tata-McGrawHill (1976).

2. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).

3. Practical Clinical Biochemistry, ed. Harold Varley, 4th Ed. CBS Publishers (1988).

4. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).

5. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC272
TITLE OF THE COURSE : ENZYMOLOGY
L: T/A: P: C : 0: 0: 8:4

1. Isolation and assay of phosphatase; effect of dilution
2. Effect of substrate on phosphatase
3. Effect of Temperature & pH on phosphatase
4. Inhibition kinetics of phosphatase by L-B plot
5. Isolation and assay of esterase; effect of dilution
6. Substrate effect on esterase
7. Effect of Temperature & pH on esterase
8. Inhibition kinetics of esterase by L-B plot

References:

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (1996)
2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)

3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)

4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).

5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC301
TITLE OF THE COURSE : MOLECULAR MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Hours: 52

Module I: DNA Replication and Repair 13h

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

Module II: Gene Expression – Transcription 13h

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5’ Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

Module III: Gene Expression – Translation **13h**

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

Module IV: Regulation of Gene expression in prokaryotes and eukaryotes 13h

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

References:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific

American Books Inc. NY.

10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.

11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC302
TITLE OF THE COURSE : METABOLISM OF NITROGEN COMPOUNDS
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: Bioenergetics **13 hrs**

Reduction Potential, Biological redox couplers, Sequence and structure of mitochondrial electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores.

Module II: Nucleotide Metabolism **13 hrs**

Nitrogen Cycle, nitrogen fixation, *nif* genes. Structure of nucleoside and nucleotide; Synthesis and degradation of purine and pyrimidine nucleotides and their regulation. Disorders: SCID, gout, Lesch-Nyhan syndrome, oroticaciduria and xanthinuria.

Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies,

Module III: Nitrogen metabolism **13 hrs**

General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle and its regulation. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.

Module IV: Amino acid metabolism **13 hrs**

Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism. Regulation of amino acid metabolism

References

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.

4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC303
TITLE OF THE COURSE : HORMONES AND CELL SIGNALLING
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: Endocrine signaling **13 hrs**

Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine, serotonin, glucagons); Ion–channel (ACh); Tyrosine kinase (RTK), [EGF, IGF, insulin] and Intrinsic enzyme / cytokine, receptors.

Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+}, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.

Module II **13hrs**

Nerve signaling: Morphology of a neuron. Astrocytes, Glial cells, Schwan cells and oligodendrocytes. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential.

Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).

Module III: Nuclear signaling and Cell Cycle **13 hrs**

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation.

Cell Cycle: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation. Cyclins and cyclin-dependent kinases.

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

Module IV: Apoptosis and Cancer **13 hrs**

Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF-β pathways). Concept of tumor suppressors.

References:

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

26 hours

Module I: Ecology and Ecosystem **13 hrs**

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves;

Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. community ecology

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module II: Developmental Biology **13 hrs**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila.

References:

1. Fundamentals of ecology by Eugene Odum, Cengage; 5 edition (2005).
2. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
3. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
4. Development Biology by N Arumugam, Saras Publication (2014)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC321
TITLE OF THE COURSE : MEMBRANE BIOCHEMISTRY AND NANOSCIENCE
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 1)

52 hours

Module I: Membrane Lipids **13 hrs**

Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol & cardiolpin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.

Module II: Membrane topology **13 hrs**

Human erythrocyte membrane as a prototype plasma membrane. Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Techniques for determination of membrane protein topology: X-ray crystallography, Freeze-fracture electron microscopy. Fluorescence photobleaching recovery (FRAP). Single particle tracking. Lipid-protein interactions. Lateral and rotational diffusion of integral membrane proteins. Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.

Module III: Nanoscience **13 hrs**

Atomic Structure and atomic size. Introduction to Nanoscale. influence of nano size and effects on surface properties. Nanoparticles – synthesis, properties, and applications, Brief account of nanolithography, Nanoporous polymers (activated carbon and zeolites) and their applications in water purification, Nanotoxicology.

Module IV: Nanobiotechnology **13 hrs**

Nanostructures –Carbon nanotube and its use as biosensors. Applications of nanoscience in biological systems - drug targeting, drug delivery with nanoliposomes. Principle and applications of Zetasizer, Scanning Tunneling microscope and Atomic force Microscopy in Nano biotechnology.

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter Molecular Biology of the Cell, 4th edition. Garland Science.

2. Michael I. Gurr, John L. Harwood, Keith N. Frayn, Denis J. Murphy and Robert H. Michell. Lipids: Biochemistry, Biotechnology and Health, 6th Edition, John Wiley & Sons
3. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
5. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831,Cambridge University Press.
6. Processing & properties of structural naonmaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC322
TITLE OF THE COURSE : PLANT AND MICROBIAL SECONDARY METABOLITES
L: T/A: P: C : 4: 1: 0: 5
(Departmental Elective - 2)
Total hours: 52

Module I: Introduction to Phytochemicals 13h

Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level.

Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, liquid-liquid extraction techniques, liquid-carbon dioxide extraction, concentration and evaporation techniques, lyophilisation.

Module II: Methods to analyse Phytochemicals 13h

Techniques for quantitative and structural analysis of plant secondary metabolites: Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry.

Application of UV/Visible, IR, ^{1}H and ^{13}C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).

Module III: Microbial metabolites 13h

Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process.

Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application.

Lactic acid: Nutrient media, production process recovery and purification.

Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.

Module IV: Special Microbial metabolites **13h**

Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine).

Health care products: Industrial production of: Penicillin and Streptomycin; production and recovery.

I P R: Patents: Patent regulations of processes, products and microorganisms.

References:

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IVth Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC371
TITLE OF THE COURSE : MOLECULAR BIOLOGY & IMMUNO TECHNIQUES
L: T/A: P: C : 0: 0: 8: 4

(Practical)

1. Isolation and Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation of plant/animal genomic DNA, and analysis by agarose gel electrophoresis
4. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency
5. Study of conjugation in *E. coli*
6. Serum Separation from whole blood and isolation of immunoglobulins from serum.
7. Study of different cells in whole blood using Giemsa/Leishman stain.
8. Blood grouping
9. ELISA/Dot ELISA
10. Radial Immunodiffusion/Ouchterlony Double Diffusion
11. Rocket Immuno Electrophoresis
12. WIDAL/RPR Test

References:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons

2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)

3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.

4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.

5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub

WH Freeman Co.

6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub.

Oxford.

7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994).

Molecular Biology of the Cell.

8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.

9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.

10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.

11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC372
TITLE OF THE COURSE : PROTEIN BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

(Practical)

[1] Extraction of phosphatase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[2] Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[3] Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation

[4] Criteria of purification of phosphatase visualized through SDS-PAGE

[5] Extraction of esterase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[6] Extraction of esterase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[7] Criteria of purification of esterase – chromatography of purified samples – ion exchange/gel permeation

[8] Criteria of purification of esterase visualized through SDS-PAGE

[9] Concepts of Isoelectric Focusing (Demonstration)

Reference Books:

[1] Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).

[2] Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC401
TITLE OF THE COURSE : GENETIC ENGINEERING AND BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Basic Concepts 13h

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors 13h

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning strategies and study of protein-DNA interactions 13h

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 13h

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6^{th} edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3^{rd} Ed), WH Freeman.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC421
TITLE OF THE COURSE : FOOD BIOCHEMISTRY AND NUTRITION
L: T/A: P: C : 4: 1: 0: 5

(Departmental elective - 1)

52 hours

Module I: Basics on Food Biochemistry 13h

Carbohydrates: Occurrence and physiological functions, factors influencing metabolism.
Lipids: Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions.
Proteins: Concepts of essential and non-essential amino acids- their role in growth and development. Physiological functions of proteins. Requirements, nitrogen balance concept. Methods for evaluating protein quality.
Regulation of food intake: role of hunger and satiety centers, effect of nutrients.

Module II: Basics on Nutrition 13h

Body composition: Methods of studying body composition. Nutritional disorders and effect on body composition- protein energy mal nutrition, renal failure and thyroid related disorders. Food borne allergens, toxins and adulterants.
Energy metabolism: Basal and resting metabolism- influencing factors. Methods to determine energy requirements and expenditure.

Module III: Nutraceuticals 13h
Nutraceuticals: Definition, example and use of nutraceuticals in traditional health sciences; their role in preventing /controlling diseases.
Prebiotics and probiotics: Usefulness of probiotics and prebiotics in gastro intestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.
Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. (with examples)
Development of nutraceutical and functional foods: Standards for health claims, Regulatory bodies (FSSAI). Process of developing - preclinical & clinical studies.

Module IV: Designer Foods and Nutrigenomics 13h
Functional Foods - Natural and synthetic, use of excipients. Characteristics of drugs action: pharmacokinetics, route and form of excretion. Drug abuse and drug resistance Drug-nutrient interactions – effect of drugs on ingestion, digestion, absorption and metabolism of nutrients, effect on nutritional status, effect on organ function, drug dosage and efficacy.

Nutrigenomics - definition, concepts and theories. Genetic materials, gene expression and inheritance. Molecular mechanisms of genetic variations linked to diet- role of diet, macro and micro nutrients. Role of animal foods. Evolution of human diseases.

References:

1. Swaminathian (1990). Food and Nutrition, Himalaya Publishers.
2. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
4. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
8. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC422
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND BIOENGINEERING
L: T/A: P: C : 4: 1: 0: 5
(Departmental Elective- 2)

52 hours

Module I **13 h**

Precision, accuracy and sensitivity. Brief introduction to carbohydrate, fat and protein metabolism (overview). Metabolic disorders: Diabetes Mellitus, Atherosclerosis, Renal failure and muscular dystrophies. Detection of these diseases through blood, liver and kidney functional tests. Role of isozymes. Clinical laboratory functioning - Laboratory information systems, Lab accreditation processes

Module II **13 h**

Drug discovery and development, including animal studies, tissue culture studies, safety, efficacy, randomization procedures, Preclinical Safety, Assessment of pharmacokinetics in early phase drug evaluation, Metabolism studies: in vitro and in vivo tests Pre clinical studies, Phase 0, Phase I, Phase II, Phase III, Phase IV, single blind and double blind studies. Regulation and quality assurance.

Module III **13 h**

Introduction to bioengineering, Quantitative and qualitative Models for biology: models used to understand DNA, proteins and lipids. Estimates; estimation of size for bacterial cells and mammalian cells including fibroblasts and intestinal cells. Relative time.

Module IV **13 h**

Complexity in biological systems, Simple mathematical models for diffusion kinetics and gene expression, transformation of energy in cells - metabolism of fuels and generation of proton motive force leading to ATP synthesis. Brief idea of Systems Biology.

References:

1. Donald Voet, Judith G Voet, Biochemistry, 4th Edition, John Wiley and Sons
2. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia; Physical biology of the Cell, 2nd edition, garland Science Publication, 2012.
3. Handbook for applicants and reviewers of Clinical trials of new drugs in India; CDSCO. ICMR, 2017.
4. The Drug development Process; US Food and Drug Administration
   URL: https://www.fda.gov/ForPatients/Approvals/Drugs/default.htm

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC471
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY & BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

(Practical)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT101
TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CELL TYPES, CELL CYCLE AND ITS CONTROL 13H

Cell types**:** Structure of prokaryotic and eukaryotic cells, ultra-structure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle**:** Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks* and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways.

MODULE II MEMBRANE TRANSPORT 13H

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na^+/K^+ Pump, Ca^{2+} Pump. ABC transporter and Multidrug resistant protein.

MODULE III CYTOSKELETON AND CELL-CELL INTERACTIONS 13H

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV CELL SIGNALING, ANTIOXIDANT DEFENSE SYSTEM AND SENESCENCE 13H

Cell signaling: Principles of cell signaling, intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions. (Ca^{2+} Cyclic modulators –cAMP, cGMP, IP3, 2AG, Nitric Oxide). Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

Senescence: Theories and concepts of aging, molecular mechanisms and genes involved in senescence and aging (daf-2 and its mutants).

REFERENCE:

1. Alberts et al., (2002).Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007).Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT102
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I- CONCEPTS IN GENETICS AND ORGANIZATION OF CHROMOSOMES IN EUKARYOTES 13H

Basic Genetics: Mendelian genetics - Concepts and theories, Morgan's linkage analysis, chromosome theory of inheritance, Fine structure of gene, Split genes and overlapping genes, gene interactions. Features of *E. coli.* and Human genome, C-value paradox. Concept of Epigenetics, Genomic imprinting and Epigenomics. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE II-MOLECULAR MECHANISMS OF RECOMBINATION 13H

Bacterial Recombination- plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination – Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of RecA in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion.Site-specific recombination: integration of lambda genome in *E.coli*. Topological manipulation of DNA

MODULE III-MOLECULAR BASIS OF MUTATION AND TRANSPOSABLE GENETIC ELEMENTS 13H

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders.Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

MODULE IV - SEX DETERMINATION AND CANCER GENETICS 13H

Dosage Compensation and Sex Determination: Dosage compensation in *Drosophila* and mammals, Factors affecting sex determination, Sex determination in *Drosophila* and mammals. Secondary sex determination in mammals. Mechanism of sex determination in

Drosophila.

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzeimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Genetic Counseling, Prenatal diagnosis, Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004). Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons.
8. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT103
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I MICROBIAL TAXONOMY AND DIVERSITY 13H

Criteria for classification of microroganisms, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Chemotaxonomy, Numerical taxonomy and Molecular taxonomy. Brief account of Bergey's manual of bacteriology.

Bacteria: Ultra structure of bacterial cell: Shapes and size, chemical composition and characterization of cell wall.

Viruses: General Properties of viruses, classification and replication of bacteriophages. Viroids and Prions.

Ultrastructure, classification and reproduction in algae, fungi and protozoa

MODULE II MICROBIAL TECHNIQUES 13H

Microscopy: Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Microbial Techniques: Cultivation of microorganisms, culture media, Pure culture techniques, Stains and staining techniques: Simple, Negative, Gram's, Acid fast and structural staining techniques.

Microbial Control: Concepts of sterilization and disinfection. Physical and chemical methods of sterilization.

MODULE III MICROBIAL PHYSIOLOGY 13H

Microbial growth, growth curve and factors affecting growth (Physical and chemical).

Bacterial photosynthesis, photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Role of microorganisms in nitrogen fixation.

Fermentative modes in microorganisms – alcoholic, lactic acid (hetero and homo lactic acid fermentation).

Overview and importance of secondary metabolites - antibiotics

MODULE IV MEDICAL MICROBIOLOGY 13H

Sources of infection (Food, water, air, vector and animal borne), Host pathogen interactions, defense mechanisms of pathogens. Etiology, epidemiology, pathogenicity and prophylaxis of Food and water borne diseases (Brucella, Hepatitis A, Typhoid, Cholera, Polio, Botulism), Air Borne diseases (Chicken pox, TB, Influenza), Water Borne Diseases (amebiasis, typhoid, cholera), Vector and Animal borne (Malaria, dengue, Rabies, plague) & STD (HIV, gonorrhea)

General characteristics of antimicrobial drugs and their mode of action, antibiotic resistance and multi-drug resistant strains.

REFERENCES:

1. Stainer R.T., Ingraham J.L., Wheelis M.L. and Painter, P.R., (1987).General Microbiology; Macmillan, 5th. Edition
2. Pelczar Jr. M.J.; Chan E.C.S. and Krieg N.R. (1986). Microbiology, Mc Graw Hill, Fifth Edition
3. Glazer A N and Nikiado H , Freeman (1995).Microbial Biotechnology and Fundamentals of Applied Microbiology.
4. Introductory Microbiology by Heritage Pub Heritage
5. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y
6. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2 Edition, Milan Publishing Co.
7. Brock T.D. and Madigan M.T). (1992)Biology of Microorganisms 6 Edn. Prentice Hall, Eagle wood cliffs N.j.
8. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T. (1994). Bergey‟s Manual of the Systemic Bacteriology 9 Edn. William and Wilkins, Baltimore.
9. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers
10. Dubey.R.C Microbiology. (2001). First edition. Chand & Company.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT104
TITLE OF THE COURSE : BIOMOLECULES AND ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CHEMISTRY OF CARBOHYDRATES AND LIPIDS 13H

Chemical basis of life: Macromolecules- monomers and polymers, Acid Base balance and its maintenance, Water- properties, pH, ionization and hydrophobicity and thermodynamics.
Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans.
Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, lipoproteins. Lipid micelles, liposomes & their applications**.**

MODULE II CHEMISTRY OF PROTEINS AND NUCLEIC ACIDS 13H

Proteins: Amino acids and peptides. Primary, secondary, tertiary and quaternary structures, Ramachandran plot. Collagen structure, models of protein folding, experimental techniques to study protein folding (X-ray Crystallography, Fluorescence spectroscopy), roles of chaperones and chaperonins. Concepts of protein sequencing and protease mapping.
Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Higher order structures of DNA (bends, cruciform, G-quadraplexes). Denaturation and renaturation studies and their applications.

MODULE III ENZYMES AND BASIC ENZYME KINETIC CONCEPTS 13H

Enzymes: Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.Enzyme Kinetics: Basic chemical kinetics, rate of reaction, order of reaction, zero order and first order reactions. Derivation of Michaelis-Menten equation, Significance of Km, Vmax and Kcat. Derivation of Lineweaver-burk plot, basic concepts of Scatchard Plot, Eadie-Hofstee Plot, Hanes-Woolf plot and their relevance.

MODULE IV ENZYME CATALYSIS AND REGULATION 13H

Mechanism of Enzyme catalysis: Mechanism of enzyme catalysis - Acid-Base catalysis, covalent catalysis, metal ion catalysis and entropy effect. Example of enzyme catalysis mechanism – chymotrypsin and transaminases.
Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots.
Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

REFERENCES:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
3. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
4. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
5. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
6. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
7. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT105
TITLE OF THE COURSE : BIOSTATISTICS (Soft core)
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION 13H

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.

Measures of Central tendency: Arithmetic mean, mode & median.

Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error

Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.

Sampling methods and their significance.

MODULE II PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS 13H

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.

Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press,Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT171
TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY AND GENETICS
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Hemocytometer: Counting of cells
3. Study of mitosis by using onion root tips
4. Study of meiosis –Grasshopper testis
5. Mounting of Barr bodies
6. Study of Karyotyping in onion, humans (normal and abnormal)
7. Study of mutation in E. coli by Physical method (UV) (2 units)
8. Study of Drosophila mutant types.
9. Mounting of polytene chromosomes – in Drosophila
10. Study of normal and abnormal cellular cell structure and their pathological significance (through permanent slides)
11. Isolation of nucleus/mitochondria and determination of its purity
12. Concept of Multiple Alleles in Humans (Blood group)
13. Solving Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance)

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

1. Determination of pI of amino acid by titration method.
2. Estimation of glucose by Dinitrosalicyclic acid (DNSA).
3. Estimation of protein by Lowry's/Bradford method.
4. Estimation of inorganic phosphate by Fiske-Subbarow method
5. Determination of saponification number and acid value of the given fat samples. (2 unit)
6. Sterilization techniques and Preparation of media
7. Isolation of microorganisms from Soil/Air/Water
8. Pure Culture Techniques – serial dilution, streaking, pour plate, spread plate
9. Staining techniques in microbiology - simple staining, negative staining, Gram staining, spore staining, capsule staining
10. Biochemical tests: Starch hydrolysis, Catalase, Gelatin Liquefaction, IMViC
11. Determination of microbial growth by turbidometric method.
12. Identification of algae, fungi and protozoa (Permanent slides): *Spirulina, Nostoc, Aspergillus, Penicillium, Paramecium* and *Amoeba.*

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT201
TITLE OF THE COURSE : BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I SPECTROSCOPY TECHNIQUES 13H

Theory and application of UV, Visible and Raman Spectroscopy, Circular Dichroism *and optical rotatory dispersion*; Fluorescence; Nuclear magnetic resonance, *Electron spin resonance*, Mass spectrometry (GC-MS, LC-MS, ICP-MS, MALDI-TOF), Atomic absorption and atomic emission spectroscopy.

MODULE II SEPARATION TECHNIQUES – CHROMATOGRAPHY AND ELECTROPHORESIS 13H

Chromatography: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity Chromatography; HPLC and FPLC; Dialysis, Criteria of protein purity.
Electrophoresis: Theory and application of Polyacrylamide gel electrophoresis and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

MODULE III SEPARATION TECHNIQUE – CENTRIFUGATION 13H

Basic principles (RCF, Sedimentation coefficient); Types of centrifuge - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

MODULE IV RADIOISOTOPY, MICROSCOPY AND CELL SORTERS 13H

Radioisotope Techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay, Units of radioactivity. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters, autoradiography, radioimmunoassay.
Microscopy**:** Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy and Atomic Force Microscopy
Cell Analysis: Florescent activated cell sorter (FACS) and Coulter counter.

REFERENCES:

1. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
2. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
3. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John Walker, Cambridge University Press (2005).
4. Biophysics – An introduction by Ronald Glaser, Springer (2012).
5. An introduction to practical biochemistry 1987.third edition by D T Plummer. pp. 332. McGraw-Hill (UK).
6. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4 edition Pub WH Freeman Co.
7. T.G. Cooper; the Tools of Biochemistry. Wiley Intersciences, 1977.
8. Protein purification techniques – A practical Approach (2001) Simon Roe, 2nd Edtion, Oxford University press

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT202
TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I: IMMUNE SYSTEM 13H

Humoral and Cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens-antigen specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and monoclonal, Complement system – component, properties and functions. Complement pathways and biological significance.

MODULE II: IMMUNE RESPONSES 13H

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

MODULE III: IMMUNE--MEDIATED DISEASES AND TRANSPLANTATION 13H

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis.
Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, Xenotransplantation.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 13H

Immunoprecipitation; Agglutination; Immuno electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; ELISPOT; ELISA; Western blotting; Hybridomas and their production;
Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines-live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. novel vaccines-subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines.
Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.
3. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd.Oxfird.
4. Hyde, R.M. (1992). Immunology, 2 edition, Williams and Wilkins, Baltimore.
5. Kuby, J. (2003). Immunology 5 Edition. WH. Freeman and Company, NY.
6. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers,London.
7. Tizard I.R.(1995). Immunology, 4 edition, Saunder College Pub.
8. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT203
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I DNA REPLICATION AND REPAIR 13H

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE II GENE EXPRESSION – TRANSCRIPTION 13H

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE IIIGENE EXPRESSION – TRANSLATION 13H

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes. Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE IV REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES 13H

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT204
TITLE OF THE COURSE : ENVIRONMENTAL AND MEDICAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I WASTE WATER AND SOLID WASTE MANAGEMENT 13H

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II APPLICATION OF BIOTECHNOLOGY IN ENVIRONMENTAL MANAGEMENT 13H

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III BIOLOGY OF HUMAN DISEASES 13H

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B) Bacteria (Typhoid, STD) Fungi (Aspergillosis, Cryptococcosis) and Protozoa (Malaraia, Amoebiasis)

Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalassemia and Diabetes

MODULE IV MOLECULAR THERAPEUTICS AND NANOBIOTECHNOLOGY 13H

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials.

REFERENCES:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Devlin, Thomas M. (2001) Textbook of Biochemistry: With Clinical Correlations (5th Ed.); John Wiley & Sons, Inc.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8H

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant
Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL.
Network Security- Group polices Fire-walls.
Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10H

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER, Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acidsand protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8H

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.

5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT271
TITLE OF THE COURSE : BIOPHYSICAL AND IMMUNOLOGICAL TECHNIQUES
L: T/A: P: C : 0: 0: 8: 4

(PRACTICAL)

1. Isolation of enzyme and estimation of its activity (Urease/Amylase/Acid Phosphatase/esterase) - any one
2. Determination of kinetic properties of amylase/acid phosphatase/urease/esterase (2 units).
3. Partial purification of the enzyme by salting out/acetone and dialysis (2 units)
4. To perform SDS-PAGE and check the purity of the isolated enzyme (2 units).
5. Immobilization of the purified enzyme and its assay.
6. To separate amino acids/ lipids using paper chromatography/Thin Layer Chromatography
7. Serum Separation from whole blood and precipitation of immunoglobulins from serum.
8. Study of different cells in whole blood using Giemsa/Leishman stain.
9. Blood grouping
10. ELISA/Dot ELISA
11. Radial Immunodiffusion/Ouchterlony Double Diffusion
12. Rocket Immuno Electrophoresis
13. WIDAL/RPR Test

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT272
TITLE OF THE COURSE : MOLECULAR BIOLOGY, MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 8: 4

1. Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation plant/animal genomic DNA, and analysis by agarose gel electrophoresis (2 units)
4. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency (2 units)
5. Study of conjugation in *E.coli*
6. Gel filtration chromatography: Sephadex/Sepharose. (Demo)
7. Estimation of SGPT/SGOT in serum samples.
8. Estimation of serum cholesterol by Zak's method.
9. Demonstration of PCR technique.
10. Determination of DO, BOD and COD of water sample (2 units)
11. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
12. Potable water quality assessment-MPN

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT301
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I Basic Concepts 13h

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization

Module II Cloning and expression vectors 13h

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Module III Cloning Strategies and study of protein-DNA interactions 13h

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display

Module IV Sequencing, PCR and its applications 13h

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT302
TITLE OF THE COURSE : PLANT BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Plant Tissue Culture 13h

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids and somatic cell genetics

Module II: Genetic Transformation Techniques for plants 13h

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated gene delivery; Cointegrate and binary vectors and their utility; Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting

Module III: Molecular Mapping & Marker Assisted Selection (MAS) 13h

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning. Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance, Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops.

Module IV: Plants as Biofactories and GM Technology 13h

Concept of biofactories; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal, Golden rice and transgenic sweet potato.

Ethical issues associated with GM crops and GM food; labelling of GM plants and products.

Environmental impact of herbicide resistance crops and superweeds

References:

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT303
TITLE OF THE COURSE : ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Basics of Animal Tissue Culture 13h

Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, Detection of Mycoplasma and viral contaminants, Maintenance of sterility and use of antibiotics, types of culture media, composition, preparation and metabolic functions. Role of CO_2, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media.

Culture and maintenance of primary and established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.

Module II: Stem Cells 13h

Stem cells – adult, embryonic, induced pluripotent stem cells: Concept, Types of stem cells (Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells); Stem cells from adult organs-Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization.

Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals 13h

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases.

Methods of cloning and their importance with reference to domestic animals. IVF- technology for live stock and humans.

Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation. Basics of artificial tissue printing.

Module IV Applications of Animal Biotechnology 13h

Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.

Biosafety: The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Good manufacturing practice and Good lab practices (GMP and GLP).

Reference books:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

Total Credit Hours: 26 Hours

Module 1: Ecology and Ecosystem 13 Hours

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves;

Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. community ecology

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module 2: Developmental Biology 13 hours

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

References:

1. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
2. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
3. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
4. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT321
TITLE OF THE COURSE : METABOLISM OF BIOMOLECULES
L: T/A: P: C : 4: 1: 0: 5

Total Hours - 52

Module I Bioenergetics and Oxidative phosphorylation 13h

Bioenergetics: laws of thermodynamics, enthalpy, entropy, and the free energy change, standard free energy change. Biochemical energetic group transfer reactions of ATP, functions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Uncouplers, inhibitors and ionophores.

Module II Carbohydrate Metabolism 13h

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation. Gluconeogenesis pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle.

Glycogen and starch: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms. Regulation of blood glucose level, disorders of carbohydrate metabolism.

Module III: Amino acid and nucleotide metabolism 13h

General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – transdeamination, amino acid oxidase, and non – oxidative deamination. Urea cycle, its regulation and significance. Biosynthesis and degradation of essential amino acids (with emphasis on aromatic amino acids). Disorders of amino acid metabolism (PKU, Alkaptonuria).

Biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage), regulation of biosynthesis. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyan syndrome, inhibitors of nucleotide synthesis.

Module IV: Lipid Metabolism 13h

Oxidation of fatty acids: even and odd numbered, unsaturated and branched chain fatty acids. Alternate routes for fatty acid oxidation. Degradation of triacylglycerols and phospholipids. Energetic of β-oxidation. Metabolism of ketone bodies; their formation, oxidation and clinical significance. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

Cholesterol biosynthesis, catabolism and regulation. Transport of cholesterol -LDL receptor pathway. Lipoproteinemias, fatty liver, hypercholesterolemia. Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL.

Reference Books:

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
2. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
3. Biochemistry; David Rawn, Panima Publishers, (1989).
4. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan
5. Publications (2012).
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
8. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
9. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
10. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT322
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I Genome Organization, structure and mapping 13h

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. C-Values of genomes, Repetitive and coding sequences. Recognition of coding and non-coding sequences and gene annotation. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping

Module II Genome sequencing and analysis 13h

Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Next Gen Sequencing, Genome sequencing projects of *E.coli*., yeast, and human genome project. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Genome sequence data bases, expressed sequenced tags (ESTs), Genome sequence analysis. determining gene location in genome sequence, Promoter prediction methods

Module III Proteomics 13h

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Mass Spectroscopy, Concept of MudPIT (Multidimensional Protein Identification Technology), Protein-protein interactions, proteome databases.

Module IV Functional and comparative Genomics 13h

Transcriptome analysis-transcripts of a tissue, use of Northern blot, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, differential display, Microarray techniques, sequence analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria.

Introduction to metabolomics, lipidomics, metagenomics, systems biology, Pharmacogenetics and drug development

References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT371
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT372
TITLE OF THE COURSE : PLANT & ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Preparation of plant tissue culture media
2. Organ culture (Shoot tip, nodal and leaf culture) (2 units)
3. Callus culture: Initiation and regeneration.
4. Isolation and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants
7. Study of VAM, isolation of spores, arbuscles and vesicles from roots
8. VAM culture
9. Animal cell culture: Preparation of (serum and non-serum supplemented) media.
10. Primary culture of fibroblast cells/liver cells/testis-leydig cells
11. Assessment of viability and counting using trypan blue exclusion method
12. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
13. Isolation of cells by explant method and Sub-culturing (2 units)

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT401
TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I: Introduction to Bioprocess technology and Bioreactors 13h

Scope and importance of bioprocess technology, Microbial growth and death kinetics (particularly with reference to industrially useful microorganisms). Screening, Isolation. Identification and characterization of industrially important microbes. Strain improvement-mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process 13h

Basic components, design and scale-up of fermenters – Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Microbial growth in batch fermenter and chemostat. Other types like surface, submerged and solidstate fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing 13h

Upstream processing: Formulation of fermentation media. Rheology of fermentation media.Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

Module IV: Industrial Bioprocessing 13h

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lycine. Industrial production of health care product: Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin).

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 1997.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.).Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT421
TITLE OF THE COURSE : APPLIED BIOTECHNOLOGY
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I Bioprocess Engineering 13h

Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation process, Industrially important products: Ethanol, citric acid, penicillin, amylase, SCP, fermented foods

Module II Plant Biotechnology 13h

Basics of Plant tissue culture, initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, edible vaccines.

Module III Animal Biotechnology 13h

Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin, Primary and Secondary Cell Culture, stem cells and tissue engineering, transgenic animals, therapeutic and pharmaceutical products,

Module IV Environmental Biotechnology 13h

Air, water, soil pollution, Bio-indicators, waste water management and treatment, bioremediation and biodegradation

IPR, patenting of biotech products, Bioethics, ethical issues related to consumption of GM crops, ethical implication of Human Genome Project

References:

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
6. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House

7. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
8. Glazer and Nikaido (1995), Microbial Biotecnology, WH Freeman and Co.
9. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
10. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
11. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
12. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
13. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
14. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT422
TITLE OF THE COURSE : HUMAN DISEASE GENETICS
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I: Genetic factors in common diseases 13h

Genetic susceptibility to common diseases. Types and mechanisms of susceptibility. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery, diseases, Schizophrenia, Alzheimer's disease, Congenital abnormalities, Huntington's disorder, Myotomic dystrophy, Neurofibromatosis, Cystic fibrosis, Duchenne Muscular Dystrophy (DMD), Becker muscular dystrophy, Hemophilia A and B. Trinucleotide Repeat Expansion mutations and their remediation.

Module II: Biochemical genetics and pharmacogenetics 13h

Biochemical genetics: Inborn errors of metabolism, molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Mucopolysaccharide and Galactosemia, Albinism

Pharmacogenetics: Definition, drug metabolism, Genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, Evolutionary origin of variation in drug responses, Pharmacogenomics, Ecogenetics, Molecular detection of diseases after human genome project,Drug discovery, Animal models in pharmacogenomics.

Module III: Cellular and molecular cytogenetic technologies 13h

Cell lines, Cell and tissue culture practices, Harvesting of cells for chromosomal analysis, Conventional and specialized staining protocols, FISH and spectral karyotyping, Imaging in cytogenetic practices, Chromosome jumping and walking, Evolving molecular cytogenetic technologies, Chromosome instability and fragile sites.

Module IV: Diagnosis of prenatal and heamatopoietic disorders 13h

Prenatal diagnosis: Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Genetic counseling, Transplantation changes in bone marrow, peripheral stem cells and umbilical cord cells with chromosomal features.

Chromosomal diagnostics in heamatopoietic disorders: Myeloid disorders, AML, CML and lymphoid leukemia, lymphoblastic lymphoma and their chromosomal changes, Chromosome changes in benign and malignant tumors, Cytogenetics of breast cancer.

REFERENCES

1 Peter Sudbery 2002. Human Molecular Genetics (Second Edition), Prentice Hall.

2 Tom Strachan & Andrew P.Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons

3 M.A. Jobling, M.E. Hurles & C. Tyler-Smith, 2004. Human Evolutionary Genetics-Origins, Peoples & Disease, Garland Science.

4 Jorge J.Yunis, 1977. Molecular Structure of Human Chromosomes, Academic Press.

5 Elaine Johansen Mange & Arthur P. Mange, 1995. Basic Human Genetics (Second Edition), Sinauer Associates, Inc.

6 Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.

7 Margarlet J.Barch, Turid Knutsen & Jack L.Spurbeck, 1997. The AGT Cytogenetics Laboratory Manual (3rd Edition), Lippincott-Raven.

8 K.C. Sawant 2003. Concise Encyclopedia of Human Genetics, Dominant Pub. & Distributors

9 Amita Sarkar, 2001. Human Genetics, Dominant publishers and Distributors.

10 Michael Baraitser & Robin Winter, 1983. A Colour Atlas of Clinical Genetics, Wolfe Medical Publications Ltd.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT471
TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY
L: T/A: P: C : 0:0:8:4

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production of organic acids (lactic acid and citric acid) from microbes
4. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
5. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
6. Laboratory scale production of wine/beer.
7. Estimation of alcohol from different sources by specific gravity method.
8. Alcoholic fermentation and determination of total acidity and non-reducing sugars
9. Microbial assay of vitamin B12 and Glutamic acid
10. Sterility tests for pharmaceutical products
11. Production of amylase by solid substrate fermentation.
12. Production of yoghurt and estimation of lactic acid at different time intervals

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB101
TITLE OF THE COURSE : BACTERIOLOGY AND VIROLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: HISTORY AND SYSTEMATICS OF MICROORGANISMS 13HOURS

History and development of Microbiology: Scope and Applications of Microbiology, discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of Louis Pasteur and Robert Koch. Microbial Systematics:

Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization.

Techniques in taxonomy: Chemotaxonomy, Numerical Taxonomy, Molecular taxonomy, Serology and Phage typing. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: BACTERIOLOGY 13HOURS

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of micrororganisms based on environmental and nutritional requirements.

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly β hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. Reproduction in bacteria.

MODULE 3: SPECIAL MICROBIAL FORMS 13HOURS

Ultrastructure, classification, cultivation, reproduction and importance of Archaebacteria, Myxobacteria, Sheathed, budding and appendaged bacteria, Spirochaete, Rickettsia, Chlamydiae, Mycoplasma, Actinomycetes, Cyanobacteria.

MODULE IV: VIROLOGY **13HOURS**

History of Virology, General properties of viruses, ICTV and classification of viruses, Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), general replication of viruses. Cultivation, purification and assay of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV). (Ultra-structure, replication and importance).

General Account and Importance of Viriods and Prions.

REFERENCES:

1. Addison Wiesley, New York. Holt J.G., Kreg N.R., Sneath PHA, Staley J.T and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994.
2. Balows, A., H.G., Dworkin, M., Harder, W and Schleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
3. Breiman, L., Friedman, J.H., Olsen, R.A and Stone. C.J. Classification and Regression Trees.
4. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
5. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
6. Edward Alcamo. Microbiology. Cliffs Notes. 1996.
7. Eldowney, S.Hardmen, D.J and Waite, S. Pollution. Ecology and Biotreatment. Longman Scientific Technical. 1993.
8. Flint L.W.,Enquist, V.R., Racaniello and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2000.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
10. Johri, B.N. Extremophiles. Springer Verlag., New York. 2002.
11. McKinney, R. Environment Microbiology. Principles and applications. Science Publishers. 2004.
12. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
13. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition. Pub.1986.
14. Nigel Dimmock N, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
15. Schlegel,H.G. General Microbiology, Cambridge University Pres.
16. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
17. Salle, A.J. Principles of Microbiology, 2ndedition., 1997, Mc Graw Hill.1997.

18. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.
19. Dubey, R.C. Microbiology 1st Edition. Chand and company
20. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
21. Pelczar, M.J., Chan, E.C.S., and Kreig N.R. Microbiology Tata McGraw-Hill Pub.1986.
22. Breiman, L., Friedman, J.H., Olsen, R.A. and Stone. C.J. Classification and Regression Trees.
23. Felsentein, J. Numerical Taxonomy, NATO ASI series, Springer-Verlag, New York. 1961
24. Edward Alcamo. Microbiology. Cliffs Notes 1996.
25. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
26. Ec. Eldowney, S. Hardmen, D.J., and Waite, S. Pollution: Ecology and Biotreatment. Longman Scientific Technical. 1993.
27. Jacquelyn G. Black, Larry M and Lewis. Microbiology: Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
28. S.J. Flint L.W. Enquist, V.R. Racaniello and A.M. Skalka. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2004
29. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
30. Balows, A., H.G., Dworkin, M., Harder, W.,andSchleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
31. Madigan and John M Martinko, Paul V. DunlP, David P. andClark Benjamin Cummings Brock Biology of Microorganisms (12th edition), 2008.
32. H.G. Schlegel. General Microbiology., Cambridge University Pres
33. Johri B.N. Extremophiles. Springer V erlag., New York. 2002.
34. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
35. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997
36. *Addison Wiesley*, New York. Holt JG, Kreg NR, Sneath PHA, Staley JT and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994
37. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB102
TITLE OF THE COURSE : EUKARYOTIC MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: PHYCOLOGY 13 HOURS

Comparative study of Eukaryotic and Prokaryotic cells and its significance**.** General characteristics of Algae, occurrence, thallus organization, classification, ultra structure of cell, vegetative, asexual and sexual reproduction. Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

MODULE 2: MYCOLOGY 13 HOURS

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, fungal spores – dormancy and dispersal.

Type studies: Aspergillus, Yeast, Pythium, Rhizopus, Fusarium, Puccinia and Agaricus (Classification, Ultrastructure, reproduction, lifecycle, importance)

MODULE 3: FUNGAL PHYSIOLOGY & REPRODUCTION 13 HOURS

Reproduction (asexual and sexual). Fungal growth (yeast cell cycle and growth of hyphae); mechanism of growth in Fungi; measurement and kinetics of growth, nutritional and environmental requirements. Fungal life cycles, mating system and genetic exchange, sex hormones in fungi; physiological specialization, phylogeny of fungi. Saprotrophic, parasitic, aquatic, endophytic, keratinophilic, coprophilous and mutualistic fungi. Economic importance of fungi.

MODULE 3: PROTOZOOLOGY 13HOURS

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Trichomonas,Paramecium, Amoeba, Entamoeba* and *Plasmodium.* Cultivation of protozoa.

REFERENCES:

1. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
2. D.K. Maheshwari. Industrial Exploitation of Microorganisms. I.K. International Publishing House Ltd.NewDelhi.. (2009)
3. JIS Khattar.. Algal Biology and Biotechnology. I.K. International Publishing House Ltd.NewDelhi,(2009)
4. K R Sridhar. Frontiers in Fungal Ecology, Diversity and Metabolites. I.K. International Publishing House Ltd.NewDelhi.(2009)
5. Marjorie Cowan, Kathleen Park Talaro. Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.(2009)
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
7. M.K.Sateesh. Comprehensive Biotechnology (Microbiology and Biostatistics). New Age International Publishers, New Delhi-110 002, India. (2007).
8. R.C. Kuhad. Lignocellulose Biotechnology: Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi.(2006)
10. A.V.S.S. Sambamurty. A Textbook of Algae. I.K. International Publishing. (2005).
11. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford(2005).
12. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications.(2002).
13. Alexopoulos, C. J. and Mims, C.W.. Introduction to Mycology, Wiley.(2001)
14. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora A.. Recent Advances in the Exploitations of Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2001)
15. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora, ABiofertilizers- Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2000).
16. Becker, E.W. Microalgae: Biotechnology and Microbiology, CambridgeUniversity Press.(1994)
17. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (1994).
18. Janet R Stein Phycological methods. Cambridge university press. (1975).
19. Chapman, V.J. and chapman, D.J. The Algae. English language book society & MacMillan(1973).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB103
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: BIOMOLECULES 13 HOURS

Carbohydrates: Structure of mono, di and polysaccharides, asymmetric centre in sugars, dextro and leavo-rotatory, anomers, epimers, reducing and non-reducing sugars. Oligo saccharides – starch, glycogen and chitin. Complex carbohydrate.

Amino acids and Proteins: Structure of amino acids, classification of amino acids, amino acids as acids and bases, peptide linkage, Classification of proteins, Structural organisation of proteins (primary, secondary, tertiary and quaternary) N-terminal and C-terminal determination.

Lipids: Structure of saturated, unsaturated fatty acids, phospholipids**,** glycolipids and steroids; structure and function of fat soluble vitamins A, D, E and K.

Nucleic acid: Structure of Nucleotides, Nucleosides and Bases, Nucleotide Coenzymes (NAD, Coenzymes A);

MODULE 3: METABOLISM 13 HOURS

Photosynthesis: Photosynthetic pigments, light reactions in eukaryotes, cyanobacteria, green and purple bacteria, process of photosynthesis with special reference to microorganisms.

Fermentation: Alcohol fermentation, Lactic acid: Homo and Heterolactic fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. **Bioluminescenc**e – mechanism and significance.

MODULE III: BIOENERGETICS 13 HOURS

Introduction, Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Energy production in aerobic and anaerobic organisms: Structure of bacterial and mitochondrial ATPase, Substrate level phosphorylation; Electron transport chain and Oxidative phosphorylation: generation and maintaince of PMF, inhibitors and un-couplers of electron transport system, phosphorylation potential and its importance.

MODULE IV: METABOLITE TRANSPORT AND ENZYMOLOGY 13 HOURS

Metabolite transport: Facilitated diffusion mechanosensitive channels, ATP- binding cassette transport family, chemiosmotic driven transport, ion ingredients, specific transport system: ATP- linked ion motive pumps, histidine permease, iron, phosphorous transferase system.

Microbial stress responses: oxidative, thermal and heat shock response.

Enzymes: Definition, classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit, isozymes, enzymes kinetics; Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters. Principles and mechanism of reversible and irreversible enzyme inhibition, Ribozymes and abzyme.

REFERENCES:

1. Berg Jeremy, Tymoczko John, Stryer Lubert. *Biochemistry* 4th Ed, W. H. Freeman, New York. 2001.
2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H. *Outlines of Biochemistry* 5th Ed , John Wiley and Sons, New Delhi.1987.
3. Dawes Edwin A. *Quantitative Problems in Biochemistry*, Churchill Livingston,Edinburgh.1972.
4. Hall D. D. and Rao K. K. *Photosynthesis* 5th Ed., Cambridge University Press.
5. Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London.1996.
6. Lehninger. Principles of Biochemistry, 3rd edition by Nelson & Cox (Worth) pub.2000.
7. Linda Sherwood and Chris Woolverto. Prescott's Microbiology**, 8th Edition**McGraw-Hill.2011.
8. Metzler David E. *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California. 2001.
9. Moat Albert G. and Foster John W. *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.1988.
10. Nelson D. L. and Cox M. M. *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York. 2005.
11. Palmer Trevor. *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England. 2001
12. Segel Irvin H. *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York. 1997.
13. Stanier R. Y., Adelberg E. A., Ingraham J. L.*General Microbiology*, 4th edition, Mac Millan Press, London.
14. Voet Donald and Voet Judith G. *Biochemistry*, 2nd Ed.. John Wiley and sons New York. 1995.
15. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.1983.

16. White David. *Physiology and Biochemistry of Prokaryotes.* 2nd Ed. Oxford University Press, New York. 2000.
17. Zubay Geoffrey. *Biochemistry*, 4th Ed., W. C. Brown, New York.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB104
TITLE OF THE COURSE : MICROBIAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: MICROBIAL TECHNIQUES 13 HOURS

Microscopy: History and development of microscopes, Principles and concepts of microscopy, Working principles of compound, dark filed, phase contrast, fluorescent, confocal, interference, polarizing, electron microscopy (TEM and SEM) and atomic force microscope; micrometry.

Stains and Staining techniques: Principles, protocols and applications of stains and staining techniques. Simple, differential and vital staining techniques.

Control of microorganisms: Terminologies, principles and applications of sterilization. Physical and chemical methods of control of microorganisms

Pure Culture Techniques: Isolation of pure cultures; serial dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures, fatty acid analysis, Fluorescent in situ hybridization (GISH) genomic in situ hybridization (GISH)

MODULE 2: MICROBIAL CULTURE AND GROWTH TECHNIQUES 13 HOURS

Microbial culture media: Culture media, requirements, types, preparation and uses of different microbial culture media. .

Microbial Growth Measurements: Microbial growth; Concept, growth type, measurement of microbial growth-cell number, turbidity and biomass, determination of microbial growth curve, Continuous and synchronous culture, balanced and unbalanced growth, dioxy-growth curve, aerobic and anaerobic growth.

Microbial culture preservation: Concept, types of microbial culture preservation, type culture collections. Advantages and limitations of culture preservation techniques.

Microbial Safety measures: Concept, safety measures in handling microbiological samples and microorganisms.

MODULE 3: CHROMATOGRAPHY AND ELECTROPHORESIS 13 HOURS

pH and Buffers: Preparation of buffers, Henderson and Hesselbach equation, pka and pkb, pH measurements, electrodes and its types, viscometer and osmometer in relation to molecular size and shape, membrane filtration techniques, Dialysis and its applications.

Chromatography: Introduction, Principle types and application of: paper, thin layer, gel permeation, affinity, ion-exchange chromatography, adsorption chromatography, High pressure liquid chromatography and Gas chromatography.

Electrophoresis: Basic principle and application of Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and native PAGE, Agarose gel electrophoresis, capillary electrophoresis, immune electrophoresis, isoelectric focusing, 2D electrophoresis.

MODULE 4: SPECTROSCOPY AND RADIOISOTOPES 13 HOURS

Spectroscopy and Spectrophotometry: Electromagnetic spectrum, Beer- Lamberts law, Principle and application of UV/VS spectroscopy, IR spectroscopy, ESR and NMR spectroscopy, Fluorescence spectroscopy, Atomic absorption spectroscopy, Raman spectroscopy, Mass spectroscopy, circular dichroism, XRD, Microarray.

Radio-isotopes detection and measurements: Nature and types of radiations, stable and unstable isotopes, labelling of biological samples, tracer technique, detection and measurement of radioactivity by Dosimetry, Ionisation chamber, GM counter, Photographic method, Scintillation counter, Autoradiography. Handling methods and safety, non-radioactive labelling.

REFERENCES:

1. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
2. Ackerman, E. I. Biophysical Science. Prentice Hall Inc. NJ, USA. 1962
3. Alonso, A., and Arrondo, J.L.R. Advanced Techniques in Biophysics.Springer,UK.2006
4. An Introduction to Practical Biochemistry: Plummer D. T.
5. Analytical Chemistry: Christion G. D.
6. Arora, M. P. Biophysics. Himalaya Publishing House, New Delhi. 2007
7. Biochemical Techniques theory and practice : White R
8. Biophysical techniques : Principles and techniques Upadhaya and Upadhaya
9. Das, D. Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.1991.
10. Edward, A.L. Radiation Biophysics. Academic Press, NY, USA.1997.
11. Gupta A. Instrumentation and Bio-Analytical Techniques. Pragati Prakashan, Meerut.2009.
12. Hoope, W. et.al. Biophysics. Springer Verlag, Berlin.1983.
13. Narayanan, P. Essentials of Biophysics. New Age International (P) Ltd. Publishers, New Delhi.2002.
14. Nuclear Magnetic Resonance: Williams
15. Roy, R.N. A Textbook of Biophysics. New Central Book Agency (P) Ltd. Calcutta.1996.
16. Srivastava, P.K. Elementary Biophysics. An Introduction. Narosa Publishing House, New Delhi.2006.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT105
TITLE OF THE COURSE : BIOSTATISTICS (SOFT CORE)
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I- MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION 13HOURS

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.

Measures of Central tendency: Arithmetic mean, mode & median.

Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error

Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.

Sampling methods and their significance.

MODULE II-PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS 13HOURS

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.

Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press,Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **17MMB171**
TITLE OF THE COURSE : **GENERAL MICROBIOLOGY AND EUKARYOTIC MICROBIOLOGY**
L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources: Serial dilution and Pure culture techniques.
3. Staining- simple, differential, acid fast, endo spore, capsule, flagella, vital, cell wall and nuclear staining.
4. Determination of bacterial motility by hanging drop method.
5. Determination of microbial size by micrometry
6. Enumeration of microorganisms by haemocytometer.
7. Determination of bacterial growth curve by turbidometry and plate count.
8. Isolation of bacteriophages from sewage.
9. Isolation and identification of fungi from soil: Dilution plate method, Warcup method, stamping method.
10. Isolation of fungi from plant material: Epibiotic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
11. Growth measurement of fungi- linear and biomass.
12. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast,Mucor, Rhizopus, Agaricus, Puccinia,*
13. Isolation and identification of microscopic algae from soil and water
14. Study of algae (permanent slides): Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria, Rivularia,
15. Isolation and identification of protozoans from soil and water.
16. Study of Protozoa (permanent slides): Euglena, Plasmodium, Paramecium, Amoeba,

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB172
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Biochemical tests for identification of bacteria:
   Catalase, Oxidase, IMViC, Gelatin hydrolysis, Hydrogen sulfide production in TSIA , Coagulase, Nitrate Reduction test, Sugar Fermentation test, Casein hydrolysis and Starch hydrolysis. Identification of bacteria by API system. (6 units)
2. Preparation of standard buffers and determination of pH of a solution.
3. Qualitative analysis of proteins.
4. Qualitative analysis of carbohydrates.
5. Quantitative estimation of glucose by DNS method
6. Quantitative estimation of reducing sugars by Benedict's method.
7. Quantitative estimation of protein by Lowry's/ Bradford method.
8. Quantitative estimation of amino acids by ninhydrin method.
9. Study of enzyme kinetics, Km and Vmax of amylase.
10. Separation of amino acids by paper / thin layer chromatography.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB201
TITLE OF THE COURSE : MICROBIAL GENETICS
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: GENOME ORGANIZATION 13 HOURS

Basic Genetics: Principles of heredity, Mendelian principles, DNA & RNA as genetic material, features of prokaryotic and eukaryotic genes, overlapping gene. Transposable elements in bacteria and yeast.

Prokaryotic Genome: Organization of prokaryotic genome, Study of *E. coli* genome.

Eukaryotic Genome: Organization and structure of eukaryotic genome, pseudogenes. Repetitive DNA sequence. C value paradox and genome size. Structure of eukaryotic chromosome, centromere, telomere, secondary constriction, banding patterns.

Organelle genome: Mitochondrial-DNA, Chloroplast-DNA.

MODULE 2: GENETIC RECOMBINATION 13 HOURS

Gene Transfer Mechanism: Bacterial transformation; host cell restriction; Plasmids, F-factor- importance and role in genetic analysis, Col factors, R plasmid. Transduction, conjugation, mechanisms and applications. Mechanisms of genetic recombination in bacteria and fungi (Holiday Model).

Bacteriophages: Life cycle of bacteriophage- lytic and lysogenic cycles, life cycle of lambda and M13.

MODULE 3: MUTATIONS AND DNA REPAIR 13 HOURS

Mutation and mutagenesis: Nature, type and effects, of mutations. Spontaneous Mutations, Mutagenesis – physical and chemical mutagens. Site directed mutagenesis. Ames Test

Repair mechanisms: direct reversal of damage, excision repair, mis-match repair, post-replication repair.

Applications of mutations in microbiology

MODULE 4: LINKAGE AND GENETIC MAPPING 13 HOURS

Linkage and linked genes, calculation of recombination frequency, genetic mapping with recombination frequency. Construction of genetic maps with two point test cross. Gene mapping using conjugation and transformation. Importance of Neurospora in fungal genetics.

REFERENCES:

1) Stanly R Maloy, David Freifelder- Microbial Genetics 2nd edition
2) George M Malacinski- Molecular Biology
3) Prescott, Harley- microbiology 6th edition
4) Uldis N. Streips, Ronald E. Yasbin- Modern Microbial Genetics 6th edition
5) Introduction to Genetics- Simmons and Snustad 7th edition
6) Keya Chaudhary- Microbial Genetics

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52 HOURS

MODULE I DNA REPLICATION AND REPAIR 13HOURS

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE II GENE EXPRESSION – TRANSCRIPTION 13HOURS

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE IIIGENE EXPRESSION – TRANSLATION 13HOURS

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and

Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE IV REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES 13HOURS

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB203
TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: SOIL MICROBIOLOGY 13HOURS

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (The rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health; Isolation of soil viruses; Genetic exchange between communities; Biogeochemical cycles-Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE 2: AQUATIC BIOLOGY AND SEWAGE TREATMENT 13 HOURS

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE 3: AEROBIOLOGY 13 HOURS

Aerobiology: Air spora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Green house effect, Ozone depletion , UV radiation and Acid rain. Aeroallergens and Allergies: Causes andtests for detection of aero allergens.

MODULE 4: BIOLEACHING AND BIODEGRADATION 13HOURS

Bioleaching- Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution**.**

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose and lignin paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water 'insitu' remediation- Engineering developments - Construted wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

REFERENCES:

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB204
TITLE OF THE COURSE : FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52 HOURS

MODULE 1: SCOPE OF FOOD MICROBIOLOGY AND FOOD PRESERVATION 13 HOURS

Scope of food microbiology: Development of food microbiology as a science, scope of food microbiology. Food as a substrate for microorganisms; intrinsic and extrinsic factors affecting the growth of microbes. microorganisms in food and their source.
Principles of Food preservation: Principles of preservation (Asepsis, Removal, Anaerobic conditions). Methods of food preservation (High temperature, Low temperature, irradiation, Drying and Food Additives), Chemical method of Food preservation (Class I and Class II Preservatives). D, Z and F values; Biopreservation, Food Packaging and benefits.

MODULE 2: PRINCIPLES OF FOOD SPOILAGE AND ILLNESS 13 HOURS

Microbial spoilage of food: Causes and sources of food spoilage, Spoilage of Vegetables, fruits, cereals, sugar products, meat and meat products, fish, poultry, canned products and miscellaneous foods. Methods for microbial examination of foods: indicator organisms,direct examination, cultural techniques, enumeration methods and molecular methods.

Foodborne Illness: Food borne Infections and Intoxications. Bacteria –*Clostridium, Bacillus, Brucella, Escherichia, Listeria, Campylobacter, Staphylococci, Salmonella, Shigella, Yersinia*. Virus- Hepatitis A and E, rota viruses, toxigenic algae, Rickettsia, Various parasites, Sea toxicants; Poisoning by chemicals; Mycotoxins (Aflotoxins, Ochratoxins, Fuminosins, Trichothecenes, Zealenone, Ergot alkaloids); Recent methods in detection of food pathogens.

MODULE 3: FERMENTED FOODS AND FOOD REGULATIONS 13 HOURS
Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread, Idli, Nutritional and therapeutic importance, Single cell Protein (Bacteria, Yeast, Algae); Probiotics and Synbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production).

Food Sanitation and Food control Agencies: HACCP, Employees Health standards, GMP, Plant sanitation, Waste treatment, Disposal, Criteria of microbiological quality control. Food control agencies and their regulations.

MODULE 4: DAIRY MICROBIOLOGY: 13 HOURS
Nutritional level of milk, microbial flora of milk, sources of milk contamination

Bacteriology of milk: Incidence and characterization of pathogenic microorganisms in milk, bacteriological aspects of pasteurization, sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant bacteria in milk and their role in milk spoilage; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

Microbiology of dairy products: Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making. Quality standards of milk products.

Advances in Food and Dairy Microbiology: Biosensors in Food Industry; Genetically modified foods; Food fortification; Food parks.

REFERENCES

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. Mc Graw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van Nostrand Rheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8HOURS

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant
Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL.
Network Security- Group polices Fire-walls.
Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10HOURS

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.
Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt
Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,
Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8HOURS

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB271
TITLE OF THE COURSE : MICROBIAL GENETICS AND MOLECULAR BIOLOGY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Qunatification of DNA by colorimetry/ spectrophotometry
2. Qunatification of RNA by colorimetry/ spectrophotometry
3. Conjugation in *E. Coli*
4. Transformation in *E.coli*
5. Antibiotic resitant mutant isolation by gradient plate technique
6. Isolation and electrophoretic analysis of genomic DNA
7. Isolation and electrophoretic analysis of plasmid DNA
8. Isolation and electrophoretic analysis of RNA
9. Identification of lytic and lysogenic cycles in bacteriophage
10. Induction and assay of β -galactosidase
11. Study of replica plating techniques.
12. Mutagenesis: Identification and isolation of fungal mutants [physical (UV)].
13. Genetics problems.
14. Protoplast fusion (Demonstration)

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB272
TITLE OF THE COURSE : ENVIRONMENTAL, FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Quantification of microorganisms in air.
2. Study of microbial interactions in soil (antagonism)
3. Detection and Estimation of Protein and Polysaccharide in Biofilm.
4. Isolation and characterization of Iron, Manganese and Methanogenic bacteria.
5. Detection of Metal tolerance in microorganisms.
6. Isolation of xenobiotic degrading organisms and estimation of chloride
7. Detection of coliform in water (MPN test)
8. Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
9. Study of Bacteriocin.
10. Study of antimicrobial activity of chemical preservative.
11. Quality test of Fermented Food.
12. Production and estimation of lactic acid by *Lactobacillus* sp.
13. Isolation of food poisoning bacteria from contaminated foods and dairy products
14. Detection of Aflotoxin production (*Aspergillus flavus)*
15. Quality test of milk – Platform and Dye reduction test

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB301
TITLE OF THE COURSE : MEDICAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours: 52 Hours

Module 1: Host Microbe Relationship and Epidemiology 13hours

Normal microbial flora of human body and its significance, tissue tropism.Contamination, Infection and Disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infections, nosocomial infections and non-infectious diseases.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxins.G protein signalling, spreading, tissue damage and antiphagocytic factors.Specific and non specific host defense.Quorum sensing.

Epidemiology-Diseases in population, epidemiological studies,epidemics of emerging and re-emerging diseases,reservoirs of infection, modes of disease transmission, herd Immunity and public health organizations.

Module 2- Bacterial, Fungal and protozoan diseases 13hours

Study of diseases - Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following

Bacterial diseases: *Streptococcus, Staphylococcus, Shigella, Salmonella, Neisseria, Corynebacteria, Vibrio, Yersinia, Haemophilus, Helicobacter, Mycobacterium, Spirochetes-Treponema, Chlamydiae, Mycoplasma.*

Protozoan and Helminthic diseases- *E. histolytica*, *Plasmodium*, *Leishmania,Filaria* and tape worm.

Fungal diseases- Dermatomycosis, Subcutaneous mycosis, Systemic mycosis and Opportunistic mycoses.

Module 3- Viral diseases13hours Etiology, Epidemiology, Pathogenicity, Diagnosis, and Prophylaxis of the following.Viral Diseases- Pox virus, Herpes virus, Varicella-zoster, Adenovirus, Picornavirus, Orthomyxoviruses (influenza), Paramyxovirus (mumps and Measels), Rhabdovirus, Hepatitis viruses, Oncogenic virus, Retrovirus, Arbovirus.

Prion infection.

Module 4- Antimicrobial Prophylaxis and Diagnostic Microbiology. 13hours

Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and antiprotozoans. Methods of testing

drug sensitivity, antibiotic assay in body fluids, drug resistance – causes, mechanism and prevention.Probiotics as therapeutic agents.Brief account of vaccine- Conventional vaccines, Subunit vaccines and DNA vaccines. Immunization schedules. Passive prophylactic measures and Interferons. Principles and applications of Immunological and PCR based diagnostic methods.

Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.

References-

1. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
2. Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virologya text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical micrbiology. Vol2, practical medical microbiology, Churchill Livingstone.
9. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
14. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
15. Warren Levinson (2000) Medical Microbiology and Immunolog: Examination and Board Review 8th Edition. McGraw Hill.
16. Warren Levinson (2000) Medical Microbiologyandimmunolog examination and board review (8th edition) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB302
TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Immune System 13hours

Innate,adaptive, humoral and cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and monoclonal, Complement system – component, properties and functions. Complement pathwaysand biological significance.

Module II: Immune Responses 13hours

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B & T cell development and regulation, B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

Module III: Immune-Mediated Diseases and Transplantation 13hours

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis. Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, xenotransplantation, tolerance.

Module IV: Immunological Techniques and Vaccines 13hours

Immunoprecipitation; Agglutination; Immunoelectrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA Western blotting; Hybridomas and their production.

Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines-live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. novel vaccines-subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abbas &Lichtman&Pillai (2014) Cellular and Molecular immunology,8th edition, Elsevier publisher
2. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
3. C.VamanRao.(2012), An Introduction to Immunology. 2nd edition , Narosa publishing house
4. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
5. K.M.Pavri. 1996, Challenge of AIDS, 2nd edition, National Book Trust, India.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. NY .

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB303
TITLE OF THE COURSE : INDUSTRIAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Introduction to Industrial Microbiology 13hours

Concepts and scope of microbes in industry.Modern era of industrial fermentation technology. Pre-requisite of industrial microorganisms: Screening, isolation, identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process 13hours

Basic components, design and scale-up of fermenters – Typical fermentor. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Microbial growth in batch fermentor and chemostat.Other types like surface, submerged and solid state fermentation.Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing 13hours

Upstream processing: Formulation of fermentation media, rheology of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. Effluent treatment.

Module IV: Industrial Bioprocessing 13hours

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product:

Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin). Applications of genetic engineering in industrial bioprocessing.
Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

REFERENCES:

1. Bailey and Ollis (1996) "Biochemical Engineering Fundamentals", McGraw Hill(2nd Ed.).
2. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
3. Dubey, R.C. (2006) "A Textbook of Biotechnology" S.Chand and Co. Ltd.
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication
7. Satyanarayana, U (2005). "Biotechnology" Books and Allied (P) Ltd. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
8. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology-An Introduction, Blackwell Science. Delhi
10. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

Total Credit Hours: 26 Hours

Module 1: Ecology and Ecosystem 13 Hours

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves; Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, community ecology.

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module 2: Developmental Biology 13 hours

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB321
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 1)

Total Credit Hours – 52 hours

Module I: Basic Concepts 13hours

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors 13hours

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning Strategies and study of protein-DNA interactions 13hours

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseIfootprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 13hours

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing)

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops.WileyDreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation Publications.(6th Ed.).Black well publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, set. OUP.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB322
TITLE OF THE COURSE : APPLIED MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 2)

Total credit hours: 52hours

Module 1: Food and Dairy Microbiology 13 hours

Food as a substrate for microorganisms, spoilage of fruits, vegetables, meats and dairy products.Food preservation, examination, standards for food and milk production. Microbial and Fermented foods- fermented vegetables, meats, beverage and dairy products. Probiotics, prebiotics, synbiotics and neutraceuticals.Quality control and their regulation, HACCP.

Module 2- Environmental Microbiology 13hours

Aerobiology- Significance of microorganisms in air, air spora in different layers of atmosphere, bioaerosol. Microbiology of indoor and outdoor environment. Air samplers and control of air borne microorganisms.

Aquatic Microbiology- Natural waters, microbial flora of aquatic environment, pollution and water borne diseases. Municipal treatment of drinking and waste water. Water quality assays and public health.

SoilMicrobiology-Soil profile, soil microorganisms, microbial interactions in soil. Bioaccumulation, biomagnification biodegradation and bioremediation,.Bioleaching of Minerals.

Module 3: Industrial and Agricultural Microbiology 13hours

Industrial Microbiology – Industrially important microorganisms, preservation and strain improvement, design and types of fermenters, upstream and downstream processing, production of beverages, antibiotics, organic acids, and enzymes .

Agricultural Microbiology- Concepts and scope of agricultural microbiology, biofertilizers and biopesticides. Plant diseases, plant defence mechanisms and disease control.

Module 4- Clinical Microbiology and Microbial Biotechnology 13hours

Clinical Microbiology- Disease epidemics, Role of Microbiologist in diagnostic laboratory, General concepts for specimen collection, handling, processing, laboratory safety and infection control. Disease diagnosis - Microscopic examination, growth and biochemical characteristics, rapid methods of identification.

Microbial Biotechnology: Introduction to microbial biotechnology, applications of microbial biotechnology in the field of medicine, industry, agriculture and environment.

References

1. Alexander M (2000) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009
4. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
5. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
6. Credric A. Mims (2004) Medical Microbiology 3rd edition Mostly Inc.
7. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
8. Fritz H. Kayser (2005) .medical microbiology, TR hiemeVerlag.
9. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
10. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. James M.J Martin, J. Loessner and David, A.G. (2006) Modern food microbiology (7thEds)
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Microbiology by MJ PelczarJr, ECS Chan, NR Krieg 5th edition, Pub: Tata Megra Hill Publising Co Ltd.
15. Norman G Marriott, (1995). Principles of Food Sanitation, 4th Edition, (Chapman and Hall Food Science Book). Aspen Publishers Inc.
16. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
17. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
18. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
19. T.J Montville and K Wikowski, Ic: M.P., Doyle, L.R. Beuchat and T.J., Montville, (Eds). 1997. Fundamentals and Frontiers. ASM Press, Washington DC.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB371
TITLE OF THE COURSE : MEDICAL MICROBIOLOGY AND IMMUNOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Effect of antiseptics on normal microbial flora of hands.
3. Dental caries susceptibility assay by Snyder's agar test
4. Isolation and identification of fungal infections (skin, nail and hair sample).
5. Isolation and identification of nosocomial pathogens
6. Study of blood smear by Giemsa's/ Leishman's staining technique.
7. Study of *M. tuberculosis* by Ziehl-Neelsen (acid fast) staining .
8. Determination of MIC - T- test, Checker board method.
9. Drug susceptibility assay for susceptibility and resistance of antibiotics by Kirby-Bauer method.
10. Isolation of lymphocytes from peripheral blood
11. Serum separation and serological reactions:
    a. Agglutination - Blood grouping and Rh typing
    b. Precipitation reactions:
        i. Ouchtlerlony Double Diffusion,
        ii. Radial Immune Diffusion
        iii. Rocket Immuno electrophoresis
12. Enzyme linked immunosorbant assay / Dot ELISA
13. Purification of IgG by column chromatography
14. WIDAL Test.
15. VDRL Test (RPR).

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB372
TITLE OF THE COURSE : INDUSTRIAL MICROBIOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production and estimation of amylase from microbial sources.
4. Production of organic acids(lactic acid and citric acid) from microbes.
5. Immobilization technique: whole cell or enzyme- sodium alginate gel method.
6. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
7. Laboratory scale production of wine.
8. Estimation of alcohol from different sources by specific gravity method.
9. Alcoholic fermentation and determination of total acidity and non-reducing sugars
10. Detection and quantification of pigment from microbes: Melanin.
11. Detection and quantification siderophore produced by *Pseudomonas* spp.
12. Microbial assay of vitamin B12 and Glutamic acid
13. Sterility tests for pharmaceutical products

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB401
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND HYTOPATHOLOGY
L: T/A: P: C : 4:1: 0:5

Total Credit Hours – 52 hours

Module I: Plant-Microbe Interactions 13hours

Distribution of microorganisms in soil, Soil fertility evaluation and improvement.Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum). Concepts of Siderophores and VAM with suitable examples.Application of nitrogen fixing genes in rDNA technology in agriculture research.

Module II: Bioinoculants And Biological Control 13hours

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, phosphate solubilising microorganisms, Azolla. Carrier-based inoculants – production, applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes Pseudomonas fluroscence, Bacillus thuringiensis, Trichodermaharzianum, Trichodermaviridae, Nuclear Polyhedrosis Virus. Production, applications and limitations.

Module III: Host Pathogen Interaction And Defense Mechanism 13hours

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Kochs' postulates. Parasitism and disease development: Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant – Mechanical forces, Microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defenses (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, plantibodies

Module IV: Plant Diseases And Their Management 13hours

Plant diseases- Red rust of tea and Algal Leaf Spot (Algae), Grain and head smut of Sorghum, tikka disease of ground nuts, red rot of sugarcane and wilt of tomato (Fungi), Root knot of mulberry and lesion nematode disease (Nematode). Tobacco mosaic disease and Papaya

ring spot (Virus), Sandal Spike Disease and grassy shoot of sugarcane (Mycoplasma), Bacterial blight of Paddy, Citrus canker and fire blight of apple (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept.Diagnosis of plant diseases, regulatory, farming education and awareness.

References

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.

17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB421
TITLE OF THE COURSE : CLINICAL MICROBIOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 1)

Total Credit hours: 52 hours

Module 1- Host Pathogen interaction and disease epidemics 13hours

Normal microbial flora of human body and its significance, infection and disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infectious and Non infectious diseases.Emerging and remerging pathogens.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxin. Epidemiology-Diseases in population, epidemiological studies, reservoirs of infection, modes of disease transmission, herd immunity and public health organizations.

Module 2: Infectious Diseases of Human Organ Systems 13hours

Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following diseases of the skin and eyes, urogenital diseases, disease of respiratory systems, oral & gastrointestinal diseases and wound infections. Cardiovascular, lymphatic diseases,zoonoses and vector transmission of human disease.Air, food and waterborne disease transmission.Immunization, Antimicrobial chemotherapy and drug resistance.

Module-3- Hospital acquired Infections (Nosocomial Infections) 13hours

Common types of hospital infection, diagnosis and control of hospital infection. Prevention of common hospital acquired infections, maintenance of hospital, surroundings and intravascular & indwelling devices. Role of the healthcare staff in infection control, restrictions in hospitals.Needle Stick Injury, vaccination of healthcare workers.Biosafety in biological laboratories.

Module 4- Diagnosis and Biomedical waste management. 13hours

Collection, transport, processing and storage of biological specimens.Care and handling of pathogens, biological materials and disposal.Laboratory Diagnosis of Infectious Diseases-bacterial, parasitic, viral and fungal diseases. Principles and applications of microscopic, microbiological, biochemical, immunological and molecular diagnostic methods.Recent advancements in disease diagnosis – scanning techniques and rapid identification systems.Regulations and accreditation of medical laboratories.Biomedical Waste, classification, types and treatment.

References-

1. Ananthanarayan and Panikar, Textbook of Microbiology for Nurses, University Press.
2. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virology a text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
9. Mackie amdMcCarthey (1996) Medical Microbiology. Vol2, practical medical microbiology, Churchill Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. R Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
14. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
15. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
16. Warren Levinson (2000) Medical Microbiology and immunolog examination and board review (8th edition) McGraw Hill.
17. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review 8th Edition. McGraw Hill.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB422
TITLE OF THE COURSE : MICROBIAL BIOTECHNOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 2)

Total Credit Hours – 52 hours

Module 1: History and Advancements in Microbial Biotechnology 13 hours

Introduction to microbial biotechnology, principle, applications, economics and milestones in microbial technology.Manipulation of gene expression in prokaryotes – use of strong and regulatable promoters, fusion proteins, unidirectional tandem gene arrays. Recombinant protein production in eukaryotes – *S. cerevisiae* expression systems, Baculo virus expression vector system, mammalian cell expression vectors. Directed mutagenesis and protein engineering.

Module 2: Applications of Microbial Biotechnology –I 13 hours

Molecular Diagnostics: Immunological diagnostics, monoclonal antibodies, DNA diagnostic systems – diagnosis of Malaria, *Trypanosomacruzi*, molecular diagnosis of genetic diseases – Sickle cell anemia.

Microbial Production of Therapeutic Agents: Interferons, human growth hormone, antibody production in *E. coli*. Vaccines: peptide vaccines, vector vaccines. Antibiotics: Polyketide antibiotics. Single cell proteins.

Module 3: Applications of Microbial Biotechnology –II 13 hours

Biosynthesis of biopolymers: Xanthan gum, animal adhesive biopolymers, rubber, polyhydroxyalkonates. Bioremediation and Biomass utilization: Degradation of xenobiotics, utilization of starch and cellulose. Plant growth promotion: Nitrogen fixation, nitrogenase, nodulation, biocontrol: siderophores, ice nucleation and antifreeze proteins. Microbial insecticides: *B. thuringiensis* and *Baculoviruses.* Brief account on transgenic plants, transgenic animals and human gene therapy

Module 4: Nanotechnology, Bioethics and Biosafety 13 hours

Introduction, tools of nanosciences, synthesis of nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles.

Introduction to Bioethics and biosafety, yeast genome project: its ethical, legal and social implications. Biosafety guidelines and regulations for Genetically Modified Microroganismss, GLP and GMP.Labelling of GM products.Ethics and safety of GM food.

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops.WileyDreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation Publications.(6th Ed.).Black well publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, set. OUP.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB471
TITLE OF THE COURSE : AGRICULTURE MICROBIOLOGY AND PHYTOPATHOLOGY
L: T/A: P: C : 0:0: 8:4

(PRACTICALS)

1. Isolation of cellulose, hemicelluloses, lignin, xylan and pectin degrading microbes.
2. Isolation and enumeration of bacteria and fungi from rhizosphere soil.
3. Examination of bacteriodes from legume root nodules
4. Isolation of symbiotic and nonsymbiotic nitrogen fixing microorganisms
5. Isolation of phosphate solubilising bacteria and fungi-plate method.
6. Isolation of bioinoculants: *Bacillus thuringiensis, Bauveriabassiana, Trichoderma, Pseudomonas*.
7. Assay of bio fertilizers (seed treatment, seedling, inoculation and measurement of root and shoot length).
8. Seed health testing by standard moist blotter (SBM).
9. Effect of seed borne fungi on seed germination and seed vigour.
10. Effect of fungicides on fungal spore germination inhibition.
11. Mass multiplication techniques of Azolla.
12. Isolation and identification of Nostoc in Azolla (from paddy field).
13. Estimation of total phenols in diseased and healthy plant tissues.
14. Sample collection and Identification of following disease:
    Tobacco mosaic disease, Sandal spike, Bacterial blight of paddy, Red rust of tea and Mango, Grain and Head smut of Sorghum, Wilt of Tomato, Root Knot of Mulberry, tikka disease of ground nuts and red rot of sugarcane.
15. Quality control assessment of biofertilizers (vialibity and shelf life).
16. Study of liquid and solid carrier material.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Physicochemical principles: Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pK_a, pK_b, pOH, preparation of buffers, Henderson-Hasselbach equation and numerical problems associated with buffer preparation. **8h**

Bonding: VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll. **5h**

Module 2: **13h**

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernsts' equation. **5h**

Thermodynamics**:** First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential. **5h**

Chemical kinetics**:** Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, Activated complex theory, catalysis **3h**

Module 3: **13h**

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids. **8h**

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions. **5h**

Module 4: **13h**

Reaction Mechanism: S_N1, S_N2 E1 & E2 reactions, aromaticity, mechanistic study of reactions important for biology, E1, E2, S_N1 and S_N2 attack – metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. **8h**
Heterocyclic compounds: Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins. **5h**

References:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(1996).

2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (1992)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)

4. Organic Mechanisms, Peter Sykes, Longman, (1977).

5. Inorganic Biochemistry. G.L. Eicharn, Elsevier

6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co

7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (1964).

8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).

9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).

11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).

12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).

13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York(1995).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC102
TITLE OF THE COURSE : BIOMOLECULES
L: T/A: P: C : 4: 1: 0: 5 52 hours

Module 1: 13h

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides, sugar derivatives. Glycosidic linkages in disaccharides, glycosides. **4h**

Complex Carbohydrates: Homopolysachharides and heteropolysachharides-starch, glycogen, cellulose chitin, glycosaminoglycans and peptidoglycans. Blood group determinants, therapeutics of cardiotonic steroids. Structure determination and sequence analysis of carbohydrates. Glycoprotiens and Glycolipids - O and N linked oligosaccharides, Proteoglycans, Lectins, lipo-polysaccharides and trehalose mycolates. **9h**

Module 2: 13h

Amino acids and peptides: Standard amino acids- structure and classification. Enantiomeric, ampholytic, UV absorption and ionic properties, amino acid derivatives in proteins and specialized roles of amino acids. Peptide bond, naturally occurring peptides-vasopressin, endorphins and glutathione, Merrifield's solid phase synthesis of peptides. **5h**

Structural organization of proteins

Primary structure determination **-** End group analysis, cleavage of Disulfide bond, sequencing methods, separation, purification and characterization of polypeptide chains, amino acid composition analysis, fragmentation of peptides by enzymes and chemicals, sequence determination and ordering the peptide fragments, assignment of disulfide bond position, Modern methods of peptide sequencing; Mass spectrometric and Recombinant DNA Technology methods. **8h**

Module 3: 13h

Secondary structure*:* Peptide bond geometry, conformational map, Chou and Fasman algorithm, α-helix and other helices, β pleated sheet, Beta bend and triple helical cable, secondary structure of fibrous proteins: α-keratin, silk fibroin and collagen, super secondary structures

Tertiary structure*:* Non covalent and covalent interactions stabilizing the 3D structure. Tertiary structure of lysozyme, myoglobin and ribonuclease, denaturation of proteins

***Quaternary structure**:* Cross linking agents to determine subunit composition. Hemoglobin Structure and mechanism of oxygen binding cooperativity. Molecular basis of Sickle-cell anemia

***Protein folding**:* Protein renaturation experiment by Anfinsen, folding accessory proteins- protein disulfide isomerases and molecular chaperones, Levinthol paradox, events during protein folding, conformational diseases: Amyloid, Alzheimer's and Prion diseases. **10h**

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of fatty acids, acylglycerols, phospholipids, plasmalogens, sphingolipids and sterols. **3h**

Module 4: 13h

Lipids: Biological importance of Prostaglandins and related compounds, lipid peroxidation and antioxidants. **3h**

Nucleic acids: Nucleosides, nucleotides and polynucleotides. secondary and tertiary structure of DNA, Cloverleaf model of t-RNA , unusual bases of nucleic acids, Isolation and purification of DNA and RNA, properties of nucleic acids in solution, melting temperature of DNA-T_m; factors affecting T_m. Maxim and Gilbert method and Sanger's dideoxy method of DNA sequencing, rapid sequencing methods. Oligonucleotide synthesis by phosphoramidite method, DNA chip and SELEX (systematic evolution of bio ligands by evolutionary enrichment). **10h**

References:

1. Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).

2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).

4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).

5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).

6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).

7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and Lubert Stryer, W H Freeman and Co. (2006).

8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC103
TITLE OF THE COURSE : BIOANALYTICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5 52 hours

Module 1: **13h**

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **8h**

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules. **5h**

Module 2: **13h**

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, Western, Northern and Southern blotting techniques, 2D gel electrophoresis. **6h**

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips **7h**

Module 3: **13h**

Chromatography : partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapathite chromatography, special chromatographic techniques for nucleic acids, FPLC **10h**

Radioactivity: Disintegration of radionucleides, half life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography. **3h**

Module 4: **13h**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications. **5h**

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property. **8h**

References

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).

2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)

4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)

5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)

6. Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III

Elsevier (2008).

7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC104
TITLE OF THE COURSE : HUMAN PHYSIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Tissue level of organization: Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues. **8h**

The muscular system: Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism. **5h**

Module 2: **13h**

Nervous system: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin **8h**

Endocrine system: Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D. **5h**

Module 3: **13h**

Cardiovascular system: functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary

circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center. **8h**

Respiratory system: Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O_2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods. **5h**

Module 4: **13h**

Digestive system: Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food **7h**

The urinary system: Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones. **6h**

References

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)

2. Biochemistry 4th Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).

3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (1997).

4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).

5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (1995).

6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).

7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (1997)

8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (1998)

9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (1991).

10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (1983).

11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (1986).

12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC105
TITLE OF THE COURSE : BIOSTATISTICS
L: T/A: P: C : 2:0:0:2

26 hours

Module I: **13h**

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.
Measures of Central tendency: Arithmetic mean, mode & median.
Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error
Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.
Sampling methods and their significance.

Module II: **13h**

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.
Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

References:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC171
TITLE OF THE COURSE : BIOCHEMICAL ESTIMATIONS
L: T/A: P: C : 0:0:8:4

1. Estimation of lactose in milk by DNS
2. Estimation of sugars in fruits
3. Estimation of proteins by Lowry's method
4. Estimation of inorganic phosphate in peas by Fiske-Subbarow method
5. Estimation of DNA by diphenylamine method.
6. Estimation of RNA by Orcinol method.
7. Estimation of total sugars in plants by anthrone method.
8. Determination of saponification number of oil/fat

.

References:

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).

2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).

3. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).

4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),

5. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990).

6. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

7. Biophysical chemistry by Upadhyay and Upadhyay.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBC172
TITLE OF THE COURSE : BIOPHYSICAL CHEMISTRY
L: T/A: P: C : 0:0:8:4

1. pH calculation and Buffer preparations - problems
2. Determination of absorption spectra, molar extinction coefficient & λ_{max} of proteins & nucleic acids.
3. Determination of pK_a of amino acid through pHmetric titration.
4. Determination of weak acid concentration by conductometric titration
5. Separation of amino acids by ascending & circular chromatography.
6. Separation of amino acids by 2-D chromatography
7. Separation of carbohydrates/amino acids by TLC.
8. SDS-PAGE of proteins.

References:

1. Biochemical Calculations, Irwin H.Segel (1976) 2nd Ed. John Wiley and Sons.

2. Modern Experimental Biochemistry R.F.Boyer [Ed.] (1986) Addition Wesley.

3. Analytical Biochemistry; D.J.Holme and H. Pick, Longman (1983).

4. Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 6th Ed. (2005) Cambridge University Press.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC201
TITLE OF THE COURSE : METABOLISM OF CARBOHYDRATES AND LIPIDS
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Carbohydrate metabolism: anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, Kreb's cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle-utilisation of TAG in germinating seeds. Glucuronic acid pathway-synthesis of L-Ascorbic acid in plants. Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins **13h**

Module 2: **13h**

Lipid metabolism: Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, energetics of β-oxidation scheme, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, shpingolipid storage disorders**.** **13h**

Module 3: **13h**

Cholesterol: structure, brief idea of synthesis and metabolism, normal and abnormal levels in the body. **2h**

Isoprenoid metabolism, insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL. Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism, obesity, atherosclerosis and hypercholesterolemia, synthesis of prostaglandins and related compounds, Non steroidal anti inflammatory drugs (NSAIDs) **11h**

Module 4: **13h**

Metabolic disorders: Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves,

and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria. **8h**

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation. Introduction to metabolomics. **5h**

References

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(1999).

2. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper IRL Oxford University Press(1995).

3. Photosynthesis, D.O. Hall and K. K. Rao, 6th Ed. Cambridge University Press (1999).

4. Hawk's Physiological Chemistry, 14th Ed , Oser, Tata-McGraHill (1976).

5. Biochemistry of Foods, Eskin, Elsevier (2012).

6. Text Book of Biochemistry with Clinical correlations; 6th Ed. Thomas M. Devlin, Wiley- Liss (2012).

7. Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).

8. Biochemistry; David Rawn, Panima Publishers (2012).

9. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D.Bender , K.M. Botham ,

P. J. Kennelly, P. A. Weil (2015)

10. Biochemistry; 7th Ed. J.M.Berg, J.L.Tymoczko, L.Stryer , W.H.Freeman &Company (2012)

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC202
TITLE OF THE COURSE : IMMUNOLOGY AND CANCER BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: **13h**

Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. **3h**

Innate immunity: Different lines and layers of defense, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils. **10h**

Module 2: **13h**

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins, genetic recombination of heavy and light chains. **5h**

Immuno techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA & ELISA. Immuno-electrophoresis, Immuno-florescence and immuno-staining techniques in electron microscopy. **3h**

Antigen recognition by T cells: T_H, T_C and T_{Reg} cells**,** T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen. **5h**

Module 3: **13h**

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self recognition. **3h**

Failures of Host Defense Mechanisms: How do pathogens evade the immune system, inherited immunodeficiency diseases, acquired immune deficiency syndrome. Autoimmune responses. Vaccines. **4h**

Allergy and Hypersensitivity: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases. **3h**

Transplantation and Network theory: Transplant rejection, immunosuppressents. Immuno-surveillance, idiotopes and immune network theory. **3h**

Module 4: **13h**

Hallmarks of cancer, tumor viruses, oncogenes, growth receptors and signaling, tumor suppressor genes, p53 and pRB-functions and regulation. Apoptosis – components of pro- and anti-apoptotic pathways. Tumorogenesis- differentiation, immortalization, genomic integrity, angiogenesis and metastasis. Rational design of cancer therapeutics. **13h**

References:

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology , 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L.Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007)
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013)
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).
8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57–70 (2000)
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC203
TITLE OF THE COURSE : ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module 1: 13h

Introduction to Enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes. **7h**

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions –nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B. **6h**

Module 2: 13h

Enzyme Kinetics: Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. **5h**

Kinetic data evaluation; linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy. **8h**

Module 3: 13h

Enzyme Inhibition: Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. **5h**

Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation - reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation. **8h**

Module 4: **13h**

The investigation of active site structure: The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labeling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies. **7h**

Enzyme catalysis: Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin) , sulphydryl enzymes(alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase). **6h**

References:

1. Enzymes- Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010)
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999)
4. Fundamentals of Enzyme Kinetics,Bowden, Portland Press (2004)
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H.. Freeman & Companys (1980).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000)
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons(1976).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC204
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: **13h**

Criteria for classification of microroganisms, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Chemotaxonomy, Numerical taxonomy and Molecular taxonomy. Brief account of Bergey's manual of bacteriology.

Bacteria: Ultra structure of bacterial cell: Shapes and size, chemical composition and characterization of cell wall.

Viruses: General Properties of viruses, classification and replication of bacteriophages. Viroids and Prions.

Ultrastructure, classification and reproduction in algae, fungi and protozoa

Module II: **13h**

Microscopy: Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Microbial Techniques: Cultivation of microorganisms, culture media, Pure culture techniques, Stains and staining techniques: Simple, Negative, Gram's, Acid fast and structural staining techniques.

Microbial Control: Concepts of sterilization and disinfection. Physical and chemical methods of sterilization.

Module III : **13h**

Microbial growth, growth curve and factors affecting growth (Physical and chemical).

Bacterial photosynthesis, photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Role of microorganisms in nitrogen fixation.

Breakdown of carbohydrates –EMP (Glycolysis), HMP shunt (pentose phosphate pathway) and ED, TCA, ETS (oxidative phosphorylation), anaerobic respiration.

Fermentative modes in microorganisms – alcoholic, lactic acid (hetero and homo lactic acid fermentation).

Overview and importance of secondary metabolites - antibiotics

Module IV: **13h**

Host pathogen interactions, defense mechanisms of pathogens, human pathogens and diseases; virus (chickenpox, measles, mumps, hepatitis B), bacteria (tetanus, TB, cholera, typhoid, anthrax), protozoa (amebiasis, malaria, toxoplasmosis), fungi (mycoses). General characteristics of antimicrobial drugs and their mode of action, antibiotic resistance and multi-drug resistant strains.

References:

1. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers
2. Stainer R.T., Ingraham J.L., Wheelis M.L. and Painter, P.R., (1987).General Microbiology; Macmillan, 5th. Edition
3. Pelczar Jr. M.J.; Chan E.C.S. and Krieg N.R. (1986). Microbiology, Mc Graw Hill, Fifth Edition
4. Glazer A N and Nikiado H , Freeman (1995).Microbial Biotechnology and Fundamentals of Applied Microbiology.
5. Introductory Microbiology by Heritage Pub Heritage
6. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y
7. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2 Edition, Milan Publishing Co.
8. Brock T.D. and Madigan M.T). (1992)Biology of Microorganisms 6 Edn. Prentice Hall, Eagle wood cliffs N.j.
9. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T. (1994). Bergey‟s Manual of the Systemic Bacteriology 9 Edn. William and Wilkins, Baltimore.
10. Dubey.R.C Microbiology. (2001). First edition. Chand & Company.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0:2

26 hours

Module I: **8h**

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant

Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Programming Languages: Introduction to programming languages - C and PERL

Module II: **10h**

Data management - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT

Structural databases - protein data Bank (PDB) & UniProt

Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,

Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

Module III : **8h**

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics;

Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models

Threading, structure evaluation and validation and *ab intio* Modeling

Applications - Molecular docking - Autodoc

References:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC271
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND MICROBIAL TECHNIQUES
L: T/A: P: C : 0: 0: 8:4

1. Estimation of glucose in blood by Folin-Wu / glucose oxidase method
2. Estimation of uric acid in blood by Caraway's method
3. Estimation of creatinine in serum and urine by Jaffe's method
4. Estimation of urea in serum and urine by urease method
5. Estimation of haemoglobin by Wong's method
6. Estimation of ketone bodies in urine
7. Estimation of reducing sugars in urine
8. Estimation of serum cholesterol by Zack's method.
9. Isolation and Identification of microorganisms from air, water and soil.
10. Microbial culture techniques- Streak Plate, Spread Plate and Pour plate.
11. Staining techniques – Simple staining and Grams staining.

References:

1. Hawk's Physiological Chemistry, 14th Ed (ed. Oser) , Tata-McGrawHill (1976).

2. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).

3. Practical Clinical Biochemistry, ed. Harold Varley, 4th Ed. CBS Publishers (1988).

4. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).

5. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBC272
TITLE OF THE COURSE : ENZYMOLOGY
L: T/A: P: C : 0: 0: 8:4

1. Isolation and assay of phosphatase; effect of dilution
2. Effect of substrate on phosphatase
3. Effect of Temperature & pH on phosphatase
4. Inhibition kinetics of phosphatase by L-B plot
5. Isolation and assay of esterase; effect of dilution
6. Substrate effect on esterase
7. Effect of Temperature & pH on esterase
8. Inhibition kinetics of esterase by L-B plot

References:

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (1996)
2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)

3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)

4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).

5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC301
TITLE OF THE COURSE : MOLECULAR MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Hours: 52

Module I: DNA Replication and Repair 13h

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

Module II: Gene Expression – Transcription 13h

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5’ Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

Module III: Gene Expression – Translation **13h**

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

Module IV: Regulation of Gene expression in prokaryotes and eukaryotes 13h

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

References:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific

American Books Inc. NY.

10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.

11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC302
TITLE OF THE COURSE : METABOLISM OF NITROGEN COMPOUNDS
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: Bioenergetics **13 hrs**

Reduction Potential, Biological redox couplers, Sequence and structure of mitochondrial electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores.

Module II: Nucleotide Metabolism **13 hrs**

Nitrogen Cycle, nitrogen fixation, *nif* genes. Structure of nucleoside and nucleotide; Synthesis and degradation of purine and pyrimidine nucleotides and their regulation. Disorders: SCID, gout, Lesch-Nyhan syndrome, oroticaciduria and xanthinuria.

Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies,

Module III: Nitrogen metabolism **13 hrs**

General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle and its regulation. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.

Module IV: Amino acid metabolism **13 hrs**

Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism. Regulation of amino acid metabolism

References

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.

4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC303
TITLE OF THE COURSE : HORMONES AND CELL SIGNALLING
L: T/A: P: C : 4: 1: 0: 5

52 hours

Module I: Endocrine signaling **13 hrs**

Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine, serotonin, glucagons); Ion–channel (ACh); Tyrosine kinase (RTK), [EGF, IGF, insulin] and Intrinsic enzyme / cytokine, receptors.

Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+}, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.

Module II **13hrs**

Nerve signaling: Morphology of a neuron. Astrocytes, Glial cells, Schwan cells and oligodendrocytes. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential.

Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).

Module III: Nuclear signaling and Cell Cycle **13 hrs**

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation.

Cell Cycle: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation. Cyclins and cyclin-dependent kinases.

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

Module IV: Apoptosis and Cancer **13 hrs**

Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF-β pathways). Concept of tumor suppressors.

References:

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

26 hours

Module I: Ecology and Ecosystem **13 hrs**

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves;

Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. community ecology

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module II: Developmental Biology **13 hrs**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila.

References:

1. Fundamentals of ecology by Eugene Odum, Cengage; 5 edition (2005).
2. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
3. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
4. Development Biology by N Arumugam, Saras Publication (2014)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC321
TITLE OF THE COURSE : MEMBRANE BIOCHEMISTRY AND NANOSCIENCE
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 1)

52 hours

Module I: Membrane Lipids **13 hrs**

Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol & cardiolpin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.

Module II: Membrane topology **13 hrs**

Human erythrocyte membrane as a prototype plasma membrane. Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Techniques for determination of membrane protein topology: X-ray crystallography, Freeze-fracture electron microscopy. Fluorescence photobleaching recovery (FRAP). Single particle tracking. Lipid-protein interactions. Lateral and rotational diffusion of integral membrane proteins. Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.

Module III: Nanoscience **13 hrs**

Atomic Structure and atomic size. Introduction to Nanoscale. influence of nano size and effects on surface properties. Nanoparticles – synthesis, properties, and applications, Brief account of nanolithography, Nanoporous polymers (activated carbon and zeolites) and their applications in water purification, Nanotoxicology.

Module IV: Nanobiotechnology **13 hrs**

Nanostructures –Carbon nanotube and its use as biosensors. Applications of nanoscience in biological systems - drug targeting, drug delivery with nanoliposomes. Principle and applications of Zetasizer, Scanning Tunneling microscope and Atomic force Microscopy in Nano biotechnology.

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter Molecular Biology of the Cell, 4th edition. Garland Science.

2. Michael I. Gurr, John L. Harwood, Keith N. Frayn, Denis J. Murphy and Robert H. Michell. Lipids: Biochemistry, Biotechnology and Health, 6th Edition, John Wiley & Sons
3. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
4. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
5. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831,Cambridge University Press.
6. Processing & properties of structural naonmaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC322
TITLE OF THE COURSE : PLANT AND MICROBIAL SECONDARY METABOLITES
L: T/A: P: C : 4: 1: 0: 5
(Departmental Elective - 2)
Total hours: 52

Module I: Introduction to Phytochemicals 13h

Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level.

Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, liquid-liquid extraction techniques, liquid-carbon dioxide extraction, concentration and evaporation techniques, lyophilisation.

Module II: Methods to analyse Phytochemicals 13h

Techniques for quantitative and structural analysis of plant secondary metabolites: Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry.

Application of UV/Visible, IR, ^{1}H and ^{13}C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).

Module III: Microbial metabolites 13h

Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process.

Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application.

Lactic acid: Nutrient media, production process recovery and purification.

Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.

Module IV: Special Microbial metabolites **13h**

Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine).

Health care products: Industrial production of: Penicillin and Streptomycin; production and recovery.

I P R: Patents: Patent regulations of processes, products and microorganisms.

References:

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IVth Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC371
TITLE OF THE COURSE : MOLECULAR BIOLOGY & IMMUNO TECHNIQUES
L: T/A: P: C : 0: 0: 8: 4

(Practical)

1. Isolation and Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation of plant/animal genomic DNA, and analysis by agarose gel electrophoresis
4. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency
5. Study of conjugation in *E. coli*
6. Serum Separation from whole blood and isolation of immunoglobulins from serum.
7. Study of different cells in whole blood using Giemsa/Leishman stain.
8. Blood grouping
9. ELISA/Dot ELISA
10. Radial Immunodiffusion/Ouchterlony Double Diffusion
11. Rocket Immuno Electrophoresis
12. WIDAL/RPR Test

References:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons

2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)

3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.

4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.

5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub

WH Freeman Co.

6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub.

Oxford.

7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994).

Molecular Biology of the Cell.

8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.

9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.

10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.

11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBC372
TITLE OF THE COURSE : PROTEIN BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

(Practical)

[1] Extraction of phosphatase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[2] Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[3] Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation

[4] Criteria of purification of phosphatase visualized through SDS-PAGE

[5] Extraction of esterase from plants and stepwise purification through organic acid precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[6] Extraction of esterase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step

[7] Criteria of purification of esterase – chromatography of purified samples – ion exchange/gel permeation

[8] Criteria of purification of esterase visualized through SDS-PAGE

[9] Concepts of Isoelectric Focusing (Demonstration)

Reference Books:

[1] Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).

[2] Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC401
TITLE OF THE COURSE : GENETIC ENGINEERING AND BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Basic Concepts 13h

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors 13h

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning strategies and study of protein-DNA interactions 13h

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 13h

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6^{th} edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3^{rd} Ed), WH Freeman.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC421
TITLE OF THE COURSE : FOOD BIOCHEMISTRY AND NUTRITION
L: T/A: P: C : 4: 1: 0: 5

(Departmental elective - 1)

52 hours

Module I: Basics on Food Biochemistry 13h

Carbohydrates: Occurrence and physiological functions, factors influencing metabolism.
Lipids: Concepts of visible and invisible fats. EFA, SFA, MUFA, PUFA- sources and physiological functions.
Proteins: Concepts of essential and non-essential amino acids- their role in growth and development. Physiological functions of proteins. Requirements, nitrogen balance concept. Methods for evaluating protein quality.
Regulation of food intake: role of hunger and satiety centers, effect of nutrients.

Module II: Basics on Nutrition 13h

Body composition: Methods of studying body composition. Nutritional disorders and effect on body composition- protein energy mal nutrition, renal failure and thyroid related disorders. Food borne allergens, toxins and adulterants.
Energy metabolism: Basal and resting metabolism- influencing factors. Methods to determine energy requirements and expenditure.

Module III: Nutraceuticals 13h
Nutraceuticals: Definition, example and use of nutraceuticals in traditional health sciences; their role in preventing /controlling diseases.
Prebiotics and probiotics: Usefulness of probiotics and prebiotics in gastro intestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.
Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. (with examples)
Development of nutraceutical and functional foods: Standards for health claims, Regulatory bodies (FSSAI). Process of developing - preclinical & clinical studies.

Module IV: Designer Foods and Nutrigenomics 13h
Functional Foods - Natural and synthetic, use of excipients. Characteristics of drugs action: pharmacokinetics, route and form of excretion. Drug abuse and drug resistance Drug-nutrient interactions – effect of drugs on ingestion, digestion, absorption and metabolism of nutrients, effect on nutritional status, effect on organ function, drug dosage and efficacy.

Nutrigenomics - definition, concepts and theories. Genetic materials, gene expression and inheritance. Molecular mechanisms of genetic variations linked to diet- role of diet, macro and micro nutrients. Role of animal foods. Evolution of human diseases.

References:

1. Swaminathian (1990). Food and Nutrition, Himalaya Publishers.
2. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
3. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
4. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
5. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
6. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
7. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
8. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC422
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY AND BIOENGINEERING
L: T/A: P: C : 4: 1: 0: 5
(Departmental Elective- 2)

52 hours

Module I **13 h**

Precision, accuracy and sensitivity. Brief introduction to carbohydrate, fat and protein metabolism (overview). Metabolic disorders: Diabetes Mellitus, Atherosclerosis, Renal failure and muscular dystrophies. Detection of these diseases through blood, liver and kidney functional tests. Role of isozymes. Clinical laboratory functioning - Laboratory information systems, Lab accreditation processes

Module II **13 h**

Drug discovery and development, including animal studies, tissue culture studies, safety, efficacy, randomization procedures, Preclinical Safety, Assessment of pharmacokinetics in early phase drug evaluation, Metabolism studies: in vitro and in vivo tests Pre clinical studies, Phase 0, Phase I, Phase II, Phase III, Phase IV, single blind and double blind studies. Regulation and quality assurance.

Module III **13 h**

Introduction to bioengineering, Quantitative and qualitative Models for biology: models used to understand DNA, proteins and lipids. Estimates; estimation of size for bacterial cells and mammalian cells including fibroblasts and intestinal cells. Relative time.

Module IV **13 h**

Complexity in biological systems, Simple mathematical models for diffusion kinetics and gene expression, transformation of energy in cells - metabolism of fuels and generation of proton motive force leading to ATP synthesis. Brief idea of Systems Biology.

References:

1. Donald Voet, Judith G Voet, Biochemistry, 4th Edition, John Wiley and Sons
2. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia; Physical biology of the Cell, 2nd edition, garland Science Publication, 2012.
3. Handbook for applicants and reviewers of Clinical trials of new drugs in India; CDSCO. ICMR, 2017.
4. The Drug development Process; US Food and Drug Administration
   URL: https://www.fda.gov/ForPatients/Approvals/Drugs/default.htm

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBC471
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY & BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

(Practical)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT101
TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CELL TYPES, CELL CYCLE AND ITS CONTROL 13H

Cell types**:** Structure of prokaryotic and eukaryotic cells, ultra-structure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle**:** Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks* and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways.

MODULE II MEMBRANE TRANSPORT 13H

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na^+/K^+ Pump, Ca^{2+} Pump. ABC transporter and Multidrug resistant protein.

MODULE III CYTOSKELETON AND CELL-CELL INTERACTIONS 13H

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV CELL SIGNALING, ANTIOXIDANT DEFENSE SYSTEM AND SENESCENCE 13H

Cell signaling: Principles of cell signaling, intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions. (Ca^{2+} Cyclic modulators –cAMP, cGMP, IP3, 2AG, Nitric Oxide). Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

Senescence: Theories and concepts of aging, molecular mechanisms and genes involved in senescence and aging (daf-2 and its mutants).

REFERENCE:

1. Alberts et al., (2002).Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007).Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT102
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I- CONCEPTS IN GENETICS AND ORGANIZATION OF CHROMOSOMES IN EUKARYOTES 13H

Basic Genetics: Mendelian genetics - Concepts and theories, Morgan's linkage analysis, chromosome theory of inheritance, Fine structure of gene, Split genes and overlapping genes, gene interactions. Features of *E. coli.* and Human genome, C-value paradox. Concept of Epigenetics, Genomic imprinting and Epigenomics. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE II-MOLECULAR MECHANISMS OF RECOMBINATION 13H

Bacterial Recombination- plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination – Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of RecA in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion.Site-specific recombination: integration of lambda genome in *E.coli*. Topological manipulation of DNA

MODULE III-MOLECULAR BASIS OF MUTATION AND TRANSPOSABLE GENETIC ELEMENTS 13H

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders.Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, Composite Transposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and their significance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

MODULE IV - SEX DETERMINATION AND CANCER GENETICS 13H

Dosage Compensation and Sex Determination: Dosage compensation in *Drosophila* and mammals, Factors affecting sex determination, Sex determination in *Drosophila* and mammals. Secondary sex determination in mammals. Mechanism of sex determination in

Drosophila.

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzeimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Genetic Counseling, Prenatal diagnosis, Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004). Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons.
8. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT103
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I MICROBIAL TAXONOMY AND DIVERSITY 13H

Criteria for classification of microroganisms, Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Chemotaxonomy, Numerical taxonomy and Molecular taxonomy. Brief account of Bergey's manual of bacteriology.

Bacteria: Ultra structure of bacterial cell: Shapes and size, chemical composition and characterization of cell wall.

Viruses: General Properties of viruses, classification and replication of bacteriophages. Viroids and Prions.

Ultrastructure, classification and reproduction in algae, fungi and protozoa

MODULE II MICROBIAL TECHNIQUES 13H

Microscopy: Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Microbial Techniques: Cultivation of microorganisms, culture media, Pure culture techniques, Stains and staining techniques: Simple, Negative, Gram's, Acid fast and structural staining techniques.

Microbial Control: Concepts of sterilization and disinfection. Physical and chemical methods of sterilization.

MODULE III MICROBIAL PHYSIOLOGY 13H

Microbial growth, growth curve and factors affecting growth (Physical and chemical).

Bacterial photosynthesis, photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Role of microorganisms in nitrogen fixation.

Fermentative modes in microorganisms – alcoholic, lactic acid (hetero and homo lactic acid fermentation).

Overview and importance of secondary metabolites - antibiotics

MODULE IV MEDICAL MICROBIOLOGY 13H

Sources of infection (Food, water, air, vector and animal borne), Host pathogen interactions, defense mechanisms of pathogens. Etiology, epidemiology, pathogenicity and prophylaxis of Food and water borne diseases (Brucella, Hepatitis A, Typhoid, Cholera, Polio, Botulism), Air Borne diseases (Chicken pox, TB, Influenza), Water Borne Diseases (amebiasis, typhoid, cholera), Vector and Animal borne (Malaria, dengue, Rabies, plague) & STD (HIV, gonorrhea)

General characteristics of antimicrobial drugs and their mode of action, antibiotic resistance and multi-drug resistant strains.

REFERENCES:

1. Stainer R.T., Ingraham J.L., Wheelis M.L. and Painter, P.R., (1987).General Microbiology; Macmillan, 5th. Edition
2. Pelczar Jr. M.J.; Chan E.C.S. and Krieg N.R. (1986). Microbiology, Mc Graw Hill, Fifth Edition
3. Glazer A N and Nikiado H , Freeman (1995).Microbial Biotechnology and Fundamentals of Applied Microbiology.
4. Introductory Microbiology by Heritage Pub Heritage
5. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y
6. Atlas R.M. (1998) Microbiology, Fundamentals and applications 2 Edition, Milan Publishing Co.
7. Brock T.D. and Madigan M.T). (1992)Biology of Microorganisms 6 Edn. Prentice Hall, Eagle wood cliffs N.j.
8. Holt J.S. Kreig N.R., Sneath P.H.A and Williams S.T. (1994). Bergey‟s Manual of the Systemic Bacteriology 9 Edn. William and Wilkins, Baltimore.
9. Prescott L.M, Harley T.P and Klein D.A. (1996) Microbiology WMC. Brown publishers
10. Dubey.R.C Microbiology. (2001). First edition. Chand & Company.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT104
TITLE OF THE COURSE : BIOMOLECULES AND ENZYMOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I CHEMISTRY OF CARBOHYDRATES AND LIPIDS 13H

Chemical basis of life: Macromolecules- monomers and polymers, Acid Base balance and its maintenance, Water- properties, pH, ionization and hydrophobicity and thermodynamics.
Carbohydrates: Energy storage molecules – starch, glycogen. Building blocks – cellulose, hemicellulose, and chitin. Cell surface molecules – glycolipids, proteoglycans.
Lipids: Triglycerides, phospholipids, glycolipids, sphingolipids, lipoproteins. Lipid micelles, liposomes & their applications.

MODULE II CHEMISTRY OF PROTEINS AND NUCLEIC ACIDS 13H

Proteins: Amino acids and peptides. Primary, secondary, tertiary and quaternary structures, Ramachandran plot. Collagen structure, models of protein folding, experimental techniques to study protein folding (X-ray Crystallography, Fluorescence spectroscopy), roles of chaperones and chaperonins. Concepts of protein sequencing and protease mapping.
Nucleic acids: Structure of DNA and RNA: A, B, and Z forms of DNA. Higher order structures of DNA (bends, cruciform, G-quadraplexes). Denaturation and renaturation studies and their applications.

MODULE III ENZYMES AND BASIC ENZYME KINETIC CONCEPTS 13H

Enzymes: Introduction to enzymes; nomenclature and classification of enzymes; chemical nature and properties of enzymes, factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.Enzyme Kinetics: Basic chemical kinetics, rate of reaction, order of reaction, zero order and first order reactions. Derivation of Michaelis-Menten equation, Significance of Km, Vmax and Kcat. Derivation of Lineweaver-burk plot, basic concepts of Scatchard Plot, Eadie-Hofstee Plot, Hanes-Woolf plot and their relevance.

MODULE IV ENZYME CATALYSIS AND REGULATION 13H

Mechanism of Enzyme catalysis: Mechanism of enzyme catalysis - Acid-Base catalysis, covalent catalysis, metal ion catalysis and entropy effect. Example of enzyme catalysis mechanism – chymotrypsin and transaminases.
Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots.
Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

REFERENCES:

1. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH Freeman Co.
2. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 rd Indian edition, Pub. Oxford.
3. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
4. Kuchel, P.W., Ralston Schaums, G.B. Outlines of Biochemistry 2 nd edition Pub: Tata.
5. Voet, D., Voet J.G. (2004). Biochemistry 2 nd Edn.
6. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
7. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT105
TITLE OF THE COURSE : BIOSTATISTICS (Soft core)
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION 13H

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.

Measures of Central tendency: Arithmetic mean, mode & median.

Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error

Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.

Sampling methods and their significance.

MODULE II PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS 13H

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.

Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press,Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT171
TITLE OF THE COURSE : MOLECULAR CELL BIOLOGY AND GENETICS
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Hemocytometer: Counting of cells
3. Study of mitosis by using onion root tips
4. Study of meiosis –Grasshopper testis
5. Mounting of Barr bodies
6. Study of Karyotyping in onion, humans (normal and abnormal)
7. Study of mutation in E. coli by Physical method (UV) (2 units)
8. Study of Drosophila mutant types.
9. Mounting of polytene chromosomes – in Drosophila
10. Study of normal and abnormal cellular cell structure and their pathological significance (through permanent slides)
11. Isolation of nucleus/mitochondria and determination of its purity
12. Concept of Multiple Alleles in Humans (Blood group)
13. Solving Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance)

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

1. Determination of pI of amino acid by titration method.
2. Estimation of glucose by Dinitrosalicyclic acid (DNSA).
3. Estimation of protein by Lowry's/Bradford method.
4. Estimation of inorganic phosphate by Fiske-Subbarow method
5. Determination of saponification number and acid value of the given fat samples. (2 unit)
6. Sterilization techniques and Preparation of media
7. Isolation of microorganisms from Soil/Air/Water
8. Pure Culture Techniques – serial dilution, streaking, pour plate, spread plate
9. Staining techniques in microbiology - simple staining, negative staining, Gram staining, spore staining, capsule staining
10. Biochemical tests: Starch hydrolysis, Catalase, Gelatin Liquefaction, IMViC
11. Determination of microbial growth by turbidometric method.
12. Identification of algae, fungi and protozoa (Permanent slides): *Spirulina, Nostoc, Aspergillus, Penicillium, Paramecium* and *Amoeba.*

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT201
TITLE OF THE COURSE : BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I 13H

SPECTROSCOPY TECHNIQUES

Theory and application of UV, Visible and Raman Spectroscopy, Circular Dichroism *and optical rotatory dispersion*; Fluorescence; Nuclear magnetic resonance, *Electron spin resonance*, Mass spectrometry (GC-MS, LC-MS, ICP-MS, MALDI-TOF), Atomic absorption and atomic emission spectroscopy.

MODULE II SEPARATION TECHNIQUES – CHROMATOGRAPHY AND ELECTROPHORESIS 13H

Chromatography: TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity Chromatography; HPLC and FPLC; Dialysis, Criteria of protein purity.
Electrophoresis: Theory and application of Polyacrylamide gel electrophoresis and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis.

MODULE III SEPARATION TECHNIQUE – CENTRIFUGATION 13H

Basic principles (RCF, Sedimentation coefficient); Types of centrifuge - Micro centrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

MODULE IV RADIOISOTOPY, MICROSCOPY AND CELL SORTERS 13H

Radioisotope Techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay, Units of radioactivity. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters, autoradiography, radioimmunoassay.
Microscopy**:** Transmission and Scanning Electron Microscopy, Tunneling Electron Microscopy and Atomic Force Microscopy
Cell Analysis: Florescent activated cell sorter (FACS) and Coulter counter.

REFERENCES:

1. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
2. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
3. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John Walker, Cambridge University Press (2005).
4. Biophysics – An introduction by Ronald Glaser, Springer (2012).
5. An introduction to practical biochemistry 1987.third edition by D T Plummer. pp. 332. McGraw-Hill (UK).
6. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry, 4 edition Pub WH Freeman Co.
7. T.G. Cooper; the Tools of Biochemistry. Wiley Intersciences, 1977.
8. Protein purification techniques – A practical Approach (2001) Simon Roe, 2nd Edtion, Oxford University press

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT202
TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I: IMMUNE SYSTEM 13H

Humoral and Cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens-antigen specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and monoclonal, Complement system – component, properties and functions. Complement pathways and biological significance.

MODULE II: IMMUNE RESPONSES 13H

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

MODULE III: IMMUNE--MEDIATED DISEASES AND TRANSPLANTATION 13H

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis.
Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, Xenotransplantation.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 13H

Immunoprecipitation; Agglutination; Immuno electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; ELISPOT; ELISA; Western blotting; Hybridomas and their production;
Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines-live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. novel vaccines-subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines.
Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.
3. Dimmock, N.J., Primrose, S.B. (1994). Introduction to Modern Virology, Blackwell Science Ltd.Oxfird.
4. Hyde, R.M. (1992). Immunology, 2 edition, Williams and Wilkins, Baltimore.
5. Kuby, J. (2003). Immunology 5 Edition. WH. Freeman and Company, NY.
6. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers,London.
7. Tizard I.R.(1995). Immunology, 4 edition, Saunder College Pub.
8. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT203
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I DNA REPLICATION AND REPAIR 13H

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE II GENE EXPRESSION – TRANSCRIPTION 13H

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE IIIGENE EXPRESSION – TRANSLATION 13H

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes. Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE IV REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES 13H

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT204
TITLE OF THE COURSE : ENVIRONMENTAL AND MEDICAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52

MODULE I WASTE WATER AND SOLID WASTE MANAGEMENT 13H

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II APPLICATION OF BIOTECHNOLOGY IN ENVIRONMENTAL MANAGEMENT 13H

Bioremediation: Concept, principles and techniques, bioremediation using microbes.

Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals)

Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III BIOLOGY OF HUMAN DISEASES 13H

Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers-amino transferases, creatine kinase, LDH, amylase and γ-glutamyl trans-peptidase

Microbial Diseases of Humans: mode of infection, symptoms, detection, epidemiology and control measures of disease caused by Viruses (AIDS, Hepatitis- B) Bacteria (Typhoid, STD) Fungi (Aspergillosis, Cryptococcosis) and Protozoa (Malaraia, Amoebiasis)

Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell aneamia, Beta Thalassemia and Diabetes

MODULE IV MOLECULAR THERAPEUTICS AND NANOBIOTECHNOLOGY 13H

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials.

REFERENCES:

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Devlin, Thomas M. (2001) Textbook of Biochemistry: With Clinical Correlations (5th Ed.); John Wiley & Sons, Inc.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8H

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant
Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL.
Network Security- Group polices Fire-walls.
Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10H

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation. Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER, Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acidsand protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8H

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.

5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT271
TITLE OF THE COURSE : BIOPHYSICAL AND IMMUNOLOGICAL TECHNIQUES
L: T/A: P: C : 0: 0: 8: 4

(PRACTICAL)

1. Isolation of enzyme and estimation of its activity (Urease/Amylase/Acid Phosphatase/esterase) - any one
2. Determination of kinetic properties of amylase/acid phosphatase/urease/esterase (2 units).
3. Partial purification of the enzyme by salting out/acetone and dialysis (2 units)
4. To perform SDS-PAGE and check the purity of the isolated enzyme (2 units).
5. Immobilization of the purified enzyme and its assay.
6. To separate amino acids/ lipids using paper chromatography/Thin Layer Chromatography
7. Serum Separation from whole blood and precipitation of immunoglobulins from serum.
8. Study of different cells in whole blood using Giemsa/Leishman stain.
9. Blood grouping
10. ELISA/Dot ELISA
11. Radial Immunodiffusion/Ouchterlony Double Diffusion
12. Rocket Immuno Electrophoresis
13. WIDAL/RPR Test

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT272
TITLE OF THE COURSE : MOLECULAR BIOLOGY, MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 8: 4

1. Estimation of DNA by colorimetric/spectrophotometric method
2. Estimation of RNA by colorimetric/spectrophotometric method
3. Isolation plant/animal genomic DNA, and analysis by agarose gel electrophoresis (2 units)
4. Preparation of competent cells and transformation by calcium chloride method and calculation of transformation efficiency (2 units)
5. Study of conjugation in *E.coli*
6. Gel filtration chromatography: Sephadex/Sepharose. (Demo)
7. Estimation of SGPT/SGOT in serum samples.
8. Estimation of serum cholesterol by Zak's method.
9. Demonstration of PCR technique.
10. Determination of DO, BOD and COD of water sample (2 units)
11. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
12. Potable water quality assessment-MPN

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT301
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I Basic Concepts 13h

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization

Module II Cloning and expression vectors 13h

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Module III Cloning Strategies and study of protein-DNA interactions 13h

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseI footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display

Module IV Sequencing, PCR and its applications 13h

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.

2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.

3. Brown TA, Genomes, 3rd ed. Garland Science 2006

4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,

6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.

7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication

8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT302
TITLE OF THE COURSE : PLANT BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Plant Tissue Culture 13h

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, Organogenesis; Somatic embryogenesis; Regulation and applications; Artificial seed production; Micropropagation; Somaclonal variation; Androgenesis and its applications in genetics and plant breeding; Germplasm conservation and cryopreservation.

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids and somatic cell genetics

Module II: Genetic Transformation Techniques for plants 13h

Agrobacterium-plant interaction; Virulence; Ti and Ri plasmids; Opines and their significance; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated gene delivery; Cointegrate and binary vectors and their utility; Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; Characterization of transgenics; Chloroplast transformation; Marker-free methodologies; Gene targeting

Module III: Molecular Mapping & Marker Assisted Selection (MAS) 13h

Quantitative and qualitative traits; MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; Molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP markers; Construction of genetic and physical map; Gene mapping and cloning; QTL mapping and cloning. Strategies for Introducing Biotic and Abiotic Stress Resistance/Tolerance, Herbicide resistance, viral resistance, bacterial resistance, fungal resistance crops.

Module IV: Plants as Biofactories and GM Technology 13h

Concept of biofactories; Cell cultures for secondary metabolite production; Production of pharmaceutically important compounds; Bioenergy generation

GM Technology: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal, Golden rice and transgenic sweet potato.

Ethical issues associated with GM crops and GM food; labelling of GM plants and products.

Environmental impact of herbicide resistance crops and superweeds

References:

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT303
TITLE OF THE COURSE : ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I: Basics of Animal Tissue Culture 13h

Introduction, cell culture laboratory-design, layout and maintenance. Equipment and Instrumentation. Methods of sterilization, Detection of Mycoplasma and viral contaminants, Maintenance of sterility and use of antibiotics, types of culture media, composition, preparation and metabolic functions. Role of CO_2, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Serum and protein free defined media.

Culture and maintenance of primary and established cell lines. Biology of cultured cells, culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity, growth parameters, cell death and Apoptosis. Expression of culture efficiency.

Module II: Stem Cells 13h

Stem cells – adult, embryonic, induced pluripotent stem cells: Concept, Types of stem cells (Hematopoietic Stem Cells, Mesenchymal Stem Cells, Embryonic Stem Cells, Fetal Stem Cells); Stem cells from adult organs-Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization.

Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals 13h

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases.

Methods of cloning and their importance with reference to domestic animals. IVF- technology for live stock and humans.

Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation. Basics of artificial tissue printing.

Module IV Applications of Animal Biotechnology 13h

Improvement of biomass, disease resistant, recombinant vaccines for poultry, livestock-pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.

Biosafety: The Cartagena protocol on biosafety. Biosafety management: Key to the environmentally responsible use of biotechnology. Good manufacturing practice and Good lab practices (GMP and GLP).

Reference books:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

Total Credit Hours: 26 Hours

Module 1: Ecology and Ecosystem 13 Hours

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves;

Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. community ecology

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module 2: Developmental Biology 13 hours

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

References:

1. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
2. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
3. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
4. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT321
TITLE OF THE COURSE : METABOLISM OF BIOMOLECULES
L: T/A: P: C : 4: 1: 0: 5

Total Hours - 52

Module I Bioenergetics and Oxidative phosphorylation 13h

Bioenergetics: laws of thermodynamics, enthalpy, entropy, and the free energy change, standard free energy change. Biochemical energetic group transfer reactions of ATP, functions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Uncouplers, inhibitors and ionophores.

Module II Carbohydrate Metabolism 13h

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation. Gluconeogenesis pathway and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle.

Glycogen and starch: degradation, synthesis and regulation, glycogen storage disorders. Pasteur effect, fermentative pathways in microorganisms. Regulation of blood glucose level, disorders of carbohydrate metabolism.

Module III: Amino acid and nucleotide metabolism 13h

General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – transdeamination, amino acid oxidase, and non – oxidative deamination. Urea cycle, its regulation and significance. Biosynthesis and degradation of essential amino acids (with emphasis on aromatic amino acids). Disorders of amino acid metabolism (PKU, Alkaptonuria).

Biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage), regulation of biosynthesis. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyan syndrome, inhibitors of nucleotide synthesis.

Module IV: Lipid Metabolism 13h

Oxidation of fatty acids: even and odd numbered, unsaturated and branched chain fatty acids. Alternate routes for fatty acid oxidation. Degradation of triacylglycerols and phospholipids. Energetic of β-oxidation. Metabolism of ketone bodies; their formation, oxidation and clinical significance. Biological functions of eicosanoids (prostaglandin, leucotrienes and thromboxane).

Cholesterol biosynthesis, catabolism and regulation. Transport of cholesterol -LDL receptor pathway. Lipoproteinemias, fatty liver, hypercholesterolemia. Chemical composition, biological functions and metabolic fate of VLDL, LDL and HDL.

Reference Books:

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
2. Biochemistry; Geoffrey Zubey, (1998), WCB Publishers.
3. Biochemistry; David Rawn, Panima Publishers, (1989).
4. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan
5. Publications (2012).
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
8. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
9. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
10. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT322
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T/A: P: C : 4: 1: 0: 5

Total hours: 52

Module I Genome Organization, structure and mapping 13h

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. C-Values of genomes, Repetitive and coding sequences. Recognition of coding and non-coding sequences and gene annotation. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques, FISH technique in gene mapping, somatic cell hybridization, radiation hybrid maps, in situ hybridization, comparative gene mapping

Module II Genome sequencing and analysis 13h

Genome sequencing, Fluorescence method, automated sequencing, shot-gun approach. Clone contig method, Next Gen Sequencing, Genome sequencing projects of *E.coli*., yeast, and human genome project. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Genome sequence data bases, expressed sequenced tags (ESTs), Genome sequence analysis. determining gene location in genome sequence, Promoter prediction methods

Module III Proteomics 13h

Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Mass Spectroscopy, Concept of MudPIT (Multidimensional Protein Identification Technology), Protein-protein interactions, proteome databases.

Module IV Functional and comparative Genomics 13h

Transcriptome analysis-transcripts of a tissue, use of Northern blot, RT-PCR, Analysis of steady state gene expression by EST tags and cDNA library, differential display, Microarray techniques, sequence analysis of gene expression (SAGE). Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria.

Introduction to metabolomics, lipidomics, metagenomics, systems biology, Pharmacogenetics and drug development

References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT371
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation of DNA from microbial and plant/animal sources.
2. Isolation of total RNA and its analysis.
3. PCR amplification and analysis by agarose gel electrophoresis.
4. Preparation of plasmid DNA from *E. coli.*
5. Restriction digestion of vector and Insert
6. Vector and insert ligation
7. Preparation of competent *E. coli.* cells
8. Transformation in *E. coli.*
9. Plasmid isolation and screening of recombinants
10. Induction of protein expression and analysis by SDS-PAGE
11. Purification of recombinant proteins (demo)
12. Southern hybridization using non-radioactive detection
13. cDNA synthesis by RT-PCR
14. Restriction mapping

SEMESTER/YEAR : III SEM
COURSE CODE : 17MBT372
TITLE OF THE COURSE : PLANT & ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Preparation of plant tissue culture media
2. Organ culture (Shoot tip, nodal and leaf culture) (2 units)
3. Callus culture: Initiation and regeneration.
4. Isolation and fusion of protoplasts
5. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
6. Agrobacterium culture, selection of transformants
7. Study of VAM, isolation of spores, arbuscles and vesicles from roots
8. VAM culture
9. Animal cell culture: Preparation of (serum and non-serum supplemented) media.
10. Primary culture of fibroblast cells/liver cells/testis-leydig cells
11. Assessment of viability and counting using trypan blue exclusion method
12. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
13. Isolation of cells by explant method and Sub-culturing (2 units)

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT401
TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I: Introduction to Bioprocess technology and Bioreactors 13h

Scope and importance of bioprocess technology, Microbial growth and death kinetics (particularly with reference to industrially useful microorganisms). Screening, Isolation. Identification and characterization of industrially important microbes. Strain improvement-mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process 13h

Basic components, design and scale-up of fermenters – Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Microbial growth in batch fermenter and chemostat. Other types like surface, submerged and solidstate fermentation. Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing 13h

Upstream processing: Formulation of fermentation media. Rheology of fermentation media.Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

Module IV: Industrial Bioprocessing 13h

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lycine. Industrial production of health care product: Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin).

Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 1997.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.).Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 1984
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT421
TITLE OF THE COURSE : APPLIED BIOTECHNOLOGY
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I Bioprocess Engineering 13h

Scope and importance of bioprocess engineering technology, Bioreactors: Typical structure of Bioreactor and their working mechanism; Fermentation media and Fermentation Process: Natural and synthetic media. Types of fermentation process, Industrially important products: Ethanol, citric acid, penicillin, amylase, SCP, fermented foods

Module II Plant Biotechnology 13h

Basics of Plant tissue culture, initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications, transgenic plants, crop improvement, Bt cotton, Bt brinjal, golden rice, edible vaccines.

Module III Animal Biotechnology 13h

Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin, Primary and Secondary Cell Culture, stem cells and tissue engineering, transgenic animals, therapeutic and pharmaceutical products,

Module IV Environmental Biotechnology 13h

Air, water, soil pollution, Bio-indicators, waste water management and treatment, bioremediation and biodegradation

IPR, patenting of biotech products, Bioethics, ethical issues related to consumption of GM crops, ethical implication of Human Genome Project

References:

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
3. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
4. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
6. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House

7. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
8. Glazer and Nikaido (1995), Microbial Biotecnology, WH Freeman and Co.
9. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
10. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
11. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
12. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
13. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
14. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT422
TITLE OF THE COURSE : HUMAN DISEASE GENETICS
L: T/A: P: C : 4:1:0:5

Total hours: 52

Module I: Genetic factors in common diseases 13h

Genetic susceptibility to common diseases. Types and mechanisms of susceptibility. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery, diseases, Schizophrenia, Alzheimer's disease, Congenital abnormalities, Huntington's disorder, Myotomic dystrophy, Neurofibromatosis, Cystic fibrosis, Duchenne Muscular Dystrophy (DMD), Becker muscular dystrophy, Hemophilia A and B. Trinucleotide Repeat Expansion mutations and their remediation.

Module II: Biochemical genetics and pharmacogenetics 13h

Biochemical genetics: Inborn errors of metabolism, molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Mucopolysaccharide and Galactosemia, Albinism

Pharmacogenetics: Definition, drug metabolism, Genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, Evolutionary origin of variation in drug responses, Pharmacogenomics, Ecogenetics, Molecular detection of diseases after human genome project,Drug discovery, Animal models in pharmacogenomics.

Module III: Cellular and molecular cytogenetic technologies 13h

Cell lines, Cell and tissue culture practices, Harvesting of cells for chromosomal analysis, Conventional and specialized staining protocols, FISH and spectral karyotyping, Imaging in cytogenetic practices, Chromosome jumping and walking, Evolving molecular cytogenetic technologies, Chromosome instability and fragile sites.

Module IV: Diagnosis of prenatal and heamatopoietic disorders 13h

Prenatal diagnosis: Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Genetic counseling, Transplantation changes in bone marrow, peripheral stem cells and umbilical cord cells with chromosomal features.

Chromosomal diagnostics in heamatopoietic disorders: Myeloid disorders, AML, CML and lymphoid leukemia, lymphoblastic lymphoma and their chromosomal changes, Chromosome changes in benign and malignant tumors, Cytogenetics of breast cancer.

REFERENCES

1 Peter Sudbery 2002. Human Molecular Genetics (Second Edition), Prentice Hall.

2 Tom Strachan & Andrew P.Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons

3 M.A. Jobling, M.E. Hurles & C. Tyler-Smith, 2004. Human Evolutionary Genetics-Origins, Peoples & Disease, Garland Science.

4 Jorge J.Yunis, 1977. Molecular Structure of Human Chromosomes, Academic Press.

5 Elaine Johansen Mange & Arthur P. Mange, 1995. Basic Human Genetics (Second Edition), Sinauer Associates, Inc.

6 Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.

7 Margarlet J.Barch, Turid Knutsen & Jack L.Spurbeck, 1997. The AGT Cytogenetics Laboratory Manual (3rd Edition), Lippincott-Raven.

8 K.C. Sawant 2003. Concise Encyclopedia of Human Genetics, Dominant Pub. & Distributors

9 Amita Sarkar, 2001. Human Genetics, Dominant publishers and Distributors.

10 Michael Baraitser & Robin Winter, 1983. A Colour Atlas of Clinical Genetics, Wolfe Medical Publications Ltd.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MBT471
TITLE OF THE COURSE : BIOPROCESS TECHNOLOGY
L: T/A: P: C : 0:0:8:4

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production of organic acids (lactic acid and citric acid) from microbes
4. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
5. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
6. Laboratory scale production of wine/beer.
7. Estimation of alcohol from different sources by specific gravity method.
8. Alcoholic fermentation and determination of total acidity and non-reducing sugars
9. Microbial assay of vitamin B12 and Glutamic acid
10. Sterility tests for pharmaceutical products
11. Production of amylase by solid substrate fermentation.
12. Production of yoghurt and estimation of lactic acid at different time intervals

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB101
TITLE OF THE COURSE : BACTERIOLOGY AND VIROLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: HISTORY AND SYSTEMATICS OF MICROORGANISMS 13HOURS

History and development of Microbiology: Scope and Applications of Microbiology, discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of Louis Pasteur and Robert Koch. Microbial Systematics:

Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization.

Techniques in taxonomy: Chemotaxonomy, Numerical Taxonomy, Molecular taxonomy, Serology and Phage typing. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: BACTERIOLOGY 13HOURS

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of micrororganisms based on environmental and nutritional requirements.

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly β hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. Reproduction in bacteria.

MODULE 3: SPECIAL MICROBIAL FORMS 13HOURS

Ultrastructure, classification, cultivation, reproduction and importance of Archaebacteria, Myxobacteria, Sheathed, budding and appendaged bacteria, Spirochaete, Rickettsia, Chlamydiae, Mycoplasma, Actinomycetes, Cyanobacteria.

MODULE IV: VIROLOGY **13HOURS**

History of Virology, General properties of viruses, ICTV and classification of viruses, Morphology and ultrastructure of viruses - capsids and their arrangements; types of envelopes and their composition- viral genome (RNA, DNA), general replication of viruses. Cultivation, purification and assay of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV). (Ultra-structure, replication and importance).

General Account and Importance of Viriods and Prions.

REFERENCES:

1. Addison Wiesley, New York. Holt J.G., Kreg N.R., Sneath PHA, Staley J.T and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994.
2. Balows, A., H.G., Dworkin, M., Harder, W and Schleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
3. Breiman, L., Friedman, J.H., Olsen, R.A and Stone. C.J. Classification and Regression Trees.
4. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
5. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
6. Edward Alcamo. Microbiology. Cliffs Notes. 1996.
7. Eldowney, S.Hardmen, D.J and Waite, S. Pollution. Ecology and Biotreatment. Longman Scientific Technical. 1993.
8. Flint L.W.,Enquist, V.R., Racaniello and Skalka A.M. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2000.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
10. Johri, B.N. Extremophiles. Springer Verlag., New York. 2002.
11. McKinney, R. Environment Microbiology. Principles and applications. Science Publishers. 2004.
12. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
13. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition. Pub.1986.
14. Nigel Dimmock N, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
15. Schlegel,H.G. General Microbiology, Cambridge University Pres.
16. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
17. Salle, A.J. Principles of Microbiology, 2ndedition., 1997, Mc Graw Hill.1997.

18. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.
19. Dubey, R.C. Microbiology 1st Edition. Chand and company
20. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
21. Pelczar, M.J., Chan, E.C.S., and Kreig N.R. Microbiology Tata McGraw-Hill Pub.1986.
22. Breiman, L., Friedman, J.H., Olsen, R.A. and Stone. C.J. Classification and Regression Trees.
23. Felsentein, J. Numerical Taxonomy, NATO ASI series, Springer-Verlag, New York. 1961
24. Edward Alcamo. Microbiology. Cliffs Notes 1996.
25. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
26. Ec. Eldowney, S. Hardmen, D.J., and Waite, S. Pollution: Ecology and Biotreatment. Longman Scientific Technical. 1993.
27. Jacquelyn G. Black, Larry M and Lewis. Microbiology: Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
28. S.J. Flint L.W. Enquist, V.R. Racaniello and A.M. Skalka. Principles of Virology: Molecular Biology, Pathogenesis and control of Animal Viruses by 2nd edition, ASM Press, Washington, DC, 2004
29. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
30. Balows, A., H.G., Dworkin, M., Harder, W.,andSchleifer, K.H. The prokaryotes. Ahand book on the biology of bacteria ecophysilogy, isolation, identification, applications. Volumes I-IV. Springer-Verlag, New York, 1992.
31. Madigan and John M Martinko, Paul V. DunlP, David P. andClark Benjamin Cummings Brock Biology of Microorganisms (12th edition), 2008.
32. H.G. Schlegel. General Microbiology., Cambridge University Pres
33. Johri B.N. Extremophiles. Springer V erlag., New York. 2002.
34. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
35. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997
36. *Addison Wiesley*, New York. Holt JG, Kreg NR, Sneath PHA, Staley JT and Williams ST. Bergey's manual of Determinative Bacteriology, 9th Edtn. Williams and Wilkins, Baltimore.1994
37. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB102
TITLE OF THE COURSE : EUKARYOTIC MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: PHYCOLOGY 13 HOURS

Comparative study of Eukaryotic and Prokaryotic cells and its significance**.** General characteristics of Algae, occurrence, thallus organization, classification, ultra structure of cell, vegetative, asexual and sexual reproduction. Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

MODULE 2: MYCOLOGY 13 HOURS

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, fungal spores – dormancy and dispersal.

Type studies: Aspergillus, Yeast, Pythium, Rhizopus, Fusarium, Puccinia and Agaricus (Classification, Ultrastructure, reproduction, lifecycle, importance)

MODULE 3: FUNGAL PHYSIOLOGY & REPRODUCTION 13 HOURS

Reproduction (asexual and sexual). Fungal growth (yeast cell cycle and growth of hyphae); mechanism of growth in Fungi; measurement and kinetics of growth, nutritional and environmental requirements. Fungal life cycles, mating system and genetic exchange, sex hormones in fungi; physiological specialization, phylogeny of fungi. Saprotrophic, parasitic, aquatic, endophytic, keratinophilic, coprophilous and mutualistic fungi. Economic importance of fungi.

MODULE 3: PROTOZOOLOGY 13HOURS

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Trichomonas,Paramecium, Amoeba, Entamoeba* and *Plasmodium.* Cultivation of protozoa.

REFERENCES:

1. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
2. D.K. Maheshwari. Industrial Exploitation of Microorganisms. I.K. International Publishing House Ltd.NewDelhi.. (2009)
3. JIS Khattar.. Algal Biology and Biotechnology. I.K. International Publishing House Ltd.NewDelhi,(2009)
4. K R Sridhar. Frontiers in Fungal Ecology, Diversity and Metabolites. I.K. International Publishing House Ltd.NewDelhi.(2009)
5. Marjorie Cowan, Kathleen Park Talaro. Microbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.(2009)
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
7. M.K.Sateesh. Comprehensive Biotechnology (Microbiology and Biostatistics). New Age International Publishers, New Delhi-110 002, India. (2007).
8. R.C. Kuhad. Lignocellulose Biotechnology: Future Prospects. I.K. International Publishing House Ltd.NewDelhi.(2007).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi.(2006)
10. A.V.S.S. Sambamurty. A Textbook of Algae. I.K. International Publishing. (2005).
11. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford(2005).
12. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications.(2002).
13. Alexopoulos, C. J. and Mims, C.W.. Introduction to Mycology, Wiley.(2001)
14. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora A.. Recent Advances in the Exploitations of Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2001)
15. Singh, P.K., Dhar, D.W., Pabbi, S., Prasanna R., Arora, ABiofertilizers- Blue Green Algae and Azolla, National Center for Conservation of Blue Green Algae, IARI, New Delhi. (2000).
16. Becker, E.W. Microalgae: Biotechnology and Microbiology, CambridgeUniversity Press.(1994)
17. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (1994).
18. Janet R Stein Phycological methods. Cambridge university press. (1975).
19. Chapman, V.J. and chapman, D.J. The Algae. English language book society & MacMillan(1973).

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB103
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: BIOMOLECULES 13 HOURS

Carbohydrates: Structure of mono, di and polysaccharides, asymmetric centre in sugars, dextro and leavo-rotatory, anomers, epimers, reducing and non-reducing sugars. Oligo saccharides – starch, glycogen and chitin. Complex carbohydrate.

Amino acids and Proteins: Structure of amino acids, classification of amino acids, amino acids as acids and bases, peptide linkage, Classification of proteins, Structural organisation of proteins (primary, secondary, tertiary and quaternary) N-terminal and C-terminal determination.

Lipids: Structure of saturated, unsaturated fatty acids, phospholipids**,** glycolipids and steroids; structure and function of fat soluble vitamins A, D, E and K.

Nucleic acid: Structure of Nucleotides, Nucleosides and Bases, Nucleotide Coenzymes (NAD, Coenzymes A);

MODULE 3: METABOLISM 13 HOURS

Photosynthesis: Photosynthetic pigments, light reactions in eukaryotes, cyanobacteria, green and purple bacteria, process of photosynthesis with special reference to microorganisms.

Fermentation: Alcohol fermentation, Lactic acid: Homo and Heterolactic fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle. Brief account of porphyrins.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. **Bioluminescenc**e – mechanism and significance.

MODULE III: BIOENERGETICS 13 HOURS

Introduction, Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain. Energy production in aerobic and anaerobic organisms: Structure of bacterial and mitochondrial ATPase, Substrate level phosphorylation; Electron transport chain and Oxidative phosphorylation: generation and maintaince of PMF, inhibitors and un-couplers of electron transport system, phosphorylation potential and its importance.

MODULE IV: METABOLITE TRANSPORT AND ENZYMOLOGY 13 HOURS

Metabolite transport: Facilitated diffusion mechanosensitive channels, ATP- binding cassette transport family, chemiosmotic driven transport, ion ingredients, specific transport system: ATP- linked ion motive pumps, histidine permease, iron, phosphorous transferase system.

Microbial stress responses: oxidative, thermal and heat shock response.

Enzymes: Definition, classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit, isozymes, enzymes kinetics; Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters. Principles and mechanism of reversible and irreversible enzyme inhibition, Ribozymes and abzyme.

REFERENCES:

1. Berg Jeremy, Tymoczko John, Stryer Lubert. *Biochemistry* 4th Ed, W. H. Freeman, New York. 2001.
2. Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H. *Outlines of Biochemistry* 5th Ed , John Wiley and Sons, New Delhi.1987.
3. Dawes Edwin A. *Quantitative Problems in Biochemistry*, Churchill Livingston,Edinburgh.1972.
4. Hall D. D. and Rao K. K. *Photosynthesis* 5th Ed., Cambridge University Press.
5. Mandelstam Joel and McQuillen Kenneth (1976) *Biochemistry of Bacterial Growth*, Blackwell Scientific Publication London.1996.
6. Lehninger. Principles of Biochemistry, 3rd edition by Nelson & Cox (Worth) pub.2000.
7. Linda Sherwood and Chris Woolverto. Prescott's Microbiology**, 8th Edition**McGraw-Hill.2011.
8. Metzler David E. *Biochemistry: The chemical Reactions of Living Cells*, Volume 1&2, Academic Press California. 2001.
9. Moat Albert G. and Foster John W. *Microbial Physiology* 2nd Ed. John Wiley and Sons New York.1988.
10. Nelson D. L. and Cox M. M. *Lehninger's Principles of Biochemistry*, Fourth edition, W. H. Freeman & Co. New York. 2005.
11. Palmer Trevor. *Enzymes: Biochemistry, Biotechnology and Clinical chemistry*, Horwood Pub. Co. Chinchester, England. 2001
12. Segel Irvin H. *Biochemical Calculations* 2nd Ed., John Wiley and Sons, New York. 1997.
13. Stanier R. Y., Adelberg E. A., Ingraham J. L.*General Microbiology*, 4th edition, Mac Millan Press, London.
14. Voet Donald and Voet Judith G. *Biochemistry*, 2nd Ed.. John Wiley and sons New York. 1995.
15. White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.1983.

16. White David. *Physiology and Biochemistry of Prokaryotes.* 2nd Ed. Oxford University Press, New York. 2000.
17. Zubay Geoffrey. *Biochemistry*, 4th Ed., W. C. Brown, New York.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB104
TITLE OF THE COURSE : MICROBIAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: MICROBIAL TECHNIQUES 13 HOURS

Microscopy: History and development of microscopes, Principles and concepts of microscopy, Working principles of compound, dark filed, phase contrast, fluorescent, confocal, interference, polarizing, electron microscopy (TEM and SEM) and atomic force microscope; micrometry.

Stains and Staining techniques: Principles, protocols and applications of stains and staining techniques. Simple, differential and vital staining techniques.

Control of microorganisms: Terminologies, principles and applications of sterilization. Physical and chemical methods of control of microorganisms

Pure Culture Techniques: Isolation of pure cultures; serial dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures, fatty acid analysis, Fluorescent in situ hybridization (GISH) genomic in situ hybridization (GISH)

MODULE 2: MICROBIAL CULTURE AND GROWTH TECHNIQUES 13 HOURS

Microbial culture media: Culture media, requirements, types, preparation and uses of different microbial culture media. .

Microbial Growth Measurements: Microbial growth; Concept, growth type, measurement of microbial growth-cell number, turbidity and biomass, determination of microbial growth curve, Continuous and synchronous culture, balanced and unbalanced growth, dioxy-growth curve, aerobic and anaerobic growth.

Microbial culture preservation: Concept, types of microbial culture preservation, type culture collections. Advantages and limitations of culture preservation techniques.

Microbial Safety measures: Concept, safety measures in handling microbiological samples and microorganisms.

MODULE 3: CHROMATOGRAPHY AND ELECTROPHORESIS 13 HOURS

pH and Buffers: Preparation of buffers, Henderson and Hesselbach equation, pka and pkb, pH measurements, electrodes and its types, viscometer and osmometer in relation to molecular size and shape, membrane filtration techniques, Dialysis and its applications.

Chromatography: Introduction, Principle types and application of: paper, thin layer, gel permeation, affinity, ion-exchange chromatography, adsorption chromatography, High pressure liquid chromatography and Gas chromatography.

Electrophoresis: Basic principle and application of Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and native PAGE, Agarose gel electrophoresis, capillary electrophoresis, immune electrophoresis, isoelectric focusing, 2D electrophoresis.

MODULE 4: SPECTROSCOPY AND RADIOISOTOPES 13 HOURS

Spectroscopy and Spectrophotometry: Electromagnetic spectrum, Beer- Lamberts law, Principle and application of UV/VS spectroscopy, IR spectroscopy, ESR and NMR spectroscopy, Fluorescence spectroscopy, Atomic absorption spectroscopy, Raman spectroscopy, Mass spectroscopy, circular dichroism, XRD, Microarray.

Radio-isotopes detection and measurements: Nature and types of radiations, stable and unstable isotopes, labelling of biological samples, tracer technique, detection and measurement of radioactivity by Dosimetry, Ionisation chamber, GM counter, Photographic method, Scintillation counter, Autoradiography. Handling methods and safety, non-radioactive labelling.

REFERENCES:

1. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
2. Ackerman, E. I. Biophysical Science. Prentice Hall Inc. NJ, USA. 1962
3. Alonso, A., and Arrondo, J.L.R. Advanced Techniques in Biophysics.Springer,UK.2006
4. An Introduction to Practical Biochemistry: Plummer D. T.
5. Analytical Chemistry: Christion G. D.
6. Arora, M. P. Biophysics. Himalaya Publishing House, New Delhi. 2007
7. Biochemical Techniques theory and practice : White R
8. Biophysical techniques : Principles and techniques Upadhaya and Upadhaya
9. Das, D. Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.1991.
10. Edward, A.L. Radiation Biophysics. Academic Press, NY, USA.1997.
11. Gupta A. Instrumentation and Bio-Analytical Techniques. Pragati Prakashan, Meerut.2009.
12. Hoope, W. et.al. Biophysics. Springer Verlag, Berlin.1983.
13. Narayanan, P. Essentials of Biophysics. New Age International (P) Ltd. Publishers, New Delhi.2002.
14. Nuclear Magnetic Resonance: Williams
15. Roy, R.N. A Textbook of Biophysics. New Central Book Agency (P) Ltd. Calcutta.1996.
16. Srivastava, P.K. Elementary Biophysics. An Introduction. Narosa Publishing House, New Delhi.2006.

SEMESTER/YEAR : I SEM
COURSE CODE : 17MBT105
TITLE OF THE COURSE : BIOSTATISTICS (SOFT CORE)
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I- MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION 13HOURS

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution.

Measures of Central tendency: Arithmetic mean, mode & median.

Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error

Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance.

Sampling methods and their significance.

MODULE II-PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS 13HOURS

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical.

Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value.

Statistical package- Features of statistical software, SPSS for various applications in Bio-statistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press,Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **17MMB171**
TITLE OF THE COURSE : **GENERAL MICROBIOLOGY AND EUKARYOTIC MICROBIOLOGY**
L: T/A: P: C : **0: 0: 8: 4**

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources: Serial dilution and Pure culture techniques.
3. Staining- simple, differential, acid fast, endo spore, capsule, flagella, vital, cell wall and nuclear staining.
4. Determination of bacterial motility by hanging drop method.
5. Determination of microbial size by micrometry
6. Enumeration of microorganisms by haemocytometer.
7. Determination of bacterial growth curve by turbidometry and plate count.
8. Isolation of bacteriophages from sewage.
9. Isolation and identification of fungi from soil: Dilution plate method, Warcup method, stamping method.
10. Isolation of fungi from plant material: Epibiotic fungi, washing method, implant method, impression method, maceration method; endophytic fungi.
11. Growth measurement of fungi- linear and biomass.
12. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast,Mucor, Rhizopus, Agaricus, Puccinia,*
13. Isolation and identification of microscopic algae from soil and water
14. Study of algae (permanent slides): Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria, Rivularia,
15. Isolation and identification of protozoans from soil and water.
16. Study of Protozoa (permanent slides): Euglena, Plasmodium, Paramecium, Amoeba,

SEMESTER/YEAR : I SEM
COURSE CODE : 17MMB172
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND BIOCHEMISTRY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Biochemical tests for identification of bacteria:
   Catalase, Oxidase, IMViC, Gelatin hydrolysis, Hydrogen sulfide production in TSIA , Coagulase, Nitrate Reduction test, Sugar Fermentation test, Casein hydrolysis and Starch hydrolysis. Identification of bacteria by API system. (6 units)
2. Preparation of standard buffers and determination of pH of a solution.
3. Qualitative analysis of proteins.
4. Qualitative analysis of carbohydrates.
5. Quantitative estimation of glucose by DNS method
6. Quantitative estimation of reducing sugars by Benedict's method.
7. Quantitative estimation of protein by Lowry's/ Bradford method.
8. Quantitative estimation of amino acids by ninhydrin method.
9. Study of enzyme kinetics, Km and Vmax of amylase.
10. Separation of amino acids by paper / thin layer chromatography.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB201
TITLE OF THE COURSE : MICROBIAL GENETICS
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: GENOME ORGANIZATION 13 HOURS

Basic Genetics: Principles of heredity, Mendelian principles, DNA & RNA as genetic material, features of prokaryotic and eukaryotic genes, overlapping gene. Transposable elements in bacteria and yeast.

Prokaryotic Genome: Organization of prokaryotic genome, Study of *E. coli* genome.

Eukaryotic Genome: Organization and structure of eukaryotic genome, pseudogenes. Repetitive DNA sequence. C value paradox and genome size. Structure of eukaryotic chromosome, centromere, telomere, secondary constriction, banding patterns.

Organelle genome: Mitochondrial-DNA, Chloroplast-DNA.

MODULE 2: GENETIC RECOMBINATION 13 HOURS

Gene Transfer Mechanism: Bacterial transformation; host cell restriction; Plasmids, F-factor- importance and role in genetic analysis, Col factors, R plasmid. Transduction, conjugation, mechanisms and applications. Mechanisms of genetic recombination in bacteria and fungi (Holiday Model).

Bacteriophages: Life cycle of bacteriophage- lytic and lysogenic cycles, life cycle of lambda and M13.

MODULE 3: MUTATIONS AND DNA REPAIR 13 HOURS

Mutation and mutagenesis: Nature, type and effects, of mutations. Spontaneous Mutations, Mutagenesis – physical and chemical mutagens. Site directed mutagenesis. Ames Test

Repair mechanisms: direct reversal of damage, excision repair, mis-match repair, post-replication repair.

Applications of mutations in microbiology

MODULE 4: LINKAGE AND GENETIC MAPPING 13 HOURS

Linkage and linked genes, calculation of recombination frequency, genetic mapping with recombination frequency. Construction of genetic maps with two point test cross. Gene mapping using conjugation and transformation. Importance of Neurospora in fungal genetics.

REFERENCES:

1) Stanly R Maloy, David Freifelder- Microbial Genetics 2nd edition
2) George M Malacinski- Molecular Biology
3) Prescott, Harley- microbiology 6th edition
4) Uldis N. Streips, Ronald E. Yasbin- Modern Microbial Genetics 6th edition
5) Introduction to Genetics- Simmons and Snustad 7th edition
6) Keya Chaudhary- Microbial Genetics

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52 HOURS

MODULE I DNA REPLICATION AND REPAIR 13HOURS

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.

Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE II GENE EXPRESSION – TRANSCRIPTION 13HOURS

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE IIIGENE EXPRESSION – TRANSLATION 13HOURS

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino Acids. Mechanism of translation in Prokaryotes and

Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE IV REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES 13HOURS

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control.

Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4 th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J{1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4 edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB203
TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL CREDIT HOURS: 52 HOURS

MODULE 1: SOIL MICROBIOLOGY 13HOURS

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (The rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health; Isolation of soil viruses; Genetic exchange between communities; Biogeochemical cycles-Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE 2: AQUATIC BIOLOGY AND SEWAGE TREATMENT 13 HOURS

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE 3: AEROBIOLOGY 13 HOURS

Aerobiology: Air spora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Green house effect, Ozone depletion , UV radiation and Acid rain. Aeroallergens and Allergies: Causes andtests for detection of aero allergens.

MODULE 4: BIOLEACHING AND BIODEGRADATION 13HOURS

Bioleaching- Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution**.**

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose and lignin paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water 'insitu' remediation- Engineering developments - Construted wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

REFERENCES:

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB204
TITLE OF THE COURSE : FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

TOTAL HOURS: 52 HOURS

MODULE 1: SCOPE OF FOOD MICROBIOLOGY AND FOOD PRESERVATION 13 HOURS

Scope of food microbiology: Development of food microbiology as a science, scope of food microbiology. Food as a substrate for microorganisms; intrinsic and extrinsic factors affecting the growth of microbes. microorganisms in food and their source.
Principles of Food preservation: Principles of preservation (Asepsis, Removal, Anaerobic conditions). Methods of food preservation (High temperature, Low temperature, irradiation, Drying and Food Additives), Chemical method of Food preservation (Class I and Class II Preservatives). D, Z and F values; Biopreservation, Food Packaging and benefits.

MODULE 2: PRINCIPLES OF FOOD SPOILAGE AND ILLNESS 13 HOURS

Microbial spoilage of food: Causes and sources of food spoilage, Spoilage of Vegetables, fruits, cereals, sugar products, meat and meat products, fish, poultry, canned products and miscellaneous foods. Methods for microbial examination of foods: indicator organisms,direct examination, cultural techniques, enumeration methods and molecular methods.

Foodborne Illness: Food borne Infections and Intoxications. Bacteria –*Clostridium, Bacillus, Brucella, Escherichia, Listeria, Campylobacter, Staphylococci, Salmonella, Shigella, Yersinia*. Virus- Hepatitis A and E, rota viruses, toxigenic algae, Rickettsia, Various parasites, Sea toxicants; Poisoning by chemicals; Mycotoxins (Aflotoxins, Ochratoxins, Fuminosins, Trichothecenes, Zealenone, Ergot alkaloids); Recent methods in detection of food pathogens.

MODULE 3: FERMENTED FOODS AND FOOD REGULATIONS 13 HOURS
Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread, Idli, Nutritional and therapeutic importance, Single cell Protein (Bacteria, Yeast, Algae); Probiotics and Synbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production).

Food Sanitation and Food control Agencies: HACCP, Employees Health standards, GMP, Plant sanitation, Waste treatment, Disposal, Criteria of microbiological quality control. Food control agencies and their regulations.

MODULE 4: DAIRY MICROBIOLOGY: 13 HOURS
Nutritional level of milk, microbial flora of milk, sources of milk contamination

Bacteriology of milk: Incidence and characterization of pathogenic microorganisms in milk, bacteriological aspects of pasteurization, sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk supplies and their importance; heat resistant bacteria in milk and their role in milk spoilage; use of detergents and sanitizers in the cleaning and sanitation of dairy equipment's; principles of quality control tests for milk; bacteriological grading, market milk production and public health control.

Microbiology of dairy products: Microbiology of cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products; use of rennet and microbial rennet substitutes in cheese making. Quality standards of milk products.

Advances in Food and Dairy Microbiology: Biosensors in Food Industry; Genetically modified foods; Food fortification; Food parks.

REFERENCES

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. Mc Graw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van Nostrand Rheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB205
TITLE OF THE COURSE : BIOINFORMATICS
L: T/A: P: C : 2: 0: 0: 2

TOTAL HOURS: 26 HOURS

MODULE I COMPUTER NETWORK AND PROGRAMMING LANGUAGES 8HOURS

Introduction to Computer: Computer soft wares- operating system- Windows, UNIX, Linux, Application software- word processor, spread sheet. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases - sequence, structure, non-redundant
Computer Network: Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL.
Network Security- Group polices Fire-walls.
Programming Languages: Introduction to programming languages - C and PERL

MODULE II BIOLOGICAL DATABASES AND THEIR APPLICATIONS 10HOURS

Introduction - Relational Databases Management (RDMS) - Oracle, SQL, Database generation.
Data mining and applications, accessing bibliographic databases- Pubmed, Nucleic acid sequence databank – NCBI and EMBL. Protein sequence databank- NBRF- PIR, SWISSPROT Structural databases - protein data Bank (PDB) & UniProt
Metabolic pathway data bank (Pub gene), Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER,
Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids and protein sequences, Identification of ORFs, Identification of motifs

MODULE III PROTEIN STRUCTURE AND MOLECULAR INTERACTION 8HOURS

Introduction to protein structure – secondary structure prediction, tertiary structure prediction, protein modeling- principles of homology and comparative modeling phylogenetics; Structure prediction methods – high-accuracy, and template based, free modeling (new folds); Secondary structure prediction; Pattern recognition – PSSMs, weight matrices; hidden Markov models Threading, structure evaluation and validation and *ab intio* Modeling Applications - Molecular docking - Autodoc

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.
9. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
10. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
11. Programming Python by M.Lutz, O'Reilly media, 2011, 4th edition.
12. Learning Perl by R.L.Schwartz, B.D.Foy, T.Phoenix, O'Reilly meida, 2011, 6th edition.
13. The C++ programming language, by B. Stroustrup, Addison-Wesley professional publishers, 2013, 4th edition.
14. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81
15. Mangan ME, et al. The UCSC Genome Browser: What Every Molecular Biologist Should Know. Curr Protoc Mol Biol. 2014 Jul 1; 107:19.

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB271
TITLE OF THE COURSE : MICROBIAL GENETICS AND MOLECULAR BIOLOGY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Qunatification of DNA by colorimetry/ spectrophotometry
2. Qunatification of RNA by colorimetry/ spectrophotometry
3. Conjugation in *E. Coli*
4. Transformation in *E.coli*
5. Antibiotic resitant mutant isolation by gradient plate technique
6. Isolation and electrophoretic analysis of genomic DNA
7. Isolation and electrophoretic analysis of plasmid DNA
8. Isolation and electrophoretic analysis of RNA
9. Identification of lytic and lysogenic cycles in bacteriophage
10. Induction and assay of β -galactosidase
11. Study of replica plating techniques.
12. Mutagenesis: Identification and isolation of fungal mutants [physical (UV)].
13. Genetics problems.
14. Protoplast fusion (Demonstration)

SEMESTER/YEAR : II SEM
COURSE CODE : 17MMB272
TITLE OF THE COURSE : ENVIRONMENTAL, FOOD AND DAIRY MICROBIOLOGY
L: T/A: P: C : 0: 0: 8: 4

PRACTICALS

1. Quantification of microorganisms in air.
2. Study of microbial interactions in soil (antagonism)
3. Detection and Estimation of Protein and Polysaccharide in Biofilm.
4. Isolation and characterization of Iron, Manganese and Methanogenic bacteria.
5. Detection of Metal tolerance in microorganisms.
6. Isolation of xenobiotic degrading organisms and estimation of chloride
7. Detection of coliform in water (MPN test)
8. Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)
9. Study of Bacteriocin.
10. Study of antimicrobial activity of chemical preservative.
11. Quality test of Fermented Food.
12. Production and estimation of lactic acid by *Lactobacillus* sp.
13. Isolation of food poisoning bacteria from contaminated foods and dairy products
14. Detection of Aflotoxin production (*Aspergillus flavus)*
15. Quality test of milk – Platform and Dye reduction test

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB301
TITLE OF THE COURSE : MEDICAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours: 52 Hours

Module 1: Host Microbe Relationship and Epidemiology 13hours

Normal microbial flora of human body and its significance, tissue tropism.Contamination, Infection and Disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infections, nosocomial infections and non-infectious diseases.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxins.G protein signalling, spreading, tissue damage and antiphagocytic factors.Specific and non specific host defense.Quorum sensing.

Epidemiology-Diseases in population, epidemiological studies,epidemics of emerging and re-emerging diseases,reservoirs of infection, modes of disease transmission, herd Immunity and public health organizations.

Module 2- Bacterial, Fungal and protozoan diseases 13hours

Study of diseases - Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following

Bacterial diseases: *Streptococcus, Staphylococcus, Shigella, Salmonella, Neisseria, Corynebacteria, Vibrio, Yersinia, Haemophilus, Helicobacter, Mycobacterium, Spirochetes-Treponema, Chlamydiae, Mycoplasma.*

Protozoan and Helminthic diseases- *E. histolytica*, *Plasmodium*, *Leishmania,Filaria* and tape worm.

Fungal diseases- Dermatomycosis, Subcutaneous mycosis, Systemic mycosis and Opportunistic mycoses.

Module 3- Viral diseases13hours Etiology, Epidemiology, Pathogenicity, Diagnosis, and Prophylaxis of the following.Viral Diseases- Pox virus, Herpes virus, Varicella-zoster, Adenovirus, Picornavirus, Orthomyxoviruses (influenza), Paramyxovirus (mumps and Measels), Rhabdovirus, Hepatitis viruses, Oncogenic virus, Retrovirus, Arbovirus.

Prion infection.

Module 4- Antimicrobial Prophylaxis and Diagnostic Microbiology. 13hours

Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and antiprotozoans. Methods of testing

drug sensitivity, antibiotic assay in body fluids, drug resistance – causes, mechanism and prevention.Probiotics as therapeutic agents.Brief account of vaccine- Conventional vaccines, Subunit vaccines and DNA vaccines. Immunization schedules. Passive prophylactic measures and Interferons. Principles and applications of Immunological and PCR based diagnostic methods.

Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.

References-

1. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
2. Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), Microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virologya text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical micrbiology. Vol2, practical medical microbiology, Churchill Livingstone.
9. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
14. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
15. Warren Levinson (2000) Medical Microbiology and Immunolog: Examination and Board Review 8th Edition. McGraw Hill.
16. Warren Levinson (2000) Medical Microbiologyandimmunolog examination and board review (8th edition) McGraw Hill.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB302
TITLE OF THE COURSE : IMMUNOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Immune System 13hours

Innate,adaptive, humoral and cellular immunity; structure and functions of immune cells - T cells, B cells, macrophages, NK cells and dendritic cells, granulocytes, mast cells. Primary and secondary lymphoid organs; Clonal selection theory; Immunological memory; Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Antibody production: Polyclonal and monoclonal, Complement system – component, properties and functions. Complement pathwaysand biological significance.

Module II: Immune Responses 13hours

Primary and secondary immune responses, lymphocyte migration, homing and trafficking, immunoglobulin genes: organization and assembly; generation of immunological diversity; Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules; HLA response; T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) and chemokines; B & T cell development and regulation, B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing.

Module III: Immune-Mediated Diseases and Transplantation 13hours

Autoimmune diseases- Insulin dependent diabetic mellitus, Systemic lupus erythematosus, Rheumatid arthritis, Myasthenia gravis and their treatment; Immune response to infectious diseases; viral, bacterial and protozoal infections; H1N1; immune response to cancer; hypersensitivity reactions - types (I, II, III, and IV), symptoms, immunodiagnosis. Tissue transplantation-Tissue typing methods for tissue and organ transplantations, Graft versus host reaction and rejection, xenotransplantation, tolerance.

Module IV: Immunological Techniques and Vaccines 13hours

Immunoprecipitation; Agglutination; Immunoelectrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA Western blotting; Hybridomas and their production.

Vaccines: Active and passive immunization, Immunization protocol. conventional vaccines-live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. novel vaccines-subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, small pox, DPT, polio, measles, Hepatitis-B.

REFERENCES:

1. Abbas &Lichtman&Pillai (2014) Cellular and Molecular immunology,8th edition, Elsevier publisher
2. Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.
3. C.VamanRao.(2012), An Introduction to Immunology. 2nd edition , Narosa publishing house
4. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
5. K.M.Pavri. 1996, Challenge of AIDS, 2nd edition, National Book Trust, India.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. NY .

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB303
TITLE OF THE COURSE : INDUSTRIAL MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

Total Credit Hours – 52 hours

Module I: Introduction to Industrial Microbiology 13hours

Concepts and scope of microbes in industry.Modern era of industrial fermentation technology. Pre-requisite of industrial microorganisms: Screening, isolation, identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Module II: Fermentation Process 13hours

Basic components, design and scale-up of fermenters – Typical fermentor. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Microbial growth in batch fermentor and chemostat.Other types like surface, submerged and solid state fermentation.Different parameters affecting fermentation - pH, temperature, dissolved oxygen, foaming and aeration.

Module III: Upstream and Downstream Processing 13hours

Upstream processing: Formulation of fermentation media, rheology of fermentation media, Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development.

Downstream processing: Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid-Liquid extraction, Solvent recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing. Effluent treatment.

Module IV: Industrial Bioprocessing 13hours

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product:

Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin). Applications of genetic engineering in industrial bioprocessing.
Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

REFERENCES:

1. Bailey and Ollis (1996) "Biochemical Engineering Fundamentals", McGraw Hill(2nd Ed.).
2. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
3. Dubey, R.C. (2006) "A Textbook of Biotechnology" S.Chand and Co. Ltd.
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
6. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication
7. Satyanarayana, U (2005). "Biotechnology" Books and Allied (P) Ltd. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
8. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
9. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology-An Introduction, Blackwell Science. Delhi
10. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB305
TITLE OF THE COURSE : ECOLOGY AND DEVELOPMENTAL BIOLOGY
L: T/A: P: C : 2: 0: 0: 2

Total Credit Hours: 26 Hours

Module 1: Ecology and Ecosystem 13 Hours

Ecology: Environment; biotic and abiotic interactions, Concept of habitat and niche; Characteristics of a population; population growth curves; Types of species interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis, community ecology.

Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.global environmental change; biodiversity-status, monitoring and documentation; biodiversity management approaches.

Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Module 2: Developmental Biology 13 hours

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB321
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 1)

Total Credit Hours – 52 hours

Module I: Basic Concepts 13hours

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors 13hours

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning Strategies and study of protein-DNA interactions 13hours

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNaseIfootprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 13hours

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing)

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin (1999) Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops.WileyDreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression: From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulation Publications.(6th Ed.).Black well publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen, set. OUP.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB322
TITLE OF THE COURSE : APPLIED MICROBIOLOGY
L: T/A: P: C : 4: 1: 0: 5

(Departmental Elective - 2)

Total credit hours: 52hours

Module 1: Food and Dairy Microbiology 13 hours

Food as a substrate for microorganisms, spoilage of fruits, vegetables, meats and dairy products.Food preservation, examination, standards for food and milk production. Microbial and Fermented foods- fermented vegetables, meats, beverage and dairy products. Probiotics, prebiotics, synbiotics and neutraceuticals.Quality control and their regulation, HACCP.

Module 2- Environmental Microbiology 13hours

Aerobiology- Significance of microorganisms in air, air spora in different layers of atmosphere, bioaerosol. Microbiology of indoor and outdoor environment. Air samplers and control of air borne microorganisms.

Aquatic Microbiology- Natural waters, microbial flora of aquatic environment, pollution and water borne diseases. Municipal treatment of drinking and waste water. Water quality assays and public health.

SoilMicrobiology-Soil profile, soil microorganisms, microbial interactions in soil. Bioaccumulation, biomagnification biodegradation and bioremediation,.Bioleaching of Minerals.

Module 3: Industrial and Agricultural Microbiology 13hours

Industrial Microbiology – Industrially important microorganisms, preservation and strain improvement, design and types of fermenters, upstream and downstream processing, production of beverages, antibiotics, organic acids, and enzymes .

Agricultural Microbiology- Concepts and scope of agricultural microbiology, biofertilizers and biopesticides. Plant diseases, plant defence mechanisms and disease control.

Module 4- Clinical Microbiology and Microbial Biotechnology 13hours

Clinical Microbiology- Disease epidemics, Role of Microbiologist in diagnostic laboratory, General concepts for specimen collection, handling, processing, laboratory safety and infection control. Disease diagnosis - Microscopic examination, growth and biochemical characteristics, rapid methods of identification.

Microbial Biotechnology: Introduction to microbial biotechnology, applications of microbial biotechnology in the field of medicine, industry, agriculture and environment.

References

1. Alexander M (2000) Introduction to soil microbiology, John Wiley and Sons Inc. N.Y.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009
4. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
5. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
6. Credric A. Mims (2004) Medical Microbiology 3rd edition Mostly Inc.
7. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
8. Fritz H. Kayser (2005) .medical microbiology, TR hiemeVerlag.
9. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
10. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. James M.J Martin, J. Loessner and David, A.G. (2006) Modern food microbiology (7thEds)
13. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
14. Microbiology by MJ PelczarJr, ECS Chan, NR Krieg 5th edition, Pub: Tata Megra Hill Publising Co Ltd.
15. Norman G Marriott, (1995). Principles of Food Sanitation, 4th Edition, (Chapman and Hall Food Science Book). Aspen Publishers Inc.
16. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
17. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
18. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
19. T.J Montville and K Wikowski, Ic: M.P., Doyle, L.R. Beuchat and T.J., Montville, (Eds). 1997. Fundamentals and Frontiers. ASM Press, Washington DC.

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB371
TITLE OF THE COURSE : MEDICAL MICROBIOLOGY AND IMMUNOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Effect of antiseptics on normal microbial flora of hands.
3. Dental caries susceptibility assay by Snyder's agar test
4. Isolation and identification of fungal infections (skin, nail and hair sample).
5. Isolation and identification of nosocomial pathogens
6. Study of blood smear by Giemsa's/ Leishman's staining technique.
7. Study of *M. tuberculosis* by Ziehl-Neelsen (acid fast) staining .
8. Determination of MIC - T- test, Checker board method.
9. Drug susceptibility assay for susceptibility and resistance of antibiotics by Kirby-Bauer method.
10. Isolation of lymphocytes from peripheral blood
11. Serum separation and serological reactions:
    a. Agglutination - Blood grouping and Rh typing
    b. Precipitation reactions:
        i. Ouchtlerlony Double Diffusion,
        ii. Radial Immune Diffusion
        iii. Rocket Immuno electrophoresis
12. Enzyme linked immunosorbant assay / Dot ELISA
13. Purification of IgG by column chromatography
14. WIDAL Test.
15. VDRL Test (RPR).

SEMESTER/YEAR : III SEM
COURSE CODE : 17MMB372
TITLE OF THE COURSE : INDUSTRIAL MICROBIOLOGY
L: T/A: P: C : 0: 0: 8: 4

(PRACTICALS)

1. Demonstration of a fermenter and its types.
2. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilisation.
3. Production and estimation of amylase from microbial sources.
4. Production of organic acids(lactic acid and citric acid) from microbes.
5. Immobilization technique: whole cell or enzyme- sodium alginate gel method.
6. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
7. Laboratory scale production of wine.
8. Estimation of alcohol from different sources by specific gravity method.
9. Alcoholic fermentation and determination of total acidity and non-reducing sugars
10. Detection and quantification of pigment from microbes: Melanin.
11. Detection and quantification siderophore produced by *Pseudomonas* spp.
12. Microbial assay of vitamin B12 and Glutamic acid
13. Sterility tests for pharmaceutical products

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB401
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND HYTOPATHOLOGY
L: T/A: P: C : 4:1: 0:5

Total Credit Hours – 52 hours

Module I: Plant-Microbe Interactions 13hours

Distribution of microorganisms in soil, Soil fertility evaluation and improvement.Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum). Concepts of Siderophores and VAM with suitable examples.Application of nitrogen fixing genes in rDNA technology in agriculture research.

Module II: Bioinoculants And Biological Control 13hours

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- Azotobacter, Rhizobium, Azospirillum, Cyanobacteria, phosphate solubilising microorganisms, Azolla. Carrier-based inoculants – production, applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes Pseudomonas fluroscence, Bacillus thuringiensis, Trichodermaharzianum, Trichodermaviridae, Nuclear Polyhedrosis Virus. Production, applications and limitations.

Module III: Host Pathogen Interaction And Defense Mechanism 13hours

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Kochs' postulates. Parasitism and disease development: Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle / Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant – Mechanical forces, Microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defenses (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, plantibodies

Module IV: Plant Diseases And Their Management 13hours

Plant diseases- Red rust of tea and Algal Leaf Spot (Algae), Grain and head smut of Sorghum, tikka disease of ground nuts, red rot of sugarcane and wilt of tomato (Fungi), Root knot of mulberry and lesion nematode disease (Nematode). Tobacco mosaic disease and Papaya

ring spot (Virus), Sandal Spike Disease and grassy shoot of sugarcane (Mycoplasma), Bacterial blight of Paddy, Citrus canker and fire blight of apple (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept.Diagnosis of plant diseases, regulatory, farming education and awareness.

References

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.

17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB421
TITLE OF THE COURSE : CLINICAL MICROBIOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 1)

Total Credit hours: 52 hours

Module 1- Host Pathogen interaction and disease epidemics 13hours

Normal microbial flora of human body and its significance, infection and disease.Pathogens, pathogenicity and virulence.Koch's Postulates.Infectious and Non infectious diseases.Emerging and remerging pathogens.Entry of pathogen into human host, portals of entry.Mechanism of microbial adhesion, colonization and invasion of mucous membranes of respiratory, enteric and urinogenital tracts.Exotoxins and Endotoxin. Epidemiology-Diseases in population, epidemiological studies, reservoirs of infection, modes of disease transmission, herd immunity and public health organizations.

Module 2: Infectious Diseases of Human Organ Systems 13hours

Etiology, Epidemiology, Pathogenicity, Diagnosis, and prophylaxis of the following diseases of the skin and eyes, urogenital diseases, disease of respiratory systems, oral & gastrointestinal diseases and wound infections. Cardiovascular, lymphatic diseases,zoonoses and vector transmission of human disease.Air, food and waterborne disease transmission.Immunization, Antimicrobial chemotherapy and drug resistance.

Module-3- Hospital acquired Infections (Nosocomial Infections) 13hours

Common types of hospital infection, diagnosis and control of hospital infection. Prevention of common hospital acquired infections, maintenance of hospital, surroundings and intravascular & indwelling devices. Role of the healthcare staff in infection control, restrictions in hospitals.Needle Stick Injury, vaccination of healthcare workers.Biosafety in biological laboratories.

Module 4- Diagnosis and Biomedical waste management. 13hours

Collection, transport, processing and storage of biological specimens.Care and handling of pathogens, biological materials and disposal.Laboratory Diagnosis of Infectious Diseases-bacterial, parasitic, viral and fungal diseases. Principles and applications of microscopic, microbiological, biochemical, immunological and molecular diagnostic methods.Recent advancements in disease diagnosis – scanning techniques and rapid identification systems.Regulations and accreditation of medical laboratories.Biomedical Waste, classification, types and treatment.

References-

1. Ananthanarayan and Panikar, Textbook of Microbiology for Nurses, University Press.
2. Brock T.D and Madigan M.T. (1992) Biology of Microorgansims 6th edition. Prentice Hall, Eagle wood cliffs N.J.
3. Fritz H. Kayser (2005), Medical Microbiology. ThiemeVerlag.
4. Jacquelyn G. Black, Larry M.L Lewis (2009). Microbiology, Principles and Exploration6th Edition Wiley, John and Sons.
5. Jenson, Wright, Robinson (1997), microbiology for the Health Sciences 4th edition, Prentice hall.
6. Kufe, etal., (2003), Cancer Medicine, BC Decker Inc.
7. Leslic Collier, John Oxford (2000). Human virology a text book for students of medicine, dentistry and microbiology (2nd edition). Oxford University Press.
8. Mackie amdMcCarthey (1996) Medical microbiology vol 1, Medical infection. Vol 2, practical medical microbiology, Churchil Livingstone.
9. Mackie amdMcCarthey (1996) Medical Microbiology. Vol2, practical medical microbiology, Churchill Livingstone.
10. Madigan, Martinko, Dunlap, Clark. (2009). Brock Biology of Microorganisms, Twelth Edition, Benjamin Cummings.
11. Marjorie Cowan, Kathleen Park Talaro(2009). Micrbiology: A Systems Approach. 2nd Edition. The McGraw/Hill.
12. Nester, Roberts, Pearsall Anderson (1998). Microbiology-A Human Perspective, 2nd edition, McGraw-Hill.
13. R Connie R Mahon (2010). Textbook of Diagnostic Microbiology. 3rd edition. Pearson.
14. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesy, Gary Sayler (1998) Techniques in Microbial Ecology, Oxford University Press. New York.
15. Wadher and Bhoosreddy (2005) Medical microbiology. Himalaya Publisher.
16. Warren Levinson (2000) Medical Microbiology and immunolog examination and board review (8th edition) McGraw Hill.
17. Warren Levinson (2000) Medical Microbiology and Immunology: Examination and Board Review 8th Edition. McGraw Hill.

SEMESTER/YEAR : IV SEM
COURSE CODE : 17MMB422
TITLE OF THE COURSE : MICROBIAL BIOTECHNOLOGY
L: T/A: P: C : 4:1: 0:5

(Inter Departmental Elective - 2)

Total Credit Hours – 52 hours

Module 1: History and Advancements in Microbial Biotechnology 13 hours

Introduction to microbial biotechnology, principle, applications, economics and milestones in microbial technology.Manipulation of gene expression in prokaryotes – use of strong and regulatable promoters, fusion proteins, unidirectional tandem gene arrays. Recombinant protein production in eukaryotes – *S. cerevisiae* expression systems, Baculo virus expression vector system, mammalian cell expression vectors. Directed mutagenesis and protein engineering.

Module 2: Applications of Microbial Biotechnology –I 13 hours

Molecular Diagnostics: Immunological diagnostics, monoclonal antibodies, DNA diagnostic systems – diagnosis of Malaria, *Trypanosomacruzi*, molecular diagnosis of genetic diseases – Sickle cell anemia.

Microbial Production of Therapeutic Agents: Interferons, human growth hormone, antibody production in *E. coli*. Vaccines: peptide vaccines, vector vaccines. Antibiotics: Polyketide antibiotics. Single cell proteins.

Module 3: Applications of Microbial Biotechnology –II 13 hours

Biosynthesis of biopolymers: Xanthan gum, animal adhesive biopolymers, rubber, polyhydroxyalkonates. Bioremediation and Biomass utilization: Degradation of xenobiotics, utilization of starch and cellulose. Plant growth promotion: Nitrogen fixation, nitrogenase, nodulation, biocontrol: siderophores, ice nucleation and antifreeze proteins. Microbial insecticides: *B. thuringiensis* and *Baculoviruses.* Brief account on transgenic plants, transgenic animals and human gene therapy

Module 4: Nanotechnology, Bioethics and Biosafety 13 hours

Introduction, tools of nanosciences, synthesis of nanomaterials using microbes. Biopolymeric nanoparticles; nanosensors, biomedical applications, antimicrobial nanoparticles.

Introduction to Bioethics and biosafety, yeast genome project: its ethical, legal and social implications. Biosafety guidelines and regulations for Genetically Modified Microroganismss, GLP and GMP.Labelling of GM products.Ethics and safety of GM food.

References:

1. Anthony JF Griffiths, William M Gelbart, Jeffrey H Miller, and Richard C Lewontin(1999) Modern Genetic Analysis (1st Ed.)W. H. Freeman Publishers.NY. application of recombinant DNA. ASM Press.
2. Benjamin Lewis, (2004) Genes VIII (3rd Ed.) Oxford University & Cell Press,NY.
3. Bernard, R.G. and Jack, J.P. (2003). Molecular Biotechnology: principles and
4. Brown T.A. (2009). Genome 3. Tylor and Francis.
5. Genetically Modified Crops.WileyDreamtech India.
6. Glick B.R and Pasternak J.J. (2010), Molecular Biotechnology: Principles andApplications of Recombinant DNA. ASM Press.
7. Glover D.M and Hames. B.D, (1996), DNA Cloning. A Practical Approach. 4-volume
8. Howe C. (1995). Gene Cloning and Manipulation. Cambridge University Press.
9. K., Adrian, M. and John W. (2000). Recombinant DNA and Biotechnology.
10. Nigel Halford. (2006). Plant Biotechnology: Current and Future Applications of
11. Old and Primrose. (1994). Principles of Gene Manipulation, Blackwell Scientific
12. Pierre Baldi G, Wesley Hatfield, (2002). DNA Microarrays and Gene Expression:From Experiments to Data Analysis and Modelling. Cambridge University Press.
13. Primrose, S. B. Twyman, P.M. and Old, R. W. (2001) Principles of gene manipulationPublications.(6th Ed.).Black well publishers.
14. Sambrose and Russell. (2001), Molecular Cloning. 3 volumes. CSH Lab Pres. Hellen,set. OUP.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(1996).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (1992)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (1977).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (1964).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid

peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three- kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of

heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 1996.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling- principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods forenvironmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MBC5201
TITLE OF THE COURSE : METABOLISM – I
L: T: P: S/P : C : 4: 0: 0: 0 : 4

MODULE I: Carbohydrate metabolism 13hrs

Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle-scheme; Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins

MODULE 2:Disorders of Carbohydrate metabolism 13hrs

Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves, and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria.Introduction to metabolomics.

MODULE 3:Amino acids and peptides 13 hrs

General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Synthesis of porphyrin rings and their breakdown into billirubin. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.

MODULE 4: Metabolism of standard amino acids 13 hrs

Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism

REFERENCES:

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(1999).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).

3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5thEd. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER/YEAR : II SEM
COURSE CODE : 19MBC5202
TITLE OF THE COURSE : HUMAN PHYSIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Tissue level of organization: 8hrs

Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues.

The muscular system: 5hrs

Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism.

MODULE 2: 13hrs

Nervous system: 8hrs

Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin

Endocrine system: 5hrs

Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D.

MODULE 3: 13hrs

Cardiovascular system: 8hrs

functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms,

Disorders of clotting. Systemic and pulmonary circulations, coronary circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center.

Respiratory system: **5hrs**

Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.

MODULE 4: **13hrs**

Digestive system: **7hrs**

Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomachand intestine. Absorption of food

The urinary system: **6hrs**

Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones.

REFERENCES:

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)
2. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (1997).
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed.Macmillan Publications (2012).
5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (1995).
6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).
7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (1997)
8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (1998)
9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (1991).
10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (1983).
11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill,(1986).
12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis,

transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J (1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. ScientificAmerican Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **19MSC5202**
TITLE OF THE COURSE : **ANALYTICAL TECHNIQUES**

L: T: P: S/P : C : **4: 0: 0: 0 : 4**

Total Hours: 52

MODULE 1: **13hrs**

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.
Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: **13hrs**

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.
Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: **13hrs**

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC
Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: **13hrs**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.
Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (1998). Bioinformatics.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology

4. Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

Semester/Year : II Sem
Course Code : 19MBC5271
Title of the Course : CLINICAL BIOCHEMISTRY - LAB
L:T:P:C : 0:0:6:3

1. Estimation of sugar from blood and urine
2. Estimation of Hemoglobin in blood by Wong's method
3. Estimation of blood albumin: globulin ratio
4. Estimation of blood cholesterol by Zak and Zlatkis method
5. Estimation of uric acid in urine by Caraway's method
6. Estimation of creatinine in urine by Jaffe's method
7. Estimation of urea in urine by Nessler's reagent
8. Estimation of bilirubin in urine
9. Titratable acidity of urine
10. Serum SGOT/SGPT assay

REFERENCES:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (1988).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(1976), Tata-McGrawHill.
5. Biochemistry, ed. Plummer Tata-McGraw Hill, (1971).

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5271
TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB
L: T/A: P: C : 0: 0: 6: 3

PRACTICALS

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20MOE5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: 10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: 10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: 10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: 10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(1996).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (1977).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (1964).

8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid

peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three- kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of

heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 1996.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling- principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods forenvironmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT5201
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 4: 0: 0: 4

Total hours: 52

MODULE I: Basic Concepts 13hrs

DNA Structure and properties; Enzymes in genetic engineering - Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Recombinases, CRISPR – cas system for gene and genome editing, Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization.

MODULE II: Cloning and expression vectors 13hrs

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

MODULE III: Cloning Strategies and study ofprotein-DNA interactions 13hrs

Gene transfer in host cells (transformation, electroporation, transfection, microprojectile, liposome – mediated, gene gun), construction and screening of genomic and cDNA libraries; construction of microarrays –cDNA arrays and oligo arrays; techniques for DNA – protein interactions - electrophoretic mobility shift assay; DNaseIfootprinting; methyl interference assay, chromatin immunoprecipitation; phage display, principle of Surface Plasmon Resonance (SPR) and its application to study protein-protein interactions.

MODULE IV: Sequencing, PCR and its applications 13hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).
PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP,Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MBT5202
TITLE OF THE COURSE : ADVANCED CELL BIOLOGY
L: T/A: P: C : 4: 0: 0: 4

Total hours: 52

MODULE I: Cell types, cell cycle and its control 13hrs

Cell types**:** Structure of prokaryotic and eukaryotic cells, ultrastructure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle**:** Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks*and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways, cell senescence.

MODULE II: Membrane transport 13hrs

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na^+/K^+ Pump, Ca^{2+} Pump. ABC transporter and Multidrug resistant protein.

MODULE III: Cytoskeleton and Cell-cell interactions 13hrs

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV: Cell Signaling and Antioxidant defense system 13hrs

Cell signaling:Principles of cell signaling,intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions.(Ca^{2+}Cyclic modulators –cAMP, cGMP, IP3, 2AG, Nitric Oxide).Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

REFERENCES:

1. Alberts et al., (2002).Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (1980). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (1996). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007).Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis,

transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J (1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **19MSC5202**
TITLE OF THE COURSE : **ANALYTICAL TECHNIQUES**

L: T: P: S/P : C : **4: 0: 0: 0 : 4**

Total Hours: 52

MODULE 1: **13hrs**

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.
Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: **13hrs**

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.
Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: **13hrs**

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC
Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: **13hrs**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.
Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (1998). Bioinformatics.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology

4. Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM
COURSE CODE : 19MBT5271
TITLE OF THE COURSE : CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB
L: T/A: P: C : 0: 0: 6: 3

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Counting of cells: Hemocytometer
3. Study of meiosis –Grasshopper testis/onion flower buds
4. Vital staining of mitochondria.
5. Preparation of competent *E. coli*. cells
6. Transformation plasmid in E. coli and screening of transformants.
7. Isolation of plasmid DNA from *E. coli* (mini-prep) and itsanalysis.
8. Amplification of DNA using PCR and analysis by agarose gel electrophoresis.
9. Restriction digestion of vector/DNA and its analysis.
10. Ligation of DNA fragments and its analysis.

REFERENCES:

1. Cell biology, Genetics, Molecular biology, evolution and ecology

SEMESTER/YEAR : II SEM

COURSE CODE : 19MSC5271

TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB

L: T/A: P: C : 0: 0: 6: 3

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(1996).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (1992)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (1977).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (1964).

8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–** amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents,

Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three- kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products-organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 1996.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (1998). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measuresof Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 19MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MMB5201
TITLE OF THE COURSE : PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY
L: T/A: P: C : 4: 0: 0: 4

Total Hours: 52hrs

MODULE 1: BIOLOGY OF VIRUS 13hrs

Difference between prokaryotic and eukaryotic microorganisms. Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages - structural organization and life cycle - lytic, lysogenic.Application of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV), (Ultra-structure, replication and importance). Viral related agents - viroid and prion.

MODULE 2: BIOLOGY OF BACTERIA 13hrs

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur globules), endospores and exospores. Reproduction in bacteria.

Special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae, Archaebacteria and extremophiles.

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of microorganisms based on environmental and nutritional requirements.

MODULE 3: BIOLOGY OF FUNGI & PROTOZOA 13hrs

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, Sex and mating in fungi fungal spores – dormancy and dispersal.

Type studies: *Aspergillus*, *Saccharomyces*, *Pythium*, *Rhizopus*, *Fusarium*, *Puccinia* and *Agaricus* (Classification, Ultrastructure, reproduction, lifecycle, importance).

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Amoeba, Entamoeba*and *Plasmodium.* Cultivation of protozoa.

MODULE 4: BIOLOGY OF ALGAE **13hrs**

General characteristics of Algae, occurrence, thallus organization, classification, ultra-structure of cell, vegetative, asexual and sexual reproduction.Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

REFERENCES:

1. Sambamurty, A.V.S.S.. A Textbook of Algae. I.K. International Publishing. (2005).
2. Alexopoulos, C. J. and Mims, C.W. Introduction to Mycology, Wiley.(2001)
3. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
4. Khattar, JIS. Algal Biology and Biotechnology. I.K. International Publishing House Ltd. NewDelhi (2009)
5. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (1994).
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi (2007).
7. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
8. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications (2002).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi (2006).
10. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford (2005).
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
13. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
14. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press. 2005
15. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MMB5202
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY
L: T/A: P: C : 4: 0: 0: 4

Total Hours: 52hrs

MODULE 1: MICROBIAL METABOLISM 13hrs

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle.Brief account of porphyrins.

Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Methanogenesis.

Fermentation: Alcohol fermentation, Lactic acid: Homo- and Heterolactic acid fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.

Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. Bioluminescence – mechanism and significance.

MODULE 2: ENZYMOLOGY 13hrs

Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups.Effect of temperature, pH and substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action

Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters, hyperbolic and LB plot. Regulation of enzymes: Covalentand noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive.Ribozymes and abzyme.

MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS 13hrs

Introduction: Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain.

Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation, structure of bacterial ATPase. Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria.

Anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria.

MODULE 4: MICROBIAL CELL MEMBRANE PHYSIOLOGY 13hrs

Metabolite transport: Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in transport, different permeases in *E. coli*. Transport of aminoacids and inorganic ions in microorganisms (Bacteria and fungi) and their mechanisms.

Stress physiology: Osmotic stress and osmoregulation by glutamate and disaccharide trehalose, Osmotic Control of Gene Expression. Aerobic to anaerobic transitions in facultative microorganisms (*E. coli*); Oxidative stress - superoxide dismutase and catalase, Regulation of the Oxidative Stress Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress, stringent Control.

REFERENCES:

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Brun, Y.V. and Shimkets, L.J. (2000). Prokaryotic Development, ASM Press.
3. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
4. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.
5. Deb, A.C. 2006. Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.
6. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
7. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
8. El-Sharoud, Walid (Ed.) (2007). Bacterial Physiology a molecular approach. Springer.
9. Moat, A.G. & Foster, J.W. (1999). Microbial physiology, Wiley-Liss.
10. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York. Postgate,J. 1998, Nitrogen Fixation, third edition, Cambridge University Press.
11. Salisbury, F.W. and W.Ross, 1992, Plant Physiology, fourth edition, Wardsworth Publishing Company, California.
12. Smith and Wood (1991). Energy in Biological Systems. Chapman and Hall.
13. Srivastava, M.L. 2008. Microbial Biochemistry, Narosa Publishing House, New Delhi.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes 13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch

action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 1993.
4. David Rawn J (1989)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (1994). Molecular Biology of the Cell.
8. Cooper, G.M. (1997).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (1990). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (1995). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR **: II SEM**
COURSE CODE **: 19MSC5202**
TITLE OF THE COURSE **: ANALYTICAL TECHNIQUES**

L: T: P: S/P : C **: 4: 0: 0: 0 : 4**

Total Hours: 52

MODULE 1: **13hrs**

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x- ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: **13hrs**

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: **13hrs**

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography,covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: **13hrs**

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).

2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (1998). Bioinformatics.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (1994). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).

7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM
COURSE CODE : 19MMB5271
TITLE OF THE COURSE : PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY - LAB
L: T/A: P: C : 0: 0: 6: 3

1. Isolation and culturing of fungi (yeasts and molds) by Dilution plate method, Warcup method implant and impression.
2. Anaerobic culturing methods – anaerobic jar and its use, thioglycollate media culturing.
3. Isolation and identification of microscopic algae from soil and water.
4. Isolation and identification of protozoa from soil and water.
5. Biochemical test: Catalase, Oxidase, IMViC, starch, casein and Gelatin hydrolysis, Hydrogen sulfide production in TSIA, Identification of bacteria by API methods. (4 Units)
6. Growth measurement of bacteria (turbidity method) and fungi (Linear method).
7. Estimation of DNA and RNA.
8. Estimation of proteins
9. Estimation of enzyme activity – amylase and protease.
10. Enzyme kinetics – K_{max} and V_{max} of amylase

REFERENCES:

1. Arora, D.K. and Seema Gupta (1996). Bacterial Physiology. Anmol Publications. New Delhi.
2. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
3. Caldwell. D.R. (1995). Microbial Physiology and metabolism, Brown Publishers.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MSC5271
TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB
L: T/A: P: C : 0: 0: 6: 3

PRACTICALS

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid

peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2099.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2096.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2099.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 2097, Mc Graw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBC5201
TITLE OF THE COURSE : METABOLISM – I
L: T: P: S/P : C : 4: 0: 0: 0 : 4

MODULE I: Carbohydrate metabolism 13hrs

Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle-scheme; Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins

MODULE 2:Disorders of Carbohydrate metabolism 13hrs

Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves, and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria.Introduction to metabolomics.

MODULE 3:Amino acids and peptides 13 hrs

General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Synthesis of porphyrin rings and their breakdown into billirubin. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.

MODULE 4: Metabolism of standard amino acids 13 hrs

Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism

REFERENCES:

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. John Wiley and Sons(2099).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).

3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5th Ed. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBC5202
TITLE OF THE COURSE : HUMAN PHYSIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Tissue level of organization: 8hrs

Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues.

The muscular system: 5hrs

Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism.

MODULE 2: 13hrs

Nervous system: 8hrs

Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin

Endocrine system: 5hrs

Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D.

MODULE 3: 13hrs

Cardiovascular system: 8hrs

functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary circulation. Cardiac cycle. Cardiac

output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center.

Respiratory system: **5hrs**

Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods.

MODULE 4: **13hrs**

Digestive system: **7hrs**

Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food

The urinary system: **6hrs**

Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones.

REFERENCES:

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)
2. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (2097).
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (2095).
6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).
7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (2097)
8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (2098)
9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (2091).
10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (2083).
11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (2086).
12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis,

transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 2093.
4. David Rawn J (2089)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
8. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5202
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: 13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: 13hrs

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: 13hrs

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.

5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBC5271
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Estimation of sugar from blood and urine
2. Estimation of Hemoglobin in blood by Wong's method
3. Estimation of blood albumin: globulin ratio
4. Estimation of blood cholesterol by Zak and Zlatkis method
5. Estimation of uric acid in urine by Caraway's method
6. Estimation of creatinine in urine by Jaffe's method
7. Estimation of urea in urine by Nessler's reagent
8. Estimation of bilirubin in urine
9. Titratable acidity of urine
10. Serum SGOT/SGPT assay

REFERENCES:

1. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (2088).
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (2096).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (2094).
4. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(2076), Tata-McGrawHill.
5. Biochemistry, ed. Plummer Tata-McGraw Hill, (2071).

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5271
TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER/YEAR : III SEM / 2nd YEAR
COURSE CODE : 20MBC5301
TITLE OF THE COURSE : METABOLISM II
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

1. Learning the role electron transport chain plays in connecting fuel breakdown and metabolism.
2. Learning about the metabolic reactions undertaken by living systems to breakdown lipids and nucleic acids for release of energy.

Course Outcomes:

1. Students will be able to comprehend the integration of metabolism, oxidative phosphorylation and ATP production.
2. They will have an in-depth idea about the role lipids play in energy storage and usage.
3. Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by nitrogen bases and fat to fuel to living systems.

Total hours: 52 Hrs

MODULE I: Bioenergetics 13 Hrs

Reduction Potential, Biological redox couplers, Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H^+ pumping by bacteriorhodopsin.

MODULE II: Nucleotide Metabolism 13 Hrs

Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies

MODULE III: Lipid metabolism 13 Hrs

Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, scheme and energetics of β-oxidation, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid

biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders**.**

MODULE IV: Cholesterol and Circulating lipids **13 Hrs**

Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds, Non steroidal anti-inflammatory drugs (NSAIDs).

REFERENCES

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed
4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010.

SEMESTER/YEAR : III SEM / 2nd YEAR
COURSE CODE : 20MBC5302
TITLE OF THE COURSE : ENZYMOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:
1. Learning about enzyme properties and coenzymes
2. Knowledge of enzyme assay, enzyme kinetics and drawing enzyme assisted reaction plots.

Course Outcomes:
1. Brief idea about regulation of enzyme activity along with enzyme Inhibition.
2. Studying active site structure and catalysis.

Total hours: 52 Hrs

MODULE I: Introduction to Enzymes 13 Hrs

Introduction to enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes.

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalysed reactions –nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B.

MODULE II: Enzyme Kinetics 13 Hrs

Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity.

Kinetic data evaluation: linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy.

MODULE III: Enzyme Inhibition 13 Hrs

Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition.

Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation

reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation.

MODULE IV: The investigation of active site structure **13 Hrs**

The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labelling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies.

Enzyme catalysis**:** Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin), sulphydryl enzymes (alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase).

REFERENCES

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (2099).
4. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2080).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (2076).

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 20MSC5301
TITLE OF THE COURSE : CLINICAL RESEARCH
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical research

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical trial studies.

Total hours: 26

MODULE I: Concepts of Clinical Research 13 Hrs

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd).* maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50} & ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research 13Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial

Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR **: III SEM/ 2nd YEAR**
COURSE CODE **: 20MSC5302**
TITLE OF THE COURSE **: SCIENTIFIC WRITING AND IPR**
L: T: P: S/P : C **: 2: 0: 0: 0 : 2**

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing: **13 Hrs**

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.
Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights **13 Hrs**

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.
Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 20MBC5321
TITLE OF THE COURSE : IMMUNOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To understand the role of different cells and organs of immune system.
2. To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
3. To understand the importance of immune system in disease and therapeutics.

Course Outcomes:

1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge about the consequences of immune system failure. They will also gain insights about the spread of cancer and its therapeutics

Total hours: 40 Hrs

MODULE I: Introduction and Innate Immunity 10 Hrs

Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity.

Innate immunity: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.

MODULE II: Antigen Antibody interactions 10 Hrs

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins.

Antigen recognition by T cells: T_H, T_C and T_{Reg} cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.

MODULE III: **Lymphocyte development and inflammation 10 Hrs**

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition.

Transplantation and Network theory: Transplant rejection, immunosuppressants.

Immuno-surveillance, idiotypes and immune network theory.

MODULE IV: Pathoimmunology & immunotechniques 10 Hrs

Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis

Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flow cytometry.

REFERENCES

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).
8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57–70 (2000).
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER/YEAR : **III SEM / 2nd YEAR**
COURSE CODE : **20MBC5322**
TITLE OF THE COURSE : **MOLECULAR PHYSIOLOGY**
L: T: P: S/P : C : **3: 0: 0: 0 : 3**

Course Objectives:

1. Introduction to hormones and their function.
2. Understanding Nerve signalling and neurotransmitters.
3. To learn different nuclear signalling mechanisms along with importance and regulation of cell cycle.
4. Brief idea about Apoptosis and Cancer.

Course Outcome:

1. Students will have an idea as to how hormones control the physiology of an organism via signalling mechanisms.
2. They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.

Total hours: 40 Hrs

MODULE I: Endocrine signaling **10 Hrs**

Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine / serotonin); Ion– channel (ACh); Tyrosine kinase (RTK), [insulin] and Intrinsic enzyme / cytokine, receptors.

Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+}, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.

MODULE II: Nerve signalling and neurotransmitters **10 Hrs**

Nerve signaling: Morphology of a neuron. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential. Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate/GABA) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).

MODULE III: Nuclear signaling and Cell Cycle **10 Hrs**

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation.

Cell Cycle: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation.

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

MODULE IV: Apoptosis and Cancer 10 Hrs

Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases and JAK-STAT pathways). Concept of tumor suppressors.

References:

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey,(1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR **: III SEM / 2nd YEAR**
COURSE CODE **: 20MBC5323**
TITLE OF THE COURSE **: GENETIC ENGINEERING**
L: T: P: S/P : C **: 3: 0: 0: 0 : 3**

Course Objectives:

1. To understand how DNA can be manipulated using different enzymes.
2. Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
3. Diverse methods to visualise modified genetic materials.
4. Applications of genetic engineering.

Course Outcomes:

1. This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.
2. It will also teach techniques to detect the engineered DNA, RNA and protein
3. Students will also learn various applications where genetic engineering can be used.

Total hours: 40 Hrs

MODULE I: Basic Concepts **10 Hrs**

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.

MODULE II: Cloning and expression vectors **10 Hrs**

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

MODULE III: Cloning strategies and study of protein-DNA interactions **10 Hrs**

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl

interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

MODULE IV: Sequencing, PCR and its applications **10 Hrs**

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR **: III SEM / 2nd YEAR**
COURSE CODE **: 20MBC5324**
TITLE OF THE COURSE **: MEMBRANE BIOCHEMISTRY AND NANO SCIENCE**
L: T: P: S/P : C **: 3: 0: 0: 0 : 3**

Course Objectives:

1. Learning the role lipids play in maintaining plasma membranes and techniques to isolate and study membranes.
2. Learning about nanotechnology and its application in various fields.

Course Outcomes:

1. Students will have a theoretical knowledge about isolating plasma membranes and studying its components to draw conclusions about the multitude of role played by membranes.
2. They will have an in-depth idea about nanotechnological solutions used to treat industrial and health related problems.

Total hours: 40 Hrs

MODULE I: Lipid properties **10 Hrs**

Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolpin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.

MODULE II: Membrane topology **10 Hrs**

Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Erythrocyte ghosts; Classification of membrane proteins based on membrane-protein interaction. Techniques for determination of membrane protein topology: Biophysical methods: X-ray crystallography, Freeze-fracture electron microscopy, Lateral and rotational diffusion of integral membrane proteins. Fluorescence photobleaching recovery (FRAP). Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.

MODULE III: Nanoscience **10 Hrs**

Definition of Nanoscale, Scientific revolution-Atomic Structure and atomic size. Nanoparticles – properties, emergence and challengs of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nanotoxicology.

MODULE 4: Nanobiotechnology **10 hrs**

Synthesis of nanoparticles and nanostructures – bottom-top and top-bottom approaches, Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, synthesis and functionalization of Graphene, electronic application of Graphene. Applications of nanoscience in biological systems - drug targeting, drug delivery and biomedicine, Bionics and Biomimicry. Scanning Tunneling microscope, Atomic force Microscopy, Zetasizer.

REFERENCES

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830- 831, Cambridge University Press.
4. Processing & properties of structural nanomaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 20MBC5325
TITLE OF THE COURSE : PHYTOCHEMICALS AND MICROBIAL SECONDARY METABOLITES
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. Learning the role of phytochemicals and microbial metabolites.
2. Learning the qualitative and quantitative with its application in various fields.

Course Outcomes:

1. Students will have a theoretical knowledge about isolation and characterization of phytochemicals and microbial metabolites, this enables the student to draw conclusions about the multitude of role played by phytobioactives.
2. They will have an in-depth idea about phytochemical and microbial metabolites solutions used to treat industrial and health related problems.

Total hours: 40 Hrs

MODULE I: Introduction to Phytochemicals 10 Hrs

Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level.

Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, concentration and evaporation techniques, lyophilisation.

MODULE II: Methods to analyse Phytochemicals 10 Hrs

Techniques for quantitative and structural analysis of plant secondary metabolites: Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry.

Application of UV/Visible, IR, 1H and 13C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).

MODULE III: Microbial metabolites 10 Hrs

Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process.

Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application.

Lactic acid: Nutrient media, production process recovery and purification.

Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.

MODULE IV: Special Microbial Metabolites **10 Hrs**

Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine).

Health care products: Industrial production and recovery: Penicillin and Streptomycin.

I P R: Patents: Patent regulations of processes, products and microorganisms.

REFERENCES

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.
2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.
3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.
4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.
5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology II Edition. ASM Press, Washington.
6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.
7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IV Edition. Pearson Education Internationl. London.
8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher.
9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.
10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 20MBC5371
TITLE OF THE COURSE : ENZYMOLOGY AND PROTEIN PURIFICATION
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:
1. Learn about the nature of enzymes and their mode of action along with the analytical techniques of protein purification.
2. To learn isolation and purification of enzymes with classical examples.

Course Outcomes:
1. This course will enable students to learn enzymology and analytical techniques which can be used to understand biomolecules specific to proteins
2. It will also enable them to learn protein chemistry techniques routinely used in medical laboratories

PRACTICALS

1. Isolation and assay of phosphatase; effect of dilution
2. Effect of substrate on phosphatase
3. Effect of Temperature & pH on phosphatase
4. Inhibition kinetics of phosphatase by L-B plot
5. Extraction of phosphatase from plants and stepwise purification through organic acid
6. precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
7. Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
8. Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation.
9. Criteria of purification of phosphatase visualized through SDS-PAGE.
10. Concepts of Isoelectric Focusing (Demonstration)

REFERENCES

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)
2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)
3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)
4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).

5. Biochemical Calculations, Irwin H. Segel (2076) 2nd Ed. John Wiley and Sons.
6. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
7. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER/YEAR : III SEM/2nd YEAR
COURSE CODE : 20MBC5372
TITLE OF THE COURSE : GENETIC ENGINEERING & IMMUNO TECHNIQUES
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:

1. Learn molecular techniques to modify DNA, introduce foreign DNA in *E.coli* host and express proteins.
2. To learn immune techniques used as diagnostic tools.

Course Outcomes:

1. This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.
2. It will also teach diagnostic immune techniques routinely used in medical laboratories

PRACTICALS

1. PCR amplification and analysis by agarose gel electrophoresis.
2. Preparation of plasmid DNA from E. coli.
3. Restriction digestion and Restriction mapping
4. Ligation
5. Preparation of competent E. coli. cells
6. Transformation in E. coli.
7. Induction of protein expression and analysis by SDS-PAGE
8. Serum Separation from whole blood and isolation of immunoglobulins from serum.
9. Study of different cells in whole blood using Giemsa/Leishman stain.
10. Blood grouping
11. ELISA/Dot ELISA
12. Radial Immunodiffusion/Ouchterlony Double Diffusion
13. Rocket Immuno Electrophoresis
14. WIDAL/RPR Test

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC

5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER/YEAR : IV SEM / 2nd YEAR
COURSE CODE : 20MSC5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: 10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: 10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: 10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: 10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C :4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparationVSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin& cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order&molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).

8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols

and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson &Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendeliangenetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.*and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL

genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:MalariaandFilaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of

heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and JayaramPanicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2099.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2096.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2099.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. McGraw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2ndedition., 2097, McGraw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *abintio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 McGraw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata McGraw Hill

SEMESTER/YEAR : II SEM
COURSE CODE : 17MBT5201
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Basic Concepts 13hrs

DNA Structure and properties; Enzymes in genetic engineering - Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Recombinases, CRISPR – cas system for gene and genome editing, Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization.

MODULE II: Cloning and expression vectors 13hrs

Plasmids; Bacteriophages; M13 mp vectors; pUC20 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo& retroviral vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors. Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

MODULE III: Cloning Strategies and study of protein-DNA interactions 13hrs

Gene transfer in host cells (transformation, electroporation, transfection, microprojectile, liposome – mediated, gene gun), construction and screening of genomic and cDNA libraries; construction of microarrays –cDNA arrays and oligo arrays; techniques for DNA – protein interactions - electrophoretic mobility shift assay; DNaseIfootprinting; methyl interference assay, chromatin immunoprecipitation; phage display, principle of Surface Plasmon Resonance (SPR) and its application to study protein-protein interactions.

MODULE IV: Sequencing, PCR and its applications 13hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina, 454, SOLiD sequencing).
PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), ASA (Allele-Specific Amplification).

REFERENCES:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBT5202
TITLE OF THE COURSE : ADVANCED CELL BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total hours: 52

MODULE I: Cell types, cell cycle and its control 13hrs

Cell types**:** Structure of prokaryotic and eukaryotic cells, ultrastructure of animal and plant cell. Cell division and control: Mitosis, meiosis and their genetic significance.

Cell cycle**:** Functional events of cell division and molecular mechanism of cell cycle, Control mechanisms: Role of cyclins, *Cdks*and inhibitors of cell cycle progression, Cell cycle check points, control of cell numbers in multicellular organisms, Cell death: Apoptosis and necrosis, related pathways, cell senescence.

MODULE II: Membrane transport 13hrs

Biological membranes: Structure and properties, Models of cell membrane, membrane constituents- phospholipids, glycolipid, cholesterol, membrane proteins.

Transport of nutrients- transport of ions and macromolecules, diffusion, osmosis, reverse osmosis; Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis; Transport Pumps and Proteins: Ionophores, permeases, Na^+/K^+ Pump, Ca^{2+} Pump. ABC transporter and Multidrug resistant protein.

MODULE III: Cytoskeleton and Cell-cell interactions 13hrs

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, Cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases, Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: desmosomes, tight junctions, gap junctions and plasmodesmata.

MODULE IV: Cell Signaling and Antioxidant defense system 13hrs

Cell signaling:Principles of cell signaling,intercellular signaling: endocrine, paracrine and autocrine signaling, Extracellular Messengers & their receptors, signaling via G-protein coupled receptors, enzyme linked receptors and kinase receptors. Role of GPCRs in sensory perceptions.(Ca^{2+}Cyclic modulators –cAMP, cGMP, IP3, 2AG, Nitric Oxide).Role of secondary messengers, Regulation of Glucose levels.

Antioxidant defense system: Free radicals-ROS, RNS, effect of free radicals on proteins, lipids and nucleic acids, and their clinical importance. Mechanism of antioxidant defense system (Glutathione, catalase, SOD, peroxidase).

REFERENCES:

1. Alberts et al., (2002).Molecular Biology of the Cell, Garland Publishing, Inc., 4th ed.
2. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
3. Darnell, J., Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY. Edwards and Hassall (2080). Biochemistry and Physiology of cell, 2nd Edn. McGraw Hill Company.
4. Garrett, R.H., Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
5. Karp, G. (2096). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
6. Lodish et al., (2007).Molecular Cell Biology, W.H. Freeman & Company, New York, 6th edition.
7. Hallwell, B., Gutteridge, J.M.C. (2002). Free Radicals Biology and Medicine. Oxford Press.UK.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 2093.
4. David Rawn J (2089)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
8. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5202
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: 13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper &agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: 13hrs

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: 13hrs

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology

4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM
COURSE CODE : 20MBT5271
TITLE OF THE COURSE : CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Micrometry: Calibration of stage and ocular micrometer and measurement of the given biological sample
2. Counting of cells: Hemocytometer
3. Study of meiosis –Grasshopper testis/onion flower buds
4. Vital staining of mitochondria.
5. Preparation of competent *E. coli*. cells
6. Transformation plasmid in E. coli and screening of transformants.
7. Isolation of plasmid DNA from *E. coli* (mini-prep) and its analysis.
8. Amplification of DNA using PCR and analysis by agarose gel electrophoresis.
9. Restriction digestion of vector/DNA and its analysis.
10. Ligation of DNA fragments and its analysis.

REFERENCES:

1. Cell biology, Genetics, Molecular biology, evolution and ecology

SEMESTER/YEAR : II SEM

COURSE CODE : 20MSC5271

TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB

L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)

SEMESTER/YEAR : III SEM/2nd year
COURSE CODE : 20MBT5301
TITLE OF THE COURSE : IMMUNOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

1. Impart fundamental concepts of Immune system and its workings.
2. Instill basic understanding of MHC, TCR, antibodies, antigens, T cells, specific immune response; application of antibodies as reagents.
3. To instill principles of vaccines as disease preventive agents; principles of hypersensitivity and autoimmune disorders.

Course Outcomes:

1. Students will develop a clear basic understanding of the fundamentals ofmammalian immune system as our defense against pathogens as well as the conceptof vaccines as protective agents.
2. Enable sufficient knowledge in application of antibodies as analytical tools.
3. Equip thestudents with sufficient basic knowledge necessary to understand concepts in research methodologies and in other Biotechnology courses, they study.

Total hours: 52 Hrs

MODULE I: **Immune System** **13 Hrs**

Innate immunity Vs adaptive immunity, cell mediated and humoral immunity, immune cells (T cells B cells, NK cells, Macrophages, DCs, granulocytes, mast cells, Inflammation concept, lymphoid organs. Basic outline of negative and positive T and B cell selection, self MHC restriction during the developmental lymphoid cells. T-cell sub-sets. Complement activation, Classic, and alternative pathway and biological function.

MODULE II: Antigens and Antibodies **13 Hrs**

Antigens- Immunogenecity versus Antigenicity, Factors that influence immunogenicity. Concept of epitopes.

Immunoglobulins: Basic structure of Immunoglobulins -Fine structure of Immunoglobulins - Immunoglobulin domains-variable region and constant region domains. isotopic, allotypic and idiotypic variation. Immunoglobulin classes, functions of Ig class. Organization and expression of Immunoglobulin Light and Heavy chain genes- generation of antibody diversity, scheme of T-cell receptor diversity. Class switching.

MODULE III:Immune Responses **13 Hrs.**

Major histocompatibility complex (MHC); structure and organization of MHC Class I and

Class II molecules. Concept of antigen specific receptor. T-cell receptor; antigen processing, antigen presentation; products and factors produced by T-cell activation; APC; cytokines. Lymphocyte migration, homing and trafficking; and chemokines; B cell activators; B-cell and helper T-cell subset interactions; cytotoxic T-cell mediated killing. Clonal selection theory, Primary and secondary immune responses. Immune response to infections, autoimmune diseases. Immune response to infectious diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis; hypersensitivity reactions

MODULE IV: Immunological techniques and vaccines 13 Hrs.

Concept of polyclonal vs monoclonal antibodies. Immunofluorescence ELISA, Western blotting. Flow Cytometry. Fractionation of leukocytes under density gradient.; Hybridomas and their production. Active & Passive immunization, Role of vaccines in prevention of diseases, Types of vaccines (Heat inactivated vaccines; Attenuated vaccines; Recombinant vaccines; Subunit vaccines)

REFERENCES

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. Kuby Immunology 7th edition. Macmillan Publishers 2014.
3. Kuby Immunology, 8th Edition | Macmillan Publishers 2020.
4. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
5. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. https://doi.org/10.1201/9781315533247
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

SEMESTER/YEAR : III SEM/2nd Year
COURSE CODE : 20MBT5302
TITLE OF THE COURSE: : INDUSTRIAL BIOTECHNOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

- To help students achieve knowledge in principles and concepts relevant to industrial biotechnology.
- To familiarize the students with upstream and downstream processing, types of fermenters and production of important microbial products.

Course Outcomes:

- Students will be updated with the current methods of fermentation process, modern fermenters and strategies for isolation of industrially important strains.
- Student will be able to apply the knowledge in their future with respect to industrial biotechnology processes.

Total hours: 52 Hrs

MODULE I: Microbial growth, development and maintenance 13 Hrs

Microbial growth and death kinetics (particularly with reference to industrially useful microorganisms). Screening, Isolation. Identification and characterization of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centres.

MODULE III: Bioreactors and Fermentation 13 Hrs

Scope and importance of fermentation in industrial Biotechnology, Basic components, design and scale-up of fermenters – Typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter. Conditions regulating fermentation - pH, temperature, dissolved oxygen, foaming and aeration. Types of fermentation - batch fermentation and chemostat, submerged and solid substrate fermentation.

MODULE IV: Upstream Processing and downstream processing 13Hrs

Formulation of fermentation media. Rheology of fermentation media. Nutrients: growth factors, carbon, nitrogen, energy and mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial strains; inoculum preparation and inoculum development. Steps in recovery and purification of fermented products. Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid- Liquid extraction, Solvent

recovery, Supercritical fluid extraction, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing, Effluent treatment.

Module V: Industrial Bioprocessing **13Hrs**

Industrial alcohol production and organic acids (citric acid), Non-alcoholic beverages (coffee, tea), food additives, biopolymers (dextran, alginate), biosurfactants, lipids & oils. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Amino acid production- L-Glutamic acid and L-lysine. Industrial production of health care product: Vaccines (Hepatitis B) and hormones (human insulin), antibiotic (Penicillin and Streptomycin).

REFERENCES:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.
3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
4. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, (2nd Ed). Taylor & Francis Ltd, UK, 2007.
5. Colin Ratledge and Bjorn Kristiansen, Basic Biotechnology (2nd Ed.) Cambridge University Press. 2002.
6. Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084
7. Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
8. Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER/YEAR : III SEM
COURSE CODE : 20MSC5301
TITLE OF THE COURSE : CLINICAL RESEARCH
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical trial.

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical research studies.

Total Hours: 26 Hrs

MODULE I: Concepts of Clinical Research 13 Hrs

General introduction, routes of drugs administration, Dose,threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd).* maximum tolerated dose (MTD).Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity.Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50}& ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research 13Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial

Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR	**: III SEM**
COURSE CODE	**: 20MSC5302**
TITLE OF THE COURSE	**: SCIENTIFIC WRITING AND IPR**
L: T: P: S/P : C	**: 2: 0: 0: 0 : 2**

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing: 13 Hrs

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.

Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights 13 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.

Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR: **III SEM**
COURSE CODE: **20MBT5321**
TITLE OF THE COURSE: **PLANT BIOTECHNOLOGY**
L: T: P: S/P : C **: 3: 0: 0: 0 : 3**

Course Objectives:

- To equip the students with fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- To familiarize the students with knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Course Outcomes:

- The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Total hours: 40 Hrs

MODULE I: Plant Tissue Culture **10 Hrs**

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, Organogenesis; Micropropagation; Somatic embryogenesis and its applications; Somaclonal variation; Anther culture for haploid production and its applications in plant breeding;

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids. Cell cultures for secondary metabolite production

MODULE II: Genetic Transformation Techniques for plants **10Hrs**

Agrobacterium-plant interaction; organization of Ti and Ri plasmids; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated transformation; Cointegrate and binary vectors and their utility; viral based vectors. Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; stability of transgene; Transplastomic technology; Marker-free methodologies; Gene editing by TALLEN and Crispr techniques

MODULE III: GM Technology and Plant Trait improvement **10 Hrs**

GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops

Concept of bio factories; Production of pharmaceutical proteins Plantibodies, vaccines and industrial enzymes in plants. Metabolic engineering for oil improvement, Crop improvement

and fortification of agricultural crops–Bt cotton, Bt brinjal, transgenic sweet potato and Golden rice. Ethical, regulatory and environmental issues associated with GM crops and GM food;

MODULE IV: Molecular Breeding: Molecular Mapping & Marker Assisted Selection

10 Hrs

Molecular markers: RFLP, RAPD, SCAR, STS, AFLP, and SNP markers; Construction of genetic and physical map; Quantitative and qualitative characters. MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; QTL mapping and cloning. Application of Molecular Markers: Genotyping tools as plant variety protection, hybrid purity tests.

REFERENCES

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5322
TITLE OF THE COURSE : ANIMAL BIOTECHNOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To acquaint the students with the basic concepts of animal cell culture set up and conditions.
2. To Equip the students with fundamentals of gene transfer methods for mammalian cells and animal transgenics followed by important applications of animal biotechnology

Course Outcome:

1. Will learn about basic animal cell culture conditions and its uses.
2. Be able to describe techniques and problems both technical and ethical in animal cloning.
3. Will be equipped with the wide area of applications of biotechnology in modern world.

Total hours: 40 Hrs

MODULE I: Basics of Animal Tissue Culture 10 Hrs

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Methods of sterilization, Detection of Mycoplasma and viral contaminants, types of culture media, composition, preparation. Serum and protein free defined media. Role of CO_2, Serum, supplements, Culture and maintenance of primary and established cell lines. Biology of cultured cells: Culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity.

Module II: Stem Cells 10 Hrs

Stem cells – Adult, embryonic, Induced pluripotent stem cells. Stem cells from adult organs-Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals 10 Hrs

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF-technology for livestock and humans. Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Animal and human cloning- ethical and social issues.

Module IV Applications of Animal Biotechnology **10 Hrs**

Disease resistant, recombinant vaccines for poultry, livestock pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, interleukins, interferons, Cell culture-based vaccines. Biosafety: The Cartagena protocol on biosafety. Good manufacturing practice and Good lab practices (GMP and GLP).

REFERENCES:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEYVCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5323
TITLE OF THE COURSE :PRINCIPLES OF ENZYMOLOGY AND METABOLISM
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives

1. To impart basic concepts of metabolisms of carbohydrates, amino acids, nucleotides and lipids, Oxidative phosphorylation and generation of ATP.
2. To equip students with basic understandings of concept of enzymology.

Course Outcomes

1. Students will be equipped with the basic concepts of metabolism of biological fuels in biological systems and oxidative phosphorylation process involved in ATP synthesis.
2. Gain sufficient knowledge on the role of enzymes and the nature of their action in metabolism.

Total hours: 40 Hrs

MODULE I: Enzymes and basic enzyme kinetic concepts 10 Hrs

Basic Concepts of Enzymes: factors affecting enzyme activities, active site, allosteric site, coenzymes and co factors. Mechanism of enzyme action: lock and key model and induced fit hypothesis. Enzyme activity and Specific activity. Isozymes and their significance.

Enzyme Kinetics: Basic chemical kinetics, rate of reaction, Significance of Km, Vmax and Kcat, basic concepts of Lineweaver-burk plot and its relevance.

Enzyme inhibition and regulation: Basic concepts of reversible and irreversible inhibition with suitable examples, competitive, uncompetitive, non-competitive inhibitors with relevant kinetic plots. Regulation of enzyme activity: Covalent modulation, Allosteric regulation, ligand interactions, co-operative interactions, feedback regulation

MODULE II: Carbohydrate and amino acid metabolism 10 Hrs

Carbohydrate metabolism; Introduction, glycolytic pathway. Gluconeogenesis pathway. Role of LDH. TCA cycle. HMP pathway, Cori's cycle. Brief scheme of glycogen metabolism. Pasteur effect, fermentative pathways in microorganisms. Amino acid metabolism: General metabolic reaction of amino acids– transamination, glucose – alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – trans deamination, amino acid oxidase, and non – oxidative deamination. Urea cycle, Biosynthesis and degradation of essential amino acids. Disorders of amino acid metabolism (PKU, Alkaptonuria).

MODULE III: Nucleotide and Lipid metabolism 10 Hrs

Nucleotide metabolism: biosynthesis of purine and pyrimidine nucleotides (de-novo and salvage). Degradation of purine and pyrimidines, and disorders associated with their metabolism.

Lipid Metabolism: Oxidation of fatty acids: beta oxidation. Cholesterol biosynthesis. Scheme of transport of cholesterol -LDL receptor pathway. Lipoproteinemia, fatty liver, hypercholesterolemia. Biological functions, and metabolic fate of VLDL, LDL and HDL.

MODULE IV: Oxidative phosphorylation 10 Hrs

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1- ATPase- structure and mechanism. Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation, Uncouplers, inhibitors, and ionophores.

REFERENCES

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Enzymes-Biochemistry, Biotechnology, Clinical Chemistry, Trevor Palmer, 2nd edition, 2008, East-West Press Edition, Horwood Publishing limited.
3. Enzyme kinetics and mechanisms. TAYLOR (Kenneth B). 2009, Kluwer Academic Press
4. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999).
5. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (1976).
9. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH. Freeman Co.
10. Stryer, L. Biochemistry 4 th Edn. W.H. Freeman and Co. NY.
11. Devlin, T.M. (1997). Biochemistry with clinical correlations, John Wiley & Sons
12. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.
13. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5324
TITLE OF THE COURSE : HEALTH AND ENVIRONMENTAL BIOTECHNOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To impart basic knowledge in environmental science, issues and biotechnological applications in waste management.
2. To familiarize students with basic concepts involving health and disease, infectious disease.
3. To give conceptual knowledge of the principles behind molecular therapeutics and nanobiotechnology.

Course outcomes:

1. Students will be equipped with basic foundation of Biotechnological applications to environmental and medical problems.
2. Students will gain basic knowledge in application of nanobiotechnology to molecular therapeutics

Total Hours: 40 Hrs

MODULE I:Waste Water and Solid Waste Management 10 Hrs

Waste/Sewage water treatment: Concept of soil, air and water pollution. Waste water characteristics, Source of water pollution, Measurement of water pollution, waste water treatment-physical, chemical, biological processes. Aerobic processes; Activated sludge, oxidation ditches, trickling filter, oxidation ponds; Anaerobic processes; Anaerobic digestion, anaerobic filters, anaerobic sludge, membrane bioreactors, and enzyme immobilization technique, Reverse osmosis and ultra-filtration. Treatment of industrial effluents: dairy, distillery and tannery industries.

Solid waste management: sources and types of waste, management of solid waste (non-hazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.

MODULE II: Application of Biotechnology in Environmental Management 10 Hrs

Bioremediation: Concept, principles and techniques, bioremediation using microbes. Biosorption of heavy metals and phytoremediation. Biodegradation and bioconversion of natural and xenobiotic compounds (Lignocellulose, petroleum products and heavy metals) Biomining and Bioleaching: types and methods, microorganism in mineral recovery, advantages and disadvantages.

MODULE III: Biology of Human Diseases 10 Hrs

Evaluation of organ functions: liver, kidney, cardiac function tests with the significant serum biomarkers. Infectious (communicable) diseases: Cause, Symptoms and treatment/prevention- Bacterial infections (Typhoid), Viral infections(H1N1), STDs. Pregnancy and infections. Genetic Disorders of Humans: Symptoms and treatment of the Genetically inherited diseases: PKU, Alkaptonuria, Galactosemia, Lesch- Nyhan syndrome, Gout, , Beta Thalassemia and Diabetes.

MODULE IV: Molecular Therapeutics and Nanobiotechnology 10 Hrs

Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect (methotrexate and rifampicin).

Gene therapy: overview of inherited and acquired diseases for gene therapy; barriers to gene delivery, Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery, use of stem cells.

Recombinant products: Erythropoietin, Insulin and Streptokinase.

Nanobiotechnology: introduction, synthesis of nanomaterials, brief overview on mechanisms of nanomaterials synthesis, types of nanomaterials, basic concept of protein and DNA based nano structures, medical applications of nanomaterials

REFERENCES

1. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier publications, 2008
2. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
3. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
4. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
5. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5325
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. The course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.
2. To aware students the concepts to make them capable to propose appropriate methods for analysis of given sample type with respect to purpose of analysis

Course Outcomes:

1. Students will be equipped to infer the basic concepts of genomics, transcriptomics and proteomics.
2. List and discuss the use of genomics and proteomics in human health.
3. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

Total hours: 40 Hrs

MODULE I: Genome Organization, structure and mapping 10 Hrs

Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Recognition of coding and non-coding sequences and gene annotation. Genetic and physical maps; markers for genetic mapping; methods and techniques used for gene mapping, physical mapping, linkage analysis, cytogenetic techniques.

Module II: Genome sequencing and analysis 10 Hrs

Genome sequencing. Clone contig method, Next Gen Sequencing, Genome sequencing projects of E. coli., yeast, and human genome project. Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; Genome sequence data bases, expressed sequenced tags (ESTs), Genome sequence analysis. determining gene location in genome sequence, Promoter prediction methods

Module III: Proteomics 10 Hrs

Protein analysis (includes measurement of concentration, amino-acid composition, N terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; Mass Spectroscopy, Concept of MudPIT (Multidimensional Protein Identification Technology), Protein-protein interactions, proteome databases.

Module IV: Functional and comparative Genomics **10 Hrs**

Transcriptome analysis-transcripts of a tissue; Massively parallel signature sequencing (MPSS), Expression profiling in human diseases. Orthologs, homologs, paralogs, gene evolution, protein evolution by exon shuffling, comparative genomics of closely related bacteria. Introduction to metabolomics, lipidomics, metagenomics, systems biology, Pharmacogenetics and drug development

REFERENCES

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry
2. 2nd Edition. Wiley 2006 2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S & Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5326
TITLE OF THE COURSE : Human Genetic Diseases
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To help students in understanding the genetic basis of different diseases.
2. To familiarise students with basics of cytogenetic analysis

Course Outcomes:

1. Students will grasp the concepts of genetic basis of different diseases.
2. Students will understand the basics of cytogenetic analysis.

Total hours: 40 Hrs

Module I: Genetic factors in common diseases 10 Hrs

Genetic susceptibility to common diseases. Genetic approaches to common diseases. Diabetes mellitus, Hypertension, Coronary artery, diseases, Alzheimer's disease, Congenital abnormalities, Huntington's disorder, Neurofibromatosis, Cystic fibrosis, Duchenne Muscular Dystrophy (DMD), Becker muscular dystrophy, Hemophilia A and B. Trinucleotide Repeat Expansion mutations and their remediation.

Module II: Biochemical genetics and pharmacogenetics 10 Hrs

Biochemical genetics: Inborn errors of metabolism, molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Mucopolysaccharide and Galactosemia, Albinism

Pharmacogenetics: Definition, drug metabolism, Genetic variation revealed solely by the effect of drugs, Hereditary disorders with altered drug response, Evolutionary origin of variation in drug responses, Pharmacogenomics, Molecular detection of diseases after human genome project, Drug discovery.

Module III: Cellular and molecular cytogenetic technologies 10 Hrs

Cell lines, Cell and tissue culture practices, harvesting of cells for chromosomal analysis, Conventional and specialized staining protocols, Imaging in cytogenetic practices, Chromosome jumping and walking, Chromosome instability and fragile sites.

Module IV: Diagnosis of prenatal and haematopoietic disorders 10 Hrs

Prenatal diagnosis: Amniocentesis, Chorionic villi biopsy, Cytogenetics of prenatal chromosomal abnormalities with clinical citations, Genetic counselling, Chromosomal diagnostics in hematopoietic disorders: Myeloid disorders, AML, CML and lymphoid

leukaemia, lymphoblastic lymphoma and their chromosomal changes, Chromosome changes in benign and malignant tumors, Cytogenetics of breast cancer.

REFERENCES

1. Peter Sudbery 2002. Human Molecular Genetics (Second Edition), Prentice Hall.
2. Tom Strachan & Andrew P.Read 1999. Human Molecular Genetics (2nd Edition), John Wiley & Sons
3. M.A. Jobling, M.E. Hurles & C. Tyler-Smith, 2004. Human Evolutionary Genetics-Origins, Peoples & Disease, Garland Science.
4. Jorge J.Yunis, 1977. Molecular Structure of Human Chromosomes, Academic Press.
5. Elaine Johansen Mange & Arthur P. Mange, 1995. Basic Human Genetics (Second Edition), Sinauer Associates, Inc.
6. Ricki Lewis, 1998. Human Genetics-Concepts & Applications (3rd Edition), McGraw-Hill.
7. Margarlet J.Barch, Turid Knutsen & Jack L.Spurbeck, 1997. The AGT Cytogenetics Laboratory Manual (3rd Edition), Lippincott-Raven.
8. K.C. Sawant 2003. Concise Encyclopedia of Human Genetics, Dominant Pub. & Distributors
9. Amita Sarkar, 2001. Human Genetics, Dominant publishers and Distributors.
10. Michael Baraitser & Robin Winter, 1983. A Colour Atlas of Clinical Genetics, Wolfe Medical Publications Ltd.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5371
TITLE OF THE COURSE :BIOPROCESS TECHNOLOGY AND IMMUNOTECHNIQUES-LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:

1. To equip students with techniques for industrial production.
2. To learn immune techniques used as diagnostic tools.

Course Outcomes:

1. This course will enable students to learn techniques which can be used in industrial production.
2. It will also teach diagnostic immune techniques routinely used in medical laboratories

PRACTICALS

1. ELISA/Dot ELISA
2. Radial Immunodiffusion/Ouchterlony Double Diffusion
3. Rocket Immuno Electrophoresis
4. Demonstration of a fermenter and its types.
5. Preservation techniques of industrially important microorganisms – soil, glycerol, mineral oil and lyophilization.
6. Production of organic acids (citric acid) from microbes
7. Immobilization technique: whole cell or enzyme- sodium alginate gel method and demonstration of its significance.
8. Production of antibiotic (penicillin) by submerged and solid substrate fermentation.
9. Laboratory scale production of wine/beer.
10. Estimation of alcohol by specific gravity method and determination of total acidity and non-reducing sugars (2 units)
11. s
12. Production of amylase by solid substrate fermentation.
13. Production of yoghurt and estimation of lactic acid at different time intervals.

REFERENCES:

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
3. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MBT5372
TITLE OF THE COURSE : ELECTIVE BASED PRACTICAL- I
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives

1. The course will help in making the students learn basic techniques for plant and animal tissue culture
2. To equip students with basic methods of isolation and purification of enzymes

Course Outcome:

1. Students will have fundamental practical knowledge of the techniques to use cell culture.
2. Students will acquire practical knowledge of isolation and purification of enzymes.

PRACTICALS

1. Preparation of plant tissue culture media
2. Isolation of plant protoplasts
3. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
4. Sterilization and inoculation of plant material for callus induction.
5. Animal cell culture: Preparation of (serum and non-serum supplemented) media.
6. Primary culture of fibroblast cells/liver cells/testis-leydig cells
7. Assessment of viability and counting using trypan blue exclusion method
8. Isolation of enzyme and estimation of its activity (Urease/Amylase/Acid Phosphatase/esterase) - any one
9. Determination of kinetic properties of amylase/acid phosphatase/urease/esterase (2 units).
10. Partial purification of the enzyme by salting out/acetone and dialysis (2 units)
11. To perform SDS-PAGE and check the purity of the isolated enzyme (2 units).

REFERENCES

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)
4. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)
5. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer,

Prentice Hall (2011)
6. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).
7. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER/YEAR : III SEM

COURSE CODE : 20MBT5372
TITLE OF THE COURSE : ELECTIVE BASED PRACTICAL- II
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives

1. The course will help in making the students learn basic techniques for understanding genetic concepts and detecting human genetic diseases.
2. The course imparts practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

Course Outcome:

1. Students will have fundamental practical knowledge of the techniques for understanding genetic diseases
3. Students will acquire practical knowledge on methods and tests useful in water quality assessment and determination of medical risks.

PRACTICALS

1. Karyotyping of normal/abnormal chromosome set
2. Restriction digestion and Restriction mapping
3. Identification of inactivated X- chromosome as Barr body.
4. Demonstration of PCR technique.
5. Estimation of SGPT/SGOT in serum samples.
6. Estimation of serum cholesterol by Zak's method.
7. Determination of Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) (3 units)
8. Isolation and enumeration of biodegradative microorganisms (hydrocarbons/ pesticides/ heavy metals) or cellulolytic microorganisms from soil.
9. Potable water quality assessment-MPN

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
4. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.
5. Ronald L Dooste- Theory and Practical of water and waste water treatment.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20MSC5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: 10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: 10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: 10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: 10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.
Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.
Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.
Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)

3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).
9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid

peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products- organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2099.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2096.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2099.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 2097, Mc Graw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER/YEAR :II SEM
COURSE TITLE :FUNDAMENTALS OF HUMAN GENETICS
COURSE CODE :20MHG5201
L: T: P: S/P : C : 4: 0: 0: 0 : 4

TOTAL HOURS: 52

COURSE OBJECTIVES:

- To be updated with the knowledge on the basics of human genetics and genetic causes for human diseases.
- To study the genetic techniques as to gain the knowledge in the field of basic human genetics.

COURSE OUTCOME:

1. The fundamentals of human genetics will help to students in obtaining basic knowledge of human genetics and its importance.
2. Students will have an idea on identifying the pattern of inheritance and genetic cause for the disease.

MODULE 1 **13 hrs**

Introduction to Genetics: Mendel and his experiments, Law of segregation and independent assortment; Chromosomal basis of segregation and independent assortment. Allelic variation and gene function, Dominance relationships, basis of dominant and recessive mutations; Multiple allelism, allelic series.

MODULE 2 **13 hrs**

History and Scope of Human Genetics: Origin of Human Genetics, Present and future prospectus of Human Genetics, Pedigrees-gathering family history, pedigree symbols, construction of pedigrees; Monogenic traits-Autosomal inheritance-dominant and recessive; Sex-linked inheritance-dominant and recessive; Sex-limited and sex-influenced traits; Y-linked; Mitochondrial inheritance, Errors in transmission (Mutation), Classification of Genetic Disorders, Medical Applications of Chromosomes, Drawing of a pedigree, Consanguinity.

MODULE 3 **13 hrs**

Human Cytogenetics: Review of cellular division mitosis and meiosis, Human Chromosomes, Chromosomal aberrations, Techniques in human chromosome analysis, Human karyotype: banding, nomenclature of banding, Pathology of human chromosomes, Nomenclature of aberrant karyotypes, Common chromosomal disorders and Mendelian disorders: Down syndrome, Edwards syndrome, Patau's syndrome and other trisomies, disorders of structural aberrations.

MODULE 4 **13 hrs**

Complex traits: Characteristics and structure of genes, Single gene disorders, Multifactorial disorders. Polygenic inheritance of continuous (quantitative) traits, Dysmorphology, Polygenic inheritance of discontinuous (dichotomous) traits-threshold model, liability and recurrence risk, Genetic susceptibility in multifactorial disorders (alcoholism, diabetes mellitus, obesity), Estimation of genetic components of multifactorial traits: empiric risk, heritability, coefficient of relationship.

REFERENCES:

1. Principle of Genetics, 8th Edition, Gardner, Simmons, Snustad.
2. Human Molecular Genetics, 2nd edition, Tom Strachan and Andrew P. Read.
3. Human Genetics, Lewis, 1999.
4. Basic human Genetics, Mange and Mange, 1999.
5. Human Molecular genetics, Strachan and Read, 2003.
6. Cummings, M.R. 1997. Human Heredity: Principles and Issues. International Thomson Publishing Co., New York.
7. Mckinlay Gardner, R.J. 2000. Chromosome Abnormalities and Genetic Counseling. Oxford University Press, Oxford.
8. Ricki Lewis. 2009. Human Genetics-Concepts and Application. Ninth Edition. McGraw-Hill Collge Publishers.
9. Stern. C. 1973. Principles of Human Genetics, 3rd ed. W.H. Freeman and Company, San Francisco.
10. Turpin, R. and Lejeune, J. 1969. Human Afflictions and Chromosomal Aberrations. Pergamon Press, Oxford.

SEMESTER/YEAR : II SEM
COURSE TITLE :HUMAN BIOCHEMICAL AND IMMUNOGENETICS
COURSE CODE : 20MHG5202
L: T: P: S/P : C : 4: 0: 0: 0 : 4

COURSE OBJECTIVES:

- To understand the genetics of biochemical disorders especially inborn errors of metabolism.
- To study the genetics of immune system and immunodeficiency diseases.

COURSE OUTCOME:

- Students will get an idea of how genetically inherited diseases are associated with biochemical pathways.
- This course will help to understand the importance of genes in gaining immunity.

MODULE 1 **13hrs**

The concept of Biochemical Polymorphism: Concept of enzyme and protein polymorphism; Effects of multiple gene loci on protein structure; Molecular structure, biosynthesis and genetics of the ABH antigens, Rh antigens and MN antigens. Quantitative and qualitative variation of enzymes; Haemoglobin variants; Hemoglobin and Hemoglobinopathies, Effects of Single Amino Acid Substitutions: Sickle cell Anaemia, Genetics of steroid and insulin receptors.

MODULE 2 **13hrs**

: Disorders of aminoacid metabolism (Alkaptonuria, Phenylketonuria, Maple Syrup Urine Disease), Disorders of Carbohydrate Metabolism (Galactosemia, Hereditary Fructose Intolerance), Glycogen storage diseases (affecting liver and muscle), Lysosomal Storage Disorders (Tay-Sachs Disease), Disorders of Lipoprotein and lipid metabolism-Hyper Lipoproteinemia, FH; Disorders of Purine metabolism Lesch Nyhan syndrome; Disorders of Pyrmidine metabolism-Orotic Aciduria, Disorders of copper metabolism (Menkes and Wilson diseases).

MODULE 3 **13hrs**

Introduction to immune system: Innate and adaptive immunity, Phagocytes, the complement system, natural killer cells; The adaptive immune system: Cellular immune system, humoral immune system; Genetic basis of structure and diversity; Immunoglobulin molecules and genetic basis of antibody diversity. Organization of immunoglobulin genes, mechanism of gene rearrangements, class switching, regulation of immunoglobulin genes.

MODULE 4 **13hrs**

Regulatory mechanisms of immune system: The Major Histocompatability complex

(MHC), Organization of HLA complex, Structure of class I and II HLA molecules, Expression of HLA genes, HLA polymorphism. Immunodeficiency diseases-Agamma- globulinemia, Severe combined immuno-deficiency, Ataxia telangiectasia, Wiskott-Aldrich syndrome. Hypersensitive reactions, Cytokine-related diseases, Immune system in human health, Immune response to infectious diseases and malignancy, Concept of immunotherapy, Vaccines, Transplantation immunology.

REFERENCES:

1. Harris, H. (1980). The Principles of Human Biochemical Genetics. North Holland/Elsevier, Boston.
2. Murphy, K. and Weaver, C. (2017). Janeway's Immunobiology: The Immune System in Health and Disease. Garland Science, Taylor & Francis, New York, USA.
3. Nelson, D.L. and Cox, M.M. (2017). Lehninger's Principles of Biochemistry. W.H. Freeman and Co., New York, 5th ed.
4. Owen, J.A., Punt, J. and Stanford, S.A. Kuby Immunology (2013). W.H. Freeman and Company, New York.
5. R. F. Mueller and I.D Yound (2001) Emery's Elements of Medical Genetics.
6. Scriver, C.R. A.L. Beudit, W.S. Styabnd D. Valle, Molecular Basis of Inherited Diseases, (6th Edition 1989) by EdsO McGrawHill, New York.
7. Robert N, Roderick M, Huntington W (2015) Thompson and Thompson Genetics in Medicine, Elsevier, Saunders, London
8. E Benjamin, G Sunshine and S Leskowitz (1997). Immunology a short course. Wiley-Liss, New York.
9. Barrett (1988). Text Book of Immunology. Mosloy
10. Roitt (2003). Essential Immunology. Blackwell

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis,

transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 2093.
4. David Rawn J (2089)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
8. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5202
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: 13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: 13hrs

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: 13hrs

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.

5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM/I YEAR
COURSE TITLE : PRACTICALS IN HUMAN CYTOGENETICS, BIOCHEMICAL AND IMMUNOGENETICS
COURSE CODE : 20MHG5271
L: T: P: S/P : C : 0: 0: 6: 0 : 3

COURSE OBJECTIVES:

- To increase students learning ability by conducting praticals of human cytogenetics, on biochemical genetics including errors in metabolism.
- To familiarize students with the various immunological techniques including antigen-antibody interactions, quantitation of antigens or antibody, agglutination reactions etc.

COURSE OUTCOMES:

- After this course students would have practical knowledge of various human cytogenetic, biochemical and immunological techniques.
- Completion of this practical course, student will have the hands on training experience, which will help to carry out such practical experiments as well as research in future.

1. Barr body identification from buccal cells.
2. Karyotyping:
   a) Setting up of Human leukocyte culture
   b) Harvesting and metaphase plate preparations
   c) Preparation of G-banded chromosomes and observation
3. Problems on patterns of Inheritance in Human: Pedigree analysis; Autosomal patterns, X and Y linked patterns.
4. Glucose estimation from Blood/Urine.
5. Sickling test to identify sickle shaped RBC's.
6. Determination of Red Blood Cell (RBC) and White Blood Cell (WBC) count by using hemocytometer.
7. Blood smear preparation and differential leukocyte count.
8. ABO-Blood grouping and Rh typing.

9. Single/Double Immunodiffussion assay for quantitation of antigens/antibody.
10. Determination of lymphocyte viability by Trypan blue dye exclusion test.

REFERENCES:

1. Wilson & Walker (2000). Practical biochemistry. Principle and techniques, Cambridge.
2. Grifith's et al. (2004). An introduction to genetic analysis, Freeman
3. Rooney, D.E. and Czepulkowski, B.H. (1992). Human Cytogenetics: A Practical Approach. IRL Press, Vol. 1&2, 2nded.
4. Stoddart, M.J. (2011). Mammalian Cell Viability: Methods and Protocols. Humana Press, New York.
5. Gersen, S.L. and Keagle, M.B. (2005). The Principles of Clinical Cytogenetics. Humana Press, 2nded.
6. Freshney, R.I. (2010). Animal Cell Culture: A Practical Approach. IRL Press, Oxford, 2nded.
7. Hay FC and Westwood OMR (2003) Practical Immunology, 4th Ed., Blackwell Publishing.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5271
TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 20MSC5301
TITLE OF THE COURSE : CLINICAL RESEARCH
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical research

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical trial studies.

Total hours: 26

MODULE I: Concepts of Clinical Research 13 Hrs

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd).* maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50} & ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research 13Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial

Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR **: III SEM/ 2nd YEAR**
COURSE CODE **: 20MSC5302**
TITLE OF THE COURSE **: SCIENTIFIC WRITING AND IPR**
L: T: P: S/P : C **: 2: 0: 0: 0 : 2**

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing: **13 Hrs**

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.
Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights **13 Hrs**

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.
Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.

2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20MSC5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: 10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: 10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: 10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: 10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: General Chemistry 13Hrs

Types of chemical bonds in biological molecules, Hydrogen bonding & its relevance in biological systems, importance of water in biological systems, pH, pKa, pKb, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation VSEPR, Crystal field theory, Ligand field theory – explanation of coordination bonds in biomolecules - bonding of iron in haemoglobin & cytochromes, cobalt in vitamin B12, magnesium in chlorophyll.

MODULE 2: Physical Chemistry 13Hrs

Electrochemistry: Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation.

Thermodynamics: First & second laws of thermodynamics , enthalpy, entropy, free energy, free energy change & its applications in biology, activity, chemical potential.

Chemical Kinetics: Rate of reaction, order& molecularity of reactions, effect of temperature on reaction rates, Arrhenius equation, activated complex theory, catalysis

MODULE 3: Organic Chemistry - I 13Hrs

Stereochemistry: Geometric & Optical Isomerism, Symmetry elements, R/S notation, chirality & optical activity, Stereochemistry of glucose & amino acids.

Reactive intermediates: Reactive intermediates, Ionic, radical & concerted reactions, transition state theory, kinetically & thermodynamically controlled reactions.

MODULE 4: Organic Chemistry - II 13Hrs

Reaction mechanism: S_N1, S_N2 E1 & E2 reactions, aromatic electrophilic and aromatic nucleophilic reactions, mechanistic study of reactions important for biology, metabolic reactions, aldol condensation – collagen and elastin, esterification of acids, oxidation and reduction. Heterocyclic compounds: aromaticity, Chemistry & biological relevance of furan, indole, thiazole, pterine, pteridine, isoalloxazine, pyrrole, chemistry of porphyrins.

REFERENCES:

1. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London(2096).
2. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Ed. Prentice Hall, India (2092)
3. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
4. Organic Mechanisms, Peter Sykes, Longman, (2077).
5. Inorganic Biochemistry. G.L. Eicharn, Elsevier
6. Physical Biochemistry. David Frifielder. 2nd Ed. W.G.Freeman and Co
7. Introduction to Biophysical Chemistry, Robert Bruce Martin, McGraw-Hill (2064).
8. Bioinorganic Chemistry Ei-Ichiro Ochiai, Elsevier (2008).

9. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
10. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (2099).
11. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
12. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
13. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (2095).

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5102
TITLE OF THE COURSE : BIOMOLECULES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: CARBOHYDRATES 13Hrs

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides and sugar derivatives. Structural elucidation of carbohydrates through oxidation and exhaustive methylation, Glycosidic linkages in disaccharides and glycosides.

Complex Carbohydrates: Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans; Glycoproteins and Glycolipids - O and N linked oligosaccharides, Blood group determinants, Lectins, lipo-polysaccharides.

MODULE 2: AMINO ACID AND PROTEINS 13Hrs

Primary structure – structure, classification and acid-base properties of amino acids, Peptide bond, peptides, Merrifield synthesis of peptides; Primary structure –scheme of determination **–**amino acid composition analysis, N and C terminal analysis, cleavage of Disulfide bond, chemical and enzymatic fragmentation and sequencing through Edman's reagent.

Secondary structure: α-, PP-, 3_{10} and π-helix, β pleated sheet, β and γbend, Peptide bond geometry and conformational map, Chou and Fasman algorithm; Super secondary structures: motifs and domains.

MODULE 3: PROTEIN CONFORMATION AND FOLDING 13Hrs

Tertiary structure: interactions stabilizing tertiary structure; denaturation of proteins, secondary and tertiary structure of fibrous proteins: α-keratin, silk fibroin and collagen.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity, molecular basis of Sickle-cell anemia; Cross linking agents to determine subunit composition.

Protein folding: Protein renaturation, significance of Anfinson's experiment, Classical model of folding, Levinthol paradox, Landscape model of folding, accessory proteins- protein disulfide isomerases and molecular chaperones; conformational diseases: Alzheimer's and Prion diseases.

MODULE 4: LIPIDS AND NUCLEIC ACID 13Hrs

Lipids: Classification and biological importance of lipids. Structure, nomenclature, properties and functions of Simple lipids - free fatty acids, acyl glycerols& wax; Complex lipids - phospholipids, ether lipids, sphingolipids, galactolipids and Derived lipids – sterols and icosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

Nucleic acids: Nucleosides, nucleotides and polynucleotides; Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; denaturation and renaturation curves of nucleic acids; Oligonucleotide synthesis by phosphoramidite method.

REFERENCES:

1. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (2093).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (2083).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (2089).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5103
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: Concepts in Genetics and Genomics 13hrs

Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2:Molecular Mechanisms of Recombination 13hrs

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3: Molecular Basis of Mutation and Transposable Genetic Elements. 13hrs

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

Module 4: Sex Determination and Cancer Genetics 13hrs

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral

and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

REFERENCES:

1. John Ringo (2004). Fundamental Genetics. Cambridge University Press.
2. Griffith et al (2011) An introduction to genetic analysis (10th Edition) W.H. Freeman and Company
3. Strachan and Read (2010) Human Molecular genetics (4th Edition) Taylor and Francis.
4. Principles of Genetics by Snustad and Simmons, 6th Edition (2011) John Wiley and Sons, Inc publisher.
5. David Freifelder (2004). Microbial genetics. 10th edition, Norosa publisher, New Delhi.
6. Lodish, H.D., Baltimore, A., Berk, B.L., Zipursky, P., Mastsydairs and Darnell, J. (2004).Molecular cell biology. Scientific American Books Inc., NY.
7. Snustad and Simmons. (2006). Principal of Genetics. 8th Edn. John Wiley & sons. Klug, W.S.,Cummings. (2003). Concepts of genetics, 7th Edn. Pearson Education.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5104
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: History and Systematics of Microorganisms 13hrs

History and development of Microbiology: Scope and Applications of Microbiology, Discovery of microorganisms, Spontaneous generation theory, Biogenesis theory, Germ theory of diseases. Contributions of scientists to Microbiology.

Microbial Systematics - Classification systems: Criteria for classification of microorganisms, classification systems artificial and phylogenetic, Haeckel's three-kingdom classification, Whittaker's five-kingdom classification, three-domain concept of Carl Woese.

Taxonomy: Identification and nomenclature, binomial nomenclature, international code of nomenclature of prokaryotes, taxonomic ranks and hierarchical organization. Molecular methods (DNA homology, DNA-RNA homology, G+C ratio), phage typing and Serological methods in taxonomy, Numerical taxonomy. Concepts and Applications of Bergey's manual of systematic and determinative bacteriology.

MODULE 2: Microbial Techniques 13hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM). Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial Nutrition and kinetics: Growth curve, Macro and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: Applied Microbiology-I 13hrs

Agriculture Microbiology- Biofertilizer: Biological Nitrogen fixation- symbiotic and asymbiotic, Phosphate solubilizing microbes, Microbial antagonism in soil, PGPR, Biological control of plant diseases (*Trichoderma, Pseudomonas* and AM fungi). Biopesticides: *Bacillus thuringiensis* and *Beauveriabassiana*.

Medical Microbiology:pathogens, host-pathogens interaction, infection and its types. Bacterial diseases: *Staphylococcus* and *Salmonella.* Fungal diseases: Candidiasis, and Aspergillosis. Viral Diseases- Pox virus and Hepatitis viruses. Protozoan and Helminthic diseases:Malariaand Filaria.

MODULE 4: Applied Microbiology-II 13hrs

Environmental Microbiology: Microbes in biogeochemical cycle, biodegradation of pesticides (2,4D and DDT), crude oil, oil spillage in ocean, Xenobiotic (PET), biosorption of heavy metals.

Industrial Microbiology: Fermentation, types, fermentor design, fermentation products-organic acids, vitamins, antibiotics and enzymes, fermented food- bread, cheese, Alcoholic products- wine and beer.

REFERENCES:

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 2099.
4. Dubey, R.C. Microbiology 1st Edition. Chand and company.
5. Edward Alcamo. Microbiology. Cliffs Notes 2096.
6. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
7. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 2099.
8. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.
9. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
10. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
11. Salle, A.J. Principles of Microbiology, 2nd edition., 2097, Mc Graw Hill.2097.
12. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005.
13. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5105
TITLE OF THE COURSE : BIOINFORMATICS – I (PROTEOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1: 13 hrs

History, scope, definitions and basic concepts in bioinformatics and its relation with molecular biology. Basic concepts in computer and its organization. Software & operating system - Windows, UNIX, Linux, Java, PERL and python. Application software- word processor, spread sheet. Introduction to networks - LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls.

Data management - Relational Databases Management (RDMS) - Database generation. Data mining and applications, accessing bibliographic databases-Pubmed, Google Scholar, NCBI, EMBL and DDBJ. Protein sequence databank- NBRF- PIR, SWISSPROT. Structural databases - protein data Bank (PDB) &UniProt, Metabolic pathway data bank (KEGG)

MODULE 2: 13 hrs

Introduction to protein structure. Data generation; Generation of large scale molecular biology data (Through, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction and protein biochips).

Tools in proteomics: databases (GENBANK, Pubmed, PDB),Sequence analysis (FASTA, BLAST, BLAT), Structure viewer (RASMOL, PyMOL). Motif and Domain: Motif databases and analysis tools. Domain databases (CDD, SMART, ProDom) and analysis tools.

Secondary structure prediction (GOR), tertiary structure prediction, protein modelling-principles of homology and comparative modelling phylogenetics; Structure prediction methods – high accuracy and template based, free modelling (new folds); Pattern recognition – PSSMs, weight matrices; hidden Markov models. Threading, structure evaluation and validation and *ab intio*Modelling, Applications - Molecular docking – Autodoc.

REFERENCES

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5106
TITLE OF THE COURSE : BIOSTATISTICS
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26

MODULE 1:Measures of Central Tendencies, Dispersion And Correlation13hrs

Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2:Probability Distributions and Testing of Hypothesis 13hrs

Probability: types of event, sample space, definition, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions-Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of “p” value. Statistical package-Features of statistical software, SPSS for various applications in Biostatistical program.

REFERENCES:

1. Daniel (2099). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (2099). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (2085). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (2083). Mathematics in microbiology Academic press
5. Green, R.H. (2079). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (2074). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (2067). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5171
TITLE OF THE COURSE : ANALYSIS OF BIOMOLECULES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Estimation of lactose in milk by Miller's method
2. Estimation of amino acids by Ninhydrin method
3. Estimation of Iodine number of fats
4. Estimation of nucleic acids by Orcinol and DPA method
5. Potentiometric titration of amino acids
6. The study of kinetics of potassium persulphate and potassium iodide via calorimetry
7. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation
8. Estimation of percentage of iron in hematite ore using barium diphenylamine sulphonate as an internal indicator
9. Estimation of calcium in lime stone by titrimetric method
10. Determination of the percentage of available chlorine in the given sample of bleaching powder

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM
COURSE CODE : 20MSC5172
TITLE OF THE COURSE : TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus*and*Puccinia.*
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria*and*Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.
11. Concept of Multiple Alleles in Humans (Blood group).
12. Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill
3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MMB5201
TITLE OF THE COURSE : PROKARYOTIC AND EUKARYOTIC MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52hrs

MODULE 1: BIOLOGY OF VIRUS 13hrs

Difference between prokaryotic and eukaryotic microorganisms. Discovery, distinctive properties, morphology and ultra-structure of Virus, Classification, Cultivation and Purification assay of virus. Bacteriophages - structural organization and life cycle - lytic, lysogenic.Application of viruses.

Type studies: Bacteriophages (T4 and λ phage), animal viruses (Polio) and plant viruses (TMV), (Ultra-structure, replication and importance). Viral related agents - viroid and prion.

MODULE 2: BIOLOGY OF BACTERIA 13hrs

Bacteriology: Ultrastructure of bacterial cell, Cell morphology, size, shape and arrangement; flagella, pili, capsule, cell wall, cell membrane, cytoplasm. Intracytoplasmic inclusions: nucleoid, plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, polyhydroxybutyrate granules, glycogen, oil droplets, and sulphur globules), endospores and exospores. Reproduction in bacteria.

Special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae, Archaebacteria and extremophiles.

Microbial growth and nutrition: Over view of cell Growth, Phases of growth, Generation time; Growth Kinetics; Physical conditions required for growth; Nutritional uptake, nutritional factors required for growth and reproduction. Classification of microorganisms based on environmental and nutritional requirements.

MODULE 3: BIOLOGY OF FUNGI & PROTOZOA 13hrs

General characteristics of fungi including habitat, classification, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, Sex and mating in fungi fungal spores – dormancy and dispersal.

Type studies: *Aspergillus*, *Saccharomyces*, *Pythium*, *Rhizopus*, *Fusarium*, *Puccinia* and *Agaricus* (Classification, Ultrastructure, reproduction, lifecycle, importance).

General features of Protozoa, classification. Structure, reproduction and significance of: *Leishmania, Amoeba, Entamoeba*and *Plasmodium.* Cultivation of protozoa.

MODULE 4: BIOLOGY OF ALGAE 13hrs

General characteristics of Algae, occurrence, thallus organization, classification, ultra-

structure of cell, vegetative, asexual and sexual reproduction.Algal life cycles- Haplontic, Diplontic, Diplohaplontic, Haplobiontic, and Diplobiontic type, Isolation from soil and water; Algal cultivation, measurement of algal growth. Structure and life cycle of *Chlamydomonas, Spirogyra, Diatoms, Sargassum and Porphyra.* Symbiotic algae: Lichens. Economic importance of algae.

REFERENCES:

1. Sambamurty, A.V.S.S.. A Textbook of Algae. I.K. International Publishing. (2005).
2. Alexopoulos, C. J. and Mims, C.W. Introduction to Mycology, Wiley.(2001)
3. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
4. Khattar, JIS. Algal Biology and Biotechnology. I.K. International Publishing House Ltd. NewDelhi (2009)
5. Kashyap and Kumar, H.D. recent advances in phycology-Rastogi Company (2094).
6. Mahendra Rai. Mycotechnology: Present Status and Future Prospects. I.K. International Publishing House Ltd.NewDelhi (2007).
7. Mark F. Wiser. Protozoa and Human Disease. Garland Science, (2010).
8. Mehrotra, R.S. and Aneja, K.R. An Introduction to Mycology, New Age Publications (2002).
9. Nagamani.. Handbook of Soil Fungi. I.K. International Publishing House. NewDelhi (2006).
10. Nick Talbot. Molecular and Cellular Biology of Filamentous Fungi: A Practical Approach Oxford (2005).
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.2086.
13. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
14. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press. 2005
15. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MMB5202
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52hrs

MODULE 1: MICROBIAL METABOLISM 13hrs

Carbohydrate and Protein Metabolism: Glycolysis, Entner – Doudoroff. TCA cycle, Gluconeogenesis, Transamination, oxidative deamination, decarboxylation, Urea cycle.Brief account of porphyrins.
Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria. Carbon dioxide fixation pathways, Methanogenesis.
Fermentation: Alcohol fermentation, Lactic acid: Homo- and Heterolactic acid fermentation; Acetic acid, butyric acid, mixed acid and proponic acid fermentation.
Fungal and bacterial secondary metabolism: Brief account on biosynthesis and action of secondary metabolites antibiotics, bacterial and fungal toxins, pigments, fungal hormones. Bioluminescence – mechanism and significance.

MODULE 2: ENZYMOLOGY 13hrs
Enzymes: Definition, classification, nomenclature, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups.Effect of temperature, pH and substrate concentration on reaction rate. Isozymes, Enzyme Kinetics and co-enzyme action
Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Determination of kinetic parameters, hyperbolic and LB plot. Regulation of enzymes: Covalentand noncovalent modification; Enzyme inhibition - types of inhibitors - competitive, noncompetitive and uncompetitive.Ribozymes and abzyme.

MODULE 3: MICROBIAL RESPIRATION AND BIOENERGETICS 13hrs
Introduction: Principles of thermodynamics, high energy compounds- ATP, NAD, FAD, FMN, quinones, components and mechanisms of respiratory chain.
Bacterial aerobic respiration: Components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation, structure of bacterial ATPase. Theories of ATP formation, generation and maintenance of PMF and inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria.
Anaerobic respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria.

MODULE 4: MICROBIAL CELL MEMBRANE PHYSIOLOGY 13hrs
Metabolite transport: Methods to study diffusion of solutes in bacteria, passive diffusion,

facilitated diffusion, different mechanisms of active diffusion (PTS, role of permeases in transport, different permeases in *E. coli*. Transport of aminoacids and inorganic ions in microorganisms (Bacteria and fungi) and their mechanisms.

Stress physiology: Osmotic stress and osmoregulation by glutamate and disaccharide trehalose, Osmotic Control of Gene Expression. Aerobic to anaerobic transitions in facultative microorganisms (*E. coli*); Oxidative stress - superoxide dismutase and catalase, Regulation of the Oxidative Stress Response, pH stress and acid tolerance; Thermal stress and heat shock response (genes); Nutrient stress and starvation stress, stringent Control.

REFERENCES:

1. Arora, D.K. and Seema Gupta (2096). Bacterial Physiology. Anmol Publications. New Delhi.
2. Brun, Y.V. and Shimkets, L.J. (2000). Prokaryotic Development, ASM Press.
3. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
4. Caldwell. D.R. (2095). Microbial Physiology and metabolism, Brown Publishers.
5. Deb, A.C. 2006. Fundamentals of Biochemistry, New Central Book Agency Pvt. Ltd., Kolkata.
6. Donald Voet and Judith G. Voet, 2011. Biochemistry. Third Edition, John Wiley and Sons, Inc. New York.
7. Stryer, L. 2010. Biochemistry, Seventh Edition, W.H. Freeman and Company, New York.
8. El-Sharoud, Walid (Ed.) (2007). Bacterial Physiology a molecular approach. Springer.
9. Moat, A.G. & Foster, J.W. (2099). Microbial physiology, Wiley-Liss.
10. Moat, A.G. and Foster, W.2002. Microbial Physiology, Fourth Edition, John Wiley and Sons, New York. Postgate,J. 2098, Nitrogen Fixation, third edition, Cambridge University Press.
11. Salisbury, F.W. and W.Ross, 2092, Plant Physiology, fourth edition, Wardsworth Publishing Company, California.
12. Smith and Wood (2091). Energy in Biological Systems. Chapman and Hall.
13. Srivastava, M.L. 2008. Microbial Biochemistry, Narosa Publishing House, New Delhi.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5201
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: DNA Replication and Repair 13hrs

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA.Structure and functions of different types of RNA. C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson& Stahl experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomeresynthesis-telomerases. regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.

Mechanism of DNA Repair:DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene Expression – Transcription 13hrs

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination-Rho dependent and Rho-independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination.

Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene Expression – Translation 13hrs

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of aminoAcids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Coand post translational modifications of proteins, translation control in Eukaryotes.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins tomitochondria, chloroplast, peroxisomes and membrane.

MODULE 4:Regulation of Gene Expression in Prokaryotes and Eukaryotes 13hrs

Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP intheexpression of lac genes and catabolite repression Regulation of tryptophan operon by Attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs oftranscription factors, posttranscriptional control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

REFERENCES:

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition). John Wiley and Sons
2. Robert F. Weaver Molecular Biology. McGraw-Hill, 2012. (4th edition)
3. Principles of gene manipulation - An introduction to genetic engineering, Old R.W.,Primrose S.B., Blackwell Scientific Publications, 2093.
4. David Rawn J (2089)Biochemistry, Neil Patterson Publishers.
5. Nelson, D.L., Cox, M.M. Lehninger Principles of Biochemistry (2005). 4th edition, Pub WH Freeman Co.
6. Elliott, W.H., Elliott, D.C. Biochemistry and Molecular Biology 3 Indian edition,Pub. Oxford.
7. Alberts, B., Bray, D., Lewis, J., Raf, M., Roberts, K. and Watson, J.D. (2094). Molecular Biology of the Cell.
8. Cooper, G.M. (2097).The Cell: A molecular approach, ASM Press, USA.
9. Darnell, J. Lodish, H., Baltimore, D. (2090). Molecular Cell Biology. Scientific American Books Inc. NY.
10. Garrett, R.H. and Gresham, C.M. (2095). Molecular aspects of Cell Biology, International edition, Saunders College Pub.
11. Genes IX. 9th ed. B. Lewin. Jones and Bartlett Publishers, 2007.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5202
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Total Hours: 52

MODULE 1: 13hrs

Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS.

Structural elucidation: CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.

MODULE 2: 13hrs

Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques.

Mass spectrometry: principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips

MODULE 3: 13hrs

Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC

Radioactivity: Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.

MODULE 4: 13hrs

Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications.

Techniques in drug discovery: General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5203
TITLE OF THE COURSE : BIOINFORMATICS – II (GENOMICS)
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: 13 hrs

Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER.

Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs, Identification of motifs

MODULE 2: 13 hrs

Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files.

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5204
TITLE OF THE COURSE : EVOLUTION AND DEVELOPMENTAL BIOLOGY
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Total Hours: 26 Hours

MODULE 1: Ecology and Evolution 13hrs

Ecology: Introduction, biotic and abiotic factors, Biomes

Population ecology: Dynamics of population, Population growth-Exponential model Logistic growth model

Community ecology: Interactions, Biogeography, Speciation, Ecological succession, Disturbances Structure- Contrasting views

Ecosystems: Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems

Evolution: Introduction, Early ideas of evolution, Darwinian view of life.

Speciation and Evolutionary Rates: The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change.

Natural selection: Stabilizing, directional, and disruptive selection.

Microevolutionary and Macroevolutionary phenomena: insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2: Developmental Biology 13hrs

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting;

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.

REFERENCES:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).

7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER/YEAR : II SEM
COURSE CODE : 20MMB5271
TITLE OF THE COURSE : PROKARYOTIC, EUKARYOTIC AND MICROBIAL PHYSIOLOGY - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

1. Isolation and culturing of fungi (yeasts and molds) by Dilution plate method, Warcup method implant and impression.
2. Anaerobic culturing methods – anaerobic jar and its use, thioglycollate media culturing.
3. Isolation and identification of microscopic algae from soil and water.
4. Isolation and identification of protozoa from soil and water.
5. Biochemical test: Catalase, Oxidase, IMViC, starch, casein and Gelatin hydrolysis, Hydrogen sulfide production in TSIA, Identification of bacteria by API methods. (4 Units)
6. Growth measurement of bacteria (turbidity method) and fungi (Linear method).
7. Estimation of DNA and RNA.
8. Estimation of proteins
9. Estimation of enzyme activity – amylase and protease.
10. Enzyme kinetics – K_{max} and V_{max} of amylase

REFERENCES:

1. Arora, D.K. and Seema Gupta (2096). Bacterial Physiology. Anmol Publications. New Delhi.
2. Byung Hong Kim and Geoffrey Michael Gadd. (2008). Bacterial Physiology. Cambridge.
3. Caldwell. D.R. (2095). Microbial Physiology and metabolism, Brown Publishers.

SEMESTER/YEAR : II SEM
COURSE CODE : 20MSC5271
TITLE OF THE COURSE : BIO-ANALYTICAL TECHNIQUES - LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

PRACTICALS

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography
9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 20MMB5301
TITLE OF THE COURSE : IMMUNOLOGY AND MEDICAL MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection.
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

Course Outcomes:

1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories, use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents.

Total Hours: 52 Hrs

MODULE I : Immune System and Immune Responses 13 Hrs

Innate, adaptive, humoral and cellular immunity. Primary and secondary immune responses. Structure and properties of antigens: Types of antigens, specificity, Haptens and adjuvants- structure and properties; Immunoglobulins: Structure and properties, types and subtypes. Immunoglobulin genes: organization and assembly. Major histocompatibility complex (MHC); structure and organization of MHC Class I and Class II molecules. T-cell receptor; B and T cell activation. Antigen processing, antigen presentation, Complement system – pathways, component, properties and functions. Immune response to cancer. Hypersensitivity reactions - types (I, II, III, and IV).

MODULE II: Autoimmune Disorders, Transplantation and Pathogenic Diseases 13 Hrs

Autoimmune diseases- Insulin dependent Diabetic mellitus, Rheumatoid arthritis, Myasthenia gravis and their treatment. **Tissue transplantation-** Graft versus host reaction and rejection, xenotransplantation, tolerance.

Host Microbe Relationship- Normal microbial flora of human body and its significance. Koch's Postulates. Mode of entry of pathogen into human host. Infections and its types- nosocomial infections and non-infectious diseases. Immune response to infectious diseases; viral, bacterial, fungal and protozoal

infections (Hepatitis, HIV, *Mycobacterium tuberculosis, Salmonella typhi, Tricophyton* spp., *Candida albicans, Plasmodium vivax*, *Entamoeba histolytica*).

MODULE III: Immunological Techniques and Diagnostic Microbiology 13 Hrs

Techniques- Immunoprecipitation; Agglutination; Immuno-electrophoresis; RIA; Immunofluorescence; Cytotoxicity assay; flow cytometry; ELISPOT; ELISA; RIA, Western blotting; Tissue typing methods for tissue and organ transplantations. Polyclonal and monoclonal antibodies. Hybridomas and their production.
Diagnostic Microbiology: Collection, transport and storage guidelines; biosafety in diagnostic laboratory and regulations, specific procedures for collection of specimens, processing of specimens. Biomedical waste management and treatment.

MODULE IV- Vaccines and Antimicrobial Prophylaxis 13 Hrs

Vaccines: Active and passive immunization, Immunization protocol. Conventional vaccines, live vaccines, killed vaccines, toxiods, antisera, polysaccharide vaccines. Novel vaccines subunit and peptide vaccines, DNA vaccines, recombinant vaccines, edible vaccines. Common immunization programmes- BCG, Small pox, DPT, Polio, Measles, Hepatitis-B.
Antimicrobial Prophylaxis: Antibiotics, Classification of Antimicrobial agents, Mechanism of drug action-antibacterial, antiviral, antifungal and anti-protozoans-causes, mechanism and prevention. Probiotics as therapeutic agents.

REFERENCES

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.

11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (2097) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER/YEAR : III SEM
COURSE CODE :20MMB5302
TITLE OF THE COURSE : INDUSTRIAL, FOOD AND DAIRY MICROBIOLOGY
L: T: P: S/P : C : 4: 0: 0: 0 : 4

Course Objectives:

1. To exhibit depth of knowledge by demonstrating microbial sciences in the field of applied fields of industrial, food and dairy microbiology.
2. To relate microbes in interdisciplinary connections with other sciences, in particular to industrial productions, food sciences and dairy products.

Course Outcomes:

1. It will develop depth of understanding on fermentation technology, modern microbial techniques and analysis relating to industrial, food and dairy microbiology.

2. It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current analysis techniques relating to productions, food sciences and dairy products.

Total hours: 52 Hrs

MODULE I: Introduction to Industrial Microbiology 13 Hrs

Concepts and scope of microbes in industry. Screening, isolation of industrially important microbes. Strain improvement- mutation, recombination- gene regulation and genetic manipulation. Preservation of industrially important microbes. Culture collection centers.

Basic components and design of typical fermenter. Types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed, fluidized bed bioreactors and air-lift fermenter. Types of fermentation - Batch, chemostat, submerged and solid-state fermentation. Different parameters affecting fermentation.

MODULE II: Industrial Bioprocessing 13 Hrs

Upstream Processing: Nutrients: growth factors, carbon, nitrogen, mineral sources, buffers, inhibitors, precursors, inducers, oxygen requirements, antifoam agents and others. Methods of sterilization; culturing techniques of microbial

strains; inoculum preparation and inoculum development. **Downstream processing:** Solid matter, Foam separation, Precipitation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Solvent recovery, chromatography, Membrane processes, Drying, Crystallization, Whole broth processing.

Productions and Applications: Alcohol production, organic acids (citric acid), enzymes: amylases-(Fungal and Bacterial). Amino acid - L-Glutamic acid. Vaccines (Hepatitis B), hormones (human insulin), antibiotic (Penicillin). Applications of genetic engineering in industrial bioprocessing. Production economics and IPR: Concept of Patenting law, Copyrights, and Trademarks. Patent regulations and filing, processes, products and microorganisms.

MODULE III: Scope of Food Microbiology and Food Preservation 13 Hrs

Scope and Development of food microbiology. Food as a substrate for microorganisms; Principles and methods of food preservation by Physical, Chemical and food Additives, Bio-preservation. Microbial spoilage of food: Causes and sources of food spoilage. Food borne Infections and Intoxications. Bacteria – *Clostridium.* Virus- *Hepatitis A*, Sea toxicants; Mycotoxins (Aflatoxins, Ochratoxins,).

Fermented foods: Fermented Vegetables, Meat Sausages, Beverages, Bread and Idli. Nutritional and therapeutic importance: Single cell Protein, Probiotics and Symbiotics; Neutraceuticals, Quorn and Single Cell Oil and their industrial production). Food control Agencies: HACCP, Employees Health standards, GMP. Industrial effluents treatment, Criteria of microbiological quality control.

MODULE IV: Dairy Microbiology 13 Hrs

Nutritional level and microbial flora of milk. Sterilization of milk; predominant types of microorganisms in chilled and refrigerated milk and their importance; heat resistant bacteria and their role in milk spoilage; principles of quality control tests for milk; bacteriological grading.
Microbiology of dairy products: cream, butter, ice-cream and indigenous dairy products such as khoa, peda, yogurt, acidophilus milk, dahi, kefir, koumiss, shrikhand, cultured butter milk, cheese and other fermented milk products. Biosensors in Food Industry; Genetically modified foods; Food fortification.

REFERENCES

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.

2. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
3. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
4. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
5. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
6. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
7. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
8. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
9. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 2096
10. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
11. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
12. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
13. John G. Essentials of Food Microbiology. Arnold International Students Edition.
14. Frazer W.C. Food Microbiology. McGraw Hill, New York. 2079.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5321
TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. The course makes students understand distribution of microorganisms in nature, their habitat and interaction with other organisms.
2. The course enables the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

Course Outcomes:

1. Students will have fundamental understanding of the distribution and habitat of microorganisms in nature. They can apply the knowledge in studying microbial diversity in various environmental niches.
2. Students are aware of the role of microorganisms in the environment. They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms. The course helps them to apply knowledge in employing microbes in various fields.

Total Hours: 40Hrs

MODULE I: Soil Microbiology 10 Hrs

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.
Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide-reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE II: Aquatic Biology and Sewage Treatment 10 Hrs

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents,

Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE III: Aerobiology **10 Hrs**

Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens.

MODULE IV: Bioleaching and Biodegradation **10 Hrs**

Bioleaching: Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution.

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin, paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water '*in-situ'* remediation- Engineering developments - Constructed wet lands; Bioremediation of oils from contaminated soils; Biosorption; Phytoremediation.

REFERENCES

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.

6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5322
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.
2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

Course Outcome:

1. The students will be equipped with knowledge about the importance of microorganisms in agricultural field. They can understand how to employ microorganisms to enhance agricultural productivity.
2. The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.

Total Hours: 40Hrs

MODULE I: Plant-Microbe Interactions 10 Hrs

Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation:Symbiotic nitrogen fixation, (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation *Azotobacter,Azospirillum*). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.

MODULE II: Bioinoculants and Biological Control 10 Hrs

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- *Rhizobium, Azotobacter, Azospirillum*, Cyanobacteria,Phosphate solubilizing microorganisms and *Azolla*. Carrier-based inoculants–production,applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples

includes *Pseudomonas fluroscence, Bacillus thuringiensis*, *Trichoderma harzianum, Trichoderma viridae,* Nuclear Polyhedrosis Virus. Production, applications and limitations.

MODULE III: Host Pathogen Interaction and Defense Mechanism 10 Hrs Host

Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators.
Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defences (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.

MODULE IV: Plant Diseases and Their Management 10 Hrs

Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria).
Plant disease control: Classification of plant diseases and plant diseases control. Principles and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept. Diagnosis of plant diseases, regulatory, farming education and awareness.

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.

5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006
13. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5323
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To understand how DNA can be manipulated using different enzymes.
2. Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
3. Diverse methods to visualise modified genetic materials.
4. Applications of genetic engineering.

Course Outcomes:

1. This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.
2. It will also teach techniques to detect the engineered DNA, RNA and protein
3. Students will also learn various applications where genetic engineering can be used.

Total hours: 40 Hrs

Module I: Basic Concepts 10 Hrs

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.

Module II: Cloning and expression vectors 10 Hrs

Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.

Module III: Cloning strategies and study of protein-DNA interactions 10 Hrs

Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.

Module IV: Sequencing, PCR and its applications 10 Hrs

Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform).

PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).

REFERENCES

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition,
S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5324
TITLE OF THE COURSE : AQUATIC MICROBIOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To make students understand the diversity of microorganisms in aquatic environments, ecology and biogeochemistry.
2. To know the importance of aquatic microbes and to derive their utility in various fields.

Course Outcomes:

1. After completion of this course, student will be able to understand microbial diversity in aquatic environments. Students understand the role of aquatic microorganisms in biogeochemical cycles.
2. Students will have a better knowledge about the application of aquatic microorganisms in various fields.

Total Hours: 40 Hrs

MODULE I: Aquatic Environment 10 Hrs

Aquatic environment and distribution of microorganisms. Major environmental conditions influencing microflora in aquatic environment. Aquatic ecosystem-fresh water (ponds, lakes, stream), marine (estuaries, mangroves, deep sea, hydrothermal vents). Microbes in atmospheric water, surface water, stored water, groundwater, mineral water, spring water, well water. Nutrients in aquatic environments and food chain. Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients).

MODULE II: Marine Microbiology 10 Hrs

Marine environment–properties of seawater, chemical and physical factors of marine environment-Ecology of coastal, shallow and deep sea microorganism - significance of marine microflora. Diversity of microorganism - Archaea, bacteria, actinobacteria, cyanobacteria, algae, fungi, viruses and protozoa in the mangroves and coral environments - Microbial endosymbionts – epiphytes - coral-microbial association, sponge-microbial association. Water zonations- upwelling and downwelling, ocean currents. Benthic microorganisms. Marine microflora and biofouling. Barophilic and Barophiles, Halophilic archaebacteria and extremozymes. Sea food contamination. Bioluminescence.

MODULE III: Aquatic Microflora and Water Treatment 10 Hrs

Introduction to Water cycle. Techniques for the study of aquatic microorganisms. Role and importance of aquatic microbial ecosystem. Microbial consortia. Surface attachment and biofilm development. Antibacterial and bioactive compounds from aquatic microorganisms.

Waste Water Treatment: Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

MODULE IV: Water Pollution and Diseases 10 Hrs

Water pollution, microbial changes induced by inorganic and organic pollutants. Metals as pollutants. Algal blooms. Biological and chemical control of algal blooms. Formation of biofilm. Algal toxicity. Biomagnifications. Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection. Water borne diseases (Waterborne diseases *Travellers'* Diarrhea, *Giardia, Salmonella, Escherichia coli*, *Cholera* and *Hepatitis* A) and control measures.

REFERENCES

1. Elements of microbiology- Pelczar, Reid and Chan
2. Aquatic microbiology-Rheinheiner
3. Microbiology-Prescott, M.J, Harley, J. P. and Klein, D. A.
4. Gerhard Rheinheimer Aquatic Microbiology, John Wiley and sons, ISBN 0471718033.
5. Biodiversity and Dynamic Interactions of Microorganisms in the Aquatic Environment and Freshwater Microbiology: John Wiley, John Wiley and sons David C. Sigee ISBN-9780471485285.
6. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
7. Atlas R.M. Handbook of media for Environmental microbiology. CRC press.

8. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press
9. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
10. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
13. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5325
TITLE OF THE COURSE : SOIL MICROBIOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

Course Objectives:

1. To observe importance of soil and soil microorganisms, life cycles in the nature, for plants growing.
2. Explains geochemical significant processes of the microbial activities and the soil factors controlling and limiting microbial activities.

Course Outcomes:

1. To understand the fundamental concepts and techniques in soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.
2. To make use of how microorganisms may be utilised in soil microbiology and in agriculture.

Total Hours: 40

MODULE I: Microbes and Soil Fertility 10 Hrs

Soil profile, Soil morphology, Biotic and abiotic interactions; Habitat and niche; Soil as an environment for microorganisms. Role of microbes in soil fertility. Microbial interactions in soil - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition. Soil pathogens and soil microflora and human health. Isolation of soil viruses; Genetic exchange between the communities.

MODULE II: Diversity and Distribution of Microorganisms 10 Hrs

Rhizosphere, Mycorrhizosphere, Actinorhizae, spermosphere, rhizoplane; symbiotic association in root nodules. Methods of enumeration, rhizosphere effect, factors influencing rhizosphere microbes. PGPR, Siderophores and VAM. Roles of microbes in biogeochemical cycles: Carbon, nitrogen, phosphorus, sulphur. Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide, reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE III: Biofertilizer and Biopesticides 10 Hrs

Biological nitrogen fixation - types (symbiotic nitrogen fixation (*Rhizobium, Frankia*), non-symbiotic nitrogen fixation (*Azotobacter, Azospirillum*); mechanism, microorganisms and factors affecting; Genetic engineering of BNF. Biofertilizer - types, production, applications and quality control. Cultivation and mass production of bioinoculants- *Azotobacter, Rhizobium, Azospirillum*, Cyanobacteria, Phosphate solubilising microorganisms, *Azolla, Frankia* and VAM. Biopesticides – viral, bacterial and fungal- Types and applications (*Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma* and Nuclear Polyhedrosis Virus).

MODULE IV: Soil Pollution and Biodegradation 10 Hrs

Soil pollution: Nature and sources of pollutants: Industrial, agricultural and municipal wastes, fertilizers, pesticides, radio nucleotides, fossil fuels, acid rains and oil spills. Heavy metals toxicity. Soil erosion - control methods, soil acidification, monitoring and control of soil pollution. **Biodegradation**: Decomposition of organic matter by microorganisms - cellulose, hemicellulose, lignin, xylan and pectin. Effect of pesticides on soil microflora. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Preparation of farmyard manure, animal manures, rural and urban composts and vermicompost.

REFERENCES

1. Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
2. Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
3. McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
4. Metting FB. 1993. *Soil Microbial Ecology - Applications in Agricultural and Environmental Management*. Marcel Dekker.
5. The Nature and Properties of Soil, Brady.
6. Agrios G.N. (2009), Plant Pathology. 5th Ed. Academic Press.
7. Paul E.A.2007. Soil Microbiology: Ecology and Biochemistry,3 Edn. Academi Press.
8. John L. Havlin et al., 2004. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th Edition). Prentice Hall.
9. Coyne M. 1999. Soil Microbiology Delmar Cengage Learning
10. Rangaswami . Gand D.J. Bagyaraj. (1998) Agricultural Microbiology. 2nd Ed. PHI. India.

11. Subbarao, N.S. and Dommergues, Y.R. (1998) Microbial interactions in agriculture and forestry. Science publishers.
12. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D. 2000. Twelth Edition, Biology Microorganisms, Prentice Hall, New Jerry.
14. Mark Wheelis, 2010. Principles of Modern Microbiology, Jones & Bartlett India Pvt. Ltd., New Delhi.
15. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

SEMESTER/YEAR : **III SEM**
COURSE CODE : **20MMB5326**
TITLE OF THE COURSE : **PHARMACEUTICAL MICROBIOLOGY**
L: T: P: S/P : C : **3: 0: 0: 0 : 3**

COURSE OBJECTIVES

1. To make students understand the applications of microorganisms in production of pharmaceutically active compounds.
2. To know the importance of microbiology knowledge in maintaining the microbial standards in pharmaceutical productions.

COURSE OUTCOMES

1. After completion of this course, student will be able to Identify different antimicrobial agents, antibiotics produced by them and it's mode of action.
2. Process involved in drug discovery and development and regulatory guidelines in pharmaceuticals product production.

Total Hours: 40Hrs

MODULE I: Antibiotics **10 Hrs**

Antibiotics and Synthetic antimicrobial agents: β-lactam, aminoglycosides, tetracyclines, ansamycins, macrolides. Antifungal antibiotics: Griseofulvin; Antiviral drugs: Amantidines; Nucleoside analogues, Interferons, Peptide antibiotics. Synthetic antibiotics: Sulphonamides; Chloramphenicol; Quinolone. Chemical disinfectants, antiseptics and preservatives. Therapeutic and prophylactic usage of drugs. Adverse reactions of drugs. Microbial resistance.

MODULE II: Mechanism of Action of Antibiotics **10 Hrs**

Inhibition of cell wall synthesis, nucleic acid and protein synthesis. Microbial resistance to antibiotics. Molecular principles of drug targeting; Drug delivery system in gene therapy. Mode of action of non–antibiotic antimicrobial agents; Mode of action of bacterial killing by quinolinones; Bacterial resistance to quionolinones.
Immobilization procedures for pharmaceutical applications (liposomes). Macromolecular, cellular and synthetic drug carriers.

MODULE III: Microbial formulation and Applications of Microbial Enzymes 10Hrs

Biochemical and molecular basis of screening for the active ingredients from microbes. Application of microbial enzymes in therapeutics. Microbial fermentation for the production of pharmaceutical compounds (Any two). Vaccine: Synthetic peptide vaccines, Multivalent subunit vaccines, DNA vaccines.

Secondary metabolites from microorganisms. Database for Drug designing; Preclinical, clinical trials and Toxicology (LD50 and ED50).

MODULE IV: Regulatory Aspects in Pharmaceuticals 10 Hrs

Design and layout of sterile product manufacturing unit. Designing of Microbiology laboratory, Biosafety levels in setting up lab and safety measures. Introduction to pharmacopoeia; FDA regulation and IP, BP, USP; Reimbursement of drugs and biological; legislative perspectives; GMP and GLP in pharmaceuticals; Quality control through WHO; ICH process. GCP Guidelines. Good Regulatory Practices, Clinical Research Regulations. Regulation and legislation for drugs, cosmetics, medical devices, biologicals and herbals formulation. Food & nutraceuticals in India. Intellectual property rights.

REFERENCES

1. Hugo, WB and Russell, AD. Pharmaceutical Microbiology, (2003). Blackwell Science, Oxford, UK.
2. Krogsgaard L, Lilijefors T. and Madsen, U. Textbook of Drug Design and Discovery, (2004). Taylor and Francis, London.
3. Geoffrey Hanlon and Norman Hodges. Essential Microbiology for pharmacy and pharmaceutical science. (2013).Wiley Blackwell.
4. S. P. Vyas & V. K. Dixit. Pharmaceutical Biotechnology. (2003) CBS Publishers & Distributors, New Delhi.
5. Bhatia R and Ichhpujani RL. Quality Assurance in Microbiology. (1995). CBS Publishers, New Delhi.
6. Gregory Gregoriadis. Drug Carriers in biology & Medicine. (2001). Academic Press New York.
7. Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S. Microbiology. (1990). Harper and Row Publishers, Singapore.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MSC5301
TITLE OF THE COURSE : CLINICAL RESEARCH
L: T: P: S/P : C : 2: 0: 0: 0 : 2

Course Objectives:

1. To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
2. To equip students with the proper designing and planning of clinical trial.

Course Outcomes:

1. Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.
2. Students will gain the concepts of designing and monitoring of clinical research studies.

Total hours: 26

MODULE I: Concepts of Clinical Research 13 Hrs

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The area under the curve (AUC) of the concentration-time profiles, absolute bioavailability, Volume of Distribution (Vd). maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD50 & ED50. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE II: Regulatory Perspectives of Clinical Research 13 Hrs

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration.

Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study-RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel:

Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions

REFERENCES

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER/YEAR	**: III SEM**
COURSE CODE	**: 20MSC5302**
TITLE OF THE COURSE	**: SCIENTIFIC WRITING AND IPR**
L: T: P: S/P : C	**: 2: 0: 0: 0 : 2**

Course Objectives:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

Course Outcomes:

1. After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.
2. They will also get an idea about patent laws and will know how to file a patent

Total hours: 26 Hrs

MODULE I: Scientific writing: 13 Hrs

Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery- driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism.

Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.

MODULE II: Intellectual Property Rights 13 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights.

Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCES

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5371
TITLE OF THE COURSE: IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY LAB
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:

1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents
2. To impart basic understanding of principles, and key concepts relevant to industrial microbiology

Course Outcomes:

1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology

PRACTICALS

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Dental caries susceptibility assay by Snyder's agar test
3. Serological reactions:
    a) Agglutination - Blood grouping and Rh typing
    b) Precipitation reactions:
        i. Ouchtlerlony Double Diffusion,
        ii. Radial Immune Diffusion
4. Assay for susceptibility and resistance of antibiotics by Kirby Bauer method.
5. Isolation of lymphocytes from peripheral blood
6. Identification of different types of blood cells
7. Production and estimation of amylase from microbial sources
8. Production of organic acids (lactic acid and citric acid) from microbes
9. Detection and quantification siderophore produced by *Pseudomonas spp.*
10. Study of different types of fermenters (Models/ Charts)
11. Immobilization technique: whole cell or enzyme- sodium alginate gel method

REFERENCES

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
2. Mackie and McCarthey (2096) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
3. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
6. Jenson, Wright robinson (2097) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (2099) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
10. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
11. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
12. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5372
TITLE OF THE COURSE : PRACTICAL BASED ELECTIVE-I
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objective:

1. The course will help in making the students learn techniques to study microbial interactions and their impact in nature.
2. The course imparts practical knowledge in screening the microorganisms for their employment in various fields.

Course Outcome:

1. Students have fundamental practical knowledge of the techniques to study microbial interactions and their role in environment.
2. Students will learn many techniques to study the impact of microorganisms in different applied microbiological studies.

PRACTICALS

1. Study of microbial interactions in soil (antagonism).
2. Isolation of cellulose and pectin degrading microbes.
3. Determination of Total solids, Dissolved Oxygen, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) –(3 Units)
4. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Estimation of total phenols in diseased and healthy plant tissues.
7. Isolation of Plasmid DNA
8. Demonstration-Restriction Enzyme digestion
9. Demonstration- Ligation of DNA fragment

REFERENCES:

1. Nicholl DST. An Introduction to Genetic Engineering. Cambridge University Press, 2002.
2. Sandhya M. Genetic Engineering: Principles and Practice. MacMillan India. 2008.
3. Primrose SB and RM Twyman. Principles of Gene Manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
4. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
5. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
6. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.
7. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.

SEMESTER/YEAR : III SEM
COURSE CODE : 20MMB5372
TITLE OF THE COURSE : PRACTICAL BASED ELECTIVE -II
L: T: P: S/P : C : 0: 0: 6: 0 : 3

COURSE OBJECTIVE:

1. To make students learn the isolation of microbes from soil and water, microbial interaction studies and their impact in nature.
2. To equip students with hands on technical exposure required to apply theoretical understanding of pharmaceutics and microbiology in screening antimicrobials.

COURSE OUITCOME:

1. Students have fundamental practical knowledge of the techniques to study microbial interactions and their role in environment.
2. Design experiments for the characterization of antimicrobial compounds. Compare and analyse the efficacy of various pharmaceutical compounds in determining minimum inhibitory concentration.

PRACTICALS

1. Isolation of microorganisms from different water sources.
2. MPN for testing potability of water.
3. Estimation of below parameter in water samples (3 Units)
    a. Dissolved Oxygen,
    b. BOD and
    c. COD in water samples.
4. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms.
5. Isolation of phosphate solubilising bacteria.
6. Isolation and identification of microscopic algae and protozoa from soil and water.
7. Minimum Inhibitory Concentration of antibiotics.
8. Sterility testing of pharmaceuticals for microbial contamination and load (tablets, syrups, suspensions, creams and ointments).

REFERENCES:

1. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
2. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
3. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education
4. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.
5. Experiments in Microbiology, Plant Pathology and Biotechnology by K.R. Aneja
6. Practical Microbiology – R.C Dubey, D.K Maheshwari, S Chand and Company, New Delhi.
7. Microbiology Laboratory Manual – Cappuccino, Sherman, Pearson Education.

8. Manual of Microbiology Kanika Sharma Ane Books Pvt. Ltd.
9 . Pharmaceutical Microbiology – Edt. by W.B.Hugo & A.D.Russell Sixth edition. Blackwell scientific Publications.
10. Analytical Microbiology –Edt by Frederick Kavanagh Volume I & II. Academic Press New York.
11. Quinolinone antimicrobial agents – Edt. by David C. Hooper, John S.Wolfson .ASM Washington DC.
12. Quality control in the Pharmaceutical Industry - Edt. by Murray S.Cooper Vol.2. Academic Press New York.
13. Biotechnology – Edt. by H.J.Rehm & G.Reed, Vol 4. VCH Publications, Federal Republic of Germany.
14. Pharmaceutical Biotechnology by S.P.Vyas & V.K.Dixit. CBS Publishers & Distributors, New Delhi.
15. Good Manufacturing Practices for Pharmaceuticals Second Edition, by Sydney H.Willig, Murray M.Tuckerman, William S.Hitchings IV. Mercel Dekker NC New York.
16. Advances in Applied Biotechnology Series Vol 10, Biopharmaceuticals in transition. Industrial Biotechnology Association by Paine Webber. Gulf Publishing Company Houston.
17. Drug Carriers in biology & Medicine Edt. by Gregory Gregoriadis. Academic Press New York.
18. Quality Assurance in Microbiology by Rajesh Bhatia, Rattan lal

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 20MSC5401
TITLE OF THE COURSE : RESEARCH METHODOLOGY
L: T: P: S/P : C : 3: 0: 0: 0 : 3

COURSE OBJECTIVE:

1. Students understand research terminology one that can be used to carry out different approaches to research
2. be aware of the ethical principles of research, challenge and approval processes

COURSE OUTCOME:

1. Demonstrate knowledge of research processes (reading, evaluating and developing)
2. Compare and contrast qualitative and quantitative research

TOTAL HOURS: 40

MODULE 1: 10Hrs

Meaning, Objectives and Characteristics of research. Research Methods Vs Methodology. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan.

MODULE 2: 10Hrs

Defining the research problem. Techniques involved in defining the problem Survey of literature. Primary and secondary sources. Reviews, treatise, monographs patents. Identifying gap areas from literature review. Development of working hypothesis.

MODULE 3: 10Hrs

Research design and methods - Basic Principle. Features of good design. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs.

MODULE 4: 10Hrs

Sampling design - Steps and types in sampling design. Measurement and scaling techniques. Methods of data collection. Testing of hypotheses. Procedure for hypotheses testing flow diagram for hypotheses testing. Data analysis with Statistical Packages. Correlation and Regression. Important parametric test. Chi-square test. Analysis of variance and Covariance.

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.

5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester- B. Sc. – Biotechnology Syllabus
***Theory:* 15BT101 Essentials of Cell Biology**

Total Credit: 52 hours

Unit 1: Cell as a basic unit of living organisms **3 h**

Discovery of cell and Cell Theory; Chemical components of a cell, catalysis and use of energy by cells, Comparison between plant and animal cells.

Unit 2: Cell Wall and membrane structure **7 h**

Cell wall; Plasma membrane – structure and functions of plasma membrane; Modifications of plasma membrane and intracellular junctions.

Unit 3: Structure and function of cellular organelles **18 h**

Cytoskeleton, Centriole, Protoplasm, Mitochondria, Chloroplast, ER, Golgi complex, Lysosome, Endosome and Microbodies, Ribosome.

Unit 4: Nucleus and chromosomes **10 h**

Structure and functions of nuclear membrane, nuclear pore complex, Nucleolus and Chromatin. Chromosomes-Discovery, morphology and structural Organization-Centromere, Secondary constriction, Telomere, Chromomere, Euchromatin and Heterochromatin, chemical composition and karyotype. Ultra-structure- Single-stranded and multi-stranded hypotheses, folded fiber and nucleoside models.

Special types of chromosome: Salivary gland and Lampbrush chromosomes.

Unit 5: Cell division and Programmed Cell Death **11 h**

a) **Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division.**

b) **Mitosis**: Significance of Mitosis, Breakdown of nuclear envelope, spindle fibers, Kinetochore, Anaphase movements.

c) **Meiosis**: Types of meiosis, the first and second meiotic division, synaptonemal complex.

d) **Programmed cell death (Apoptosis):** intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.

Unit 6: Cell motility **3 h**

Structure and functions of cilia, and Flagella,

Types-Amoeboid, Ciliary and Flagellar movements

***Practical:* 15BT171 Techniques in Cell Biology**

1. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
2. Cell division: Study of mitosis using onion root tips.
3. Cell division: Study of and Meiosis in grasshopper testes/onion flower buds
4. Chromosomes: Mounting of polytene chromosomes
5. Preparation of Buccal smear for study of barr bodies.
6. Karyotypeanalysis-Man and onion Man-Normal and Abnormal-Down and Turner's syndromes.
7. Blood cell count by Hemocytometer.
8. Blood smear-differential staining.
9. Vital Staining of mitochondria.
10. Isolation of chloroplast from spinach leaves.

References:

1. Molecular Biology of Cell-Bruce Albert's et.al, Garland publications (2005).

2. Cell Biology &Molecular Biology EDP Robertis& EMF Robertis, Saunder College (2001).

3. Cell Biology C.B. Powar, Himalaya Publication (2004).

4. Cell Biology by David E Sadava, Jones and Bartlett Publications (1993).

5. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

6. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester – B. Sc. Biochemistry syllabus
***Theory*: 15BC101 Inorganic and Biophysical Chemistry**

- Total Credit Hours- 52h

Unit 1: Measurement **1h**

Units – SI and CGS, accuracy, precision and errors in quantitative analysis.

Unit 2: Atomic Structure **4h**
Electromagnetic radiation. Wave particle duality - de Broglie equation, The Heisenberg uncertainty principal. The Schrodinger wave equation. Quantum numbers. Atomic orbitals and their shapes. The Pauli's Exclusion principal, Hund's rule, Electronic Configuration.

Unit 3: Periodic Classification **3h**
Trends in the periodic table: ionic radii, ionization energy, electro negativity and electron affinity. Oxidation number

Unit 4: Chemical Bonding **6h**
Types of bonds, Ionic and covalent bond- VBT, MOT and CFT, Coordinate bond, Weak and hydrophobic interactions, Hydrogen bond. Examples in biological system – stability and solvation of biomolecules.

Unit 5: Solutions and Colligative Properties. **6h**
Concentration and amount – mole, molarity, molality, normality and mole fraction, Homogenous and heterogeneous solutions, Factors influencing solubility, solubility curves, Henry's Law applications, Donnan membrane equilibrium and its application in membrane stability, Relative lowering of vapour pressure, Raoult's law, Elevation of boiling point, depression of freezing point, Numericals.

Unit 6: Electrochemistry **7h**
Strong and weak electrolyte, activity, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- (brief) application in nervous system, Standard electrode potentials. Reference electrodes; Calomel and Glass, pHmeter basics, Ion selective electrodes and their applications.

Unit 7: Acids, Bases and Buffers **7h**

Modern concepts of acids and bases. Ionization of acids. Dissociation of water. Ionic product of water. Common ion effect with examples, Definition and determination of pH and associated numericals, Buffer preparation by H-H equation – detailed calculations, buffer capacity. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.

Unit 8: Adsorption **2h**

Freudlich and Langmuir adsorption isotherm with derivations. Applications of adsorption.

Unit 9: Phase Rule **5h**

Definition of phase, component and degrees of freedom, Gibbs Phase rule statement, Application of phase rule to one component system- water and CO_2, two component systems of water-phenol and water-KI System, Lever rule, Eutactic point, azeotropes, distillation. Concept of Partition coefficient.

Unit 10: Chemical Equilibrium **3h**

Chatelier's principle, reversible reactions with examples, Calculation of K_p and K_c for selective reactions (Synthesis of ammonia and dissociation of HI)

Unit 11: Reaction Kinetics **4h**

Rate equation, Velocity constant-molecularity and order of a reaction, factors influencing rate of reaction, Kinetic Equation of zero, first and second order reactions- Arrhenius hypothesis and equation, Activated complex and energy of activation and its terms, transition state theory.

Unit 12: Thermodynamics **5h**

First and second law, free energy, entropy, chemical potential, standard free energy change of chemical reaction, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant.

Unit 13: Solid State **4h**

Types- Crystalline and Amorphous, Definition of Space Lattice, planes and Unit cell, Elements of symmetry, Law of Rational Indices and Miller Indices with simple numerical , Crystal defects and their applications.

***Practical*: Quantitative analysis and Volumetry 15BC171**

- Total Credit Hours- 36h

[1] GLP & Calibration of glassware.
[2] Acid-base: Preparation of standard potassium biphthalate and estimation of alkali.
[3] Redox: Preparation of standard sodium oxalate and estimation of potassium permanganate.
[4] Redox with indicator: Preparation of standard potassium dichromate solution and estimation of sodium thiosulphate.

[5] Chelatometry: Estimation of hardness of water using EDTA/Zinc sulphate
[6] Iodometry; Estimation of iodide with sodium thiosulfate.
[7] Argentometry: Chloride estimation by Mohr's method.
[8] Estimation of Iron by dichromate.

References:

1. Concise Inorganic Chemistry - Lee. Wiley-Blackwell Publishing House.
2. Inorganic Chemistry: Principles of Structure and Reactivity - Huhee, Keiter & Keiter. Pearson Education Publishers.
3. Physical Chemistry – Atkins. Oxford University Press.
4. General and Inorganic Chemistry - Sarkar. Sapna Publishers.
5. Physical Chemistry- Pahadi. Central Publishers
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester – B. Sc. Genetics Syllabus
***Theory:* 15GN101 - Fundamentals of Cell Biology**

Total Credit Hours – 52 Hours.

UNIT I - Techniques in Cell Biology **8 h**

Microscopy: Bright field, dark field, Phase contrast, Polarization, Confocal, Fluorescence and Electron microscopy (SEM and TEM) Centrifugation, Two photon microscopy.

UNIT II - Ultra Structure of Cell **8 h**

Structure and types of cells: Prokaryotic and eukaryotic cells- characteristics and differences.

Cell Wall: Ultra structure, chemical composition and function.
Cell membrane: structure, chemical composition; fluid mosaic model- lipids, carbohydrates and proteins- transport channels
Transport across membrane: diffusion, active transport, co-transport, bulk transport; ion gated channels- propagation of action potential; liposomes.

UNITIII -Cell Organelles **16 h**

Structure and functions of Nucleus, Nucleolus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Plastids, Lysosome, Ribosomes andMicrosome.

UNIT IV - Cell Cycle and Cell Division: **10 h**

Cell cycle: Interphase and M phase

Mitosis: Mitotic phases; cytokinesis; mitotic apparatus; stimulation and control of mitosis; significance of mitosis.
Meiosis: meiotic phases; events of Prophase-I; structure and function of synaptonemal complex; significance of meiosis.
Cell senescence and cell death: Programmed Cell Death(PCD)- mechanism and significance of Apoptosis and Necrosis.

UNIT V - Study of Life Cycle: **10 h**

Bacteria- *E. coli,* Viruses: TMV, Bacteriophage - Lambda phage, Fungi- *Neurospora*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila*

First Semester – B. Sc. Genetics Practical Syllabus
15GN171 - Fundamentals of Cell Biology

1) Handling of dissection, stereo and compound microscopes — 1 Unit

2) Study of Model organisms — 4 Units
   - Bacteria- *E. coli*
   - Viruses : TMV
   - Bacteriophage - Lambda phage
   - Fungi- *Neurospora*
   - *Caenorhabditis elegans*
   - *Arabidopsis thaliana*
   - *Drosophila*

3) Staining of RNA and DNA with methyl green and pyronin (*Paramecium*) — 1 Unit

4) Vital staining of mitochondria (Yeast) — 1 Unit

5) Gram staining *(E. coli/ Staphylococcus aureus*) — 1 Unit

6) Temporary squash preparation of onion root tips — 1 Unit

7) Observation of: Mitotic stages in permanent slides — 1 Unit

References

- Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
- Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications.
- Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
- Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.
- Powar C. B. Cell Biology. Vol I and II (1982) Himalaya Publication.
- Nicklin J. et al., Instant notes in Microbiology (2003). Viva Books.
- Brian E. S., Steer M. W., et al. Plant cell Biology: Structure and Function (1996) Jones and Bartlett.

- Stern K. R. Introductory plant Biology, 8th Edition (2006) McGraw Hill, Boston.

- Darnell J. H., Lodish and Baltimore D. Molecular Cell Biology. 2 Edition (1990) Scientific American Books.
- Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
- Cooper G. M., Hausman R. E. The Cell: A Molecular Approach 6th Edition (2013) Sinauer Associates

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester- B. Sc. – Chemistry Syllabus
***Theory:* 15CH101 Fundamentals of Chemistry 1**

Total Credit Hours: 52

UNIT I: Atomic Structure **7 h**

de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation, significance of wave functions, emrgence of Quantum numbers. radial and angular wave functions, Atomic orbitals, shapes of s, p and d orbitals. Radial distribution curves of 1s, 2s, 2p, 3s, 3p atomic orbitals. Energy level diagram of atomic orbitals (up to 4s), Aufbau and Paulis exclusion principle. Hund's multiplicity rule. n+l rule, pairing energy, exchange energy, (explain by taking filling of electrons in p and d orbitals) electronic configuration of elements.

UNIT II: The Periodic Table and Chemical Periodicity **7 h**

Modern periodic law: The relationship between chemical periodicity and electronic structure of the atom.

The long form of the periodic Table: Classification of elements in s,p,d and f block of elements. Periodicity in oxidation state of elements, metallic/non-metallic character, oxidizing and reducing behavior; acidic and basic character of oxides; trends in bond type with position of element and with oxidation state for a given element; trends in the stability of compounds and regularities in methods used for extraction of elements from their compounds;
s and p block elements: Anomalous behavior of elements of 2^{nd} period (Li to F) compared to other members in the same groups of s & p block elements; The diagonal relationship between elements, the inert pair effect;
d-b lock elements: General valence shell configuration of 3d series elements (also in box diagram) variable oxidation states, colors, magnetic properties and catalytic properties of transition elements.

UNIT IV: Noble gases **3 h**

Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

UNIT V: Hydrogen **3**

hUnique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and para hydrogen, Industrial production of hydrogen by chemically assisted electrolysis, Photobiological water splitting, Biocatalysed electrolysis and Steam reforming.

Heavy water: Physical properties (with comparison to light water), Applications.
Hydrogen bonding: definition, types, importance.

Hydrates: Chemical nature and their stability.

UNIT VI: The First Law of Thermodynamics **7 h**

Introduction: Thermodynamic terms and basic concepts, intensive and extensive properties, State functions and differentials, thermodynamic processes, reversibility, irreversibility, nature of heat and work, conservation of energy,

First law of thermodynamics: Various statements of first law, Manipulations of first law, internal energy (U) and enthalphy (H). Reversible isothermal expansion of ideal and real gases, Molar heat capacity at constant pressure CP and at constant volume CV, relation between CP and CV, Reversible adiabatic expansion of ideal and real gases, Joule Thomson effect.

UNIT VII: Gaseous state **9 h**

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations).
Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems.
Andrew‘s isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves.
Derivation of critical constants Tc, Pc and Vc from van der Waal‘s equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagat‘s mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b.
Law of corresponding states - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde‘s process.

UNIT VIII: Organic reaction intermediates **4 h**

Covalent bond, Bond cleavage – homolytic and heterolytic. Types of reagents – electrophilic and nucleophilic reagents.

Reactive intermediates - generation of carbocation, carbanion, carbon free radicals and carbenes

– explanation for stability and reactivity of the above intermediates based on inductive, resonance and hyperconjugation effects.
Types of organic reactions – substitution, addition, and elimination (free radical, electrophilic and nucleophilic types).

Concept of isomerism – structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol) in carbonyl compounds).

UNIT IX: Alkanes and Cycloalkanes **8 h**

Definition, classification, IUPAC nomenclature, the alkyl groups (stick formula of a few branched and unbranched alkanes) 1^o, 2^o and 3^o carbon atoms, in alkanes.

Alkanes: sources, methods of preparation - Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties: melting points, boiling points and solubility. Chemical reactions of alkanes – combustion, halogenation, mechanism of free radical halogenation of methane; orientation, reactivity and selectivity. Uses of alkanes.

Cycloalkanes – nomenclature, methods of preparation by Carbene insertion and Dieckmann condensation reactions, chemical reactions – oxidation, Halogenation and **Opening reactions of three and four-membered rings,** Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring; banana bonds.

UNIT X: Alkenes **4 h**

Definition, classification, Preparation of alkenes by Wittig reaction. Chemical properties: Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and importance.

Practical: 15CH171 Fundamentals of Chemistry 1

Total Credit Hours - 36

1. Good Laboratory practices, significant figures, volumetric calculations.(problems to be solved) **1 Unit**

2. Calibrations of pipette, burette and standard volumetric flasks. **1 Unit**

3. Estimation of potassium permanganate using standard sodium oxalate solution. **1 Unit**

4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with ferroin indicator. **1 Unit**

5. Estimation of sodium thiosulphate using standard potassium dichromate solution. **1 Unit**

6. Estimation of iodine using standard sodium thiosulphate. **1 Unit**

7. Determination of percentage of manganese dioxide in pyrolusite ore. **1 Unit**

8. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution. **1 Unit**

9. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid. **1 Unit**

10. Estimation of carbonate and bicarbonate in a given mixture. **1 Unit**

11. Determination of the percentage of available chlorine in the given sample of bleaching powder. **1 Unit**

12. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator). **1 Unit**

References:

Inorganic Chemistry

1. Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
2. Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001.
3. Inorganic Chemistry, 4th Edition, J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Inorganic Chemistry, ELBS 2nd Edition, D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
5. Environmental Chemistry, A. K. De, Wiley Eastern Ltd., 1999.

6. Nuclear and Radiation Chemistry, Sharma B. K, Goel Publishing House, 1987.
7. Modern Inorganic Chemistry, W. L. Jolly, McGraw Hill Co.
8. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
9. Inorganic Chemistry, 3rd Edition (ISE), A G Sharpe, Addison Wesley, 1989.
10. Basic Inorganic Chemistry, 3rd Edition, F. A. Cotton, G. Wilkinson, P. L. Gaus-John Wiley & Sons, 1995.
11. Essential Chemistry, International Edition, R. Chang, McGraw Hill Co, 1996.
12. University Chemistry, 4th Edition (ISE), B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
13. Essential Trends in Inorganic Chemistry, C. M. P. Mingos, Oxford Univ Press, 1998
14. Chemistry, 3rd Edition, P. Atkins &L.Jones, W. H. Freeman & Company, 1997.
15. Modern Chemistry, 4th Edition, D. W. Oxicby, H. P. Gills & N. H. Nachtrieb, Saunders College Publishing, 1998.
16. Fundamental Concepts of applied Chemistry, Jayashree Ghosh, S Chand Publications.
17. Industrial Chemistry, B. K. Sharma, Goel Publishing House

Organic Chemistry

1. Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum, 1990.
3. Organic Chemistry, Vol I & II, I. L. Finar, ELBS, 1986, 1991, 2005
4. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991
5. Organic Chemistry, Maitland Jones, Jr., W. W. Norton & Company
6. Advanced Organic Chemistry, O. S. Bahl and A. Bahl., S. Chand & Co. 1995
7. Advanced Organic Chemistry, J. March, John Wiley & Sons, 2008.
8. Understanding Organic Reaction Mechanisms, A. Jacobs, CambridgeUniv Press, 1998.

9. Organic Chemistry, M. K. Jain, Nagin& Co., 1987
10. A Guide to Mechanism in Organic Chemistry, P. Sykes, Orient Longman, 2005.
11. Organic Spectroscopy, V. R. Dani, Tata McGraw Hill, 1998.
12. Organic Spectroscopy, W. Kemp, ELBS IV Edition, 1998.
13. Synthetic Drugs, G. R. Chatwaal, Himalaya Publications, 2000.
14. Steriochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen, Wiley India Edition, 1994

Physical Chemistry

1. Physical Chemistry, 7th Edition, P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
2. The Elements of Physical Chemistry, 3rd Edition, Peter Atkins, OxfordUniv. Press, 2000.
3. Physcial Chemistry – A molecular Approach, Donal A. Mcquarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
4. Introduction to Physical Chemistry, 3rd Edition, Mark Ladd, Cambridge Low-Priced Edition, 1999.
5. Text Book of Physical Chemistry, S. Glasstone, MacMillan India Ltd., 1998.
6. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
7. Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.
8. Physcial Chemistry, Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
9. Physical Chemistry, G. M. Barrow, McGraw Hill, 1986.
10. Physical Chemistry, 3rd Edition, Gibert W. Castellan, Narora Publishing House, 1985.
11. Text Book of Polymer Science, Billmeyer, Dr. F. W. John Wiley & Sons, 1984.
12. Basic Physical Chemistry, Walter J. Moore, Prentice Hall, 1972.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester- B. Sc. – Zoology Syllabus
***Theory:* 15ZG101 Non – Chordata**

Total Credit Hours - 52 hours

UNIT- I - INTRODUCTION **2 h**

Principles of taxonomy, Zoological nomenclature, Species and Species Concept, Zoogeography, Biodiversity concept.

UNIT- II- SUB KINGDOM PROTISTA (PHYLUM PROTOZOA) **5 h**

General organization, Classification up to classes with suitable examples and Systematic position

Morphological modifications, Locomotion: cilia, flagella, pseudopoida, Food and feeding, Reproduction.

Life cycle of parasitic protozoans *Entamoeba, Plasmodium* and *Trypanosoma* .

UNIT- III- PHYLUM PORIFERA **5 h**

General characters of the phylum, classification up to classes with suitable examples.
General organization (*Leucosolenia* spp.), Microscopic structure of the body wall, Canal System and its evolution, asexual and sexual reproduction in porifera.

UNIT- IV- PHYLUM CNIDARIA **5 h**

General characters of the phylum
General organization (Hydra), Nerve Net, Stinging cells – structure and function. Polymorphism, in cnideria.
Corals and coral reefs.

UNIT- V- PHYLUM PLATYHELMINTHES **4 h**

General characters of the Phylum Platyhelminthes and classification up to classes with suitable examples.
General organization (*Planaria* spp.), host parasite relationship andparasitic adaptations.
Life cycle of Liver fluke and Tape worm.

UNIT – VI- PHYLUM NEMATODA **5 h**

General characters of the Phylum Nematoda and classification up to classes with suitable examples.

Life cycle of *Ascaris and Wuchereria bancrofti*

Plant and animal nematode

UNIT – VII- PHYLUM ANNELIDA **6 h**

General characters of the phylum and classification up to classes with suitable examples.

General organization in annelids (Earthworm), cephalisation, coelom, metamerism, food and feeding, digestive system, excretory system, reproductive system, reproduction and development

Role of annelids in human welfare.

UNIT- VIII- PHYLUM ARTHROPODA **7 h**

General characters of the phylum and classification up to classes with suitable examples. General morphology (Pyla), structure and function of appendages of prawn, Reproduction in prawn, Crustacean larvae.

Metamorphosis in insects with suitable examples

Sense organs in arthropods.

General organization and affinities of Peripatus.

A brief account on Arthropods as a successful animal group.

UNIT- IX- PHYLUM MOLLUSCA **5 h**

General characters of the phylum and classification upto classes with suitable examples.

General organization, shell and foot modification, food and feeding, digestive system, reproductive systems, larvae, with special reference to fresh water mussels (*Unio*)

Torsion in Gastropods.

UNIT- X- PHYLUM ECHINODERMATA **5 h**

General characters of the phylum and classification upto classes with suitable examples.

Starfish- general organization in, spines and pedicellaria, water vascular system.

Echinoderm larvae.

UNIT- XI-MINOR PHYLA **4 h**

General organization and systematic position of Ctenophora, Nemertinea, Chaetognatha, Entoprocta, Phoronida, Brachiopoda, Xiphosura with suitable examples.

Practical 15ZG171 – NON – CHORDATA (PRACTICAL)

Total Credit Hours - 36

1. **PHYLUM PROTOZOA**: Study of permanent slides of *Amoeba, Euglena, Noctiluca, Paramecium, Vorticella,* Radiolarian and Foraminiferon ooze, *Entamoeba , Plasmodium*

1 Unit

2. **PHYLUM PORIFERA**: Sycon, *Euplectella, Hyalonema, Spongilla and Euspongia.* Permanent slides of T.S. of *Sycon,* spicules and gemmule. **1 Unit**

3. **PHYLUM CNIDERIA**: *Hydra, Obelia colony, Obelia medusa, Physalia, Aurelia and Ephyra larva. Corals -Fungia, Corallium, Meandrina, Gorgonia and Pennatula.* **2 Units**

4. **PHYLUM HELMINTHES**: Planaria, Liver fluke, Miracidium, Redia, Cercaria and Tape worm, *Ascaris* - Male, female and T.S of both. **1 Unit**

5. **PHYLUM ANNELIDA**: Earthworm species, T.S of Earthworm, Nereis, Heteroneries, T. S. of Parapodium. Study of general anatomy of Earthworm**.** **1 Unit**

6. **PHYLUM ARTHROPODA:** *Penaeus, Palaemon*, Lobster, Crustacean larvae - Nauplius, Zoea, Mysis, Scorpion, Spider, *Limulus, Peripatus,* Millipede and Centipede. Study of Nervous system Cockroach **2 Units**

7. **PHYLUM MOLLUSCA**: *Mytilus, Chiton, Aplysia, Octopus, Sepia, Loligo and Glochidium larva.* Shell pattern – *Unio, Pila, Ostrea, Cypraea, Murex, Nautilus, Patella, Dentalium***,** Study of digestive system of *Unio.* **2 Units**

8. **PHYLUM ECHINODERMATA**: Sea star, Brittle star, Sea urchin, Cake urchin, Sea cucumber, Sea lily. Bipinnaria larva and echinopluteus larva, Pedicillaria. **1 Unit**

9. **MINOR PHYLA**: *Pleurobrachia* W.M., Sagitta, king crab (*Carcinoscorpius).* **1 Unit**

References

1. Arumugam N., Text book of Invertebrata, Saras Publications. Nagerkoil , (2008)
2. Barnes R.D. Invertebrate Zoology, 2nd Edn. Saunders Philadelphia,(1968).
3. Barrington, E.J.W. Invertebrate structure and function. Neelson, London,(1967).
4. Dhami P.S. and J.K. Dhami. Invertebrate Zoology. S. Chand & co, New Delhi, (2003)
5. EkambaranathaIyer M. and T.N. Ananthakrishnan. A Manual of Zoology Viswanathan Publications, Chennai, (2003)
6. Hymann, L.H. The Invertebrate, Vol. I-IV. Mc Graw- Hill, New York, 1940-67
7. Jordon and P.S. Verma. Invertebrate Zoology E.L. S.Chand& co.NewDelhi, (2005)
8. Kotpal R. L. Invertebrate Zoology-Rastogi Publications, Meerat, India (2005)

9. Kotpal R. L. Zoology phylum books Protozoa to Echinodermata Rastogi publications, Meerut, India. (1975)

10. Marshall, A.J. and Williams, W.D. (Eds.). Text book of Zoology – Invertebrate VII Ed., Vol. I, A.I.T. B.S. Publishers.(1995)

11. Russell-Hunter, W.D. A biology of lower Invertebrates. Macmillan Company, New York,(1968).

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

First Semester- B. Sc. – Environment and Public Health Syllabus 15EP191

Total credit hours - 26 hours

Unit I **3 hours**

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

Unit 2 **4 hours**

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

Unit 3 **5 hours**

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

Unit 4 **4 hours**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha, and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth

Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

Unit 5 **4 hours**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

Unit 6 **6 hours**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.
- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.

- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.
- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water

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Recommended readings:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore
3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16- 19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.

7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman _Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester- B. Sc. – Biotechnology Syllabus
***Theory:* 15BT102 Principles of Microbiology and Biostatistics**

Total Credit: 52 hours

Principles of Microbiology **36 h**

Unit 1: Historical perspectives of microbiology **3 h**
Introduction – microbial origin, Contributions and discoveries, Germ theory, Scope of Microbiology.

Unit 2: Sterilization and Sanitization **8 h**
Sterilization-. Concept of Sterilization - Definition of sterilization, disinfection, Sanitization, antisepsis and fumigation. Physical, Chemical and radiation methods of sterilization, and their applications

Unit 3: Classification of Microbes **9 h**
Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of molecular classification of microorganisms Systematics of bacteria, Nutritional types (Definition and examples).
Classification on the basis of oxygen requirement

Unit 4: Microbes in Extreme Environment **8 h**
Nature, special features of the thermophiles, methanogens and halophiles, Archaea; photosynthetic bacteria, Cyanobacteria, some Archaea living in extreme conditions like cold, and space (Extremophiles)

Unit 5: Pathogenic Microorganisms **8 h**

General Account of Viruses and Bacteria

A. Plant viruses-CAMV, Animal Viruses-Hepatitis B, Bacterial virus- lambda phage

B. Bacteria-Ultra structure of a bacterial cell (both Gram positive and Gram negative) endospore and capsule. The common bacterial, fungal and viral diseasesof human beings (Name of the disease, causative pathogen, parts affected)

Unit 6: Biostatistics **16 h**

Importance and Applications 1 h

Tabulation and classification of Data - Frequency distribution and graphical distribution of Data 2 h

Measures of Central Tendencies - Mean, Median, Mode and their properties 3 h

Measures of Dispersion - Mean Deviation, Variance, Standard Deviation and Coefficient of Variation 4 h

Hypothesis testing - Student T and Chi Square test 2 h

Probability and distribution - Concepts and problems on probability, Binomial, Poisson, normal distribution and their application 4 h

***Practical*: 15BT171 Microbial Techniques**

Total Credit Hours- 36 h

1. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
2. Common instruments used in a microbiology Lab: Principles and operations - Incubators & Shakers Centrifuge pH meter Colorimeter Spectrophotometer
3. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa)
4. Sampling and quantification of microorganisms in air, soil and water.
5. Isolation of bacteria - Streak plate, spread plate, pour plate, serial dilution
6. Biochemical tests – IMViC, starch hydrolysis, catalase & gelatin liquefaction
7. Antibiotic sensitivity test-paper disc method
8. Study of Rhizobium from root nodules of legumes.
9. Microscopic study of phytoplankton & zooplanktons.

References:

1. Microbiology-Pelczar, Chan, Krieg Tata McGraw Hill Publications(2000)
2. Microbiology- Concepts and applications by Paul A. Ketchum Wiley Publications(2001)

3. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications(2003)
4. Microbiology –Ronald M. Atlas (1990)
5. Introductory Biotechnology-R.B Singh C.B.D India (1990)
6. Microbiology by L M Prescott, Mc Graw Hill
7. General Microbiology –C.B. Powar, H.F. Daginawala, Himalayan Publishing House(2001)

Biostatistics

1. Fundamental of Biostatistics by Khan and Khanum, Ukaaz Publications (1994)
2. Statistics for Biologists by RC Campbell, Cambridge University Press (1989)
3. Biostatistics by Wayne W Daniel, Wiley 10th Edition (2014)

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester – B. Sc. Biochemistry syllabus
***Theory*: 15BC102 Organic Chemistry, Drug design and Toxicology**

Total Credit Hours - 52h

Unit 1: Introduction **6h**

IUPAC nomenclature of organic compounds, Inductive effect, resonance and hyperconjugation, Reactive intermediates: carbocations, carbanions, carbines and free radicals.

Unit 2: Aliphatic and Aromatic Hydrocarbons **9h**

General characteristics of alkanes, alkenes and alkynes, substitution and bond opening reactions: Wurtz & Kolbe reaction for alkane, Hydrogenation with Merkownikoff's rule and ozonolysis of alkenes. Organometallic compounds - definition, examples and synthetic applications of Grignard Reagents.

Baeyer strain theory. Sachse-Mohr theory. Boat and chair forms of cycloalkane. Axial and equatorial bonds. Benzene structure, Aromaticity, Huckel's rule, orienting influence of substituent on group addition.

Unit 3: Mechanisms **3h**

Substitution of alkyl halides via SN_1 and SN_2, elimination via E1 and E2.

Unit 4: Alcohols **3h**

Definition and classification. Monohydric alcohols – general properties; distinguishing reactions of primary, secondary and tertiary alcohols – Lucas Test, Victor Meyer Test and Oxidation reactions. Acidity of phenol, Kolbe & Reimer-Tiemann reactions.

Unit 5: Acids and Aldehydes **4h**

Definition and examples. General properties, acid strength, esterification of acid, oxidation of alcohols to aldehydes and ketones. Keto-enol tautomerism, Perkin reaction, Claisen and aldol condensation, Cannizzaro reaction and reduction.

Unit 6: Stereochemistry **6h**

Stereoisomerism: Optical isomerism: Molecular dissymmetry, Chirality, Nomenclature of enantiomers -The RS and the DL system.

Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism in alkenes and ring compounds. Structure and properties of malic and fumaric acid, E-Z system of specifying geometrical isomer, examples of chirality in the biological world.

Unit 7: Amines **2h**

Classification. Isomerism. Distinguishing reaction of 1°, 2° and 3° amines. pK_b values of amines. Effect of substituents on the basic strength of amines. Some biologically important amines.

Unit 8: Heterocyclic Compounds, Terpenes and Alkalolds. **2h**

Structure, formulae and occurrence of furan, thiophene, pyrrole, imidazole, pyridine and indole. Aromaticity of furan, thiophene, pyrrole and pyridine. Isoprene rule, biological importance and occurrence of terpenes & alkaloids. Phytochemicals- Introduction and uses.

Unit 9: Organic synthesis and Drug Design **9h**

Retro-synthetic planning and synthetic execution, retron and synthon.
Michael addition, Diels Alder reaction, Organo-lithium and epoxide-based reactions to create synthones, Reaction of diazonium salts coupling reactions, ethyl acetoacetate and its synthetic application, increasing C-atoms by n units, selective removal of C-atoms.

Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug-receptor interaction

Principles of Drug Design, Traditional analog (QSAR) and mechanism based approaches, Computer Aided Drug Designing (CADD) and molecular modeling.

Synthesis of aspirin, anthraquinone, sulfanilamide, paludrine, acetaminophen (paracetamol) and pentothal.

Unit 10: Toxicology **8h**

Toxins, venom, poison with examples, Dose Response curves, bioavailability, biosorption, IC_{50}, LD_{50}, ED_{50}, Genotoxicity, Xenobiotics, Role of Cytochrome P450, Various mechanisms of Detoxification. Whole animal studies, Perfusion studies, Metabolic cage, Tissue culture, Common cell lines used for studying diseases.

***Practical*: Qualitative analysis and organic preparations 15BC172**

Total Credit Hours- 36 h

[1] Systematic qualitative analysis of sample organic compound – alcohol, phenols, carboxylic acids, aldehyde, ketones, esters, aromatic hydrocarbons, halo-compounds, and amines.
[2] Organic Preparations:

a) Nitration of nitrobenzene
b) Acetylation of salicylic acid
c) Oxidation of benzaldehyde
d) Bromination of phenol/ acetanilide.

References:

1. Organic Chemistry-Morrison and Boyd. Prentice-Hall of India
2. Organic Chemistry-Solomons and Fryhle. Wiley & Sons.
3. A Guidebook to Mechanism in Organic Chemistry-Sykes. Longman Publishers.
4. Advanced Organic chemistry-Bahl and Bahl. S. Chand Publishing House.
5. A textbook of Modern Toxicology – Hodgeson. Wiley & Sons.
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester – B. Sc. Genetics Syllabus
15GN102 - Basic Genetics

Total credit hours – 52hours.

UNIT I - History of Genetics: 3 h

History and scope of Genetics, Pre- Mendelian genetic concepts - Pre-formation, epigenesis, pangenesis, germplasm theory.

UNIT II - Mendelian Principles: 9 h

Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross. Pattern of inheritance in haploid and diploid organisms.

UNIT III - Extensions Of Mendelism: 8h

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles;Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy.

UNIT IV - Gene Interactions: 3 h

Epistasis- dominant, recessive. Supplementry and Complementry gene interactions; Non epistatic inter allelic gene interaction, Position effect

UNIT V - Sex Determination: 11 h

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridge's genetic balance theory.Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in *Drosophila*. Sex differentiation and dosage compensation *(Drosophila* and Man).Sex linked and sex limited traits in Humans- Hemophilia, Hypertrichosis.

UNIT VI - Extra Chromosomal Inheritance 6 h

Extra Chromosomal inheritance, flower colour in *Mirabilis jalapa*, kappa particle in *Paramecium*, sigma factor in *Drosophila*, Cytoplasmic Male Sterility (CMS) in maize.

UNIT VII - Elements of Biometry: **12 h**

Measures of Central tendency – Mean, Median and Mode.
Measures of Dispersion – Range, Variance, Standard deviation and Standard error.
Test of Hypothesis - Student‘s_t‘ test, chi square test.
Probability - Basic concepts; Distribution- Normal, Binomial and Poisson.

Second Semester – B. Sc. Genetics Practical Syllabus
15GN172 - Basic Genetics

1) Temporary squash preparation of: (2 Units)

- Grasshopper Testes
- Onion Flower Bud

2) Blood Typing (1 Unit)

3) Study of: (1 Unit)

- Flower color in *Antirrhinum / Mirabilis*
- Coat color in Mice
- Comb pattern in fowl

4) Computation of: (2 Units)

- Mean, median and mode
- Standard deviation and standard error.

5) Problems on: (1 Unit)

- Student‘s _t‘ test and Chi square test.

6) Problems on Probability (1 Unit)

7) Genetic problems on: (2 Units)

- Multiple Alleles
- Gene Interaction
- Sex Linkage

References:

- Strickberger M. W., Genetics. (1968) Macmilla Publishers.
- Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
- Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
- Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
- Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
- Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
- Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
- Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
- Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
- Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
- Stansfield W. D., Theory and problems of Genetics – (Schaum's Outline Series). (2002) McGraw Hill.
- Stubbe H., History of Genetics (1972). Harper and Row New York.
- Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
- Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester- B. Sc. – Chemistry Syllabus
***Theory:* 15CH102 Fundamentals of Chemistry 2**

Total Credit Hours: 52

Unit I: Chemical Bonding **10 h**

Ionic Bond: Definition and conditions for formation of an ionic bond, examples of formation of an ionic compound (NaCl, $CaCl_2$, MgO).
Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle (NaCl, $CaCl_2$ and MgO), problems, polarizing power and polarizability, Fajan's rules.
Covalent Bond: Definition, octet rule, limitation electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).
Valence Shell Electron pair repulsion (VSEPR) Theory: Shapes of simple inorganic molecules and ions such as NH_3, H_3O+, SF_4, ClF_3, ICl_2 and H_2O.

Hybridisation concept: various types of hybridization, structure of molecules based on hybridization concept and by valence shell electron pair repulsion (VSEPR) theory.
Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6 molecules.
Molecular orbital theory: linear combination of atomic orbitals (LCAO), MOT postulates, bonding, nonbonding and antibonding molecular orbitals. Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules (H_2, N_2, O_2, HF and CO),
Metallic Bond: Definition, properties of metals and band theory, electrical properties of metals, semiconductors and insulators.
Weak Intermolecular interactions: van der waals forces, dipole dipole interactions and their significance. Hydrogen Bond – types and its significance on molecular properties.

Unit II: The Second Law of Thermodynamics **8 h**

Introduction: Spontaneous change, Carnot Cycle, conclusions from Carnot cycle, efficiency of heat engines, Second law of thermodynamics, entropy, entropy as a state function, Clausius inequality, entropy as criterion of spontaneity, natural processes, different types of entropy changes under isothermal and non-isothermal conditions, entropy change in irreversible processes. Helmholtz function (A), Gibbs function (G), standard molar free energy changes, Maxwell relations, dependence of free energy functions on temperature and pressure, total differential equations. Gibbs Helmholtz equations, thermodynamic criteria for spontaneity. Heat

capacity at low temperature, Nernst heat theorem,

Third law of thermodynamics, third law entropies.

Unit III: Chemical Kinetics **7 h**

Review of terms: Rate, Order and Molecularity. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction. Determination of order of reaction: differential method, method of integration, method of half life period and isolation method.

Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis).

Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

Unit IV: Liquids and Solutions **9 h**

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by:

(i) Berkeley-Hartley's method (□); (ii) Beckmann's method (□Tf) and (iii) Landsberger's method. Numerical problems.

Unit V: s & p block elements **8 h**

s- block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.

p – block elements: Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.

Halogens: Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

Unit VI: Dienes and Alkynes **4 h**

Dienes: Classification - isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction- 1,3-butadiene with maleic anhydride.
Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with $KMnO_4$, acidic nature of terminal alkynes.

Unit VII: Stereochemistry **2 h**

Fischer, saw-horse and Newman projection formulae. Chirality-optical activity, enantiomerism and diastereoisomerism involving one and two chiral centers, configuration, geometrical isomerism, D/L, R/S and E/Z nomenclatures.

Unit VIII: Organic halogen compounds **4 h**

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanism with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on SN1 and SN2 mechanisms.
Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.
Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

***Practical:* 15CH172 Fundamentals of Chemistry 2**

Total Credit Hours: 36 h

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer. **1 Unit**

2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer. **1 Unit**

3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method. **1 Unit**

4. Determination of transition temperature of a salt hydrate by thermometric method. **1 Unit**

5. Determination of distribution coefficient of benzoic acid between water and toluene. **1 Unit**

6. Effect of surfactants on the surface tension of water (Stock solution to be given). **1 Unit**

7. Estimation of hardness of water by EDTA method. **1 Unit**

8. Determination of dissolved oxygen (DO) in water sample. **1 Unit**

9. Compare the strength of HCl and H_2SO_4 in the hydrolysis of ethyl acetate (K for one acid is given) **1 Unit**

10. Paper chromatography: Separation of Methyl red and methylene blue. **1 Unit**

11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds. **1 Unit**

12. Column Chromatography: Separation of Methyl red and methylene blue. **1 Unit**

References:

Inorganic Chemistry

- Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
- Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001.
- Inorganic Chemistry, 4th Edition, J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
- Inorganic Chemistry, ELBS 2nd Edition, D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
- Environmental Chemistry, A. K. De, Wiley Eastern Ltd., 1999.
- Nuclear and Radiation Chemistry, Sharma B. K, Goel Publishing House, 1987.
- Modern Inorganic Chemistry, W. L. Jolly, McGraw Hill Co.
- Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
- Inorganic Chemistry, 3rd Edition (ISE), A G Sharpe, Addison Wesley, 1989.
- Basic Inorganic Chemistry, 3rd Edition, F. A. Cotton, G. Wilkinson, P. L. Gaus- John Wiley & Sons, 1995.
- Essential Chemistry, International Edition, R. Chang, McGraw Hill Co, 1996.
- University Chemistry, 4th Edition (ISE), B. H. Mahan & R. J. Myers, Addison Wesley, 1989.
- Essential Trends in Inorganic Chemistry, C. M. P. Mingos, Oxford Univ Press, 1998
- Chemistry, 3rd Edition, P. Atkins &L.Jones, W. H. Freeman & Company, 1997.
- Modern Chemistry, 4th Edition, D. W. Oxicby, H. P. Gills & N. H. Nachtrieb, Saunders College Publishing, 1998.
- Fundamental Concepts of applied Chemistry, Jayashree Ghosh, S Chand Publications.
- Industrial Chemistry, B. K. Sharma, Goel Publishing House

Organic Chemistry

- Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
- Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum, 1990.
- Organic Chemistry, Vol I & II, I. L. Finar, ELBS, 1986, 1991, 2005
- Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991
- Organic Chemistry, Maitland Jones, Jr., W. W. Norton & Company
- Advanced Organic Chemistry, O. S. Bahl and A. Bahl., S. Chand & Co. 1995
- Advanced Organic Chemistry, J. March, John Wiley & Sons, 2008.
- Understanding Organic Reaction Mechanisms, A. Jacobs, CambridgeUniv Press, 1998.
- Organic Chemistry, M. K. Jain, Nagin& Co., 1987
- A Guide to Mechanism in Organic Chemistry, P. Sykes, Orient Longman, 2005.
- Organic Spectroscopy, V. R. Dani, Tata McGraw Hill, 1998.
- Organic Spectroscopy, W. Kemp, ELBS IV Edition, 1998.
- Synthetic Drugs, G. R. Chatwaal, Himalaya Publications, 2000.

- Steriochemistry of Organic Compounds, Ernest L. Eliel, Samuel H. Wilen, Wiley India Edition, 1994

Physical Chemistry

- Physical Chemistry, 7th Edition, P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
- The Elements of Physical Chemistry, 3rd Edition, Peter Atkins, OxfordUniv. Press, 2000.
- Physcial Chemistry – A molecular Approach, Donal A. Mcquarrie and John D. Simon, Viva Low-priced Student Edition, 2001.
- Introduction to Physical Chemistry, 3rd Edition, Mark Ladd, Cambridge Low-Priced Edition, 1999.
- Text Book of Physical Chemistry, S. Glasstone, MacMillan India Ltd., 1998.
- Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
- Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.
- Physcial Chemistry, Alberty R. A. and Silbey R. J. John Wiley & Sons, 1992.
- Physical Chemistry, G. M. Barrow, McGraw Hill, 1986.
- Physical Chemistry, 3rd Edition, Gibert W. Castellan, Narora Publishing House, 1985.
- Text Book of Polymer Science, Billmeyer, Dr. F. W. John Wiley & Sons, 1984.
- Basic Physical Chemistry, Walter J. Moore, Prentice Hall, 1972.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester- B. Sc. – Zoology Syllabus
***Theory* 15ZG102 – Chordata and Comparative Anatomy**

Total Credit Hours – 52 h

UNIT- I- PROTOCHORDATA **2 h**

Basic Chordate characters and outline classification and evolution.

UNIT- II- HEMICHORDATA **4 h**

General characters and classification upto classes with suitable example.
Type study – *Balanoglossus* – Morphology, coelom, Tornaria larva.
Affinities and systematic position of Hemichordata.

UNIT- III- UROCHORDATA **4 h**
General characters and classification upto classes with suitable example
Simple *Ascidian* – General organisation, Ascidian tadpole and Retrogressive Metamorphosis.
Neotony

UNIT- IV- CEPHALOCHORDATA **2 h**
Amphioxus – General organization and affinities

UNIT- V- AGNATHA **4 h**
General characters and classification of Agnatha Salient features of Cyclostomata and Ostracodermi with examples.
Ammocoete larva and its evolutionary significance.

UNIT- VI - PISCES **5 h**
Salient features and classification up to subclasses - Chondrichthyes and Osteichthyes
Dipnoi: Interesting features and their evolutionary significance.
Types of scales and fins in fishes, air bladder in fishes. Migration in fishes

UNIT- VII- AMPHIBIA **5 h**

Origin and evolution of Amphibia. General characters and classification of living Amphibians up to orders, with suitable examples. Indian bull frog.

UNIT- VIII- REPTILLIA **5 h**

General characters and classification of modern reptiles with suitable examples. Adaptive radiation in of living reptiles with examples. Temporal fossae in reptiles. poisonous and non-poisonous snakes. Turtles.

UNIT- IX- AVES **5 h**

General characters and classification with suitable examples. Differences between Ratitae and Carinatae. Flight adaptations in birds. Beak and foot modification. Migration in birds, types, theories on migration. *Archaeopteryx.*

UNIT-X- MAMMALIA **6 h**

General characters and classification up to subclasses (Prototheria, Metatheria and Eutheria) with suitable examples. Interesting features of mammalian orders (Insectivora, Carnivora, Chiroptera, Cetacea, Proboscidia, Ungulata – Perissodactyla and Artiodactyla, and Primates –Platyrhini and Catarhini) with examples. Dentition in Mammals

UNIT- XI- COMPARATIVE ANATOMY OF VERTEBRATES **10 h**

Evolutionary trend of Integument and its derivatives, Brain, Blood pigments, Respiration,hearts and aortic arches, Urinogenital system among fishes, amphibians, reptiles, Aves and Mammals

15ZG172 – CHORDATA AND COMPARATIVE ANATOMY (PRACTICAL)

Total Credit Hours – 36 h

1. **HEMICHORDATA**: specimen - *Balanoglossus*, T.S through proboscis, Tornaria larva.
2. **UROCHORDATA:** *Ascidian*, Ascidian tadpole.
3. **PROTOCHORDATA**: *Amphioxus*, T.S. of Amphioxus through pharynx and intestine.
4. **CYCLOSTOMA:** *Petromyzon*, Ammocoete larva and *Myxine.*

1 Unit

5. **PISCES**: Cartilaginous Fishes – Narcine, Trygon, Pristis, Myolobatis (any two) –

   Bony Fishes – Hippocampus, Muraena, Ostracion, Tetradon, Pleuronectus, Diodon, Echeneis, Accessory respiratory organs - Saccobranchus, Clarias and Anabas.

1 Unit

6. **AMPHIBIA**: Frog, Bufo, Ambystoma, Axolotl larva, Necturus and Ichthyophis. Endoskeleton of frog: Skull, lower jaw, vertebrae, pectoral and pelvic girdles.

2 Units

7. **REPTILLIA**: Turtle, Varanus, poisonous snakes – Cobra, Krait, Russell's viper and Hydrophis. Non poisonous snake-Rat snake **1 Unit**

8. **AVES**: Endoskeleton – Skull, heterocoelous vertebra, synsacrum, sternum, pectoral girdle, pelvic girdle. Beak modifications. **1 Unit**

9. **MAMMALIA**: Mongoose, Squirrel, Hedge Hog, Rabbit, Rat and Bat **1 Unit**

10. **COMPARATIVE ANATOMY:** Comparative study of derivatives of integument in vertebrates: Scale of a Fish – cartilaginous and bony, carapace and plastron of tortoise/turtle, contour feather of bird, horn of sheep/goat/cow, hoof of sheep/goat/cow.
    Comparative study of skin of Vertebrates- fish, frog, mammal
    Comparative study of heart of Vertebrates: fish (shark), amphibian (frog), bird (hen) and mammal (rat/human)
    Comparative study of brain of Vertebrates: fish (shark), amphibian (frog), bird (hen) and mammal(rat/human)
    Comparative study of mesonephric kidneys of frog and metanephric kidneys of rat (or Human) Mounting of placoid, cteniod and cycloid scales

5 Units

References:

1. Arumugam N. Text book of Vertebrates. Saras Pubulications. Nagerkoil (2008).
2. Dhami P.S. and J.K. Dhami. Chordate Zoology. R. Chand & co. New Delhi, (2006).
3. Jordon E. L. and P.S. Verma. Chordate Zoology. S. Chand & co. New Delhi, (2006).
4. M. EkambaranathaIyer and T.N. Ananthakrishnan. Chordate – A Manual of Zoology.Viswanathan Publications, Chennai, (2003).
5. Kotpal R. L. Vertebrate Zoology–Rastogi Publications, Meerut, (2005).
6. Vimala C.M. Introduction to Zoology Vol 3 and 4. Interline publication. Bangalore, (2005).
7. Romer, A.S., Vertebrate Body IIIrd Ed. W.B. Saunders Co., Philadelphia, (1986)
8. Sedgwick, A.A. (XXXX) Students Text Book of Zoology, Vol.II.
9. Smith, H.S. (XXXX) Evolution of Chordata structure Hold Rinchart and Winstoin Inc. New York.
10. Walter, H.E. and Sayles, L.D. Biology of vertebrates, MacMillan & Co. New York, (1970).
11. Young J.Z. Life of vertebrates The oxford University publication, (1977).
12. Comparative Anatomy by Hymann (1966)

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Second Semester- B. Sc. – Computer Applications and Information Technology 15CA192

Total Credit Hours - 26 h

Unit 1: History and Generations of Computers **4 h**

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

Unit 2: Categories of Computers and Operating Systems. **5 h**

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

Unit 3: Data processing & presentation **4 h**

Introduction, Office Automation Software (Open Source Software)

Unit 4: Computer viruses and Internet Searches. **5 h**

An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, bibliographic databases.

Unit 5: Algorithms, Flowcharts & Programming concepts: **5 h**

Algorithms: Concepts & definitions , Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases.

Unit 6: Bio-informatics **3 h**

Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics.

References:

- Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
- Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
- Biostatistics:P.N.Arora ,P.K.Malha.
- Introduction To Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester – Biochemistry Syllabus

Paper: Physico-Analytical techniques

Paper Code: 15BC103 **Total Credit Hours: 52h**

Unit 1: Spectroscopy **10h**

Wave particle duality, the electromagnetic spectrum, Lambert-Beer's law, Absorbance, extinction coefficient, Chromic shifts, auxochromes. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscope; assay of biomolecules. Principle, Schematics and Application of Luminometry, Flame photometry and AAS. IR spectroscopy, equation, vibrational modes of various bonds, applications in the identification of common functional groups in biomolecules.

Unit 2: Techniques for structure determination **3h**

X-Ray Diffraction: crystal planes, Braggs Equation, Diffractometer, Applications in crystal characterization. NMR: principle and applications in structure elucidation of biomolecules.

Unit 3: Techniques in Medical Applications **3h**

NMR based techniques – Magnetic Resonance Imaging and Diffusion tensor imaging – brief idea, X-ray based technique: CAT scan and radioactivity based technique: PET scan

Unit 4: Chromatography **9h**

Distribution coefficient, Adsorption, partition, Retention factor. Types: Planar and columnar, S-L, L-L, G-S and G-L. Paper, thin layer, gel permeation, ion exchange, hydrophobic and affinity chromatography with applications, Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules. Brief idea about HPLC (C8 and C18) and FPLC.

Unit 5: Electrophoresis **9h**

Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis, Applications.

Gel electrophoresis: - Types of gels, Procedure, Column & slab gels. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration).

Principle and application of SDS-PAGE, IEF, peptide mapping, OFGE, Application in molecular biology and genomics.

Unit 6: Immunological techniques **4h**

Immuno-diffusion, immuno-electrophoresis, RIA, ELISA and immuno-fluorescence.

Unit 7: Isotopic tracer technique **7h**

Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography. Applications of isotopes in biochemistry with reference to studies in metabolism, Principles of tracer techniques, it's advantages and limitations,

Unit 8: Centrifugation **4h**

Basic principles, Mathematics & theory: RCF, Sedimentation coefficient, Svedberg constant, nomogram. Preparative centrifugation: - Differential & density gradient centrifugation, Applications Analytical centrifugation: - Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.

Unit 9: Electrochemistry **3h**

Potentiometry, potentiometer schematics and use as pHmeter, Conductance, specific and equivalent conductance, Conductivity meter.

Practical III: Bioanalytical separations
Paper Code: 15BC173

[1] pH metric /potentiometric titrations of HCl-NaOH and Acetic acid-NaOH
[2] Estimation of pK_a of glycine.
[3] Determination of density & viscosity of given unknown solution.
[4] Paper chromatography of amino acid, lipids and sugar (Ascending and circular)
[5] Paper electrophoresis for separation of biomolecules.
[6] Separation of amino acid by TLC.
[7] Column chromatography of pigments on adsorbent.
[8] Conductometric titration of an amino acid against HCl and NaOH.

REFERENCES:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Principles and Techniques of practical Biochemistry – Wilson and Walker. Camridge.
4. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
5. Immunology – Kuby. Freeman Publishers.
6. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – Biochemistry Syllabus

Paper: Physiology of living systems

Paper Code: 15BC104 **Total Credit Hours: 52h**

Unit 1: Nutrition **6h**

Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods, Nitrogen balance, BUN, NPN, Calorific value of foods, bomb calorimeter. Respiratory quotient, BMR, SDA and factors affecting them. Role of protein, lipid and carbohydrates as fuel molecules, Protein sparing effect of carbohydrates. Dietary fiber. Essential fatty acids and their biological importance**.** Food fortification & food supplementation, Minerals and vitamins.

Unit 2: Skeletal system **5h**

Tissues- introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodeling and regulation by hormones.

Unit 3: Hematology and respiration **7h**

Blood components and their functions, blood groups: the ABO system, rhesus system, blood clotting factors, intrinsic and extrinsic pathways for blood clotting.

Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxy hemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.

Unit 4: Excretion **5h**

Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

Unit 5: Digestion **6h**

Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Structure and function of liver and Gall bladder, LFT.

Unit 6: Reproduction **4h**

Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

Unit 7: Neurobiology **8h**

Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and nonmyelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

Unit 8: Muscle **5h**

Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle- structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

Unit 9: Cardiovascular System **6h**

Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

Practical IV: Clinical Biochemistry
Paper Code: 15BC174

[1] Qualitative analysis of normal and abnormal components of urine – ketone, sugar, urea, uric acid, Creatinine, protein.
[2] Protein/DNA by UV absorption.
[3] Protein by Folin - Ciocalteu method,
[4] Iron by Ossian's method
[5] Phosphate by Fiske – Subbarow's method
[6] Creatinine by Jaffe's method
[7] Glucose estimation by Miller's method
[8] Calcium estimation by Alizarin S

REFERENCES:

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester – Biotechnology Syllabus

Paper: Basic Principles of Biochemistry and Biophysics

Paper Code: 15BT201 **Total Credit Hours: 52h**

Unit 1. Amino acids **3 h**

Classification and properties of amino acids, titration curve of amino acid, concept of zwitter ion, pKa and pI.

Unit 2. Carbohydrates **5 h**

Structure, properties and classification with examples– Monosaccharides, Disaccharides, polysaccharides (storage and structural, homo and hetero polysaccharides).

Unit 3. Lipids **4 h**

Structure, properties and classification and functions – Phospholipids, sphingolipids and glycolipids.

Unit 4. Proteins **5 h**

Classification based on structure and function, structural organization of proteins – Primary, secondary (alpha helix and beta sheet), tertiary and quaternary structure.

Unit 5. Nucleic Acids **3 h**

Nucleic acids and their components – Nitrogenous bases (purines and pyrimidines), nucleosides and nucleotides, formation of phosphodiester bond.

Unit 6. Enzymes **6 h**

Introduction, classification, co-enzymes and co-factors, enzyme kinetics (Michelis- Menten equation), factors influencing enzyme activity- Substrate, enzyme, temperature and pH, Inhibition mechanisms (competitive and non-competitive).

Unit 7. Vitamins and Hormones **6 h**

Water Soluble and fat-soluble vitamins, Dietary source, Clinical relevance.

Functions of Steroid hormones (testosterone and estrogen), Glucocorticoid hormones (cortisol and mineralocorticoid), pituitary hormones (MSH and FSH). Examples of Plant Hormones (Auxins, Cytokinins and Gibberllins)

Unit 8. Introduction to Biophysics. **3 h**

Scope of Biophysics, pH and Buffer concepts

Unit 9. Biophysical techniques **14 h**

Principles and applications of -

a) Chromatography (Paper, thin layer, column, GLC and HPLC)

b) Centrifugation (differential, density gradient, Ultra centrifugation)

c) Spectroscopy (UV, Visible, X-Ray crystallography, NMR, IR, Fluorescence and Atomic Absorption)

d) Electrophoresis

Unit 10. Isotopes **3 h**

Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

Practical: 15BT271

Biochemical and Biophysical Techniques

Total Hours: 36

1. Preparation of Buffers-Citrate and Phosphate.
2. Estimation of reducing sugars by DNS method.
3. Estimation of reducing sugars by Somogyi-Nelson Method.
4. Estimation of Amino acids by Ninhydrin method.
5. Estimation of Protein by Biuret method.
6. Estimation of protein using Lowry's method.
7. Preparation of crude amylase extract from biological source
8. Assay of amylase enzyme activity using starch as a substrate. (2 Units)
9. Separation of Amino acids by Paper Chromatography.
10. Separation of amino acids/sugars by Thin layer chromatography.

REFERENCES:

BIOCHEMISTRY

1. Lehninger's Principles of Biochemistry- W H Freeman (2008)

2. Biochemistry-Lubert Stryer Freeman International Edition (2002).

3. Biochemistry-Keshav Trehan Wiley Eastern Publications (1987).

4. Fundamentals of Biochemistry J.L. Jain S. Chand and company (2007).

5. Biochemistry by U Satyanarayana and Chakrapani, Elsevier Inc. (2013).

6. Biochemistry by Voet and Voet, Wiley Publishing (2010).

BIOPHYSICS

1. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).

2. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)

3. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John Walker, Cambridge University Press (2005).

4. Biophysics – An introduction by Ronald Glaser, Springer (2012).

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – Biotechnology Syllabus

Paper: Molecular Biology

Paper Code: 15BT202 **Total Credit Hours: 52h**

Unit 1. Molecular basis of life **3 h**

Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses).

Unit 2. Recombination **4 h**

Transformation, Conjugation and Transduction; Holliday model of recombination.

Unit 3. Structure and function of DNA and RNA **4 h**

Structure of DNA. Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA

Unit 4. DNA Replication **7 h**

Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication.

Unit 5. DNA Repair **5 h**

Causes of DNA damages, mechanisms of repair– photo-reactivation, excision repair, mismatch repair, SOS repair.

Unit 6. Transcription in Prokaryotes and Eukaryotes **7 h**

RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes.

Post-transcriptional modifications of Eukaryotic mRNA.

Unit 7. Translation **7 h**

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins.

Unit 8. Regulation of Gene Expression **7 h**

Regulation of Gene expression in Prokaryotes– Operon concepts, induction, repression, attenuation, examples of *Lac* and *Trp* operons

Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.

Role of *cis* and *trans* elements in regulation of gene expression

Unit 9. Extra nuclear Genomes: Mitochondria and chloroplasts. **3 h**

Unit 10. Mobile Genetic Elements **5 h**

Insertional elements, transposons in Bacteria, Maize and Drosophila.

Practical: 15BT272

Techniques in Molecular Biology

Total Hours - 36

1. Estimation of DNA and RNA by UV-Vis Spectroscopy/Colorimetric method.
2. Partial purification of protein from plant source by Ammonium sulphate precipitation and its estimation. (2 Units)
3. Partial purification of protein from animal source by organic solvent (acetone) and its estimation. (2 Units)
4. Isolation of genomic DNA from plant source and its analysis using agarose gel electrophoresis (2 units).
5. Isolation of genomics DNA from animal/bacterial source and its analysis using agarose gel electrophoresis. (2 units)
6. Column Chromatography (Demo)

7. Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)

REFERENCES

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson *et al*, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts *et al*, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester – Genetics Syllabus
Paper: Fundamentals of Cytogenetics

Paper Code: 15GN201 **Total Credit Hours: 52h**

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UNIT I - PHYSICAL BASIS OF INHERITANCE: 11 h

Chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres, types of chromosomes. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Idiogram.

UNIT II - SPECIAL TYPES OF CHROMOSOME: 3 h

Polytene chromosome- Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte, B Chromosome.

UNIT III - LINKAGE: 7 h

Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage-complete linkage and incomplete linkage,Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc.

UNIT IV - CROSSING OVER 14 h

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in *Drosophila*. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks, Crossing over in *Drosophila* and Tetrad analysis in *Neurospora*, Interference and coincidence, Construction of genetic maps (*Drosophila* and maize) and Punnett square.

UNIT V - SEX LINKAGE: 7 h

Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in *Drosophila*. Sex linked genes in Poultry and moths. Sex related genes in maize. Attached X-chromosome.

UNIT VI - CHROMOSOMAL ABERRATIONS: 10 h

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission.Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

Practical III Semester –Genetics Syllabus
15GN271 - Fundamentals of Cytogenetics

1. Culturing and Handling of *Drosophila* (2 Units)

- Cleaning and Sterilization of bottles.
- Media Preparation.
- Handling of *Drosophila*.

2. Study of at least five types of *Drosophila*: (2 Units)

- Body color mutant- Ebony body and Yellow body.
- Wing mutant- Curly wing and vestigial wing.
- Eye color mutant- Bar eye, white eye, sepia eye.

3. Mounting of Sex Comb of *Drosophila melanogaster* (1 Unit)

4. Mounting of Genital plate of *Drosophila melanogaster* (1 Unit)

5. Salivary gland Chromosome (2 Units)

- Dissection of Salivary glands.
- Preparation of Polytene chromosome.

6. Study of Chromosomal Aberrations: (3 Units)

- Observation of permanent slides of chromosomal aberrations.
- Inversion- Salivary gland chromosomes of *Drosophila nasuta*.
- Induction of polyploidy in Onion root tips.

7. Genetic Problems on Linkage & Crossing over: (1Unit)

- *Drosophila*.
- Maize.
- Human (Sex Linkage).

References:

- Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
- Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
- Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
- Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
- Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
- Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
- Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
- Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
- Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – Genetics Syllabus
Paper: Molecular Genetics

Paper Code: 15GN202 **Total Credit Hours: 52h**

UNIT I - CHEMICAL BASIS OF HEREDITY: 12 h

DNA as genetic material, Experiments of Griffith, Avery, MacLeod, McCarty and Hershey-Chase. RNA as genetic material- Experiment of Fraenkel and Singer.
Nucleic acids: DNA structure and types (A, B and Z model), RNA types and structure
DNA Replication: DNA Replication in prokaryotes and rolling circle model, DNA Replication in eukaryotes

UNIT II - GENE EXPRESSION: 15 h

Genetic code - Brief account, central dogma. Transcription - Initiation, elongation, termination ("rho" dependent and "rho" independent termination). Post Transcriptional modifications. Translation - Initiation, elongation and termination in prokaryotes and eukaryotes. Regulation of gene expression: Inducible operon - galactose, Repressible operon - tryptophan

UNIT III - GENOME ORGANISATION AND FINE STRUCTURE OF GENE: 5 h

Prokaryotic genome - Chromosomal and plasmid, Eukaryotic genome - Chromosomal and organellar, Fine structure of the Gene - cistron, muton and recon. Organelle genomes - Chloroplast and Mitochondria

UNIT IV- Bacterial Genetics: 7 h

Conjugation - F factor mediated, Hfr and Sexduction. Transformation. Transduction - Generalized and specialized. Bacteriophage genetics.

UNIT V - TRANSPOSABLE ELEMENTS: 3 h

Types and classification, Transposable elements in Maize and *Drosophila.*

UNIT VI - MUTATIONS: 10 h

Introduction and types of gene mutations - Base substitution, Frame shift mutation (insertion, deletion, missense, nonsense mutation). Mutagens - physical and chemical. Reverse mutation in

bacteria. DNA repair mechanism (Mismatch repair photoreactivation, excision and SOS repair). Beneficial and harmful effects of mutations.

Practical IV Semester – Genetics Syllabus
15GN272 - Molecular Genetics

1. Instrumentation: (2 Units)

- Centrifuge
- Ultra centrifuge
- pH meter
- Electrophoretic unit
- Spectrophotometer/colorimeter

2. Extraction of DNA from: (4 Units)

- Plants (Cauliflower/Coconut endosperm/any)
- Animal tissue (Liver Tissue/any)

3. Paper Chromatography for Separation of: (3 Units)

- Leaf pigments
- *Drosophila* eye pigments
- Amino acids

4. Electrophoresis (1 Unit)

- Agarose gel electrophoresis

5. Mutations: (2 Units)

a) Study of examples of mutations

- Sickle cell Anaemia – Missense mutation.
- Thalassemia – frame shift mutation.

b) Induction of Mutation in *Drosophila* and detection of sex linked lethal by Muller 5 stock

References:

- Watson J. D., Hopkins N. H., Roberts J. W., Steitz J. A. and Weiner A.M. 1987.Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company, Menlo Park, CA.
- Gestel and Cech R. T. and Atkins J. 1999.The RNA World. II Edition. Cold Spring Harbor, New York.
- Twyman R. M. 1998. Advanced Molecular Biology. Viva Books Ltd.
- Turner P. C. 2002. Instant Notes in Molecular Biology. Viva Books.
- Hames D. and Hooper N. M. 2002. Instant Notes in Biochemistry. II Edition. Viva Books.
- Brown T.A. 2002.Genomes. Viva Books.
- Alberts B., Johnson. A., Lewis J., Roff M., Roberts K. and Walter P. 2002. Molecular Biology of the Cell IV Edition. Garland Science, New York.
- Darnell J., Lodish H. and Baltimore D. 1990. Molecular cell Biology. II Edition. Scientific American Books, New York.
- Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
- Watson J. D. 1992. Recombinant DNA Technology. W. H. Freeman Publisher.
- Bharadwaj D.N. 2008. Molecular Genetics. Kalyani Publisher.
- Daniel L. Hartl and Jones W. 2011. Genetics: Analysis of Gens and genomes. VII Edition. Jones and Bartlett Publishers.
- Hartwell L., Hood L. and Goldberg M. L. 2008. Genetics: from genes to genomics. McGraw-Hill publications.
- De Robertis, E. D. P. and De Robertis E. M. F. 2001. Cell Biology and Molecular Biology. VIII Edition. Lippincott Williams & Wilkins Publishers.
- Rastogi S. C., Mendiratta N. and Rastogi P. 2008. Bioinformatics: Methods and applications. III Edition. PHI Learning Publishers.
- Chiranjib C. 2004. Bioinformatics: Approaches and applications. Biotech Books Publishers.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester - Microbiology Syllabus

Paper: Microbial Physiology, Microbial Genetics and Instrumentation

Paper Code: 15MB201 **Total Credit Hours: 52 h**

MICROBIAL PHYSIOLOGY

Unit I: Biomolecules **5 h**

A brief account of the properties, classification and importance of carbohydrates, lipids and proteins.

Unit II: Enzymes **5 h**

Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes.

Unit III: Metabolismand Bioenergetics

Primary metabolism **8 h**

Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H.

Bacterial photosynthesis **3 h**

Definition, Photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria.

Fermentation **4 h**

Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo, acetic acid, propionic acid, butyric acid, mixed acid and butanediol fermentation.

Secondary metabolism: **2 h**

Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

Bioenergetics: **3 h**

Free energy, ATP and its production, other high energy compounds, Oxidation – Reduction reactions.

MICROBIAL GENETICS

Unit IV - Basics of Genetics **2 h**

Mendelian Principles of genetics (Monohybrid, Dihybrid and Test cross), Morphology of Prokaryotic and Eukaryotic genetic material.

Unit V - Molecular Genetics:

Chemical basis of heredity: **2 h**

Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment),

Genetic code: **2 h**

Properties of genetic code and Wobble hypothesis.

Genetic Recombination: **3 h**

Transformation, Conjugation and Transduction. Transposons in recombination.

Extra chromosomal genetic elements and their importance. **1 h**

Molecular basis of mutations: **3 h**

Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.

Unit VI: Overview of microbial genomics and proteomics **1 h**

INSTRUMENTATION

Unit VII: Bioanalytical Methods

Centrifugation **2 h**

Basic principles, Low-speed and High speed centrifuges, ultracentrifugation, Applications.

Chromatography **2 h**

Paper, Thin layer, Column chromatography, HPLC

Electrophoresis **2 h**

Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, SDS-PAGE

Spectrophotometer **2 h**

Principles of Spectroscopy, UV Visible spectroscopy, NMR spectroscopy

Practical III: Microbial Physiology and Microbial Genetics
Paper Code: 15MB271
Total Credit hours – 39 (1 unit – 3hours)

1. **Biochemical tests:** (5 units)
   - Starch hydrolysis.
   - Gelatin hydrolysis.
   - Catalase test.
   - Sugar fermentation test.
   - Nitrate reduction test.
   - H_2S production test.
   - IMViC test
   - Oxidase test.
   - Casein hydrolysis test.
   - ONPG test.
2. Qualitative analysis of carbohydrates. (1 unit)
3. Qualitative analysis of proteins. (1 unit)
4. Quantitative determination of reducing sugars by DNS method. (1 unit)
5. Quantitative determination of proteins by biuret method. (1 unit)
6. Partial purification of protein by ammonium sulphate precipitation method (1 unit)
7. Genetic problems (1 unit)
8. Isolation of antibiotics resistant mutant by gradient plate technique (1 unit)
9. Demonstration of replica plating method for selection of antibiotic resistant mutants (1 unit)

REFERENCES:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Freifelder, D. 2002. Microbial Genetics, Narosa Publishing House, New Delhi.
7. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 2008. Principles of Genetics. Eight edition. Wiley Publications.
8. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc. Publication. USA. p: 1-458.
9. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.

10. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
11. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – Microbiology Syllabus

Paper : Molecular Biology and Recombinant DNA Technology

Paper Code: 15MB202 **Total Credit Hours: 52h**

MOLECULAR BIOLOGY

Unit I : Introduction to nucleic acids: **6 h**

Structure of bases – A, T, G, C and U. Definition of nucleosides and nucleotides, Watson and Crick model of DNA, Types of DNA (A, B and Z), Types of RNA and their functions.

Unit II: DNA Replication **6 h**

Modes of replication- Conservative, Semi conservative (Messelson and Stahl experiment) and Dispersive. Methods of DNA replication (Rolling circle and Linear), and mechanism of Prokaryotic DNA replication.

Unit III: Gene Expression **7 h**

Central dogma, Transcription- mechanism, post transcriptional modification. Translation - mechanisms, post translational modification in prokaryotes.

Unit IV: Regulation of Gene Expression **7 h**

The operon concept, induction, repression catabolic repression and attenuation. The *lac* operon and *trp* operon.

RECOMBINANT DNA TECHNOLOGY

Unit V: History and fundamentals of r-DNA technology **1 h**

Unit VI: Tools for r-DNA technology

- **Enzymes** **4 h**
  DNA manipulative enzymes enzymes, Restriction enzymes, Ligases and other DNA modifying
- **Gene cloning vectors** **5 h**

Salient features, Plasmids- properties, types pBR322, bacteriophages- λ and M 13, Cosmids-properties, Bacterial Artificial Chromosomes (BAC's),Yeast Artificial Chromosomes (YAC's), *Agrobacterium tumifaciens*, SV 40.

- Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). **1 h**
- **Cutting of DNA molecules** **3 h**
- Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters.
- **Transformation of r-DNA into target host organisms:** **4 h**
  Calcium chloride mediated gene transfer, *Agrobacterium* mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment.

Unit VII: Screening and selection of recombinant host cells: **5 h**
Insertional inactivation, *in situ* colony/DNA hybridization, Polymerase chain reaction, blotting techniques and immunological techniques.

Unit VIII: Applications of Genetic Engineering: **2 h**
a) Medicine: Gene therapy b) Agriculture: *nif* gene cloning

Unit IX: Potential hazards and safe guards of genetic engineering **1 h**

Paper IV: Molecular Biology and Recombinant DNA Technology

(Paper code - 15MB272) **Total Credit hours – 39 (1 unit – 3hours)**

1. Determination of λmax for the given biomolecule (Protein/DNA/ Sugar) (1 unit)
2. Isolation of Genomic DNA from bacteria (1 unit)
3. Isolation of plasmid DNA from bacteria (1 unit)
4. Analysis of genomic DNA by Agarose gel electrophoresis (1 unit)
5. Estimation of DNA by DPA method (1 unit)
6. Estimation of RNA by orcinol method (1 unit)
7. Demonstration of the following models/ photographs/charts of DNA, t-RNA, Replication, Trancription, Translation, Transformation, conjugation and transduction. DNA repair mechanisms. (1 unit)
8. Demonstration of instruments – PCR, Southern Blotting assembly
9. Charts on genetic engineering. (2 units)
   pBR 322, pUC 18 and 19, SV 40, Bacteriophages- Lambda, Gene cloning, Selection of recombinants by replica plate technique.
10. Kit based experiments (3 units)
    - Restriction digestion
    - Ligation
    - Transformation

REFERENCES:

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis – an Introduction. Sixth edition. Wiley Blackwell.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Cooper, G.M. 2013. The Cell – A Molecular Approach. 6th edition. Sinauer Associates.
5. Karp, G. 2008. Cell and Molecular Biology. 5th edition. McGraw Hill Book Company, New York.
6. Nelson, D.L. and Cox, M.M. 2007. Lehninger's Principles of Biochemistry. Fourth edition. Macmillan Press/Worth Publishers. New Delhi.
7. Palmer, T. and Bonner, P.L. 2007. Biochemistry, Biotechnology and Clinical Chemistry. Second edition. Wood head Publishing co.
8. Prescott, L.M. Harley, J.P. and Klein, D.A. 2011. Microbiology. Eight edition. WCB – McGrawHill, New York.
9. Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene manipulation and Genomics. Seventh edition. Blackwell Publishing.
10. Singh, B.D. 2008. Biotechnology – Expanding Horizons. Kalyani Publishers.
11. Watson, J. D. Recombinant DNA, Scientific American Books, New York.

12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levne, M., and Losick, R. 2004. Molecular Biology of the Gene. Fifth Edition. Pearson Education.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester – Zoology Syllabus

Paper : Cytology and Histology

Paper Code: 15ZG201 **Total Credit Hours: 52h**

UNIT-I-CYTOLOGY

Introduction to cytology: definition and scope **1 h**
Structure and function of Plasma membrane,cell organelles, Endoplasmic reticulum, Golgi complex, Lysosomes, Mitochondria, Nucleus, Microtubules and Microfilaments, Microsomes and Centrioles **15 h**
Cell cycle: Mitosis and Meiosis, Cell death: Apoptosis, Necrosis, Necrobiosis **2 h**
Cancer cell: Characteristics,causes, types of cancer based upon origin **2 h**

UNIT-II- HISTOLOGY

Introduction: definition and scope **1 h**
Tissues types: epithelial, glandular, muscle, and nervous **2 h**
Histological study of following organs:
Skin, tooth, tongue - mucosa papillae and taste bud **2 h**
Alimentary canal: esophagus,stomach, duodenum, Ileum and rectum **4 h**
Glands associated with digestive system: Salivary glands – parotid,submandibular, sublingual, liver, and pancreas includingboth exocrinal and endocrinal components. **4h**
Respiratory organs: Trachea and lung **1 h**
Blood vessels: Artery, vein, and capillaries **1 h**
Kidney, structure of nephron, and juxta glomerular complex. **2 h**
Reproductive organs: a)Testis: structure and functionb) Ovary - matured(Graffian)follicle, accessory glands **3 h**
Endocrine glands: 1)Pituitary. 2) Thyroid 3)Adrenal. **3 h**

UNIT-III-MICROTECHNIQUE

Histological localization of lipids, carbohydrates and proteins in different tissues. **3 h**
Histochemical staining for carbohydrates (PAS), protein (Millon's staining method)

and lipids (Sudan black-B method) and Fulgen nuclear staining for DNA. **3 h**
Histopathology- Degenerative changes and histopathological manifestations, Liver, Cirrhosis and Nephrosis **3 h**

Practical III Semester – Zoology
Syllabus 15ZG271 – Cytology and Histology

TOTAL CREDIT HOURS - 36

1.	Permanent slide study of Mitosis and Meiosis stages	**1 unit**
2.	Study of Mitotic stages using Onion root tips	**1 unit**
3.	Study of Meiosis stages using Grasshopper testis	**1 unit**
4.	Yeast Mitochondrial Staining using Janus Green B stain	**1 unit**
5.	Tissue collection and fixation, Block Making	**2 units**
6.	Sectioning. Staining & mounting. Permanent slides preparation.	**2 units**
7.	Study of permanent histological slides of skin, tooth, tongue, stomach, duodenum, ileum, liver, pancreas and any one salivary gland.	**2 units**
8.	Study of permanent histological slides of trachea, lung, kidney testis, ovary,thyroid and adrenal.	**2 units**

References

1. De Robertis EDP and De Robertis EME. Cell and molecular biology. Molt Saunders Inc. (1988)
2. C. B. Powar. Cell biology.Himalaya Publications House.(1986)
3. Dupraw I. Cell and molecular biology.Academic Press New York. (1968)
4. Avers, C. J. Molecular Cell Biology. Reading, Mass.: Addison-Wesley. New York & London (1976)
5. Carp, G.Cell and molecular biology.John Wiley,USA. (1996)
6. Sadava, D. E. Cell biology.Johnes and Bartlett Publication. London.(1993)
7. A.G. Lowey, Siekevitz, J.R. Menninger & J.A.N. Gallew. Cell Structure and Function, 3rd edn, Saundercollege Publication. Philadelphia.(1991)
8. Verma and Agarwal.Cell Biology, Genetics, Molecular Biology, Evolution, and Ecology. S Chand; Reprint.Edn.(2006)

9. Bailey's Text book of Histology, 1971, 16th edn. The William &Wilkings company Baltimore.
10. Arthur W. Ham. David H. Cormark. Histology 1979, 8th edn. J.B. Lippincott. Co. Philadelphia.
11. Krishan Garg, Indira Bahl &Mohini Kaul.A text book of Histology, 1991 2nd edn.CBS Publishers& Distributors, Delhi.
12. R.D. Greep& L.Weill. Histology, 1973. 3rd edn,. McGraw Hill Int. Book C. New York.
13. Athawale & Latey. Histology of Mammals, Narendra Prakashan, Pune.
14. Peter Gray. Hand book of Basic Microtechnique, 1964, 3rd edn. McGraw Hill Book Co. New York.
15. S.K. David. Hand Book of Histological & Histochemistry Technique, 1991, 1st edn., CBS Publishers& Distributors, Delhi.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – Zoology Syllabus

Paper: Animal Physiology and Development Biology

Paper Code: 15ZG202 **Total Credit Hours: 52h**

UNIT-I – ANIMAL PHYSIOLOGY **1 h**

Introduction, definition and scope

UNIT-II- DIGESTION **5 h**

Physiology of digestion, Digestive enzymes and theiractions- salivary,gastric and intestinal digestion. Role of liver and pancreas.

Metabolic pathway: Carbohydrates- glycolysis. Lipids - Fatty acid beta oxidation.

Proteins - Deamination, transamination, decarboxylation, transmethylation.

UNIT- III- CIRCULATION **4 h**

Structure and function of heart.Cardiac cycle – systole, diastole, pacemakers. ECG, Eco-cardiograph, Respiratory pigments (Haemoglobin, Myoglobin, Heamocyanin), a short note on heart attack

UNIT-IV- RESPIRATION **5 h**

Mechanism of transport of gases, a) Transport of oxygen—oxyhaemoglobin formation. b) Transport of carbondioxide in the form of --- physical solution of carbonic acid, carbamino compounds and bicarbonate ions or chloride shift. Respiratory quotient and BMR.Respiratory disturbances –Definitions - Apnoea, dyspnoea, arterial hypoxia, hypo- and hypercapnia, asphyxia.

UNIT-V- EXCRETION **4 h**

Physiology of urine formation, Urine composition, ultrafiltration, selective reabsorption, tubular secretion. Counter current multiplier and amplifier for urine concentration.

Definitions and clinical significance —renal failure, renal calculi, dialysis.

UNIT-VI- MUSCLE PHYSIOLOGY **4 h**

Striated muscle (structure and ultra-structure) Chemical composition.Sliding filament theory of muscle contraction.Physical and chemical changes during muscle contraction. Response of muscle to stimulation – simple muscle twitch, tetany, muscle fatigue, rigor mortis.Comparison with smooth and cardiac muscle.

UNIT-VII- NERVOUS SYSTEM **4 h**

Definitions- Impulse, stimulation, conduction, response,Originand conductionof nerve impulse, axonal and saltatory conduction. Synapse – Ultra structure and transmission of nerve impulse. Neurotransmitters- definition, properties and types- serotonin, dopamine, histamine, acetylcholine, GABA. EEG and epilepsy.

UNIT-VIII- REPRODUCTION **4 h**

Oestrous& menstrual cycle and hormonal regulation. Pregnancy, parturition, lactation and their hormonal control. Hormonal control of male reproductive system.

UNIT-IX- ENDOCRINOLOGY **3 h**

Positive and negative feed-back mechanism.Hypo and hyper secretion of pituitary, thyroid, pancreas and adrenal.

UNIT-X- DEVELOPMENTAL BIOLOGY **18 h**

Gametogenesis, Oogenesis, types of eggs,
Spermatogenesis, Spermiogenesis, ultrastructure of the spermatozoa (Sperm attraction and activation, Contact of gametes, fusion, prevention to polyspermy—slow and fast block,activation of egg metabolism, fusion of genetic material)
Vitellogenesis and organization of the egg (polarized distribution of components, egg cortex, nucleus and egg membranes)
Fertilization (external and internal fertilization) and mechanism of fertilization
Development of frog: cleavage, blastula, gastrula, neurala, metamorphosis. Fate map of frog.
Development of chick: cleavage, blastula, gastrula, neurala, metamorphosis (48 hrs of development).
Basic concepts in regeneration with reference to Hydra and Planaria.
Importance of cell death during development (at least one example such as digit formation)

Practical IV Semester – Zoology Syllabus 15ZG271 – Animal Physiology and Development Biology

TOTAL CREDIT HOURS - 36

1. Effect of hypo, iso and hypertonic solutions on RBCs. **1 Unit**
2. A] Clotting time of blood. B] Preparation of haemin crystals.
3. Study of ECG using recorded graph. **1 Unit**
4. Study on experiment to show the salt gain and salt loss by Crab **1 Unit**
5. Estimation of blood glucose **1 Unit**
6. Identification of food constituents— a) Carbohydrates—Glucose, Starch.
   b) Protein- Albumin-Biuret test, Ninhydrin test, Millon's test, Xanthoproteic test.
   c) Fats—Olive oil/ Groundnut oil—Emulsion test, Solubility test, ppSaponification test **3 Units**
7. Identification of nitrogenous wastes - ammonia, uric acid, urea **1 Unit**
8. Study of any five clinical conditions associated with hypo/hyper active endocrine glands with the help of photographs—Gigantism, Dwarfism, Acromegaly, Cretinism, Myxodema, Grave's disease, Cushing's disease. **1 Unit**
9. Study of sperm abnormalities, types of eggs (insect/frog/hen), Types of blastulae and gastrulae (insect/frog/hen). **1 Unit**
10. Study of chick embryo whole mounts 18 h (primitive streak), 24h, 36 h, 48h, 72h & 96h of incubation. **1 Unit**
11. Study of temporary preparation of whole mount of chick embryo.
12. Study of structure of fallopian tube and uterus. **1 Unit**

References

1. Kunt Schmidt, Neilson. Animal Physiology. 4th edn., Cambridge University Press Cambridge. (1990)
2. Marshall & Hughes. Physiology of Mammals & other vertebrates. 2 ndedn.. Cambridge University Press Cambridge. (1980)
3. Roger Eckert & David Randall. Animal Physiology. CBS Publishers & Distributors, Delhi. (1987)
4. Hurt & Mathur. Text of Animal Physiology.S.Chand& Co. New Delhi. (1976)
5. William S Hoar. General & Comparative Physiology. 3rd edn. Prentice hall, India, New Delhi. (1991).
6. Nagbushanam, Kodarkar & Sarojini. Text of Animal Physiology, 2nd edn, , Oxford & IBI Pub. New Delhi. (1991)
7. CLadd Prosser. Comparative Animal Physiology (Environment & Metabolic Animal Physiology,) 4th edn. Wiley-Liss, Publication, New York (1991)

8. C. Ladd Prosser. Comparative Animal Physiology (Neural & Integrative Animal Physiology) 4th edn. Wiley-Liss, Publication New York. (1991)
9. Dr. C. C. Chatterjee. Human Physiology, Vol. I& II.12th edn, Medical applied Agency, Calcutta.(1980)
10. P.J.Bently. Comparative Vertebrate Endocrinology. 2nd ed. Cambridge University Press, London. (1982)
11. Dr.P.V.Chandha. Handbook of Experimental Physiology & Biochemistry. Jaypee Brothers Medical Publishers, New Delhi. (1993)
12. Turner C.D. &Baganara J.T. General Endocrinology.6th .edn. W.B.Saunders Co., Philadelphia.(1976)
13. Zubay G. Biochemistry. 3rd edn..Wm.C.Brown Communications Inc.U.S.A. (1993)
14. Guyton, A.C. Text book of Medical Physiology, 8th edn. W.B. Saunders com., Philadelphia (Indian edn. Prism Book Bangalore.(1991)
15. Gilbert, S. F. Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA. (2006).
16. Balinsky, B.I. An introduction to Embryology, International Thomson Computer Press. (2008).
17. Kalthoff. Analysis of Biological Development, II Edition, McGraw-Hill Professional.(2000).

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Third Semester – B.Sc. Syllabus

Paper: Constitution of India and Human Rights

Paper Code: 15CI291 **Total Credit Hours: 26h**

UNIT – 1:

a. Framing of the Indian Constitution: Role of the Constituent Assembly.
b. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

UNIT – 2:

a. Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities.
b. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

UNIT – 3:

a. Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
b. Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

UNIT – 4:

1. State Government: Governor, Chief Minister and Council of ministers, Legislature.

2. Centre – State relations: Political, financial, administrative: Recent Trends.

UNIT – 5:

a. Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs.
b. Emergency provisions (Article 356)

REFERENCES:

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

DAYANANDA SAGAR UNIVERSITY SCHOOL OF BASIC AND APPLIED SCIENCES DEPARTMENT OF BIOLOGICAL SCIENCES

Fourth Semester – B.Sc. Syllabus
Paper: Entrepreneurship Syllabus

Paper Code: 15EP292 **Total Credit Hours: 26h**

UNIT I - 1 THE NATURE AND IMPORTANCE OF ENTREPRENEURS

Nature and Development of Entrepreneurship, Definition of Entrepreneur Today, Entrepreneurial Decision Process, Role of Entrepreneurship in Economic Development, Intrapreneurship, Entrepreneurship, Entrepreneurial Careers and Education, The Future of Entrepreneurship Module

UNIT II - THE ENTREPRENEURIAL AND INTRAPRENEURIAL MIND

The Entrepreneurial Process, Identify and Evaluate the Opportunity, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise, Managerial versus Entrepreneurial Decision Making, Causes for Interest in Intrapreneurship, Corporate versus Intrapreneurial Culture, - Climate for Intrapreneurship, Intrapreneurial. Leadership Characteristics, Establishing in the Organization, factors affecting entrepreneurship — qualities of successful entrepreneurship.

UNIT III - SMALL & MEDIUM ENTERPRISES (SME)

Role of SME, concept and definitions of SME, government policy and SME in India, growth and performance of SME sector, problems for SMEs, Sickness in SME, criteria to identity sickness, causes, symptoms and remedial measures of sickness, institutional support for SMEs.

UNIT IV - STARTING THE BUSINESS - BUSINESS IDEA & INNOVATION

Business idea, Opportunity Recognition , Product Planning and Development Process, Establishing Evaluation Criteria, Idea Stage, Concept Stage Product Stage, Test Marketing Stage, Creativity, Innovation and entrepreneurship, barriers to creativity, techniques for

improving the creative process, corporate entrepreneurship, causes, climate, intrapreneurial leadership characteristics, Establishing intrapreneurship in the organization

UNIT V - LEGAL ISSUES FOR THE ENTREPRENEUR

Various forms of organization, Legal Issues in Setting up the Organization, The various statutory registrations and clearances required.

REFERENCES:

1. M. lall, Entrepreneurship, Excel books
2. Vasant Desai:- Dynamics of Entrepreneurial Development and ManagementHPH
3. Hisrich, Robert D., Peters, Michael P., and Shephered, dean

   a: entrepreneurship, tata mcgraw hill; sixth edition, 2007
4. Mathew J Manimala:- Entrepreneurship at the Crossroads - Biztantra
5. Mohanty – Fundamentals of Entrepreneurship, Prentice Hall of India
6. Zimmerer & Scarborough – Essentials of Entrepreneurship

   & Small Business Management, Prentice Hall of India

Annexure Ia

SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

B.Sc. – BIOTECHNOLOGY - V SEMESTER SYLLABUS

Paper: Principles of Immunology and Basics of Animal Biotechnology

Paper Code: 15BT301

Total credits: 45 hours

Unit 1: Elements of Immune System 10h

History and scope of Immunology, Innate and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells. Interleukins and Interferons – brief introduction and their important functions. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated)

Unit 2: Antigens and Antibodies 10h

Antigens – types, epitopes, haptens, factors affecting antigenicity, antigen processing and presentation, antigen processing cells (APCs). Major Histocompatibility Complex (MHC) – MHC I and II. Antibodies – structure, types and functions of Immunoglobulins. Antigen-Antibody reactions – Precipitation, Immunoelectrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, ImmunoFluorescence.

Unit 3: Vaccines and Immunization

05h

Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

Unit 4: Animal Cell Culture

10h

Introduction, history and scope of Animal Biotechnology, Facilities in Animal Cell Culture, Media – natural and chemically defined, importance of serum in the media. Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method. Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK)

Unit 5: Applications of Animal Tissue Culture

10h

Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep)

Practicals - 15BT371: Immunology and Animal Biotechnology

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins (2 units)
5. Differential Count of WBC
6. Introduction to instruments and laboratory set up for animal biotechnology
7. Preparation of media for animal cell culture (2 units).
8. Isolation of liver parenchyma cells by mechanical method and set up primary culture (2 units)
9. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
10. Isolation of cells by explant method and Sub-culturing (2 units)
11. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

References

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
3. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier Health
4. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.

5. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
6. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
7. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
8. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

Dayananda Sagar University

School of Basic and Applied Sciences

B.Sc. – BIOTECHNOLOGY - V SEMESTER SYLLABUS

Paper: Departmental Elective: Environmental Biotechnology

Paper Code: 15BT321

Total Credits: 45 hours

Unit 1: Sources of Energy

10h

Renewable and non-renewable sources of energy, Conventional fuels and their environmental impact, Modern fuels and their environmental impact, methanogenic bacteria, microbial hydrogen production, biogas production, conversion of sugar to alcohol, gasohol, biofuel (algae).

Unit 2: Waste management

12h

Treatment of municipal solid waste and industrial effluents, preliminary treatment, primary treatment – sedimentation, secondary treatment – aerated lagoons, activated sludge, batch reactor, trickling filter, rotating biological contractor, packed bed process, pond

treatment system – aerobic, anaerobic and facultative, tertiary treatment – solid, nitrogen, phosphorus removal and disinfection.

Unit 3: Bioremediation and Bioleaching

16h

Bioremediation techniques – *in situ* and *ex situ*, bioremediation of soil and water contaminated with oil spills, heavy metals and detergents, Phytoremediation, degradation of pesticides and toxic chemicals by microorganisms - aromatic and chlorinated hydrocarbons, petroleum products, genetically modified organisms in bioremediation. Microbes used in leaching, mechanism, leaching process, case studies related to bioleaching.

Unit 4: Novel Methods for Environment protection

07h

Bioindicators (Terrestrial & Aquatic) and Biosensors of pollution. Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products.

References:

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House

2. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
3. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
4. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

Dayananda Sagar University

School of Basic and Applied Sciences

B.Sc. – BIOTECHNOLOGY - V SEMESTER SYLLABUS

Paper: Industrial Biotechnology

Paper Code: 15BT322

45 hours

Unit 1: Screening and Selection of strains

10h

Introduction, basics of fermentation technology, Isolation and screening of microorganisms, maintenance of strains, strain improvement – mutant selection, recombinant DNA method

Unit 2: Fermentation Media, Fermentors and Fermentation

12h

Fermentation media – natural and synthetic, media sterilization. Types of Fermentors – Basic design, Airlift, tower and bubble cap fermentor; Immobilized cells and enzyme fermentor. Types of Fermentation - Solid state, submerged, Batch, Fed-batch and Continuous.

Unit 3: Downstream Processing

12h

Solid-liquid separation (Filtration, flocculation, centrifugation, sedimentation), release of intracellular products – physical, enzymatic, chemical, concentration and purification of products.

Unit 4 Production of Microbial Products

11h

Production of wine, beer, citric acid, penicillin, glutamic acid, Vitamin B12, Amylase, insulin, fermented foods (Yoghurt, cheese), Spirulina.

References

1. Glazer and Nikaido (1995), Microbial Biotecnology, WH Freeman and Co.
2. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
3. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
4. Nduka Okafor (2007) Modern Industrial Microbiology and Biotechnology, CRC Press
5. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
6. LEJR Casida (2007) Industrial Microbiology, New Age International Publishers
7. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

Semester V - B. Sc. Biochemistry syllabus

Theory: 15BC301 Enzyme technology and Protein chemistry
45h

Unit 1 Introduction
10h

Classification & nomenclature of enzymes, Active site: Lock & key, induced fit model and strain/TS theory- lysozyme and chymotrypsin as examples, Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientation effect, Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogen phosphorylase) enzymes, Units-Katal & IU. Effect of physical and chemical parameters on enzyme activity with examples.

Unit 2 Enzyme kinetics
6h

Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of K_{cat} / K_m. Bisubstrate reactions – brief introduction.

Unit 3 Enzyme assay and purification
4h

Enzyme assay, Specific activity. Enzyme isolation and purification, criteria for enzyme purity. Isoenzymes and clinical applications, Biotechnological applications, enzyme biosensors.

Unit 4 Vitamins and coenzymes

5h

Structure and reaction mechanisms of vitamins – fat-soluble: A, D, E & K; water-soluble: thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, cobalamine and ascorbic acid.

Unit 5 Proteins

8h

Classification based on composition, shape and function, assay techniques. Peptide bond, Ramachandran Plot, Structural organization: primary, secondary, tertiary and quaternary structures, Hemoglobin, Immunoglobulin, Collagen, myosin and Keratin structures. Denaturation and melting temperature, Hofmeister series. Protein synthesis.

Unit 6 Analytical techniques to characterize proteins

12h

Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography. Sequence determination by Sanger and Edman methods. Mass spectromtery of proteins: mass determination, Hydropathy plot, Protein Expression, Vectors and hosts, downstream processing.

Departmental Elective:

Theory 15BC321 Chemistry and Metabolism of Carbohydrates and Proteins **45h**

Unit 1 Carbohydrate chemistry

14h

Biological importance and classification. Fischer structure, D-L designation. Glucose-structural elucidation and

conformation. Ring and open-chain structure of fructose, galactose, mannose and arabinose. Epimers and anomers, pyranose and furanose ring. Reactions: Benedict's, oxidation, osazone, ester, amino and deoxy sugar formation.
Derived monosaccharide: structure and biological importance of amino sugars and sugar phosphates.
Oligosaccharides: glycoside linkage, structure and biological importance of sucrose, maltose, lactose, isomaltose, cellobiose and trehalose.
Polysaccharides: starch, glycogen, cellulose, inulin, chitin and pectin.
Mucoploysaccharide: glycosaminoglycans, cell wall components: peptidogycan and teichioc acid.

Unit 2 Carbohydrate metabolism

17h

Glycolysis, entry of other carbohydrates into glycolysis, the fate of pyruvate, the citric acid cycle, the energetics of glucose metabolism. The amphipathic role of the citric acid cycle. Outline of pentose phosphate pathway and its significance. Brief idea about the Cori cycle, Gluconeogenesis and glycogen metabolism. Substrate level phosphorylation, regulation of blood sugar level. Diabetes mellitus. Determination of glucose in body fluids; fasting, post-prandial, GTT. Glycogen storage disorders.

Unit 3 Amino Acids

08h

Protein and non-protein amino acids, structure and classification of α-amino acids, acids-base, chemical and optical properties. Synthesis and degradation of selected amino acids (tyrosine, methionine and leucine), transamination, deamination, Urea cycle.

Unit 4 Peptides

06h

Biologically important peptides- leptin, ghrelin, neuropeptides, substance P, enkephalin, angiotensin, defensin, vasopressin and oxytocin. Chemical synthesis of peptides.

References:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

Departmental Elective:

Theory 2 15BC322 Nutrition and biomembranes

45h

Unit 1 Introduction to nutrition

5h

Food as source of nutrients, functions of food, definition of nutrition, nutrients & energy, adequate, optimum & good nutrition, malnutrition. Nutrition - Fitness, Athletics & Sports.

Unit 2 Food components and availability

10h

Basic five food groups How to use food guide (according to R.D.A.) Interrelationship between nutrition & health. Sources, function, storage and deficiency of carbohydrates, fats, oils, fiber and proteins. Water - as a nutrient, function, sources, requirement, water balance & effect of deficiency.

Unit 3 micronutrients

5h

Minerals - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium Vitamins (water & fat soluble) - definition, classification & functions. Functional food, food fortification, food additives, role of FDA.

Unit 4 Biological membranes - introduction

8h

Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, composition and trans bilayer asymmetry, Isolation of membrane components, effect of lipid size and saturation on membrane fluidity, role of cholesterol, lipid rafts, non bilayer lipids and their role in membrane, Liposomes; properties and application in membrane biochemistry

Unit 5 Transport across membrane

10h

Passive – ion channels, ionophore and porins; Facilitated diffusion: aquaporin, gated ion channels – sodium and potassium ion channels in muscle, calcium ion channel in heart; Active transport – P, V and F-type ATPase – structure, function and location, ATP-binding cassatte transporters and multi drug resistance transporters, patch-clamp study.

Unit 6 Protein trafficking

7h

Protein sorting; Membrane enclosed organelles of eukaryotic cells, evolutionary origin Protein trafficking: Sorting signals. Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Intracellular vesicular trafficking, Vesicles: types, Clathrin coated- Assembly and disassembly.

References:

1. Biochemistry 5th Ed. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
2. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell , The McGraw-Hill .
3. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science .
4. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier .
5. Molecular Biology of the Cell, Alberts et al., Garland Publications.

6. Molecular Biology of the Cell; 6 th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science.
7. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co.
8. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley .
9. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell .
10. Textbook of medical Biochemistry Chatterjee and Shinde, JP Medical Ltd, 8th edition.

*Prac*tical: 15BC371 Enzymology and recombinant protein purification

Enzymology

[1] Isolation of enzymes from biological source and activity determination
[2] Determination of kinetic constants through LB plot.
[3] Effect of temperature and Arrhenius constant.
[4] Effect of enzyme dilution
[5] Effect of substrate concentration
[6] Effect of pH
[7] Effect of activator
[8] Effect of inhibitor.
[9] Immobilization of enzyme using calcium alginate.

Recombinant Protein Purification

[1] Preparation of competent cells and transformation
[2] Protein purification by Ni- NTA Affinity chromatogram
[3] SDS-PAGE of purified protein
[4] Protein concentration determination from spectrophotometry
[5] Purification of protease from plant by ammonium sulphate fractionation
[6] Protease assay through FC method

ENGINEERING 15 Hours

Introduction to Genetic Engineering: Overview of major steps involved

Tools for Genetic Engineering: Enzymes and Vectors

a. Enzymes:

- Restriction endonucleases: Types and characteristic features; Nomenclature; Modification of cut ends.
- DNA ligases.
- Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

b. Vectors: Properties of an ideal vector. Types: Cloning and expression vectors

- **Cloning vectors:** Prokaryotic vectors: Plasmids- pUC 18; Bacteriophages - Lambda.
- Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.*
- For higher plants: Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid
- For animals: Animal viral vectors- SV 40.
- **Expression vectors** in Prokaryotes and Eukaryotes

UNIT II: Gene isolation and transfer

15 Hours

a) Isolation of the desired gene: cDNA library, Genomic library, Amplification through PCR.

b) Direct gene transfer methods: Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method).

c) Selection and screening of recombinants: Identification and

selection of transformed cells:

- Direct methods - Visual screening method, Plaque formation.
- Indirect methods - Colony hybridization, Immunochemical detection.

UNIT III: GENETIC ENGINEERING TECHNIQUES AND APPLICATIONS 15 Hours

- **Technique for Genetic Engineering:** Gel electrophoresis: AGE and SDS-PAGE Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method.
- **Applications:** Transgenic animals: Mouse; Poultry, Fish with value added attributes.

  Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

PRACTICAL SYLLABUS - GENETICS
15GN371 – Genetic Engineering

1. Instrumentation:
a) UV Transilluminator
b) PCR

2. Vecors:
a) pUC 18
b) YAC,
c) Ti plasmid
d) SV 40

3. Transgenic organisms:
Plants-Bt cotton and Animals-Knock out Mouse

4. Experiments:

a) Quantification of DNA by DPA method
b) Quantification of RNA by Orcinol method
c) Agarose Gel Electrophoresis of DNA

5. Demonstrations:

a) Isolation of Plasmid DNA
b) Restriction Enzyme digestion
c) Ligation of DNA fragment
d) Transformation- α complementation

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- Lewin B. Genes VIII. Oxford University Press. Oxford, 2003.
- Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.
- Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India. 2004.
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DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

V Semester – B.Sc Genetics Syllabus

15GN321 - Basic Human Genetics

TOTAL CREDIT HOURS – 45 hours.

UNIT I: HUMAN CHROMOSOMES, INHERITANCE AND GENETIC DISEASES

Human Chromosomes: Normal Human Karotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes), FACS - Fluorescence activated cell sorter.

Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.

Genetic Diseases and Inheritance Pattern:

Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney and Achondroplasia).

Autosomal Recessive Inheritance (Ex.- Albinism and Phenylketonuria).

X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD).

X-linked Dominant Inheritance (Ex.- Xg blood group).

Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF).

UNIT II: IMMUNOGENETICS AND ONCOGENETICS

15 Hours

Immunology and Immunogenetics: Introduction

immunology

Cells of immune system, Genetics of immune system, Immune response, Innate and acquired immunity. Inherited immunodeficiency (Ex. – X- linked agammaglobulinaemia). Major Histocompatibilty. Complex- Study of twins (MHC), HLA disease associations. Transplantation, graft-versus-host disease.

Oncogenetics: Properties of malignant cells, Types of genes - Proto oncogenes, Oncogenes, Cellular oncogenes, Tumor Suppressor genes, Chromosomal abnormalities associated with specific malignancies -

Acute Promyelocytic Leukemia (APL), Chronic Myeloid Leukemia (CML) and Retinoblastoma

UNIT III: DERMATOGLYPHICS, DIAGNOSIS AND THERAPY 15 Hours

Dermatoglyphics: Introduction and classification, Flexion creases. Dermatoglyphics in clinical disorders. Clinical applications, advantages and limitations.

Diagnosis: Prenatal diagnosis: Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography. Invasive methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Technology in reproductive assistance

Therapy and Ethics: Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes. Gene therapy, Stem cells - Definition, types and sources. A brief account on Cord blood banking and Stem cell therapy. Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

References:

- Bhatnagar etal S.M. Essentials of Human Genetics. IV edition. Orient Longman. 1999
- Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
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Livingstone Pvt. Ltd., New Delhi. 2001.

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- Cummings, M. R. Human Heredity: Principles and Issues. West Publishing Company. 1994.
- Epstein, R. J. Human Molecular Biology. Cambridge Univ. Press, Cambridge. 2003.
- Khoury, M. J., J. Little and W. Burke. Human Genome Epidemiology. Oxford Univ. Press,Oxford. 2004.
- Motulsky, V. Human Genetics. Springer & Verlag, Berlin. 1977.
- Strachan, T. and A. P. Reads, Human Molecular Genetics 3. Garland Science, London. 2004.
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- Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter. Molecular Biology of the cell. V Ed. Garland Science, New York. 2008.
- Goldsby R. A., Kindt T. J. and Osborne B. A. Kuby Immunology. W. H. Freeman and Company, N. Y. 2000.

DEPARTMENT OF BIOLOGICAL SCIENCES

Sixth Semester – B.Sc Genetics Syllabus
15GN322 – Plant Genetics

TOTAL CREDIT HOURS – 45 hours.

UNIT I: GENE REGULATION IN PLANTS
15 Hours

Over view of plants as genetic model systems, Genome structure of *Arabidopsis*, rice. Gene regulation in plants: Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf. Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes.

UNIT II: APPLIED GENETICS OF PLANTS
15 Hours

Genetic basis of disease resistance and susceptibility in plants. Genetic basis of Crown Gall disease development. Agrobacterium-Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants. Basics of marker assisted breeding and selection in plants.

UNIT III: PROTOPLAST TECHNOLOGY
15 Hours

Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application. Biofertilizer: Production and beneficial roles of

Rhizobium, Innoculants and Azatobacter inoculants, field application of Rhizobium, Azatobacter blue green algae, mycorizal fungi and Azolla.

References

- Altman A. and Hasegawa, P.M. Plant biotechnology and Agriculture – Prospects for the 21st Century, Elsevier Science Publishers, Amsterdam. 2011.
- Brahma Mishra, Fertilizer Technology and Management, I.K. International Publishing House Ltd., New Delhi. 2009.
- Chawla H.S. Plant Biotechnology, Oxford and IBH publishing Co. Pvt Ltd., New Delhi. 2003.
- Chrispeels M. J. and Sadava D. E. Plants, Genes and Agriculture, Jones and Bartlett Publishers, Boston. 1994.
- Dickinson M. Molecular Plant Pathology. BIOS Scientific, Oxford, UK. 2003.
- Purohit, S.S. Agricultural Biotechnology, Agribios, Jodhpur. 2006.
- Rangaswami, G. and Bagyaraj. D.J. Agricultural Microbiology (2nd Ed.), PHI Learning, India. 1998.
- Satyanarayana, U. Biotechnology, Books and Allied (P) Ltd., Kolkata. 2010.
- Srivastava, P.S. Alka Narula, Sheela Srivastava. Plant Biotechnology and Molecular Markers, Anamaya Publishers, New Delhi. 2004
- Griffiths A. J. F., Miller J. H., et al. An introduction to genetic analysis. W. H. Freeman, N. Y. 2000.
- Ringo J. Fundamental Genetics. Cambridge Univ. Press, Cambridge. 2004.
- Cullis C. A. Plant Genomics and Proteomics. Wiley-VCH. 2001.

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- Grierson D. and Covey, S. N. Plant molecular biology. Blackie Academic & Professional. London. 1998.
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SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

V Semester – B.Sc Genetics Syllabus
15GN301 – Genetic Engineering

TOTAL CREDIT HOURS – 45 hours.

UNIT I: INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING 15 Hours

Introduction to Genetic Engineering: Overview of major steps involved

Tools for Genetic Engineering: Enzymes and Vectors

a. Enzymes:

- Restriction endonucleases: Types and characteristic features; Nomenclature; Modification of cut ends.
- DNA ligases.
- Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal transferase, RNA dependent DNA Polymerase. nucleotidyl

b. Vectors: Properties of an ideal vector. Types: Cloning and expression vectors

- **Cloning vectors:** Prokaryotic vectors: Plasmids- pUC 18; Bacteriophages - Lambda.
- Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.*
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- Expression vectors in Prokaryotes and Eukaryotes

UNIT II: Gene isolation and transfer

15 Hours

a. **Isolation of the desired gene:** cDNA library, Genomic library, Amplification through PCR.

b. **Direct gene transfer methods:** Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method).

c. **Selection and screening of recombinants:** Identification and selection of transformed cells:

d. Direct methods - Visual screening method, Plaque formation.

e. Indirect methods - Colony hybridization, Immunochemical detection.

UNIT III: GENETIC ENGINEERING TECHNIQUES AND APPLICATIONS 15 Hours

- **Technique for Genetic Engineering:** Gel electrophoresis: AGE and SDS-PAGE Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method.
- **Applications:** Transgenic animals: Mouse; Poultry, Fish with value added attributes.

  Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

PRACTICAL SYLLABUS - GENETICS

15GN371 – Genetic Engineering

1. Instrumentation:

a) UV Transilluminator

b) PCR

2. Vecors:

e) pUC 18
f) YAC,
g) Ti plasmid
h) SV 40

3. Transgenic organisms:

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b) Quantification of RNA by Orcinol method
c) Agarose Gel Electrophoresis of DNA

5. Demonstrations:

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DAYANANDA SAGAR UNIVERSITY
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DEPARTMENT OF BIOLOGICAL SCIENCES

V Semester – B.Sc Genetics Syllabus

15GN321 - Basic Human Genetics

TOTAL CREDIT HOURS – 45 hours.

UNIT I: HUMAN CHROMOSOMES, INHERITANCE AND GENETIC DISEASES - 15 Hours

Human Chromosomes: Normal Human Karotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes), FACS - Fluorescence activated cell sorter.

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UNIT II: IMMUNOGENETICS AND ONCOGENETICS

15 Hours

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UNIT III: DERMATOGLYPHICS, DIAGNOSIS AND THERAPY 15 Hours

Dermatoglyphics: Introduction and classification, Flexion creases. Dermatoglyphics in clinical disorders. Clinical applications, advantages and limitations.

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Therapy and Ethics: Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes. Gene therapy, Stem cells - Definition, types and sources. A brief account on Cord blood banking and Stem cell therapy. Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

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DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

Sixth Semester – B.Sc Genetics Syllabus
15GN322 – Plant Genetics

TOTAL CREDIT HOURS – 45 hours.

UNIT I: GENE REGULATION IN PLANTS

15 Hours

Over view of plants as genetic model systems, Genome structure of *Arabidopsis*, rice. Gene regulation in plants: Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf. Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes.

UNIT II: APPLIED GENETICS OF PLANTS

15 Hours

Genetic basis of disease resistance and susceptibility in plants. Genetic basis of Crown Gall disease development. Agrobacterium-Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants. Basics of marker assisted breeding and selection in plants.

UNIT III: PROTOPLAST TECHNOLOGY

15 Hours

Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application. Biofertilizer: Production and beneficial roles of Rhizobium, Innoculants and Azatobacter inoculants, field application of Rhizobium, Azatobacter blue green algae, mycorizal fungi and Azolla.

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DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

Semester V - B.Sc. - Microbiology Syllabus
Paper: Agricultural Microbiology and Environmental Microbiology

Paper Code: 15MB301
Total Credit – 45hours

PART A: AGRICULTURAL MICROBIOLOGY

Unit 1: Biofertilizers **05h**

Definition, types, characterization, mass cultivation of *Rhizobium*, PGPR, *Trichoderma* and *Azolla*. Mode of application of biofertlizers, advantages and limitations. ISI standards.

Unit 2: Biological control **05h**

Definition, mechanisms of biological control, field applications of *Bacillus thuringiensis*, *Beauveria bassiana* and Nuclear Polyhedrosis Virus.Advantages and limitations.

Unit 3: Plant Pathology

13h

Introduction, host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases.

Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies].

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism). Genetic engineering methods

Study of different plant diseases- Bacteria – Blight of rice, Fungi – Rust of sorghum, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

Unit 4: Aerobiology 05h

Introduction, Microbiology of indoor and outdoor environment, Significance of microorganisms in air, aerosols, air borne pathogens and aeroallergens. Techniques in aerobiology: Plate exposure and Anderson Samplers. Control of Air borne microorganisms – Dust control, Filteration, Fumigation, UV light exposure.

Unit 5: Soil Microbiology 05h

Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Nitrogen fixation. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negativeinteractions (amensalism, antagonism and parasitism).General account of bioleaching, biodegradation and bioremediation.

Unit 6: Aquatic Microbiology 06h

Introduction, Natural waters (Atmospheric, Surface and Ground water), Zonation of water system, Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients), general account on water borne diseases and their management. Water Pollution - Sources, Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filtration and Disinfection.

Unit 7: Waste Water Microbiology

06h Introduction, types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

Practical 15MB371: Agricultural Microbiology and Environmental Microbiology

1. Isolation and enumeration of bacteria, fungi and actinomycetes from rhizosphere soil
2. Examination of bacteriodes from legume root nodules
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
4. Demonstration of fungal contaminants in ground nut by standard blotter method
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Study of plant pathogens (specimens/charts)- Bacteria (Citrus canker, bacterial blight of rice), Fungi (Tikka Disease of ground nuts, red rot of sugarcane, rust of sorghum), virus (tobacco mosaic virus), mycoplasma (sandal spike)
7. Study of antagonism between soil microorganisms
8. Isolation of air borne microorganism by petriplate exposure method
9. Estimation of dissolved oxygen in water
10. Determination of Biological Oxygen Demand
11. Standard water quality analysis by MPN test
12. Estimation of total solids in sewage
13. Field visit to agriculture fields and sewage treatment plant

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.

3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.

19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES
Sixth Semester- B.Sc. - Microbiology Syllabus

Paper: Departmental Elective - Food Microbiology

Paper Code: 15MB321
Total Credits – 45 Hours

Unit 1: Food as a substrate for microorganisms 05h

Introduction to food microbiology, food parks and its importance. Intrinsic and extrinsic factors in food affecting microorganisms; natural flora and source of contamination of foods in general

Unit 2: Microbial spoilage of food 07h

Spoilage of Cereals, Vegetables, Fruits, Meat, fish, eggs and canned foods

Unit 3: Food Borne Diseases: 08h

Food hazards, significance of food borne diseases, types – food infection (*E. coli*, Salmonellosis, Shigellosis), food intoxication: Bacterial (*Clostridium botulinum*, *Staphylococcus spp.*) and fungal (aflatoxins), Virus (Polio), Helminths (Tape worms), Protozoa (*Entamoeba histolytica*)

Unit 4:- Principles and methods of food preservation

08h

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, nitrite and nitrates, antibiotics and bacteriocin.

Unit 5: Fermented foods

08h

Introduction, nutritional and therapeutic importance. Fermented Vegetables, Meat, Beverages, Bread, Idli, Single cell Protein (Yeast, Algae) and Mushrooms. General account on Probiotics and Prebiotics.

Unit 7: Microbiological quality control in foods

09h

Microbiological food examination: DMC, Viable colony count, dye reduction tests, MPN, immunological and molecular methods. Sampling schemes, Microbiological criteria, Control at source, Codes for Good Manufacturing practice, HACCP concept.

REFERENCES

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.

4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van NostrandRheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES
V Semester- B.Sc. - Microbiology Syllabus

Paper: Departmental Electives- Dairy Microbiology

Paper Code: 15MB322
Total Credit –45 Hours

Unit 1: Microbiology of milk 08h

Physical and chemical properties of milk. Types of microorganisms in milk (bacteria, fungi and yeast). Source of microbial contamination of milk- Milk producing animal, Milking environment, utensils, equipment, water, personnel and packing material.

Unit 2: Fermentation in milk 05h

Souring, lactic acid fermentation, colour and flavour fermentation, gassy fermentation, proteolysis and lipolysis.

Unit 3: Milk borne infections 08h

Introduction, Tuberculosis, Brucellosis, Listeriosis, Anthrax, Q fever, Cow pox, Foot and Mouth diseases. Preventive and Control Measures.

Unit 4: Milk and Milk products

Unit 5: Microbiological analysis of milk **08h**

Rapid platform tests- organoleptic test, clot on boiling, lactometer, titratable acidity, alcohol test, DMC, sedimentation tests and pH. Standard plate count, reductase test- MBRT, Resazurin test and Methylene blue test.

Unit6: Milk Processing **08h**

Collection, transport of Milk, Cold Storage, Pasteurization, sterilization, dehydration, and preservation of milk quality, Indian standards of grading milk. General account on milk adulteration: effects and detection.

Dairy starter cultures, Fermented Dairy products – curd, lassi, yogurt, flavoured milk, cheese, condensed milks, acidophilus milk, kefir and milk powders.

REFERENCES

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
3. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hali Incorporated, London.
4. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw- Hill Publishing Company Limited, New Delhi.
5. Varnam A.H and Evans M.G Food borne Pathogens, Wolfe Publishing House, London.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

5TH Semester B.Sc – Zoology Syllabus

Theory: 15ZG301 – Genetics and Evolutionary Biology

Total Credit Hours: 45 hrs

PART A - GENETICS

Unit1:Heredity and Environment 12h

Definition of genotype, phenotype, hereditary disease, studies on human twins.

A brief account of Mendel and his works. Simple problems in Mendelism.

Deviations from Mendelism: Incomplete Dominance; Interaction of genes, Linkage and crossing over, chromosome mapping.; Epistasis;Multiple alleles: ABO and Rh blood groups inheritance and their applications - Solving problems.; Sex Linkage: Eye colour in Drosophila, colour blindness and Haemophilia in man - Solving problems; Multiple factor inheritance: Inheritance of skin colour and eye colour in man.

Unit2: Genetic Sex Determination and Human Karyotyping 5h

Genetic determination Sex: XX-XY, XX-XO AND ZZ-ZO types. Genic balance theory of Bridges; Gynandromophs and Free martins.

Human Karyotyping: Non-disjuction of sex chromosomes in man, Klinefelter's and Turner's syndrome. Autosomal anomalies-Down syndrome, Cri-du-chat syndrome.

Unit3: Gene mutations, Concept of gene and Eugenics 5h

Gene Mutations: Spontaneous and induced mutations, CIB Method of detection of mutations, chemical matagens, Effects of radation.

Concept of Gene: Classical concept, dominant and recessive, genome, fine structure of the gene-cistron, muton and recon.;Operon Concept, position effect.

Eugenics: Definition; positive and negative aspects, Genetic counseling euthenics and Euphenics.

Unit4: Genetic Engineering and Biotechnology 5h

Endonucleases, Plasmids, cloning, Recombinant DNAtechnology.

DNA finger printing, DNA chip technology, DNA vaccines, PCR and DNA

Sequencing, Applications of genetic engineering in pharmaceuticals, food technology, agriculture and industries. Insulin and Interferon, Useful and harmful effects of Biotechnology

PART B: EVOLUTIONARY BIOLOGY

Unit5: Theories of organic evolution
06h

Lamarckism, Darwinism,Critical account of Darwinism,Neo-Darwinism,Elementary forces of evolution; Mutation, selection and genetic drift. Population genetics and evolution: Hardy-Weinberg law, Origin of New species. Role of isolation.

Unit6: Evidences for evolution
12h

Anatomical and morphological, serological and embryological; Palaentological evidences; Fossils: Definition, their importance, formation types of Fossils; Dating of fossils: Uranium lead method, potassium-argon method, radio Carbon method;Geological time scale-Eras, periods, Epochs with major fauna of each period.

Zoogeographical evidence: Continental drift, Distribution of animals, isolation, mechanisms and speciation

Evolution of horse: Hyracotherium, Mesophippus, Merichippus, Equus.

Evolution of modern man: Australopithecus Ramapithecus, Java Man, Peking man,

Neandrethal Man, Cromagnon Man.

Practical: 15ZG371 – Genetics and Evolutionary Biology

Total Credit Hours: 36 hrs

Problem solving practicals:

1. Monohybrid & Dihybrid inheritance

2. Sex linked inheritance in Drosophila

3. Buccal smear preparation for sex chromatin

4. Blood group in man

5.Study of Human Karyotypes (normal) and abnormal- (Turner's, Klinefelter's, Down' s and Cri-du-chat syndrome)

6.Study of Homolgous organs:

a) Forelimb of Frog and Bird

b) Mouthparts of Cockroach and Mosquito

7. Serial Homology: Appendages of prawn

8.Study of Analogous organs: Vertebrate eye and ciphalopod eye, wing of Bird and

insect.

9.Study of Vestigeal Organs: Appendix, coccyx, molar tooth study of fossils. 1unit

10.Whole mount preparations: Fish scales, Colenterate Colonies, mouth parts of

insects

11. Submission of report on: Evolution of Camel, Evolution of Elephant, Evolution of Man 1unit

SUGGESTED READINGS

1. Gardner, E.J.Simmons, M.J., Snustad, D.P (2008).Principles of Genetics.VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J (2009). Principles of Genetics Edition.John Wiley and sons Inc.
3. Klug,W.S.,Cumming,M.R., Spencer,C.A.(2012).Concepts of Genetics X Edition. Benjamin Cummings.
4. Russell, P.J. (2009) Genetics-A Molecular Approach.III Edition. Benjamin Cumming.
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C.andCarrol, S.B. Introduction to Genetic Analysis. IX Edition. W.h.Freeman and Co.
6. Ridiey, M. (2004) Evolution.III Edition. Blackwell Publishing
7. Barton.N.H. Briggs, D.E.G., Eisen, J.A., Goldstein, D.B.and N.H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
8. Hall,B.K.and Hallgrimsson,B.(2008) Evolution.IV Edition,Jones and Bartlett Publishers
9. Campbell, N.A.and Reece J.B. (2011) Biology.IX Edition, Pearson, Benjamin, Cummungs.
10. Douglas,J.Futuyma91997)Evolutionary Biology.Sinauer Associates
11. Organic Evolution by Veer Bala Rastogi
12. Human Genetics by Mange and Manage
13. Principles of Genetics by Robert.H.Tamarin, Tata McGraw-Hill pub.
14. Genetics by P.K.Gupta.
15. Genetics by Veer BAL Rastogi.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

5TH Semester B.Sc – Zoology Syllabus

Theory: 15ZG321 – Environmental Biology

Total Credit Hours: 45 hrs

Unit 1: Fundamentals in Ecology **03h**

Introdution, sub-divisions and scope of ecology.

Concepts of Habitat and Niche: Niche: Definition-Types-Spatial, trophic and multidimensional; Habitat: Definition-microhabitat and macrohabitat.

Unit 2: Environmental factors **08h**

Temperature: Thermal stratification, Range of tolerance, Piokilothermy and

Homeothermy.

Light: Distribution, Ecological effects, Photoperiodism and Bioluminescence.

Water: Structure of water, Sources of water, Classification of animals on the basis of

water requirement-Hydrocoles, Xerocoles and Mesocoles. Properties of water.

Liebig's Law of Minimum and Shelford's Law of Tolerance.

Unit 3: Energy flow in the ecosystem

04h

Concept of productivity, Laws of thermodynamics, examples of energy flow in nature.

Unit 4: Population Ecology
04h

Population density, Natality, mortality, population growth, Biotic potential, population regulation, Human population explosion.

Unit 5: Community Ecology

05h

Intra and inter-specific interactions, Neutral (Neutralism), Positive (mutualism, protocooperation and commensalism) and negative (antibiosis, exploitation, competition)

Unit 6: Animal Adaptations

04h

Deep sea adaptation in Fish, Aerial adaptation in Insects, Desert adaptation in Camel.

Unit 7: Pollution

06h

Definition, types-water, soil and air pollution, with Reference to industrial, thermal, organic and inorganic pollutants Bioremediation-Phytoremediation; Biomining

Unit 8: Radiations and chemical hazards
05h

Thermal power projects, Measures of disposal, ozone layer, Green-house effect, global Warming

Unit 9: Wildlife conservation and its management
06h

Red data book, Endangered species,Major wild life sanctuaries and national parks Of India. Major organizations involved in wild life conservation. Chipko and Appiko movements.

References

1] Fundamentals of Ecology by Eugene. P. Odum

2] Essential Environment by Dr M.K. Goyal.



DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

5TH Semester B.Sc – Zoology Syllabus

Theory: 15ZG322 – Biodiversity Conservation & Management

Total Credit Hours: 45 hrs

Unit 1:Biodiversity and its Conservation
10h

Biodiversity and its Conservation: Introduction, Definition, Types of biodiversity such as genetic, species and ecosystem biodiversity; Biodiversity at Global, National and local levels; mega-diversity countries of the world; Bio geographical classification of India.

Importance and value of biodiversity: consumptive use, productive use, social, ethical,

aesthetic and option values.

Measurment of Biodiversity-Species richness, species diversity, Simpson Index, Shannon Wiener Index, Alpha, Beta and Gamma Diversity

Unit 2: Threats to Biodiversity
06h

Threats to biodiversity-Habitat loss and degradation, poaching of wild life, introduction of exotic species, genetic pollution, climate change, man wildlife conflict.

Endangered and endemic species of India; extinction of species, key stone species IUCN categories, Red Data Book, Hot spots of biodiversity.

Unit 3: Biodiversity Conservation
10h

Biodiversity conservation. Insitu conservation–protected areas-National parks, Wildlife sanctuaries, Biosphere reserves, Definition, concept and short description of and importance of major reserves; Nilgiri Biosphere Reserve, Agasthyamalai Biosphere Reserve, Sunderban, Andaman and Nicobar,Gulf of Mannar.Project Tiger, Project Elephant , sacred groves with special reference to Kerala, Documenting traditional knowledge.

Exsitu conservation-Botanical gardens,zoos,aquaria,National Bureau of Plant Genetic

Resources(NBPGR), National Bureau of Animal Genetic Resources (NBAGR), Documenting traditional knowledge.

Unit 4: Global strategy for conservation
07h

Global strategy for conservation-Stockholm conference 1972, Montreal Protocol 1987, London,1989, Kyoto Protocol 1996,Johannesberg Conference 2002.

People's movement for environmental conservation in India-Bishnoi Movement, Chipko Movement, Narmada Bachao Andolan, Apikko movement, Silent Valley Movement, Baliyapal

Unit 5: Documenting Biodiversity
12h

Documenting Biodiversity: Quantitative Sampling Methods in Ecology: Transect-Line transect and belt transect; Quadrat.

Remote Sensing and GIS: Principles of Remote Sensing, Electromagnetic spectrum, Aerial photographs and their interpretation; Satellite imageries; Platform and airborne

sensors;Types of sensors; Applications of Remote sensing and GIS in Environmental Studies.

References:

- Essential Environmental Studies, 2009. S.P.Misra, S.N.Pandey, (Ane Books Pvt.Ltd,Chennai)
- Text Book of Environmental Studies, Erach Bharucha, 2005.Orient Longman Pvt. Ltd.,Ernakulam
- Ecology and Environment,2008-2009. P.D. Sharma, Rastogi Pub., New Delhi.
- Remote Sensing and Image Interpretation, Lillesand, T.M. and Kieffer, R.W., John Wiley and Sons.
- Remote Sensing: Principles and Applications, Sabbins, F.E., Freeman.
- Environmental Biology, P.S. Verma and V.K. Agarwal, S.Chand & Co.,New Delhi.
- Remote Sensing and GIS, 2006. Menon,A.R.R., KFRI Publications, KFRI,Peechi,Thrissur

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Fifth Semester - Chemistry Syllabus

Paper: Physical Chemistry and Cheminformatics
Paper Code: 15CH301 **Total Credit Hours: 45**

Unit 1: Electrochemistry I
12 hours

Review of electrolytes and Conductance and related terms

Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.

Kohlausch's law and its applications: (i) evaluation of Λ_∞ and Λ_+ Λ_- (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Problems based on the above concepts.

Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equatation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

Unit I2: Electrochemistry II

06 Hours

Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of E^o of Zn/Zn^{2+} and Cu/Cu^{2+} electrodes. Liquid junction potentials, elimination of liquid junction potential.

Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts.

Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

Unit 3: Ionic Equilibria

05 Hours

Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems based on the above concepts.

Common-ion effect, buffers, buffer action buffer range and buffer capacity. pH of buffers. Henderson's equation and its derivation and applications. Applications of buffer in analytical chemistry and biochemical processes in human body. Solubility product and ionic product in precipitation and in qualitative analysis. Theories of indicators; selection of indicators and their limitations.

Unit 4: Photochemistry

05 Hours

Laws of photochemistry. Grotthus-Drpare law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemical and thermal relations. Quantum yield of photochemical combinations of (i) H_2 and Cl_2 (ii) H_2 and Br_2 (iii) dissociation of HI (iv) dimerization of anthracene. Photosensitization, photostationary equilibrium. Singlet and triplet states based on Jabloski diagram. Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensiors.

Beer-Lambert's law and its limitataions. Numerical problems on absorption coefficient and molar extinction coefficient.

Unit 5: Cheminformatics I

09 Hours

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation.

Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification.

Database Concepts, Structured Query Language, Design of Chemical Databases, Data Abstraction; Data Models (Elementary ideas only)

Unit 6: Cheminformatics II

08 Hours

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative

Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;

Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries.

Books for References

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
2. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. Oprea, T. I. Chemoinformatics in drug discovery. John Wiley & Sons: New York, NY, 2005
5. Andrew Leach, An Introduction to Chemoinformatics Johann Gasteiger (Editor), Thomas Engel (Editor) Chemoinformatics: A Textbook Wiley Publications

V Semester:
Practical V; 15CH371
4 hours per week

Practicals

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a =b).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pKa of a weak acid by pH metric method.
10. Determination of percentage of sodium chloride by miscibility temperature method.
11. Introduction to chemistry related softwares such as ISIS Draw, Chemdraw, Origin etc.
12. Chemistry related Database such as Pubchem, Chemspider etc.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Fifth Semester - Chemistry Syllabus

Paper: Elective Paper-I Industrial Chemistry
Paper Code: 15CH321 **Total Credit Hours: 45**

Unit 1: Introduction to Green Chemistry:
02 Hours

Principles of Green chemistry and its application to the synthesis of paracetamol.

Unit 2: Industrial Materials II
09 Hours

Refractories: Properties, classification, determination of PCE values.

Abrasives – definition and classification with examples, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituents of varnishes.

Unit 3: Industrial Materials II

09 Hours

Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal-Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coal gas and composition of LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac, ranitidine, sulphanilamide and chloramphenicol.

Zeolites: Introduction, types of zeolites, manufacture of synthetic zeolites and applications.

Metal Organic Frameworks: Introduction, synthesis and important applications.

Dendrimers: Introduction, Synthesis (convergent, divergent and click chemistry) and important applications.

Unit 4: Polymers

12 hours

Fundamentals of polymers: Monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization and ring opening polymerization, Types of polymerisation methods (Bulk, Solution, Suspension and Emulsion).

Molecular weight and size. Polydispersion. Average molecular weight concepts–number, weight and viscosity average molecular weight.

Numerical problems. Determination of molecular weights - viscosity method, osmotic pressure method

Preparation and applications of the following types of polymers

1. Plastics:

i) thermosetting plastics(Phenol-formaldehyde)
ii) thermo softening plastics(PVC)

2. Fibers: Acrylic, polyamide, polyester types: one example for each
3. Rubber: Neoprene,
4. Fluoro Carbons: Teflon
5. Silicones: Polydimethysiloxane (PDMS)
6. Conducting Polymers: Polyaniline

Unit V: Super conductors and Fullerenes

06 Hours

Introduction, definition, type 1, type 2 and atypical. Preparation of high temperature super conductor-$Y_1Ba_2Cu_3O_{x\pm\delta}$, BCS theory (qualitative treatment only) and general applications of high temperature super conductors.

Introduction to Fullerenes, definition, preparation and isolation of C_{60}. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C_{60}. Commercial uses of C_{60}. Carbon nanotubes: definition, single wall and multi wall carbon nanotubes, applications.

Unit VI: Nanomaterials:

07 Hours

Introduction, definition and electronic properties. Different methods of production: top down and bottom up approach with examples. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles (silver oxide with gold composites).Important applications of nanomaterials.

Inorganic and organic nanoporous aerogels. Heat capacity of solids: Einstein and Debye equations.

Books for References

1. B.K Sharma ,Industrial Chemistry,Goyal Publication
2. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
3. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt. Ltd. New Delhi, 2009
4. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005)
5. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
6. V. R. Gowariker, Polymer Science, Wiley Eastern(Chapters 1,2,9)

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Fifth Semester - Chemistry Syllabus

Paper: Elective Paper-II Pharmaceutical Chemistry
Paper Code: 15CH322 **Total Credit Hours: 45**

Unit 1: Introduction
04Hours

Historical development of pharmaceutical chemistry, Codes of pharmaceutical ethics. Important aspects of pharmaceutical chemistry.

Unit 2: Common diseases
04 Hours

Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases.

Unit 3: Terminology
06 Hours

Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites. Absorption of drugs - routes of administration of drugs, factors affecting absorption.

Unit 4: Assay of drugs
04 Hours

Chemical, biological, immunological assays, LD_{50} and ED_{50} therapeutic index, drug dosage.

Unit 5: Designation of drugs
09 Hours

Designation of drugs based on physiological action; Definition and two examples with structure each of: Anesthetics-General and local. Analgesics - Narcotic and synthetic. Antipyretics and anti inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins. Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents.

Unit 6: Health promoting medicines I
08 Hours

Nutracenticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids.

Unit 7: Health promoting medicines II
10 Hours

Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) - Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases.

Books for References

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.
2. Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, 1995, New Delhi.
3. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.

4. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI publishers.

DAYANANDA SAGAR UNIVERSITY
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DEPARTMENT OF BIOLOGICAL SCIENCES

B.Sc.- BIOTECHNOLOGY

VI SEMESTER SYLLABUS

15BT302 Recombinant DNA Technology

45 hours

Unit 1 Tools for Genetic Engineering

12 hours

Introduction to Recombinant DNA technology, DNA manipulative and Modifying enzymes – Restriction enzymes, DNA ligases, Alkaline phosphatases, polynucleotide kinase, exonuclease, DNase I, DNA polymerase and Klenow fragment, RNA dependent DNA polymerase, terminal nucleotide transferase. Vectors – Basic features, Cloning vectors -Prokaryotic (pUC18, Lambda phage), Eukaryotic vectors (YAC, Ti plasmid, SV40 vectors) – basic features. Expression vectors in Prokaryotes and Eukaryotes – Basic features, role of promoters and RBS.

Unit 2 Methods of Gene transfer

6 hours

Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion

Unit 3 Techniques in Recombinant DNA technology

12 hours

Introduction to Hybridization Methods– Southern, Northern and Western, DNA Sequencing (Sanger's di-deoxy method), Principle of PCR and its types, Basic scheme for construction of genomic and cDNA library, basics of *In vitro* Mutagenesis.

Unit 4 Introduction to Direct and Indirection Selection of Recombinants 10 hours

Identification and selection of transformed cells, Direct methods – blue-white selection, plaque formation, Indirect methods – colony hybridization, immunochemical detection, Basic Description of Expression of cloned genes.

Unit 5 Applications of r-DNA technology

5 hours

Application in the fields of health, medicine, agriculture and environment.

References:

1. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
2. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
3. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
5. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

Dayananda Sagar University, Bangalore

B.Sc.- BIOTECHNOLOGY

VI SEMESTER SYLLABUS

15BT303 Plant Biotechnology

45 hours

Unit 1 Introduction to Plant Tissue Culture

15 hours

History and Overview, Concepts on differentiation and totipotency, Basic organization of Plant tissue culture lab, Instruments, sterilization of media and explants. Initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinins, gibberlins).

Unit 2 Different types of tissue culture

12 hours

Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications. Organ culture – anther and ovule culture. Basic concepts of Organogenesis and embryogenesis

Unit 3 Protoplast culture and Somatic Hybridization

10 hours

Protoplast culture – isolation, mechanical, enzymatic, culture of protoplast and plant regeneration

Methods of protoplast fusion – mechanical, chemical and electro fusion, application, Concept of Somatic hybridization, Somaclonal Variants – introduction and their significance.

Unit 4 Transgenics and Applications of Plant Biotechnology

08 hours

Transgenic plants – technique of transformation (*Agarobacterium* mediated, physical and chemical methods of gene transfer), application of transgenic plants. Role of Plant tissue culture in health, agriculture, horticulture and forestry. *In vitro* production of secondary metabolites.

References

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

Dayananda Sagar University, Bangalore

B.Sc.- BIOTECHNOLOGY

VI SEMESTER SYLLABUS

Practicals - 15BT372 Genetic Engineering and Plant Biotechnology

1. Preparation of competent cells (2 units)
2. Transformation of Plasmid DNA in competent cells and screening of transformants (2 units)
3. Isolation of plasmid DNA and analysis using gel electrophoresis (2 units)
4. Restriction digestion and ligation (2 units)
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media (2 units)
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus (2 units)
10. Production of synthetic seeds.

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SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

Semester VI - B. Sc. Biochemistry syllabus

Paper 1: 15BC302 Bioenergetics and Molecular Physiology
45h

Unit 1 Bioenergetics
08h

Bioenergetics, Energy transformation in living systems and concept of free energy; Exergonic and endergonic reaction, ATP and other high energy compounds, energy coupling. Biological oxidation, standard reduction potentials of same biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions.

Unit 2 Biological oxidation
10h

Mitochondrial electron transport chain-components, reactions and structures, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation – ATPase- structure (rotor-stator model) and function, Chemiosmotic theory, Regulation of ETC, thermogenin, Isolation of ETC components.

Unit 3 Endocrinology
11h

Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms.
Signal transduction - G-protein as cellular transducer, adenylate cyclase system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade – brief idea.
Functions of pancreatic, adrenal, pituitary and GIT hormones.
Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.

Unit 4 Molecular Biology

6h

Central dogma, prokaryotic and eukaryotic genomes, complexity of genomes, Enzymes and proteins related to prokaryotic replication and transcription.

Unit 5 Cell cycle and Apoptosis

10h

Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest.
Apoptosis: Caspases - function and activation. Intrinsic and extrinsic pathway. Factors initiating apoptosis and steps leading to cell death. Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

Semester VI - B. Sc. Biochemistry syllabus

Paper 2: 15BC303 Chemistry and Metabolism of lipids and nucleic acids **45h**

Unit 1 Lipid Chemistry **12h**

Classification of lipids.
Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids.
Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid.
DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids) .
Arachidonic acid derivatives: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3.
Lipoproteins & GPI-linked proteins: Types and functions.
Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model.
Steroids - Function of hopnoids, cholesterol, androgen and estrogens.
Lipid peroxidation and its role as a stress marker.

Unit 2 Lipid Metabolism

14h

The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation (only scheme), Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

Unit 3 Nucleic acids

13h

Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides.

DNA: Biological role, structure, polymorphism, denaturation, renaturation and T_m. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins.

RNA: Types, secondary structure and biological role of various RNA

Unit 4 Nucleic Acid Metabolism

6h

Outline of purine and pyrimidine metabolism. Hyperuricemia & other inborn errors.

***Practical*: 15BC471 Estimation of biomolecules**

[1] Qualitative analysis of
   a. carbohydrates,
   b. amino acids,
   c. proteins,
   d. lipids and
   e. Preparation of solid derivatives of monosaccharides – osazone crystal.

[2] Estimation of amino acids by formal titration.

[3] Estimation of ascorbic acid from biological samples by titrimetric method.

[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

References:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

VI Semester – B.Sc Genetics Syllabus

15GN302 - Applied Genetics

TOTAL CREDIT HOURS – 45 hours.

UNIT I: GENETIC RESOURCES AND BIODIVERSITY
08 Hours

Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centers of Diversity, Vavilovian Centers of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.

UNIT II: INTRODUCTION TO PLANT TISSUE CULTURE
07 Hours

Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.

UNIT III: HETEROSIS IN ANIMALS AND PLANTS
15 Hours

Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry.

Introduction to plants breeding: Estimation of heterosis- Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques- intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.

UNIT IV: GENETICS IN MEDICINE & INDUSTRY

10 Hours

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines- Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying.

UNIT V: BIOINFORMATICS

05 Hours

Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.

References:

- Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.

- Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
- Singh B. D. Biotechnology. Kalyani Publication. 2002.
- Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
- Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
- Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
- Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
- Phundan Singh , Elements of Plant Breeding. 2nd Edition. Kalyani Pulications. 2001
- Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.
- Brown, T. A. Genetics: A Molecular Approach (2nd Ed.), Garland Science, New York. 2002.
- Baxevanis and Bff Oluellette. Bioinformatics : A practical guide to the analysis of genes and proteins, Ad Wiley Interscince – new York. 2001.
- Stephen Misener and Stephan A. Krawetz. Bioinformatics: Methods and protocol. Humana press, New Jersey. 2000
- Des Higgins and Willie Tylore. Bioinformatics: sequence, structure and databanks, Oxford University press. 2000.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES
VI Semester – B.Sc Genetics Syllabus
15GN303 – Genomics and Proteomics
TOTAL CREDIT HOURS – 45 hours.

UNIT I: PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION 8 Hours

Prokaryotes: Bacteria. Eukaryotic nuclear genomes: *Drosophila*. Eukaryotic organelle genomes- Chloroplast and Mitochondria.

UNIT II: GENOME MAPPING TECHNIQUES 8 Hours

Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.

UNIT III: HUMAN GENOME PROJECT 7 Hours

History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of

nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes.

UNIT IV: COMPARATIVE GENOMICS

7 Hours

Whole genome analysis, Genome sequence, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping. Comparative genomics of mitochondria and chloroplast genomes.

UNIT V: PROTEIN PROPERTIES AND STRUCTURE ANALYSIS 8 Hours

Classification of proteins, Properties of amino acids - Hydrophobicity, α and β propensities. Inter-atomic forces and protein structure, covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, dipole interaction. Prediction of primary, secondary and tertiary structure of proteins- SCOP, CATH classification. Determining protein structure: Homology modeling.

UNIT VI: PROTEIN PROFILING

7 Hours

Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system .

References

- T.A. Brown, Genomes, Bios, 2002.
- Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
- Dale and Schartz, From Genes to Genomes, Wiley, 2003.

- Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
- Hawley and Mori, The Human Genome, Academic, 1999.
- Lewis, Human Genetics, WCB, 1999.
- Liebler, Introduction to Proteomics, Humana, 2002.
- Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
- Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
- Strachan and Read, Human Molecular Genetics, Wiley, 1999.
- Sudbery, Human Molecular Genetics, Prentice Hall, 2002.
- The Drosophila Genome. Science Vol. 267. 2000.
- The Caenorhabditiselegans genome Science. Vol. 282. 1998.
- The Arabidopsis Genome. Nature vol. 408. 2000

PRACTICAL SYLLABUS

15GN372 – Applied Genetics, Genomics and Proteomics

Applied Genetics

1. Tissue culture techniques:
   - Sterilization
   - Explants preparation
   - Media Composition and preparation
   - Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
   - Synthetic seed preparation
2. Study of different techniques in plant hybridization
3. Study of pollen fertility
4. Study of diagnostic kits - WIDAL & VDRL
5. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.
6. Study of hybrid animals - Poultry, dairy, fishery.
7. Homology sequence analysis using Blast and Fasta.

Genomics and Proteomics:

1. Physical mapping by Restriction mapping of plasmid DNA
2. Genetic mapping by RFLP analysis
3. RAPD analysis
4. DNA fingerprinting analysis: Parentage detection
5. Homogenization, fractionation and separation of enzymes/ proteins in plants and animals by SDS- PAGE method
6. Protein database study SCOP, DALIDD, CATH

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES
Sixth Semester- B.Sc. - Microbiology Syllabus

Paper: Immunology and Medical Microbiology

Paper Code: 15MB302
Total Credits– 45 hours

Part A: Immunology

Unit 1: Elements of Immune system
10h

History and scope of immunology, Definition and types of immunity (innate and adaptive).Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT . Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immunity, tolerance. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

Unit 2: Antigens
03h

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types, Haptens, Super antigens, Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Adjuvants.

Unit 3: Antibodies

04h

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic), clonal selection theory of antibody production; Production and application of Monoclonal antibodies

Unit 4: Immunological Techniques

04h

Principles and applications of Precipitation, Agglutination, Complement fixation, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry and Immunoelectron microscopy.

Unit 5: Immunological Disorders and Cancer immunology

04h

Definition, Hypersensitivity reactions (Definition and types), auto immune disorders, immunodeficiencies, graft vs host diseases. Brief concept of cancer immunology.

Part B: Medical Microbiology

Unit 1: Normal microflora of human body

04h

Normal flora of skin, oral cavity and other body regions. Relationship between normal microbiota and host.

Unit 2: Host - Pathogen Interactions

04h

Pathogenicity, Virulence, Invasion, Toxins: Exotoxins, Enterotoxins and Endotoxins. Evasion.

Unit 3: Study of diseases caused by pathogenic bacteria

08h

Epidemiology, etiology, pathogenesis and prophylaxis of the following:

Bacteria–*Salmonella typhi*, *Staphylococcus aureus, Clostridium tetani, Mycobacterium tuberculosis, Treponema pallidum, Corynebacterium diphtheriae, Chlamydiae*

Fungi–*Tricophyton spp.* and *Candida albicans*

Viruses –Hepatitis, Rabies, HIV and Ebola.

Prion diseases

Protozoa – *Plasmodium vivax* and *Entamoebahistolytica*

Unit 6: Antimicrobial Chemotherapy and Immunoprophylaxis

04h

Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration). Immunoprophylaxis - Vaccines and immunization schedule.

References:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.

3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES
Sixth Semester- B.Sc., Microbiology Syllabus

Paper: Microbial Fermentation
Paper Code: 15MB303
Total credits– 45hours

Unit 1: Introduction
02h

Introduction to fermentation technology, history and development of fermentation technology.

Unit 2: Industrial Microbiology
08h

Isolation, Screening (Primary and Secondary), Enrichment, Preservation (storage at low temperature (liquid nitrogen), storage in soil, silica, mineral oil, Lyophilization) and Strain improvement of industrially important microorganisms. Culture collection centres

Unit 3: Fermenter
08h

Design, Construction and Components of a typical fermenter, types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 4: Fermentation process **08h**

Batch, continuous, surface, submerged and solid state fermentation. Control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit 5: Downstream processes
10h

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration,lyophilization, spray drying, purification and concentration of products by chromatographic techniques.

Unit 6: Fermentation Products:
09h

Industrial production of organic acids (Citric acid), Amino acid (glutamic acid), Alcohol (wine), Vitamin (vit B12), Antibiotics (penicillin), Enzymes (Amylase), Vaccines (Hepatitis B) and hormones (human insulin).

References:

1. Casida Jr. L.E. (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi

5. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
6. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
7. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
8. HolgerPalzelt, Thomas Brenner (2008) Handbook of Bioentrepreneurship. Springer Sciences.
9. Pandey A, Soccol RC and Larroche C (2008) Current Developments in Solid state Fermentation, Springer.
10. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
11. Santaniello V, Evenson RE, ZibermanDand Carlson GA (2003) Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issues in Biotechnology. Universities Press.
12. Carlos M, Correa (2010) Research Handbook on the protection of Intellectual Property Under WTO Rules. Intellectual Property in the WTO Volume I and II Edward Elgar Publishing.
13. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar.

Practical 15MB372: Immunology, Medical Microbiology and Microbial fermentation

1. Isolation of normal microflora from skin and oral cavity
2. Dental caries Susceptibility test
3. Blood grouping and Rh typing
4. Dot ELISA
5. Precipitation reactions: Ouchtlerlony Double Diffusion, Radial Immune Diffusion, Rocket Immuno electrophoresis
6. Antibiotic sensitivity test
7. Determination of effectiveness of antiseptics by thumb impression method
8. Identification of different types of blood cells
9. Production and determination of amylase activity
10. Preparation of wine
11. Study of different types of fermenters (Models/ Charts)
12. Cell immobilization techniques (yeast cells)
13. Sterility assays of pharmaceutical products

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

6th Semester B.Sc – Zoology Syllabus

Theory: 15ZG302 –Ethology, Techniques in Biology, Economic Zoology & Biostatistics

Total Credit Hours: 45 hrs

Unit1: Ethology

7h

Introduction to animal behaviour, historical perception, aims and objectives; Stereotyped behaviours – Taxis, Kinesis, Reflexes, Instincts – with suitable examples;

Learning – imprinting and habituation, Trial and error learning, Animal communication- functions of signals, odours, sounds and light; Social organization – origin and evolution of social organization in Primate society. Eg. Monkey, Social behaviour of ants and honey bees.

Unit 2: Biotechniques

9h

Concepts of sterilization: Filtration, autoclaving, dry heat sterilization,wet sterilization and radiation; Separation of

biomolecules: Centrifugation (Sedimentation, density gradient); Chromatography (Elementary idea of thin layer, gel filtration and ion exchange-Principles and applications); Electrophoresis: Agarose gel electrophoresis, SDS-PAGE; Principles of colorimeter and spectrophotometers.

Unit 3: Economic Zoology- Aquaculture and Farm animal breeding 5h

Site selection and construction, Pre stocking and post stocking manangement of nursery, rearing and stocking ponds; Breeding of fishes by bund and Chinese hatcheries. Induced breeding by hypophysetion. New generation drugs in induced breeding; Fish products and byproducts, Fish preservation, Farm animal breeding – general principles and *breeding* methods.

Unit 4: Economic Zoology-Prawn culture and Pearl culture 5h

Prawn culture and Pearl culture, Fabrication and setting up of aquarium and its maintenance, Breeding of aquarium fishes – Live bearers and egg layers, Diseases caused by fungi, bacteria, protozoa and helminthes

Unit 5 : Economic Entomology -Methods of pest control 5h

Chemical control : Insecticides - Pyrethroids, carbomate and HCN – mode of action,merits and demerits; Biological control – Biological agents – predators and parasites; merits and demerits; Crop pest: Life cycle, damage and control of -I. Cotton spotted boll worm – *Eariasvitella,*Stored grain pests- Rice Weevil, *Sitophilusoryzae.*

Unit 6: Industrial Entomology

8h

Sericulture- Types of Silkworm. Life cycle and rearing of mulberry silkworm,*Bombyx mori*, Life cycle and rearing ofnon mulberry silkworm (Tasar), *Antheraeamylitta* ; Brief idea of coccon processing for silk fabric - coccon boiling, reeling, rereeling,winding, doubling, twisting and weaving

Apiculture – Types of honey bees. Life cycle, culture, movable frame hive, bee product and its economic importance

Lac culture – Lac insect, *Laccifer lacca* - Life cycle, Lac processing, Lac products and economic importance.

Unit 7: Biostatistics

6h

Biostatistics – Tabulation of data, presentation of data, sampling errors, mean, mode, median, probability, standard error and standard deviation, Common Biostatistical softwares – Graphpad prism, SigmaPlot.

Reference

1.Introduction to Animal behaviour by Manning and M.S. Dawkins.

2.Animal Behaviour by Reena Mathur.

3. Wealth of India, Raw Material, Vol. IV – ICAR

4. Fishes of India vol I & II- Day

5. Fish & Fisheries of India – Jhingran

6. Hatchery Manual for Common Indian & Chinese carps – Jhivgan&Pallin

7. Fish Pathology – Roberts

8. Introduction of Fishes – Khanna

9. Fishery Science & Indian Fishes – Khanna

10. Fishery Science & Indian Fisheries – Shrivastava

11. A Manual of F. W. Aquaculture – Santhanam

12. An Aid to Identification of Commercial Fishes of India & Pakistan- Mishra

13. Standard Methods for Examination of Water & Waste Water - APHA

14. Hand Book of Breeding of Major Carps by Pituitary Hormones– S. L. Chonder

15. Principles of Aquaculture – Zade S. B., Khune C. J., Sitre S.R. and Tijare R.V.

16. T. B. of Applied Entomology – K. P. Shrivastava

17. T. B. of Agricultural Entomology - II S Pruthi

18. Modern Entomology – D. B. Tembhare (2nd Edition)

19. A Hand Book of Practical Sericulture – Ullar S. R. &Narsimhanna M.N.

20. Destructive and Useful Insects – Metcalf C.L. & Flint W.P.

21. General Text Book of Entomology – Richards O. W. & Davis R. G.

22. Agricultural Pests of India & South East Asia – Atawal A.S.

23. Hand Book of Economic Entomology for South Asia – Ayyar& Ram Krishna.

24. Medical Entomology – Hati A. K.

25. Bee-Keeping in India – Singh S

26. Animal Tissue Technique – Humason

27. Histological Technique – Devaenport

28. Microtechnique – Jiwaji&Patki

29. Microtechnique – Wankhede

30. Biophysical Chemistry – Upadhyay, Upadhyay and Nath

31. Techniques in Life Sciences – D. B. Tembhare

32. Mount W. 2004. Bioinformatics and Sequence Genome Analysis 2nd Editon CBS

Pub. New Delhi.

33. Bergman, N. H. Comparative Genomics. Humana Press Inc. Part of Springer Science+BusinessMedia, 2007.

34. Baxevanis, A. D. Ouellate, B. F. F. 2009. Bioinformatics: A Practical Guide to the

Analysis of Genes and Proteins.John-Wiley and Sons Publications, New York.

35. Campbell A. M. and Heyer, L. J. 2007. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings.

36. Des Higgins and Willie Taylor 2000. Bioinformatics: Sequence, Structure and

Databanks.Oxford University Press.

37. Rashidi H. H. and Buehler 2002. Bioinformatics Basics: Applications in BiologicalScience and Medicine, CRC Press, London.

38. Gibas Cynthia and Jambeck P. 2001. Developing Bioinformatics Computer Skills:

Shroff Publishersand Distributors Pvt. Ltd. (O'Reilly), Mumbai.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

6th Semester B.Sc – Zoology Syllabus

Theory: 15ZG303 – Genetic Engineering and Biotechnology

Total Credit Hours: 45 hrs

Unit 1: Introduction to Biotechnology and Bioengineering 3h

Introduction to Bioengineering, Biotechnology and its branches, scope of Biotechnology and Bioengineering.

Unit 2: Gene Isolation, Downstream processing and Biomolecular methods 10h

Isolation of desired gene, cloning vector (Plasmid), cloning enzyme, Restriction endonucleases, DNA ligase, Construction of rDNA, Transformation of Host cell, Mass culture in bioreactor, downstream processing; Brief account of Genomic library and c- DNA library; Bimolecular methods: Gel electrophoresis, Extraction of DNA from Agarose Gel (Free squeeze method and Low temperature melting method) Restriction digestion of DNA.

Unit 3: Introducing Genes into Animal cells 5h

Integration of DNA in mammalian cells, Co-transfection, pSV and pRSV plasmids, Viral vectors: Adeno and Baculo virus, Reporter genes: TK and HGPRT genes, antibiotic resistance genes.

Unit 4: Transferring genes

5h

Transferring genes into animal oocytes, zygotes, embryos and specific animal tissues with reference to Xenopus, Drosophila and mammals. Stem Cell – definition and practical uses of stem cells.

Unit5: Tissue culture techniques

5h

Animal tissue culture techniques,Primary cell line and permanent cell lines, media preparation.

Unit6: Application of Biotechnology and Genetic Engineering 6h

Application of Biotechnology for human welfare: 10L - Production of hormones, vaccines, DNA fingerprinting. - Basic information about human and other genome sequencing.

Unit7: Blotting Techniques

3h

Southern, Northern, Western blotting techniques with their applications.

Unit8: Transgenic Elements

4h

Transgenic animals: Nuclear transplantation method (Dolly), Micro injection method (Mice) Embryonic stem cell transplantation (Chimeric mice)

Unit9:Assisted Reproductive Technology

4h

Assisted reproductive Technology: Cryopreservation of semen, fetal cord blood preservation, AI, GIFT, IVF and ETTechniques, Applications of assisted reproductive technology in human and exotic animals.

Reference Reading

1. Elements of Biotechnology – Gupta
2. T. B. of Biotechnology – Dubey
3. Modern Concept of Biotechnology – Kumar H. D
4. Advances in Biotechnology – Jogdand
5. T. B. of Biotechnology – Chatwal
6. Molecular Biotechnology – Primrose
7. Genetics & Genetic Engineering – Joshi
8. Genetic Engineering & its applications – Joshi
9. Genetics – Gardener
10. Genetics – Winchester
11. Genetics – Gupta
12. Principles of Genetics – Sinnot Dunn, Dobzansy
13. Genetics –Ahluwalia
14. Genetics – Sarin
15. Elementary Genetics – Singleton
16. General Genetics – SRb, Owen & Edger
17. Genetics –Alenberg
18. Foundation of Genetics – Pai
19. Genetics - Stickberger
20. T. B. of Genetics- VeerbalaRastogi

21. Gene VI by Benjamin Lewis, Oxford press
22. Gene VIII by Benjamin Lewis, Oxford press
23. Genetics Vol. I and II by Pawar C. B., Himalaya publication

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

6th Semester B.Sc – Zoology Syllabus

Practical: 15ZG372 – Ethology, Techniques in Biology, Economic Zoology, Biostatistics, Genetic Engineering and Biotechnology

Total Credit Hours: 36 hrs

Ethology:

Project report on:

Eco-behaviourial adaptations: Deep sea fishes; Bio-Luminiscence; Migratory fishes; Birds; Desert fauna

Economic Zoology:

Collection and identification of fishes: Catla, Rohu, mrigal, grass carp, silver carp, *Cyprinouscarpio* ,*Ophiocephalous, Clariaus, Heteropneustes, Wallago,Mystus,*

Study of Insect Pest

Agriculture pest – Grasshopper , Red Cotton bug, Gram pod borer, Cotton pink bollworm, Cotton spotted bollworm

Veterinary pest – Stable fly , Dog tick, Bird lice

Stored grain pest – Stored grain weevil, Flour moth

Useful Insects – Honeybee, Silk moth, Lac insect, Dragon fly, Lady bird beetle

Biotechniques, Biostatistics, Biotechnology

Understanding the working principle and demonstration of paper chromatography

Determination of mean, mode, median from a given biostatistical data and/or graphical representation of the data using computers

Staining of Barr body from: buccal epithelium

Isolation and quantification of DNA

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Sixth Semester - Chemistry Syllabus

Paper: Inorganic & Analytical Chemistry

Paper Code: 15CH302 **Total Credit Hours: 45**

Unit 1: Co-ordination and Organometallic compounds 8h

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and square planar complexes). Magnetic properties of $[CoF_6]^{3-}$, $[Fe(CN)_6]^{4}$Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.

Unit 2: Organometallic compounds

4h

Ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta^2\text{-}C_2H_4)]$

Metal carbonyls – $Cr(CO)_6$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples.

Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation.

Unit III: Chemical Spectroscopy I

7H

The interaction of electromagnetic radiation radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques.

Origin of molecular absorption spectra: Born-Oppenheimer approximation.

Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy. Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO_2 and H_2O molecules.

Raman spectroscopy

Concept of polarisability. Stokes and anti-Stoke's lines-selection rules.

Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.

Unit IV: Spectroscopy II

6h

UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and red shift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free and H-bonded), alkyl –C-H, C=C, C≡C C=O, C-X and C-O groups (by taking suitable examples).

NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclear shielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMR spectroscopy including identification of simple organic molecules.

Unit V: Chromatography

12h

Principles of chromatography: Distribution coefficients, types of chromatography, selection of stationary and mobile phases in TLC, analyte development and elution. Chromatographic performance parameters-Retention time and volume, capacity factor, plate height and resolution.

Thin layer chromatography: Principle, apparatus-preparation of plates, sample application, plate development, detection of analytes. Applications.

Gas-liquid chromatography: Principle. Instrumentation, columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography: Principle and applications.

Unit VI: Electroanalytical Methods

5h

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME. Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential.

Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

Unit VI: Analytical chemistry

3h

Analytical chemistry- scope of analytical chemistry.Errors and treatment of analytical data: Limitations of analytical methods-Error-determinate and indeterminate errors, minimization of errors. Accuracy and precision. Distribution of random errors, the normal error curve. Statistical treatment of finite samples-measures of central tendency and variability-mean, median, range, standard deviation and variance. Student's t-test.

References

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.

3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
5. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Sixth Semester - Chemistry Syllabus

Paper: Biochemistry
Paper Code: 15CH303 **Total Credit Hours: 45**

Unit I: Carbohydrates
05h

Structure and biological importance of derivatives of monosaccharides.

Amino sugars : ß-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramicacid (NAMA); N-acetylneuraminic acid (NANA)

Sugar acids–structure and biological importance of D-gluconic acid, D-glucuronic acid and Dglucaricacid.

Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P, Fructose-1,6-di-P, ß-D-ribose-5-P and ß-D-deoxyribose-5-P.

Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose. Polysaccharides -source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

Unit II: Lipids
06h

Introduction, Classification.

Fatty acids–definition, classification as saturated and unsaturated with examples and structure
(lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples

Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides-acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides.

Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol.

Cholesterol – definition, types (HDL, LDL and VLDL)

Sphingolipids–structure and biological significance of ceramide.

Unit III: Proteins

6h

α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin.

Levels of organizations of Protein: Primary structure, Secondary structure (a-helix, triple helix eg., Collagen and ß-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure.

Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with ribonuclease.

Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

Unit V: Nucleic Acids

3h

Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide.

Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs.

Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Unit VI: Hormones

03h

Definition. Classification -a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis.

Mediators of hormone action – Ca^{2+}, cyclic AMP.

Unit VII: Enzymes

05h

Introduction, Holo enzyme (apo enzyme and co enzyme).Active site, specificity.

Classification of enzymes (EC code number not required).

Enzyme substrate interaction-Fischer and Koshland models.

Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration, substrate

concentration, pH and temperature (mention M. M. equation).

Allosteric enzymes–definition and example

Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

Unit VIII: Biological Oxidation

06h

Bioenergetics-Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and Keq.

High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation of ATP).

Examples of high energy phosphates other than ATP. Energy coupling in biological reactions

(Explain the concept with suitable examples).

Biological oxidation – comparison of oxidation with combustion using glucose as an example.

Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).

Mitochondrial electrotransport chain, oxidative phosphorylation. Substrate level phosphorylation.

Unit IX: Metabolism

07h

Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic.

Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, ß-oxidation pathway, energetics.

Protein metabolism–general aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.

Unit X: Molecular Biology

04h

Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation.

DNA finger printing – Definition and its applications.

References

1. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000. .
2. Biochemistry A. L. Lehningeret. al., CBS, 2000.
3. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.
4. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.
5. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.

VI Semester:

Practical VI: 15CH372- Inorganic Chemistry and Basics In Biochemistry

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na_2CO_3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.
11. Preparation of buffers and determination of their pH values using pH meter.
12. Estimation of reducing sugars by Hegdorn-Jensen method.
13. Estimation of lactose in milk by Nelson-Somyogi's method.
14. Estimation of creatinine by Jaffe's method.
15. Estimation of inorganic phosphate by Fiske-Subbarow method.
16. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
17. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
18. Identification of α-amino acids by paper chromatography.
19. Isolation of DNA from onions.
20. Estimation of cholesterol by colorimetric method.

SEMESTER: I

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BT101
TITLE OF THE COURSE : ESSENTIALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To equip students with the basic understanding of structures and functions of basic organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES: 1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control and different stages in cell division.

MODULE 1 **10Hrs**

Cell as a basic unit of living organisms. Discovery of cell and Cell Theory; Chemical components of a cell, catalysis and use of energy by cells, Comparison between plant and animal cells. Cell Wall and membrane structure; Cell wall; Plasma membrane – structure and functions of plasma membrane; Modifications of plasma membrane and intracellular junctions.

MODULE 2 **10Hrs**

Structure and functions of cellular organelles - Mitochondria, Chloroplast, ER, Golgi complex and Ribosome.

MODULE 3 **10Hrs**

Structure and functions of - Cytoskeleton, Centriole, Protoplasm, Cell motility; Structure and functions of cilia, and Flagella, Types-Amoeboid, Ciliary and Flagellar movements.

MODULE 4 **11Hrs**

Nucleus and chromosomes; Structure and functions of nuclear membrane, nuclear pore complex, Nucleolus and Chromatin. Chromosomes-Discovery, morphology and structural Organization-Centromere, Secondary constriction, Telomere, Chromomere, Euchromatin and Heterochromatin, chemical composition and karyotype. Ultra-structure- Single-stranded and multi-stranded hypotheses, folded fiber and nucleoside models. Special types of chromosome: Salivary gland and Lampbrush chromosomes.

MODULE 5 **11Hrs**

Cell division and Programmed Cell Death; a) Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division. b) Mitosis: Significance of Mitosis, Breakdown of nuclear envelope, spindle fibers, Kinetochore, Anaphase movements. c) Meiosis: Types of meiosis, the first and second meiotic division, synaptonemal

complex. d) Programmed cell death (Apoptosis): intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.

REFERENCE BOOKS

1. Molecular Biology of Cell-Bruce Albert's et.al, Garland publications (2005).
2. Cell Biology &Molecular Biology EDP Robertis & EMF Robertis, Saunder College (2001).
3. Cell Biology C.B. Powar, Himalaya Publication (2004).
4. Cell Biology by David E Sadava, Jones and Bartlett Publications (1993).
5. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).
6. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BT171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic techniques used in cell biology to study – cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES: 1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
2. Cell division: Study of mitosis using onion root tips.
3. Cell division: Study of and Meiosis in grasshopper testes/onion flower buds
4. Chromosomes: Mounting of polytene chromosomes
5. Preparation of Buccal smear for study of barr bodies.
6. Karyotype analysis-Man and onion Man-Normal and Abnormal-Down and Turner's syndromes.
7. Blood cell count by Hemocytometer.
8. Blood smear-differential staining.
9. Vital Staining of mitochondria.
10. Isolation of chloroplast from spinach leaves.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC101
TITLE OF THE COURSE : INORGANIC AND BIOPHYSICAL CHEMISTRY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: Introducing the Basic principles of General Chemistry, Inorganic chemistry and Biophysical Chemistry to the students.

COURSE OUTCOMES: The students will be familiarized with Basic concepts in General Chemistry, Inorganic and Biophysical Chemistry so that they will have a better understanding of advanced Biochemistry.

MODULE 1 **11Hrs**

Measurement: Units – SI and CGS, accuracy, precision and errors in quantitative analysis.
Atomic Structure: Electromagnetic radiation. Wave particle duality - de Broglie equation, The Heisenberg uncertainty principal. The Schrodinger wave equation. Quantum numbers. Atomic orbitals and their shapes. The Pauli's Exclusion principal, Hund's rule, Electronic Configuration.
Periodic Classification: Trends in the periodic table: ionic radii, ionization energy, electro negativity and electron affinity. Oxidation number
Chemical Bonding: Types of bonds, Ionic and covalent bond- VBT, MOT and CFT, Coordinate bond, Weak and hydrophobic interactions, Hydrogen bond. Examples in biological system – stability and solvation of biomolecules.

MODULE 2 **11Hrs**

Solutions and Colligative Properties: Concentration and amount – mole, molarity, molality, normality and mole fraction, Homogenous and heterogeneous solutions, Factors influencing solubility, solubility curves, Henry's Law applications, Donnan membrane equilibrium and its application in membrane stability, Relative lowering of vapour pressure, Raoult's law, Elevation of boiling point, depression of freezing point, Numericals.
Electrochemistry: Strong and weak electrolyte, activity, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- (brief) application in nervous system, Standard electrode potentials. Reference electrodes; Calomel and Glass, pHmeter basics, Ion selective electrodes and their applications.

MODULE 3 **10Hrs**

Acids, Bases and Buffers: Modern concepts of acids and bases. Ionization of acids. Dissociation of water. Ionic product of water. Common ion effect with examples, Definition and determination of pH and associated numerical, Buffer preparation by H-H equation – detailed calculations, buffer capacity. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.
Adsorption: Freudlich and Langmuir adsorption isotherm with derivations. Applications of adsorption.

Phase Rule: Definition of phase, component and degrees of freedom, Gibbs Phase rule statement, Application of phase rule to one component system- water and CO2, two component systems of water-phenol and water-KI System, Lever rule, Eutactic point, azeotropes, distillation. Concept of Partition coefficient.

MODULE 4 **10Hrs**

Chemical Equilibrium: Chatelier's principle, reversible reactions with examples, Calculation of Kp and Kc for selective reactions (Synthesis of ammonia and dissociation of HI)
Reaction Kinetics: Rate equation, Velocity constant-molecularity and order of a reaction, factors influencing rate of reaction, Kinetic Equation of zero, first and second order reactions-Arrhenius hypothesis and equation, Activated complex and energy of activation and its terms, transition state theory.

MODULE 5 **10Hrs**

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change of chemical reaction, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant.
Solid State: Types- Crystalline and Amorphous, Definition of Space Lattice, planes and Unit cell, Elements of symmetry, Law of Rational Indices and Miller Indices with simple numericals, Crystal defects and their applications.

Reference books

1. Concise Inorganic Chemistry - Lee. Wiley- Blackwell Publishing House.
2. Inorganic Chemistry: Principles of Structure and Reactivity - Huhee, Keiter & Keiter. Pearson Education Publishers.
3. Physical Chemistry – Atkins. Oxford University Press.
4. General and Inorganic Chemistry - Sarkar. Sapna Publishers.
5. Physical Chemistry- Pahadi. Central Publishers
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC171
TITLE OF THE COURSE : QUANTITATIVE ANALYSIS AND VOLUMETRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. Students will demonstrate basic skills in calibration and volumetric analysis methods.

COURSE OUTCOMES: 1. Students demonstrate acquisition of basic laboratory skills, calibration of glass ware and volumetric analysis.
2. They will develop ability to perform titrations, find the end point, calculate the molecular weight, strength and concentration from these experiments.

[1] GLP & Calibration of glassware.

[2] Acid-base: Preparation of standard potassium biphthalate and estimation of alkali.

[3] Redox: Preparation of standard sodium oxalate and estimation of potassium permanganate.

[4] Redox with indicator: Preparation of standard potassium dichromate solution and estimation of sodium thiosulphate.

[5] Chelatometry: Estimation of hardness of water using EDTA/Zinc sulphate

[6] Iodometry; Estimation of iodide with sodium thiosulfate.

[7] Argentometry: Chloride estimation by Mohr's method.

[8] Estimation of Iron by dichromate.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN101
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. To provide an introduction to Cell Biology from general organelles structure, composition and function.
2. Understand the evolution, insights and benefits in of model organisms in genetics

COURSE OUTCOMES:
1. Students can understand the multidisciplinary science of the eukaryotic cell biology.
2. Student will gain understanding of the eukaryotic and prokaryotic systems in genetic studies.

MODULE 1 -TECHNIQUES IN CELL BIOLOGY 10Hrs

Microscopy: Bright field, dark field, Phase contrast, Polarization, Confocal, Fluorescence and Electron microscopy (SEM and TEM) Centrifugation, Two photon microscopy.

MODULE 2 -ULTRA STRUCTURE OF CELL 11Hrs

Structure and types of cells: Prokaryotic and eukaryotic cells- characteristics and differences. Cell Wall: Ultra structure, chemical composition and function. Cell membrane: structure, chemical composition; fluid mosaic model- lipids, carbohydrates and proteins- transport channels Transport across membrane: diffusion, active transport, co-transport, bulk transport; ion gated channels- propagation of action potential; liposomes.

MODULE 3 -CELL ORGANELLES 11Hrs

Structure and functions of Nucleus, Nucleolus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Plastids, Lysosome, Ribosomes and Microsome.

MODULE 4- CELL CYCLE AND CELL DIVISION 10Hrs

Cell cycle: Interphase and M phase. Mitosis: Mitotic phases; cytokinesis; mitotic apparatus; stimulation and control of mitosis; significance of mitosis. Meiosis: meiotic phases; events of Prophase-I; structure and function of synaptonemal complex; significance of meiosis. Cell senescence and cell death: Programmed Cell Death (PCD)- mechanism and significance of Apoptosis and Necrosis.

MODULE 5- STUDY OF LIFE CYCLE 10Hrs

Bacteria- *E. coli,* Viruses: TMV, Bacteriophage - Lambda phage, Fungi- *Neurospora*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila.*

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.

REFERENCE BOOKS

1. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
2. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.
3. Powar C. B. Cell Biology. Vol I and II (1982) Himalaya Publication.
4. Nicklin J. et al., Instant notes in Microbiology (2003). Viva Books.
5. Brian E. S., Steer M. W., et al. Plant cell Biology: Structure and Function (1996) Jones and Bartlett.
6. Stern K. R. Introductory plant Biology, 8th Edition (2006) McGraw Hill,
7. Boston. Darnell J. H., Lodish and Baltimore D. Molecular Cell Biology. 2 Edition (1990) Scientific American Books.
8. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
9. Cooper G. M., Hausman R. E. The Cell: A Molecular Approach 6th Edition (2013) Sinauer Associates

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN171
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to different types of microscopy and sample visualization.
2. Hands on training in specimen preparation and study

COURSE OUTCOMES:

1. Gain experience in handling microscopes and learn the concept of being meticulous while preparing samples.
2. They will relate hands on training better with their theory courses

1) Handling of dissection, stereo and compound microscopes
2) Study of Model organisms
Bacteria- *E. coli*
Viruses: TMV
Bacteriophage - Lambda phage
Fungi- Neurospora
Caenorhabditis elegans
Arabidopsis thaliana
Drosophila
3) Staining of RNA and DNA with methyl green and pyronin (Paramecium)
4) Vital staining of mitochondria (Yeast)
5) Gram staining (E. coli/ Staphylococcus aureus)
6) Temporary squash preparation of onion root tips
7) Observation of: Mitotic stages in permanent slides

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB101
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. The importance of microorganisms to our global society.
2. The structure/function of cells, their metabolism and how they grow/divide.

COURSE OUTCOMES: 1. Provides a strong grounding in fundamental aspects of the basic biology.
2. Able to understand microorganisms and their environment, microbial structure and function.

MODULE 1 - HISTORY AND DEVELOPMENT OF MICROBIOLOGY 10Hrs

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation and branches of microbiology. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald ross.

MODULE 2- MICROBIAL SYSTEMATICS 10Hrs

Binomial nomenclature, Whittaker's five kingdom and Carl Woese's threekingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. Brief account of Bergey's manual of bacteriology. Criteria for classification of bacteria.

MODULE 3 – MICROSCOPY AND STAINING TECHNIQUES 10Hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Fixation, types of dyes. Simple staining(negative staining), Differential staining- Gram staining, acid-fast staining, Staining of specific structures- endospore staining, capsule staining, flagella staining and cell wall staining.

MODULE 4 - CULTURE MEDIA AND PURE CULTURE TECHNIQUES 10Hrs

Microbial Nutrition: Common nutrient requirements, Nutritional types of microorganisms and growth factors. Uptake of nutrients by cells.
Culture Media: Synthetic or defined media. Basal media and Special Media - selective, differential, enrichment media, enriched media and transport media
Isolation of bacteria and fungi by serial dilution technique and Methods of pure culture techniques. Introduction to uncultivable microorganisms.

MODULE 5 - CONTROL OF MICROORGANISMS 10Hrs

Fundamentals of control- Thermal death time
Physical methods of control: Dry heat -Flaming, Incineration and hot air oven.

Moist heat - Boiling, Pasteurization, Fractional sterilization-Tyndallization and heat under pressure (autoclave).
Filtration –Diatomaceous earth filter, Seitz filter, membrane filter and HEPA Filters
Radiation- Ionizing and Non- ionizing radiations
Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, quaternary ammonium compounds and sterilizing gases as antimicrobial agents. Study of antiseptic and disinfectants.

Reference Books

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Benson, H.J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
4. Brock, T.D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
5. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
6. Pelczar, M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
7. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
8. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
9. Salle, A.J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill PublishingCompany Limited, New Delhi.
10. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India Private Limited, New Delhi.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB171
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY (PRACTICAL)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic microbiology techniques

COURSE OUTCOMES: 1. To understand microorganisms and their environment, microbial structure and function

1) **Biosafety measures in Laboratory**
2) **Use and care of compound microscope and simple microscope**
3) **Study of basic instruments in Microbiology laboratory**
    - Autoclave
    - Hot air oven
    - Incubator
    - pH meter
    - High speed centrifuge
    - Colorimeter / Spectrophotometer
    - Anaerobic jar
    - Bacterial Filters
    - Laminar air flow.

4) Microscopic examination of bacterial smear
    - Simple staining
    - Gram's staining
    - Capsule staining
    - Endospore staining
    - Cell wall staining

5) **Sterilization of glasswares** (Chromic acid preparation)
6) **Aseptic techniques –** Preparation of cotton plugs for test tubes and pipettes, wrapping of petriplates and pipettes.
7) **Preparation of culture media**:
    - Basal media (Nutrient agar and broth, Czapekdox media and MRBA);
    - Selective media (EMBagar and McConkeyagar),
    - Enriched media (Blood agar).

8) Isolation of bacteria and fungi by serial dilution technique

9) Methods of pure culture techniques
    - Pour plate technique
    - Spread plate technique
    - Streak plate technique

10) Transfer of media and inoculum
    - Slant culture technique
    - Broth culture technique
    - Stab culture technique

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1
L: T/A: P: C : 3:1:0:4

COURSE OBJECTIVES:

1. Introducing the basics principles of General Chemistry, physical chemistry and Organic Chemistry to the students.

2. The basic concepts of General Chemistry, Physical Chemistry and organic Chemistry involving the important concepts in each branch will be introduced to the students.

COURSE OUTCOMES:

1. The students will be familiar with basics principles of General Chemistry, Physical Chemistry and Organic Chemistry

MODULE 1 **11Hrs**

Atomic Structure:

de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation. significance of wave functions, emergence of Quantum numbers. radial and angular wave functions, Atomic orbitals, shapes of s, p and d orbitals. Radial distribution curves of 1s, 2s,2p, 3s, 3p atomic orbitals. Energy level diagram of atomic orbitals (up to 4s), Aufbau and Paulis exclusion principle. Hund's multiplicity rule. n+l rule, pairing energy, exchange energy, (explain by taking filling of electrons in p and d orbitals) electronic configuration of elements.

The Periodic Table and Chemical Periodicity:

Modern periodic law: The relationship between chemical periodicity and electronic structure of the atom. *The long form of the periodic Table*: Classification of elements in s,p,d and f block of elements. Periodicity in oxidation state of elements, metallic/non-metallic character, oxidizing and reducing behaviour; acidic and basic character of oxides; trends in bond type with position of element and with oxidation state for a given element; trends in the stability of compounds and regularities in methods used for extraction of elements from their compounds; *s and p block elements:* Anomalous behaviour of elements of 2nd period (Li to F) compared to other members in the same groups of s & p block elements; The diagonal relationship between elements, the inert pair effect; *d-block elements:* General valence shell configuration of 3d series elements (also in box diagram) variable oxidation states, colors, magnetic properties and catalytic properties of transition elements.

MODULE 2 09**Hrs**

Noble gases:

Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF2, XeF4, XeF6, XeO3, XeO4).

Hydrogen:

Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and parahydrogen, Industrial production of hydrogen by chemically assisted electrolysis, Photobiological water splitting, Biocatalysed electrolysis and Steam reforming. *Heavy water:* Physical properties (with comparison to light water), Applications. *Hydrogen bonding:* definition, types, importance *Hydrates:* Chemical nature and their stability.

MODULE 3 **05Hrs**

The First Law of Thermodynamics:

Introduction: Thermodynamic terms and basic concepts, intensive and extensive properties, State functions and differentials, thermodynamic processes, reversibility, irreversibility, nature of heat and work, conservation of energy, *First law of thermodynamics:* Various statements of first law, Manipulations of first law, internal energy (U) and enthalphy (H). Reversible isothermal expansion of ideal and real gases, Molar heat capacity at constant pressure CP and at constant volume CV, relation between CP and CV, Reversible adiabatic expansion of ideal and real gases, Joule Thomson effect.

MODULE 4 **11Hrs**

Gaseous state:

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations).Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems .Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves. Derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagats mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b. *Law of corresponding states* - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition(no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

MODULE 5 **11 hrs**

Organic reaction intermediates:

Covalent bond, Bond cleavage **–** homolytic and heterolytic. Types of reagents **–** electrophilic and nucleophilic reagents. *Reactive intermediates* - generation of carbocation, carbanion, carbon free radicals and carbenes **–** explanation for stability and reactivity of the above intermediates based on inductive, resonance and hyperconjugation effects. *Types of organic reactions* **–** substitution, addition, and elimination (free radical, electrophilic and nucleophilic types). *Concept of*

isomerism – structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol) in carbonylcompounds).

MODULE 6 **05 hrs**

Alkanes and Cycloalkanes:

Definition, classification, IUPAC nomenclature, the alkyl groups (stick formula of a fewbranched and unbranched alkanes) 1o, 2o and 3o carbon atoms, in alkanes. *Alkanes:* sources, methods of preparation - Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties: melting points, boiling points and solubility. Chemical reactions of alkanes – combustion, halogenation ,mechanism of free radical halogenation of methane; orientation, reactivity and selectivity. Uses of alkanes. *Cycloalkanes* – nomenclature, methods of preparation by Carbene insertion and Dieckmann condensation reactions, chemical reactions – oxidation, Halogenation and Opening reactions of three and four membered rings, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. The case of cyclopropane ring;- banana bonds.

Alkenes:

Definition, classification, Preparation of alkenes by Wittig reaction. Chemical properties: Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and importance.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH171
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1 PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Students will be given instructions like Good Laboratory practies, significant figures, volumetric calculations.(problems to be solved).
2. Students will be trained to calibrate various glass ware like pipette, burette and standard volumetric flasks.
3. The various volumetric titration experiments will be introduced to students like acid base redox etc.,.
4. The titration experiments can be deigned to estimate N_2 in ammonia, carbonate in bicarbonate ,chloride etc.,

COURSE OUTCOMES:

1. The students will be well versed with all the necessary laboratory practices.
2. The students will independently calibrate the glass ware before using for experiments.
3. The students will be able to use the principles of titration experiments in volumetric analysis.
4. The students can be able to estimate the carbonate, nitrogen, chlorine from the various matrix given.

1. Good Laboratory practices, significant figures, volumetric calculations. Problems to be solved)
2. Calibrations of pipette, burette and standard volumetric flasks.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using standard sodium thiosulphate.
7. Determination of percentage of manganese dioxide in pyrolusite ore.
8. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
9. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
10. Estimation of carbonate and bicarbonate in a given mixture.
11. Determination of the percentage of available chlorine in the given sample of bleaching powder.
12. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

Prints I, by Nandini Iyer

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16EP191
TITLE OF THE COURSE : ENVIRONMENT AND PUBLIC HEALTH
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT - 26 HRS

MODULE 1 **3h**

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 **4h**

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 **5h**

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4h**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4h**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6h**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.
- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.

- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore
3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER: II

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT102
TITLE OF THE COURSE : PRINCIPLES OF MICROBIOLOGY AND BIOSTATISTICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about classification and diversity of microorganisms and familiarize the students with the cultivation of microorganisms and sterilization techniques.
2. To impart the basic concepts in biostatistics.

COURSE OUTCOMES: 1. Student will be aware of basic microbiological and sterilization techniques.
2. Student will have sufficient understanding of statistical methods used in biological sciences for data handling.

MODULE 1 **10Hrs**

Historical perspectives of microbiology: Introduction – microbial origin, Contributions and discoveries, Germ theory, Scope of Microbiology. Concept of Sterilization - Definition of sterilization, disinfection, Sanitization, antisepsis and fumigation. Physical, Chemical and radiation methods of sterilization, and their applications.

MODULE 2 **11Hrs**

Classification of Microbes: Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of molecular classification of microorganisms Systematics of bacteria, Nutritional types (Definition and examples). Classification on the basis of oxygen requirement. General Account of Viruses and Bacteria; Bacteria-Ultra structure of a bacterial cell (both Gram positive and Gram negative) endospore and capsule.

MODULE 3 **11Hrs**

Microbes in Extreme Environment; Nature, special features of the thermophiles, methanogens and halophiles, Archaea; photosynthetic bacteria, Cyanobacteria, some Archaea living in extreme conditions like cold, and space (Extremophiles). Pathogenic Microorganisms; A. Plant viruses-CAMV, Animal Viruses-Hepatitis B, Bacterial virus- lambda phage B. The common bacterial, fungal and viral diseases of human beings (Name of the disease, causative pathogen, parts affected).

MODULE 4 **10Hrs**

Biostatistics: Importance and Applications; Tabulation and classification of Data - Frequency distribution and graphical distribution of Data; Measures of Central Tendencies - Mean, Median, Mode and their properties; Measures of Dispersion - Mean Deviation, Variance, Standard Deviation and Coefficient of Variation;

MODULE 5 **10Hrs**

Hypothesis testing - Student T and Chi Square test; Probability and distribution - Concepts and problems on probability, Binomial, Poisson, normal distribution and their application.

REFERENCE BOOKS

1. Microbiology-Pelczar, Chan, Krieg Tata McGraw Hill Publications (2000)
2. Microbiology- Concepts and applications by Paul A. Ketchum Wiley Publications (2001)
3. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications (2003)
4. Microbiology –Ronald M. Atlas (1990)
5. Introductory Biotechnology-R.B Singh C.B.D India (1990)
6. Microbiology by L M Prescott, Mc Graw Hill
7. General Microbiology –C.B. Powar, H.F. Daginawala, Himalayan Publishing House (2001)
8. Fundamental of Biostatistics by Khan and Khanum, Ukaaz Publications (1994)
9. Statistics for Biologists by RC Campbell, Cambridge University Press (1989)
10. Biostatistics by Wayne W Daniel, Wiley 10th Edition (2014)

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT172
TITLE OF THE COURSE : MICROBIAL TECHNIQUES
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make the students aware of basic microbiological techniques.

COURSE OUTCOMES: 1. Student will be trained in basic sterilization and microbiological techniques.

1. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
2. Common instruments used in a microbiology Lab: Principles and operations - Incubators & Shakers Centrifuge pH meter Colorimeter Spectrophotometer
3. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa)
4. Sampling and quantification of microorganisms in air, soil and water.
5. Isolation of bacteria - Streak plate, spread plate, pour plate, serial dilution (2 units)
6. Biochemical tests – IMViC, starch hydrolysis, catalase & gelatin liquefaction (3 units)
7. Antibiotic sensitivity test-paper disc method
8. Study of Rhizobium from root nodules of legumes.
9. Microscopic study of phytoplankton & zooplanktons.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC102
TITLE OF THE COURSE : ORGANIC CHEMISTRY, DRUG SYNTHESIS AND TOXICOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: This course will provide the basics in Organic chemistry and drug development. They will gain a basic knowledge of methods used in drug discovery and basic toxicology.

COURSE OUTCOMES: Students will recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism. They will understand the basics in drug design and toxicology.

MODULE 1 **10Hrs**

Introduction: IUPAC nomenclature of organic compounds, Inductive effect, resonance and hyperconjugation, Reactive intermediates: carbocations, carbanions, carbines and free radicals.
Aliphatic and Aromatic Hydrocarbons: General characteristics of alkanes, alkenes and alkynes, substitution and bond opening reactions: Wurtz & Kolbe reaction for alkane, Hydrogenation with Merkownikoff's rule and ozonolysis of alkenes. Organometallic compounds - definition, examples and synthetic applications of Grignard Reagents. Baeyer strain theory. Sachse-Mohr theory. Boat and chair forms of cycloalkane. Axial and equatorial bonds. Benzene structure, Aromaticity, Huckel's rule, orienting influence of substituent on group addition.

MODULE 2 **10Hrs**

Mechanisms: Substitution of alkyl halides via SN1 and SN2, elimination via E1 and E2.
Alcohols: Definition and classification. Monohydric alcohols – general properties; distinguishing reactions of primary, secondary and tertiary alcohols – Lucas Test, Victor Meyer Test and Oxidation reactions. Acidity of phenol, Kolbe & Reimer-Tiemann reactions.
Acids and Aldehydes: Definition and examples. General properties, acid strength, esterification of acid, oxidation of alcohols to aldehydes and ketones. Keto-enol tautomerism, Perkin reaction, Claisen and aldol condensation, Cannizzaro reaction and reduction.

MODULE 3 **10Hrs**

Stereochemistry: Stereoisomerism: Optical isomerism: Molecular dissymmetry, Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism in alkenes and ring compounds. Structure and properties of malic and fumaric acid, E-Z system of specifying geometrical isomer, examples of chirality in the biological world.
Amines: Classification. Isomerism. Distinguishing reaction of 1°, 2° and 3° amines. pKb values of amines. Effect of substituents on the basic strength of amines. Some biologically important amines.
Heterocyclic Compounds, Terpenes and Alkalolds: Structure, formulae and occurrence of furan, thiophene, pyrrole, imidazole, pyridine and indole. Aromaticity of furan, thiophene,

pyrrole and pyridine. Isoprene rule, biological importance and occurrence of terpenes & alkaloids. Phytochemicals- Introduction and uses.

MODULE 4 **10Hrs**

Organic synthesis and Drug Design: Retro-synthetic planning and synthetic execution, retron and synthon. Michael addition, Diels Alder reaction, Organo-lithium and epoxide-based reactions to create synthones, Reaction of diazonium salts coupling reactions, ethyl acetoacetate and its synthetic application, increasing C-atoms by n units, selective removal of C-atoms. Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug-receptor interaction Principles of Drug Design, Traditional analog (QSAR) and mechanism based approaches, Computer Aided Drug Designing (CADD) and molecular modeling. Synthesis of aspirin, anthraquinone, sulfanilamide, paludrine, acetaminophen (paracetamol) and pentothal**.**

MODULE 5 **10Hrs**

Toxicology: Toxins, venom, poison with examples, Dose Response curves, bioavailability, biosorption, IC50, LD50, ED50, Genotoxicity, Xenobiotics, Role of Cytochrome P450, Various mechanisms of Detoxification. Whole animal studies, Perfusion studies, Metabolic cage, Tissue culture, Common cell lines used for studying diseases.

REFERENCES BOOKS

1. Organic Chemistry-Morrison and Boyd. Prentice-Hall of India
2. Organic Chemistry-Solomons and Fryhle. Wiley & Sons.
3. A Guidebook to Mechanism in Organic Chemistry-Sykes. Longman Publishers.
4. Advanced Organic chemistry-Bahl and Bahl. S. Chand Publishing House.
5. A textbook of Modern Toxicology – Hodgeson. Wiley & Sons.
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC172
TITLE OF THE COURSE : Qualitative analysis and organic preparations
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To recognize the basic practical skills for the analysis and synthesis of organic compounds.

COURSE OUTCOMES: Predict and identify the organic compound after analysis. Students will also be able to synthesize few drugs like acetyl salicyclic acid and few other organic compounds.

[1] SYSTEMATIC QUALITATIVE ANALYSIS OF SAMPLE ORGANIC COMPOUND –

Alcohol
Phenols
Carboxylic acids
Aldehyde
Ketones
Esters
Aromatic hydrocarbons
Halocompounds
Amines

[2] ORGANIC PREPARATIONS:

a) Nitration of nitrobenzene
b) Acetylation of salicylic acid
c) Oxidation of benzaldehyde
d) Bromination of phenol/ acetanilide

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16GN102
TITLE OF THE COURSE : BASIC GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Introduction to genetic evolution and impact on genetics today.
2. Impact and diversity of genetics in life sciences**.**

COURSE OUTCOMES:
1. Students will understand the basic concept of hereditary
2. Student will understand genetic basis of human disease and extrapolate or critically evaluate other diseases they come across.

MODULE 1 -HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross. Pattern of inheritance in haploid and diploid organisms.

MODULE 2- EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementry and Complementry gene interactions; Non epistatic inter allelic gene interaction, Position effect

MODULE 3- SEX DETERMINATION 10Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridge s genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in *Drosophila*. Sex differentiation and dosage compensation *(Drosophila* and Man). Sex linked and sex limited traits in Humans- Hemophilia, Hypertrichosis.

MODULE 4- EXTRA CHROMOSOMAL INHERITANCE 10Hrs

Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in *Paramecium*, sigma factor in *Drosophila*, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 5- ELEMENTS OF BIOMETRY 10Hrs

Measures of Central tendency Mean, Median and Mode. Measures of Dispersion Range, Variance, Standard deviation and Standard error. Test of Hypothesis - Student s t test, chi square test. Probability - Basic concepts; Distribution- Normal, Binomial and Poisson.

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFERENCE BOOKS

1. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
2. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009)
3. McGraw-Hill. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
4. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
5. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
6. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
7. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16GN172
TITLE OF THE COURSE : BASIC GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. Genetic calculations to determine inheritance traits.
2. Basics of statistical analysis for determining quantitative inheritance.

COURSE OUTCOMES:
1. Ability to be able to determine understand the allele distribution using different types of crosses.
2. Apply statistical knowledge to address different types of genetic data.

1) Temporary squash preparation of:
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing
3) Study of:
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Computation of:
   Mean, median and mode
   Standard deviation and standard error.
5) Problems on:
   Student s t test and Chi square test.
6) Problems on Probability
7) Genetic problems on:
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB102
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Deliberate existing theories about the origin of life, microbial evolution and systematics
2. Make simple calculations of microbial growth kinetics in batch and continuous culture and describe how microbial growth can be controlled

COURSE OUTCOMES: 1. The course will enable students to relate the principles in classifying microbial systems and know their beneficial and harmful effects.
2. Enable to apply this knowledge in microbial biotechnology starting from screening of desired microbe

MODULE 1 - MORPHOLOGY AND STRUCTURE OF BACTERIA 10Hrs

Morphology of bacteria:- Size, shape and arrangement , Ultra structure of bacteria :- structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae .Bacterial cell wall and structure. Structures internal to the cell wall -Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic);Nuclear material- Bacterial Chromosome (Fundamental differences with eukaryotic chromosome)Plasmids and episomes, Ribosomes, Exospores and Cysts: types and structure; Endospore.

MODULE 2 - SPECIAL MICROBIAL FORMS AND VIRUSES 11Hrs

General account of Archaebacteria, Actinomycetes, Rickettsiae, Mycoplasma and Chlamydiae. Early development of virology, General structure and characteristics of viruses, cultivation of viruses, general replication of viruses. Type study: classification, structure, replication, cultivation and application of - TMV, Polio virus, T4 and Lamada phage. Brief account of Viroids and Prions.

MODULE 3 - EUKARYOTIC MICROBES-I 10Hrs

Algae: General characteristics of algae including occurrence, thallus organization, alga cell ultrastructure, pigments, flagella, eyespot food reserves, and vegetative, asexual and sexual reproduction. Different types of life cycles in algae: Haplontic type, Diplontic type, Haplobiontic type, Diplobiontic type. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

MODULE 4 - EUKARYOTIC MICROBES- II 11Hrs

Fungi: General account of Fungi-General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual reproduction and sexual reproduction. Economic importance of fungi**,** Type study of Zygomycetes (*Rhizopus)*,

Ascomycetes (*Aspergillus,* yeast *and (Penicillium)*, Basidiomycetes (*Agaricus*)and Deuteromycetes(*Fusarium*).

Protozoa: General characteristics with special reference to *Amoeba, Paramecium, Giardia, Plasmodium, Entamoeba*.

MODULE 5- GROWTH KINETICS **10Hrs**

Definition of microbial growth, factors affecting microbial growth (pH, Temperature, Oxygen concentration, Pressure and Radiations), Cell division, Growth curve of bacteria, Kinetics of growth:- Mathematics of growth-generation time and growth rate constant. Measurement of growth: Measurement of cell numbers- Counting chambers, electronic counters, viable counting techniques, membrane filter technique. Measurement of cell mass- dry weight and turbidity measurement. Measurement of cell activity, Batch culture, Continuous culture-Chemostat and Turbidostat. Synchronous culture (definition and brief description).

REFERENCE BOOKS

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock, T. D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
6. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
7. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
8. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
10. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
12. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India PrivateLimited, New Delhi.

Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB172
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make the students aware of basic staining techniques.

COURSE OUTCOMES: 1. Student will be trained in different classification of microorganisms.

1) Isolation and identification of fungi (Lactophenol cotton blue mount)
2) Micrometry:
   Microscopic measurement of bacterial cell (*Bacillus*), yeast (*Saccharomyces),* fungal spores (*Pencillium and Aspergillus*) and onion cell by micrometry.
3) Enumeration of microbes by Haemocytometer (yeast).
4) Study of the following algae by preparing temporary slides:
   Chlamydomonas and *Spirulina*
5) Study of the fungi by preparing temporary slides:
   Rhizopus, *Aspergillus, Penicillium*, Yeast, *Fusarium*
6) Study of Protozoa by using permanent slides:
   Amoeba, Paramecium, Giardia and Plasmodium
7) Study of growth curve of bacteria by turbidometric estimation
8) Study of growth curve of fungi by colony diameter method
9) Cultivation of bacteriophage
10) Cultivation of Algae

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CH102
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 2
L: T/A: P: C : 3: 1: 0 : 4

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. In General Chemistry the principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen , alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen compounds, alkenes were introduced to the students.

MODULE 1 **10Hrs**

Chemical Bonding:

Ionic Bond: Definition and conditions for formation of an ionic bond, examples of formation of an ionic compound (NaCl, CaCl2, MgO).Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle (NaCl,CaCl2 and MgO), problems, polarizing power and polarizability, Fajan's rules.

Covalent Bond: Definition, octet rule, limitation electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Valence Shell Electron pair repulsion (VSEPR) Theory: Shapes of simple inorganic molecules and ions such as NH3, H3O+, SF4, ClF3, ICl2 and H2O.

Hybridisation concept: various types of hybridization, structure of molecules based on hybridization concept and by valence shell electron pair repulsion (VSEPR) theory.

Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6 molecules.

Molecular orbital theory: linear combination of atomic orbitals (LCAO), MOT postulates, bonding, nonbonding and antibonding molecular orbitals. Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules (H2, N2, O2, HF and CO).

Metallic Bond: Definition, properties of metals and band theory, electrical properties of metals, semiconductors and insulators.

Weak Intermolecular interactions: vanderwaals forces, dipole dipole interactions and their significance. Hydrogen Bond – types and its significance on molecular properties.

MODULE 2 **11Hrs**

The Second Law of Thermodynamics:

Introduction: Spontaneous change, Carnot Cycle, conclusions from Carnot cycle, efficiency of heat engines, Second law of thermodynamics, entropy, entropy as a state function, Clausius inequality, entropy as criterion of spontaneity, natural processes, different types of entropy changes under isothermal and non-isothermal conditions, entropy change in irreversible processes. Helmholtz function (A), Gibbs function (G), standard molar free energy changes, Maxwell relations, dependence of free energy functions on temperature and pressure, total differential equations. Gibbs Helmholtz equations, thermodynamic criteria for spontaneity. Heat capacity at low temperature, Nernst heat theorem, Third law of thermodynamics, third law entropies.

Chemical Kinetics:

Review of terms: Rate, Order and Molecularity. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, halflife period, mean life period and order of reaction. Determination of order of reaction: differential method, method of integration, method of half life period and isolation method. Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis).Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE 3 **11Hrs**

Liquids and Solutions:

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.

MODULE 4 **9Hrs**

s & p block elements:

s- block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.*p – block elements:* Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.*Halogens:* Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

MODULE 5 11**Hrs**

Dienes and Alkynes:

Dienes: Classification - isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction- 1,3-butadiene with maleic anhydride.
Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction –significance. Oxidation with KMnO4, acidic nature of terminal alkynes.

Stereochemistry:

Fischer, saw-horse and Newman projection formulae. Chirality-optical activity, enantiomerism and diastereoisomerism involving one and two chiral centers, configuration, geometrical isomerism, D/L, R/S and E/Z nomenclatures.

Organic halogen compounds:

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanism with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii)nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism. *Aryl halides:* Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.
3.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16CH172**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 2**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. Students will determine various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

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COURSE OUTCOMES:

1.The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. The students will be sell versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Determination of transition temperature of a salt hydrate by thermometric method.
5. Determination of distribution coefficient of benzoic acid between water and toluene.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Determination of dissolved oxygen (DO) in water sample.
9. Compare the strength of HCl and H_2SO_4 in the hydrolysis of ethyl acetate (K for one acid is given)
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

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SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CA192
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L: T/A: P: C : 2: 0: 0: 0

Total Credit - 26 Hrs

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems. 5 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: Data processing & presentation 4 Hrs

Introduction, Office Automation Software (Open Source Software)

MODULE 4: Computer viruses and Internet Searches. 5 Hrs

An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 5: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCE BOOKS

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER III

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BT201
TITLE OF THE COURSE : BASIC PRINCIPLES OF BIOCHEMISTRY AND BIOPHYSICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.
2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES: 1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **10Hrs**

Carbohydrates: Structure, properties and classification with examples – Monosaccharides, Disaccharides, polysaccharides (storage and structural, homo and hetero polysaccharides). Lipids: Structure, properties and classification and functions – Phospholipids, sphingolipids and glycolipids.

MODULE 2 **10Hrs**

Classification and properties of amino acids, titration curve of amino acid, concept of zwitter ion, pKa and pI. Proteins: Classification based on structure and function, structural organization of proteins – Primary, secondary (alpha helix and beta sheet), tertiary and quaternary structure. Nucleic Acids: Nucleic acids and their components – Nitrogenous bases (purines and pyrimidines), nucleosides and nucleotides, formation of phosphodiester bond.

MODULE 3 **11Hrs**

Enzymes: Introduction, classification, co-enzymes and co-factors, enzyme kinetics (Michelis-Menten equation), factors influencing enzyme activity- Substrate, enzyme, temperature and pH, Inhibition mechanisms (competitive and non-competitive). Vitamins and Hormones: Water Soluble and fat-soluble vitamins, Dietary source, Clinical relevance. Functions of Steroid hormones (testosterone and estrogen), Glucocorticoid hormones (cortisol and mineralocorticoid), pituitary hormones (MSH and FSH). Examples of Plant Hormones (Auxins, Cytokinins and Gibberllins).

MODULE 4 **10Hrs**

Scope of Biophysics, pH and Buffer concepts. Principles and applications of Chromatography (Paper, thin layer, column, GLC and HPLC); Centrifugation (differential, density gradient, Ultra centrifugation);

MODULE 5 **11Hrs**

Principles and applications of Spectroscopy (UV, Visible, X-Ray crystallography, NMR, IR, Fluorescence and Atomic; Absorption); and Electrophoresis. Isotopes: Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

REFERENCE BOOKS

1. Lehninger's Principles of Biochemistry- W H Freeman (2008)
2. Biochemistry-Lubert Stryer Freeman International Edition (2002).
3. Biochemistry-Keshav Trehan Wiley Eastern Publications (1987).
4. Fundamentals of Biochemistry J.L. Jain S. Chand and company (2007).
5. Biochemistry by U Satyanarayana and Chakrapani, Elsevier Inc. (2013).
6. Biochemistry by Voet and Voet, Wiley Publishing (2010).
7. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
8. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
9. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John
10. Walker, Cambridge University Press (2005).
11. Biophysics – An introduction by Ronald Glaser, Springer (2012).

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16BT271**
TITLE OF THE COURSE : **BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES**
L: T/A: P: C : **0: 0: 4: 2**

Course Objectives: 1. To make students learn quantitative and qualitative methods for study of biomolecules.

Course Outcomes: 1. Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

1. Preparation of Buffers-Citrate and Phosphate.
2. Estimation of reducing sugars by DNS method.
3. Estimation of reducing sugars by Somogyi-Nelson Method.
4. Estimation of Amino acids by Ninhydrin method.
5. Estimation of Protein by Biuret method.
6. Estimation of protein using Lowry's method.
7. Preparation of crude amylase extract from biological source
8. Assay of amylase enzyme activity using starch as a substrate. (2 MODULEs)
9. Separation of Amino acids by Paper Chromatography.
10. Separation of amino acids/sugars by Thin layer chromatography

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16BC201**
TITLE OF THE COURSE : **PHYSICO-ANALYTICAL TECHNIQUES**
L: T/A: P: C : **3: 1: 0: 4**

COURSE OBJECTIVES:

1. To create general understanding about fundamentals of biomolecules, their structure and function.

2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES:

1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **11Hrs**

Spectroscopy: Wave particle duality, the electromagnetic spectrum, Lambert-Beer's law, Absorbance, extinction coefficient, Chromic shifts, auxochromes. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscope; assay of biomolecules. Principle, Schematics and Application of Luminometry, Flame photometry and AAS. IR spectroscopy, equation, vibrational modes of various bonds, applications in the identification of common functional groups in biomolecules.

MODULE 2 **11Hrs**

Techniques for structure determination
X-Ray Diffraction: crystal planes, Braggs Equation, Diffractometer, Applications in crystal characterization. NMR: principle and applications in structure elucidation of biomolecules.

Techniques in Medical Applications
NMR based techniques – Magnetic Resonance Imaging and Diffusion tensor imaging – brief idea, X-ray based technique: CAT scan and radioactivity based technique: PET scan

Chromatography
Distribution coefficient, Adsorption, partition, Retention factor. Types: Planar and columnar, S-L, L-L, G-S and G-L. Paper, thin layer, gel permeation, ion exchange, hydrophobic and affinity chromatography with applications, Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules. Brief idea about HPLC (C8 and C18) and FPLC.

MODULE 3 **10Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis, Applications. Gel electrophoresis: - Types of gels, Procedure, Column & slab gels. Detection, Recovery & characterization of macromolecules

(molecular weight determination and subMODULE enumeration). Principle and application of SDS-PAGE, IEF, peptide mapping, OFGE, Application in molecular biology and genomics.
Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

MODULE 4 **10Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography. Applications of isotopes in biochemistry with reference to studies in metabolism, Principles of tracer techniques, it's advantages and limitations,

MODULE 5 **10Hrs**

Centrifugation: Basic principles, Mathematics & theory: RCF, Sedimentation coefficient, Svedberg constant, nomogram. Preparative centrifugation: Differential & density gradient centrifugation, Applications**.** Analytical centrifugation: - Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.
Electrochemistry: Potentiometry, potentiometer schematics and use as pH meter,Conductance, specific and equivalent conductance, Conductivity meter.

REFERENCE BOOKS

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Principles and Techniques of practical Biochemistry – Wilson and Walker. Camridge.
4. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
5. Immunology – Kuby. Freeman Publishers.
6. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BC271
TITLE OF THE COURSE : BIOANALYTICAL SEPARATIONS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic, potentiometric and chromatographic techniques.

1. pH metric /potentiometric titrations of HCl- NaOH and Acetic acid-NaOH
2. Estimation of pKa of glycine.
3. Determination of density & viscosity of given unknown solution.
4. Paper chromatography of amino acid, lipids and sugar (Ascending and circular)
5. Paper electrophoresis for separation of biomolecules.
6. Separation of amino acid by TLC.
7. Column chromatography of pigments on adsorbent.
8. Conductometric titration of an amino acid against HCl and NaOH.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16GN201
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Genetic inheritance associated with chromosomal modifications.
2. Diverse role of sex chromosomes in genetic inheritance

COURSE OUTCOMES:
1. Students understand the diverse modifications chromosomes undertake for inheritance pattern.
2. Student will understand how intricate is the role of sex chromosomes in maintaining diversity as well as consistency.

MODULE 1 PHYSICAL BASIS OF INHERITANCE 11Hrs

Chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres, types of chromosomes. Heterochromatin and Euchromatin and its significance. Ultra-structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Idiogram.

MODULE 2 SPECIAL TYPES OF CHROMOSOME AND LINKAGE 10Hrs

Polytene chromosome- Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte, B Chromosome. Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage- complete linkage and incomplete linkage,Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc.

MODULE 3 CROSSING OVER 11Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in *Drosophila*. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks, Crossing over in *Drosophila* and Tetrad analysis in *Neurospora*, Interference and coincidence, Construction of genetic maps (*Drosophila* and maize) and Punnett square.

MODULE 4 SEX LINKAGE 10Hrs

Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in *Drosophila*. Sex linked genes in Poultry and moths. Sex related genes in maize.Attached X-chromosome.

MODULE 5 CHROMOSOMAL ABERRATIONS 10Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomesand Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

TEXT BOOKS

1. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
2. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.

REFERENCE BOOKS

1. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
2. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
3. Sinha U., SMODULEa and SMODULEa Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
4. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
   Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
5. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
6. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16GN271**
TITLE OF THE COURSE : **FUNDAMENTALS OF CYTOGENETICS PRACTICAL**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. Detail culture maintenance of Model organism Drosophila melanogaster
2. Understanding and visualising different chromosomal aberrations

COURSE OUTCOMES:

1. Students will learn the complete methods of culturing, dissection and study of model organisms. Develop skills on hands on experiments
2. Perform genetic analysis on linkage and crossing over. Determine skills of genetic analysis using different plant and animal models.

1) Culturing and Handling of Drosophila
   - Cleaning and Sterilization of bottles.
   - Media Preparation.
   - Handling of Drosophila.

2) Study of at least five types of Drosophila:
   - Body color mutant- Ebony body and Yellow body.
   - Wing mutant- Curly wing and vestigial wing.
   - Eye color mutant- Bar eye, white eye, sepia eye.

3) Mounting of Sex Comb of Drosophila melanogaster

4) Mounting of Genital plate of Drosophila melanogaster

5) Salivary gland Chromosome
   - Dissection of Salivary glands.
   - Preparation of Polytene chromosome.

6) Study of Chromosomal Aberrations:
   - Observation of permanent slides of chromosomal aberrations.
   - Inversion- Salivary gland chromosomes of Drosophila nasuta.
   - Induction of polyploidy in Onion root tips.

7) Genetic Problems on Linkage & Crossing over:
   - Drosophila.
   - Maize.
   - Human (Sex Linkage).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB201
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY, MICROBIAL GENETICS AND INSTRUMENTATION
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics.
2. To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype.

COURSE OUTCOMES: 1. To understand the complexity of microbial structures, genetics and metabolism.
2. Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment

MODULE 1: BIOMOLECULES AND ENZYMES 10Hrs

A brief account of the properties, classification and importance of carbohydrates, lipids and proteins.

Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes.

MODULE 2: METABOLISM AND BIOENERGETICS-I 11Hrs

Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H.

Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: METABOLISM AND BIOENERGETICS-II 11Hrs

Bacterial photosynthesis and Fermentation: Definition, Photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid.

Bioenergetics: Free energy, ATP and its production, other high energy compounds, Oxidation – Reduction reactions.

MODULE 4: MICROBIAL GENETICS 10Hrs

Basics of Genetics: Mendelian Principles of genetics (Monohybrid, Dihybrid and Test cross), Morphology of Prokaryotic and Eukaryotic genetic material.

Chemical basis of heredity: Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment). Properties of genetic

code and Wobble hypothesis. Transformation, Conjugation and Transduction. Transposons in recombination. Extra chromosomal genetic elements and their importance.
Molecular basis of mutations: Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.

MODULE 5: INSTRUMENTATION **10Hrs**
Centrifugation: Basic principles, Low-speed and High speed centrifuges, ultracentrifugation, Applications.
Chromatography: Paper, Thin layer, Column chromatography, HPLC
Electrophoresis: Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, SDS-PAGE
Spectrophotometer: Principles of Spectroscopy, UV Visible spectroscopy, NMR spectroscopy.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Freifelder, D. 2002. Microbial Genetics, Narosa Publishing House, New Delhi.
7. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 2008. Principles of Genetics. Eight edition. Wiley Publications.
8. Griffin, D.H. 1993**.** Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
9. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
10. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
11. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB271
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES: 1. Student will be equipped with coloured based changes given out by microbial tests

1. **Biochemical tests:**

- Starch hydrolysis.
- Gelatin hydrolysis.
- Catalase test.
- Sugar fermentation test.
- Nitrate reduction test.
- H_2S production test.
- IMViC test
- Oxidase test.
- Casein hydrolysis test.
- ONPG test.

2. Qualitative analysis of carbohydrates.
3. Qualitative analysis of proteins.
4. Quantitative determination of reducing sugars by DNS method.
5. Quantitative determination of proteins by biuret method.
6. Partial purification of protein by ammonium sulphate precipitation method
7. Genetic problems
8. Isolation of antibiotics resistant mutant by gradient plate technique
9. Demonstration of replica plating method for selection of antibiotic resistant mutants

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16CH201**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 3**
L: T/A: P: C : **3 : 1 : 0: 4**

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.

2. In General Chemistry the principles of metallurgy, fertilizer in physical chemistry, basic principles of the II and III laws of thermodynamics and in organic chemistry the principles of aldehydes, ketones ,alcohols compounds, alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physic Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of metallurgy, fertilizers in physical chemistry, basic principles of the II and III lwa of thermodynamics and in organic chemistry the principles of aldehydes, alcohols compounds, alkenes were introduced to the students. Ketones.

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MODULE 1 **11Hrs**

Surface chemistry

Review of surface phenomena. Theories of adsorption. Adsorption isotherms and BET equation (derivation included), Surface area calculation using BET. Adsorption indicators. Surface film on liquids. Catalysis –Types and theories ((intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Auto catalysis.

THERMODYNAMICS II

II Law of Thermodynamics

Limitations of I law, scope of II law, Statements of II law of thermodynamics (to be introduced wherever the concepts arise). Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Driving force for spontaneous processes. Concept of entropy and its physical significance. Entropy change in adiabatic and isothermal reversible expansions of an ideal gas. Change in entropy of an ideal gas with change in P, V and T (derivation of equation) – modified equation for isothermal, isochoric and isobaric processes. Entropy of phase change. Entropy changes in the system and surroundings in an isothermal reversible expansion and isothermal irreversible expansion of an ideal gas, entropy criteria for spontaneity, Carnot cycle – derivation of efficiency based on entropy concept. Relation between entropy and probability.

MODULE 2 **09Hrs**

III **law of thermodynamics** – Determination of absolute entropies of substances, standard entropies, residual entropy. Free energy – Gibb's free energy & Helmholtz free energy (work function), Relation between w and ΔA, w and ΔG, standard free energy change of a reaction. Free energy criteria of spontaneity, variation of G with T and P. Gibb's Helmholtz equation – derivation. Relation between free energy & equilibrium constant of a reaction. Clausius–Clapeyron equation–derivation, application to liquid-vapour and solid-liquid equilibria.

MODULE 3 **9Hrs**

Metallurgy:

Introduction, classification. Ellingham's diagrams: Salient features for the formation of oxides. Extraction of the following metals -i) Nickel from sulphide oreii) Thorium from Monazites and iii) Plutonium from Nuclear waste. Advantages of powder metallurgy. Methods of production of metal powders.

Fertilizers:

Introduction (need of fertilizers), functions of essential plant nutrients (N, P, K). Classification of fertilizers with examples. Manufacture of urea and Super phosphate of lime, and their uses.

Environmental Chemistry:

Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

MODULE 4 **09Hrs**

Alcohols and Thiols

Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Pondorff-Verley reaction); (ii) From acids and esters (by reduction with LiAlH4).Reactions of alcohols: Comparison of the reactivity of 1°, 2° and 3° alcohols - Lucas test,oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using KMnO4 and from epoxides. Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats. Uses.

Thiols: Methods of formation and chemical reactions (with metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes.

MODULE 5 **09Hrs**

Aldehydes and Ketones

Nomenclature: Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Addition of HCN - mechanism. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalyzed acetal formation. Addition of amines (primary and secondary amines, hydrazine and hydroxylamine). Wittig reaction (no meachanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α-Hydrogen, enolate ion. Keto- enol

tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanismof both), crossed aldol reaction (practical crossed aldol reactions). Claisen-Schmidt reaction (nomechanism). Addition to α,β-unsaturated aldehydes and ketones (no mechanism). Michael addition (no mechanism).

MODULE 6 **05Hrs**

Phenols

Nomenclature, classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO2 group and electron donating –CH3 group on acidity of phenols at o-, m-, p- positions, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Ethers and Epoxides

Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions – Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1, 2 disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

Organometallic compounds

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S.Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CH271
TITLE OF THE COURSE : ORGANIC CHEMISTRY (Practical)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. The students will be trained the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2.The students will be given hands on experience on synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

COURSE OUTCOMES:
1. The students will be experts of the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2. The students will be experts of synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

Preparation and purification of organic compounds
1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
(Preparation, recrystallization and melting point determination of the recrystallized sample in the following organic preparations)
One stage preparation
3. Preparation of aspirin from salicylic acid.
4. Preparation of paracetamol from *p*-aminophenol.
5. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
6. Preparation of *m*-dintrobenzene from nitrobenzene.
7. Preparation of benzoic acid from benzaldehyde.
8. Purification of solids by sublimation. (Benzoic acid / Napthalene)
Two stage preparations
9. Preparation of *p*-bromoaniline from acetanilide.
10. Preparation of *p*-nitroaniline from acetanilide.
11. Preparation of *m*-nitrobenzoic acid from methyl benzoate.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CI291
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT: 26 HRS

MODULE 1: 5h

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6h

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5h

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5h

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, and administrative: Recent Trends.

MODULE 5: 5h

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER IV

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To provide comprehensive understanding molecular processes inthe cell required for its growth and maintenance of genetic material.
2. To equip with fundamental understanding of the underlying mechanisms in regulation of gene expression.

COURSE OUTCOMES: 1. Student will be well versed with mechanisms in the expression, regulation and maintenance of genetic information, within a biological system.
2. Student will be able to critically think in the field of application of molecular biology.

MODULE 1 **10Hrs**

Molecular basis of life: Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Structure and function of DNA and RNA: Structure of DNA. Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA. Recombination: Transformation, Conjugation and Transduction; Holliday model of recombination. Extra nuclear Genomes: Mitochondria and chloroplasts.

MODULE 2 **11Hrs**

MODULE 4. DNA Replication: Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. Causes of DNA damages, mechanisms of repair– photo-reactivation, excision repair, mismatch repair, SOS repair.

MODULE 3 **10Hrs**

Transcription in Prokaryotes and Eukaryotes: RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA.

MODULE 4 **10Hrs**

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes. Post translational modification of Proteins.

MODULE 5 **11Hrs**

Regulation of Gene Expression: Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons Regulation of Gene expression in Eukaryotes – galactose metabolism in yeast. Role of cis and trans elements in regulation of gene expression. Mobile Genetic Elements: Insertional elements, transposons in Bacteria, Maize and Drosophila.

REFERENCE BOOKS

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER/YEAR : **IV SEM / II YEAR**
COURSE CODE : **16BT272**
TITLE OF THE COURSE : **TECHNIQUES IN MOLECULAR BIOLOGY**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES: 1. To skill students for isolation and quantitation of DNA and proteins from different sources.

COURSE OUTCOMES: 1. Student will be able to isolate and analyze DNA from different sources using appropriate buffers and partially purify proteins using common protocols.

1. Estimation of DNA and RNA by UV-Vis Spectroscopy/Colorimetric method.
2. Partial purification of protein from plant source by Ammonium sulphate precipitation and its estimation.
3. Partial purification of protein from animal source by organic solvent (acetone) and its estimation.
4. Isolation of genomic DNA from plant source and its analysis using agarose gel electrophoresis.
5. Isolation of genomics DNA from animal/bacterial source and its analysis using agarose gel electrophoresis.
6. Column Chromatography (Demo)
7. Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC202
TITLE OF THE COURSE : PHYSIOLOGY OF LIVING SYSTEMS.
L: T/A: P: C : 3: 1: 0: 4

MODULE 1 **11Hrs**

Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods, Nitrogen balance, BUN, NPN, Calorific value of foods, bomb calorimeter.
Respiratory quotient, BMR, SDA and factors affecting them. Role of protein, lipid and carbohydrates as fuel molecules, Protein sparing effect of carbohydrates. Dietary fiber. Essential fatty acids and their biological importance**.** Food fortification & food supplementation, Minerals and vitamins.
Skeletal system: Tissues- introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodelling and regulation by hormones.

MODULE 2 **11Hrs**

Hematology and respiration: Blood components and their functions, blood groups: the ABO system, rhesus system, blood clotting factors, intrinsic and extrinsic pathways for blood clotting. Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxy hemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.
Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

MODULE 3 **10Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Structure and function of liver and Gall bladder, LFT.
Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

MODULE 4 **10Hrs**

Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and non-myelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and

adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

MODULE 5 **10Hrs**

Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

REFERENCES BOOKS

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC272
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVE: 1. To provide an advanced understanding and applied knowledge of the clinical biochemistry.

COURSE OUTCOME: 1. Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.

1. Qualitative analysis of normal and abnormal components of urine – ketone, sugar, urea, uric acid, Creatinine, protein.
2. Protein/DNA by UV absorption.
3. Protein by Folin - Ciocalteu method,
4. Iron by Ossian's method
5. Phosphate by Fiske – Subbarow's method
6. Creatinine by Jaffe's method
7. Glucose estimation by Miller's method
8. Calcium estimation by Alizarin S

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN202
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Basic study of the chemical and genetic organization of the human genetic material.
2. Basic mutations and modifications of the genetic materials

COURSE OUTCOMES:
1. Learn the composition and backbone of the genetic material (DNA).
2. Understand different ways of genetic alterations and its consequences- benefits and drawbacks. This course will instigate higher thought process in the field of genetics manipulations.

MODULE 1 CHEMICAL BASIS OF HEREDITY 11Hrs

DNA as genetic material, Experiments of Griffith, Avery, MacLeod, McCarty and Hershey - Chase. RNA as genetic material- Experiment of Fraenkel and Singer. Nucleic acids: DNA structure and types (A, B and Z model), RNA types and structure. DNA Replication: DNA Replication in prokaryotes and rolling circle model, DNA Replication in eukaryotes

MODULE 2 GENE EXPRESSION 11Hrs

Genetic code - Brief account, central dogma. Transcription - Initiation, elongation, termination (rho dependent and rho independent termination). Post Transcriptional modifications. Translation - Initiation, elongation and termination in prokaryotes and eukaryotes. Regulation of gene expression: Inducible operon - galactose, Repressible operon - tryptophan

MODULE 3 GENOME ORGANISATION AND FINE STRUCTURE OF GENE 10Hrs

Prokaryotic genome - Chromosomal and plasmid, Eukaryotic genome - Chromosomal and organellar, Fine structure of the Gene - cistron, muton and recon. Organelle genomes - Chloroplast and Mitochondria

MODULE 4 Bacterial Genetics AND TRANSPOSABLE ELEMENTS: 10Hrs

Conjugation - F factor mediated, Hfr and Sexduction. Transformation. Transduction - Generalized and specialized. Bacteriophage genetics. Types and classification, Transposable elements in Maize and *Drosophila.*

MODULE 5 MUTATIONS 10Hrs

Introduction and types of gene mutations - Base substitution, Frame shift mutation (insertion, deletion, missense, nonsense mutation). Mutagens - physical and chemical. Reverse mutation in bacteria. DNA repair mechanism (Mismatch repair photo reactivation, excision and SOS repair). Beneficial and harmful effects of mutations.

TEXT BOOKS

1. Watson J. D., Hopkins N. H., Roberts J. W., Steitz J. A. and Weiner A.M. 1987. Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company, Menlo Park, CA.
2. Alberts B., Johnson. A., Lewis J., Roff M., Roberts K. and Walter P. 2002. Molecular Biology of the Cell IV Edition. Garland Science, New York.

REFERENCE BOOKS

1. Gestel and Cech R. T. and Atkins J. 1999.The RNA World. II Edition. Cold Spring Harbor, New York.
2. Twyman R. M. 1998. Advanced Molecular Biology. Viva Books Ltd.
   Turner P. C. 2002. Instant Notes in Molecular Biology. Viva Books.
3. Hames D. and Hooper N. M. 2002. Instant Notes in Biochemistry. II Edition. Viva Books.
4. Brown T.A. 2002.Genomes. Viva Books.
5. Darnell J., Lodish H. and Baltimore D. 1990. Molecular cell Biology. II Edition. Scientific American Books, New York.
6. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
7. Watson J. D. 1992. Recombinant DNA Technology. W. H. Freeman Publisher.
   Bharadwaj D.N. 2008. Molecular Genetics. Kalyani Publisher.
8. Daniel L. Hartl and Jones W. 2011. Genetics: Analysis of Gens and genomes. VII Edition. Jones and Bartlett Publishers.
9. Hartwell L., Hood L. and Goldberg M. L. 2008. Genetics: from genes to genomics. McGraw-Hill publications.
10. De Robertis, E. D. P. and De Robertis E. M. F. 2001. Cell Biology and Molecular Biology. VIII Edition. Lippincott Williams & Wilkins Publishers.
11. Rastogi S. C., Mendiratta N. and Rastogi P. 2008. Bioinformatics: Methods and applications. III Edition. PHI Learning Publishers.
12. Chiranjib C. 2004. Bioinformatics: Approaches and applications. Biotech Books Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN272
TITLE OF THE COURSE : MOLECULAR GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction and usage of the different instruments in a basic molecular genetics lab.
2. Different methods of isolation and study of the genetic material (DNA).

COURSE OUTCOMES:

1. Students will appreciate the methods of DNA isolation and its manipulations and its potential applications.
2. Student will also be able to make connections with the different techniques and its usage in identifying and understanding genetic diseases.

1) Instrumentation:
   Centrifuge
   Ultra centrifuge
   pH meter
   Electrophoretic MODULE
   Spectrophotometer/colorimeter
2) Extraction of DNA from:
   Plants (Cauliflower/Coconut endosperm/any)
   Animal tissue (Liver Tissue/any)
3) Paper Chromatography for Separation of:
   Leaf pigments
   Drosophila eye pigments
   Amino acids
4) Electrophoresis
   Agarose gel electrophoresis
5) Mutations:
   Study of examples of mutations: Sickle cell Anaemia Missense mutation and Thalassemia frame shift mutation.
   Induction of Mutation in *Drosophila* and detection of sex linked lethal by Muller 5 stock

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB202
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.
2. To adapt molecular and biotechnological techniques to research and industry for the welfare of mankind.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.
2. Describe the applications of molecular biology in areas such as transgenic plants and animals, vaccines and therapeutic agents.

MODULE 1: INTRODUCTION TO NUCLEIC ACIDS AND REPLICATION 11Hrs

Structure of bases – A, T, G, C and U. Definition of nucleosides and nucleotides,Watson and Crick model of DNA, Types of DNA (A, B and Z), Types of RNA and their functions. Modes of replication- Conservative, Semi conservative (Messelson and Stahl experiment) and Dispersive. Methods of DNA replication (Rolling circle and Linear), and mechanism of Prokaryotic DNA replication.

MODULE 2: GENE EXPRESSION AND REGULATION 11Hrs

Central dogma, Transcription- mechanism, post transcriptional modification. Translation - mechanisms, post translational modification in prokaryotes. The operon concept, induction, repression catabolic repression and attenuation. The lac operon and trp operon.

MODULE 3: RECOMBINANT DNA TECHNOLOGY 10Hrs

History and fundamentals of r-DNA technology, Tools for r-DNA technology

Enzymes: DNA manipulative enzymes, Restriction enzymes, Ligases and other DNA modifying enzymes

Gene cloning vectors: Salient features, Plasmids- properties, types pBR322, bacteriophages- λ and M 13, Cosmids-properties, Bacterial Artificial Chromosomes (BAC's),Yeast Artificial Chromosomes (YAC's), *Agrobacterium tumifaciens*, SV 40.

MODULE 4: TOOLS IN rDNA TECHNOLOGY 10Hrs

Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). Cutting of DNA molecules. Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters.

Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment.

MODULE 5: SCREENING, SELECTION AND APPLICATIONS 10Hrs

Insertional inactivation, in situ colony/DNA hybridization, Polymerase chain reaction, blotting techniques and immunological techniques. Applications of Genetic Engineering: a) Medicine: Gene therapy b) Agriculture: nif gene cloning

Potential hazards and safe guards of genetic engineering.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis – an Introduction. Sixth edition. Wiley Blackwell.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Cooper, G.M. 2013. The Cell – A Molecular Approach. 6th edition. Sinauer Associates.
5. Karp, G. 2008. Cell and Molecular Biology. 5th edition. McGraw Hill Book Company, New York.
6. Nelson, D.L. and Cox, M.M. 2007. Lehninger's Principles of Biochemistry. Fourth edition. Macmillan Press/Worth Publishers. New Delhi.
7. Palmer, T. and Bonner, P.L. 2007. Biochemistry, Biotechnology and Clinical Chemistry. Second edition. Wood head Publishing co.
8. Prescott, L.M. Harley, J.P. and Klein, D.A. 2011. Microbiology. Eight edition. WCB – McGrawHill, New York.
9. Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene manipulation and Genomics. Seventh edition. Blackwell Publishing.
10. Singh, B.D. 2008. Biotechnology – Expanding Horizons. Kalyani Publishers.
11. Watson, J. D. Recombinant DNA, Scientific American Books, New York.
12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levne, M., and Losick, R. 2004. Molecular Biology of the Gene. Fifth Edition. Pearson Education.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB272
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.

1. Determination of λmax for the given biomolecule (Protein/DNA/ Sugar)
2. Isolation of Genomic DNA from bacteria
3. Isolation of plasmid DNA from bacteria
4. Analysis of genomic DNA by Agarose gel electrophoresis
5. Estimation of DNA by DPA method
6. Estimation of RNA by orcinol method
7. Demonstration of the following models/ photographs/charts of DNA, t-RNA, Replication, Trancription, Translation, Transformation, conjugation and transduction. DNA repair mechanisms.
8. Demonstration of instruments – PCR, Southern Blotting assembly
9. Charts on genetic engineering- pBR 322, pUC 18 and 19, SV 40, Bacteriophages- Lambda, Gene cloning, Selection of recombinants by replica plate technique.
10. Kit based experiments
    - Restriction digestion
    - Ligation
    - Transformation

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16CH202
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 4
L: T/A: P: C : 3 : 1: 0: 4

COURSE OBJECTIVES: 1.To introduce the basic concepts of phase rule, colloidal solutions, nuclear, radio chemistry and different aspects of solid state chemistry like different crystal systems etc.,
2. The basic concepts of organic chemistry like carboxylic acids, amines and heterocyclic compounds will be introduced to the students.

COURSE OUTCOMES: 1. The student will be well versed with one component, two component systems in phase rule MODULE .Similarly, the differtypes of colloidal solutions and ther behaviors and applications will be known by students after learning this MODULE.

2. The students will be familiar with different types of organic acids, their acidic strengths, reactivity orders, reactions and their preparations. Similarly, with heterocyclic compounds and amines.

MODULE 1 **11Hrs**

Phase Equilibria, Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method).
Colloids: The Colloidal State, preparation and purification of colloids and their characteristic properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

MODULE 2 **11Hrs**
Solid state, Crystalline state, Laws of crystallography. Symmetry elements in cubic systems, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation. Problems Liquid crystals-Types (Smectic, Nematic and Cholestric) with examples. Applications. Superconducting solids-High temperature superconductors. Applications.

Water Technology
Types of impurities present in water. Causes for the hardness of water. Permissible levels of ions present in water. Treatment of water for domestic and Industrial purposes by the following

methods. i) Demineralization of water by Ion exchange method. ii) by reverse Osmosis method. Removal of fluorides in water.

MODULE 3 **11Hrs**

STEEL

Chemical composition of Steel. Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of Steel. Ferro alloys: Production of ferro chrome, ferro manganese, and ferro silicon and their applications. Carbon steel: classification. Heat treatment: hardening, case hardening, carbiding, nitriding, tempering and annealing.

Nuclear and Radiochemistry.

Instability of nucleus, binding energy its calculations. Radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ-radiation,α,n,p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes- use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

MODULE 4 **11Hrs**

CARBOXYLIC ACIDS AND THEIR DERIVATIVES

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidity of carboxylic acids Acidic strength (pKa values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (Comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids; benzoic and p-nitrobenzoicacid; benzoic acid and p-aminobenzoic acid).Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Nucleophilic substitution at the carboxylic carbon-General mechanism. Relative reactivity of acid derivatives. Decarboxylation and reduction (using LiAlH4).Acid derivatives: Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates). Acid anhydrides (hydrolysis, reaction with alcohol, ammonia).Esters (alkaline hydrolysis, ammonolysis and alcoholysis).Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalyzed.

Amines

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimde synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quarternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 10, 20and 30amines. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (Conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (phydroxyazobenzene and 1-phenylazo-2-naphthol).

MODULE 5 08**Hrs**

HETEROCYCLIC COMPOUNDS

Introduction, classification - monocyclic and bicyclic, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Comparison of basicity of pyrrole, pyridine and piperidine.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16 CH272
TITLE OF THE COURSE : Inorganic Chemistry (Practical)
L: T/A: P: C : 0 : 0 : 4 : 2

COURSE OBJECTIVES:

1. In practical classes, the students will be give hands on training on semi- micro qualitative analyses of mixture of two simple inorganic salts.
2. In practical classes, the students will be given hands on training on paper chromatographic technique. Using this technique, the sudents will be separating the metal cations. They will also calculate the Rf values of different species present in the mixture.

COURSE OUTCOMES:

1. After the practical classes, the students are well familiarized in semi-micro-qualitative analysis of mixture of two inorganic salts.
2. After the practical classes, the students are well familiarized with paper chromatographic technique for separation of analyses in mixtures.
3. The students can measure and calculate the different parameters of the effluents during effluent analysis.
4. The students can become experts of solvent extraction techniques.

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixture of salts with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+}) using paper chromatography and calculation of Rf values.
3. Separation of Mg (II) and Fe (II) by solvent extraction technique.
4. Effluent analysis.
5. Separation of Phosphate / Borate ions.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16EP292
TITLE OF THE COURSE : ENTREPRENEURSHIP

L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT HRS: 26 HRS

MODULE 1: THE NATURE AND IMPORTANCE OF ENTREPRENEURS 5h

Nature and Development of Entrepreneurship, Definition of Entrepreneur Today, Entrepreneurial Decision Process, Role of Entrepreneurship in Economic Development, Intrapreneurship, Entrepreneurship, Entrepreneurial Careers and Education, The Future of Entrepreneurship Module.

MODULE 2: THE ENTREPRENEURIAL AND INTRAPRENEURIAL MIND 6h

The Entrepreneurial Process, Identify and Evaluate the OpportMODULEy, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise, Managerial versus Entrepreneurial Decision Making, Causes for Interest in Intrapreneurship, Corporate versus Intrapreneurial Culture, - Climate for Intrapreneurship, Intrapreneurial. Leadership Characteristics, Establishing in the Organization, factors affecting entrepreneurship — qualities of successful entrepreneurship.

MODULE 3: SMALL & MEDIUM ENTERPRISES (SME) 5h

Role of SME, concept and definitions of SME, government policy and SME in India, growth and performance of SME sector, problems for SMEs, Sickness in SME, criteria to identity sickness, causes, symptoms and remedial measures of sickness, institutional support for SMEs.

MODULE 4: STARTING THE BUSINESS - BUSINESS IDEA & INNOVATION 5h

Business idea, OpportMODULEy Recognition , Product Planning and Development Process, Establishing Evaluation Criteria, Idea Stage, Concept Stage Product Stage, Test Marketing Stage, Creativity, Innovation and entrepreneurship, barriers to creativity, techniques for improving the creative process, corporate entrepreneurship, causes, climate, intrapreneurial leadership characteristics, Establishing intrapreneurship in the organization.

MODULE 5: LEGAL ISSUES FOR THE ENTREPRENEUR 5h

Various forms of organization, Legal Issues in Setting up the Organization, The various statutory registrations and clearances required.

REFERENCES:

1. M. Lall, Entrepreneurship, Excel books
2. Vasant Desai:- Dynamics of Entrepreneurial Development and Management. HPH
3. Hisrich, Robert D., Peters, Michael P., and Shephered, dean a: entrepreneurship, Tata McGraw hill; sixth edition, 2007
4. Mathew J Manimala:- Entrepreneurship at the Crossroads - Biztantra
5. Mohanty – Fundamentals of Entrepreneurship, Prentice Hall of India
6. Zimmerer & Scarborough – Essentials of Entrepreneurship & Small BusinessManagement, Prentice Hall of India

SEMESTER V

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT301
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGY AND BASICS OF ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To equip the students with cells and organs of immune system and immunological techniques.
2. To provide basic understanding on animal cell culture and applications of animal biotechnology in modern research.

COURSE OUTCOMES:
1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge on animal biotechnology and its application.

MODULE 1 **09Hrs**

Elements of Immune System: History and scope of Immunology, Innate and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Interleukins and Interferons – brief introduction and their important functions. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE 2 **09Hrs**

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting antigenicity, antigen processing and presentation, antigen processing cells (APCs); Major Histocompatibility Complex (MHC) – MHC I and II, Antibodies – structure, types and functions of Immunoglobulins

MODULE 3 **09Hrs**

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence.
Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

MODULE 4 **09Hrs**

Animal Cell Culture: Introduction, history and scope of Animal Biotechnology, Facilities inAnimal Cell Culture, Media – natural and chemically defined, importance of serum in the media.Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK)

MODULE 5 **09Hrs**

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep)

REFERENCE BOOKS

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
3. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. Health
4. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
5. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
6. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
7. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
8. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT371
TITLE OF THE COURSE : IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To acquaint the student with the important techniques in immunology and animal biotechnology.

COURSE OUTCOMES: 1. Student will be well equipped with immunological techniques utilized for diagnostic assays.
2. Students will be skilled to set up primary cell culture and perform cell count and cell viability assay.

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Preparation of media for animal cell culture
7. Isolation of liver parenchyma cells by mechanical method and set up primary culture
8. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
9. Isolation of cells by explant method and Sub-culturing
10. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT321
TITLE OF THE COURSE : ENVIRONMENTAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To impart basic knowledge in environmental science, environmental issues and the management.
2. To familiarize the significant techniques in biotechnology that contribute to environment protection.

COURSE OUTCOMES:
1. Student will be well acquainted with the role of various environmental pollutants, and environment monitoring techniques.
2. Students will be familiarized with the waste water treatment, bioremediation and bioleaching.

MODULE 1 **10Hrs**

Sources of Energy: Renewable and non-renewable sources of energy, Conventional fuels and their environmental impact, Modern fuels and their environmental impact, methanogenic bacteria, microbial hydrogen production, biogas production, conversion of sugar to alcohol, gasohol, biofuels.

MODULE 2 **10Hrs**

Waste management: Treatment of municipal solid waste and industrial effluents, preliminary treatment, primary treatment – sedimentation, secondary treatment – aerated lagoons, activated sludge, batch reactor, trickling filter, rotating biological contractor, packed bed process, pond treatment system – aerobic, anaerobic and facultative, tertiary treatment – solid, nitrogen, phosphorus removal and disinfection.

MODULE 3 **09Hrs**

Bioremediation: Bioremediation techniques – *in situ* and *ex situ*, bioremediation of soil and water contaminated with oil spills, heavy metals and detergents, Phytoremediation, degradation of pesticides and toxic chemicals by microorganisms - aromatic and chlorinated hydrocarbons, petroleum products, genetically modified organisms in bioremediation

MODULE 4 **07Hrs**

Bioleaching: Microbes used in leaching, mechanism, leaching process, some case studies related to bioleaching.

MODULE 5 **09Hrs**

Environment monitoring: Bioindicators (Terrestrial & Aquatic), Biosensors of pollution
Novel methods for environment protection: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products.

REFERENCE BOOKS

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
2. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
3. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
4. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT322
TITLE OF THE COURSE : INDUSTRIAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
2. To familiarize students with downstream processing and production of important microbial products.

COURSE OUTCOMES: 1. Student will be aware of fermentation process, types of fermentation media and strategies for isolation of industrially important strains.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.

MODULE 1 **09Hrs**

Screening and Selection of strains: Introduction, basics of fermentation technology, Isolation and screening of microorganisms, maintenance of strains, strain improvement – mutant selection, recombinant DNA method

MODULE 2 **10Hrs**

Fermentation Media, Fermentors and Fermentation: Fermentation media – natural and synthetic, media sterilization, Types of Fermentors – Basic design, Airlift, tower and bubble cap fermentor; Immobilized cells and enzyme fermentor; Types of Fermentation -Solid state, submerged, Batch, Fed-batch and Continuous.

MODULE 3 **08Hrs**

Downstream Processing: Solid-liquid separation (Filtration, flocculation, centrifugation, sedimentation),

MODULE 4 **08hrs**

Downstream processing for release of intracellular products – physical, enzymatic, chemical, concentration and purification of products.

MODULE 5 **10Hrs**

Production of Microbial Products: Production of wine, beer, citric acid, penicillin, glutamic acid, Vitamin B12, Amylase, insulin, fermented foods (Yoghurt, cheese), Single Cell Protein (SCP)

REFERENCE BOOKS

1. Glazer and Nikaido (1995), Microbial Biotechnology, WH Freeman and Co.
2. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
3. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
4. Nduka Okafor (2007) Modern Industrial Microbiology and Biotechnology, CRC Press

5. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
6. LEJR Casida (2007) Industrial Microbiology, New Age International Publishers
7. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC301
TITLE OF THE COURSE : ENZYME TECHNOLOGY AND PROTEIN CHEMISTRY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Learning about enzyme properties along with enzyme and inhibition kinetics.
2. Knowledge of enzyme assay and drawing enzyme assisted reaction plots.
3. Brief idea about the various coenzymes.
4. Introduction to Protein structure understanding with various examples.
5. Studying analytical techniques to characterize proteins including brief introduction to proteomics.

COURSE OUTCOMES:
1. They will have a working knowledge of the active site of the enzyme and how it helps in reactions.
2. Students will be equipped with adequate knowledge on drawing various plots to understand the nature of enzyme and inhibitor.
3. Students will know the classification and function of various proteins along with their structural hierarchy.
4. They will also be able to analyze results obtained after protein characterization.

DEPARTMENTAL ELECTIVE 1:

MODULE 1 **9 Hrs**

INTRODUCTION: Classification & nomenclature of enzymes, Active site: Lock & key, induced fit model and strain/TS theory- lysozyme and chymotrypsin as examples, Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientationeffect, Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogenphosphorylase) enzymes, MODULEs-Katal & IU. Effect of physical and chemical parameters on enzyme activity with examples.

MODULE 2 **9 Hrs**

ENZYME KINETICS: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km. Bisubstrate reactions – brief introduction.

ENZYME ASSAY AND PURIFICATION: Enzyme assay, Specific activity. Enzyme isolation and purification, criteria for enzyme purity. Isoenzymes and clinical applications, Biotechnological applications, enzyme biosensors.

MODULE 3 **9 Hrs**

VITAMINS AND COENZYMES

Structure and reaction mechanisms of vitamins – fat-soluble: A, D, E & K; water-soluble: Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, cobalamine and ascorbic acid.

MODULE 4 **9 Hrs**

PROTEINS

Classification based on composition, shape and function, assay techniques. Peptide bond, Ramachandran Plot, Structural organization: primary, secondary, tertiary and quaternary structures, Hemoglobin, Immunoglobulin, Collagen, myosin and Keratin structures. Denaturation and melting temperature, Hofmeister series. Protein synthesis.

MODULE 5 **9 Hrs**

INTRODUCTORY PROTEOMICS: Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography. Sequence determination by Sanger and Edman methods. Mass spectroscopy of proteins: mass determination, Hydropathy plot, Protein Expression, Vectors and hosts, downstream processing.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC371
TITLE OF THE COURSE : ENZYMOLOGY AND RECOMBINANT PROTEIN PURIFICATION
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To introduce students to various practical aspects of enzymology;and give them hands on learning in function and kinetics of enzymeand their role as catalyst and regulator of cell metabolism.
2. Serve as foundation for more advanced enzymology courses.
3. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation, expression and purification of recombinant protein

1. Isolation of enzymes from biological source and activity determination
2. Determination of kinetic constants through LB plot.
3. Effect of temperature and Arrhenius constant.
4. Effect of enzyme dilution
5. Effect of substrate concentration
6. Effect of pH
7. Effect of activator
8. Effect of inhibitor
9. Immobilization of enzyme using calcium alginate.
10. Preparation of competent cells and transformation
11. Protein purification by Ni- NTA Affinity chromatogram
12. SDS-PAGE of purified protein
13. Protein concentration determination from spectrophotometry
14. Purification of protease from plant by ammonium sulphate fractionation
15. Protease assay through FC method

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC321
TITLE OF THE COURSE : CHEMISTRY AND METABOLISM OF CARBOHYDRATES AND PROTEINS
L: T/A: P: C : 3: 0: 0: 3

DEPARTMENTAL ELECTIVE 2:

COURSE OBJECTIVES: Learning structure and reactions of carbohydrates used in metabolism by living systems. Learning about the physiological reactions undertaken by living systems to breakdown the carbohydrates and release of energy. To have a brief idea about amino acid metabolism with examples. To learn about the metabolic roles performed by small peptides.

COURSE OUTCOMES: Once the course is over, students will be able to draw structure of mono, di and polysaccharides. They will have an overall idea about the role carbohydrates play in energy storage and usage. Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems. They will understand the role of urea cycle and the various functionalities that peptides play in metabolism.

MODULE 1 **9 Hrs**

CARBOHYDRATE CHEMISTRY
Biological importance and classification. Fischer structure, D-L designation. Glucosestructural elucidation and conformation. Ring and open-chain structure of fructose, galactose, mannose and arabinose. Epimers and anomers, pyranose and furanose ring. Reactions: Benedict's, oxidation, osazone, ester, amino and deoxy sugar formation. Derived monosaccharide: structure and biological importance of amino sugars and sugar phosphates. Oligosaccharides: glycoside linkage, structure and biological importance of sucrose, maltose, lactose, isomaltose, cellobiose and trehalose.
Polysaccharides: starch, glycogen, cellulose, inulin, chitin and pectin. Mucoploysaccharide: glycosaminoglycans, cell wall components: peptidogycan and teichioc acid.

MODULE 2 **9 Hrs**

CARBOHYDRATE METABOLISM
Glycolysis, entry of other carbohydrates into glycolysis, the fate of pyruvate, the citric acid cycle, the energetics of glucose metabolism. Enzymatic control of glycolysis and TCA cycle. The amphipathic role of the citric acid cycle. Outline of pentose phosphate pathway and its significance.

MODULE 3 **9 Hrs**

The Cori cycle, Gluconeogenesis and glycogen metabolism. Substrate level phosphorylation, regulation of blood sugar level. Diabetes mellitus. Determination of glucose in body fluids; fasting, post-prandial, GTT. Glycogen storage disorders.

MODULE 4 **9 Hrs**

AMINO ACIDS

Protein and non-protein amino acids, structure and classification of α-amino acids, acidsbase, chemical and optical properties. Synthesis and degradation of selected amino acids (tyrosine, methionine, glutamine), transamination, deamination, Urea cycle.

MODULE 5 **9 Hrs**

PEPTIDES AND PROTEINS

Biologically important peptides- leptin, ghrelin, neuropeptides, substance P, enkephalin, angiotensin, defensin, vasopressin and oxytocin. Chemical synthesis of peptides.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC322
TITLE OF THE COURSE : NUTRITION AND BIOMEMBRANES
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.Introduction to nutrition, food components and micronutrients.

2. Idea about biological membrane and the transport systems that allow material movement through the membrane.

COURSE OUTCOMES: 1. Students will have an idea about the nutritional quality of food stuff and know about a balanced diet.
2. They will be aware of the various processes that can be made to increase nutritional quality of food.
3. Students will know the ultra-structure of membranes and have detailed knowledge about the role of each component.
4. They will be able to interpret the various movements through the membrane and the types associated with them.
5. They will have an idea about how proteins are sent to various parts of a cell.

MODULE 1 **9 Hrs**

INTRODUCTION TO NUTRITION: Food as source of nutrients, functions of food, definition of nutrition, nutrients & energy, adequate, optimum & good nutrition, malnutrition. Nutrition - fitness, athletics & sports.

MODULE 2 **9 Hrs**

FOOD COMPONENTS AND AVAILABILITY: Basic five food groups How to use food guide (according to R.D.A.) Interrelationship between nutrition & health. Sources, function, storage and deficiency of carbohydrates, fats, oils, fiber and proteins. Water - as a nutrient, function, sources, requirement, water balance & effect of deficiency.

MODULE 3 **9 Hrs**

MICRONUTRIENTS: Minerals - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium Vitamins (water & fat soluble) - definition, classification & functions. Functional food, food fortification, food additives, role of FDA.

BIOLOGICAL MEMBRANES: Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, composition and trans bilayer asymmetry, Isolation of membrane components, effect of lipid size and saturation on membrane fluidity, role of cholesterol, lipid rafts, non-bilayer lipids and their role in membrane, Liposomes; properties and application in membrane biochemistry

MODULE 4 **9 Hrs**

TRANSPORT ACROSS MEMBRANE: Passive – ion channels, ionophore and porins; Facilitated diffusion: aquaporin, gated ion channels – sodium and potassium ion channels in muscle, calcium ion channel in heart; Active transport – P, V and F-type ATPase – structure, function and location, ATPbinding cassatte transporters and multi drug resistance transporters, patch-clamp study.

MODULE 5 **9 Hrs**

PROTEIN TRAFFICKING: Protein sorting; Membrane enclosed organelles of eukaryotic cells, evolutionary origin Protein trafficking: Sorting signals. Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Intracellular vesicular trafficking, Vesicles: types, Clathrin coated- Assembly and disassembly.

REFERENCE BOOKS

1. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
2. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell , The McGraw-Hill .
3. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science .
4. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier .
5. Molecular Biology of the Cell, Alberts et al., Garland Publications .
6. Molecular Biology of the Cell; 6 th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science .
7. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co.
8. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley
9. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell .
10. Textbook of medical Biochemistry Chatterjee and Shinde, JP Medical Ltd, 8th edition.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN301
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Understand the usage of other sources for DNA manipulation
2. Diverse methods to visualise modified genetic materials.

COURSE OUTCOMES:
1. Students will appreciate the different techniques of manipulating the genetic material and further validating it.
2. Student will understand how experiments need to be carried out carefully and with well planning. This will teach the concept of "attention to details"

MODULE 1- INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING 9Hrs

Introduction to Genetic Engineering: Overview of major steps involved. Tools for Genetic Engineering: Enzymes and Vectors. Enzymes: Restriction endonucleases: Types and characteristic features; Nomenclature; Modification of cut ends. DNA ligases. Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

MODULE 2- VECTORS 9Hrs

Properties of an ideal vector. Types: Cloning and expression vectors Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages - Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.* For higher plants: Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV). For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes

MODULE 3- GENE ISOLATION AND TRANSFER 9Hrs

Isolation of the desired gene: cDNA library, Genomic library, Organo-chemical synthesis, Amplification through PCR. Direct gene transfer methods: Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method). Selection and screening of recombinants: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutritio Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.

MODULE 4- GENETIC ENGINEERING TECHNIQUES 9Hrs

Technique for Genetic Engineering: Gel electrophoresis: AGE and SDS-PAGE Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes.

MODULE 5- APPLICATIONS **9Hrs**

Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS

1. Sandhya M. Genetic engineering: Principles and practice, MacMillan India Ltd. 2008.
2. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.

REFERENCE BOOKS

1. Nicholl D. S. T. An introduction to Genetic engineering (2nd ED), Cambridge University Press, 200
2. Satyanarayana U. Biotechnology, Books and Allied (P) Ltd., Kolkata, 2008.
3. Purohit S. S. Biotechnology Fundamentals and applications, student Edition, Jodhpur, 2003.
4. Channarayappa. Molecular Biotechnology- Principles and practices, University press (India) Private Limited, 2006.
5. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. Genetics from Genes to Genomes. McGraw Hill. 2004.
6. Lewin B. Genes VIII. Oxford University Press. Oxford, 2003.
7. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India. 2004.
8. Brown T. A. Genomes 3. Garland Science Publishing, New York. 2007.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN371
TITLE OF THE COURSE : GENETIC ENGINEERING PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to instruments and isolation methods of the genetic materials.
2. Further study of quantification and manipulating of the genetic material with extra-chromosomal genetic material from other sources.

COURSE OUTCOMES:

1. Students will understand how genetic material from different sources can work together in genetic engineering.
2. Student with competitive approach can use this Multidisciplinary approach to think innovative concepts.

1. **INSTRUMENTATION:**
   - UV Transilluminator
   - PCR
2. **VECTORS:**

- pBR 322 and Cosmid,
- YAC,
- Ti plasmid - Binary vector,
- SV 40 (any one type)

3. **TRANSGENIC ORGANISMS:**
   - Plants-Bt cotton and Animals-Knock out Mouse

4. **EXPERIMENTS:**
   - Quantification of DNA by DPA method
   - Quantification of RNA by Orcinol method
   - Agarose Gel Electrophoresis of DNA
   -
5. **DEMONSTRATIONS:**
   - Isolation of Plasmid DNA
   - Restriction Enzyme digestion
   - Ligation of DNA fragment
   - Transformation- α complementation

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN321
TITLE OF THE COURSE : BASIC HUMAN GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of inheritance pattern and immunogenetics.
2. Highlight the applications of genetics in different aspects of life.

COURSE OUTCOMES:
1. Students will understand the application of genetic outside the lab.
2. Understand how early life genetic studies can help future generations.

MODULE 1 HUMAN CHROMOSOMES, INHERITANCE AND GENETIC DISEASES 9Hrs

Human Chromosomes: Normal Human Karotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes), FACS - Fluorescence activated cell sorter. Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.

MODULE 2 GENETIC DISEASES AND INHERITANCE PATTERN 9Hrs

Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis). Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria). X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD). X-linked Dominant Inheritance (Ex- Xg blood group). Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF). Multi-factorial inheritance (Ex.-Congenital malformations-Cleft lip and palate, Rheumatoid arthritis and Diabetes). Mitochondrial diseases (Ex.- Leber's heriditary optic neuropathy).

MODULE 3 IMMUNOGENETICS AND ONCOGENETICS 9Hrs

Immunology and Immunogenetics: Introduction to immunology, Cells of immune system, Genetics of immune system, Immune response, Innate and acquired immunity. Inherited immunodeficiency (Ex. X- linked agammaglobulinaemia). Major Histocompatibilty. Complex-Study of twins (MHC), HLA disease associations. Transplantation, graft-versus-host disease. Oncogenetics: Properties of malignant cells, Types of genes - Proto oncogenes, Oncogenes, Cellular oncogenes, Tumor Suppressor genes, Chromosomal abnormalities associated with specific malignancies - Acute Promyelocytic Leukemia (APL), Chronic Myeloid Leukemia (CML) and Retinoblastoma.

MODULE 4 DERMATOGLYPHICS, DIAGNOSIS AND THERAPY 9Hrs

Dermatoglyphics: Introduction and classification, Flexion creases. Dermatoglyphics in clinical disorders. Clinical applications, advantages and limitations. **Diagnosis:** Prenatal diagnosis: Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography. Invasive

methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Technology in reproductive assistance

MODULE 5 THERAPY AND ETHICS **9Hrs**

Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes. Gene therapy, Stem cells - Definition, types and sources. A brief account on Cord blood banking and Stem cell therapy. Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

TEXT BOOKS

1. Bhatnagar etal S.M. Essentials of Human Genetics. IV edition. Orient Longman. 1999.
2. Goldsby R. A., Kindt T. J. and Osborne B. A. Kuby Immunology. W. H. Freeman and Company, N. Y. 2000.

REFERENCE BOOKS

1. Lewis R. Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
2. Manage E. J. and Manage A.P. Basic Human Genetics. Rastogi Publications, Meerut. 1997
3. Gangane S.D. Human Genetics (2nd edition), B.L Churchill Livingstone Pvt. Ltd., New Delhi. 2001.
4. Mc. Kusick V.A. Mendelian inheritance in Man. 12 Edition, John Hopsins University Press. 1998
5. Cummings, M. R. Human Heredity: Principles and Issues. West Publishing Company. 1994.
6. Epstein, R. J. Human Molecular Biology. Cambridge Univ. Press, Cambridge. 2003.
7. Khoury, M. J., J. Little and W. Burke. Human Genome Epidemiology. Oxford Univ. Press,Oxford. 2004.
8. Motulsky, V. Human Genetics. Springer & Verlag, Berlin. 1977.
9. Strachan, T. and A. P. Reads, Human Molecular Genetics 3. Garland Science, London. 2004.
10. Abbas, A. K., A. H. Lichtman and J. S. Pober. Cellular and molecular immunology. W. B. Saunders Company. 1994.
11. Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter. Molecular Biology of the cell. V Ed. Garland Science, New York. 2008.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN322
TITLE OF THE COURSE : PLANT GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of plant genetics and gene regulation in plants.
2. Highlight the applications of plant genetics.

COURSE OUTCOMES:
1. Students will understand gene regulation and stress response pattern in plants.
2. Understand applications plant genetics study.

MODULE- 1: GENE REGULATION IN PLANTS 9Hrs

Over view of plants as genetic model systems, gene regulation in plants. Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf.

MODULE-2: GENE REGULATION DURING SRESS 9Hrs

Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes. Mechanism of self-incompatibility in plants.

MODULE- 3: APPLIED GENETICS OF PLANTS 9Hrs

Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction. Genetic basis of Crown Gall disease development. Agrobacterium- Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants.

MODULE- 4: PROTOPLAST TECHNOLOGY 9Hrs

Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application.

MODULE –5 BIOFERTILIZER 9Hr

Biofertilizer: Production and beneficial roles of Rhizobium, Innoculants and Azatobacter inoculants, field application of Rhizobium, Azatobacter blue green algae, mycorizal fungi and Azolla.

TEXT BOOKS

1. Altman A. and Hasegawa, P.M. Plant biotechnology and Agriculture – Prospects for the 21st Century, Elsevier Science Publishers, Amsterdam. 2011.
2. Chawla H.S. Plant Biotechnology, Oxford and IBH publishing Co. Pvt Ltd., New Delhi. 2003.

REFERENCE BOOKS

1. Brahma Mishra, Fertilizer Technology and Management, I.K. International Publishing House Ltd., New Delhi. 2009.
2. Genes and Agriculture, Jones and Bartlett Publishers, Boston. 1994.
3. Dickinson M. Molecular Plant Pathology. BIOS Scientific, Oxford, UK. 2003.
4. Purohit, S.S. Agricultural Biotechnology, Agribios, Jodhpur. 2006.
5. Rangaswami, G. and Bagyaraj. D.J. Agricultural Microbiology (2nd Ed.), PHI Learning, India. 1998.
6. Satyanarayana, U. Biotechnology, Books and Allied (P) Ltd., Kolkata. 2010.
7. Srivastava, P.S. Alka Narula, Sheela Srivastava. Plant Biotechnology and Molecular Markers, Anamaya Publishers, New Delhi. 2004
8. Griffiths A. J. F., Miller J. H., et al. An introduction to genetic analysis. W. H. Freeman, N. Y. 2000.
9. Ringo J. Fundamental Genetics. Cambridge Univ. Press, Cambridge. 2004.
10. Cullis C. A. Plant Genomics and Proteomics. Wiley-VCH. 2001.
11. Hughes M. A. Plant molecular genetics. Addison Wesley Longman Ltd. U.K. 1996.
12. Grierson D. and Covey, S. N. Plant molecular biology. Blackie Academic & Professional. London. 1998.
13. Murphy T. M. and Thompson W. F. Molecular plant development. Prentice Hall, New Jersey. 1988.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB301
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To observe importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
2. Explains geochemically and environmentally significant processes that the activities of microorganisms and the environmental factors controlling and limiting microbial activities

COURSE OUTCOMES: 1. Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.
2. To make use of how microorganisms may be utilised in agricultural biotechnology, including specific techniques such as cloning and expression of genes.

PART A: AGRICULTURAL MICROBIOLOGY

MODULE 1: BIOFERTILIZERS AND BIOLOGICAL CONTROL 9Hrs

Definition, types, characterization, mass cultivation of *Rhizobium*, *Azotobacter*, *Azospirillum*, and *Azolla* .Mode of application of biofertlizers, advantages and limitations.. ISI standards. Mechanisms of biological control, field applications of *Bacillus thuringiensis*, *Trichoderma* spp. and Nuclear Polyhedrosis Virus. Advantages and limitations.

MODULE 2: PLANT PATHOLOGY-I 9Hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases. Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies].

MODULE 3: PLANT PATHOLOGY-II 9 Hrs

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism). Genetic engineering methods Study of different plant diseases- Bacteria –

Blight of rice, Fungi – Rust of sorghum, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE 4: AEROBIOLOGY AND SOIL MICROBIOLOGY 9Hrs

Microbiology of indoor and outdoor environment, Significance of microorganisms in air, aerosols, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Hirst Trap, Liquid Impingers and Filteration. Control of Air borne microorganisms – Dust control, Filteration, Fumigation, UV light exposure.
Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism).General account of bioleaching, biodegradation and bioremediation

MODULE 5: AQUATIC AND WASTE WATER MICROBIOLOGY 9Hrs

Introduction, Natural waters (Atmospheric, Surface and Ground water), Zonation of water system, Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients), general account on water borne diseases and their management. Water Pollution: Sources, Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection.

Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

REFERENCE BOOKS

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.

7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB371
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To understand the fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems.

COURSE OUTCOMES: 1. To enable us to know how microorganisms may be utilised in agricultural microbiology.

1. Isolation and enumeration of bacteria, fungi and actinomycetes from rhizosphere soil
2. Examination of bacteriodes from legume root nodules
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
4. Demonstration of fungal contaminants in ground nut by standard blotter method
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Study of plant pathogens (specimens/charts)- Bacteria (Citrus canker, bacterial blight of rice), Fungi (Tikka Disease of ground nuts, red rot of sugarcane, rust of sorghum), virus (tobacco mosaic virus), mycoplasma (sandal spike)
7. Study of antagonism between soil microorganisms
8. Isolation of air borne microorganism by petriplate exposure method
9. Estimation of dissolved oxygen in water
10. Determination of Biological Oxygen Demand
11. Standard water quality analysis by MPN test
12. Estimation of total solids in sewage
13. Field visit to agriculture fields and sewage treatment plant

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB321
TITLE OF THE COURSE : FOOD MICROBIOLOGY (DEPARTMENTAL ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To exhibit depth and breadth of knowledge by demonstrating biological sciences, in the field of food microbiology
2. To related to food microbiology has interdisciplinary connections with other sciences, in particular food science.

COURSE OUTCOMES: 1. It will develop depth of understanding of the microbiology of food, food-borne diseases, food spoilage, fermentation of food and modern microbial analysis techniques relating to food.

2. It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current food analysis techniques.

MODULE 1: FOOD AS A SUBSTRATE AND FOOD BORNE DISEASES 9Hrs

Intrinsic and extrinsic factors in food affecting microorganisms; natural flora and source of contamination of foods in general. Food hazards, significance of food borne diseases, types – food infection (*E.coli*, Salmonellosis, Shigellosis), food intoxication: Bacterial (*Clostridium botulinum*, *Staphylococcus spp.*) and fungal (aflatoxins), Virus (Polio), Helminths (Tape worms), Protozoa (*Entamoeba*histolytica).

MODULE 2: PRINCIPLES AND METHODS OF FOOD PRESERVATION 9Hrs

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, nitrite and nitrates, antibiotics and bacteriocin.

MODULE 3: MICROBIAL SPOILAGE OF FOOD 9Hrs

Introduction, Different ways of food spoilage. Spoilage of Cereals, Vegetables, Fruits, Meat, fish, eggs and canned foods

MODULE 4: FERMENTED FOODS 9Hrs

Introduction, nutritional and therapeutic importance .Fermented Vegetables, Meat, Beverages, Bread, Idli, Single cell Protein (Yeast, Algae) and Mushrooms. General account on Probiotics and Prebiotics.

MODULE 5: MICROBIAL EXAMINATION OF FOOD AND QUALITY CONTROL 9Hrs

DMC, Viable colony count, dye reduction tests, MPN, immunological and molecular methods. Sampling schemes, Microbiological criteria, Control at source, Codes for Good Manufacturing practice, HACCP concept.

REFERENCE BOOKS

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van NostrandRheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB322
TITLE OF THE COURSE : DAIRY MICROBIOLOGY (ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide in-depth knowledge in various MODULE operations and basic concepts in dairy processing.
2. To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products

COURSE OUTCOMES: 1. Enables students about additional knowledge on microbiological analysis on organisms relevant for dairy products.
2. Knowledge of the most important spoilage and pathogens in dairy products has also been obtained.

MODULE 1: MICROBIOLOGY AND FERMENTATION IN MILK 9hrs

Physical and chemical properties of milk. Types of microorganisms in milk (bacteria, fungi and yeast). Source of microbial contamination of milk- Milk producing animal, Milking environment, utensils, equipment, water, personnel and packing material. Souring, lactic acid fermentation, colour and flavour fermentation, gassy fermentation, proteolysis and lipolysis.

MODULE 2: MILK BORNE INFECTIONS 9hrs

Introduction, Tuberculosis, Brucellosis, Listeriosis, Anthrax, Q fever, Cow pox, Foot and Mouth diseases.Preventive and Control Measures.

MODULE 3: MILK AND MILK PRODUCTS 9hrs

Dairy starter cultures, Fermented Dairy products – curd, lassi, yogurt, flavoured milk, cheese, condensed milks, acidophilus milk, kefir and milk powders.

MODULE 4: MICROBIOLOGICAL ANALYSIS OF MILK 9hrs

Rapid platform tests- organoleptic, clot on boiling, lactometer, titratable acidity, alcohol test, DMC, sedimentation tests and pH.Standard plate count, reductase test- MBRT, Resazurin test, Methylene blue test.

MODULE 5: MILK PROCESSING 9hrs

Collection, transport of Milk, Cold Storage,Pasteurization, sterilization, dehydration**,** and preservation of milk quality, Indian standards of grading milk. General account on milk adulteration: effects and detection.

REFERENCE BOOKS

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
3. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
4. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw- Hill Publishing Company Limited, New Delhi.
5. Varnam A.H and Evans M.G Food borne Pathogens, Wolfe Publishing House, London.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH 301
TITLE OF THE COURSE : PHYSICAL CHEMISTRY AND CHEMINFORMATICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.The basic principles and concepts of electrochemistry, ionic equilibria, photochemistry and chemoinformatics will be taught to the students.

2. In electrochemistry, the terms like equivalent and molar conductivities, their determinations, transport numbers and determinations, Nernst equations, numerical, pH measurements will be tought.

3. The basic concepts of chemoinformatics and its application in drug designing will be thought.

COURSE OUTCOMES:

1.The students will be well versed with the basic principles, terms and equations and methods to determine conductivities and pH measurements of the solutions.

2. The students will be familiar with buffer solutions, significance, preparations and significance.

3. The students will be familiar with the basic principles, terms ,laws, and equations regarding the photochemistry.

4. The students will be well versed with terms, concepts, and terminalagies used in chemoinformatics and their applications in drug analysis.

MODULE 1 9**Hrs**

Electrochemistry I: Review of electrolytes and Conductance and related terms Methods of determination of molar conductance. Conductometric titrations (only acid-basetype). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.Kohlausch's law and its applications: (i) evaluation of $\Lambda\infty$ and $\Lambda+$ $\Lambda-$ (ii) evaluation of degreeof dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv)determination of solubility from conductance of saturated solutions of sparingly soluble salts
(AgCl and $BaSO_4$). Problems based on the above concepts.Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel- Onsagar equatation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

MODULE 2 9**Hrs**

Electrochemistry II : Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of Eo of Zn/Zn2+ and Cu/Cu2+ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

MODULE 3 10**Hrs**

Ionic Equilibria : Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems based on the above concepts.Common-ion effect, buffers, buffer action buffer range and buffer capacity. pH of buffers.Henderson's equation and its derivation and applications. Applications of buffer in analyticalchemistry and biochemical processes in human body. Solubility product and ionic product inprecipitation and in qualitative analysis. Theories of indicators; selection of indicators and their limitations.

Photochemistry

Laws of photochemistry. Grotthus-Drpare law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemicaland thermal relations. Quantum yield of photochemical combinations of (i) H2 and Cl2 (ii) H2and Br2 (iii) dissociation of HI (iv) dimerization of anthracene.Photosensitization,photostationary equilibrium. Singlet and triplet states based on Jabloski diagram.Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensiors. Beer-Lambert's law and its limitataions. Numerical problems on absorption coefficient and molar extinction coefficient.

MODULE 4 9**Hrs**

Cheminformatics I: Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation. Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification. Database Concepts, Structured Query Language, Design of Chemical Databases, Data.Abstraction; Data Models (Elementary ideas only)

MODULE 5 8**Hrs**

Cheminformatics II: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
2. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. Oprea, T. I. Chemoinformatics in drug discovery. John Wiley & Sons: New York, NY, 2005
5. Andrew Leach, An Introduction to Chemoinformatics Johann Gasteiger (Editor), Thomas Engel (Editor) Chemoinformatics: A Textbook Wiley Publications.

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16CH371**
TITLE OF THE COURSE : **PHYSICAL CHEMISTRY & CHEMINFORMATICS**
L: T/A: P: C : **0 : 0 :4 : 2**

COURSE OBJECTIVES:

1.The experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The physical experiment like determination of % NaCl by missibility temperature method will be tought to students.

3.Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

COURSE OUTCOMES:

1.The students will be well versed with experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The students will be well versed with experiments determination of % NaCl by missibility temperature method will be tought to students.

3.The students will be well versed with Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

PRACTICALS

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a =b).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pKa of a weak acid by pH metric method.
10. Determination of percentage of sodium chloride by miscibility temperature method.
11. Introduction to chemistry related softwares such as ISIS Draw, Chemdraw, Origin etc.
12. Chemistry related Database such as Pubchem, Chemspider etc.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1 . Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH321
TITLE OF THE COURSE : INDUSTRIAL CHEMISTRY (ELECTIVE PAPER I)
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:
1. Introducing the basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. Introducing the raw materials, and properties of raw materials, in the synthesis of important industrial materials to students.
3. Introducing the basic concepts and principles of polymer chemistry to students.
4. Introducing the basic concepts and principles of nano materials, their synthesis, and Applications.

COURSE OUTCOMES:
1. The students will be well versed with basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. The students will be well versed with the raw materials, and properties of raw materials, in the synthesis of important industrial materials.
3. The students will be well versed with the basic concepts and principles of polymer chemistry to students.
4. The students will be well versed with the basic concepts and principles of nano materials, their synthesis, and Applications.

MODULE 1 11**Hrs**

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of paracetamol.

Industrial Materials II

Refractories: Properties, classification, determination of PCE values.

Abrasives – definition and classification with examples, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituent's of varnishes.

MODULE 2 09**Hrs**

Industrial Materials III: Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal-Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coalgas and composition of LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac,ranitidine, sulphanilamide and chloramphenicol.

Zeolites: Introduction, types of zeolites, manufacture of synthetic zeolites and applications.

Metal Organic Frameworks: Introduction, synthesis and important applications.

Dendrimers: Introduction, Synthesis (convergent, divergent and click chemistry) and important applications.

MODULE 3 **11Hrs**

Polymers : Fundamentals of polymers: Monomers, repeat MODULEs, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation,addition, free radical, ionic, co-ordination polymerization and ring opening polymerization,Types of polymerisation methods (Bulk, Solution, Suspension and Emulsion).Molecular weight and size. Polydispersion. Average molecular weight concepts– number,weight and viscosity average molecular weight. Numerical problems. Determination of molecular weights - viscosity method, osmotic pressure method.

Preparation and applications of the following types of polymers

1. Plastics:

i) thermosetting plastics(Phenol-formaldehyde)

ii) thermo softening plastics(PVC)

2. Fibers: Acrylic, polyamide, polyester types: one example for each

3. Rubber: Neoprene,

4. Fluoro Carbons: Teflon

5. Silicones: Polydimethysiloxane (PDMS)

6. Conducting Polymers: Polyaniline

MODULE 4 **10Hrs**

Super conductors and Fullerenes: Introduction, definition, type 1, type 2 and atypical. Preparation of high temperature super conductor-Y1Ba2Cu3Ox±δ, BCS theory (qualitative treatment only) and general applications of high temperature super conductors. Introduction to Fullerenes, definition, preparation and isolation of C60. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C60. Commercial uses of C60. Carbon nanotubes: definition, single wall and multi wall carbon nanotubes, applications.

MODULE 5 **04 HRS**

Nanomaterials: Introduction, definition and electronic properties. Different methods of production: top down and bottom up approach with examples. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles (silver oxide with gold composites).Important applications of nanomaterials.

Inorganic and organic nanoporous aerogels. Heat capacity of solids: Einstein and Debye equations.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. B.K Sharma ,Industrial Chemistry,Goyal Publication
2. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
3. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt.
4. Ltd. New Delhi, 2009
5. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005)
6. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
7. V. R. Gowariker, Polymer Science, Wiley Eastern(Chapters 1,2,9)

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH322
TITLE OF THE COURSE : PHARMACEUTICAL CHEMISTRY ELECTIVE -II
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Students are introduced to historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be thought to the students.
3. The students will be introduced to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be introduced to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

COURSE OUTCOMES : 1. Students will be well versed with historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be familiar to students after this course.
3. The students will be familiar to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be familiar to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

MODULE 1 **11Hrs**

Introduction Historical development of pharmaceutical chemistry, Codes of pharmaceutical ethics. Important aspects of pharmaceutical chemistry. 4 Hrs

Common diseases Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases.

Terminology Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti-metabolites. Absorption of drugs - routes of administration of drugs, factors affecting absorption.

MODULE 2 **10Hrs**

Assay of drugs Chemical, biological, immunological assays, LD50 and ED50 therapeutic index, drug dosage. 4 Hrs MODULE V: Designation of drugs Designation of drugs based on physiological action; Definition and two examples with structure each of: Anesthetics-General and local. Analgesics - Narcotic and synthetic.

MODULE 3 **10 Hrs**

Antipyretics and anti-inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins. Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents. Health promotingmedicines I Nutracenticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids.

MODULE 4 **10 Hrs**

Health promoting medicines II Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) –

MODULE 5 **4 Hrs**

Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases.

TEXT BOOKS

1. An Introduction to Medicinal Chemistry, Graham L Patrick, Oxford University press, 2017, ISBN-9780198749691.
2. The Organic Chemistry of Drug Design and Drug Action, Richard B Silverman,2014, Acadaemic press, ISBN-13:9780123820303.

REFERENCE BOOKS

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.
2. Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, 1995, New Delhi.
3. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.
4. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI Publishers.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16IP391
TITLE OF THE COURSE : BIOSAFETY, BIOETHICS, AND IPR
L: T/A: P: C : 2: 0: 0: 0

Total Credit– 26Hrs

MODULE 1: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8 Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6 Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol-status of implementation in India.

MODULE 3: BIOETHICS 4 Hrs

What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.

MODULE 4: INTELLECTUAL PROPERTY RIGHTS 3 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications-Biodiversity and farmer rights.

MODULE 5: PATENTS AND PATENT LAWS 5 Hrs

Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCE BOOKS

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (1998)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local CommMODULEies [Paperback],Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montegomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International

SEMESTER -VI

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT302
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To acquaint the student with the significant component of biotechnology -Recombinant DNA technology.

2. To impart knowledge on important tools, techniques, protocols for genetic engineering.

COURSE OUTCOMES:

1. Student will be well equipped with the scientific understanding of the fundamental requirement of recombinant DNA technology

2. Student will gain optimum knowledge of application of recombinant DNA techniques in today's Life science Research.

MODULE- 1 **09Hrs**

Tools for Genetic Engineering: Introduction to Recombinant DNA technology, DNA manipulative and Modifying enzymes – Restriction enzymes, DNA ligases, Alkaline phosphatases, polynucleotide kinase, exonuclease, DNase I, DNA polymerase and Klenow fragment, RNA dependent DNA polymerase, terminal nucleotide transferase.

MODULE- 2 **09Hrs**

Vectors – Basic features, Cloning vectors -Prokaryotic (pBR322, pUC18, Lambda phage, m13, cosmids), Eukaryotic vectors (YAC, shuttle vectors, Ti plasmid, Binary vectors, SV40, Retroviral and Vaccinia viral vectors) Expression vectors in Prokaryotes and Eukaryotes – Basic features, role of promoters. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion

MODULE- 3 **09Hrs**

Techniques in Recombinant DNA technology**:** Hybridization – Southern, Northern, Western, DNA Sequencing (Sanger's di-deoxy method), Basics of New Generation Sequencing, PCR, Real Time PCR, Construction of genomic library, cDNA library.

MODULE- 4 **09Hrs**

Selection and Screening of Recombinants: Identification and selection of transformed cells, Direct methods – insertional inactivation, blue-white selection, plaque formation, complementation of mutation, Indirect methods – colony hybridization, immunochemical detection, Use of selectable marker genes in eukaryotes for expression, Expression of cloned genes

MODULE- 5 **09Hrs**

Microarray, Yeast two hybrid system, *In vitro* Mutagenesis. Applications of r-DNA technology: Production of Insulin, Recombinant Vaccines, hGH, Role in gene therapy, GM crops, Ethics and Biosafety involved.

REFERENCE BOOKS

1. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
2. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
3. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication.
5. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT303
TITLE OF THE COURSE : PLANT BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide an overview of plant biotechnology with focus on plant tissue culture and their application in modern biology.
2. To equip the student with the fundamental understanding of different processes involved in plant biotechnology

COURSE OUTCOMES: 1. Student will gain fundamental knowledge in different techniques used in plant biotechnology.
2. Student will be familiar with transgenic plants and significant applications of plant biotechnology.

MODULE- 1 **10Hrs**

Introduction to Plant Tissue Culture: Initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin's, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications

MODULE- 2 **08Hrs**

Tissue and Organ Culture: Organ culture – anther, embryo, endosperm culture and applications, Ovary and Ovule culture Organogenesis and embryogenesis – technique and applications

MODULE- 3 **12Hrs**

Protoplast culture – isolation, mechanical, enzymatic, culture of protoplast and plant regeneration. Somatic Hybridization and Variations: Somatic hybridization, method of protoplast fusion – chemical and electro fusion, application, cybrids; Somaclonal Variants – production and screening methods of somaclonal variants and their significance.

MODULE- 4 **08Hrs**

Transgenics and Applications of Plant Biotechnology: Transgenic plants – technique of transformation (*Agarobacterium* mediated, physical and chemical methods of gene transfer), application of transgenic plants

MODULE- 5 **07Hrs**

Edible vaccines – vaccine production in plants, Hepatitis B vaccine. Role of Plant tissue culture in agriculture, horticulture and forestry. *In vitro* production of secondary metabolites.

REFERENCE BOOKS

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford

Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR **: VI SEM / III YEAR**
COURSE CODE **: 16BT372**
TITLE OF THE COURSE **: GENETIC ENGINEERING AND PLANT TISSUE CULTURE**
L: T/A: P: C **: 0: 0: 6: 3**

COURSE OBJECTIVES: 1. To skill students for basic techniques required to establish plant tissue culture
2. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. Student should be able to prepare and sterilize culture media and establish callus growth.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation.

1. Preparation of competent cells
2. Transformation of Plasmid DNA in competent cells and screening of transformants
3. Isolation of plasmid DNA and analysis using gel electrophoresis
4. Restriction digestion and ligation
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus
10. Production of synthetic seeds.

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC302**
TITLE OF THE COURSE : **BIOENERGETICS AND MOLECULAR PHYSIOLOGY**
L: T/A: P: C : **3: 0: 0: 3**
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Course Objective:

1. Production of energy through movement of electron rich substrates.
2. Learning about biological oxidation and production of ATP. 3. Introduction to hormones and their functionality.
4. Brief idea about cell cycle and programmed cell death

Course Outcome:

1. Once they complete the course, students will have an idea about the energy production processes that occur in a cell.

2. The ultimate goal of this course would be integrate the knowledge obtained in 5^{th} semester (through Enzymology and Carbohydrate metabolism) with the current semester courses (Lipid metabolism) to have an integrated holistic idea about how life functions through reactions.

3. They will also be aware of the various hormones that are synthesized by living systems that regulate metabolism. Students will be able to link this information with whatever has been learnt in the previous semester.

MODULE- 1 **9 Hrs**

BIOENERGETICS
Bioenergetics, Energy transformation in living systems and concept of free energy; Exergonic and endergonic reaction, ATP and other high energy compounds, energy coupling. Biological oxidation, standard reduction potentials of same biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions.

MODULE- 2 **9 Hrs**

BIOLOGICAL OXIDATION: Mitochondrial electron transport chain-components, reactions and structures, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation – ATPase structure (rotor-stator model) and function, Chemiosmotic theory, Regulation of ETC, thermogenin, Isolation of ETC components.

MODULE- 3 **9 Hrs**

ENDOCRINOLOGY: Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms. Signal transduction - G-protein as cellular transducer, adenylate cyclase

system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade. Functions of pancreatic, adrenal, pituitary and GIT hormones. Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.

MODULE- 4 **9 Hrs**

MOLECULAR BIOLOGY: Central dogma, prokaryotic and eukaryotic genomes, complexity of genomes, Enzymes and proteins related to prokaryotic replication and transcription.

MODULE- 5 **9 Hrs**

CELL CYCLE AND APOPTOSIS: Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Apoptosis: Caspases, structure, function and activation. Factors initiating apoptosis and steps leading to cell death. Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC303**
TITLE OF THE COURSE : **CHEMISTRY AND METABOLISM OF LIPIDS AND NUCLEIC ACIDS**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVE:

1. Introduction to structure and classification of lipids.
2. Learning about the various reactions in which lipids are broken down by living systems to generate energy.
3. Learning about nucleic acid structures and properties along with synthesis and breakdown.

COURSE OUTCOME:

1. Students will have an idea about the various lipid molecules and how they behave in contact with water.
2. They will be aware of the importance of lipid in energy storage.
3. Students will able to comprehend the synthesis and breakdown of RNA/DNA and the enzymes that assist in the process.

MODULE- 1 **9 Hrs**

LIPID CHEMISTRY

Classification of lipids. Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids. Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid. DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids).

MODULE- 2 **9 Hrs**

ARACHIDONIC ACID DERIVATIVES: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3. Lipoproteins & GPI-linked proteins: Types and functions. Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model. Steroids - Function of hopnoids, cholesterol, androgen and estrogens. Lipid peroxidation and its role as a stressmarker.

MODULE- 3 **9 Hrs**

LIPID METABOLISM: The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation, Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

MODULE- 4 **9 Hrs**

NUCLEIC ACIDS: Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides. DNA: Biological role, structure, polymorphism, denaturation, renaturation and Tm. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins. RNA: Types, secondary structure and biological role of various RNA

MODULE- 5 **9 Hrs**

NUCLEIC ACID METABOLISM: Metabolism of purine and pyrimidine nucleotides. Hyperuricemia & other inborn errors.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BC372
TITLE OF THE COURSE : ESTIMATION OF BIOMOLECULES
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVE: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

[1] Qualitative analysis of
a. carbohydrates,
b. amino acids,
c. proteins,
d. lipids and
e. Preparation of solid derivatives of monosaccharides – osazone crystal.
[2] Estimation of amino acids by formal titration.
[3] Estimation of ascorbic acid from biological samples by titrimetric method.
[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN302
TITLE OF THE COURSE : APPLIED GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To get a glimpse of the role of genetics application
2. Understand and integrate biology and computation

COURSE OUTCOMES:
1. Industrial and agricultural application of genetics
2. Development of key skill such as bioinformatics**.**

MODULE - 1 GENETIC RESOURCES AND BIODIVERSITY 9Hrs

Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centers of Diversity, Vavilovian Centers of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.

MODULE - 2 INTRODUCTION TO PLANT TISSUE CULTURE 9Hrs

Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.

MODULE - 3 HETEROSIS IN ANIMALS AND PLANTS 9Hrs

Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis-Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques-intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.

MODULE - 4 GENETICS IN MEDICINE & INDUSTRY 9Hrs

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying.

MODULE – 5 BIOINFORMATICS 9Hrs

Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.

TEXT BOOKS

1. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
2. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.

REFERENCE BOOKS

1. Singh B. D. Biotechnology. Kalyani Publication. 2002.
2. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
3. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
4. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
5. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
6. Phundan Singh , Elements of Plant Breeding. 2nd Edition. Kalyani Pulications. 2001
7. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.
8. Brown, T. A. Genetics: A Molecular Approach (2nd Ed.), Garland Science, New York. 2002.
9. Baxevanis and Bff Oluellette. Bioinformatics : A practical guide to the analysis of genes and proteins, Ad Wiley Interscince – new York. 2001.
10. Stephen Misener and Stephan A. Krawetz. Bioinformatics: Methods and protocol. Humana press, New Jersey. 2000
11. Des Higgins and Willie Tylore. Bioinformatics: sequence, structure and databanks, Oxford University press. 2000.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN303
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Basic knowledge on genome organization, mapping and the impact of the human genome project.
2. Understand the protein structure and analysis

COURSE OUTCOMES:
1. Students will understand the diversity of the genome organization and its implication
2. Students will learn how to apply the information to study at protein levels using various techniques.

MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION 9Hrs

Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: *Arabidopsis*, rice, yeast, *Drosophila*, *C. elegans* and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.

MODULE 2 GENOME MAPPING TECHNIQUES 9Hrs

Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.

MODULE 3 HUMAN GENOME PROJECT AND COMPARATIVE GENOMICS 9Hrs

History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes. Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.

MODULE 4 PROTEIN PROPERTIES AND STRUCTURE ANALYSIS 9Hrs

Classification of proteins, Backbone flexibility- Φ and ψ. Properties of amino acids - Hydrophobicity, Molecular weight, α and β propensities etc. Inter-atomic forces and protein structure, covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, charge/dipole interaction, Van der Waals forces, steric interaction. Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modeling.

MODULE 5 PROTEIN PROFILING 9Hrs

Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.

TEXT BOOKS

1. T.A. Brown, Genomes, Bios, 2002.
2. Liebler, Introduction to Proteomics, Humana, 2002.

REFERENCE BOOKS

1. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
2. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
3. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
4. Hawley and Mori, The Human Genome, Academic, 1999.
5. Lewis, Human Genetics, WCB, 1999.
6. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
7. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
8. Strachan and Read, Human Molecular Genetics, Wiley, 1999.
9. Sudbery, Human Molecular Genetics, Prentice Hall, 2002.
10. The Drosophila Genome. Science Vol. 267. 2000.
11. The Caenorhabditiselegans genome Science. Vol. 282. 1998.
12. The Arabidopsis Genome. Nature vol. 408. 2000

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16GN372**
TITLE OF THE COURSE : **APPLIED GENETICS, GENOMICS AND PROTEOMICS PRACTICALS**
L: T/A: P: C : **0: 0: 6: 3**

COURSE OBJECTIVES:
1. To understand the tissue culture techniques for genetic manipulation of plants/crops.
2. Use different genomic and proteomic approaches to genetics.

COURSE OUTCOMES:
1. Broaden horizon on the potential applications of plant and animal genome and proteome.
2. Hands on skills on the usage of bioinformatics tools to study genomic and proteomic data.

APPLIED GENETICS

1. Tissue culture techniques:

- Sterilization
- Explants preparation
- Media Composition and preparation
- Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
- Synthetic seed preparation

2.Study of different techniques in plant hybridization

3. Study of pollen fertility

4. Study of diagnostic kits - WIDAL & VDRL

5. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.

6. Study of hybrid animals - Poultry, dairy, fishery.

7. Homology sequence analysis using Blast and Fasta.

GENOMICS AND PROTEOMICS:

1) Physical mapping by Restriction mapping of plasmid DNA
2) Genetic mapping by RFLP analysis
3) RAPD analysis
4) DNA fingerprinting analysis: Parentage detection
5) Homogenization, fractionation and separation of enzymes/ proteins in plants and animals by SDS- PAGE method
6) Protein database study SCOP, DALIDD, CATH

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB302
TITLE OF THE COURSE : IMMUNOLOGY AND MEDICAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

PART A: IMMUNOLOGY

MODULE 1: ELEMENTS OF IMMUNE SYSTEM 9Hrs

History and scope of immunology, Definition and types of immMODULEy (innate and adaptive).Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT . Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immMODULEy, tolerance. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

MODULE 2: ANTIGENS AND ANTIBODIES 9Hrs

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types,Haptens, Super antigens, Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic), clonal selection theory of antibody production; Production and application of Monoclonal antibodies

MODULE 3: IMMUNOLOGICAL DISORDERS, ONCOLOGY AND TECHNIQUES 9Hrs

Definition, Hypersensitivity reactions (Definition and types), auto immune disorders, immunodeficiencies, graft vs host diseases.Brief concept of cancer immunology. Principles and applications of Precipitation, Agglutination, Complement fixation, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry andImmunoelectron microscopy.

PART B: MEDICAL MICROBIOLOGY

MODULE 4: INTRODUCTION TO MEDICAL MICROBIOLOGY 9Hrs

Normal flora of skin, oral cavity and other body regions.Relationship between normal microbiota and host. Pathogenecity, Virulence,Invasion,Toxins: Exotoxins, Enterotoxins and Endotoxins.Evasion.

MODULE 5: PATHOGENICITY AND ANTIMICROBIAL CHEMOTHERAPY 9Hrs

Epidemiology, etiology, pathogenesis and prophylaxis of the following: **Bacteria**–*Salmonella typhi*, *Staphylococcus aureus, Clostridium tetani, Mycobacterium tuberculosis, Treponemapallidum, Corynebacteriumdiphtheriae, Chlamydiae.* **Fungi–***Tricophytonspp.* and *Candida albicans.* **Viruses –**Hepatitis, Rabies, HIV and Ebola. **Prion diseases. Protozoa** – *Plasmodium vivax* and *Entamoebahistolytica*

Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration).Immunoprophylaxis- Vaccines and immunization schedule.

REFERENCE BOOKS

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB303
TITLE OF THE COURSE : MICROBIAL FERMENTATION
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2.To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

MODULE 1: INDUSTRIAL MICROBIOLOGY 9Hrs

Introduction to fermentation technology, history and development of fermentation technology. Isolation, Screening (Primary and Secondary), Enrichment, Preservation (storage at low temperature (liquid nitrogen), storage in soil, silica, mineral oil, Lyophilization) and Strain improvement of industrially important microorganisms. Culture collection centres

MODULE 2: FERMENTERS 9Hrs

Design, Construction and Components of a typical fermenter, types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

MODULE 3: FERMENTATION PROCESS 9Hrs

Introduction, Batch, continuous, surface, submerged and solid state fermentation. Control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

MODULE 4: DOWNSTREAM PROCESSES 9Hrs

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying, purification and concentration of products by chromatographic techniques.

MODULE 5: FERMENTATION PRODUCTS AND ECONOMICS 9Hrs

Industrial production of organic acids (Citric acid), Amino acid (glutamic acid), Alcohol (wine), Vitamin (vit B12), Antibiotics (penicillin), Enzymes (Amylase), Vaccines (Hepatitis B) and

hormones (human insulin). Market potential, fermentation and product recovery costs. General concepts and importance of IPR.

REFERENCE BOOKS

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
5. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
6. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
7. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
8. HolgerPalzelt, Thomas Brenner (2008) Handbook of Bioentrepreneurship. Springer Sciences.
9. Pandey A, Soccol RC and Larroche C (2008) Current Developments in Solid state Fermentation, Springer.
10. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
11. Santaniello V, Evenson RE, ZibermanDand Carlson GA (2003) Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issues in Biotechnology. Universities Press.
12. Carlos M, Correa (2010) Research Handbook on the protection of Intellectual Property Under WTO Rules. Intellectual Property in the WTO Volume I and II Edward Elgar Publishing.
13. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB372
TITLE OF THE COURSE : IMMUNOLOGY, MEDICAL MICROBIOLOGY AND MICROBIAL FERMENTATION
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVES: 1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.

1. Isolation of normal microflora from skin and oral cavity
2. Snyders test for dental caries detection
3. Blood grouping and Rh typing
4. Dot ELISA
5. Precipitation reactions: Ouchtlerlony Double Diffusion, Radial Immune Diffusion, Rocket Immuno electrophoresis
6. Antibiotic sensitivity test
7. Determination of effectiveness of antiseptics by thumb impression method
8. Identification of different types of blood cells
9. Production and determination of amylase activity
10. Preparation of wine
11. Study of different types of fermenters (Models/ Charts)
12. Cell immobilization techniques (yeast cells)
13. Sterility assays of pharamaceutical products

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH302
TITLE OF THE COURSE : INORGANIC & ANALYTICAL CHEMISTRY
L: T/A: P: C : 3: 0:0: 3

COURSE OBJECTIVES: 1.The students will be introduced to the concepts of coordination and organometallic chemistry.
2. The students will be introduced to the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be introduced to the basic concepts and principles of various chromatographic and electroanalytical techniques.

COURSE OUTCOMES: 1. The students will be well versed with the concepts of coordination and organometallic chemistry.
2. The students will be well versed with the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be well versed with the basic concepts and principles of various chromatographic and electroanalytical techniques.

MODULE 1 **11Hrs**

Co-ordination and Organometallic compounds

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra,penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclatureof coordination compounds. Theories of structure and bonding (Explanation for the formationof complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bondtheory-postulates, low spin and high spin complexes with examples (cobalt and nickel based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of [CoF6]3-, [Fe(CN)6]4Spectral properties of [Ti(H2O)6]3+, [Co(H2O)6]3+Isomerism-Structural: ionization, linkage, hydrate andcoordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.

Organometallic compounds

Ligands, classification (hapticity). Synthesis and structure of K[PtCl3(η2-C2H4)] Metal carbonyls – Cr(CO)6, Mn2(CO)10; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na2Ca,EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation.

MODULE 2 **10Hrs**

Chemical Spectroscopy I

The interaction of electromagnetic radiation radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular absorption spectra: Born-Oppenheimer approximation.

Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy.Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO2 and H2O molecules.

Raman spectroscopy

Concept of polarisability. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.

Spectroscopy II

UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and redshift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free andH-bonded), alkyl –C-H, C=C, C=C C=O, C-X and C-O groups (by taking suitable examples).

NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spinquantum number I, influence of the magnetic field on the spin of nuclei, spin population,saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclearshielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons.Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMRspectroscopy including identification of simple organic molecules.

MODULE 3 10**Hrs**

Chromatography

Principles of chromatography: Distribution coefficients, types of chromatography, selection of stationary and mobile phases in TLC, analyte development and elution. Chromatographic performance parameters-Retention time and volume, capacity factor, plate height and resolution.

Thin layer chromatography: Principle, apparatus-preparation of plates, sample application, plate development, detection of analytes. Applications.

Gas-liquid chromatography: Principle. Instrumentation, columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, and detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography**:** Principle and applications.

MODULE 4 10**Hrs**

Electroanalytical Methods

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME.Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential.Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

MODULE 5 04 **Hrs**

Analytical chemistry

Analytical chemistry- scope of analytical chemistry. Errors and treatment of analytical data: Limitations of analytical methods-Error-determinate and indeterminate errors, minimization

of errors. Accuracy and precision. Distribution of random errors, the normal error curve. Statistical treatment of finite samples-measures of central tendency and variability-mean, median, range, standard deviation and variance. Student's t-test.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
5. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH303
TITLE OF THE COURSE : BASICS IN BIOCHEMISTRY
L: T/A: P: C : 3 :0:0 : 3

COURSE OBJECTIVES:
1. The students will be introduced to various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be introduced to various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students will be introduced to bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be introduced to concepts of protein metabolism.

COURSE OUTCOMES:
1. The students will be well versed with various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be well versed with various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students well versed with bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be well versed concepts of protein metabolism.

MODULE 1 11Hrs

Carbohydrates: Structure and biological importance of derivatives of monosaccharides. Amino sugars: ß-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramicacid (NAMA); N-acetylneuraminic acid (NANA) Sugar acids–structure and biological importance of D-gluconic acid, D-glucuronic acid and D glucaricacid. Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P,Fructose-1,6-di-P, ß-D-ribose-5-P and ß-D-deoxyribose-5-P. Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose. Polysaccharides -source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

Lipids: Introduction, Classification. Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides-acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides. Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Cholesterol – definition,

types (HDL, LDL and VLDL) Sphingolipids–structure and biological significance of ceramide.

MODULE 2 **6Hrs**

Proteins α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non- essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Levels of organizations of Protein: Primary structure, Secondary structure (a-helix, triple helix eg., Collagen and ß-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure. Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with, ribonuclease. Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

MODULE 3 **11Hrs**

Nucleic Acids: Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide. Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs. Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Hormones: Definition. Classification -a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis. Mediators of hormone action – Ca2+, cyclic AMP.

Enzymes: Introduction, Holo enzyme (apo enzyme and co enzyme).Active site, specificity. Classification of enzymes (EC code number not required). Enzyme substrate interaction-Fischer and Koshland models. Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration, substrate concentration, pH and temperature (mention M. M. equation). Allosteric enzymes–definition and example. Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

MODULE 4 **10Hrs**

Biological Oxidation: Bioenergetics-Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and Keq. High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation ofATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reaction. Comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).Mitochondrial electro transport chain, oxidative phosphorylation. Substrate level phosphorylation.

MODULE 5 **8 Hrs**

Metabolism, Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic. Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, ß-oxidation pathway, energetics.
Protein metabolism– General aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.
Molecular Biology : Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation. DNA finger printing – Definition and its applications.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000. .
2. Biochemistry A. L. Lehningeret. al., CBS, 2000.
3. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.
4. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.
5. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH372
TITLE OF THE COURSE : INORGANIC CHEMISTRY AND BASICS IN BIOCHEMISTRY
L: T/A: P: C : 0:0: 6: 3

COURSE OBJECTIVES:

1. Conducting colorimetric estimations of biomolecuels viz., crabohydrates, lipids and proteins by various procedures.

COURSE OUTCOMES:

1. The students will be aware of the estimations and calculations invovlevd in estimating various biomolecules.

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na_2CO_3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.
11. Preparation of buffers and determination of their pH values using pH meter.
12. Estimation of reducing sugars by Hegdorn-Jensen method.
13. Estimation of lactose in milk by Nelson-Somyogi's method.
14. Estimation of creatinine by Jaffe's method.
15. Estimation of inorganic phosphate by Fiske-Subbarow method.
16. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
17. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
18. Identification of α-amino acids by paper chromatography.
19. Isolation of DNA from onions.
20. Estimation of cholesterol by colorimetric method.

TEXT BOOKS

1. College Chemistry, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER: I

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BT101
TITLE OF THE COURSE : ESSENTIALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To equip students with the basic understanding of structures and functions of basic organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES: 1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control and different stages in cell division.

MODULE 1 **10Hrs**

Cell as a basic unit of living organisms. Discovery of cell and Cell Theory; Chemical components of a cell, catalysis and use of energy by cells, Comparison between plant and animal cells. Cell Wall and membrane structure; Cell wall; Plasma membrane – structure and functions of plasma membrane; Modifications of plasma membrane and intracellular junctions.

MODULE 2 **10Hrs**

Structure and functions of cellular organelles - Mitochondria, Chloroplast, ER, Golgi complex and Ribosome.

MODULE 3 **10Hrs**

Structure and functions of - Cytoskeleton, Centriole, Protoplasm, Cell motility; Structure and functions of cilia, and Flagella, Types-Amoeboid, Ciliary and Flagellar movements.

MODULE 4 **11Hrs**

Nucleus and chromosomes; Structure and functions of nuclear membrane, nuclear pore complex, Nucleolus and Chromatin. Chromosomes-Discovery, morphology and structural Organization-Centromere, Secondary constriction, Telomere, Chromomere, Euchromatin and Heterochromatin, chemical composition and karyotype. Ultra-structure- Single-stranded and multi-stranded hypotheses, folded fiber and nucleoside models. Special types of chromosome: Salivary gland and Lampbrush chromosomes.

MODULE 5 **11Hrs**

Cell division and Programmed Cell Death; a) Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division. b) Mitosis: Significance of Mitosis, Breakdown of nuclear envelope, spindle fibers, Kinetochore, Anaphase movements. c) Meiosis: Types of meiosis, the first and second meiotic division, synaptonemal

complex. d) Programmed cell death (Apoptosis): intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.

REFERENCE BOOKS

1. Molecular Biology of Cell-Bruce Albert's et.al, Garland publications (2005).
2. Cell Biology &Molecular Biology EDP Robertis & EMF Robertis, Saunder College (2001).
3. Cell Biology C.B. Powar, Himalaya Publication (2004).
4. Cell Biology by David E Sadava, Jones and Bartlett Publications (1993).
5. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).
6. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BT171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic techniques used in cell biology to study – cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES: 1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
2. Cell division: Study of mitosis using onion root tips.
3. Cell division: Study of and Meiosis in grasshopper testes/onion flower buds
4. Chromosomes: Mounting of polytene chromosomes
5. Preparation of Buccal smear for study of barr bodies.
6. Karyotype analysis-Man and onion Man-Normal and Abnormal-Down and Turner's syndromes.
7. Blood cell count by Hemocytometer.
8. Blood smear-differential staining.
9. Vital Staining of mitochondria.
10. Isolation of chloroplast from spinach leaves.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC101
TITLE OF THE COURSE : INORGANIC AND BIOPHYSICAL CHEMISTRY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: Introducing the Basic principles of General Chemistry, Inorganic chemistry and Biophysical Chemistry to the students.

COURSE OUTCOMES: The students will be familiarized with Basic concepts in General Chemistry, Inorganic and Biophysical Chemistry so that they will have a better understanding of advanced Biochemistry.

MODULE 1 **11Hrs**

Measurement: Units – SI and CGS, accuracy, precision and errors in quantitative analysis.
Atomic Structure: Electromagnetic radiation. Wave particle duality - de Broglie equation, The Heisenberg uncertainty principal. The Schrodinger wave equation. Quantum numbers. Atomic orbitals and their shapes. The Pauli's Exclusion principal, Hund's rule, Electronic Configuration.
Periodic Classification: Trends in the periodic table: ionic radii, ionization energy, electro negativity and electron affinity. Oxidation number
Chemical Bonding: Types of bonds, Ionic and covalent bond- VBT, MOT and CFT, Coordinate bond, Weak and hydrophobic interactions, Hydrogen bond. Examples in biological system – stability and solvation of biomolecules.

MODULE 2 **11Hrs**

Solutions and Colligative Properties: Concentration and amount – mole, molarity, molality, normality and mole fraction, Homogenous and heterogeneous solutions, Factors influencing solubility, solubility curves, Henry's Law applications, Donnan membrane equilibrium and its application in membrane stability, Relative lowering of vapour pressure, Raoult's law, Elevation of boiling point, depression of freezing point, Numericals.
Electrochemistry: Strong and weak electrolyte, activity, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- (brief) application in nervous system, Standard electrode potentials. Reference electrodes; Calomel and Glass, pHmeter basics, Ion selective electrodes and their applications.

MODULE 3 **10Hrs**

Acids, Bases and Buffers: Modern concepts of acids and bases. Ionization of acids. Dissociation of water. Ionic product of water. Common ion effect with examples, Definition and determination of pH and associated numerical, Buffer preparation by H-H equation – detailed calculations, buffer capacity. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.
Adsorption: Freudlich and Langmuir adsorption isotherm with derivations. Applications of adsorption.

Phase Rule: Definition of phase, component and degrees of freedom, Gibbs Phase rule statement, Application of phase rule to one component system- water and CO2, two component systems of water-phenol and water-KI System, Lever rule, Eutactic point, azeotropes, distillation. Concept of Partition coefficient.

MODULE 4 **10Hrs**

Chemical Equilibrium: Chatelier's principle, reversible reactions with examples, Calculation of Kp and Kc for selective reactions (Synthesis of ammonia and dissociation of HI)
Reaction Kinetics: Rate equation, Velocity constant-molecularity and order of a reaction, factors influencing rate of reaction, Kinetic Equation of zero, first and second order reactions-Arrhenius hypothesis and equation, Activated complex and energy of activation and its terms, transition state theory.

MODULE 5 **10Hrs**

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change of chemical reaction, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant.
Solid State: Types- Crystalline and Amorphous, Definition of Space Lattice, planes and Unit cell, Elements of symmetry, Law of Rational Indices and Miller Indices with simple numericals, Crystal defects and their applications.

Reference books

1. Concise Inorganic Chemistry - Lee. Wiley- Blackwell Publishing House.
2. Inorganic Chemistry: Principles of Structure and Reactivity - Huhee, Keiter & Keiter. Pearson Education Publishers.
3. Physical Chemistry – Atkins. Oxford University Press.
4. General and Inorganic Chemistry - Sarkar. Sapna Publishers.
5. Physical Chemistry- Pahadi. Central Publishers
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC171
TITLE OF THE COURSE : QUANTITATIVE ANALYSIS AND VOLUMETRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. Students will demonstrate basic skills in calibration and volumetric analysis methods.

COURSE OUTCOMES: 1. Students demonstrate acquisition of basic laboratory skills, calibration of glass ware and volumetric analysis.
2. They will develop ability to perform titrations, find the end point, calculate the molecular weight, strength and concentration from these experiments.

[1] GLP & Calibration of glassware.

[2] Acid-base: Preparation of standard potassium biphthalate and estimation of alkali.

[3] Redox: Preparation of standard sodium oxalate and estimation of potassium permanganate.

[4] Redox with indicator: Preparation of standard potassium dichromate solution and estimation of sodium thiosulphate.

[5] Chelatometry: Estimation of hardness of water using EDTA/Zinc sulphate

[6] Iodometry; Estimation of iodide with sodium thiosulfate.

[7] Argentometry: Chloride estimation by Mohr's method.

[8] Estimation of Iron by dichromate.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN101
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. To provide an introduction to Cell Biology from general organelles structure, composition and function.
2. Understand the evolution, insights and benefits in of model organisms in genetics

COURSE OUTCOMES:
1. Students can understand the multidisciplinary science of the eukaryotic cell biology.
2. Student will gain understanding of the eukaryotic and prokaryotic systems in genetic studies.

MODULE 1 -TECHNIQUES IN CELL BIOLOGY 10Hrs

Microscopy: Bright field, dark field, Phase contrast, Polarization, Confocal, Fluorescence and Electron microscopy (SEM and TEM) Centrifugation, Two photon microscopy.

MODULE 2 -ULTRA STRUCTURE OF CELL 11Hrs

Structure and types of cells: Prokaryotic and eukaryotic cells- characteristics and differences. Cell Wall: Ultra structure, chemical composition and function. Cell membrane: structure, chemical composition; fluid mosaic model- lipids, carbohydrates and proteins- transport channels Transport across membrane: diffusion, active transport, co-transport, bulk transport; ion gated channels- propagation of action potential; liposomes.

MODULE 3 -CELL ORGANELLES 11Hrs

Structure and functions of Nucleus, Nucleolus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Plastids, Lysosome, Ribosomes and Microsome.

MODULE 4- CELL CYCLE AND CELL DIVISION 10Hrs

Cell cycle: Interphase and M phase. Mitosis: Mitotic phases; cytokinesis; mitotic apparatus; stimulation and control of mitosis; significance of mitosis. Meiosis: meiotic phases; events of Prophase-I; structure and function of synaptonemal complex; significance of meiosis. Cell senescence and cell death: Programmed Cell Death (PCD)- mechanism and significance of Apoptosis and Necrosis.

MODULE 5- STUDY OF LIFE CYCLE 10Hrs

Bacteria- *E. coli,* Viruses: TMV, Bacteriophage - Lambda phage, Fungi- *Neurospora*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila.*

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.

REFERENCE BOOKS

1. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
2. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.
3. Powar C. B. Cell Biology. Vol I and II (1982) Himalaya Publication.
4. Nicklin J. et al., Instant notes in Microbiology (2003). Viva Books.
5. Brian E. S., Steer M. W., et al. Plant cell Biology: Structure and Function (1996) Jones and Bartlett.
6. Stern K. R. Introductory plant Biology, 8th Edition (2006) McGraw Hill,
7. Boston. Darnell J. H., Lodish and Baltimore D. Molecular Cell Biology. 2 Edition (1990) Scientific American Books.
8. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
9. Cooper G. M., Hausman R. E. The Cell: A Molecular Approach 6th Edition (2013) Sinauer Associates

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN171
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to different types of microscopy and sample visualization.
2. Hands on training in specimen preparation and study

COURSE OUTCOMES:

1. Gain experience in handling microscopes and learn the concept of being meticulous while preparing samples.
2. They will relate hands on training better with their theory courses

1) Handling of dissection, stereo and compound microscopes
2) Study of Model organisms
Bacteria- *E. coli*
Viruses: TMV
Bacteriophage - Lambda phage
Fungi- Neurospora
Caenorhabditis elegans
Arabidopsis thaliana
Drosophila
3) Staining of RNA and DNA with methyl green and pyronin (Paramecium)
4) Vital staining of mitochondria (Yeast)
5) Gram staining (E. coli/ Staphylococcus aureus)
6) Temporary squash preparation of onion root tips
7) Observation of: Mitotic stages in permanent slides

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB101
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. The importance of microorganisms to our global society.
2. The structure/function of cells, their metabolism and how they grow/divide.

COURSE OUTCOMES: 1. Provides a strong grounding in fundamental aspects of the basic biology.
2. Able to understand microorganisms and their environment, microbial structure and function.

MODULE 1 - HISTORY AND DEVELOPMENT OF MICROBIOLOGY 10Hrs

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation and branches of microbiology. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald ross.

MODULE 2- MICROBIAL SYSTEMATICS 10Hrs

Binomial nomenclature, Whittaker's five kingdom and Carl Woese's threekingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. Brief account of Bergey's manual of bacteriology. Criteria for classification of bacteria.

MODULE 3 – MICROSCOPY AND STAINING TECHNIQUES 10Hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Fixation, types of dyes. Simple staining(negative staining), Differential staining- Gram staining, acid-fast staining, Staining of specific structures- endospore staining, capsule staining, flagella staining and cell wall staining.

MODULE 4 - CULTURE MEDIA AND PURE CULTURE TECHNIQUES 10Hrs

Microbial Nutrition: Common nutrient requirements, Nutritional types of microorganisms and growth factors. Uptake of nutrients by cells.
Culture Media: Synthetic or defined media. Basal media and Special Media - selective, differential, enrichment media, enriched media and transport media
Isolation of bacteria and fungi by serial dilution technique and Methods of pure culture techniques. Introduction to uncultivable microorganisms.

MODULE 5 - CONTROL OF MICROORGANISMS 10Hrs

Fundamentals of control- Thermal death time
Physical methods of control: Dry heat -Flaming, Incineration and hot air oven.

Moist heat - Boiling, Pasteurization, Fractional sterilization-Tyndallization and heat under pressure (autoclave).
Filtration –Diatomaceous earth filter, Seitz filter, membrane filter and HEPA Filters
Radiation- Ionizing and Non- ionizing radiations
Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, quaternary ammonium compounds and sterilizing gases as antimicrobial agents. Study of antiseptic and disinfectants.

Reference Books

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Benson, H.J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
4. Brock, T.D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
5. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
6. Pelczar, M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
7. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
8. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
9. Salle, A.J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill PublishingCompany Limited, New Delhi.
10. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India Private Limited, New Delhi.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB171
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY (PRACTICAL)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic microbiology techniques

COURSE OUTCOMES: 1. To understand microorganisms and their environment, microbial structure and function

1) **Biosafety measures in Laboratory**
2) **Use and care of compound microscope and simple microscope**
3) **Study of basic instruments in Microbiology laboratory**
    - Autoclave
    - Hot air oven
    - Incubator
    - pH meter
    - High speed centrifuge
    - Colorimeter / Spectrophotometer
    - Anaerobic jar
    - Bacterial Filters
    - Laminar air flow.

4) Microscopic examination of bacterial smear
    - Simple staining
    - Gram's staining
    - Capsule staining
    - Endospore staining
    - Cell wall staining

5) **Sterilization of glasswares** (Chromic acid preparation)
6) **Aseptic techniques –** Preparation of cotton plugs for test tubes and pipettes, wrapping of petriplates and pipettes.
7) **Preparation of culture media**:
    - Basal media (Nutrient agar and broth, Czapekdox media and MRBA);
    - Selective media (EMBagar and McConkeyagar),
    - Enriched media (Blood agar).

8) Isolation of bacteria and fungi by serial dilution technique

9) Methods of pure culture techniques
    - Pour plate technique
    - Spread plate technique
    - Streak plate technique

10) Transfer of media and inoculum
    - Slant culture technique
    - Broth culture technique
    - Stab culture technique

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1
L: T/A: P: C : 3:1:0:4

COURSE OBJECTIVES:

1. Introducing the basics principles of General Chemistry, physical chemistry and Organic Chemistry to the students.

2. The basic concepts of General Chemistry, Physical Chemistry and organic Chemistry involving the important concepts in each branch will be introduced to the students.

COURSE OUTCOMES:

1. The students will be familiar with basics principles of General Chemistry, Physical Chemistry and Organic Chemistry

MODULE 1 **11Hrs**

Atomic Structure:

de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation. significance of wave functions, emergence of Quantum numbers. radial and angular wave functions, Atomic orbitals, shapes of s, p and d orbitals. Radial distribution curves of 1s, 2s,2p, 3s, 3p atomic orbitals. Energy level diagram of atomic orbitals (up to 4s), Aufbau and Paulis exclusion principle. Hund's multiplicity rule. n+l rule, pairing energy, exchange energy, (explain by taking filling of electrons in p and d orbitals) electronic configuration of elements.

The Periodic Table and Chemical Periodicity:

Modern periodic law: The relationship between chemical periodicity and electronic structure of the atom. *The long form of the periodic Table*: Classification of elements in s,p,d and f block of elements. Periodicity in oxidation state of elements, metallic/non-metallic character, oxidizing and reducing behaviour; acidic and basic character of oxides; trends in bond type with position of element and with oxidation state for a given element; trends in the stability of compounds and regularities in methods used for extraction of elements from their compounds; *s and p block elements:* Anomalous behaviour of elements of 2nd period (Li to F) compared to other members in the same groups of s & p block elements; The diagonal relationship between elements, the inert pair effect; *d-block elements:* General valence shell configuration of 3d series elements (also in box diagram) variable oxidation states, colors, magnetic properties and catalytic properties of transition elements.

MODULE 2 09**Hrs**

Noble gases:

Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF2, XeF4, XeF6, XeO3, XeO4).

Hydrogen:

Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and parahydrogen, Industrial production of hydrogen by chemically assisted electrolysis, Photobiological water splitting, Biocatalysed electrolysis and Steam reforming. *Heavy water:* Physical properties (with comparison to light water), Applications. *Hydrogen bonding:* definition, types, importance *Hydrates:* Chemical nature and their stability.

MODULE 3 **05Hrs**

The First Law of Thermodynamics:

Introduction: Thermodynamic terms and basic concepts, intensive and extensive properties, State functions and differentials, thermodynamic processes, reversibility, irreversibility, nature of heat and work, conservation of energy, *First law of thermodynamics:* Various statements of first law, Manipulations of first law, internal energy (U) and enthalphy (H). Reversible isothermal expansion of ideal and real gases, Molar heat capacity at constant pressure CP and at constant volume CV, relation between CP and CV, Reversible adiabatic expansion of ideal and real gases, Joule Thomson effect.

MODULE 4 **11Hrs**

Gaseous state:

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations).Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems .Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves. Derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagats mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b. *Law of corresponding states* - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition(no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

MODULE 5 **11 hrs**

Organic reaction intermediates:

Covalent bond, Bond cleavage **–** homolytic and heterolytic. Types of reagents **–** electrophilic and nucleophilic reagents. *Reactive intermediates* - generation of carbocation, carbanion, carbon free radicals and carbenes **–** explanation for stability and reactivity of the above intermediates based on inductive, resonance and hyperconjugation effects. *Types of organic reactions* **–** substitution, addition, and elimination (free radical, electrophilic and nucleophilic types). *Concept of*

isomerism – structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol) in carbonylcompounds).

MODULE 6 **05 hrs**

Alkanes and Cycloalkanes:

Definition, classification, IUPAC nomenclature, the alkyl groups (stick formula of a fewbranched and unbranched alkanes) 1o, 2o and 3o carbon atoms, in alkanes. *Alkanes:* sources, methods of preparation - Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties: melting points, boiling points and solubility. Chemical reactions of alkanes – combustion, halogenation ,mechanism of free radical halogenation of methane; orientation, reactivity and selectivity. Uses of alkanes. *Cycloalkanes* – nomenclature, methods of preparation by Carbene insertion and Dieckmann condensation reactions, chemical reactions – oxidation, Halogenation and Opening reactions of three and four membered rings, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. The case of cyclopropane ring;- banana bonds.

Alkenes:

Definition, classification, Preparation of alkenes by Wittig reaction. Chemical properties: Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and importance.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH171
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1 PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Students will be given instructions like Good Laboratory practies, significant figures, volumetric calculations.(problems to be solved).
2. Students will be trained to calibrate various glass ware like pipette, burette and standard volumetric flasks.
3. The various volumetric titration experiments will be introduced to students like acid base redox etc.,.
4. The titration experiments can be deigned to estimate N_2 in ammonia, carbonate in bicarbonate ,chloride etc.,

COURSE OUTCOMES:

1. The students will be well versed with all the necessary laboratory practices.
2. The students will independently calibrate the glass ware before using for experiments.
3. The students will be able to use the principles of titration experiments in volumetric analysis.
4. The students can be able to estimate the carbonate, nitrogen, chlorine from the various matrix given.

1. Good Laboratory practices, significant figures, volumetric calculations. Problems to be solved)
2. Calibrations of pipette, burette and standard volumetric flasks.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using standard sodium thiosulphate.
7. Determination of percentage of manganese dioxide in pyrolusite ore.
8. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
9. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
10. Estimation of carbonate and bicarbonate in a given mixture.
11. Determination of the percentage of available chlorine in the given sample of bleaching powder.
12. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16EP191
TITLE OF THE COURSE : ENVIRONMENT AND PUBLIC HEALTH
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT - 26 HRS

MODULE 1 **3h**

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 **4h**

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 **5h**

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4h**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4h**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6h**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.
- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.

- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore
3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER: II

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT102
TITLE OF THE COURSE : PRINCIPLES OF MICROBIOLOGY AND BIOSTATISTICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about classification and diversity of microorganisms and familiarize the students with the cultivation of microorganisms and sterilization techniques.
2. To impart the basic concepts in biostatistics.

COURSE OUTCOMES: 1. Student will be aware of basic microbiological and sterilization techniques.
2. Student will have sufficient understanding of statistical methods used in biological sciences for data handling.

MODULE 1 **10Hrs**

Historical perspectives of microbiology: Introduction – microbial origin, Contributions and discoveries, Germ theory, Scope of Microbiology. Concept of Sterilization - Definition of sterilization, disinfection, Sanitization, antisepsis and fumigation. Physical, Chemical and radiation methods of sterilization, and their applications.

MODULE 2 **11Hrs**

Classification of Microbes: Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of molecular classification of microorganisms Systematics of bacteria, Nutritional types (Definition and examples). Classification on the basis of oxygen requirement. General Account of Viruses and Bacteria; Bacteria-Ultra structure of a bacterial cell (both Gram positive and Gram negative) endospore and capsule.

MODULE 3 **11Hrs**

Microbes in Extreme Environment; Nature, special features of the thermophiles, methanogens and halophiles, Archaea; photosynthetic bacteria, Cyanobacteria, some Archaea living in extreme conditions like cold, and space (Extremophiles). Pathogenic Microorganisms; A. Plant viruses-CAMV, Animal Viruses-Hepatitis B, Bacterial virus- lambda phage B. The common bacterial, fungal and viral diseases of human beings (Name of the disease, causative pathogen, parts affected).

MODULE 4 **10Hrs**

Biostatistics: Importance and Applications; Tabulation and classification of Data - Frequency distribution and graphical distribution of Data; Measures of Central Tendencies - Mean, Median, Mode and their properties; Measures of Dispersion - Mean Deviation, Variance, Standard Deviation and Coefficient of Variation;

MODULE 5 **10Hrs**

Hypothesis testing - Student T and Chi Square test; Probability and distribution - Concepts and problems on probability, Binomial, Poisson, normal distribution and their application.

REFERENCE BOOKS

1. Microbiology-Pelczar, Chan, Krieg Tata McGraw Hill Publications (2000)
2. Microbiology- Concepts and applications by Paul A. Ketchum Wiley Publications (2001)
3. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications (2003)
4. Microbiology –Ronald M. Atlas (1990)
5. Introductory Biotechnology-R.B Singh C.B.D India (1990)
6. Microbiology by L M Prescott, Mc Graw Hill
7. General Microbiology –C.B. Powar, H.F. Daginawala, Himalayan Publishing House (2001)
8. Fundamental of Biostatistics by Khan and Khanum, Ukaaz Publications (1994)
9. Statistics for Biologists by RC Campbell, Cambridge University Press (1989)
10. Biostatistics by Wayne W Daniel, Wiley 10th Edition (2014)

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT172
TITLE OF THE COURSE : MICROBIAL TECHNIQUES
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make the students aware of basic microbiological techniques.

COURSE OUTCOMES: 1. Student will be trained in basic sterilization and microbiological techniques.

1. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
2. Common instruments used in a microbiology Lab: Principles and operations - Incubators & Shakers Centrifuge pH meter Colorimeter Spectrophotometer
3. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa)
4. Sampling and quantification of microorganisms in air, soil and water.
5. Isolation of bacteria - Streak plate, spread plate, pour plate, serial dilution (2 units)
6. Biochemical tests – IMViC, starch hydrolysis, catalase & gelatin liquefaction (3 units)
7. Antibiotic sensitivity test-paper disc method
8. Study of Rhizobium from root nodules of legumes.
9. Microscopic study of phytoplankton & zooplanktons.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC102
TITLE OF THE COURSE : ORGANIC CHEMISTRY, DRUG SYNTHESIS AND TOXICOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: This course will provide the basics in Organic chemistry and drug development. They will gain a basic knowledge of methods used in drug discovery and basic toxicology.

COURSE OUTCOMES: Students will recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism. They will understand the basics in drug design and toxicology.

MODULE 1 **10Hrs**

Introduction: IUPAC nomenclature of organic compounds, Inductive effect, resonance and hyperconjugation, Reactive intermediates: carbocations, carbanions, carbines and free radicals.
Aliphatic and Aromatic Hydrocarbons: General characteristics of alkanes, alkenes and alkynes, substitution and bond opening reactions: Wurtz & Kolbe reaction for alkane, Hydrogenation with Merkownikoff's rule and ozonolysis of alkenes. Organometallic compounds - definition, examples and synthetic applications of Grignard Reagents. Baeyer strain theory. Sachse-Mohr theory. Boat and chair forms of cycloalkane. Axial and equatorial bonds. Benzene structure, Aromaticity, Huckel's rule, orienting influence of substituent on group addition.

MODULE 2 **10Hrs**

Mechanisms: Substitution of alkyl halides via SN1 and SN2, elimination via E1 and E2.
Alcohols: Definition and classification. Monohydric alcohols – general properties; distinguishing reactions of primary, secondary and tertiary alcohols – Lucas Test, Victor Meyer Test and Oxidation reactions. Acidity of phenol, Kolbe & Reimer-Tiemann reactions.
Acids and Aldehydes: Definition and examples. General properties, acid strength, esterification of acid, oxidation of alcohols to aldehydes and ketones. Keto-enol tautomerism, Perkin reaction, Claisen and aldol condensation, Cannizzaro reaction and reduction.

MODULE 3 **10Hrs**

Stereochemistry: Stereoisomerism: Optical isomerism: Molecular dissymmetry, Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism in alkenes and ring compounds. Structure and properties of malic and fumaric acid, E-Z system of specifying geometrical isomer, examples of chirality in the biological world.
Amines: Classification. Isomerism. Distinguishing reaction of 1°, 2° and 3° amines. pKb values of amines. Effect of substituents on the basic strength of amines. Some biologically important amines.
Heterocyclic Compounds, Terpenes and Alkalolds: Structure, formulae and occurrence of furan, thiophene, pyrrole, imidazole, pyridine and indole. Aromaticity of furan, thiophene,

pyrrole and pyridine. Isoprene rule, biological importance and occurrence of terpenes & alkaloids. Phytochemicals- Introduction and uses.

MODULE 4 **10Hrs**

Organic synthesis and Drug Design: Retro-synthetic planning and synthetic execution, retron and synthon. Michael addition, Diels Alder reaction, Organo-lithium and epoxide-based reactions to create synthones, Reaction of diazonium salts coupling reactions, ethyl acetoacetate and its synthetic application, increasing C-atoms by n units, selective removal of C-atoms. Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug-receptor interaction Principles of Drug Design, Traditional analog (QSAR) and mechanism based approaches, Computer Aided Drug Designing (CADD) and molecular modeling. Synthesis of aspirin, anthraquinone, sulfanilamide, paludrine, acetaminophen (paracetamol) and pentothal**.**

MODULE 5 **10Hrs**

Toxicology: Toxins, venom, poison with examples, Dose Response curves, bioavailability, biosorption, IC50, LD50, ED50, Genotoxicity, Xenobiotics, Role of Cytochrome P450, Various mechanisms of Detoxification. Whole animal studies, Perfusion studies, Metabolic cage, Tissue culture, Common cell lines used for studying diseases.

REFERENCES BOOKS

1. Organic Chemistry-Morrison and Boyd. Prentice-Hall of India
2. Organic Chemistry-Solomons and Fryhle. Wiley & Sons.
3. A Guidebook to Mechanism in Organic Chemistry-Sykes. Longman Publishers.
4. Advanced Organic chemistry-Bahl and Bahl. S. Chand Publishing House.
5. A textbook of Modern Toxicology – Hodgeson. Wiley & Sons.
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC172
TITLE OF THE COURSE : Qualitative analysis and organic preparations
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To recognize the basic practical skills for the analysis and synthesis of organic compounds.

COURSE OUTCOMES: Predict and identify the organic compound after analysis. Students will also be able to synthesize few drugs like acetyl salicyclic acid and few other organic compounds.

[1] SYSTEMATIC QUALITATIVE ANALYSIS OF SAMPLE ORGANIC COMPOUND –

Alcohol
Phenols
Carboxylic acids
Aldehyde
Ketones
Esters
Aromatic hydrocarbons
Halocompounds
Amines

[2] ORGANIC PREPARATIONS:

a) Nitration of nitrobenzene
b) Acetylation of salicylic acid
c) Oxidation of benzaldehyde
d) Bromination of phenol/ acetanilide

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16GN102
TITLE OF THE COURSE : BASIC GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Introduction to genetic evolution and impact on genetics today.
2. Impact and diversity of genetics in life sciences**.**

COURSE OUTCOMES:
1. Students will understand the basic concept of hereditary
2. Student will understand genetic basis of human disease and extrapolate or critically evaluate other diseases they come across.

MODULE 1 -HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross. Pattern of inheritance in haploid and diploid organisms.

MODULE 2- EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementry and Complementry gene interactions; Non epistatic inter allelic gene interaction, Position effect

MODULE 3- SEX DETERMINATION 10Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridge s genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in *Drosophila*. Sex differentiation and dosage compensation *(Drosophila* and Man). Sex linked and sex limited traits in Humans- Hemophilia, Hypertrichosis.

MODULE 4- EXTRA CHROMOSOMAL INHERITANCE 10Hrs

Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in *Paramecium*, sigma factor in *Drosophila*, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 5- ELEMENTS OF BIOMETRY 10Hrs

Measures of Central tendency Mean, Median and Mode. Measures of Dispersion Range, Variance, Standard deviation and Standard error. Test of Hypothesis - Student s t test, chi square test. Probability - Basic concepts; Distribution- Normal, Binomial and Poisson.

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFERENCE BOOKS

1. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
2. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009)
3. McGraw-Hill. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
4. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
5. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
6. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
7. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16GN172
TITLE OF THE COURSE : BASIC GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. Genetic calculations to determine inheritance traits.
2. Basics of statistical analysis for determining quantitative inheritance.

COURSE OUTCOMES:
1. Ability to be able to determine understand the allele distribution using different types of crosses.
2. Apply statistical knowledge to address different types of genetic data.

1) Temporary squash preparation of:
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing
3) Study of:
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Computation of:
   Mean, median and mode
   Standard deviation and standard error.
5) Problems on:
   Student s t test and Chi square test.
6) Problems on Probability
7) Genetic problems on:
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB102
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Deliberate existing theories about the origin of life, microbial evolution and systematics
2. Make simple calculations of microbial growth kinetics in batch and continuous culture and describe how microbial growth can be controlled

COURSE OUTCOMES: 1. The course will enable students to relate the principles in classifying microbial systems and know their beneficial and harmful effects.
2. Enable to apply this knowledge in microbial biotechnology starting from screening of desired microbe

MODULE 1 - MORPHOLOGY AND STRUCTURE OF BACTERIA 10Hrs

Morphology of bacteria:- Size, shape and arrangement , Ultra structure of bacteria :- structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae .Bacterial cell wall and structure. Structures internal to the cell wall -Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic);Nuclear material- Bacterial Chromosome (Fundamental differences with eukaryotic chromosome)Plasmids and episomes, Ribosomes, Exospores and Cysts: types and structure; Endospore.

MODULE 2 - SPECIAL MICROBIAL FORMS AND VIRUSES 11Hrs

General account of Archaebacteria, Actinomycetes, Rickettsiae, Mycoplasma and Chlamydiae. Early development of virology, General structure and characteristics of viruses, cultivation of viruses, general replication of viruses. Type study: classification, structure, replication, cultivation and application of - TMV, Polio virus, T4 and Lamada phage. Brief account of Viroids and Prions.

MODULE 3 - EUKARYOTIC MICROBES-I 10Hrs

Algae: General characteristics of algae including occurrence, thallus organization, alga cell ultrastructure, pigments, flagella, eyespot food reserves, and vegetative, asexual and sexual reproduction. Different types of life cycles in algae: Haplontic type, Diplontic type, Haplobiontic type, Diplobiontic type. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

MODULE 4 - EUKARYOTIC MICROBES- II 11Hrs

Fungi: General account of Fungi-General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual reproduction and sexual reproduction. Economic importance of fungi**,** Type study of Zygomycetes (*Rhizopus)*,

Ascomycetes (*Aspergillus,* yeast *and (Penicillium)*, Basidiomycetes (*Agaricus*)and Deuteromycetes(*Fusarium*).

Protozoa: General characteristics with special reference to *Amoeba, Paramecium, Giardia, Plasmodium, Entamoeba*.

MODULE 5- GROWTH KINETICS **10Hrs**

Definition of microbial growth, factors affecting microbial growth (pH, Temperature, Oxygen concentration, Pressure and Radiations), Cell division, Growth curve of bacteria, Kinetics of growth:- Mathematics of growth-generation time and growth rate constant. Measurement of growth: Measurement of cell numbers- Counting chambers, electronic counters, viable counting techniques, membrane filter technique. Measurement of cell mass- dry weight and turbidity measurement. Measurement of cell activity, Batch culture, Continuous culture-Chemostat and Turbidostat. Synchronous culture (definition and brief description).

REFERENCE BOOKS

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock, T. D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
6. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
7. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
8. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
10. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
12. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India PrivateLimited, New Delhi.

Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB172
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make the students aware of basic staining techniques.

COURSE OUTCOMES: 1. Student will be trained in different classification of microorganisms.

1) Isolation and identification of fungi (Lactophenol cotton blue mount)
2) Micrometry:
   Microscopic measurement of bacterial cell (*Bacillus*), yeast (*Saccharomyces),* fungal spores (*Pencillium and Aspergillus*) and onion cell by micrometry.
3) Enumeration of microbes by Haemocytometer (yeast).
4) Study of the following algae by preparing temporary slides:
   Chlamydomonas and *Spirulina*
5) Study of the fungi by preparing temporary slides:
   Rhizopus, *Aspergillus, Penicillium*, Yeast, *Fusarium*
6) Study of Protozoa by using permanent slides:
   Amoeba, Paramecium, Giardia and Plasmodium
7) Study of growth curve of bacteria by turbidometric estimation
8) Study of growth curve of fungi by colony diameter method
9) Cultivation of bacteriophage
10) Cultivation of Algae

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CH102
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 2
L: T/A: P: C : 3: 1: 0 : 4

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. In General Chemistry the principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen , alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen compounds, alkenes were introduced to the students.

MODULE 1 **10Hrs**

Chemical Bonding:

Ionic Bond: Definition and conditions for formation of an ionic bond, examples of formation of an ionic compound (NaCl, CaCl2, MgO).Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle (NaCl,CaCl2 and MgO), problems, polarizing power and polarizability, Fajan's rules.

Covalent Bond: Definition, octet rule, limitation electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Valence Shell Electron pair repulsion (VSEPR) Theory: Shapes of simple inorganic molecules and ions such as NH3, H3O+, SF4, ClF3, ICl2 and H2O.

Hybridisation concept: various types of hybridization, structure of molecules based on hybridization concept and by valence shell electron pair repulsion (VSEPR) theory.

Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6 molecules.

Molecular orbital theory: linear combination of atomic orbitals (LCAO), MOT postulates, bonding, nonbonding and antibonding molecular orbitals. Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules (H2, N2, O2, HF and CO).

Metallic Bond: Definition, properties of metals and band theory, electrical properties of metals, semiconductors and insulators.

Weak Intermolecular interactions: vanderwaals forces, dipole dipole interactions and their significance. Hydrogen Bond – types and its significance on molecular properties.

MODULE 2 **11Hrs**

The Second Law of Thermodynamics:

Introduction: Spontaneous change, Carnot Cycle, conclusions from Carnot cycle, efficiency of heat engines, Second law of thermodynamics, entropy, entropy as a state function, Clausius inequality, entropy as criterion of spontaneity, natural processes, different types of entropy changes under isothermal and non-isothermal conditions, entropy change in irreversible processes. Helmholtz function (A), Gibbs function (G), standard molar free energy changes, Maxwell relations, dependence of free energy functions on temperature and pressure, total differential equations. Gibbs Helmholtz equations, thermodynamic criteria for spontaneity. Heat capacity at low temperature, Nernst heat theorem, Third law of thermodynamics, third law entropies.

Chemical Kinetics:

Review of terms: Rate, Order and Molecularity. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, halflife period, mean life period and order of reaction. Determination of order of reaction: differential method, method of integration, method of half life period and isolation method. Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis).Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE 3 **11Hrs**

Liquids and Solutions:

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.

MODULE 4 **9Hrs**

s & p block elements:

s- block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.*p – block elements:* Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.*Halogens:* Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

MODULE 5 11**Hrs**

Dienes and Alkynes:

Dienes: Classification - isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction- 1,3-butadiene with maleic anhydride.
Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction –significance. Oxidation with KMnO4, acidic nature of terminal alkynes.

Stereochemistry:

Fischer, saw-horse and Newman projection formulae. Chirality-optical activity, enantiomerism and diastereoisomerism involving one and two chiral centers, configuration, geometrical isomerism, D/L, R/S and E/Z nomenclatures.

Organic halogen compounds:

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanism with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii)nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism. *Aryl halides:* Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.
3.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16CH172**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 2**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. Students will determine various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

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COURSE OUTCOMES:

1.The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. The students will be sell versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Determination of transition temperature of a salt hydrate by thermometric method.
5. Determination of distribution coefficient of benzoic acid between water and toluene.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Determination of dissolved oxygen (DO) in water sample.
9. Compare the strength of HCl and H_2SO_4 in the hydrolysis of ethyl acetate (K for one acid is given)
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CA192
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L: T/A: P: C : 2: 0: 0: 0

Total Credit - 26 Hrs

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems. 5 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: Data processing & presentation 4 Hrs

Introduction, Office Automation Software (Open Source Software)

MODULE 4: Computer viruses and Internet Searches. 5 Hrs

An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 5: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCE BOOKS

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER III

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BT201
TITLE OF THE COURSE : BASIC PRINCIPLES OF BIOCHEMISTRY AND BIOPHYSICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.
2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES: 1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **10Hrs**

Carbohydrates: Structure, properties and classification with examples – Monosaccharides, Disaccharides, polysaccharides (storage and structural, homo and hetero polysaccharides). Lipids: Structure, properties and classification and functions – Phospholipids, sphingolipids and glycolipids.

MODULE 2 **10Hrs**

Classification and properties of amino acids, titration curve of amino acid, concept of zwitter ion, pKa and pI. Proteins: Classification based on structure and function, structural organization of proteins – Primary, secondary (alpha helix and beta sheet), tertiary and quaternary structure. Nucleic Acids: Nucleic acids and their components – Nitrogenous bases (purines and pyrimidines), nucleosides and nucleotides, formation of phosphodiester bond.

MODULE 3 **11Hrs**

Enzymes: Introduction, classification, co-enzymes and co-factors, enzyme kinetics (Michelis-Menten equation), factors influencing enzyme activity- Substrate, enzyme, temperature and pH, Inhibition mechanisms (competitive and non-competitive). Vitamins and Hormones: Water Soluble and fat-soluble vitamins, Dietary source, Clinical relevance. Functions of Steroid hormones (testosterone and estrogen), Glucocorticoid hormones (cortisol and mineralocorticoid), pituitary hormones (MSH and FSH). Examples of Plant Hormones (Auxins, Cytokinins and Gibberllins).

MODULE 4 **10Hrs**

Scope of Biophysics, pH and Buffer concepts. Principles and applications of Chromatography (Paper, thin layer, column, GLC and HPLC); Centrifugation (differential, density gradient, Ultra centrifugation);

MODULE 5 **11Hrs**

Principles and applications of Spectroscopy (UV, Visible, X-Ray crystallography, NMR, IR, Fluorescence and Atomic; Absorption); and Electrophoresis. Isotopes: Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

REFERENCE BOOKS

1. Lehninger's Principles of Biochemistry- W H Freeman (2008)
2. Biochemistry-Lubert Stryer Freeman International Edition (2002).
3. Biochemistry-Keshav Trehan Wiley Eastern Publications (1987).
4. Fundamentals of Biochemistry J.L. Jain S. Chand and company (2007).
5. Biochemistry by U Satyanarayana and Chakrapani, Elsevier Inc. (2013).
6. Biochemistry by Voet and Voet, Wiley Publishing (2010).
7. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
8. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
9. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John
10. Walker, Cambridge University Press (2005).
11. Biophysics – An introduction by Ronald Glaser, Springer (2012).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BT271
TITLE OF THE COURSE : BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 0: 0: 4: 2

Course Objectives: 1. To make students learn quantitative and qualitative methods for study of biomolecules.

Course Outcomes: 1. Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

1. Preparation of Buffers-Citrate and Phosphate.
2. Estimation of reducing sugars by DNS method.
3. Estimation of reducing sugars by Somogyi-Nelson Method.
4. Estimation of Amino acids by Ninhydrin method.
5. Estimation of Protein by Biuret method.
6. Estimation of protein using Lowry's method.
7. Preparation of crude amylase extract from biological source
8. Assay of amylase enzyme activity using starch as a substrate. (2 MODULEs)
9. Separation of Amino acids by Paper Chromatography.
10. Separation of amino acids/sugars by Thin layer chromatography

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BC201
TITLE OF THE COURSE : PHYSICO-ANALYTICAL TECHNIQUES
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.

2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES: 1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **11Hrs**

Spectroscopy: Wave particle duality, the electromagnetic spectrum, Lambert-Beer's law, Absorbance, extinction coefficient, Chromic shifts, auxochromes. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscope; assay of biomolecules. Principle, Schematics and Application of Luminometry, Flame photometry and AAS. IR spectroscopy, equation, vibrational modes of various bonds, applications in the identification of common functional groups in biomolecules.

MODULE 2 **11Hrs**

Techniques for structure determination
X-Ray Diffraction: crystal planes, Braggs Equation, Diffractometer, Applications in crystal characterization. NMR: principle and applications in structure elucidation of biomolecules.
Techniques in Medical Applications
NMR based techniques – Magnetic Resonance Imaging and Diffusion tensor imaging – brief idea, X-ray based technique: CAT scan and radioactivity based technique: PET scan
Chromatography
Distribution coefficient, Adsorption, partition, Retention factor. Types: Planar and columnar, S-L, L-L, G-S and G-L. Paper, thin layer, gel permeation, ion exchange, hydrophobic and affinity chromatography with applications, Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules. Brief idea about HPLC (C8 and C18) and FPLC.

MODULE 3 **10Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis, Applications. Gel electrophoresis: - Types of gels, Procedure, Column & slab gels. Detection, Recovery & characterization of macromolecules

(molecular weight determination and subMODULE enumeration). Principle and application of SDS-PAGE, IEF, peptide mapping, OFGE, Application in molecular biology and genomics.
Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

MODULE 4 **10Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography. Applications of isotopes in biochemistry with reference to studies in metabolism, Principles of tracer techniques, it's advantages and limitations,

MODULE 5 **10Hrs**

Centrifugation: Basic principles, Mathematics & theory: RCF, Sedimentation coefficient, Svedberg constant, nomogram. Preparative centrifugation: Differential & density gradient centrifugation, Applications**.** Analytical centrifugation: - Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.
Electrochemistry: Potentiometry, potentiometer schematics and use as pH meter,Conductance, specific and equivalent conductance, Conductivity meter.

REFERENCE BOOKS

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Principles and Techniques of practical Biochemistry – Wilson and Walker. Camridge.
4. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
5. Immunology – Kuby. Freeman Publishers.
6. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BC271
TITLE OF THE COURSE : BIOANALYTICAL SEPARATIONS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic, potentiometric and chromatographic techniques.

1. pH metric /potentiometric titrations of HCl- NaOH and Acetic acid-NaOH
2. Estimation of pKa of glycine.
3. Determination of density & viscosity of given unknown solution.
4. Paper chromatography of amino acid, lipids and sugar (Ascending and circular)
5. Paper electrophoresis for separation of biomolecules.
6. Separation of amino acid by TLC.
7. Column chromatography of pigments on adsorbent.
8. Conductometric titration of an amino acid against HCl and NaOH.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16GN201
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Genetic inheritance associated with chromosomal modifications.
2. Diverse role of sex chromosomes in genetic inheritance

COURSE OUTCOMES:
1. Students understand the diverse modifications chromosomes undertake for inheritance pattern.
2. Student will understand how intricate is the role of sex chromosomes in maintaining diversity as well as consistency.

MODULE 1 PHYSICAL BASIS OF INHERITANCE 11Hrs

Chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres, types of chromosomes. Heterochromatin and Euchromatin and its significance. Ultra-structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Idiogram.

MODULE 2 SPECIAL TYPES OF CHROMOSOME AND LINKAGE 10Hrs

Polytene chromosome- Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte, B Chromosome. Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage- complete linkage and incomplete linkage,Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc.

MODULE 3 CROSSING OVER 11Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in *Drosophila*. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks, Crossing over in *Drosophila* and Tetrad analysis in *Neurospora*, Interference and coincidence, Construction of genetic maps (*Drosophila* and maize) and Punnett square.

MODULE 4 SEX LINKAGE 10Hrs

Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in *Drosophila*. Sex linked genes in Poultry and moths. Sex related genes in maize.Attached X-chromosome.

MODULE 5 CHROMOSOMAL ABERRATIONS 10Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomesand Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

TEXT BOOKS

1. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
2. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.

REFERENCE BOOKS

1. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
2. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
3. Sinha U., SMODULEa and SMODULEa Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
4. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
   Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
5. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
6. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16GN271**
TITLE OF THE COURSE : **FUNDAMENTALS OF CYTOGENETICS PRACTICAL**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:
1. Detail culture maintenance of Model organism Drosophila melanogaster
2. Understanding and visualising different chromosomal aberrations

COURSE OUTCOMES:
1. Students will learn the complete methods of culturing, dissection and study of model organisms. Develop skills on hands on experiments
2. Perform genetic analysis on linkage and crossing over. Determine skills of genetic analysis using different plant and animal models.

1) Culturing and Handling of Drosophila
   - Cleaning and Sterilization of bottles.
   - Media Preparation.
   - Handling of Drosophila.
2) Study of at least five types of Drosophila:
   - Body color mutant- Ebony body and Yellow body.
   - Wing mutant- Curly wing and vestigial wing.
   - Eye color mutant- Bar eye, white eye, sepia eye.
3) Mounting of Sex Comb of Drosophila melanogaster
4) Mounting of Genital plate of Drosophila melanogaster
5) Salivary gland Chromosome
   - Dissection of Salivary glands.
   - Preparation of Polytene chromosome.
6) Study of Chromosomal Aberrations:
   - Observation of permanent slides of chromosomal aberrations.
   - Inversion- Salivary gland chromosomes of Drosophila nasuta.
   - Induction of polyploidy in Onion root tips.
7) Genetic Problems on Linkage & Crossing over:
   - Drosophila.
   - Maize.
   - Human (Sex Linkage).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB201
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY, MICROBIAL GENETICS AND INSTRUMENTATION
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics.
2. To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype.

COURSE OUTCOMES: 1. To understand the complexity of microbial structures, genetics and metabolism.
2. Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment

MODULE 1: BIOMOLECULES AND ENZYMES 10Hrs

A brief account of the properties, classification and importance of carbohydrates, lipids and proteins.

Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes.

MODULE 2: METABOLISM AND BIOENERGETICS-I 11Hrs

Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H.

Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: METABOLISM AND BIOENERGETICS-II 11Hrs

Bacterial photosynthesis and Fermentation: Definition, Photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid.

Bioenergetics: Free energy, ATP and its production, other high energy compounds, Oxidation – Reduction reactions.

MODULE 4: MICROBIAL GENETICS 10Hrs

Basics of Genetics: Mendelian Principles of genetics (Monohybrid, Dihybrid and Test cross), Morphology of Prokaryotic and Eukaryotic genetic material.

Chemical basis of heredity: Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment). Properties of genetic

code and Wobble hypothesis. Transformation, Conjugation and Transduction. Transposons in recombination. Extra chromosomal genetic elements and their importance.
Molecular basis of mutations: Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.

MODULE 5: INSTRUMENTATION **10Hrs**
Centrifugation: Basic principles, Low-speed and High speed centrifuges, ultracentrifugation, Applications.
Chromatography: Paper, Thin layer, Column chromatography, HPLC
Electrophoresis: Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, SDS-PAGE
Spectrophotometer: Principles of Spectroscopy, UV Visible spectroscopy, NMR spectroscopy.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Freifelder, D. 2002. Microbial Genetics, Narosa Publishing House, New Delhi.
7. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 2008. Principles of Genetics. Eight edition. Wiley Publications.
8. Griffin, D.H. 1993**.** Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
9. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
10. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
11. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB271
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES: 1. Student will be equipped with coloured based changes given out by microbial tests

1. **Biochemical tests:**

- Starch hydrolysis.
- Gelatin hydrolysis.
- Catalase test.
- Sugar fermentation test.
- Nitrate reduction test.
- H_2S production test.
- IMViC test
- Oxidase test.
- Casein hydrolysis test.
- ONPG test.

2. Qualitative analysis of carbohydrates.
3. Qualitative analysis of proteins.
4. Quantitative determination of reducing sugars by DNS method.
5. Quantitative determination of proteins by biuret method.
6. Partial purification of protein by ammonium sulphate precipitation method
7. Genetic problems
8. Isolation of antibiotics resistant mutant by gradient plate technique
9. Demonstration of replica plating method for selection of antibiotic resistant mutants

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16CH201**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 3**
L: T/A: P: C : **3 : 1 : 0: 4**

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.

2. In General Chemistry the principles of metallurgy, fertilizer in physical chemistry, basic principles of the II and III laws of thermodynamics and in organic chemistry the principles of aldehydes, ketones ,alcohols compounds, alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physic Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of metallurgy, fertilizers in physical chemistry, basic principles of the II and III lwa of thermodynamics and in organic chemistry the principles of aldehydes, alcohols compounds, alkenes were introduced to the students. Ketones.

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MODULE 1 **11Hrs**

Surface chemistry

Review of surface phenomena. Theories of adsorption. Adsorption isotherms and BET equation (derivation included), Surface area calculation using BET. Adsorption indicators. Surface film on liquids. Catalysis –Types and theories ((intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Auto catalysis.

THERMODYNAMICS II

II Law of Thermodynamics

Limitations of I law, scope of II law, Statements of II law of thermodynamics (to be introduced wherever the concepts arise). Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Driving force for spontaneous processes. Concept of entropy and its physical significance. Entropy change in adiabatic and isothermal reversible expansions of an ideal gas. Change in entropy of an ideal gas with change in P, V and T (derivation of equation) – modified equation for isothermal, isochoric and isobaric processes. Entropy of phase change. Entropy changes in the system and surroundings in an isothermal reversible expansion and isothermal irreversible expansion of an ideal gas, entropy criteria for spontaneity, Carnot cycle – derivation of efficiency based on entropy concept. Relation between entropy and probability.

MODULE 2 **09Hrs**

III **law of thermodynamics** – Determination of absolute entropies of substances, standard entropies, residual entropy. Free energy – Gibb's free energy & Helmholtz free energy (work function), Relation between w and ΔA, w and ΔG, standard free energy change of a reaction. Free energy criteria of spontaneity, variation of G with T and P. Gibb's Helmholtz equation – derivation. Relation between free energy & equilibrium constant of a reaction. Clausius–Clapeyron equation–derivation, application to liquid-vapour and solid-liquid equilibria.

MODULE 3 **9Hrs**

Metallurgy:

Introduction, classification. Ellingham's diagrams: Salient features for the formation of oxides. Extraction of the following metals -i) Nickel from sulphide oreii) Thorium from Monazites and iii) Plutonium from Nuclear waste. Advantages of powder metallurgy. Methods of production of metal powders.

Fertilizers:

Introduction (need of fertilizers), functions of essential plant nutrients (N, P, K). Classification of fertilizers with examples. Manufacture of urea and Super phosphate of lime, and their uses.

Environmental Chemistry:

Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

MODULE 4 **09Hrs**

Alcohols and Thiols

Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Pondorff-Verley reaction); (ii) From acids and esters (by reduction with LiAlH4).Reactions of alcohols: Comparison of the reactivity of 1°, 2° and 3° alcohols - Lucas test,oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using KMnO4 and from epoxides. Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats. Uses.

Thiols: Methods of formation and chemical reactions (with metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes.

MODULE 5 **09Hrs**

Aldehydes and Ketones

Nomenclature: Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Addition of HCN - mechanism. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalyzed acetal formation. Addition of amines (primary and secondary amines, hydrazine and hydroxylamine). Wittig reaction (no meachanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α-Hydrogen, enolate ion. Keto- enol

tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanismof both), crossed aldol reaction (practical crossed aldol reactions). Claisen-Schmidt reaction (nomechanism). Addition to α,β-unsaturated aldehydes and ketones (no mechanism). Michael addition (no mechanism).

MODULE 6 **05Hrs**

Phenols

Nomenclature, classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO2 group and electron donating –CH3 group on acidity of phenols at o-, m-, p- positions, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Ethers and Epoxides

Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions – Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1, 2 disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

Organometallic compounds

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S.Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CH271
TITLE OF THE COURSE : ORGANIC CHEMISTRY (Practical)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. The students will be trained the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2.The students will be given hands on experience on synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

COURSE OUTCOMES:
1. The students will be experts of the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2. The students will be experts of synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

Preparation and purification of organic compounds
1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
(Preparation, recrystallization and melting point determination of the recrystallized sample in the following organic preparations)
One stage preparation
3. Preparation of aspirin from salicylic acid.
4. Preparation of paracetamol from *p*-aminophenol.
5. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
6. Preparation of *m*-dintrobenzene from nitrobenzene.
7. Preparation of benzoic acid from benzaldehyde.
8. Purification of solids by sublimation. (Benzoic acid / Napthalene)
Two stage preparations
9. Preparation of *p*-bromoaniline from acetanilide.
10. Preparation of *p*-nitroaniline from acetanilide.
11. Preparation of *m*-nitrobenzoic acid from methyl benzoate.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : III EMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CI291
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT: 26 HRS

MODULE 1: 5h

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6h

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5h

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5h

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, and administrative: Recent Trends.

MODULE 5: 5h

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER IV

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To provide comprehensive understanding molecular processes inthe cell required for its growth and maintenance of genetic material.
2. To equip with fundamental understanding of the underlying mechanisms in regulation of gene expression.

COURSE OUTCOMES: 1. Student will be well versed with mechanisms in the expression, regulation and maintenance of genetic information, within a biological system.
2. Student will be able to critically think in the field of application of molecular biology.

MODULE 1 **10Hrs**

Molecular basis of life: Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Structure and function of DNA and RNA: Structure of DNA. Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA. Recombination: Transformation, Conjugation and Transduction; Holliday model of recombination. Extra nuclear Genomes: Mitochondria and chloroplasts.

MODULE 2 **11Hrs**

MODULE 4. DNA Replication: Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. Causes of DNA damages, mechanisms of repair– photo-reactivation, excision repair, mismatch repair, SOS repair.

MODULE 3 **10Hrs**

Transcription in Prokaryotes and Eukaryotes: RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA.

MODULE 4 **10Hrs**

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes. Post translational modification of Proteins.

MODULE 5 **11Hrs**

Regulation of Gene Expression: Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons Regulation of Gene expression in Eukaryotes – galactose metabolism in yeast. Role of cis and trans elements in regulation of gene expression. Mobile Genetic Elements: Insertional elements, transposons in Bacteria, Maize and Drosophila.

REFERENCE BOOKS

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT272
TITLE OF THE COURSE : TECHNIQUES IN MOLECULAR BIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To skill students for isolation and quantitation of DNA and proteins from different sources.

COURSE OUTCOMES: 1. Student will be able to isolate and analyze DNA from different sources using appropriate buffers and partially purify proteins using common protocols.

1. Estimation of DNA and RNA by UV-Vis Spectroscopy/Colorimetric method.
2. Partial purification of protein from plant source by Ammonium sulphate precipitation and its estimation.
3. Partial purification of protein from animal source by organic solvent (acetone) and its estimation.
4. Isolation of genomic DNA from plant source and its analysis using agarose gel electrophoresis.
5. Isolation of genomics DNA from animal/bacterial source and its analysis using agarose gel electrophoresis.
6. Column Chromatography (Demo)
7. Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC202
TITLE OF THE COURSE : PHYSIOLOGY OF LIVING SYSTEMS.
L: T/A: P: C : 3: 1: 0: 4

MODULE 1 **11Hrs**

Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods, Nitrogen balance, BUN, NPN, Calorific value of foods, bomb calorimeter.
Respiratory quotient, BMR, SDA and factors affecting them. Role of protein, lipid and carbohydrates as fuel molecules, Protein sparing effect of carbohydrates. Dietary fiber. Essential fatty acids and their biological importance**.** Food fortification & food supplementation, Minerals and vitamins.
Skeletal system: Tissues- introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodelling and regulation by hormones.

MODULE 2 **11Hrs**

Hematology and respiration: Blood components and their functions, blood groups: the ABO system, rhesus system, blood clotting factors, intrinsic and extrinsic pathways for blood clotting. Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxy hemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.
Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

MODULE 3 **10Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Structure and function of liver and Gall bladder, LFT.
Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

MODULE 4 **10Hrs**

Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and non-myelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and

adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

MODULE 5 **10Hrs**

Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

REFERENCES BOOKS

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC272
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVE: 1. To provide an advanced understanding and applied knowledge of the clinical biochemistry.

COURSE OUTCOME: 1. Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.

1. Qualitative analysis of normal and abnormal components of urine – ketone, sugar, urea, uric acid, Creatinine, protein.
2. Protein/DNA by UV absorption.
3. Protein by Folin - Ciocalteu method,
4. Iron by Ossian's method
5. Phosphate by Fiske – Subbarow's method
6. Creatinine by Jaffe's method
7. Glucose estimation by Miller's method
8. Calcium estimation by Alizarin S

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN202
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Basic study of the chemical and genetic organization of the human genetic material.
2. Basic mutations and modifications of the genetic materials

COURSE OUTCOMES:
1. Learn the composition and backbone of the genetic material (DNA).
2. Understand different ways of genetic alterations and its consequences- benefits and drawbacks. This course will instigate higher thought process in the field of genetics manipulations.

MODULE 1 CHEMICAL BASIS OF HEREDITY 11Hrs

DNA as genetic material, Experiments of Griffith, Avery, MacLeod, McCarty and Hershey - Chase. RNA as genetic material- Experiment of Fraenkel and Singer. Nucleic acids: DNA structure and types (A, B and Z model), RNA types and structure. DNA Replication: DNA Replication in prokaryotes and rolling circle model, DNA Replication in eukaryotes

MODULE 2 GENE EXPRESSION 11Hrs

Genetic code - Brief account, central dogma. Transcription - Initiation, elongation, termination (rho dependent and rho independent termination). Post Transcriptional modifications. Translation - Initiation, elongation and termination in prokaryotes and eukaryotes. Regulation of gene expression: Inducible operon - galactose, Repressible operon - tryptophan

MODULE 3 GENOME ORGANISATION AND FINE STRUCTURE OF GENE 10Hrs

Prokaryotic genome - Chromosomal and plasmid, Eukaryotic genome - Chromosomal and organellar, Fine structure of the Gene - cistron, muton and recon. Organelle genomes - Chloroplast and Mitochondria

MODULE 4 Bacterial Genetics AND TRANSPOSABLE ELEMENTS: 10Hrs

Conjugation - F factor mediated, Hfr and Sexduction. Transformation. Transduction - Generalized and specialized. Bacteriophage genetics. Types and classification, Transposable elements in Maize and *Drosophila.*

MODULE 5 MUTATIONS 10Hrs

Introduction and types of gene mutations - Base substitution, Frame shift mutation (insertion, deletion, missense, nonsense mutation). Mutagens - physical and chemical. Reverse mutation in bacteria. DNA repair mechanism (Mismatch repair photo reactivation, excision and SOS repair). Beneficial and harmful effects of mutations.

TEXT BOOKS

1. Watson J. D., Hopkins N. H., Roberts J. W., Steitz J. A. and Weiner A.M. 1987. Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company, Menlo Park, CA.
2. Alberts B., Johnson. A., Lewis J., Roff M., Roberts K. and Walter P. 2002. Molecular Biology of the Cell IV Edition. Garland Science, New York.

REFERENCE BOOKS

1. Gestel and Cech R. T. and Atkins J. 1999.The RNA World. II Edition. Cold Spring Harbor, New York.
2. Twyman R. M. 1998. Advanced Molecular Biology. Viva Books Ltd.
   Turner P. C. 2002. Instant Notes in Molecular Biology. Viva Books.
3. Hames D. and Hooper N. M. 2002. Instant Notes in Biochemistry. II Edition. Viva Books.
4. Brown T.A. 2002.Genomes. Viva Books.
5. Darnell J., Lodish H. and Baltimore D. 1990. Molecular cell Biology. II Edition. Scientific American Books, New York.
6. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
7. Watson J. D. 1992. Recombinant DNA Technology. W. H. Freeman Publisher.
   Bharadwaj D.N. 2008. Molecular Genetics. Kalyani Publisher.
8. Daniel L. Hartl and Jones W. 2011. Genetics: Analysis of Gens and genomes. VII Edition. Jones and Bartlett Publishers.
9. Hartwell L., Hood L. and Goldberg M. L. 2008. Genetics: from genes to genomics. McGraw-Hill publications.
10. De Robertis, E. D. P. and De Robertis E. M. F. 2001. Cell Biology and Molecular Biology. VIII Edition. Lippincott Williams & Wilkins Publishers.
11. Rastogi S. C., Mendiratta N. and Rastogi P. 2008. Bioinformatics: Methods and applications. III Edition. PHI Learning Publishers.
12. Chiranjib C. 2004. Bioinformatics: Approaches and applications. Biotech Books Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN272
TITLE OF THE COURSE : MOLECULAR GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction and usage of the different instruments in a basic molecular genetics lab.
2. Different methods of isolation and study of the genetic material (DNA).

COURSE OUTCOMES:

1. Students will appreciate the methods of DNA isolation and its manipulations and its potential applications.
2. Student will also be able to make connections with the different techniques and its usage in identifying and understanding genetic diseases.

1) Instrumentation:
   Centrifuge
   Ultra centrifuge
   pH meter
   Electrophoretic MODULE
   Spectrophotometer/colorimeter
2) Extraction of DNA from:
   Plants (Cauliflower/Coconut endosperm/any)
   Animal tissue (Liver Tissue/any)
3) Paper Chromatography for Separation of:
   Leaf pigments
   Drosophila eye pigments
   Amino acids
4) Electrophoresis
   Agarose gel electrophoresis
5) Mutations:
   Study of examples of mutations: Sickle cell Anaemia Missense mutation and Thalassemia frame shift mutation.
   Induction of Mutation in *Drosophila* and detection of sex linked lethal by Muller 5 stock

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB202
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.
2. To adapt molecular and biotechnological techniques to research and industry for the welfare of mankind.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.
2. Describe the applications of molecular biology in areas such as transgenic plants and animals, vaccines and therapeutic agents.

MODULE 1: INTRODUCTION TO NUCLEIC ACIDS AND REPLICATION 11Hrs

Structure of bases – A, T, G, C and U. Definition of nucleosides and nucleotides,Watson and Crick model of DNA, Types of DNA (A, B and Z), Types of RNA and their functions. Modes of replication- Conservative, Semi conservative (Messelson and Stahl experiment) and Dispersive. Methods of DNA replication (Rolling circle and Linear), and mechanism of Prokaryotic DNA replication.

MODULE 2: GENE EXPRESSION AND REGULATION 11Hrs

Central dogma, Transcription- mechanism, post transcriptional modification. Translation - mechanisms, post translational modification in prokaryotes. The operon concept, induction, repression catabolic repression and attenuation. The lac operon and trp operon.

MODULE 3: RECOMBINANT DNA TECHNOLOGY 10Hrs

History and fundamentals of r-DNA technology, Tools for r-DNA technology

Enzymes: DNA manipulative enzymes, Restriction enzymes, Ligases and other DNA modifying enzymes

Gene cloning vectors: Salient features, Plasmids- properties, types pBR322, bacteriophages- λ and M 13, Cosmids-properties, Bacterial Artificial Chromosomes (BAC's),Yeast Artificial Chromosomes (YAC's), *Agrobacterium tumifaciens*, SV 40.

MODULE 4: TOOLS IN rDNA TECHNOLOGY 10Hrs

Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). Cutting of DNA molecules. Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters.

Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment.

MODULE 5: SCREENING, SELECTION AND APPLICATIONS 10Hrs

Insertional inactivation, in situ colony/DNA hybridization, Polymerase chain reaction, blotting techniques and immunological techniques. Applications of Genetic Engineering: a) Medicine: Gene therapy b) Agriculture: nif gene cloning

Potential hazards and safe guards of genetic engineering.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis – an Introduction. Sixth edition. Wiley Blackwell.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Cooper, G.M. 2013. The Cell – A Molecular Approach. 6th edition. Sinauer Associates.
5. Karp, G. 2008. Cell and Molecular Biology. 5th edition. McGraw Hill Book Company, New York.
6. Nelson, D.L. and Cox, M.M. 2007. Lehninger's Principles of Biochemistry. Fourth edition. Macmillan Press/Worth Publishers. New Delhi.
7. Palmer, T. and Bonner, P.L. 2007. Biochemistry, Biotechnology and Clinical Chemistry. Second edition. Wood head Publishing co.
8. Prescott, L.M. Harley, J.P. and Klein, D.A. 2011. Microbiology. Eight edition. WCB – McGrawHill, New York.
9. Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene manipulation and Genomics. Seventh edition. Blackwell Publishing.
10. Singh, B.D. 2008. Biotechnology – Expanding Horizons. Kalyani Publishers.
11. Watson, J. D. Recombinant DNA, Scientific American Books, New York.
12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levne, M., and Losick, R. 2004. Molecular Biology of the Gene. Fifth Edition. Pearson Education.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB272
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.

1. Determination of λmax for the given biomolecule (Protein/DNA/ Sugar)
2. Isolation of Genomic DNA from bacteria
3. Isolation of plasmid DNA from bacteria
4. Analysis of genomic DNA by Agarose gel electrophoresis
5. Estimation of DNA by DPA method
6. Estimation of RNA by orcinol method
7. Demonstration of the following models/ photographs/charts of DNA, t-RNA, Replication, Trancription, Translation, Transformation, conjugation and transduction. DNA repair mechanisms.
8. Demonstration of instruments – PCR, Southern Blotting assembly
9. Charts on genetic engineering- pBR 322, pUC 18 and 19, SV 40, Bacteriophages- Lambda, Gene cloning, Selection of recombinants by replica plate technique.
10. Kit based experiments
    - Restriction digestion
    - Ligation
    - Transformation

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16CH202
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 4
L: T/A: P: C : 3 : 1: 0: 4

COURSE OBJECTIVES: 1.To introduce the basic concepts of phase rule, colloidal solutions, nuclear, radio chemistry and different aspects of solid state chemistry like different crystal systems etc.,
2. The basic concepts of organic chemistry like carboxylic acids, amines and heterocyclic compounds will be introduced to the students.

COURSE OUTCOMES: 1. The student will be well versed with one component, two component systems in phase rule MODULE .Similarly, the differtypes of colloidal solutions and ther behaviors and applications will be known by students after learning this MODULE.

2. The students will be familiar with different types of organic acids, their acidic strengths, reactivity orders, reactions and their preparations. Similarly, with heterocyclic compounds and amines.

MODULE 1 **11Hrs**

Phase Equilibria, Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method).
Colloids: The Colloidal State, preparation and purification of colloids and their characteristic properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

MODULE 2 **11Hrs**
Solid state, Crystalline state, Laws of crystallography. Symmetry elements in cubic systems, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation. Problems Liquid crystals-Types (Smectic, Nematic and Cholestric) with examples. Applications. Superconducting solids-High temperature superconductors. Applications.

Water Technology
Types of impurities present in water. Causes for the hardness of water. Permissible levels of ions present in water. Treatment of water for domestic and Industrial purposes by the following

methods. i) Demineralization of water by Ion exchange method. ii) by reverse Osmosis method. Removal of fluorides in water.

MODULE 3 **11Hrs**

STEEL

Chemical composition of Steel. Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of Steel. Ferro alloys: Production of ferro chrome, ferro manganese, and ferro silicon and their applications. Carbon steel: classification. Heat treatment: hardening, case hardening, carbiding, nitriding, tempering and annealing.

Nuclear and Radiochemistry.

Instability of nucleus, binding energy its calculations. Radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ-radiation,α,n,p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes- use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

MODULE 4 **11Hrs**

CARBOXYLIC ACIDS AND THEIR DERIVATIVES

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidity of carboxylic acids Acidic strength (pKa values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (Comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids; benzoic and p-nitrobenzoicacid; benzoic acid and p-aminobenzoic acid).Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Nucleophilic substitution at the carboxylic carbon-General mechanism. Relative reactivity of acid derivatives. Decarboxylation and reduction (using LiAlH4).Acid derivatives: Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates). Acid anhydrides (hydrolysis, reaction with alcohol, ammonia).Esters (alkaline hydrolysis, ammonolysis and alcoholysis).Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalyzed.

Amines

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimde synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quarternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 10, 20and 30amines. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (Conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (phydroxyazobenzene and 1-phenylazo-2-naphthol).

MODULE 5 08**Hrs**

HETEROCYCLIC COMPOUNDS

Introduction, classification - monocyclic and bicyclic, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Comparison of basicity of pyrrole, pyridine and piperidine.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16 CH272
TITLE OF THE COURSE : Inorganic Chemistry (Practical)
L: T/A: P: C : 0 : 0 : 4 : 2

COURSE OBJECTIVES:

1. In practical classes, the students will be give hands on training on semi- micro qualitative analyses of mixture of two simple inorganic salts.
2. In practical classes, the students will be given hands on training on paper chromatographic technique. Using this technique, the sudents will be separating the metal cations. They will also calculate the Rf values of different species present in the mixture.

COURSE OUTCOMES:

1. After the practical classes, the students are well familiarized in semi-micro-qualitative analysis of mixture of two inorganic salts.
2. After the practical classes, the students are well familiarized with paper chromatographic technique for separation of analyses in mixtures.
3. The students can measure and calculate the different parameters of the effluents during effluent analysis.
4. The students can become experts of solvent extraction techniques.

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixture of salts with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+}) using paper chromatography and calculation of Rf values.
3. Separation of Mg (II) and Fe (II) by solvent extraction technique.
4. Effluent analysis.
5. Separation of Phosphate / Borate ions.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16EP292
TITLE OF THE COURSE : ENTREPRENEURSHIP

L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT HRS: 26 HRS

MODULE 1: THE NATURE AND IMPORTANCE OF ENTREPRENEURS 5h

Nature and Development of Entrepreneurship, Definition of Entrepreneur Today, Entrepreneurial Decision Process, Role of Entrepreneurship in Economic Development, Intrapreneurship, Entrepreneurship, Entrepreneurial Careers and Education, The Future of Entrepreneurship Module.

MODULE 2: THE ENTREPRENEURIAL AND INTRAPRENEURIAL MIND 6h

The Entrepreneurial Process, Identify and Evaluate the OpportMODULEy, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise, Managerial versus Entrepreneurial Decision Making, Causes for Interest in Intrapreneurship, Corporate versus Intrapreneurial Culture, - Climate for Intrapreneurship, Intrapreneurial. Leadership Characteristics, Establishing in the Organization, factors affecting entrepreneurship — qualities of successful entrepreneurship.

MODULE 3: SMALL & MEDIUM ENTERPRISES (SME) 5h

Role of SME, concept and definitions of SME, government policy and SME in India, growth and performance of SME sector, problems for SMEs, Sickness in SME, criteria to identity sickness, causes, symptoms and remedial measures of sickness, institutional support for SMEs.

MODULE 4: STARTING THE BUSINESS - BUSINESS IDEA & INNOVATION 5h

Business idea, OpportMODULEy Recognition , Product Planning and Development Process, Establishing Evaluation Criteria, Idea Stage, Concept Stage Product Stage, Test Marketing Stage, Creativity, Innovation and entrepreneurship, barriers to creativity, techniques for improving the creative process, corporate entrepreneurship, causes, climate, intrapreneurial leadership characteristics, Establishing intrapreneurship in the organization.

MODULE 5: LEGAL ISSUES FOR THE ENTREPRENEUR 5h

Various forms of organization, Legal Issues in Setting up the Organization, The various statutory registrations and clearances required.

REFERENCES:

1. M. Lall, Entrepreneurship, Excel books
2. Vasant Desai:- Dynamics of Entrepreneurial Development and Management. HPH
3. Hisrich, Robert D., Peters, Michael P., and Shephered, dean a: entrepreneurship, Tata McGraw hill; sixth edition, 2007
4. Mathew J Manimala:- Entrepreneurship at the Crossroads - Biztantra
5. Mohanty – Fundamentals of Entrepreneurship, Prentice Hall of India
6. Zimmerer & Scarborough – Essentials of Entrepreneurship & Small BusinessManagement, Prentice Hall of India

SEMESTER V

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT301
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGY AND BASICS OF ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To equip the students with cells and organs of immune system and immunological techniques.
2. To provide basic understanding on animal cell culture and applications of animal biotechnology in modern research.

COURSE OUTCOMES:
1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge on animal biotechnology and its application.

MODULE 1 **09Hrs**

Elements of Immune System: History and scope of Immunology, Innate and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Interleukins and Interferons – brief introduction and their important functions. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE 2 **09Hrs**

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting antigenicity, antigen processing and presentation, antigen processing cells (APCs); Major Histocompatibility Complex (MHC) – MHC I and II, Antibodies – structure, types and functions of Immunoglobulins

MODULE 3 **09Hrs**

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence.
Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

MODULE 4 **09Hrs**

Animal Cell Culture: Introduction, history and scope of Animal Biotechnology, Facilities inAnimal Cell Culture, Media – natural and chemically defined, importance of serum in the media.Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK)

MODULE 5 **09Hrs**

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep)

REFERENCE BOOKS

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
3. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. Health
4. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
5. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
6. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
7. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
8. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT371
TITLE OF THE COURSE : IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To acquaint the student with the important techniques in immunology and animal biotechnology.

COURSE OUTCOMES: 1. Student will be well equipped with immunological techniques utilized for diagnostic assays.
2. Students will be skilled to set up primary cell culture and perform cell count and cell viability assay.

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Preparation of media for animal cell culture
7. Isolation of liver parenchyma cells by mechanical method and set up primary culture
8. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
9. Isolation of cells by explant method and Sub-culturing
10. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT321
TITLE OF THE COURSE : ENVIRONMENTAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To impart basic knowledge in environmental science, environmental issues and the management.
2. To familiarize the significant techniques in biotechnology that contribute to environment protection.

COURSE OUTCOMES:
1. Student will be well acquainted with the role of various environmental pollutants, and environment monitoring techniques.
2. Students will be familiarized with the waste water treatment, bioremediation and bioleaching.

MODULE 1 **10Hrs**

Sources of Energy: Renewable and non-renewable sources of energy, Conventional fuels and their environmental impact, Modern fuels and their environmental impact, methanogenic bacteria, microbial hydrogen production, biogas production, conversion of sugar to alcohol, gasohol, biofuels.

MODULE 2 **10Hrs**

Waste management: Treatment of municipal solid waste and industrial effluents, preliminary treatment, primary treatment – sedimentation, secondary treatment – aerated lagoons, activated sludge, batch reactor, trickling filter, rotating biological contractor, packed bed process, pond treatment system – aerobic, anaerobic and facultative, tertiary treatment – solid, nitrogen, phosphorus removal and disinfection.

MODULE 3 **09Hrs**

Bioremediation: Bioremediation techniques – *in situ* and *ex situ*, bioremediation of soil and water contaminated with oil spills, heavy metals and detergents, Phytoremediation, degradation of pesticides and toxic chemicals by microorganisms - aromatic and chlorinated hydrocarbons, petroleum products, genetically modified organisms in bioremediation

MODULE 4 **07Hrs**

Bioleaching: Microbes used in leaching, mechanism, leaching process, some case studies related to bioleaching.

MODULE 5 **09Hrs**

Environment monitoring: Bioindicators (Terrestrial & Aquatic), Biosensors of pollution
Novel methods for environment protection: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products.

REFERENCE BOOKS

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
2. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
3. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
4. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT322
TITLE OF THE COURSE : INDUSTRIAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
2. To familiarize students with downstream processing and production of important microbial products.

COURSE OUTCOMES: 1. Student will be aware of fermentation process, types of fermentation media and strategies for isolation of industrially important strains.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.

MODULE 1 **09Hrs**

Screening and Selection of strains: Introduction, basics of fermentation technology, Isolation and screening of microorganisms, maintenance of strains, strain improvement – mutant selection, recombinant DNA method

MODULE 2 **10Hrs**

Fermentation Media, Fermentors and Fermentation: Fermentation media – natural and synthetic, media sterilization, Types of Fermentors – Basic design, Airlift, tower and bubble cap fermentor; Immobilized cells and enzyme fermentor; Types of Fermentation -Solid state, submerged, Batch, Fed-batch and Continuous.

MODULE 3 **08Hrs**

Downstream Processing: Solid-liquid separation (Filtration, flocculation, centrifugation, sedimentation),

MODULE 4 **08hrs**

Downstream processing for release of intracellular products – physical, enzymatic, chemical, concentration and purification of products.

MODULE 5 **10Hrs**

Production of Microbial Products: Production of wine, beer, citric acid, penicillin, glutamic acid, Vitamin B12, Amylase, insulin, fermented foods (Yoghurt, cheese), Single Cell Protein (SCP)

REFERENCE BOOKS

1. Glazer and Nikaido (1995), Microbial Biotechnology, WH Freeman and Co.
2. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
3. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
4. Nduka Okafor (2007) Modern Industrial Microbiology and Biotechnology, CRC Press

5. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
6. LEJR Casida (2007) Industrial Microbiology, New Age International Publishers
7. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC301
TITLE OF THE COURSE : ENZYME TECHNOLOGY AND PROTEIN CHEMISTRY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Learning about enzyme properties along with enzyme and inhibition kinetics.
2. Knowledge of enzyme assay and drawing enzyme assisted reaction plots.
3. Brief idea about the various coenzymes.
4. Introduction to Protein structure understanding with various examples.
5. Studying analytical techniques to characterize proteins including brief introduction to proteomics.

COURSE OUTCOMES:
1. They will have a working knowledge of the active site of the enzyme and how it helps in reactions.
2. Students will be equipped with adequate knowledge on drawing various plots to understand the nature of enzyme and inhibitor.
3. Students will know the classification and function of various proteins along with their structural hierarchy.
4. They will also be able to analyze results obtained after protein characterization.

DEPARTMENTAL ELECTIVE 1:

MODULE 1 **9 Hrs**

INTRODUCTION: Classification & nomenclature of enzymes, Active site: Lock & key, induced fit model and strain/TS theory- lysozyme and chymotrypsin as examples, Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientationeffect, Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogenphosphorylase) enzymes, MODULEs-Katal & IU. Effect of physical and chemical parameters on enzyme activity with examples.

MODULE 2 **9 Hrs**

ENZYME KINETICS: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km. Bisubstrate reactions – brief introduction.

ENZYME ASSAY AND PURIFICATION: Enzyme assay, Specific activity. Enzyme isolation and purification, criteria for enzyme purity. Isoenzymes and clinical applications, Biotechnological applications, enzyme biosensors.

MODULE 3 **9 Hrs**

VITAMINS AND COENZYMES

Structure and reaction mechanisms of vitamins – fat-soluble: A, D, E & K; water-soluble: Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, cobalamine and ascorbic acid.

MODULE 4 **9 Hrs**

PROTEINS

Classification based on composition, shape and function, assay techniques. Peptide bond, Ramachandran Plot, Structural organization: primary, secondary, tertiary and quaternary structures, Hemoglobin, Immunoglobulin, Collagen, myosin and Keratin structures. Denaturation and melting temperature, Hofmeister series. Protein synthesis.

MODULE 5 **9 Hrs**

INTRODUCTORY PROTEOMICS: Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography. Sequence determination by Sanger and Edman methods. Mass spectroscopy of proteins: mass determination, Hydropathy plot, Protein Expression, Vectors and hosts, downstream processing.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC371
TITLE OF THE COURSE : ENZYMOLOGY AND RECOMBINANT PROTEIN PURIFICATION
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To introduce students to various practical aspects of enzymology;and give them hands on learning in function and kinetics of enzymeand their role as catalyst and regulator of cell metabolism.
2. Serve as foundation for more advanced enzymology courses.
3. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation, expression and purification of recombinant protein

1. Isolation of enzymes from biological source and activity determination
2. Determination of kinetic constants through LB plot.
3. Effect of temperature and Arrhenius constant.
4. Effect of enzyme dilution
5. Effect of substrate concentration
6. Effect of pH
7. Effect of activator
8. Effect of inhibitor
9. Immobilization of enzyme using calcium alginate.
10. Preparation of competent cells and transformation
11. Protein purification by Ni- NTA Affinity chromatogram
12. SDS-PAGE of purified protein
13. Protein concentration determination from spectrophotometry
14. Purification of protease from plant by ammonium sulphate fractionation
15. Protease assay through FC method

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC321
TITLE OF THE COURSE : CHEMISTRY AND METABOLISM OF CARBOHYDRATES AND PROTEINS
L: T/A: P: C : 3: 0: 0: 3

DEPARTMENTAL ELECTIVE 2:

COURSE OBJECTIVES: Learning structure and reactions of carbohydrates used in metabolism by living systems. Learning about the physiological reactions undertaken by living systems to breakdown the carbohydrates and release of energy. To have a brief idea about amino acid metabolism with examples. To learn about the metabolic roles performed by small peptides.

COURSE OUTCOMES: Once the course is over, students will be able to draw structure of mono, di and polysaccharides. They will have an overall idea about the role carbohydrates play in energy storage and usage. Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems. They will understand the role of urea cycle and the various functionalities that peptides play in metabolism.

MODULE 1 **9 Hrs**

CARBOHYDRATE CHEMISTRY
Biological importance and classification. Fischer structure, D-L designation. Glucosestructural elucidation and conformation. Ring and open-chain structure of fructose, galactose, mannose and arabinose. Epimers and anomers, pyranose and furanose ring. Reactions: Benedict's, oxidation, osazone, ester, amino and deoxy sugar formation. Derived monosaccharide: structure and biological importance of amino sugars and sugar phosphates. Oligosaccharides: glycoside linkage, structure and biological importance of sucrose, maltose, lactose, isomaltose, cellobiose and trehalose.
Polysaccharides: starch, glycogen, cellulose, inulin, chitin and pectin. Mucoploysaccharide: glycosaminoglycans, cell wall components: peptidogycan and teichioc acid.

MODULE 2 **9 Hrs**

CARBOHYDRATE METABOLISM
Glycolysis, entry of other carbohydrates into glycolysis, the fate of pyruvate, the citric acid cycle, the energetics of glucose metabolism. Enzymatic control of glycolysis and TCA cycle. The amphipathic role of the citric acid cycle. Outline of pentose phosphate pathway and its significance.

MODULE 3 **9 Hrs**

The Cori cycle, Gluconeogenesis and glycogen metabolism. Substrate level phosphorylation, regulation of blood sugar level. Diabetes mellitus. Determination of glucose in body fluids; fasting, post-prandial, GTT. Glycogen storage disorders.

MODULE 4 **9 Hrs**

AMINO ACIDS

Protein and non-protein amino acids, structure and classification of α-amino acids, acidsbase, chemical and optical properties. Synthesis and degradation of selected amino acids (tyrosine, methionine, glutamine), transamination, deamination, Urea cycle.

MODULE 5 **9 Hrs**

PEPTIDES AND PROTEINS

Biologically important peptides- leptin, ghrelin, neuropeptides, substance P, enkephalin, angiotensin, defensin, vasopressin and oxytocin. Chemical synthesis of peptides.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC322
TITLE OF THE COURSE : NUTRITION AND BIOMEMBRANES
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.Introduction to nutrition, food components and micronutrients.

2. Idea about biological membrane and the transport systems that allow material movement through the membrane.

COURSE OUTCOMES: 1. Students will have an idea about the nutritional quality of food stuff and know about a balanced diet.
2. They will be aware of the various processes that can be made to increase nutritional quality of food.
3. Students will know the ultra-structure of membranes and have detailed knowledge about the role of each component.
4. They will be able to interpret the various movements through the membrane and the types associated with them.
5. They will have an idea about how proteins are sent to various parts of a cell.

MODULE 1 **9 Hrs**

INTRODUCTION TO NUTRITION: Food as source of nutrients, functions of food, definition of nutrition, nutrients & energy, adequate, optimum & good nutrition, malnutrition. Nutrition - fitness, athletics & sports.

MODULE 2 **9 Hrs**

FOOD COMPONENTS AND AVAILABILITY: Basic five food groups How to use food guide (according to R.D.A.) Interrelationship between nutrition & health. Sources, function, storage and deficiency of carbohydrates, fats, oils, fiber and proteins. Water - as a nutrient, function, sources, requirement, water balance & effect of deficiency.

MODULE 3 **9 Hrs**

MICRONUTRIENTS: Minerals - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium Vitamins (water & fat soluble) - definition, classification & functions. Functional food, food fortification, food additives, role of FDA.

BIOLOGICAL MEMBRANES: Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, composition and trans bilayer asymmetry, Isolation of membrane components, effect of lipid size and saturation on membrane fluidity, role of cholesterol, lipid rafts, non-bilayer lipids and their role in membrane, Liposomes; properties and application in membrane biochemistry

MODULE 4 **9 Hrs**

TRANSPORT ACROSS MEMBRANE: Passive – ion channels, ionophore and porins; Facilitated diffusion: aquaporin, gated ion channels – sodium and potassium ion channels in muscle, calcium ion channel in heart; Active transport – P, V and F-type ATPase – structure, function and location, ATPbinding cassatte transporters and multi drug resistance transporters, patch-clamp study.

MODULE 5 **9 Hrs**

PROTEIN TRAFFICKING: Protein sorting; Membrane enclosed organelles of eukaryotic cells, evolutionary origin Protein trafficking: Sorting signals. Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Intracellular vesicular trafficking, Vesicles: types, Clathrin coated- Assembly and disassembly.

REFERENCE BOOKS

1. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
2. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell , The McGraw-Hill .
3. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science .
4. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier .
5. Molecular Biology of the Cell, Alberts et al., Garland Publications .
6. Molecular Biology of the Cell; 6 th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science .
7. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co.
8. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley
9. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell .
10. Textbook of medical Biochemistry Chatterjee and Shinde, JP Medical Ltd, 8th edition.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN301
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Understand the usage of other sources for DNA manipulation
2. Diverse methods to visualise modified genetic materials.

COURSE OUTCOMES:
1. Students will appreciate the different techniques of manipulating the genetic material and further validating it.
2. Student will understand how experiments need to be carried out carefully and with well planning. This will teach the concept of "attention to details"

MODULE 1- INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING 9Hrs

Introduction to Genetic Engineering: Overview of major steps involved. Tools for Genetic Engineering: Enzymes and Vectors. Enzymes: Restriction endonucleases: Types and characteristic features; Nomenclature; Modification of cut ends. DNA ligases. Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

MODULE 2- VECTORS 9Hrs

Properties of an ideal vector. Types: Cloning and expression vectors Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages - Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.* For higher plants: Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV). For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes

MODULE 3- GENE ISOLATION AND TRANSFER 9Hrs

Isolation of the desired gene: cDNA library, Genomic library, Organo-chemical synthesis, Amplification through PCR. Direct gene transfer methods: Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method). Selection and screening of recombinants: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutritio Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.

MODULE 4- GENETIC ENGINEERING TECHNIQUES 9Hrs

Technique for Genetic Engineering: Gel electrophoresis: AGE and SDS-PAGE Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes.

MODULE 5- APPLICATIONS **9Hrs**

Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS

1. Sandhya M. Genetic engineering: Principles and practice, MacMillan India Ltd. 2008.
2. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.

REFERENCE BOOKS

1. Nicholl D. S. T. An introduction to Genetic engineering (2nd ED), Cambridge University Press, 200
2. Satyanarayana U. Biotechnology, Books and Allied (P) Ltd., Kolkata, 2008.
3. Purohit S. S. Biotechnology Fundamentals and applications, student Edition, Jodhpur, 2003.
4. Channarayappa. Molecular Biotechnology- Principles and practices, University press (India) Private Limited, 2006.
5. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. Genetics from Genes to Genomes. McGraw Hill. 2004.
6. Lewin B. Genes VIII. Oxford University Press. Oxford, 2003.
7. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India. 2004.
8. Brown T. A. Genomes 3. Garland Science Publishing, New York. 2007.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN371
TITLE OF THE COURSE : GENETIC ENGINEERING PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to instruments and isolation methods of the genetic materials.
2. Further study of quantification and manipulating of the genetic material with extra-chromosomal genetic material from other sources.

COURSE OUTCOMES:

1. Students will understand how genetic material from different sources can work together in genetic engineering.
2. Student with competitive approach can use this Multidisciplinary approach to think innovative concepts.

1. **INSTRUMENTATION:**
   - UV Transilluminator
   - PCR
2. **VECTORS:**

- pBR 322 and Cosmid,
- YAC,
- Ti plasmid - Binary vector,
- SV 40 (any one type)

3. **TRANSGENIC ORGANISMS:**
   - Plants-Bt cotton and Animals-Knock out Mouse

4. **EXPERIMENTS:**
   - Quantification of DNA by DPA method
   - Quantification of RNA by Orcinol method
   - Agarose Gel Electrophoresis of DNA
   -
5. **DEMONSTRATIONS:**
   - Isolation of Plasmid DNA
   - Restriction Enzyme digestion
   - Ligation of DNA fragment
   - Transformation- α complementation

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN321
TITLE OF THE COURSE : BASIC HUMAN GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of inheritance pattern and immunogenetics.
2. Highlight the applications of genetics in different aspects of life.

COURSE OUTCOMES:
1. Students will understand the application of genetic outside the lab.
2. Understand how early life genetic studies can help future generations.

MODULE 1 HUMAN CHROMOSOMES, INHERITANCE AND GENETIC DISEASES 9Hrs

Human Chromosomes: Normal Human Karotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes), FACS - Fluorescence activated cell sorter. Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.

MODULE 2 GENETIC DISEASES AND INHERITANCE PATTERN 9Hrs

Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis). Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria). X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD). X-linked Dominant Inheritance (Ex- Xg blood group). Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF). Multi-factorial inheritance (Ex.-Congenital malformations-Cleft lip and palate, Rheumatoid arthritis and Diabetes). Mitochondrial diseases (Ex.- Leber's heriditary optic neuropathy).

MODULE 3 IMMUNOGENETICS AND ONCOGENETICS 9Hrs

Immunology and Immunogenetics: Introduction to immunology, Cells of immune system, Genetics of immune system, Immune response, Innate and acquired immunity. Inherited immunodeficiency (Ex. X- linked agammaglobulinaemia). Major Histocompatibilty. Complex-Study of twins (MHC), HLA disease associations. Transplantation, graft-versus-host disease. Oncogenetics: Properties of malignant cells, Types of genes - Proto oncogenes, Oncogenes, Cellular oncogenes, Tumor Suppressor genes, Chromosomal abnormalities associated with specific malignancies - Acute Promyelocytic Leukemia (APL), Chronic Myeloid Leukemia (CML) and Retinoblastoma.

MODULE 4 DERMATOGLYPHICS, DIAGNOSIS AND THERAPY 9Hrs

Dermatoglyphics: Introduction and classification, Flexion creases. Dermatoglyphics in clinical disorders. Clinical applications, advantages and limitations. **Diagnosis:** Prenatal diagnosis: Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography. Invasive

methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Technology in reproductive assistance

MODULE 5 THERAPY AND ETHICS **9Hrs**

Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes. Gene therapy, Stem cells - Definition, types and sources. A brief account on Cord blood banking and Stem cell therapy. Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

TEXT BOOKS

1. Bhatnagar etal S.M. Essentials of Human Genetics. IV edition. Orient Longman. 1999.
2. Goldsby R. A., Kindt T. J. and Osborne B. A. Kuby Immunology. W. H. Freeman and Company, N. Y. 2000.

REFERENCE BOOKS

1. Lewis R. Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
2. Manage E. J. and Manage A.P. Basic Human Genetics. Rastogi Publications, Meerut. 1997
3. Gangane S.D. Human Genetics (2nd edition), B.L Churchill Livingstone Pvt. Ltd., New Delhi. 2001.
4. Mc. Kusick V.A. Mendelian inheritance in Man. 12 Edition, John Hopsins University Press. 1998
5. Cummings, M. R. Human Heredity: Principles and Issues. West Publishing Company. 1994.
6. Epstein, R. J. Human Molecular Biology. Cambridge Univ. Press, Cambridge. 2003.
7. Khoury, M. J., J. Little and W. Burke. Human Genome Epidemiology. Oxford Univ. Press,Oxford. 2004.
8. Motulsky, V. Human Genetics. Springer & Verlag, Berlin. 1977.
9. Strachan, T. and A. P. Reads, Human Molecular Genetics 3. Garland Science, London. 2004.
10. Abbas, A. K., A. H. Lichtman and J. S. Pober. Cellular and molecular immunology. W. B. Saunders Company. 1994.
11. Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter. Molecular Biology of the cell. V Ed. Garland Science, New York. 2008.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN322
TITLE OF THE COURSE : PLANT GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of plant genetics and gene regulation in plants.
2. Highlight the applications of plant genetics.

COURSE OUTCOMES:
1. Students will understand gene regulation and stress response pattern in plants.
2. Understand applications plant genetics study.

MODULE- 1: GENE REGULATION IN PLANTS 9Hrs

Over view of plants as genetic model systems, gene regulation in plants. Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf.

MODULE-2: GENE REGULATION DURING SRESS 9Hrs

Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes. Mechanism of self-incompatibility in plants.

MODULE- 3: APPLIED GENETICS OF PLANTS 9Hrs

Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction. Genetic basis of Crown Gall disease development. Agrobacterium- Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants.

MODULE- 4: PROTOPLAST TECHNOLOGY 9Hrs

Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application.

MODULE –5 BIOFERTILIZER 9Hr

Biofertilizer: Production and beneficial roles of Rhizobium, Innoculants and Azatobacter inoculants, field application of Rhizobium, Azatobacter blue green algae, mycorizal fungi and Azolla.

TEXT BOOKS

1. Altman A. and Hasegawa, P.M. Plant biotechnology and Agriculture – Prospects for the 21st Century, Elsevier Science Publishers, Amsterdam. 2011.
2. Chawla H.S. Plant Biotechnology, Oxford and IBH publishing Co. Pvt Ltd., New Delhi. 2003.

REFERENCE BOOKS

1. Brahma Mishra, Fertilizer Technology and Management, I.K. International Publishing House Ltd., New Delhi. 2009.
2. Genes and Agriculture, Jones and Bartlett Publishers, Boston. 1994.
3. Dickinson M. Molecular Plant Pathology. BIOS Scientific, Oxford, UK. 2003.
4. Purohit, S.S. Agricultural Biotechnology, Agribios, Jodhpur. 2006.
5. Rangaswami, G. and Bagyaraj. D.J. Agricultural Microbiology (2nd Ed.), PHI Learning, India. 1998.
6. Satyanarayana, U. Biotechnology, Books and Allied (P) Ltd., Kolkata. 2010.
7. Srivastava, P.S. Alka Narula, Sheela Srivastava. Plant Biotechnology and Molecular Markers, Anamaya Publishers, New Delhi. 2004
8. Griffiths A. J. F., Miller J. H., et al. An introduction to genetic analysis. W. H. Freeman, N. Y. 2000.
9. Ringo J. Fundamental Genetics. Cambridge Univ. Press, Cambridge. 2004.
10. Cullis C. A. Plant Genomics and Proteomics. Wiley-VCH. 2001.
11. Hughes M. A. Plant molecular genetics. Addison Wesley Longman Ltd. U.K. 1996.
12. Grierson D. and Covey, S. N. Plant molecular biology. Blackie Academic & Professional. London. 1998.
13. Murphy T. M. and Thompson W. F. Molecular plant development. Prentice Hall, New Jersey. 1988.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB301
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To observe importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
2. Explains geochemically and environmentally significant processes that the activities of microorganisms and the environmental factors controlling and limiting microbial activities

COURSE OUTCOMES: 1. Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.
2. To make use of how microorganisms may be utilised in agricultural biotechnology, including specific techniques such as cloning and expression of genes.

PART A: AGRICULTURAL MICROBIOLOGY

MODULE 1: BIOFERTILIZERS AND BIOLOGICAL CONTROL 9Hrs

Definition, types, characterization, mass cultivation of *Rhizobium*, *Azotobacter*, *Azospirillum*, and *Azolla* .Mode of application of biofertlizers, advantages and limitations.. ISI standards. Mechanisms of biological control, field applications of *Bacillus thuringiensis*, *Trichoderma* spp. and Nuclear Polyhedrosis Virus. Advantages and limitations.

MODULE 2: PLANT PATHOLOGY-I 9Hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases. Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies].

MODULE 3: PLANT PATHOLOGY-II 9 Hrs

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism). Genetic engineering methods Study of different plant diseases- Bacteria –

Blight of rice, Fungi – Rust of sorghum, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE 4: AEROBIOLOGY AND SOIL MICROBIOLOGY 9Hrs

Microbiology of indoor and outdoor environment, Significance of microorganisms in air, aerosols, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Hirst Trap, Liquid Impingers and Filteration. Control of Air borne microorganisms – Dust control, Filteration, Fumigation, UV light exposure.
Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism).General account of bioleaching, biodegradation and bioremediation

MODULE 5: AQUATIC AND WASTE WATER MICROBIOLOGY 9Hrs

Introduction, Natural waters (Atmospheric, Surface and Ground water), Zonation of water system, Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients), general account on water borne diseases and their management. Water Pollution: Sources, Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection.

Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

REFERENCE BOOKS

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.

7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB371
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To understand the fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems.

COURSE OUTCOMES: 1. To enable us to know how microorganisms may be utilised in agricultural microbiology.

1. Isolation and enumeration of bacteria, fungi and actinomycetes from rhizosphere soil
2. Examination of bacteriodes from legume root nodules
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
4. Demonstration of fungal contaminants in ground nut by standard blotter method
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Study of plant pathogens (specimens/charts)- Bacteria (Citrus canker, bacterial blight of rice), Fungi (Tikka Disease of ground nuts, red rot of sugarcane, rust of sorghum), virus (tobacco mosaic virus), mycoplasma (sandal spike)
7. Study of antagonism between soil microorganisms
8. Isolation of air borne microorganism by petriplate exposure method
9. Estimation of dissolved oxygen in water
10. Determination of Biological Oxygen Demand
11. Standard water quality analysis by MPN test
12. Estimation of total solids in sewage
13. Field visit to agriculture fields and sewage treatment plant

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB321
TITLE OF THE COURSE : FOOD MICROBIOLOGY (DEPARTMENTAL ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To exhibit depth and breadth of knowledge by demonstrating biological sciences, in the field of food microbiology
2. To related to food microbiology has interdisciplinary connections with other sciences, in particular food science.

COURSE OUTCOMES: 1. It will develop depth of understanding of the microbiology of food, food-borne diseases, food spoilage, fermentation of food and modern microbial analysis techniques relating to food.

2. It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current food analysis techniques.

MODULE 1: FOOD AS A SUBSTRATE AND FOOD BORNE DISEASES 9Hrs

Intrinsic and extrinsic factors in food affecting microorganisms; natural flora and source of contamination of foods in general. Food hazards, significance of food borne diseases, types – food infection (*E.coli*, Salmonellosis, Shigellosis), food intoxication: Bacterial (*Clostridium botulinum*, *Staphylococcus spp.*) and fungal (aflatoxins), Virus (Polio), Helminths (Tape worms), Protozoa (*Entamoeba*histolytica).

MODULE 2: PRINCIPLES AND METHODS OF FOOD PRESERVATION 9Hrs

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, nitrite and nitrates, antibiotics and bacteriocin.

MODULE 3: MICROBIAL SPOILAGE OF FOOD 9Hrs

Introduction, Different ways of food spoilage. Spoilage of Cereals, Vegetables, Fruits, Meat, fish, eggs and canned foods

MODULE 4: FERMENTED FOODS 9Hrs

Introduction, nutritional and therapeutic importance .Fermented Vegetables, Meat, Beverages, Bread, Idli, Single cell Protein (Yeast, Algae) and Mushrooms. General account on Probiotics and Prebiotics.

MODULE 5: MICROBIAL EXAMINATION OF FOOD AND QUALITY CONTROL 9Hrs

DMC, Viable colony count, dye reduction tests, MPN, immunological and molecular methods. Sampling schemes, Microbiological criteria, Control at source, Codes for Good Manufacturing practice, HACCP concept.

REFERENCE BOOKS

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van NostrandRheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB322
TITLE OF THE COURSE : DAIRY MICROBIOLOGY (ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide in-depth knowledge in various MODULE operations and basic concepts in dairy processing.
2. To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products

COURSE OUTCOMES: 1. Enables students about additional knowledge on microbiological analysis on organisms relevant for dairy products.
2. Knowledge of the most important spoilage and pathogens in dairy products has also been obtained.

MODULE 1: MICROBIOLOGY AND FERMENTATION IN MILK 9hrs

Physical and chemical properties of milk. Types of microorganisms in milk (bacteria, fungi and yeast). Source of microbial contamination of milk- Milk producing animal, Milking environment, utensils, equipment, water, personnel and packing material. Souring, lactic acid fermentation, colour and flavour fermentation, gassy fermentation, proteolysis and lipolysis.

MODULE 2: MILK BORNE INFECTIONS 9hrs

Introduction, Tuberculosis, Brucellosis, Listeriosis, Anthrax, Q fever, Cow pox, Foot and Mouth diseases.Preventive and Control Measures.

MODULE 3: MILK AND MILK PRODUCTS 9hrs

Dairy starter cultures, Fermented Dairy products – curd, lassi, yogurt, flavoured milk, cheese, condensed milks, acidophilus milk, kefir and milk powders.

MODULE 4: MICROBIOLOGICAL ANALYSIS OF MILK 9hrs

Rapid platform tests- organoleptic, clot on boiling, lactometer, titratable acidity, alcohol test, DMC, sedimentation tests and pH.Standard plate count, reductase test- MBRT, Resazurin test, Methylene blue test.

MODULE 5: MILK PROCESSING 9hrs

Collection, transport of Milk, Cold Storage,Pasteurization, sterilization, dehydration**,** and preservation of milk quality, Indian standards of grading milk. General account on milk adulteration: effects and detection.

REFERENCE BOOKS

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
3. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
4. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw- Hill Publishing Company Limited, New Delhi.
5. Varnam A.H and Evans M.G Food borne Pathogens, Wolfe Publishing House, London.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH 301
TITLE OF THE COURSE : PHYSICAL CHEMISTRY AND CHEMINFORMATICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.The basic principles and concepts of electrochemistry, ionic equilibria, photochemistry and chemoinformatics will be taught to the students.

2. In electrochemistry, the terms like equivalent and molar conductivities, their determinations, transport numbers and determinations, Nernst equations, numerical, pH measurements will be tought.

3. The basic concepts of chemoinformatics and its application in drug designing will be thought.

COURSE OUTCOMES:

1.The students will be well versed with the basic principles, terms and equations and methods to determine conductivities and pH measurements of the solutions.

2. The students will be familiar with buffer solutions, significance, preparations and significance.

3. The students will be familiar with the basic principles, terms ,laws, and equations regarding the photochemistry.

4. The students will be well versed with terms, concepts, and terminalagies used in chemoinformatics and their applications in drug analysis.

MODULE 1 9**Hrs**

Electrochemistry I: Review of electrolytes and Conductance and related terms Methods of determination of molar conductance. Conductometric titrations (only acid-basetype). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.Kohlausch's law and its applications: (i) evaluation of $\Lambda\infty$ and $\Lambda+$ $\Lambda-$ (ii) evaluation of degreeof dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv)determination of solubility from conductance of saturated solutions of sparingly soluble salts
(AgCl and $BaSO_4$). Problems based on the above concepts.Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel- Onsagar equatation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

MODULE 2 9**Hrs**

Electrochemistry II : Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of Eo of Zn/Zn2+ and Cu/Cu2+ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

MODULE 3 10**Hrs**

Ionic Equilibria : Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems based on the above concepts.Common-ion effect, buffers, buffer action buffer range and buffer capacity. pH of buffers.Henderson's equation and its derivation and applications. Applications of buffer in analyticalchemistry and biochemical processes in human body. Solubility product and ionic product inprecipitation and in qualitative analysis. Theories of indicators; selection of indicators and their limitations.

Photochemistry

Laws of photochemistry. Grotthus-Drpare law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemicaland thermal relations. Quantum yield of photochemical combinations of (i) H2 and Cl2 (ii) H2and Br2 (iii) dissociation of HI (iv) dimerization of anthracene.Photosensitization,photostationary equilibrium. Singlet and triplet states based on Jabloski diagram.Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensiors. Beer-Lambert's law and its limitataions. Numerical problems on absorption coefficient and molar extinction coefficient.

MODULE 4 9**Hrs**

Cheminformatics I: Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation. Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification. Database Concepts, Structured Query Language, Design of Chemical Databases, Data.Abstraction; Data Models (Elementary ideas only)

MODULE 5 8**Hrs**

Cheminformatics II: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
2. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. Oprea, T. I. Chemoinformatics in drug discovery. John Wiley & Sons: New York, NY, 2005
5. Andrew Leach, An Introduction to Chemoinformatics Johann Gasteiger (Editor), Thomas Engel (Editor) Chemoinformatics: A Textbook Wiley Publications.

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16CH371**
TITLE OF THE COURSE : **PHYSICAL CHEMISTRY & CHEMINFORMATICS**
L: T/A: P: C : **0 : 0 :4 : 2**

COURSE OBJECTIVES:

1.The experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The physical experiment like determination of % NaCl by missibility temperature method will be tought to students.

3.Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

COURSE OUTCOMES:

1.The students will be well versed with experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The students will be well versed with experiments determination of % NaCl by missibility temperature method will be tought to students.

3.The students will be well versed with Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

PRACTICALS

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a =b).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pKa of a weak acid by pH metric method.
10. Determination of percentage of sodium chloride by miscibility temperature method.
11. Introduction to chemistry related softwares such as ISIS Draw, Chemdraw, Origin etc.
12. Chemistry related Database such as Pubchem, Chemspider etc.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1 . Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH321
TITLE OF THE COURSE : INDUSTRIAL CHEMISTRY (ELECTIVE PAPER I)
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:
1. Introducing the basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. Introducing the raw materials, and properties of raw materials, in the synthesis of important industrial materials to students.
3. Introducing the basic concepts and principles of polymer chemistry to students.
4. Introducing the basic concepts and principles of nano materials, their synthesis, and Applications.

COURSE OUTCOMES:
1. The students will be well versed with basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. The students will be well versed with the raw materials, and properties of raw materials, in the synthesis of important industrial materials.
3. The students will be well versed with the basic concepts and principles of polymer chemistry to students.
4. The students will be well versed with the basic concepts and principles of nano materials, their synthesis, and Applications.

MODULE 1 11**Hrs**

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of paracetamol.

Industrial Materials II

Refractories: Properties, classification, determination of PCE values.

Abrasives – definition and classification with examples, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituent's of varnishes.

MODULE 2 09**Hrs**

Industrial Materials III: Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal-Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coalgas and composition of LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac,ranitidine, sulphanilamide and chloramphenicol.

Zeolites: Introduction, types of zeolites, manufacture of synthetic zeolites and applications.

Metal Organic Frameworks: Introduction, synthesis and important applications.

Dendrimers: Introduction, Synthesis (convergent, divergent and click chemistry) and important applications.

MODULE 3 **11Hrs**

Polymers : Fundamentals of polymers: Monomers, repeat MODULEs, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation,addition, free radical, ionic, co-ordination polymerization and ring opening polymerization,Types of polymerisation methods (Bulk, Solution, Suspension and Emulsion).Molecular weight and size. Polydispersion. Average molecular weight concepts– number,weight and viscosity average molecular weight. Numerical problems. Determination of molecular weights - viscosity method, osmotic pressure method.

Preparation and applications of the following types of polymers

1. Plastics:

i) thermosetting plastics(Phenol-formaldehyde)

ii) thermo softening plastics(PVC)

2. Fibers: Acrylic, polyamide, polyester types: one example for each

3. Rubber: Neoprene,

4. Fluoro Carbons: Teflon

5. Silicones: Polydimethysiloxane (PDMS)

6. Conducting Polymers: Polyaniline

MODULE 4 **10Hrs**

Super conductors and Fullerenes: Introduction, definition, type 1, type 2 and atypical. Preparation of high temperature super conductor-Y1Ba2Cu3Ox±δ, BCS theory (qualitative treatment only) and general applications of high temperature super conductors. Introduction to Fullerenes, definition, preparation and isolation of C60. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C60. Commercial uses of C60. Carbon nanotubes: definition, single wall and multi wall carbon nanotubes, applications.

MODULE 5 **04 HRS**

Nanomaterials: Introduction, definition and electronic properties. Different methods of production: top down and bottom up approach with examples. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles (silver oxide with gold composites).Important applications of nanomaterials.

Inorganic and organic nanoporous aerogels. Heat capacity of solids: Einstein and Debye equations.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. B.K Sharma ,Industrial Chemistry,Goyal Publication
2. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
3. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt.
4. Ltd. New Delhi, 2009
5. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005)
6. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
7. V. R. Gowariker, Polymer Science, Wiley Eastern(Chapters 1,2,9)

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH322
TITLE OF THE COURSE : PHARMACEUTICAL CHEMISTRY ELECTIVE -II
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Students are introduced to historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be thought to the students.
3. The students will be introduced to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be introduced to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

COURSE OUTCOMES : 1. Students will be well versed with historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be familiar to students after this course.
3. The students will be familiar to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be familiar to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

MODULE 1 **11Hrs**

Introduction Historical development of pharmaceutical chemistry, Codes of pharmaceutical ethics. Important aspects of pharmaceutical chemistry. 4 Hrs

Common diseases Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases.

Terminology Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti-metabolites. Absorption of drugs - routes of administration of drugs, factors affecting absorption.

MODULE 2 **10Hrs**

Assay of drugs Chemical, biological, immunological assays, LD50 and ED50 therapeutic index, drug dosage. 4 Hrs MODULE V: Designation of drugs Designation of drugs based on physiological action; Definition and two examples with structure each of: Anesthetics-General and local. Analgesics - Narcotic and synthetic.

MODULE 3 **10 Hrs**

Antipyretics and anti-inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins. Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents. Health promotingmedicines I Nutracenticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids.

MODULE 4 **10 Hrs**

Health promoting medicines II Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) –

MODULE 5 **4 Hrs**

Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases.

TEXT BOOKS

1. An Introduction to Medicinal Chemistry, Graham L Patrick, Oxford University press, 2017, ISBN-9780198749691.
2. The Organic Chemistry of Drug Design and Drug Action, Richard B Silverman,2014, Acadaemic press, ISBN-13:9780123820303.

REFERENCE BOOKS

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.
2. Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, 1995, New Delhi.
3. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.
4. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI Publishers.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16IP391
TITLE OF THE COURSE : BIOSAFETY, BIOETHICS, AND IPR
L: T/A: P: C : 2: 0: 0: 0

Total Credit– 26Hrs

MODULE 1: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8 Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6 Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol-status of implementation in India.

MODULE 3: BIOETHICS 4 Hrs

What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.

MODULE 4: INTELLECTUAL PROPERTY RIGHTS 3 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications-Biodiversity and farmer rights.

MODULE 5: PATENTS AND PATENT LAWS 5 Hrs

Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCE BOOKS

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (1998)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local CommMODULEies [Paperback],Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montegomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International

SEMESTER -VI

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT302
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To acquaint the student with the significant component of biotechnology -Recombinant DNA technology.

2. To impart knowledge on important tools, techniques, protocols for genetic engineering.

COURSE OUTCOMES:

1. Student will be well equipped with the scientific understanding of the fundamental requirement of recombinant DNA technology

2. Student will gain optimum knowledge of application of recombinant DNA techniques in today's Life science Research.

MODULE- 1 **09Hrs**

Tools for Genetic Engineering: Introduction to Recombinant DNA technology, DNA manipulative and Modifying enzymes – Restriction enzymes, DNA ligases, Alkaline phosphatases, polynucleotide kinase, exonuclease, DNase I, DNA polymerase and Klenow fragment, RNA dependent DNA polymerase, terminal nucleotide transferase.

MODULE- 2 **09Hrs**

Vectors – Basic features, Cloning vectors -Prokaryotic (pBR322, pUC18, Lambda phage, m13, cosmids), Eukaryotic vectors (YAC, shuttle vectors, Ti plasmid, Binary vectors, SV40, Retroviral and Vaccinia viral vectors) Expression vectors in Prokaryotes and Eukaryotes – Basic features, role of promoters. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion

MODULE- 3 **09Hrs**

Techniques in Recombinant DNA technology**:** Hybridization – Southern, Northern, Western, DNA Sequencing (Sanger's di-deoxy method), Basics of New Generation Sequencing, PCR, Real Time PCR, Construction of genomic library, cDNA library.

MODULE- 4 **09Hrs**

Selection and Screening of Recombinants: Identification and selection of transformed cells, Direct methods – insertional inactivation, blue-white selection, plaque formation, complementation of mutation, Indirect methods – colony hybridization, immunochemical detection, Use of selectable marker genes in eukaryotes for expression, Expression of cloned genes

MODULE- 5 **09Hrs**

Microarray, Yeast two hybrid system, *In vitro* Mutagenesis. Applications of r-DNA technology: Production of Insulin, Recombinant Vaccines, hGH, Role in gene therapy, GM crops, Ethics and Biosafety involved.

REFERENCE BOOKS

1. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
2. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
3. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication.
5. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT303
TITLE OF THE COURSE : PLANT BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide an overview of plant biotechnology with focus on plant tissue culture and their application in modern biology.
2. To equip the student with the fundamental understanding of different processes involved in plant biotechnology

COURSE OUTCOMES: 1. Student will gain fundamental knowledge in different techniques used in plant biotechnology.
2. Student will be familiar with transgenic plants and significant applications of plant biotechnology.

MODULE- 1 **10Hrs**

Introduction to Plant Tissue Culture: Initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin's, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications

MODULE- 2 **08Hrs**

Tissue and Organ Culture: Organ culture – anther, embryo, endosperm culture and applications, Ovary and Ovule culture Organogenesis and embryogenesis – technique and applications

MODULE- 3 **12Hrs**

Protoplast culture – isolation, mechanical, enzymatic, culture of protoplast and plant regeneration. Somatic Hybridization and Variations: Somatic hybridization, method of protoplast fusion – chemical and electro fusion, application, cybrids; Somaclonal Variants – production and screening methods of somaclonal variants and their significance.

MODULE- 4 **08Hrs**

Transgenics and Applications of Plant Biotechnology: Transgenic plants – technique of transformation (*Agarobacterium* mediated, physical and chemical methods of gene transfer), application of transgenic plants

MODULE- 5 **07Hrs**

Edible vaccines – vaccine production in plants, Hepatitis B vaccine. Role of Plant tissue culture in agriculture, horticulture and forestry. *In vitro* production of secondary metabolites.

REFERENCE BOOKS

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford

Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR **: VI SEM / III YEAR**
COURSE CODE **: 16BT372**
TITLE OF THE COURSE **: GENETIC ENGINEERING AND PLANT TISSUE CULTURE**
L: T/A: P: C **: 0: 0: 6: 3**

COURSE OBJECTIVES: 1. To skill students for basic techniques required to establish plant tissue culture
2. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. Student should be able to prepare and sterilize culture media and establish callus growth.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation.

1. Preparation of competent cells
2. Transformation of Plasmid DNA in competent cells and screening of transformants
3. Isolation of plasmid DNA and analysis using gel electrophoresis
4. Restriction digestion and ligation
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus
10. Production of synthetic seeds.

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC302**
TITLE OF THE COURSE : **BIOENERGETICS AND MOLECULAR PHYSIOLOGY**
L: T/A: P: C : **3: 0: 0: 3**
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Course Objective:

1. Production of energy through movement of electron rich substrates.
2. Learning about biological oxidation and production of ATP. 3. Introduction to hormones and their functionality.
4. Brief idea about cell cycle and programmed cell death

Course Outcome:

1. Once they complete the course, students will have an idea about the energy production processes that occur in a cell.

2. The ultimate goal of this course would be integrate the knowledge obtained in 5^{th} semester (through Enzymology and Carbohydrate metabolism) with the current semester courses (Lipid metabolism) to have an integrated holistic idea about how life functions through reactions.

3. They will also be aware of the various hormones that are synthesized by living systems that regulate metabolism. Students will be able to link this information with whatever has been learnt in the previous semester.

MODULE- 1 **9 Hrs**

BIOENERGETICS
Bioenergetics, Energy transformation in living systems and concept of free energy; Exergonic and endergonic reaction, ATP and other high energy compounds, energy coupling. Biological oxidation, standard reduction potentials of same biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions.

MODULE- 2 **9 Hrs**

BIOLOGICAL OXIDATION: Mitochondrial electron transport chain-components, reactions and structures, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation – ATPase structure (rotor-stator model) and function, Chemiosmotic theory, Regulation of ETC, thermogenin, Isolation of ETC components.

MODULE- 3 **9 Hrs**

ENDOCRINOLOGY: Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms. Signal transduction - G-protein as cellular transducer, adenylate cyclase

system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade. Functions of pancreatic, adrenal, pituitary and GIT hormones. Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.

MODULE- 4 **9 Hrs**

MOLECULAR BIOLOGY: Central dogma, prokaryotic and eukaryotic genomes, complexity of genomes, Enzymes and proteins related to prokaryotic replication and transcription.

MODULE- 5 **9 Hrs**

CELL CYCLE AND APOPTOSIS: Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Apoptosis: Caspases, structure, function and activation. Factors initiating apoptosis and steps leading to cell death. Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC303**
TITLE OF THE COURSE : **CHEMISTRY AND METABOLISM OF LIPIDS AND NUCLEIC ACIDS**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVE:

1. Introduction to structure and classification of lipids.
2. Learning about the various reactions in which lipids are broken down by living systems to generate energy.
3. Learning about nucleic acid structures and properties along with synthesis and breakdown.

COURSE OUTCOME:

1. Students will have an idea about the various lipid molecules and how they behave in contact with water.
2. They will be aware of the importance of lipid in energy storage.
3. Students will able to comprehend the synthesis and breakdown of RNA/DNA and the enzymes that assist in the process.

MODULE- 1 **9 Hrs**

LIPID CHEMISTRY

Classification of lipids. Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids. Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid. DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids).

MODULE- 2 **9 Hrs**

ARACHIDONIC ACID DERIVATIVES: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3. Lipoproteins & GPI-linked proteins: Types and functions. Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model. Steroids - Function of hopnoids, cholesterol, androgen and estrogens. Lipid peroxidation and its role as a stressmarker.

MODULE- 3 **9 Hrs**

LIPID METABOLISM: The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation, Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

MODULE- 4 **9 Hrs**

NUCLEIC ACIDS: Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides. DNA: Biological role, structure, polymorphism, denaturation, renaturation and Tm. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins. RNA: Types, secondary structure and biological role of various RNA

MODULE- 5 **9 Hrs**

NUCLEIC ACID METABOLISM: Metabolism of purine and pyrimidine nucleotides. Hyperuricemia & other inborn errors.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BC372
TITLE OF THE COURSE : ESTIMATION OF BIOMOLECULES
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVE: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

[1] Qualitative analysis of
a. carbohydrates,
b. amino acids,
c. proteins,
d. lipids and
e. Preparation of solid derivatives of monosaccharides – osazone crystal.
[2] Estimation of amino acids by formal titration.
[3] Estimation of ascorbic acid from biological samples by titrimetric method.
[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN302
TITLE OF THE COURSE : APPLIED GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To get a glimpse of the role of genetics application
2. Understand and integrate biology and computation

COURSE OUTCOMES:
1. Industrial and agricultural application of genetics
2. Development of key skill such as bioinformatics**.**

MODULE - 1 GENETIC RESOURCES AND BIODIVERSITY 9Hrs

Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centers of Diversity, Vavilovian Centers of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.

MODULE - 2 INTRODUCTION TO PLANT TISSUE CULTURE 9Hrs

Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.

MODULE - 3 HETEROSIS IN ANIMALS AND PLANTS 9Hrs

Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis-Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques-intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.

MODULE - 4 GENETICS IN MEDICINE & INDUSTRY 9Hrs

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying.

MODULE – 5 BIOINFORMATICS 9Hrs

Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.

TEXT BOOKS

1. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
2. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.

REFERENCE BOOKS

1. Singh B. D. Biotechnology. Kalyani Publication. 2002.
2. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
3. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
4. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
5. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
6. Phundan Singh , Elements of Plant Breeding. 2nd Edition. Kalyani Pulications. 2001
7. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.
8. Brown, T. A. Genetics: A Molecular Approach (2nd Ed.), Garland Science, New York. 2002.
9. Baxevanis and Bff Oluellette. Bioinformatics : A practical guide to the analysis of genes and proteins, Ad Wiley Interscince – new York. 2001.
10. Stephen Misener and Stephan A. Krawetz. Bioinformatics: Methods and protocol. Humana press, New Jersey. 2000
11. Des Higgins and Willie Tylore. Bioinformatics: sequence, structure and databanks, Oxford University press. 2000.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN303
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Basic knowledge on genome organization, mapping and the impact of the human genome project.
2. Understand the protein structure and analysis

COURSE OUTCOMES:
1. Students will understand the diversity of the genome organization and its implication
2. Students will learn how to apply the information to study at protein levels using various techniques.

MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION 9Hrs

Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: *Arabidopsis*, rice, yeast, *Drosophila*, *C. elegans* and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.

MODULE 2 GENOME MAPPING TECHNIQUES 9Hrs

Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.

MODULE 3 HUMAN GENOME PROJECT AND COMPARATIVE GENOMICS 9Hrs

History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes. Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.

MODULE 4 PROTEIN PROPERTIES AND STRUCTURE ANALYSIS 9Hrs

Classification of proteins, Backbone flexibility- Φ and ψ. Properties of amino acids - Hydrophobicity, Molecular weight, α and β propensities etc. Inter-atomic forces and protein structure, covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, charge/dipole interaction, Van der Waals forces, steric interaction. Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modeling.

MODULE 5 PROTEIN PROFILING 9Hrs

Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.

TEXT BOOKS

1. T.A. Brown, Genomes, Bios, 2002.
2. Liebler, Introduction to Proteomics, Humana, 2002.

REFERENCE BOOKS

1. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
2. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
3. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
4. Hawley and Mori, The Human Genome, Academic, 1999.
5. Lewis, Human Genetics, WCB, 1999.
6. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
7. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
8. Strachan and Read, Human Molecular Genetics, Wiley, 1999.
9. Sudbery, Human Molecular Genetics, Prentice Hall, 2002.
10. The Drosophila Genome. Science Vol. 267. 2000.
11. The Caenorhabditiselegans genome Science. Vol. 282. 1998.
12. The Arabidopsis Genome. Nature vol. 408. 2000

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16GN372**
TITLE OF THE COURSE : **APPLIED GENETICS, GENOMICS AND PROTEOMICS PRACTICALS**
L: T/A: P: C : **0: 0: 6: 3**

COURSE OBJECTIVES:
1. To understand the tissue culture techniques for genetic manipulation of plants/crops.
2. Use different genomic and proteomic approaches to genetics.

COURSE OUTCOMES:
1. Broaden horizon on the potential applications of plant and animal genome and proteome.
2. Hands on skills on the usage of bioinformatics tools to study genomic and proteomic data.

APPLIED GENETICS

1. Tissue culture techniques:

- Sterilization
- Explants preparation
- Media Composition and preparation
- Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
- Synthetic seed preparation

2.Study of different techniques in plant hybridization

3. Study of pollen fertility

4. Study of diagnostic kits - WIDAL & VDRL

5. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.

6. Study of hybrid animals - Poultry, dairy, fishery.

7. Homology sequence analysis using Blast and Fasta.

GENOMICS AND PROTEOMICS:

1) Physical mapping by Restriction mapping of plasmid DNA
2) Genetic mapping by RFLP analysis
3) RAPD analysis
4) DNA fingerprinting analysis: Parentage detection
5) Homogenization, fractionation and separation of enzymes/ proteins in plants and animals by SDS- PAGE method
6) Protein database study SCOP, DALIDD, CATH

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB302
TITLE OF THE COURSE : IMMUNOLOGY AND MEDICAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

PART A: IMMUNOLOGY

MODULE 1: ELEMENTS OF IMMUNE SYSTEM 9Hrs

History and scope of immunology, Definition and types of immMODULEy (innate and adaptive).Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT . Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immMODULEy, tolerance. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

MODULE 2: ANTIGENS AND ANTIBODIES 9Hrs

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types,Haptens, Super antigens, Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic), clonal selection theory of antibody production; Production and application of Monoclonal antibodies

MODULE 3: IMMUNOLOGICAL DISORDERS, ONCOLOGY AND TECHNIQUES 9Hrs

Definition, Hypersensitivity reactions (Definition and types), auto immune disorders, immunodeficiencies, graft vs host diseases.Brief concept of cancer immunology. Principles and applications of Precipitation, Agglutination, Complement fixation, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry andImmunoelectron microscopy.

PART B: MEDICAL MICROBIOLOGY

MODULE 4: INTRODUCTION TO MEDICAL MICROBIOLOGY 9Hrs

Normal flora of skin, oral cavity and other body regions.Relationship between normal microbiota and host. Pathogenecity, Virulence,Invasion,Toxins: Exotoxins, Enterotoxins and Endotoxins.Evasion.

MODULE 5: PATHOGENICITY AND ANTIMICROBIAL CHEMOTHERAPY 9Hrs

Epidemiology, etiology, pathogenesis and prophylaxis of the following: **Bacteria**–*Salmonella typhi*, *Staphylococcus aureus, Clostridium tetani, Mycobacterium tuberculosis, Treponemapallidum, Corynebacteriumdiphtheriae, Chlamydiae.* **Fungi–***Tricophytonspp.* and *Candida albicans.* **Viruses –**Hepatitis, Rabies, HIV and Ebola. **Prion diseases. Protozoa** – *Plasmodium vivax* and *Entamoebahistolytica*

Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration).Immunoprophylaxis- Vaccines and immunization schedule.

REFERENCE BOOKS

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB303
TITLE OF THE COURSE : MICROBIAL FERMENTATION
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2.To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

MODULE 1: INDUSTRIAL MICROBIOLOGY 9Hrs

Introduction to fermentation technology, history and development of fermentation technology. Isolation, Screening (Primary and Secondary), Enrichment, Preservation (storage at low temperature (liquid nitrogen), storage in soil, silica, mineral oil, Lyophilization) and Strain improvement of industrially important microorganisms. Culture collection centres

MODULE 2: FERMENTERS 9Hrs

Design, Construction and Components of a typical fermenter, types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

MODULE 3: FERMENTATION PROCESS 9Hrs

Introduction, Batch, continuous, surface, submerged and solid state fermentation. Control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

MODULE 4: DOWNSTREAM PROCESSES 9Hrs

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying, purification and concentration of products by chromatographic techniques.

MODULE 5: FERMENTATION PRODUCTS AND ECONOMICS 9Hrs

Industrial production of organic acids (Citric acid), Amino acid (glutamic acid), Alcohol (wine), Vitamin (vit B12), Antibiotics (penicillin), Enzymes (Amylase), Vaccines (Hepatitis B) and

hormones (human insulin). Market potential, fermentation and product recovery costs. General concepts and importance of IPR.

REFERENCE BOOKS

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
5. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
6. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
7. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
8. HolgerPalzelt, Thomas Brenner (2008) Handbook of Bioentrepreneurship. Springer Sciences.
9. Pandey A, Soccol RC and Larroche C (2008) Current Developments in Solid state Fermentation, Springer.
10. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
11. Santaniello V, Evenson RE, ZibermanDand Carlson GA (2003) Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issues in Biotechnology. Universities Press.
12. Carlos M, Correa (2010) Research Handbook on the protection of Intellectual Property Under WTO Rules. Intellectual Property in the WTO Volume I and II Edward Elgar Publishing.
13. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB372
TITLE OF THE COURSE : IMMUNOLOGY, MEDICAL MICROBIOLOGY AND MICROBIAL FERMENTATION
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVES: 1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.

1. Isolation of normal microflora from skin and oral cavity
2. Snyders test for dental caries detection
3. Blood grouping and Rh typing
4. Dot ELISA
5. Precipitation reactions: Ouchtlerlony Double Diffusion, Radial Immune Diffusion, Rocket Immuno electrophoresis
6. Antibiotic sensitivity test
7. Determination of effectiveness of antiseptics by thumb impression method
8. Identification of different types of blood cells
9. Production and determination of amylase activity
10. Preparation of wine
11. Study of different types of fermenters (Models/ Charts)
12. Cell immobilization techniques (yeast cells)
13. Sterility assays of pharamaceutical products

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH302
TITLE OF THE COURSE : INORGANIC & ANALYTICAL CHEMISTRY
L: T/A: P: C : 3: 0:0: 3

COURSE OBJECTIVES: 1.The students will be introduced to the concepts of coordination and organometallic chemistry.
2. The students will be introduced to the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be introduced to the basic concepts and principles of various chromatographic and electroanalytical techniques.

COURSE OUTCOMES: 1. The students will be well versed with the concepts of coordination and organometallic chemistry.
2. The students will be well versed with the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be well versed with the basic concepts and principles of various chromatographic and electroanalytical techniques.

MODULE 1 **11Hrs**

Co-ordination and Organometallic compounds

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra,penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclatureof coordination compounds. Theories of structure and bonding (Explanation for the formationof complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bondtheory-postulates, low spin and high spin complexes with examples (cobalt and nickel based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of [CoF6]3-, [Fe(CN)6]4Spectral properties of [Ti(H2O)6]3+, [Co(H2O)6]3+Isomerism-Structural: ionization, linkage, hydrate andcoordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.

Organometallic compounds

Ligands, classification (hapticity). Synthesis and structure of K[PtCl3(η2-C2H4)] Metal carbonyls – Cr(CO)6, Mn2(CO)10; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na2Ca,EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation.

MODULE 2 **10Hrs**

Chemical Spectroscopy I

The interaction of electromagnetic radiation radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular absorption spectra: Born-Oppenheimer approximation.

Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy.Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO2 and H2O molecules.

Raman spectroscopy

Concept of polarisability. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.

Spectroscopy II

UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and redshift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free andH-bonded), alkyl –C-H, C=C, C=C C=O, C-X and C-O groups (by taking suitable examples).

NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spinquantum number I, influence of the magnetic field on the spin of nuclei, spin population,saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclearshielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons.Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMRspectroscopy including identification of simple organic molecules.

MODULE 3 10**Hrs**

Chromatography

Principles of chromatography: Distribution coefficients, types of chromatography, selection of stationary and mobile phases in TLC, analyte development and elution. Chromatographic performance parameters-Retention time and volume, capacity factor, plate height and resolution.

Thin layer chromatography: Principle, apparatus-preparation of plates, sample application, plate development, detection of analytes. Applications.

Gas-liquid chromatography: Principle. Instrumentation, columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, and detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography**:** Principle and applications.

MODULE 4 10**Hrs**

Electroanalytical Methods

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME.Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential.Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

MODULE 5 04 **Hrs**

Analytical chemistry

Analytical chemistry- scope of analytical chemistry. Errors and treatment of analytical data: Limitations of analytical methods-Error-determinate and indeterminate errors, minimization

of errors. Accuracy and precision. Distribution of random errors, the normal error curve. Statistical treatment of finite samples-measures of central tendency and variability-mean, median, range, standard deviation and variance. Student's t-test.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
5. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH303
TITLE OF THE COURSE : BASICS IN BIOCHEMISTRY
L: T/A: P: C : 3 :0:0 : 3

COURSE OBJECTIVES:
1. The students will be introduced to various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be introduced to various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students will be introduced to bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be introduced to concepts of protein metabolism.

COURSE OUTCOMES:
1. The students will be well versed with various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be well versed with various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students well versed with bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be well versed concepts of protein metabolism.

MODULE 1 11Hrs

Carbohydrates: Structure and biological importance of derivatives of monosaccharides. Amino sugars: ß-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramicacid (NAMA); N-acetylneuraminic acid (NANA) Sugar acids–structure and biological importance of D-gluconic acid, D-glucuronic acid and D glucaricacid. Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P,Fructose-1,6-di-P, ß-D-ribose-5-P and ß-D-deoxyribose-5-P. Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose. Polysaccharides -source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

Lipids: Introduction, Classification. Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides-acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides. Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Cholesterol – definition,

types (HDL, LDL and VLDL) Sphingolipids–structure and biological significance of ceramide.

MODULE 2 **6Hrs**

Proteins α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non- essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Levels of organizations of Protein: Primary structure, Secondary structure (a-helix, triple helix eg., Collagen and ß-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure. Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with, ribonuclease. Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

MODULE 3 **11Hrs**

Nucleic Acids: Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide. Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs. Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Hormones: Definition. Classification -a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis. Mediators of hormone action – Ca2+, cyclic AMP.

Enzymes: Introduction, Holo enzyme (apo enzyme and co enzyme).Active site, specificity. Classification of enzymes (EC code number not required). Enzyme substrate interaction-Fischer and Koshland models. Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration, substrate concentration, pH and temperature (mention M. M. equation). Allosteric enzymes–definition and example. Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

MODULE 4 **10Hrs**

Biological Oxidation: Bioenergetics-Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and Keq. High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation ofATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reaction. Comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).Mitochondrial electro transport chain, oxidative phosphorylation. Substrate level phosphorylation.

MODULE 5 **8 Hrs**

Metabolism, Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic. Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, ß-oxidation pathway, energetics.
Protein metabolism– General aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.
Molecular Biology : Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation. DNA finger printing – Definition and its applications.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000. .
2. Biochemistry A. L. Lehningeret. al., CBS, 2000.
3. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.
4. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.
5. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH372
TITLE OF THE COURSE : INORGANIC CHEMISTRY AND BASICS IN BIOCHEMISTRY
L: T/A: P: C : 0:0: 6: 3

COURSE OBJECTIVES:

1. Conducting colorimetric estimations of biomolecuels viz., crabohydrates, lipids and proteins by various procedures.

COURSE OUTCOMES:

1. The students will be aware of the estimations and calculations invovlevd in estimating various biomolecules.

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na_2CO_3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.
11. Preparation of buffers and determination of their pH values using pH meter.
12. Estimation of reducing sugars by Hegdorn-Jensen method.
13. Estimation of lactose in milk by Nelson-Somyogi's method.
14. Estimation of creatinine by Jaffe's method.
15. Estimation of inorganic phosphate by Fiske-Subbarow method.
16. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
17. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
18. Identification of α-amino acids by paper chromatography.
19. Isolation of DNA from onions.
20. Estimation of cholesterol by colorimetric method.

TEXT BOOKS

1. College Chemistry, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

Semester: I

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BT101
TITLE OF THE COURSE : ESSENTIALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To equip students with the basic understanding of structures and functions of basic organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES: 1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control and different stages in cell division.

MODULE 1 **10Hrs**

Cell as a basic unit of living organisms. Discovery of cell and Cell Theory; Chemical components of a cell, catalysis and use of energy by cells, Comparison between plant and animal cells. Cell Wall and membrane structure; Cell wall; Plasma membrane – structure and functions of plasma membrane; Modifications of plasma membrane and intracellular junctions.

MODULE 2 **10Hrs**

Structure and functions of cellular organelles - Mitochondria, Chloroplast, ER, Golgi complex and Ribosome.

MODULE 3 **10Hrs**

Structure and functions of - Cytoskeleton, Centriole, Protoplasm, Cell motility; Structure and functions of cilia, and Flagella, Types-Amoeboid, Ciliary and Flagellar movements.

MODULE 4 **11Hrs**

Nucleus and chromosomes; Structure and functions of nuclear membrane, nuclear pore complex, Nucleolus and Chromatin. Chromosomes-Discovery, morphology and structural Organization-Centromere, Secondary constriction, Telomere, Chromomere, Euchromatin and Heterochromatin, chemical composition and karyotype. Ultra-structure- Single-stranded and multi-stranded hypotheses, folded fiber and nucleoside models. Special types of chromosome: Salivary gland and Lampbrush chromosomes.

MODULE 5 **11Hrs**

Cell division and Programmed Cell Death; a) Cell cycle - An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division. b) Mitosis: Significance of Mitosis, Breakdown of nuclear envelope, spindle fibers, Kinetochore, Anaphase movements. c) Meiosis: Types of meiosis, the first and second meiotic division, synaptonemal

complex. d) Programmed cell death (Apoptosis): intrinsic & extrinsic pathways of cell death, Apoptosis in relation with Cancer, Viral disease (AIDS) & Organ transplant.

REFERENCE BOOKS

1. Molecular Biology of Cell-Bruce Albert's et.al, Garland publications (2005).
2. Cell Biology &Molecular Biology EDP Robertis & EMF Robertis, Saunder College (2001).
3. Cell Biology C.B. Powar, Himalaya Publication (2004).
4. Cell Biology by David E Sadava, Jones and Bartlett Publications (1993).
5. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).
6. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **16BT171**
TITLE OF THE COURSE : **TECHNIQUES IN CELL BIOLOGY**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES: 1. To equip students with the basic techniques used in cell biology to study – cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES: 1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
2. Cell division: Study of mitosis using onion root tips.
3. Cell division: Study of and Meiosis in grasshopper testes/onion flower buds
4. Chromosomes: Mounting of polytene chromosomes
5. Preparation of Buccal smear for study of barr bodies.
6. Karyotype analysis-Man and onion Man-Normal and Abnormal-Down and Turner's syndromes.
7. Blood cell count by Hemocytometer.
8. Blood smear-differential staining.
9. Vital Staining of mitochondria.
10. Isolation of chloroplast from spinach leaves.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC101
TITLE OF THE COURSE : INORGANIC AND BIOPHYSICAL CHEMISTRY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: Introducing the Basic principles of General Chemistry, Inorganic chemistry and Biophysical Chemistry to the students.

COURSE OUTCOMES: The students will be familiarized with Basic concepts in General Chemistry, Inorganic and Biophysical Chemistry so that they will have a better understanding of advanced Biochemistry.

MODULE 1 **11Hrs**

Measurement: Units – SI and CGS, accuracy, precision and errors in quantitative analysis.
Atomic Structure: Electromagnetic radiation. Wave particle duality - de Broglie equation, The Heisenberg uncertainty principal. The Schrodinger wave equation. Quantum numbers. Atomic orbitals and their shapes. The Pauli's Exclusion principal, Hund's rule, Electronic Configuration.
Periodic Classification: Trends in the periodic table: ionic radii, ionization energy, electro negativity and electron affinity. Oxidation number
Chemical Bonding: Types of bonds, Ionic and covalent bond- VBT, MOT and CFT, Coordinate bond, Weak and hydrophobic interactions, Hydrogen bond. Examples in biological system – stability and solvation of biomolecules.

MODULE 2 **11Hrs**

Solutions and Colligative Properties: Concentration and amount – mole, molarity, molality, normality and mole fraction, Homogenous and heterogeneous solutions, Factors influencing solubility, solubility curves, Henry's Law applications, Donnan membrane equilibrium and its application in membrane stability, Relative lowering of vapour pressure, Raoult's law, Elevation of boiling point, depression of freezing point, Numericals.
Electrochemistry: Strong and weak electrolyte, activity, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- (brief) application in nervous system, Standard electrode potentials. Reference electrodes; Calomel and Glass, pHmeter basics, Ion selective electrodes and their applications.

MODULE 3 **10Hrs**

Acids, Bases and Buffers: Modern concepts of acids and bases. Ionization of acids. Dissociation of water. Ionic product of water. Common ion effect with examples, Definition and determination of pH and associated numerical, Buffer preparation by H-H equation – detailed calculations, buffer capacity. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.
Adsorption: Freudlich and Langmuir adsorption isotherm with derivations. Applications of adsorption.

Phase Rule: Definition of phase, component and degrees of freedom, Gibbs Phase rule statement, Application of phase rule to one component system- water and CO2, two component systems of water-phenol and water-KI System, Lever rule, Eutactic point, azeotropes, distillation. Concept of Partition coefficient.

MODULE 4 **10Hrs**

Chemical Equilibrium: Chatelier's principle, reversible reactions with examples, Calculation of Kp and Kc for selective reactions (Synthesis of ammonia and dissociation of HI)
Reaction Kinetics: Rate equation, Velocity constant-molecularity and order of a reaction, factors influencing rate of reaction, Kinetic Equation of zero, first and second order reactions-Arrhenius hypothesis and equation, Activated complex and energy of activation and its terms, transition state theory.

MODULE 5 **10Hrs**

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change of chemical reaction, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant.
Solid State: Types- Crystalline and Amorphous, Definition of Space Lattice, planes and Unit cell, Elements of symmetry, Law of Rational Indices and Miller Indices with simple numericals, Crystal defects and their applications.

Reference books

1. Concise Inorganic Chemistry - Lee. Wiley- Blackwell Publishing House.
2. Inorganic Chemistry: Principles of Structure and Reactivity - Huhee, Keiter & Keiter. Pearson Education Publishers.
3. Physical Chemistry – Atkins. Oxford University Press.
4. General and Inorganic Chemistry - Sarkar. Sapna Publishers.
5. Physical Chemistry- Pahadi. Central Publishers
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16BC171
TITLE OF THE COURSE : QUANTITATIVE ANALYSIS AND VOLUMETRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. Students will demonstrate basic skills in calibration and volumetric analysis methods.

COURSE OUTCOMES: 1. Students demonstrate acquisition of basic laboratory skills, calibration of glass ware and volumetric analysis.
2. They will develop ability to perform titrations, find the end point, calculate the molecular weight, strength and concentration from these experiments.

[1] GLP & Calibration of glassware.

[2] Acid-base: Preparation of standard potassium biphthalate and estimation of alkali.

[3] Redox: Preparation of standard sodium oxalate and estimation of potassium permanganate.

[4] Redox with indicator: Preparation of standard potassium dichromate solution and estimation of sodium thiosulphate.

[5] Chelatometry: Estimation of hardness of water using EDTA/Zinc sulphate

[6] Iodometry; Estimation of iodide with sodium thiosulfate.

[7] Argentometry: Chloride estimation by Mohr's method.

[8] Estimation of Iron by dichromate.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN101
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. To provide an introduction to Cell Biology from general organelles structure, composition and function.
2. Understand the evolution, insights and benefits in of model organisms in genetics

COURSE OUTCOMES:
1. Students can understand the multidisciplinary science of the eukaryotic cell biology.
2. Student will gain understanding of the eukaryotic and prokaryotic systems in genetic studies.

MODULE 1 -TECHNIQUES IN CELL BIOLOGY 10Hrs

Microscopy: Bright field, dark field, Phase contrast, Polarization, Confocal, Fluorescence and Electron microscopy (SEM and TEM) Centrifugation, Two photon microscopy.

MODULE 2 -ULTRA STRUCTURE OF CELL 11Hrs

Structure and types of cells: Prokaryotic and eukaryotic cells- characteristics and differences. Cell Wall: Ultra structure, chemical composition and function. Cell membrane: structure, chemical composition; fluid mosaic model- lipids, carbohydrates and proteins- transport channels Transport across membrane: diffusion, active transport, co-transport, bulk transport; ion gated channels- propagation of action potential; liposomes.

MODULE 3 -CELL ORGANELLES 11Hrs

Structure and functions of Nucleus, Nucleolus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Plastids, Lysosome, Ribosomes and Microsome.

MODULE 4- CELL CYCLE AND CELL DIVISION 10Hrs

Cell cycle: Interphase and M phase. Mitosis: Mitotic phases; cytokinesis; mitotic apparatus; stimulation and control of mitosis; significance of mitosis. Meiosis: meiotic phases; events of Prophase-I; structure and function of synaptonemal complex; significance of meiosis. Cell senescence and cell death: Programmed Cell Death (PCD)- mechanism and significance of Apoptosis and Necrosis.

MODULE 5- STUDY OF LIFE CYCLE 10Hrs

Bacteria- *E. coli,* Viruses: TMV, Bacteriophage - Lambda phage, Fungi- *Neurospora*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, *Drosophila.*

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.

REFERENCE BOOKS

1. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
2. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.
3. Powar C. B. Cell Biology. Vol I and II (1982) Himalaya Publication.
4. Nicklin J. et al., Instant notes in Microbiology (2003). Viva Books.
5. Brian E. S., Steer M. W., et al. Plant cell Biology: Structure and Function (1996) Jones and Bartlett.
6. Stern K. R. Introductory plant Biology, 8th Edition (2006) McGraw Hill,
7. Boston. Darnell J. H., Lodish and Baltimore D. Molecular Cell Biology. 2 Edition (1990) Scientific American Books.
8. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
9. Cooper G. M., Hausman R. E. The Cell: A Molecular Approach 6th Edition (2013) Sinauer Associates

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16GN171
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to different types of microscopy and sample visualization.
2. Hands on training in specimen preparation and study

COURSE OUTCOMES:

1. Gain experience in handling microscopes and learn the concept of being meticulous while preparing samples.
2. They will relate hands on training better with their theory courses

1) Handling of dissection, stereo and compound microscopes
2) Study of Model organisms
Bacteria- *E. coli*
Viruses: TMV
Bacteriophage - Lambda phage
Fungi- Neurospora
Caenorhabditis elegans
Arabidopsis thaliana
Drosophila
3) Staining of RNA and DNA with methyl green and pyronin (Paramecium)
4) Vital staining of mitochondria (Yeast)
5) Gram staining (E. coli/ Staphylococcus aureus)
6) Temporary squash preparation of onion root tips
7) Observation of: Mitotic stages in permanent slides

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB101
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. The importance of microorganisms to our global society.
2. The structure/function of cells, their metabolism and how they grow/divide.

COURSE OUTCOMES: 1. Provides a strong grounding in fundamental aspects of the basic biology.
2. Able to understand microorganisms and their environment, microbial structure and function.

MODULE 1 - HISTORY AND DEVELOPMENT OF MICROBIOLOGY 10Hrs

Development of microbiology as a discipline, spontaneous generation vs. biogenesis, development of various microbiological techniques, concept of fermentation and branches of microbiology. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald ross.

MODULE 2- MICROBIAL SYSTEMATICS 10Hrs

Binomial nomenclature, Whittaker's five kingdom and Carl Woese's threekingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. Brief account of Bergey's manual of bacteriology. Criteria for classification of bacteria.

MODULE 3 – MICROSCOPY AND STAINING TECHNIQUES 10Hrs

Study of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope, Fluorescence and Electron Microscope (TEM and SEM).

Fixation, types of dyes. Simple staining(negative staining), Differential staining- Gram staining, acid-fast staining, Staining of specific structures- endospore staining, capsule staining, flagella staining and cell wall staining.

MODULE 4 - CULTURE MEDIA AND PURE CULTURE TECHNIQUES 10Hrs

Microbial Nutrition: Common nutrient requirements, Nutritional types of microorganisms and growth factors. Uptake of nutrients by cells.
Culture Media: Synthetic or defined media. Basal media and Special Media - selective, differential, enrichment media, enriched media and transport media
Isolation of bacteria and fungi by serial dilution technique and Methods of pure culture techniques. Introduction to uncultivable microorganisms.

MODULE 5 - CONTROL OF MICROORGANISMS 10Hrs

Fundamentals of control- Thermal death time
Physical methods of control: Dry heat -Flaming, Incineration and hot air oven.

Moist heat - Boiling, Pasteurization, Fractional sterilization-Tyndallization and heat under pressure (autoclave).
Filtration –Diatomaceous earth filter, Seitz filter, membrane filter and HEPA Filters
Radiation- Ionizing and Non- ionizing radiations
Chemical methods: Alcohol, aldehydes, phenols, halogen, metallic salts, quaternary ammonium compounds and sterilizing gases as antimicrobial agents. Study of antiseptic and disinfectants.

Reference Books

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Benson, H.J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
4. Brock, T.D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
5. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
6. Pelczar, M.J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
7. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
8. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
9. Salle, A.J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill PublishingCompany Limited, New Delhi.
10. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India Private Limited, New Delhi.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16MB171
TITLE OF THE COURSE : FUNDAMENTALS OF MICROBIOLOGY (PRACTICAL)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To equip students with the basic microbiology techniques

COURSE OUTCOMES: 1. To understand microorganisms and their environment, microbial structure and function

1) **Biosafety measures in Laboratory**
2) **Use and care of compound microscope and simple microscope**
3) **Study of basic instruments in Microbiology laboratory**
    - Autoclave
    - Hot air oven
    - Incubator
    - pH meter
    - High speed centrifuge
    - Colorimeter / Spectrophotometer
    - Anaerobic jar
    - Bacterial Filters
    - Laminar air flow.

4) Microscopic examination of bacterial smear
    - Simple staining
    - Gram's staining
    - Capsule staining
    - Endospore staining
    - Cell wall staining

5) **Sterilization of glasswares** (Chromic acid preparation)
6) **Aseptic techniques –** Preparation of cotton plugs for test tubes and pipettes, wrapping of petriplates and pipettes.
7) **Preparation of culture media**:
    - Basal media (Nutrient agar and broth, Czapekdox media and MRBA);
    - Selective media (EMBagar and McConkeyagar),
    - Enriched media (Blood agar).

8) Isolation of bacteria and fungi by serial dilution technique

9) Methods of pure culture techniques
    - Pour plate technique
    - Spread plate technique
    - Streak plate technique

10) Transfer of media and inoculum
    - Slant culture technique
    - Broth culture technique
    - Stab culture technique

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH101
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1
L: T/A: P: C : 3:1:0:4

COURSE OBJECTIVES:

1. Introducing the basics principles of General Chemistry, physical chemistry and Organic Chemistry to the students.

2. The basic concepts of General Chemistry, Physical Chemistry and organic Chemistry involving the important concepts in each branch will be introduced to the students.

COURSE OUTCOMES:

1. The students will be familiar with basics principles of General Chemistry, Physical Chemistry and Organic Chemistry

MODULE 1 **11Hrs**

Atomic Structure:

de Broglie matter waves. Heisenberg uncertainty principle. Schrödinger wave equation. significance of wave functions, emergence of Quantum numbers. radial and angular wave functions, Atomic orbitals, shapes of s, p and d orbitals. Radial distribution curves of 1s, 2s,2p, 3s, 3p atomic orbitals. Energy level diagram of atomic orbitals (up to 4s), Aufbau and Paulis exclusion principle. Hund's multiplicity rule. n+l rule, pairing energy, exchange energy, (explain by taking filling of electrons in p and d orbitals) electronic configuration of elements.

The Periodic Table and Chemical Periodicity:

Modern periodic law: The relationship between chemical periodicity and electronic structure of the atom. *The long form of the periodic Table*: Classification of elements in s,p,d and f block of elements. Periodicity in oxidation state of elements, metallic/non-metallic character, oxidizing and reducing behaviour; acidic and basic character of oxides; trends in bond type with position of element and with oxidation state for a given element; trends in the stability of compounds and regularities in methods used for extraction of elements from their compounds; *s and p block elements:* Anomalous behaviour of elements of 2nd period (Li to F) compared to other members in the same groups of s & p block elements; The diagonal relationship between elements, the inert pair effect; *d-block elements:* General valence shell configuration of 3d series elements (also in box diagram) variable oxidation states, colors, magnetic properties and catalytic properties of transition elements.

MODULE 2 09**Hrs**

Noble gases:

Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF2, XeF4, XeF6, XeO3, XeO4).

Hydrogen:

Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and parahydrogen, Industrial production of hydrogen by chemically assisted electrolysis, Photobiological water splitting, Biocatalysed electrolysis and Steam reforming. *Heavy water:* Physical properties (with comparison to light water), Applications. *Hydrogen bonding:* definition, types, importance *Hydrates:* Chemical nature and their stability.

MODULE 3 **05Hrs**

The First Law of Thermodynamics:

Introduction: Thermodynamic terms and basic concepts, intensive and extensive properties, State functions and differentials, thermodynamic processes, reversibility, irreversibility, nature of heat and work, conservation of energy, *First law of thermodynamics:* Various statements of first law, Manipulations of first law, internal energy (U) and enthalphy (H). Reversible isothermal expansion of ideal and real gases, Molar heat capacity at constant pressure CP and at constant volume CV, relation between CP and CV, Reversible adiabatic expansion of ideal and real gases, Joule Thomson effect.

MODULE 4 **11Hrs**

Gaseous state:

Introduction: Need for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations).Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems .Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves. Derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagats mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b. *Law of corresponding states* - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition(no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

MODULE 5 **11 hrs**

Organic reaction intermediates:

Covalent bond, Bond cleavage **–** homolytic and heterolytic. Types of reagents **–** electrophilic and nucleophilic reagents. *Reactive intermediates* - generation of carbocation, carbanion, carbon free radicals and carbenes **–** explanation for stability and reactivity of the above intermediates based on inductive, resonance and hyperconjugation effects. *Types of organic reactions* **–** substitution, addition, and elimination (free radical, electrophilic and nucleophilic types). *Concept of*

isomerism – structural isomerism, stereo isomerism - geometrical and optical isomerism, chiral center – definition and examples. Tautomerism (keto – enol) in carbonylcompounds).

MODULE 6 **05 hrs**

Alkanes and Cycloalkanes:

Definition, classification, IUPAC nomenclature, the alkyl groups (stick formula of a fewbranched and unbranched alkanes) 1o, 2o and 3o carbon atoms, in alkanes. *Alkanes:* sources, methods of preparation - Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids). Physical properties: melting points, boiling points and solubility. Chemical reactions of alkanes – combustion, halogenation ,mechanism of free radical halogenation of methane; orientation, reactivity and selectivity. Uses of alkanes. *Cycloalkanes* – nomenclature, methods of preparation by Carbene insertion and Dieckmann condensation reactions, chemical reactions – oxidation, Halogenation and Opening reactions of three and four membered rings, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strain less rings. The case of cyclopropane ring;- banana bonds.

Alkenes:

Definition, classification, Preparation of alkenes by Wittig reaction. Chemical properties: Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4. Ozonolysis- mechanism and importance.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16CH171
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 1 PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Students will be given instructions like Good Laboratory practies, significant figures, volumetric calculations.(problems to be solved).
2. Students will be trained to calibrate various glass ware like pipette, burette and standard volumetric flasks.
3. The various volumetric titration experiments will be introduced to students like acid base redox etc.,.
4. The titration experiments can be deigned to estimate N_2 in ammonia, carbonate in bicarbonate ,chloride etc.,

COURSE OUTCOMES:

1. The students will be well versed with all the necessary laboratory practices.
2. The students will independently calibrate the glass ware before using for experiments.
3. The students will be able to use the principles of titration experiments in volumetric analysis.
4. The students can be able to estimate the carbonate, nitrogen, chlorine from the various matrix given.

1. Good Laboratory practices, significant figures, volumetric calculations. Problems to be solved)
2. Calibrations of pipette, burette and standard volumetric flasks.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous ammonium sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of sodium thiosulphate using standard potassium dichromate solution.
6. Estimation of iodine using standard sodium thiosulphate.
7. Determination of percentage of manganese dioxide in pyrolusite ore.
8. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
9. Estimation of nitrogen in an ammonium salt using sodium hydroxide solution and standard oxalic acid.
10. Estimation of carbonate and bicarbonate in a given mixture.
11. Determination of the percentage of available chlorine in the given sample of bleaching powder.
12. Estimation of chloride by Mohr's method (using potassium chromate as an adsorption indicator).

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 16EP191
TITLE OF THE COURSE : ENVIRONMENT AND PUBLIC HEALTH
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT - 26 HRS

MODULE 1 **3h**

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 **4h**

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 **5h**

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4h**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4h**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6h**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.
- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.

- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore
3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER: II

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BT102
TITLE OF THE COURSE : PRINCIPLES OF MICROBIOLOGY AND BIOSTATISTICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about classification and diversity of microorganisms and familiarize the students with the cultivation of microorganisms and sterilization techniques.
2. To impart the basic concepts in biostatistics.

COURSE OUTCOMES: 1. Student will be aware of basic microbiological and sterilization techniques.
2. Student will have sufficient understanding of statistical methods used in biological sciences for data handling.

MODULE 1 **10Hrs**

Historical perspectives of microbiology: Introduction – microbial origin, Contributions and discoveries, Germ theory, Scope of Microbiology. Concept of Sterilization - Definition of sterilization, disinfection, Sanitization, antisepsis and fumigation. Physical, Chemical and radiation methods of sterilization, and their applications.

MODULE 2 **11Hrs**

Classification of Microbes: Systems of classification, Numerical taxonomy, Identifying characters for classification, General properties and principles of molecular classification of microorganisms Systematics of bacteria, Nutritional types (Definition and examples). Classification on the basis of oxygen requirement. General Account of Viruses and Bacteria; Bacteria-Ultra structure of a bacterial cell (both Gram positive and Gram negative) endospore and capsule.

MODULE 3 **11Hrs**

Microbes in Extreme Environment; Nature, special features of the thermophiles, methanogens and halophiles, Archaea; photosynthetic bacteria, Cyanobacteria, some Archaea living in extreme conditions like cold, and space (Extremophiles). Pathogenic Microorganisms; A. Plant viruses-CAMV, Animal Viruses-Hepatitis B, Bacterial virus- lambda phage B. The common bacterial, fungal and viral diseases of human beings (Name of the disease, causative pathogen, parts affected).

MODULE 4 **10Hrs**

Biostatistics: Importance and Applications; Tabulation and classification of Data - Frequency distribution and graphical distribution of Data; Measures of Central Tendencies - Mean, Median, Mode and their properties; Measures of Dispersion - Mean Deviation, Variance, Standard Deviation and Coefficient of Variation;

MODULE 5 **10Hrs**

Hypothesis testing - Student T and Chi Square test; Probability and distribution - Concepts and problems on probability, Binomial, Poisson, normal distribution and their application.

REFERENCE BOOKS

1. Microbiology-Pelczar, Chan, Krieg Tata McGraw Hill Publications (2000)
2. Microbiology- Concepts and applications by Paul A. Ketchum Wiley Publications (2001)
3. Fundamentals of Microbiology –Frobisher, Saunders & Toppan Publications (2003)
4. Microbiology –Ronald M. Atlas (1990)
5. Introductory Biotechnology-R.B Singh C.B.D India (1990)
6. Microbiology by L M Prescott, Mc Graw Hill
7. General Microbiology –C.B. Powar, H.F. Daginawala, Himalayan Publishing House (2001)
8. Fundamental of Biostatistics by Khan and Khanum, Ukaaz Publications (1994)
9. Statistics for Biologists by RC Campbell, Cambridge University Press (1989)
10. Biostatistics by Wayne W Daniel, Wiley 10th Edition (2014)

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16BT172**
TITLE OF THE COURSE : **MICROBIAL TECHNIQUES**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES: 1. To make the students aware of basic microbiological techniques.

COURSE OUTCOMES: 1. Student will be trained in basic sterilization and microbiological techniques.

1. Sterilization: principles & operations – Autoclave, Hot Air Oven, Filtration, Laminar Air Flow
2. Common instruments used in a microbiology Lab: Principles and operations - Incubators & Shakers Centrifuge pH meter Colorimeter Spectrophotometer
3. Preparation of Microbial media (bacteria, yeast, mold, algae, protozoa)
4. Sampling and quantification of microorganisms in air, soil and water.
5. Isolation of bacteria - Streak plate, spread plate, pour plate, serial dilution (2 units)
6. Biochemical tests – IMViC, starch hydrolysis, catalase & gelatin liquefaction (3 units)
7. Antibiotic sensitivity test-paper disc method
8. Study of Rhizobium from root nodules of legumes.
9. Microscopic study of phytoplankton & zooplanktons.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC102
TITLE OF THE COURSE : ORGANIC CHEMISTRY, DRUG SYNTHESIS AND TOXICOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: This course will provide the basics in Organic chemistry and drug development. They will gain a basic knowledge of methods used in drug discovery and basic toxicology.

COURSE OUTCOMES: Students will recall the fundamental principles of organic chemistry that include chemical bonding, nomenclature, structural isomerism, stereochemistry, chemical reactions and mechanism. They will understand the basics in drug design and toxicology.

MODULE 1 **10Hrs**

Introduction: IUPAC nomenclature of organic compounds, Inductive effect, resonance and hyperconjugation, Reactive intermediates: carbocations, carbanions, carbines and free radicals.
Aliphatic and Aromatic Hydrocarbons: General characteristics of alkanes, alkenes and alkynes, substitution and bond opening reactions: Wurtz & Kolbe reaction for alkane, Hydrogenation with Merkownikoff's rule and ozonolysis of alkenes. Organometallic compounds - definition, examples and synthetic applications of Grignard Reagents. Baeyer strain theory. Sachse-Mohr theory. Boat and chair forms of cycloalkane. Axial and equatorial bonds. Benzene structure, Aromaticity, Huckel's rule, orienting influence of substituent on group addition.

MODULE 2 **10Hrs**

Mechanisms: Substitution of alkyl halides via SN1 and SN2, elimination via E1 and E2.
Alcohols: Definition and classification. Monohydric alcohols – general properties; distinguishing reactions of primary, secondary and tertiary alcohols – Lucas Test, Victor Meyer Test and Oxidation reactions. Acidity of phenol, Kolbe & Reimer-Tiemann reactions.
Acids and Aldehydes: Definition and examples. General properties, acid strength, esterification of acid, oxidation of alcohols to aldehydes and ketones. Keto-enol tautomerism, Perkin reaction, Claisen and aldol condensation, Cannizzaro reaction and reduction.

MODULE 3 **10Hrs**

Stereochemistry: Stereoisomerism: Optical isomerism: Molecular dissymmetry, Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism in alkenes and ring compounds. Structure and properties of malic and fumaric acid, E-Z system of specifying geometrical isomer, examples of chirality in the biological world.
Amines: Classification. Isomerism. Distinguishing reaction of 1°, 2° and 3° amines. pKb values of amines. Effect of substituents on the basic strength of amines. Some biologically important amines.
Heterocyclic Compounds, Terpenes and Alkalolds: Structure, formulae and occurrence of furan, thiophene, pyrrole, imidazole, pyridine and indole. Aromaticity of furan, thiophene,

pyrrole and pyridine. Isoprene rule, biological importance and occurrence of terpenes & alkaloids. Phytochemicals- Introduction and uses.

MODULE 4 **10Hrs**

Organic synthesis and Drug Design: Retro-synthetic planning and synthetic execution, retron and synthon. Michael addition, Diels Alder reaction, Organo-lithium and epoxide-based reactions to create synthones, Reaction of diazonium salts coupling reactions, ethyl acetoacetate and its synthetic application, increasing C-atoms by n units, selective removal of C-atoms. Physico-chemical aspects (Optical, geometric and bioisosterism) of drug molecules and biological action, Drug-receptor interaction Principles of Drug Design, Traditional analog (QSAR) and mechanism based approaches, Computer Aided Drug Designing (CADD) and molecular modeling. Synthesis of aspirin, anthraquinone, sulfanilamide, paludrine, acetaminophen (paracetamol) and pentothal**.**

MODULE 5 **10Hrs**

Toxicology: Toxins, venom, poison with examples, Dose Response curves, bioavailability, biosorption, IC50, LD50, ED50, Genotoxicity, Xenobiotics, Role of Cytochrome P450, Various mechanisms of Detoxification. Whole animal studies, Perfusion studies, Metabolic cage, Tissue culture, Common cell lines used for studying diseases.

REFERENCES BOOKS

1. Organic Chemistry-Morrison and Boyd. Prentice-Hall of India
2. Organic Chemistry-Solomons and Fryhle. Wiley & Sons.
3. A Guidebook to Mechanism in Organic Chemistry-Sykes. Longman Publishers.
4. Advanced Organic chemistry-Bahl and Bahl. S. Chand Publishing House.
5. A textbook of Modern Toxicology – Hodgeson. Wiley & Sons.
6. Practical Chemistry – Ghoshal, Mohapatra & Nad. Central Publishers.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16BC172
TITLE OF THE COURSE : Qualitative analysis and organic preparations
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To recognize the basic practical skills for the analysis and synthesis of organic compounds.

COURSE OUTCOMES: Predict and identify the organic compound after analysis. Students will also be able to synthesize few drugs like acetyl salicyclic acid and few other organic compounds.

[1] SYSTEMATIC QUALITATIVE ANALYSIS OF SAMPLE ORGANIC COMPOUND –

Alcohol
Phenols
Carboxylic acids
Aldehyde
Ketones
Esters
Aromatic hydrocarbons
Halocompounds
Amines

[2] ORGANIC PREPARATIONS:

a) Nitration of nitrobenzene
b) Acetylation of salicylic acid
c) Oxidation of benzaldehyde
d) Bromination of phenol/ acetanilide

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16GN102
TITLE OF THE COURSE : BASIC GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Introduction to genetic evolution and impact on genetics today.
2. Impact and diversity of genetics in life sciences**.**

COURSE OUTCOMES:
1. Students will understand the basic concept of hereditary
2. Student will understand genetic basis of human disease and extrapolate or critically evaluate other diseases they come across.

MODULE 1 -HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross. Pattern of inheritance in haploid and diploid organisms.

MODULE 2- EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementry and Complementry gene interactions; Non epistatic inter allelic gene interaction, Position effect

MODULE 3- SEX DETERMINATION 10Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridge s genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in *Drosophila*. Sex differentiation and dosage compensation *(Drosophila* and Man). Sex linked and sex limited traits in Humans- Hemophilia, Hypertrichosis.

MODULE 4- EXTRA CHROMOSOMAL INHERITANCE 10Hrs

Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in *Paramecium*, sigma factor in *Drosophila*, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 5- ELEMENTS OF BIOMETRY 10Hrs

Measures of Central tendency Mean, Median and Mode. Measures of Dispersion Range, Variance, Standard deviation and Standard error. Test of Hypothesis - Student s t test, chi square test. Probability - Basic concepts; Distribution- Normal, Binomial and Poisson.

TEXT BOOKS

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFERENCE BOOKS

1. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
2. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009)
3. McGraw-Hill. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
4. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
5. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
6. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
7. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16GN172**
TITLE OF THE COURSE : **BASIC GENETICS PRACTICAL**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. Genetic calculations to determine inheritance traits.
2. Basics of statistical analysis for determining quantitative inheritance.

COURSE OUTCOMES:

1. Ability to be able to determine understand the allele distribution using different types of crosses.
2. Apply statistical knowledge to address different types of genetic data.

1) Temporary squash preparation of:
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing
3) Study of:
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Computation of:
   Mean, median and mode
   Standard deviation and standard error.
5) Problems on:
   Student s t test and Chi square test.
6) Problems on Probability
7) Genetic problems on:
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB102
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Deliberate existing theories about the origin of life, microbial evolution and systematics
2. Make simple calculations of microbial growth kinetics in batch and continuous culture and describe how microbial growth can be controlled

COURSE OUTCOMES: 1. The course will enable students to relate the principles in classifying microbial systems and know their beneficial and harmful effects.
2. Enable to apply this knowledge in microbial biotechnology starting from screening of desired microbe

MODULE 1 - MORPHOLOGY AND STRUCTURE OF BACTERIA 10Hrs

Morphology of bacteria:- Size, shape and arrangement , Ultra structure of bacteria :- structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae .Bacterial cell wall and structure. Structures internal to the cell wall -Cytoplasmic membrane (Fluid mosaic model of Singer - Nicholson); Cytoplasmic inclusion bodies - (inorganic, organic);Nuclear material- Bacterial Chromosome (Fundamental differences with eukaryotic chromosome)Plasmids and episomes, Ribosomes, Exospores and Cysts: types and structure; Endospore.

MODULE 2 - SPECIAL MICROBIAL FORMS AND VIRUSES 11Hrs

General account of Archaebacteria, Actinomycetes, Rickettsiae, Mycoplasma and Chlamydiae. Early development of virology, General structure and characteristics of viruses, cultivation of viruses, general replication of viruses. Type study: classification, structure, replication, cultivation and application of - TMV, Polio virus, T4 and Lamada phage. Brief account of Viroids and Prions.

MODULE 3 - EUKARYOTIC MICROBES-I 10Hrs

Algae: General characteristics of algae including occurrence, thallus organization, alga cell ultrastructure, pigments, flagella, eyespot food reserves, and vegetative, asexual and sexual reproduction. Different types of life cycles in algae: Haplontic type, Diplontic type, Haplobiontic type, Diplobiontic type. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

MODULE 4 - EUKARYOTIC MICROBES- II 11Hrs

Fungi: General account of Fungi-General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis, asexual reproduction and sexual reproduction. Economic importance of fungi**,** Type study of Zygomycetes (*Rhizopus)*,

Ascomycetes (*Aspergillus,* yeast *and (Penicillium)*, Basidiomycetes (*Agaricus*)and Deuteromycetes(*Fusarium*).

Protozoa: General characteristics with special reference to *Amoeba, Paramecium, Giardia, Plasmodium, Entamoeba*.

MODULE 5- GROWTH KINETICS **10Hrs**

Definition of microbial growth, factors affecting microbial growth (pH, Temperature, Oxygen concentration, Pressure and Radiations), Cell division, Growth curve of bacteria, Kinetics of growth:- Mathematics of growth-generation time and growth rate constant. Measurement of growth: Measurement of cell numbers- Counting chambers, electronic counters, viable counting techniques, membrane filter technique. Measurement of cell mass- dry weight and turbidity measurement. Measurement of cell activity, Batch culture, Continuous culture-Chemostat and Turbidostat. Synchronous culture (definition and brief description).

REFERENCE BOOKS

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock, T. D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
6. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
7. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
8. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
10. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
12. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India PrivateLimited, New Delhi.

Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : II SEM / I YEAR

COURSE CODE : 16MB172
TITLE OF THE COURSE : MICROBIAL DIVERSITY AND GROWTH KINETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make the students aware of basic staining techniques.

COURSE OUTCOMES: 1. Student will be trained in different classification of microorganisms.

1) Isolation and identification of fungi (Lactophenol cotton blue mount)
2) Micrometry:
   Microscopic measurement of bacterial cell (*Bacillus*), yeast (*Saccharomyces),* fungal spores (*Pencillium and Aspergillus*) and onion cell by micrometry.
3) Enumeration of microbes by Haemocytometer (yeast).
4) Study of the following algae by preparing temporary slides:
   Chlamydomonas and *Spirulina*
5) Study of the fungi by preparing temporary slides:
   Rhizopus, *Aspergillus, Penicillium*, Yeast, *Fusarium*
6) Study of Protozoa by using permanent slides:
   Amoeba, Paramecium, Giardia and Plasmodium
7) Study of growth curve of bacteria by turbidometric estimation
8) Study of growth curve of fungi by colony diameter method
9) Cultivation of bacteriophage
10) Cultivation of Algae

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CH102
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 2
L: T/A: P: C : 3: 1: 0 : 4

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. In General Chemistry the principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen , alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of chemical bonding, in physical chemistry, basic principles of the chemical kinetics and in organic chemistry the principles of halogen compounds, alkenes were introduced to the students.

MODULE 1 **10Hrs**

Chemical Bonding:

Ionic Bond: Definition and conditions for formation of an ionic bond, examples of formation of an ionic compound (NaCl, CaCl2, MgO).Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle (NaCl,CaCl2 and MgO), problems, polarizing power and polarizability, Fajan's rules.

Covalent Bond: Definition, octet rule, limitation electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Valence Shell Electron pair repulsion (VSEPR) Theory: Shapes of simple inorganic molecules and ions such as NH3, H3O+, SF4, ClF3, ICl2 and H2O.

Hybridisation concept: various types of hybridization, structure of molecules based on hybridization concept and by valence shell electron pair repulsion (VSEPR) theory.

Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6 molecules.

Molecular orbital theory: linear combination of atomic orbitals (LCAO), MOT postulates, bonding, nonbonding and antibonding molecular orbitals. Applications of MO theory to explain the stability of homo and hetero dinuclear diatomic molecules (H2, N2, O2, HF and CO).

Metallic Bond: Definition, properties of metals and band theory, electrical properties of metals, semiconductors and insulators.

Weak Intermolecular interactions: vanderwaals forces, dipole dipole interactions and their significance. Hydrogen Bond – types and its significance on molecular properties.

MODULE 2 **11Hrs**

The Second Law of Thermodynamics:

Introduction: Spontaneous change, Carnot Cycle, conclusions from Carnot cycle, efficiency of heat engines, Second law of thermodynamics, entropy, entropy as a state function, Clausius inequality, entropy as criterion of spontaneity, natural processes, different types of entropy changes under isothermal and non-isothermal conditions, entropy change in irreversible processes. Helmholtz function (A), Gibbs function (G), standard molar free energy changes, Maxwell relations, dependence of free energy functions on temperature and pressure, total differential equations. Gibbs Helmholtz equations, thermodynamic criteria for spontaneity. Heat capacity at low temperature, Nernst heat theorem, Third law of thermodynamics, third law entropies.

Chemical Kinetics:

Review of terms: Rate, Order and Molecularity. Derivation of expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, halflife period, mean life period and order of reaction. Determination of order of reaction: differential method, method of integration, method of half life period and isolation method. Theories of reaction rates: Effect of temperature on rate of reaction, Arrhenius equation, concept of activation energy. Problems. Simple collisions theory based on hard sphere model, transition state theory (equilibrium hypothesis).Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE 3 **11Hrs**

Liquids and Solutions:

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.

MODULE 4 **9Hrs**

s & p block elements:

s- block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.*p – block elements:* Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.*Halogens:* Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

MODULE 5 11**Hrs**

Dienes and Alkynes:

Dienes: Classification - isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction- 1,3-butadiene with maleic anhydride.
Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction –significance. Oxidation with KMnO4, acidic nature of terminal alkynes.

Stereochemistry:

Fischer, saw-horse and Newman projection formulae. Chirality-optical activity, enantiomerism and diastereoisomerism involving one and two chiral centers, configuration, geometrical isomerism, D/L, R/S and E/Z nomenclatures.

Organic halogen compounds:

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanism with energy profile diagrams. Effect of (i) nature of alkyl groups, (ii) nature of leaving groups, (iii)nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism. *Aryl halides:* Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.
3.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **16CH172**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 2**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. Students will determine various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

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COURSE OUTCOMES:

1.The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen.
3. The students will be sell versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Determination of transition temperature of a salt hydrate by thermometric method.
5. Determination of distribution coefficient of benzoic acid between water and toluene.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Determination of dissolved oxygen (DO) in water sample.
9. Compare the strength of HCl and H_2SO_4 in the hydrolysis of ethyl acetate (K for one acid is given)
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 16CA192
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L: T/A: P: C : 2: 0: 0: 0

Total Credit - 26 Hrs

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems. 5 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: Data processing & presentation 4 Hrs

Introduction, Office Automation Software (Open Source Software)

MODULE 4: Computer viruses and Internet Searches. 5 Hrs

An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 5: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCE BOOKS

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER III

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BT201
TITLE OF THE COURSE : BASIC PRINCIPLES OF BIOCHEMISTRY AND BIOPHYSICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.
2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES: 1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **10Hrs**

Carbohydrates: Structure, properties and classification with examples – Monosaccharides, Disaccharides, polysaccharides (storage and structural, homo and hetero polysaccharides). Lipids: Structure, properties and classification and functions – Phospholipids, sphingolipids and glycolipids.

MODULE 2 **10Hrs**

Classification and properties of amino acids, titration curve of amino acid, concept of zwitter ion, pKa and pI. Proteins: Classification based on structure and function, structural organization of proteins – Primary, secondary (alpha helix and beta sheet), tertiary and quaternary structure. Nucleic Acids: Nucleic acids and their components – Nitrogenous bases (purines and pyrimidines), nucleosides and nucleotides, formation of phosphodiester bond.

MODULE 3 **11Hrs**

Enzymes: Introduction, classification, co-enzymes and co-factors, enzyme kinetics (Michelis-Menten equation), factors influencing enzyme activity- Substrate, enzyme, temperature and pH, Inhibition mechanisms (competitive and non-competitive). Vitamins and Hormones: Water Soluble and fat-soluble vitamins, Dietary source, Clinical relevance. Functions of Steroid hormones (testosterone and estrogen), Glucocorticoid hormones (cortisol and mineralocorticoid), pituitary hormones (MSH and FSH). Examples of Plant Hormones (Auxins, Cytokinins and Gibberllins).

MODULE 4 **10Hrs**

Scope of Biophysics, pH and Buffer concepts. Principles and applications of Chromatography (Paper, thin layer, column, GLC and HPLC); Centrifugation (differential, density gradient, Ultra centrifugation);

MODULE 5 **11Hrs**

Principles and applications of Spectroscopy (UV, Visible, X-Ray crystallography, NMR, IR, Fluorescence and Atomic; Absorption); and Electrophoresis. Isotopes: Types, their importance in biological studies, measure of radioactivity, GM counters and Scintillation counters.

REFERENCE BOOKS

1. Lehninger's Principles of Biochemistry- W H Freeman (2008)
2. Biochemistry-Lubert Stryer Freeman International Edition (2002).
3. Biochemistry-Keshav Trehan Wiley Eastern Publications (1987).
4. Fundamentals of Biochemistry J.L. Jain S. Chand and company (2007).
5. Biochemistry by U Satyanarayana and Chakrapani, Elsevier Inc. (2013).
6. Biochemistry by Voet and Voet, Wiley Publishing (2010).
7. Essentials of Biophysics, Narayanan, P, New Age Int. Pub. New Delhi (2008).
8. Biophysical Chemistry – Theory and Principles, Upadhyay, Upadhyay and Nath, Himalaya Publishing House (2010)
9. Principles and Techniques of Biochemistry and Molecular Biology – Keith Wilson and John
10. Walker, Cambridge University Press (2005).
11. Biophysics – An introduction by Ronald Glaser, Springer (2012).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BT271
TITLE OF THE COURSE : BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES
L: T/A: P: C : 0: 0: 4: 2

Course Objectives: 1. To make students learn quantitative and qualitative methods for study of biomolecules.

Course Outcomes: 1. Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

1. Preparation of Buffers-Citrate and Phosphate.
2. Estimation of reducing sugars by DNS method.
3. Estimation of reducing sugars by Somogyi-Nelson Method.
4. Estimation of Amino acids by Ninhydrin method.
5. Estimation of Protein by Biuret method.
6. Estimation of protein using Lowry's method.
7. Preparation of crude amylase extract from biological source
8. Assay of amylase enzyme activity using starch as a substrate. (2 MODULEs)
9. Separation of Amino acids by Paper Chromatography.
10. Separation of amino acids/sugars by Thin layer chromatography

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BC201
TITLE OF THE COURSE : PHYSICO-ANALYTICAL TECHNIQUES
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To create general understanding about fundamentals of biomolecules, their structure and function.

2. To familiarize the students with basic concepts and principles of biophysical techniques used in biological sciences.

COURSE OUTCOMES: 1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.

MODULE 1 **11Hrs**

Spectroscopy: Wave particle duality, the electromagnetic spectrum, Lambert-Beer's law, Absorbance, extinction coefficient, Chromic shifts, auxochromes. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscope; assay of biomolecules. Principle, Schematics and Application of Luminometry, Flame photometry and AAS. IR spectroscopy, equation, vibrational modes of various bonds, applications in the identification of common functional groups in biomolecules.

MODULE 2 **11Hrs**

Techniques for structure determination
X-Ray Diffraction: crystal planes, Braggs Equation, Diffractometer, Applications in crystal characterization. NMR: principle and applications in structure elucidation of biomolecules.
Techniques in Medical Applications
NMR based techniques – Magnetic Resonance Imaging and Diffusion tensor imaging – brief idea, X-ray based technique: CAT scan and radioactivity based technique: PET scan
Chromatography
Distribution coefficient, Adsorption, partition, Retention factor. Types: Planar and columnar, S-L, L-L, G-S and G-L. Paper, thin layer, gel permeation, ion exchange, hydrophobic and affinity chromatography with applications, Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules. Brief idea about HPLC (C8 and C18) and FPLC.

MODULE 3 **10Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis: - Electrophoretic run, Detection techniques, Cellulose acetate electrophoresis, High voltage electrophoresis, Applications. Gel electrophoresis: - Types of gels, Procedure, Column & slab gels. Detection, Recovery & characterization of macromolecules

(molecular weight determination and subMODULE enumeration). Principle and application of SDS-PAGE, IEF, peptide mapping, OFGE, Application in molecular biology and genomics.
Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

MODULE 4 **10Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography. Applications of isotopes in biochemistry with reference to studies in metabolism, Principles of tracer techniques, it's advantages and limitations,

MODULE 5 **10Hrs**

Centrifugation: Basic principles, Mathematics & theory: RCF, Sedimentation coefficient, Svedberg constant, nomogram. Preparative centrifugation: Differential & density gradient centrifugation, Applications**.** Analytical centrifugation: - Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods.
Electrochemistry: Potentiometry, potentiometer schematics and use as pH meter,Conductance, specific and equivalent conductance, Conductivity meter.

REFERENCE BOOKS

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Principles and Techniques of practical Biochemistry – Wilson and Walker. Camridge.
4. Handbook of Analytical Techniques – Gunzler and Williams. Wiley & Sons.
5. Immunology – Kuby. Freeman Publishers.
6. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
7. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16BC271
TITLE OF THE COURSE : BIOANALYTICAL SEPARATIONS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic, potentiometric and chromatographic techniques.

1. pH metric /potentiometric titrations of HCl- NaOH and Acetic acid-NaOH
2. Estimation of pKa of glycine.
3. Determination of density & viscosity of given unknown solution.
4. Paper chromatography of amino acid, lipids and sugar (Ascending and circular)
5. Paper electrophoresis for separation of biomolecules.
6. Separation of amino acid by TLC.
7. Column chromatography of pigments on adsorbent.
8. Conductometric titration of an amino acid against HCl and NaOH.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16GN201
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Genetic inheritance associated with chromosomal modifications.
2. Diverse role of sex chromosomes in genetic inheritance

COURSE OUTCOMES:
1. Students understand the diverse modifications chromosomes undertake for inheritance pattern.
2. Student will understand how intricate is the role of sex chromosomes in maintaining diversity as well as consistency.

MODULE 1 PHYSICAL BASIS OF INHERITANCE 11Hrs

Chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organization. Primary and Secondary constriction, Sat-bodies, telomeres, types of chromosomes. Heterochromatin and Euchromatin and its significance. Ultra-structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Idiogram.

MODULE 2 SPECIAL TYPES OF CHROMOSOME AND LINKAGE 10Hrs

Polytene chromosome- Salivary gland chromosome in *Drosophila*, Lampbrush chromosome in amphibian Oocyte, B Chromosome. Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- *Drosophila*, maize and man, Types of linkage- complete linkage and incomplete linkage,Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc.

MODULE 3 CROSSING OVER 11Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in *Drosophila*. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks, Crossing over in *Drosophila* and Tetrad analysis in *Neurospora*, Interference and coincidence, Construction of genetic maps (*Drosophila* and maize) and Punnett square.

MODULE 4 SEX LINKAGE 10Hrs

Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in *Drosophila*. Sex linked genes in Poultry and moths. Sex related genes in maize.Attached X-chromosome.

MODULE 5 CHROMOSOMAL ABERRATIONS 10Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomesand Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

TEXT BOOKS

1. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
2. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.

REFERENCE BOOKS

1. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
2. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
3. Sinha U., SMODULEa and SMODULEa Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
4. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
   Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
5. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
6. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16GN271**
TITLE OF THE COURSE : **FUNDAMENTALS OF CYTOGENETICS PRACTICAL**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:
1. Detail culture maintenance of Model organism Drosophila melanogaster
2. Understanding and visualising different chromosomal aberrations

COURSE OUTCOMES:
1. Students will learn the complete methods of culturing, dissection and study of model organisms. Develop skills on hands on experiments
2. Perform genetic analysis on linkage and crossing over. Determine skills of genetic analysis using different plant and animal models.

1) Culturing and Handling of Drosophila
   - Cleaning and Sterilization of bottles.
   - Media Preparation.
   - Handling of Drosophila.
2) Study of at least five types of Drosophila:
   - Body color mutant- Ebony body and Yellow body.
   - Wing mutant- Curly wing and vestigial wing.
   - Eye color mutant- Bar eye, white eye, sepia eye.
3) Mounting of Sex Comb of Drosophila melanogaster
4) Mounting of Genital plate of Drosophila melanogaster
5) Salivary gland Chromosome
   - Dissection of Salivary glands.
   - Preparation of Polytene chromosome.
6) Study of Chromosomal Aberrations:
   - Observation of permanent slides of chromosomal aberrations.
   - Inversion- Salivary gland chromosomes of Drosophila nasuta.
   - Induction of polyploidy in Onion root tips.
7) Genetic Problems on Linkage & Crossing over:
   - Drosophila.
   - Maize.
   - Human (Sex Linkage).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB201
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY, MICROBIAL GENETICS AND INSTRUMENTATION
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. Learn the fundamentals of molecular microbial physiology such as microbial structure, energetics, metabolism and genetics.
2. To understand antimicrobial resistance, differentiation, and ecology of microbes with respect to their genotype as well as phenotype.

COURSE OUTCOMES: 1. To understand the complexity of microbial structures, genetics and metabolism.
2. Enable to grasp the mechanisms of various interactions that exist between the microbes, microbes and higher forms of life/environment

MODULE 1: BIOMOLECULES AND ENZYMES 10Hrs

A brief account of the properties, classification and importance of carbohydrates, lipids and proteins.

Introduction, properties, nomenclature and classification, Mechanism of enzyme action, effect of various factors influencing enzyme activity, enzyme inhibition, enzyme regulation and ribozymes.

MODULE 2: METABOLISM AND BIOENERGETICS-I 11Hrs

Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways – EMP, HMP shunt/pentose phosphate pathway and ED: TCA: ETS and oxidative phosphorylation, anaerobic respiration, chemoautotrophy oxidation of inorganic compounds – N, S, Fe and H.

Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: METABOLISM AND BIOENERGETICS-II 11Hrs

Bacterial photosynthesis and Fermentation: Definition, Photosynthetic pigments of prokaryotes, photosynthesis in purple and green bacteria. Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid.

Bioenergetics: Free energy, ATP and its production, other high energy compounds, Oxidation – Reduction reactions.

MODULE 4: MICROBIAL GENETICS 10Hrs

Basics of Genetics: Mendelian Principles of genetics (Monohybrid, Dihybrid and Test cross), Morphology of Prokaryotic and Eukaryotic genetic material.

Chemical basis of heredity: Evidence for DNA and RNA as genetic material (Griffith's experiment and Hershey and Chase experiment and Singer's experiment). Properties of genetic

code and Wobble hypothesis. Transformation, Conjugation and Transduction. Transposons in recombination. Extra chromosomal genetic elements and their importance.
Molecular basis of mutations: Nature, types of mutations (point and frame shift mutations), DNA repair mechanisms.

MODULE 5: INSTRUMENTATION **10Hrs**
Centrifugation: Basic principles, Low-speed and High speed centrifuges, ultracentrifugation, Applications.
Chromatography: Paper, Thin layer, Column chromatography, HPLC
Electrophoresis: Agarose Gel Electrophoresis, Poly Acrylamide Gel Electrophoresis, SDS-PAGE
Spectrophotometer: Principles of Spectroscopy, UV Visible spectroscopy, NMR spectroscopy.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Freifelder, D. 2002. Microbial Genetics, Narosa Publishing House, New Delhi.
7. Gardner, E.J., Simmons, M.J., and Snustad, D.P. 2008. Principles of Genetics. Eight edition. Wiley Publications.
8. Griffin, D.H. 1993**.** Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
9. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
10. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
11. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
12. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
13. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16MB271
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY AND MICROBIAL GENETICS
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES: 1. Student will be equipped with coloured based changes given out by microbial tests

1. **Biochemical tests:**

- Starch hydrolysis.
- Gelatin hydrolysis.
- Catalase test.
- Sugar fermentation test.
- Nitrate reduction test.
- H_2S production test.
- IMViC test
- Oxidase test.
- Casein hydrolysis test.
- ONPG test.

2. Qualitative analysis of carbohydrates.
3. Qualitative analysis of proteins.
4. Quantitative determination of reducing sugars by DNS method.
5. Quantitative determination of proteins by biuret method.
6. Partial purification of protein by ammonium sulphate precipitation method
7. Genetic problems
8. Isolation of antibiotics resistant mutant by gradient plate technique
9. Demonstration of replica plating method for selection of antibiotic resistant mutants

SEMESTER/YEAR : **III SEM / II YEAR**
COURSE CODE : **16CH201**
TITLE OF THE COURSE : **FUNDAMENTALS OF CHEMISTRY 3**
L: T/A: P: C : **3 : 1 : 0: 4**

COURSE OBJECTIVES:

1. The students will be introduced to the basic principles of General Chemistry, Physical Chemistry, and organic Chemistry.

2. In General Chemistry the principles of metallurgy, fertilizer in physical chemistry, basic principles of the II and III laws of thermodynamics and in organic chemistry the principles of aldehydes, ketones ,alcohols compounds, alkenes were introduced to the students.

COURSE OUTCOMES:

1. The students will be well-versed with the concepts related to the basic principles of General Chemistry, Physic Chemistry, and organic Chemistry.
2. The students will be well-versed with the concepts related to principles of metallurgy, fertilizers in physical chemistry, basic principles of the II and III lwa of thermodynamics and in organic chemistry the principles of aldehydes, alcohols compounds, alkenes were introduced to the students. Ketones.

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MODULE 1 **11Hrs**

Surface chemistry

Review of surface phenomena. Theories of adsorption. Adsorption isotherms and BET equation (derivation included), Surface area calculation using BET. Adsorption indicators. Surface film on liquids. Catalysis –Types and theories ((intermediate compound theory and adsorption theory). Heterogeneous catalysis: surface reactions, unimolecular, bi-molecular surface reactions. pH dependence of rate constant of catalysed reactions. Auto catalysis.

THERMODYNAMICS II

II Law of Thermodynamics

Limitations of I law, scope of II law, Statements of II law of thermodynamics (to be introduced wherever the concepts arise). Spontaneous and non-spontaneous processes, spontaneity and equilibrium. Driving force for spontaneous processes. Concept of entropy and its physical significance. Entropy change in adiabatic and isothermal reversible expansions of an ideal gas. Change in entropy of an ideal gas with change in P, V and T (derivation of equation) – modified equation for isothermal, isochoric and isobaric processes. Entropy of phase change. Entropy changes in the system and surroundings in an isothermal reversible expansion and isothermal irreversible expansion of an ideal gas, entropy criteria for spontaneity, Carnot cycle – derivation of efficiency based on entropy concept. Relation between entropy and probability.

MODULE 2 **09Hrs**

III **law of thermodynamics** – Determination of absolute entropies of substances, standard entropies, residual entropy. Free energy – Gibb's free energy & Helmholtz free energy (work function), Relation between w and ΔA, w and ΔG, standard free energy change of a reaction. Free energy criteria of spontaneity, variation of G with T and P. Gibb's Helmholtz equation – derivation. Relation between free energy & equilibrium constant of a reaction. Clausius–Clapeyron equation–derivation, application to liquid-vapour and solid-liquid equilibria.

MODULE 3 **9Hrs**

Metallurgy:

Introduction, classification. Ellingham's diagrams: Salient features for the formation of oxides. Extraction of the following metals -i) Nickel from sulphide oreii) Thorium from Monazites and iii) Plutonium from Nuclear waste. Advantages of powder metallurgy. Methods of production of metal powders.

Fertilizers:

Introduction (need of fertilizers), functions of essential plant nutrients (N, P, K). Classification of fertilizers with examples. Manufacture of urea and Super phosphate of lime, and their uses.

Environmental Chemistry:

Depletion of ozone in the stratosphere, causes and remedial measures. The green-house effect and its consequences. Acid rain, photochemical smog. Treatment of sewage and industrial effluents. Disposal of radioactive wastes.

MODULE 4 **09Hrs**

Alcohols and Thiols

Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Pondorff-Verley reaction); (ii) From acids and esters (by reduction with LiAlH4).Reactions of alcohols: Comparison of the reactivity of 1°, 2° and 3° alcohols - Lucas test,oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using KMnO4 and from epoxides. Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats. Uses.

Thiols: Methods of formation and chemical reactions (with metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes.

MODULE 5 **09Hrs**

Aldehydes and Ketones

Nomenclature: Synthesis of aldehydes by the oxidation of primary alcohols and by the reduction of acyl chloride, esters and nitriles. Synthesis of ketones by ozonolysis, oxidation of secondary alcohols, Friedel Craft's reaction and using Grignard reagent. Nucleophilic addition to carbonyl compounds: Mechanism of addition using strong nucleophiles and acid catalyzed nucleophilic addition. Addition of HCN - mechanism. Relative reactivity of aldehydes versus ketones. Addition of alcohols. Mechanism of acid catalyzed acetal formation. Addition of amines (primary and secondary amines, hydrazine and hydroxylamine). Wittig reaction (no meachanism, only a few examples). Oxidation of aldehydes and ketones. Acidity of α-Hydrogen, enolate ion. Keto- enol

tautomerism. Base catalysed aldol reaction, dehydration of aldol product (mechanismof both), crossed aldol reaction (practical crossed aldol reactions). Claisen-Schmidt reaction (nomechanism). Addition to α,β-unsaturated aldehydes and ketones (no mechanism). Michael addition (no mechanism).

MODULE 6 **05Hrs**

Phenols

Nomenclature, classification. Acidic nature - Comparison of acidic strength of phenol with alcohols and monocarboxylic acids. Effect of electron withdrawing –NO2 group and electron donating –CH3 group on acidity of phenols at o-, m-, p- positions, Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

Ethers and Epoxides

Ethers: Methods of preparation – (i) dehydration of alcohols, (ii) Williamson's ether synthesis. Reactions – Ethers as Lewis bases (complexation with metal ions), cleavage and auto-oxidation. Ziesel's method.

Epoxides: Preparation using per acids, Darzen's reaction. Reactions of mono and 1, 2 disubstituted epoxides with (i) carbon nucleophiles, (ii) nitrogen nucleophiles, (iii) reduction with $LiAlH_4$.

Organometallic compounds

Preparation and synthetic applications of Grignard reagents, Organolithium compounds and lithium dialkylcuprates.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S.Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CH271
TITLE OF THE COURSE : ORGANIC CHEMISTRY (Practical)
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:
1. The students will be trained the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2.The students will be given hands on experience on synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

COURSE OUTCOMES:
1. The students will be experts of the simple procedures like, recrystallization, melting point determination of single and mixed components, distillation.
2. The students will be experts of synthesizing the drugs like aspirin and other single stage and double stage organic synthesis.

Preparation and purification of organic compounds
1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids.
(Preparation, recrystallization and melting point determination of the recrystallized sample in the following organic preparations)
One stage preparation
3. Preparation of aspirin from salicylic acid.
4. Preparation of paracetamol from *p*-aminophenol.
5. Preparation of dibenzalacetone from benzaldehyde (using acetone-alcoholic sodium hydroxide).
6. Preparation of *m*-dintrobenzene from nitrobenzene.
7. Preparation of benzoic acid from benzaldehyde.
8. Purification of solids by sublimation. (Benzoic acid / Napthalene)
Two stage preparations
9. Preparation of *p*-bromoaniline from acetanilide.
10. Preparation of *p*-nitroaniline from acetanilide.
11. Preparation of *m*-nitrobenzoic acid from methyl benzoate.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 16CI291
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT: 26 HRS

MODULE 1: 5h

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6h

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5h

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5h

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, and administrative: Recent Trends.

MODULE 5: 5h

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER IV

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT202
TITLE OF THE COURSE : MOLECULAR BIOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To provide comprehensive understanding molecular processes inthe cell required for its growth and maintenance of genetic material.
2. To equip with fundamental understanding of the underlying mechanisms in regulation of gene expression.

COURSE OUTCOMES: 1. Student will be well versed with mechanisms in the expression, regulation and maintenance of genetic information, within a biological system.
2. Student will be able to critically think in the field of application of molecular biology.

MODULE 1 **10Hrs**

Molecular basis of life: Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Structure and function of DNA and RNA: Structure of DNA. Watson and Crick model of DNA and other forms of DNA (A and Z). Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA. Recombination: Transformation, Conjugation and Transduction; Holliday model of recombination. Extra nuclear Genomes: Mitochondria and chloroplasts.

MODULE 2 **11Hrs**

MODULE 4. DNA Replication: Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication. Causes of DNA damages, mechanisms of repair– photo-reactivation, excision repair, mismatch repair, SOS repair.

MODULE 3 **10Hrs**

Transcription in Prokaryotes and Eukaryotes: RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA.

MODULE 4 **10Hrs**

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes. Post translational modification of Proteins.

MODULE 5 **11Hrs**

Regulation of Gene Expression: Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons Regulation of Gene expression in Eukaryotes – galactose metabolism in yeast. Role of cis and trans elements in regulation of gene expression. Mobile Genetic Elements: Insertional elements, transposons in Bacteria, Maize and Drosophila.

REFERENCE BOOKS

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009)
2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013)
3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007)
4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008)
5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011).
6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008).
7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006).

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BT272
TITLE OF THE COURSE : TECHNIQUES IN MOLECULAR BIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To skill students for isolation and quantitation of DNA and proteins from different sources.

COURSE OUTCOMES: 1. Student will be able to isolate and analyze DNA from different sources using appropriate buffers and partially purify proteins using common protocols.

1. Estimation of DNA and RNA by UV-Vis Spectroscopy/Colorimetric method.
2. Partial purification of protein from plant source by Ammonium sulphate precipitation and its estimation.
3. Partial purification of protein from animal source by organic solvent (acetone) and its estimation.
4. Isolation of genomic DNA from plant source and its analysis using agarose gel electrophoresis.
5. Isolation of genomics DNA from animal/bacterial source and its analysis using agarose gel electrophoresis.
6. Column Chromatography (Demo)
7. Separation of proteins using Polyacrylamide Gel Electrophoresis (Demo)

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC202
TITLE OF THE COURSE : PHYSIOLOGY OF LIVING SYSTEMS.
L: T/A: P: C : 3: 1: 0: 4

MODULE 1 **11Hrs**

Nutrition: Basic principles of a balanced diet to provide energy and nutrients. Proximate analysis of foods, Nitrogen balance, BUN, NPN, Calorific value of foods, bomb calorimeter.
Respiratory quotient, BMR, SDA and factors affecting them. Role of protein, lipid and carbohydrates as fuel molecules, Protein sparing effect of carbohydrates. Dietary fiber. Essential fatty acids and their biological importance**.** Food fortification & food supplementation, Minerals and vitamins.
Skeletal system: Tissues- introduction. Extracellular matrix and its components, Bone-ultra structure, composition, cells: osteoblasts, osteocytes and osteoclasts. Bone growth, remodelling and regulation by hormones.

MODULE 2 **11Hrs**

Hematology and respiration: Blood components and their functions, blood groups: the ABO system, rhesus system, blood clotting factors, intrinsic and extrinsic pathways for blood clotting. Components of respiratory system: nasal cavity, trachea, pharynx, lungs, bronchi, bronchioles and alveoli and their functions, role of hemoglobin in oxygen transport, dissociation curve of oxy hemoglobin and its significance. The Bohr effect, transport of oxygen and carbon dioxide along with chloride shift. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.
Excretion: Structure of nephron in brief, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & Active secretion, Regulation of acid–base balance by the kidney, Acidosis and alkalosis.

MODULE 3 **10Hrs**

Digestion: Anatomy of GIT and accessory organs, Regulation of GIT movement, Digestion, absorption and transport of carbohydrates, lipids and proteins. Structure and function of liver and Gall bladder, LFT.
Reproduction: Brief account of histological structure of ovary & testis. Structure & functions of male & female sex hormones. Menstrual Cycle.

MODULE 4 **10Hrs**

Neurobiology: Structure of Neurons, Physiological properties of Nerve fibers, Detailed account of impulse generation, Membrane potential, development, depolarization and repolarization. Transmission of impulse in myelinated and non-myelinated nerve fibers. Nernst's and Goldman Equation, Nernst's potential. Synapse and mechanism of synaptic transmission: Cholinergic and

adrenergic transmission, Functions of acetyl choline, GABA, dopamine and glutamate as neurotransmitters.

Muscle: Types – smooth, striated and cardiac. Contractile and regulatory proteins of muscle structure of actin and myosin. The sarcomere, sliding filament model of skeletal muscle contraction. Brief idea of contraction of smooth muscles.

MODULE 5 **10Hrs**

Cardiovascular System: Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias.

REFERENCES BOOKS

1. Textbook of Medical Physiology – Guyton and Hall. Elsevier.
2. Human Physiology – Chatterjee. Sapna Publishers.
3. Fundamentals of Biochemistry - Deb. Central Publishers.
4. Medical Biochemistry – Chatterjee and Shindey.
5. Biochemistry – Das. Central Publishers.
6. Biochemistry –Jain. Himalaya Publications.
7. Principles of Nutrition – Swaminathan. Himalaya Publications.
8. Laboratory Manual for Practical Biochemistry –Hemavathi, Shivraja and Ganesh. Jaypee Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16BC272
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVE: 1. To provide an advanced understanding and applied knowledge of the clinical biochemistry.

COURSE OUTCOME: 1. Students will be able to perform a range of diagnostic techniques relevant to the field of laboratory medicine.

1. Qualitative analysis of normal and abnormal components of urine – ketone, sugar, urea, uric acid, Creatinine, protein.
2. Protein/DNA by UV absorption.
3. Protein by Folin - Ciocalteu method,
4. Iron by Ossian's method
5. Phosphate by Fiske – Subbarow's method
6. Creatinine by Jaffe's method
7. Glucose estimation by Miller's method
8. Calcium estimation by Alizarin S

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN202
TITLE OF THE COURSE : MOLECULAR GENETICS
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:
1. Basic study of the chemical and genetic organization of the human genetic material.
2. Basic mutations and modifications of the genetic materials

COURSE OUTCOMES:
1. Learn the composition and backbone of the genetic material (DNA).
2. Understand different ways of genetic alterations and its consequences- benefits and drawbacks. This course will instigate higher thought process in the field of genetics manipulations.

MODULE 1 CHEMICAL BASIS OF HEREDITY 11Hrs

DNA as genetic material, Experiments of Griffith, Avery, MacLeod, McCarty and Hershey - Chase. RNA as genetic material- Experiment of Fraenkel and Singer. Nucleic acids: DNA structure and types (A, B and Z model), RNA types and structure. DNA Replication: DNA Replication in prokaryotes and rolling circle model, DNA Replication in eukaryotes

MODULE 2 GENE EXPRESSION 11Hrs

Genetic code - Brief account, central dogma. Transcription - Initiation, elongation, termination (rho dependent and rho independent termination). Post Transcriptional modifications. Translation - Initiation, elongation and termination in prokaryotes and eukaryotes. Regulation of gene expression: Inducible operon - galactose, Repressible operon - tryptophan

MODULE 3 GENOME ORGANISATION AND FINE STRUCTURE OF GENE 10Hrs

Prokaryotic genome - Chromosomal and plasmid, Eukaryotic genome - Chromosomal and organellar, Fine structure of the Gene - cistron, muton and recon. Organelle genomes - Chloroplast and Mitochondria

MODULE 4 Bacterial Genetics AND TRANSPOSABLE ELEMENTS: 10Hrs

Conjugation - F factor mediated, Hfr and Sexduction. Transformation. Transduction - Generalized and specialized. Bacteriophage genetics. Types and classification, Transposable elements in Maize and *Drosophila.*

MODULE 5 MUTATIONS 10Hrs

Introduction and types of gene mutations - Base substitution, Frame shift mutation (insertion, deletion, missense, nonsense mutation). Mutagens - physical and chemical. Reverse mutation in bacteria. DNA repair mechanism (Mismatch repair photo reactivation, excision and SOS repair). Beneficial and harmful effects of mutations.

TEXT BOOKS

1. Watson J. D., Hopkins N. H., Roberts J. W., Steitz J. A. and Weiner A.M. 1987. Molecular Biology of the Gene. The Benjamin/Cummings Publishing Company, Menlo Park, CA.
2. Alberts B., Johnson. A., Lewis J., Roff M., Roberts K. and Walter P. 2002. Molecular Biology of the Cell IV Edition. Garland Science, New York.

REFERENCE BOOKS

1. Gestel and Cech R. T. and Atkins J. 1999.The RNA World. II Edition. Cold Spring Harbor, New York.
2. Twyman R. M. 1998. Advanced Molecular Biology. Viva Books Ltd.
   Turner P. C. 2002. Instant Notes in Molecular Biology. Viva Books.
3. Hames D. and Hooper N. M. 2002. Instant Notes in Biochemistry. II Edition. Viva Books.
4. Brown T.A. 2002.Genomes. Viva Books.
5. Darnell J., Lodish H. and Baltimore D. 1990. Molecular cell Biology. II Edition. Scientific American Books, New York.
6. Lewin B. 2003. Genes VIII. Oxford University Press. Oxford.
7. Watson J. D. 1992. Recombinant DNA Technology. W. H. Freeman Publisher.
   Bharadwaj D.N. 2008. Molecular Genetics. Kalyani Publisher.
8. Daniel L. Hartl and Jones W. 2011. Genetics: Analysis of Gens and genomes. VII Edition. Jones and Bartlett Publishers.
9. Hartwell L., Hood L. and Goldberg M. L. 2008. Genetics: from genes to genomics. McGraw-Hill publications.
10. De Robertis, E. D. P. and De Robertis E. M. F. 2001. Cell Biology and Molecular Biology. VIII Edition. Lippincott Williams & Wilkins Publishers.
11. Rastogi S. C., Mendiratta N. and Rastogi P. 2008. Bioinformatics: Methods and applications. III Edition. PHI Learning Publishers.
12. Chiranjib C. 2004. Bioinformatics: Approaches and applications. Biotech Books Publishers.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16GN272
TITLE OF THE COURSE : MOLECULAR GENETICS PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction and usage of the different instruments in a basic molecular genetics lab.
2. Different methods of isolation and study of the genetic material (DNA).

COURSE OUTCOMES:

1. Students will appreciate the methods of DNA isolation and its manipulations and its potential applications.
2. Student will also be able to make connections with the different techniques and its usage in identifying and understanding genetic diseases.

1) Instrumentation:
   Centrifuge
   Ultra centrifuge
   pH meter
   Electrophoretic MODULE
   Spectrophotometer/colorimeter
2) Extraction of DNA from:
   Plants (Cauliflower/Coconut endosperm/any)
   Animal tissue (Liver Tissue/any)
3) Paper Chromatography for Separation of:
   Leaf pigments
   Drosophila eye pigments
   Amino acids
4) Electrophoresis
   Agarose gel electrophoresis
5) Mutations:
   Study of examples of mutations: Sickle cell Anaemia Missense mutation and Thalassemia frame shift mutation.
   Induction of Mutation in *Drosophila* and detection of sex linked lethal by Muller 5 stock

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB202
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.
2. To adapt molecular and biotechnological techniques to research and industry for the welfare of mankind.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.
2. Describe the applications of molecular biology in areas such as transgenic plants and animals, vaccines and therapeutic agents.

MODULE 1: INTRODUCTION TO NUCLEIC ACIDS AND REPLICATION 11Hrs

Structure of bases – A, T, G, C and U. Definition of nucleosides and nucleotides,Watson and Crick model of DNA, Types of DNA (A, B and Z), Types of RNA and their functions. Modes of replication- Conservative, Semi conservative (Messelson and Stahl experiment) and Dispersive. Methods of DNA replication (Rolling circle and Linear), and mechanism of Prokaryotic DNA replication.

MODULE 2: GENE EXPRESSION AND REGULATION 11Hrs

Central dogma, Transcription- mechanism, post transcriptional modification. Translation - mechanisms, post translational modification in prokaryotes. The operon concept, induction, repression catabolic repression and attenuation. The lac operon and trp operon.

MODULE 3: RECOMBINANT DNA TECHNOLOGY 10Hrs

History and fundamentals of r-DNA technology, Tools for r-DNA technology

Enzymes: DNA manipulative enzymes, Restriction enzymes, Ligases and other DNA modifying enzymes

Gene cloning vectors: Salient features, Plasmids- properties, types pBR322, bacteriophages- λ and M 13, Cosmids-properties, Bacterial Artificial Chromosomes (BAC's),Yeast Artificial Chromosomes (YAC's), *Agrobacterium tumifaciens*, SV 40.

MODULE 4: TOOLS IN rDNA TECHNOLOGY 10Hrs

Isolation of passenger DNA from bacteria (gene of interest) and isolation of vector DNA (Bacteria). Cutting of DNA molecules. Physical methods, enzymatic methods & Joining of DNA molecules-Homopolymer tails, Linkers, Adapters.

Transformation of r-DNA into target host organisms: Calcium chloride mediated gene transfer, Agrobacterium mediated DNA transfer, Electroporation, Microinjection, Liposome fusion and Micro particle bombardment.

MODULE 5: SCREENING, SELECTION AND APPLICATIONS 10Hrs

Insertional inactivation, in situ colony/DNA hybridization, Polymerase chain reaction, blotting techniques and immunological techniques. Applications of Genetic Engineering: a) Medicine: Gene therapy b) Agriculture: nif gene cloning

Potential hazards and safe guards of genetic engineering.

REFERENCE BOOKS

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Brown, T.A. 2010. Gene Cloning and DNA Analysis – an Introduction. Sixth edition. Wiley Blackwell.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Cooper, G.M. 2013. The Cell – A Molecular Approach. 6th edition. Sinauer Associates.
5. Karp, G. 2008. Cell and Molecular Biology. 5th edition. McGraw Hill Book Company, New York.
6. Nelson, D.L. and Cox, M.M. 2007. Lehninger's Principles of Biochemistry. Fourth edition. Macmillan Press/Worth Publishers. New Delhi.
7. Palmer, T. and Bonner, P.L. 2007. Biochemistry, Biotechnology and Clinical Chemistry. Second edition. Wood head Publishing co.
8. Prescott, L.M. Harley, J.P. and Klein, D.A. 2011. Microbiology. Eight edition. WCB – McGrawHill, New York.
9. Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene manipulation and Genomics. Seventh edition. Blackwell Publishing.
10. Singh, B.D. 2008. Biotechnology – Expanding Horizons. Kalyani Publishers.
11. Watson, J. D. Recombinant DNA, Scientific American Books, New York.
12. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levne, M., and Losick, R. 2004. Molecular Biology of the Gene. Fifth Edition. Pearson Education.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16MB272
TITLE OF THE COURSE : MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To examine basic techniques used in molecular microbiology.

COURSE OUTCOMES: 1. Determine which technique(s) is appropriate in solving a specific experimental problem.

1. Determination of λmax for the given biomolecule (Protein/DNA/ Sugar)
2. Isolation of Genomic DNA from bacteria
3. Isolation of plasmid DNA from bacteria
4. Analysis of genomic DNA by Agarose gel electrophoresis
5. Estimation of DNA by DPA method
6. Estimation of RNA by orcinol method
7. Demonstration of the following models/ photographs/charts of DNA, t-RNA, Replication, Trancription, Translation, Transformation, conjugation and transduction. DNA repair mechanisms.
8. Demonstration of instruments – PCR, Southern Blotting assembly
9. Charts on genetic engineering- pBR 322, pUC 18 and 19, SV 40, Bacteriophages- Lambda, Gene cloning, Selection of recombinants by replica plate technique.
10. Kit based experiments
    - Restriction digestion
    - Ligation
    - Transformation

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16CH202
TITLE OF THE COURSE : FUNDAMENTALS OF CHEMISTRY 4
L: T/A: P: C : 3 : 1: 0: 4

COURSE OBJECTIVES: 1.To introduce the basic concepts of phase rule, colloidal solutions, nuclear, radio chemistry and different aspects of solid state chemistry like different crystal systems etc.,
2. The basic concepts of organic chemistry like carboxylic acids, amines and heterocyclic compounds will be introduced to the students.

COURSE OUTCOMES: 1. The student will be well versed with one component, two component systems in phase rule MODULE .Similarly, the differtypes of colloidal solutions and ther behaviors and applications will be known by students after learning this MODULE.

2. The students will be familiar with different types of organic acids, their acidic strengths, reactivity orders, reactions and their preparations. Similarly, with heterocyclic compounds and amines.

MODULE 1 **11Hrs**

Phase Equilibria, Statement and explanation of the terms with examples for phase (P), component (C) and degree of freedom (F), Definition and significance of phase rule. Derivation of phase rule. Application of phase rule to one component systems-water and sulphur, -modified form of phase rule to two component systems. Water–potassium iodide and lead-silver systems. Eutectic mixtures and their applications (examples: freezing mixtures, desilverisation of lead by Patterson's method).
Colloids: The Colloidal State, preparation and purification of colloids and their characteristic properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

MODULE 2 **11Hrs**
Solid state, Crystalline state, Laws of crystallography. Symmetry elements in cubic systems, crystal systems. Weiss and Miller indices. X-ray diffraction of crystals-derivation of Bragg's equation. Problems Liquid crystals-Types (Smectic, Nematic and Cholestric) with examples. Applications. Superconducting solids-High temperature superconductors. Applications.

Water Technology
Types of impurities present in water. Causes for the hardness of water. Permissible levels of ions present in water. Treatment of water for domestic and Industrial purposes by the following

methods. i) Demineralization of water by Ion exchange method. ii) by reverse Osmosis method. Removal of fluorides in water.

MODULE 3 **11Hrs**

STEEL

Chemical composition of Steel. Alloy steels: Influence of Si, Mn, Cr, Ni, Ti and W on the properties of Steel. Ferro alloys: Production of ferro chrome, ferro manganese, and ferro silicon and their applications. Carbon steel: classification. Heat treatment: hardening, case hardening, carbiding, nitriding, tempering and annealing.

Nuclear and Radiochemistry.

Instability of nucleus, binding energy its calculations. Radioactive decay law, half life: numerical problems. Radioactive equilibrium, radioactive series. Artificial radioactivity: Nuclear reactions induced by γ-radiation,α,n,p, and d particles. Nuclear fission and fusion. Nuclear reactors, Breeder reactors, atomic energy programme in India. Isotopes- use of radio isotopes in tracer technique, agriculture, medicine, food preservation and Carbon dating-Numerical problems.

MODULE 4 **11Hrs**

CARBOXYLIC ACIDS AND THEIR DERIVATIVES

Nomenclature. Preparation: Acid hydrolysis of nitriles with mechanism. Acidity of carboxylic acids Acidic strength (pKa values) - Effect of substituents on the strength of aliphatic and aromatic carboxylic acids. (Comparison of acidic strength of formic and acetic acids; acetic acid and monochloro, dichloro, trichloro acetic acids; benzoic and p-nitrobenzoicacid; benzoic acid and p-aminobenzoic acid).Reactions: Formation of esters, acid chlorides, amides and anhydrides. Hell-Vollhardt-Zelinski reaction, Nucleophilic substitution at the carboxylic carbon-General mechanism. Relative reactivity of acid derivatives. Decarboxylation and reduction (using LiAlH4).Acid derivatives: Reactions of acid chlorides (hydrolysis, reaction with alcohol, ammonia and lithium dialkylcuprates). Acid anhydrides (hydrolysis, reaction with alcohol, ammonia).Esters (alkaline hydrolysis, ammonolysis and alcoholysis).Amides (hydrolysis, reduction, Hoffmann rearrangement). Mechanism of ester hydrolysis - acid and base catalyzed.

Amines

Classification. Preparation of alkyl and aryl amines-reductive amination of carbonyl compounds, Gabriel phthalimde synthesis. Basicity of amines in aqueous solution: Inductive, resonance, steric and solvation effects on the basicity of amines. Reaction of amines as nucleophiles – Methylation, quarternary salts, Hoffmann elimination with mechanism. Distinguishing reactions of 10, 20and 30amines. Diazotization and synthetic applications of diazonium salts. Sandmeyer's reaction. (Conversion to chlorobenzene, bromobenzene and benzonitrile), hydrolysis, reduction (to phenyl hydrazine and aniline), coupling reactions to give azo dyes (phydroxyazobenzene and 1-phenylazo-2-naphthol).

MODULE 5 08**Hrs**

HETEROCYCLIC COMPOUNDS

Introduction, classification - monocyclic and bicyclic, structures, resonance and aromatic character of furan, pyrrole, thiophene and pyridine. Methods of preparation and reactions of pyrrole, furan, thiophene, pyridine. Comparison of basicity of pyrrole, pyridine and piperidine.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand &Co., 1998.
2. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987.
3. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice Hall, 1991.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16 CH272
TITLE OF THE COURSE : Inorganic Chemistry (Practical)
L: T/A: P: C : 0 : 0 : 4 : 2

COURSE OBJECTIVES:

1. In practical classes, the students will be give hands on training on semi- micro qualitative analyses of mixture of two simple inorganic salts.
2. In practical classes, the students will be given hands on training on paper chromatographic technique. Using this technique, the sudents will be separating the metal cations. They will also calculate the Rf values of different species present in the mixture.

COURSE OUTCOMES:

1. After the practical classes, the students are well familiarized in semi-micro-qualitative analysis of mixture of two inorganic salts.
2. After the practical classes, the students are well familiarized with paper chromatographic technique for separation of analyses in mixtures.
3. The students can measure and calculate the different parameters of the effluents during effluent analysis.
4. The students can become experts of solvent extraction techniques.

1. Systematic semi-micro qualitative analysis of a mixture of two simple salts (At least seven mixture of salts with no interfering radicals).
2. Separation of metal ions (Cu^{2+}, Co^{2+}, Ni^{2+}, Fe^{2+}) using paper chromatography and calculation of Rf values.
3. Separation of Mg (II) and Fe (II) by solvent extraction technique.
4. Effluent analysis.
5. Separation of Phosphate / Borate ions.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 16EP292
TITLE OF THE COURSE : ENTREPRENEURSHIP

L: T/A: P: C : 2: 0: 0: 0

TOTAL CREDIT HRS: 26 HRS

MODULE 1: THE NATURE AND IMPORTANCE OF ENTREPRENEURS 5h

Nature and Development of Entrepreneurship, Definition of Entrepreneur Today, Entrepreneurial Decision Process, Role of Entrepreneurship in Economic Development, Intrapreneurship, Entrepreneurship, Entrepreneurial Careers and Education, The Future of Entrepreneurship Module.

MODULE 2: THE ENTREPRENEURIAL AND INTRAPRENEURIAL MIND 6h

The Entrepreneurial Process, Identify and Evaluate the OpportMODULEy, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise, Managerial versus Entrepreneurial Decision Making, Causes for Interest in Intrapreneurship, Corporate versus Intrapreneurial Culture, - Climate for Intrapreneurship, Intrapreneurial. Leadership Characteristics, Establishing in the Organization, factors affecting entrepreneurship — qualities of successful entrepreneurship.

MODULE 3: SMALL & MEDIUM ENTERPRISES (SME) 5h

Role of SME, concept and definitions of SME, government policy and SME in India, growth and performance of SME sector, problems for SMEs, Sickness in SME, criteria to identity sickness, causes, symptoms and remedial measures of sickness, institutional support for SMEs.

MODULE 4: STARTING THE BUSINESS - BUSINESS IDEA & INNOVATION 5h

Business idea, OpportMODULEy Recognition , Product Planning and Development Process, Establishing Evaluation Criteria, Idea Stage, Concept Stage Product Stage, Test Marketing Stage, Creativity, Innovation and entrepreneurship, barriers to creativity, techniques for improving the creative process, corporate entrepreneurship, causes, climate, intrapreneurial leadership characteristics, Establishing intrapreneurship in the organization.

MODULE 5: LEGAL ISSUES FOR THE ENTREPRENEUR 5h

Various forms of organization, Legal Issues in Setting up the Organization, The various statutory registrations and clearances required.

REFERENCES:

1. M. Lall, Entrepreneurship, Excel books
2. Vasant Desai:- Dynamics of Entrepreneurial Development and Management. HPH
3. Hisrich, Robert D., Peters, Michael P., and Shephered, dean a: entrepreneurship, Tata McGraw hill; sixth edition, 2007
4. Mathew J Manimala:- Entrepreneurship at the Crossroads - Biztantra
5. Mohanty – Fundamentals of Entrepreneurship, Prentice Hall of India
6. Zimmerer & Scarborough – Essentials of Entrepreneurship & Small BusinessManagement, Prentice Hall of India

SEMESTER V

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT301
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGY AND BASICS OF ANIMAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To equip the students with cells and organs of immune system and immunological techniques.
2. To provide basic understanding on animal cell culture and applications of animal biotechnology in modern research.

COURSE OUTCOMES:
1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge on animal biotechnology and its application.

MODULE 1 **09Hrs**

Elements of Immune System: History and scope of Immunology, Innate and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Interleukins and Interferons – brief introduction and their important functions. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE 2 **09Hrs**

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting antigenicity, antigen processing and presentation, antigen processing cells (APCs); Major Histocompatibility Complex (MHC) – MHC I and II, Antibodies – structure, types and functions of Immunoglobulins

MODULE 3 **09Hrs**

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence.
Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated and Recombinant vaccines – Peptide and DNA Vaccines

MODULE 4 **09Hrs**

Animal Cell Culture: Introduction, history and scope of Animal Biotechnology, Facilities inAnimal Cell Culture, Media – natural and chemically defined, importance of serum in the media.Growth factors promoting proliferation of animal cells – EGF, FGF, PDGF and erythropoietin. Primary Cell Culture: Isolation of tissue – disaggregation techniques (mechanical, enzymatic), explant method Secondary Cell Culture: Transformed and continuous cell lines (Hela, CHO, BHK)

MODULE 5 **09Hrs**

Applications of Animal Tissue Culture: Transfection of animal cell lines, HAT selection, Expression of cloned genes in animal cells – expression vector, over-production and downstream processing of the expressed protein, production of vaccines in animal cells, Hybridoma Technology for Monoclonal antibody production, Transgenic animals – techniques and applications (examples of mice and sheep)

REFERENCE BOOKS

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
3. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier
8. Health
4. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
5. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
6. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
7. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
8. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16BT371**
TITLE OF THE COURSE : **IMMUNOLOGY AND ANIMAL BIOTECHNOLOGY**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES: 1. To acquaint the student with the important techniques in immunology and animal biotechnology.

COURSE OUTCOMES: 1. Student will be well equipped with immunological techniques utilized for diagnostic assays.
2. Students will be skilled to set up primary cell culture and perform cell count and cell viability assay.

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Preparation of media for animal cell culture
7. Isolation of liver parenchyma cells by mechanical method and set up primary culture
8. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
9. Isolation of cells by explant method and Sub-culturing
10. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT321
TITLE OF THE COURSE : ENVIRONMENTAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To impart basic knowledge in environmental science, environmental issues and the management.
2. To familiarize the significant techniques in biotechnology that contribute to environment protection.

COURSE OUTCOMES: 1. Student will be well acquainted with the role of various environmental pollutants, and environment monitoring techniques.
2. Students will be familiarized with the waste water treatment, bioremediation and bioleaching.

MODULE 1 **10Hrs**

Sources of Energy: Renewable and non-renewable sources of energy, Conventional fuels and their environmental impact, Modern fuels and their environmental impact, methanogenic bacteria, microbial hydrogen production, biogas production, conversion of sugar to alcohol, gasohol, biofuels.

MODULE 2 **10Hrs**

Waste management: Treatment of municipal solid waste and industrial effluents, preliminary treatment, primary treatment – sedimentation, secondary treatment – aerated lagoons, activated sludge, batch reactor, trickling filter, rotating biological contractor, packed bed process, pond treatment system – aerobic, anaerobic and facultative, tertiary treatment – solid, nitrogen, phosphorus removal and disinfection.

MODULE 3 **09Hrs**

Bioremediation: Bioremediation techniques – *in situ* and *ex situ*, bioremediation of soil and water contaminated with oil spills, heavy metals and detergents, Phytoremediation, degradation of pesticides and toxic chemicals by microorganisms - aromatic and chlorinated hydrocarbons, petroleum products, genetically modified organisms in bioremediation

MODULE 4 **07Hrs**

Bioleaching: Microbes used in leaching, mechanism, leaching process, some case studies related to bioleaching.

MODULE 5 **09Hrs**

Environment monitoring: Bioindicators (Terrestrial & Aquatic), Biosensors of pollution
Novel methods for environment protection: Vermitechnology, Waste Water Treatment Using Aquatic Plants, Root Zone Treatment. Biodegradable and Ecofriendly Products.

REFERENCE BOOKS

1. Indu Shekhar Thakur (2011) Environmental Biotechnology: Basic concepts and Applications (2nd Ed) IK International Publishing House
2. Pradipta Kumar Mohapatra (2006) Textbook of Environmental Biotechnology, IK Publishing House
3. Parihar (2008) Environmental Biotechnology-Fundamentals and Application, Agrobios (India).
4. SK Agarwal (2005) Advanced Environmental Biotechnology, APH publishing corporation.
5. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BT322
TITLE OF THE COURSE : INDUSTRIAL BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To impart basic understanding of principles, and key concepts relevant to industrial biotechnology.
2. To familiarize students with downstream processing and production of important microbial products.

COURSE OUTCOMES: 1. Student will be aware of fermentation process, types of fermentation media and strategies for isolation of industrially important strains.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial biotechnology processes.

MODULE 1 **09Hrs**

Screening and Selection of strains: Introduction, basics of fermentation technology, Isolation and screening of microorganisms, maintenance of strains, strain improvement – mutant selection, recombinant DNA method

MODULE 2 **10Hrs**

Fermentation Media, Fermentors and Fermentation: Fermentation media – natural and synthetic, media sterilization, Types of Fermentors – Basic design, Airlift, tower and bubble cap fermentor; Immobilized cells and enzyme fermentor; Types of Fermentation -Solid state, submerged, Batch, Fed-batch and Continuous.

MODULE 3 **08Hrs**

Downstream Processing: Solid-liquid separation (Filtration, flocculation, centrifugation, sedimentation),

MODULE 4 **08hrs**

Downstream processing for release of intracellular products – physical, enzymatic, chemical, concentration and purification of products.

MODULE 5 **10Hrs**

Production of Microbial Products: Production of wine, beer, citric acid, penicillin, glutamic acid, Vitamin B12, Amylase, insulin, fermented foods (Yoghurt, cheese), Single Cell Protein (SCP)

REFERENCE BOOKS

1. Glazer and Nikaido (1995), Microbial Biotechnology, WH Freeman and Co.
2. Prescott, Harley ad Klein (2002) Microbiology (5th Ed), Mc-Graw Hill Co.
3. Prescott & Dunn (2002) Industrial Microbiology, Agrobios Publishers
4. Nduka Okafor (2007) Modern Industrial Microbiology and Biotechnology, CRC Press

5. Stanbury, Whitaker and Hall (2008) Principles of Fermentation Technology, Elsevier
6. LEJR Casida (2007) Industrial Microbiology, New Age International Publishers
7. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC301
TITLE OF THE COURSE : ENZYME TECHNOLOGY AND PROTEIN CHEMISTRY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Learning about enzyme properties along with enzyme and inhibition kinetics.
2. Knowledge of enzyme assay and drawing enzyme assisted reaction plots.
3. Brief idea about the various coenzymes.
4. Introduction to Protein structure understanding with various examples.
5. Studying analytical techniques to characterize proteins including brief introduction to proteomics.

COURSE OUTCOMES:
1. They will have a working knowledge of the active site of the enzyme and how it helps in reactions.
2. Students will be equipped with adequate knowledge on drawing various plots to understand the nature of enzyme and inhibitor.
3. Students will know the classification and function of various proteins along with their structural hierarchy.
4. They will also be able to analyze results obtained after protein characterization.

DEPARTMENTAL ELECTIVE 1:

MODULE 1 **9 Hrs**

INTRODUCTION: Classification & nomenclature of enzymes, Active site: Lock & key, induced fit model and strain/TS theory- lysozyme and chymotrypsin as examples, Enzyme specificity: bond, group, absolute and stereo-chemical specificity. Enzyme catalysis: Proximity & Orientationeffect, Regulatory enzymes: - Allosteric (ATCase) and covalently modulated (Glycogenphosphorylase) enzymes, MODULEs-Katal & IU. Effect of physical and chemical parameters on enzyme activity with examples.

MODULE 2 **9 Hrs**

ENZYME KINETICS: Importance of measuring initial velocities, Derivation of Michaelis-Menten equation, Single & double reciprocal plots, Inhibition (Competitive, Noncompetitive & Uncompetitive) on Lineweaver-Burke plots. Importance of Kcat / Km. Bisubstrate reactions – brief introduction.

ENZYME ASSAY AND PURIFICATION: Enzyme assay, Specific activity. Enzyme isolation and purification, criteria for enzyme purity. Isoenzymes and clinical applications, Biotechnological applications, enzyme biosensors.

MODULE 3 **9 Hrs**

VITAMINS AND COENZYMES

Structure and reaction mechanisms of vitamins – fat-soluble: A, D, E & K; water-soluble: Thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, biotin, folic acid, cobalamine and ascorbic acid.

MODULE 4 **9 Hrs**

PROTEINS

Classification based on composition, shape and function, assay techniques. Peptide bond, Ramachandran Plot, Structural organization: primary, secondary, tertiary and quaternary structures, Hemoglobin, Immunoglobulin, Collagen, myosin and Keratin structures. Denaturation and melting temperature, Hofmeister series. Protein synthesis.

MODULE 5 **9 Hrs**

INTRODUCTORY PROTEOMICS: Isolation and purification of proteins (non-enzymatic), Characterization through gel permeation, ion exchange and affinity chromatography. Sequence determination by Sanger and Edman methods. Mass spectroscopy of proteins: mass determination, Hydropathy plot, Protein Expression, Vectors and hosts, downstream processing.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC371
TITLE OF THE COURSE : ENZYMOLOGY AND RECOMBINANT PROTEIN PURIFICATION
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To introduce students to various practical aspects of enzymology;and give them hands on learning in function and kinetics of enzymeand their role as catalyst and regulator of cell metabolism.
2. Serve as foundation for more advanced enzymology courses.
3. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. The student will learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory process.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation, expression and purification of recombinant protein

1. Isolation of enzymes from biological source and activity determination
2. Determination of kinetic constants through LB plot.
3. Effect of temperature and Arrhenius constant.
4. Effect of enzyme dilution
5. Effect of substrate concentration
6. Effect of pH
7. Effect of activator
8. Effect of inhibitor
9. Immobilization of enzyme using calcium alginate.
10. Preparation of competent cells and transformation
11. Protein purification by Ni- NTA Affinity chromatogram
12. SDS-PAGE of purified protein
13. Protein concentration determination from spectrophotometry
14. Purification of protease from plant by ammonium sulphate fractionation
15. Protease assay through FC method

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC321
TITLE OF THE COURSE : CHEMISTRY AND METABOLISM OF CARBOHYDRATES AND PROTEINS
L: T/A: P: C : 3: 0: 0: 3

DEPARTMENTAL ELECTIVE 2:

COURSE OBJECTIVES: Learning structure and reactions of carbohydrates used in metabolism by living systems. Learning about the physiological reactions undertaken by living systems to breakdown the carbohydrates and release of energy. To have a brief idea about amino acid metabolism with examples. To learn about the metabolic roles performed by small peptides.

COURSE OUTCOMES: Once the course is over, students will be able to draw structure of mono, di and polysaccharides. They will have an overall idea about the role carbohydrates play in energy storage and usage. Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems. They will understand the role of urea cycle and the various functionalities that peptides play in metabolism.

MODULE 1 **9 Hrs**

CARBOHYDRATE CHEMISTRY
Biological importance and classification. Fischer structure, D-L designation. Glucosestructural elucidation and conformation. Ring and open-chain structure of fructose, galactose, mannose and arabinose. Epimers and anomers, pyranose and furanose ring. Reactions: Benedict's, oxidation, osazone, ester, amino and deoxy sugar formation. Derived monosaccharide: structure and biological importance of amino sugars and sugar phosphates. Oligosaccharides: glycoside linkage, structure and biological importance of sucrose, maltose, lactose, isomaltose, cellobiose and trehalose.
Polysaccharides: starch, glycogen, cellulose, inulin, chitin and pectin. Mucoploysaccharide: glycosaminoglycans, cell wall components: peptidogycan and teichioc acid.

MODULE 2 **9 Hrs**

CARBOHYDRATE METABOLISM
Glycolysis, entry of other carbohydrates into glycolysis, the fate of pyruvate, the citric acid cycle, the energetics of glucose metabolism. Enzymatic control of glycolysis and TCA cycle. The amphipathic role of the citric acid cycle. Outline of pentose phosphate pathway and its significance.

MODULE 3 **9 Hrs**

The Cori cycle, Gluconeogenesis and glycogen metabolism. Substrate level phosphorylation, regulation of blood sugar level. Diabetes mellitus. Determination of glucose in body fluids; fasting, post-prandial, GTT. Glycogen storage disorders.

MODULE 4 **9 Hrs**

AMINO ACIDS

Protein and non-protein amino acids, structure and classification of α-amino acids, acidsbase, chemical and optical properties. Synthesis and degradation of selected amino acids (tyrosine, methionine, glutamine), transamination, deamination, Urea cycle.

MODULE 5 **9 Hrs**

PEPTIDES AND PROTEINS

Biologically important peptides- leptin, ghrelin, neuropeptides, substance P, enkephalin, angiotensin, defensin, vasopressin and oxytocin. Chemical synthesis of peptides.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Protein Protocols Handbook – Walker. Humana Press.
7. Protein Purification Applications – Roe. Oxford University Press.
8. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16BC322
TITLE OF THE COURSE : NUTRITION AND BIOMEMBRANES
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.Introduction to nutrition, food components and micronutrients.

2. Idea about biological membrane and the transport systems that allow material movement through the membrane.

COURSE OUTCOMES: 1. Students will have an idea about the nutritional quality of food stuff and know about a balanced diet.
2. They will be aware of the various processes that can be made to increase nutritional quality of food.
3. Students will know the ultra-structure of membranes and have detailed knowledge about the role of each component.
4. They will be able to interpret the various movements through the membrane and the types associated with them.
5. They will have an idea about how proteins are sent to various parts of a cell.

MODULE 1 **9 Hrs**

INTRODUCTION TO NUTRITION: Food as source of nutrients, functions of food, definition of nutrition, nutrients & energy, adequate, optimum & good nutrition, malnutrition. Nutrition - fitness, athletics & sports.

MODULE 2 **9 Hrs**

FOOD COMPONENTS AND AVAILABILITY: Basic five food groups How to use food guide (according to R.D.A.) Interrelationship between nutrition & health. Sources, function, storage and deficiency of carbohydrates, fats, oils, fiber and proteins. Water - as a nutrient, function, sources, requirement, water balance & effect of deficiency.

MODULE 3 **9 Hrs**

MICRONUTRIENTS: Minerals - functions, sources. Bioavailability and deficiency of Calcium, Iron, Iodine, Sodium & Potassium Vitamins (water & fat soluble) - definition, classification & functions. Functional food, food fortification, food additives, role of FDA.

BIOLOGICAL MEMBRANES: Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, composition and trans bilayer asymmetry, Isolation of membrane components, effect of lipid size and saturation on membrane fluidity, role of cholesterol, lipid rafts, non-bilayer lipids and their role in membrane, Liposomes; properties and application in membrane biochemistry

MODULE 4 **9 Hrs**

TRANSPORT ACROSS MEMBRANE: Passive – ion channels, ionophore and porins; Facilitated diffusion: aquaporin, gated ion channels – sodium and potassium ion channels in muscle, calcium ion channel in heart; Active transport – P, V and F-type ATPase – structure, function and location, ATPbinding cassatte transporters and multi drug resistance transporters, patch-clamp study.

MODULE 5 **9 Hrs**

PROTEIN TRAFFICKING: Protein sorting; Membrane enclosed organelles of eukaryotic cells, evolutionary origin Protein trafficking: Sorting signals. Signal Hypothesis: Signal Sequence, SRP-receptors for protein import to ER. Organization of translocation pore, Intracellular vesicular trafficking, Vesicles: types, Clathrin coated- Assembly and disassembly.

REFERENCE BOOKS

1. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
2. Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell , The McGraw-Hill .
3. Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science .
4. Biochemistry of Lipids, Lipoproteins and Membranes; 5th Edn. Dennis E. Vance and Jean E. Vance, Elsevier .
5. Molecular Biology of the Cell, Alberts et al., Garland Publications .
6. Molecular Biology of the Cell; 6 th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts and Peter Walter; Garland Science .
7. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co.
8. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley
9. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell .
10. Textbook of medical Biochemistry Chatterjee and Shinde, JP Medical Ltd, 8th edition.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN301
TITLE OF THE COURSE : GENETIC ENGINEERING
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Understand the usage of other sources for DNA manipulation
2. Diverse methods to visualise modified genetic materials.

COURSE OUTCOMES:
1. Students will appreciate the different techniques of manipulating the genetic material and further validating it.
2. Student will understand how experiments need to be carried out carefully and with well planning. This will teach the concept of "attention to details"

MODULE 1- INTRODUCTION AND TOOLS FOR GENETIC ENGINEERING 9Hrs

Introduction to Genetic Engineering: Overview of major steps involved. Tools for Genetic Engineering: Enzymes and Vectors. Enzymes: Restriction endonucleases: Types and characteristic features; Nomenclature; Modification of cut ends. DNA ligases. Other enzymes: A brief account of Alkaline phosphatase, Polynucleotide kinase, Exonuclease III, DNase I, DNA polymerase and Klenow fragment, Terminal nucleotidyl transferase, RNA dependent DNA Polymerase.

MODULE 2- VECTORS 9Hrs

Properties of an ideal vector. Types: Cloning and expression vectors Cloning vectors: Prokaryotic vectors: Plasmids- pBR 322; pUC 18; Bacteriophages - Lambda phage, Cosmids. Eukaryotic vectors: YAC vectors; Shuttle vectors- Yeast and *E. coli.* For higher plants: Integrative DNA transfer- *Agrobacterium* vectors-Ti plasmid-Binary and Co integrated vectors; Non integrative DNA transfer-Plant viral vectors (CaMV). For animals: Animal viral vectors- SV 40 (3 types); Expression vectors in Prokaryotes and Eukaryotes

MODULE 3- GENE ISOLATION AND TRANSFER 9Hrs

Isolation of the desired gene: cDNA library, Genomic library, Organo-chemical synthesis, Amplification through PCR. Direct gene transfer methods: Chemical methods, Lipofection, Electroporation, Microinjection, Ballistic method (Particle shot gun method). Selection and screening of recombinants: Identification and selection of transformed cells: Direct methods - Insertional inactivation, Visual screening method, Plaque formation, Complementation of mutation /nutritio Indirect methods - Colony hybridization, Immunochemical detection. Use of selectable and scorable genes: Selectable genes: Plants-npt; Animals-TK. Scorable genes: Plants-Gus; Animals-lux.

MODULE 4- GENETIC ENGINEERING TECHNIQUES 9Hrs

Technique for Genetic Engineering: Gel electrophoresis: AGE and SDS-PAGE Hybridization: Southern; Northern; Western; Dot blots, Autoradiography, DNA sequencing: Sanger's Dideoxy method, Molecular probes.

MODULE 5- APPLICATIONS **9Hrs**

Transgenic animals: Mouse (Knock-out; Methodology, applications); A brief account of Transgenic Sheep, Poultry, Fish, Cow, with value added attributes. Transgenic Plants: Resistance to diseases (Pathogen resistant-viral, fungal and bacterial); insects (Bt gene transfer); Fertilizer management- Nif gene transfer.

TEXT BOOKS

1. Sandhya M. Genetic engineering: Principles and practice, MacMillan India Ltd. 2008.
2. Primrose, S. B., and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA. 2006.

REFERENCE BOOKS

1. Nicholl D. S. T. An introduction to Genetic engineering (2nd ED), Cambridge University Press, 200
2. Satyanarayana U. Biotechnology, Books and Allied (P) Ltd., Kolkata, 2008.
3. Purohit S. S. Biotechnology Fundamentals and applications, student Edition, Jodhpur, 2003.
4. Channarayappa. Molecular Biotechnology- Principles and practices, University press (India) Private Limited, 2006.
5. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres. Genetics from Genes to Genomes. McGraw Hill. 2004.
6. Lewin B. Genes VIII. Oxford University Press. Oxford, 2003.
7. Watson, J. D., T. A. Baker S. P. Bell, A Cann, M. Levine and R. Losick, Molecular Biology of Gene V Edition, Pearson Education RH Ltd. India. 2004.
8. Brown T. A. Genomes 3. Garland Science Publishing, New York. 2007.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN371
TITLE OF THE COURSE : GENETIC ENGINEERING PRACTICAL
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. Introduction to instruments and isolation methods of the genetic materials.
2. Further study of quantification and manipulating of the genetic material with extra-chromosomal genetic material from other sources.

COURSE OUTCOMES:

1. Students will understand how genetic material from different sources can work together in genetic engineering.
2. Student with competitive approach can use this Multidisciplinary approach to think innovative concepts.

1. **INSTRUMENTATION:**
   - UV Transilluminator
   - PCR
2. **VECTORS:**

- pBR 322 and Cosmid,
- YAC,
- Ti plasmid - Binary vector,
- SV 40 (any one type)

3. **TRANSGENIC ORGANISMS:**
   - Plants-Bt cotton and Animals-Knock out Mouse

4. **EXPERIMENTS:**
   - Quantification of DNA by DPA method
   - Quantification of RNA by Orcinol method
   - Agarose Gel Electrophoresis of DNA
   -
5. **DEMONSTRATIONS:**
   - Isolation of Plasmid DNA
   - Restriction Enzyme digestion
   - Ligation of DNA fragment
   - Transformation- α complementation

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN321
TITLE OF THE COURSE : BASIC HUMAN GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of inheritance pattern and immunogenetics.
2. Highlight the applications of genetics in different aspects of life.

COURSE OUTCOMES:
1. Students will understand the application of genetic outside the lab.
2. Understand how early life genetic studies can help future generations.

MODULE 1 HUMAN CHROMOSOMES, INHERITANCE AND GENETIC DISEASES 9Hrs

Human Chromosomes: Normal Human Karotype: Paris Nomenclature, Flow karyotyping (Quantification of DNA of individual chromosomes), FACS - Fluorescence activated cell sorter. Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.

MODULE 2 GENETIC DISEASES AND INHERITANCE PATTERN 9Hrs

Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis). Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria). X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD). X-linked Dominant Inheritance (Ex- Xg blood group). Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF). Multi-factorial inheritance (Ex.-Congenital malformations-Cleft lip and palate, Rheumatoid arthritis and Diabetes). Mitochondrial diseases (Ex.- Leber's heriditary optic neuropathy).

MODULE 3 IMMUNOGENETICS AND ONCOGENETICS 9Hrs

Immunology and Immunogenetics: Introduction to immunology, Cells of immune system, Genetics of immune system, Immune response, Innate and acquired immunity. Inherited immunodeficiency (Ex. X- linked agammaglobulinaemia). Major Histocompatibilty. Complex-Study of twins (MHC), HLA disease associations. Transplantation, graft-versus-host disease. Oncogenetics: Properties of malignant cells, Types of genes - Proto oncogenes, Oncogenes, Cellular oncogenes, Tumor Suppressor genes, Chromosomal abnormalities associated with specific malignancies - Acute Promyelocytic Leukemia (APL), Chronic Myeloid Leukemia (CML) and Retinoblastoma.

MODULE 4 DERMATOGLYPHICS, DIAGNOSIS AND THERAPY 9Hrs

Dermatoglyphics: Introduction and classification, Flexion creases. Dermatoglyphics in clinical disorders. Clinical applications, advantages and limitations. **Diagnosis:** Prenatal diagnosis: Noninvasive methods- X- radiation, Ultrasonography and Fetal echocardiography. Invasive

methods- Maternal serum screening, Amniocentesis, Chorionic villus sampling and Fetoscopy. Technology in reproductive assistance

MODULE 5 THERAPY AND ETHICS **9Hrs**

Genetic counseling: Definition, Components, Psychotherapeutic counseling, Decision making, risk assessment and counseling in Mendelian and multifactorial syndromes. Gene therapy, Stem cells - Definition, types and sources. A brief account on Cord blood banking and Stem cell therapy. Management of genetic disorders, Models of eugenics, human right, human genetics and legal, social and ethical considerations.

TEXT BOOKS

1. Bhatnagar etal S.M. Essentials of Human Genetics. IV edition. Orient Longman. 1999.
2. Goldsby R. A., Kindt T. J. and Osborne B. A. Kuby Immunology. W. H. Freeman and Company, N. Y. 2000.

REFERENCE BOOKS

1. Lewis R. Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
2. Manage E. J. and Manage A.P. Basic Human Genetics. Rastogi Publications, Meerut. 1997
3. Gangane S.D. Human Genetics (2nd edition), B.L Churchill Livingstone Pvt. Ltd., New Delhi. 2001.
4. Mc. Kusick V.A. Mendelian inheritance in Man. 12 Edition, John Hopsins University Press. 1998
5. Cummings, M. R. Human Heredity: Principles and Issues. West Publishing Company. 1994.
6. Epstein, R. J. Human Molecular Biology. Cambridge Univ. Press, Cambridge. 2003.
7. Khoury, M. J., J. Little and W. Burke. Human Genome Epidemiology. Oxford Univ. Press,Oxford. 2004.
8. Motulsky, V. Human Genetics. Springer & Verlag, Berlin. 1977.
9. Strachan, T. and A. P. Reads, Human Molecular Genetics 3. Garland Science, London. 2004.
10. Abbas, A. K., A. H. Lichtman and J. S. Pober. Cellular and molecular immunology. W. B. Saunders Company. 1994.
11. Alberts, B., A. Jhonson, J. Lewis, M. Raff, K. Roberts and P. Walter. Molecular Biology of the cell. V Ed. Garland Science, New York. 2008.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16GN322
TITLE OF THE COURSE : PLANT GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Introduce the concept of plant genetics and gene regulation in plants.
2. Highlight the applications of plant genetics.

COURSE OUTCOMES:
1. Students will understand gene regulation and stress response pattern in plants.
2. Understand applications plant genetics study.

MODULE- 1: GENE REGULATION IN PLANTS 9Hrs

Over view of plants as genetic model systems, gene regulation in plants. Genes involved in regulation of flower development. Homeotic genes, Development of dorsal and ventral asymmetry in leaves. Role of KNOX genes in evolution of compound leaf.

MODULE-2: GENE REGULATION DURING SRESS 9Hrs

Types of abiotic stresses and gene regulation during water deficit and heat stress. Plant nodule genes. Mechanism of self-incompatibility in plants.

MODULE- 3: APPLIED GENETICS OF PLANTS 9Hrs

Genetic basis of disease resistance and susceptibility in plants. Molecular basis of host pathogen interaction. Genetic basis of Crown Gall disease development. Agrobacterium- Genetics of Ti plasmid. Plant wound genes and control of 'vir' gene expression. Mechanism of T-DNA transfer and their utility in production of transgenic plants.

MODULE- 4: PROTOPLAST TECHNOLOGY 9Hrs

Isolation, maintenance and viability tests for protoplast, regeneration of plants from protoplast, methods of protoplast fusion and its application.

MODULE –5 BIOFERTILIZER 9Hr

Biofertilizer: Production and beneficial roles of Rhizobium, Innoculants and Azatobacter inoculants, field application of Rhizobium, Azatobacter blue green algae, mycorizal fungi and Azolla.

TEXT BOOKS

1. Altman A. and Hasegawa, P.M. Plant biotechnology and Agriculture – Prospects for the 21st Century, Elsevier Science Publishers, Amsterdam. 2011.
2. Chawla H.S. Plant Biotechnology, Oxford and IBH publishing Co. Pvt Ltd., New Delhi. 2003.

REFERENCE BOOKS

1. Brahma Mishra, Fertilizer Technology and Management, I.K. International Publishing House Ltd., New Delhi. 2009.
2. Genes and Agriculture, Jones and Bartlett Publishers, Boston. 1994.
3. Dickinson M. Molecular Plant Pathology. BIOS Scientific, Oxford, UK. 2003.
4. Purohit, S.S. Agricultural Biotechnology, Agribios, Jodhpur. 2006.
5. Rangaswami, G. and Bagyaraj. D.J. Agricultural Microbiology (2nd Ed.), PHI Learning, India. 1998.
6. Satyanarayana, U. Biotechnology, Books and Allied (P) Ltd., Kolkata. 2010.
7. Srivastava, P.S. Alka Narula, Sheela Srivastava. Plant Biotechnology and Molecular Markers, Anamaya Publishers, New Delhi. 2004
8. Griffiths A. J. F., Miller J. H., et al. An introduction to genetic analysis. W. H. Freeman, N. Y. 2000.
9. Ringo J. Fundamental Genetics. Cambridge Univ. Press, Cambridge. 2004.
10. Cullis C. A. Plant Genomics and Proteomics. Wiley-VCH. 2001.
11. Hughes M. A. Plant molecular genetics. Addison Wesley Longman Ltd. U.K. 1996.
12. Grierson D. and Covey, S. N. Plant molecular biology. Blackie Academic & Professional. London. 1998.
13. Murphy T. M. and Thompson W. F. Molecular plant development. Prentice Hall, New Jersey. 1988.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB301
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To observe importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products.
2. Explains geochemically and environmentally significant processes that the activities of microorganisms and the environmental factors controlling and limiting microbial activities

COURSE OUTCOMES: 1. Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them.
2. To make use of how microorganisms may be utilised in agricultural biotechnology, including specific techniques such as cloning and expression of genes.

PART A: AGRICULTURAL MICROBIOLOGY

MODULE 1: BIOFERTILIZERS AND BIOLOGICAL CONTROL 9Hrs

Definition, types, characterization, mass cultivation of *Rhizobium*, *Azotobacter*, *Azospirillum*, and *Azolla* .Mode of application of biofertlizers, advantages and limitations.. ISI standards. Mechanisms of biological control, field applications of *Bacillus thuringiensis*, *Trichoderma* spp. and Nuclear Polyhedrosis Virus. Advantages and limitations.

MODULE 2: PLANT PATHOLOGY-I 9Hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases. Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies].

MODULE 3: PLANT PATHOLOGY-II 9 Hrs

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism). Genetic engineering methods Study of different plant diseases- Bacteria –

Blight of rice, Fungi – Rust of sorghum, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE 4: AEROBIOLOGY AND SOIL MICROBIOLOGY 9Hrs

Microbiology of indoor and outdoor environment, Significance of microorganisms in air, aerosols, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Hirst Trap, Liquid Impingers and Filteration. Control of Air borne microorganisms – Dust control, Filteration, Fumigation, UV light exposure.
Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism).General account of bioleaching, biodegradation and bioremediation

MODULE 5: AQUATIC AND WASTE WATER MICROBIOLOGY 9Hrs

Introduction, Natural waters (Atmospheric, Surface and Ground water), Zonation of water system, Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients), general account on water borne diseases and their management. Water Pollution: Sources, Biological indicators and Eutrophication. Water quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection.

Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

REFERENCE BOOKS

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.

7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.
13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB371
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY
L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES: 1. To understand the fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems.

COURSE OUTCOMES: 1. To enable us to know how microorganisms may be utilised in agricultural microbiology.

1. Isolation and enumeration of bacteria, fungi and actinomycetes from rhizosphere soil
2. Examination of bacteriodes from legume root nodules
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
4. Demonstration of fungal contaminants in ground nut by standard blotter method
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Study of plant pathogens (specimens/charts)- Bacteria (Citrus canker, bacterial blight of rice), Fungi (Tikka Disease of ground nuts, red rot of sugarcane, rust of sorghum), virus (tobacco mosaic virus), mycoplasma (sandal spike)
7. Study of antagonism between soil microorganisms
8. Isolation of air borne microorganism by petriplate exposure method
9. Estimation of dissolved oxygen in water
10. Determination of Biological Oxygen Demand
11. Standard water quality analysis by MPN test
12. Estimation of total solids in sewage
13. Field visit to agriculture fields and sewage treatment plant

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB321
TITLE OF THE COURSE : FOOD MICROBIOLOGY (DEPARTMENTAL ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To exhibit depth and breadth of knowledge by demonstrating biological sciences, in the field of food microbiology
2. To related to food microbiology has interdisciplinary connections with other sciences, in particular food science.

COURSE OUTCOMES: 1. It will develop depth of understanding of the microbiology of food, food-borne diseases, food spoilage, fermentation of food and modern microbial analysis techniques relating to food.

2. It will develop problem solving capabilities in practical working in teams in laboratory-based virtual experiments to gather and evaluate microbial data using a range of current food analysis techniques.

MODULE 1: FOOD AS A SUBSTRATE AND FOOD BORNE DISEASES 9Hrs

Intrinsic and extrinsic factors in food affecting microorganisms; natural flora and source of contamination of foods in general. Food hazards, significance of food borne diseases, types – food infection (*E.coli*, Salmonellosis, Shigellosis), food intoxication: Bacterial (*Clostridium botulinum*, *Staphylococcus spp.*) and fungal (aflatoxins), Virus (Polio), Helminths (Tape worms), Protozoa (*Entamoeba*histolytica).

MODULE 2: PRINCIPLES AND METHODS OF FOOD PRESERVATION 9Hrs

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, nitrite and nitrates, antibiotics and bacteriocin.

MODULE 3: MICROBIAL SPOILAGE OF FOOD 9Hrs

Introduction, Different ways of food spoilage. Spoilage of Cereals, Vegetables, Fruits, Meat, fish, eggs and canned foods

MODULE 4: FERMENTED FOODS 9Hrs

Introduction, nutritional and therapeutic importance .Fermented Vegetables, Meat, Beverages, Bread, Idli, Single cell Protein (Yeast, Algae) and Mushrooms. General account on Probiotics and Prebiotics.

MODULE 5: MICROBIAL EXAMINATION OF FOOD AND QUALITY CONTROL 9Hrs

DMC, Viable colony count, dye reduction tests, MPN, immunological and molecular methods. Sampling schemes, Microbiological criteria, Control at source, Codes for Good Manufacturing practice, HACCP concept.

REFERENCE BOOKS

1. James M.J. Modern Food Microbiology, CBS Publishers and Distributers, Delhi. 1996
2. James M. and Jay J.M. Food Borne Pathogen An Illustrated Text, Wolfe publications Ltd, England. 1991.
3. Colin Rand Bjorn K. Basic Biotechnology 2nd Edition. Cambridge University Press. 2002.
4. Mary E.T and Richard E. I. Microbial Food Safety Animal Agriculture: Current Topics, Iowa state University Press. 2003
5. Bibek R. Fundamentals of Food Microbiology. Bibek Ray. 2nd Edition. CRC press. 2001.
6. Adams M.R. and Moss M.O. Food Microbiology. Royal Publishing Corporation. 2000.
7. Robinson. Dairy Microbiology VoI and II.
8. John G. Essentials of Food Microbiology. Arnold International Students Edition.
9. Riemann H. Food borne infections and intoxications. Academic Presss Inc., New York. 1969.
10. Powar and Daginawala. General Microbiology. Himalayan Publication. 1982.
11. Frazer W.C. Food Microbiology. McGraw Hill, New York. 1979.
12. Jay J.M. Modern Food Microbiology. Van NostrandRheinhold. New York. 1970.
13. Foster E.M. et al., Dairy Microbiology. Prentice Hall Inc., Englewood. 1975.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16MB322
TITLE OF THE COURSE : DAIRY MICROBIOLOGY (ELECTIVES)
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide in-depth knowledge in various MODULE operations and basic concepts in dairy processing.
2. To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products

COURSE OUTCOMES: 1. Enables students about additional knowledge on microbiological analysis on organisms relevant for dairy products.
2. Knowledge of the most important spoilage and pathogens in dairy products has also been obtained.

MODULE 1: MICROBIOLOGY AND FERMENTATION IN MILK 9hrs

Physical and chemical properties of milk. Types of microorganisms in milk (bacteria, fungi and yeast). Source of microbial contamination of milk- Milk producing animal, Milking environment, utensils, equipment, water, personnel and packing material. Souring, lactic acid fermentation, colour and flavour fermentation, gassy fermentation, proteolysis and lipolysis.

MODULE 2: MILK BORNE INFECTIONS 9hrs

Introduction, Tuberculosis, Brucellosis, Listeriosis, Anthrax, Q fever, Cow pox, Foot and Mouth diseases.Preventive and Control Measures.

MODULE 3: MILK AND MILK PRODUCTS 9hrs

Dairy starter cultures, Fermented Dairy products – curd, lassi, yogurt, flavoured milk, cheese, condensed milks, acidophilus milk, kefir and milk powders.

MODULE 4: MICROBIOLOGICAL ANALYSIS OF MILK 9hrs

Rapid platform tests- organoleptic, clot on boiling, lactometer, titratable acidity, alcohol test, DMC, sedimentation tests and pH.Standard plate count, reductase test- MBRT, Resazurin test, Methylene blue test.

MODULE 5: MILK PROCESSING 9hrs

Collection, transport of Milk, Cold Storage,Pasteurization, sterilization, dehydration**,** and preservation of milk quality, Indian standards of grading milk. General account on milk adulteration: effects and detection.

REFERENCE BOOKS

1. Betty C. Hobbs, Food Microbiology, Arnold-Heinemann Publishing Private Limited, New Delhi.
2. Frazier and Wasthoff, Food Microbiology, Tata McGraw-Hill Publishing Company Limited, New Delhi
3. Hammer B.W and Babal, Dairy Bacteriology, Prentice Hall Incorporated, London.
4. Salle A.J. Fundamental Principles of Bacteriology, Tata McGraw- Hill Publishing Company Limited, New Delhi.
5. Varnam A.H and Evans M.G Food borne Pathogens, Wolfe Publishing House, London.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH 301
TITLE OF THE COURSE : PHYSICAL CHEMISTRY AND CHEMINFORMATICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.The basic principles and concepts of electrochemistry, ionic equilibria, photochemistry and chemoinformatics will be taught to the students.

2. In electrochemistry, the terms like equivalent and molar conductivities, their determinations, transport numbers and determinations, Nernst equations, numerical, pH measurements will be tought.

3. The basic concepts of chemoinformatics and its application in drug designing will be thought.

COURSE OUTCOMES:

1.The students will be well versed with the basic principles, terms and equations and methods to determine conductivities and pH measurements of the solutions.

2. The students will be familiar with buffer solutions, significance, preparations and significance.

3. The students will be familiar with the basic principles, terms ,laws, and equations regarding the photochemistry.

4. The students will be well versed with terms, concepts, and terminalagies used in chemoinformatics and their applications in drug analysis.

MODULE 1 9**Hrs**

Electrochemistry I: Review of electrolytes and Conductance and related terms Methods of determination of molar conductance. Conductometric titrations (only acid-basetype). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.Kohlausch's law and its applications: (i) evaluation of $\Lambda\infty$ and $\Lambda+$ $\Lambda-$ (ii) evaluation of degreeof dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv)determination of solubility from conductance of saturated solutions of sparingly soluble salts
(AgCl and $BaSO_4$). Problems based on the above concepts.Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel- Onsagar equatation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

MODULE 2 9**Hrs**

Electrochemistry II : Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of Eo of Zn/Zn2+ and Cu/Cu2+ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

MODULE 3 10**Hrs**

Ionic Equilibria : Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems based on the above concepts.Common-ion effect, buffers, buffer action buffer range and buffer capacity. pH of buffers.Henderson's equation and its derivation and applications. Applications of buffer in analyticalchemistry and biochemical processes in human body. Solubility product and ionic product inprecipitation and in qualitative analysis. Theories of indicators; selection of indicators and their limitations.

Photochemistry

Laws of photochemistry. Grotthus-Drpare law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemicaland thermal relations. Quantum yield of photochemical combinations of (i) H2 and Cl2 (ii) H2and Br2 (iii) dissociation of HI (iv) dimerization of anthracene.Photosensitization,photostationary equilibrium. Singlet and triplet states based on Jabloski diagram.Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensiors. Beer-Lambert's law and its limitataions. Numerical problems on absorption coefficient and molar extinction coefficient.

MODULE 4 9**Hrs**

Cheminformatics I: Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation. Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification. Database Concepts, Structured Query Language, Design of Chemical Databases, Data.Abstraction; Data Models (Elementary ideas only)

MODULE 5 8**Hrs**

Cheminformatics II: Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
2. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. Oprea, T. I. Chemoinformatics in drug discovery. John Wiley & Sons: New York, NY, 2005
5. Andrew Leach, An Introduction to Chemoinformatics Johann Gasteiger (Editor), Thomas Engel (Editor) Chemoinformatics: A Textbook Wiley Publications.

SEMESTER/YEAR : **V SEM / III YEAR**
COURSE CODE : **16CH371**
TITLE OF THE COURSE : **PHYSICAL CHEMISTRY & CHEMINFORMATICS**
L: T/A: P: C : **0 : 0 :4 : 2**

COURSE OBJECTIVES:

1.The experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The physical experiment like determination of % NaCl by missibility temperature method will be tought to students.

3.Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

COURSE OUTCOMES:

1.The students will be well versed with experiments related to electrochemistry like conductmetric , and potentiometric titrations will be conducted .

2.The students will be well versed with experiments determination of % NaCl by missibility temperature method will be tought to students.

3.The students will be well versed with Various software pacakges like pubchem, chemspider, origion and chemsketch will be taught to students.

PRACTICALS

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a =b).
3. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.
4. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5. Determination of dissociation constant of monochloroacetic acid by conductivity method.
6. Conductometric titration of hydrochloric acid with sodium hydroxide.
7. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8. Determination of Critical Micellar Concentration (CMC) by conductivity method.
9. Determination of pKa of a weak acid by pH metric method.
10. Determination of percentage of sodium chloride by miscibility temperature method.
11. Introduction to chemistry related softwares such as ISIS Draw, Chemdraw, Origin etc.
12. Chemistry related Database such as Pubchem, Chemspider etc.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1 . Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH321
TITLE OF THE COURSE : INDUSTRIAL CHEMISTRY (ELECTIVE PAPER I)
L: T/A: P: C : 3 : 0 : 0 : 3

COURSE OBJECTIVES:
1. Introducing the basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. Introducing the raw materials, and properties of raw materials, in the synthesis of important industrial materials to students.
3. Introducing the basic concepts and principles of polymer chemistry to students.
4. Introducing the basic concepts and principles of nano materials, their synthesis, and Applications.

COURSE OUTCOMES:
1. The students will be well versed with basic principles of green chemistry and its advantages over the classical chemical synthesis practices to students.
2. The students will be well versed with the raw materials, and properties of raw materials, in the synthesis of important industrial materials.
3. The students will be well versed with the basic concepts and principles of polymer chemistry to students.
4. The students will be well versed with the basic concepts and principles of nano materials, their synthesis, and Applications.

MODULE 1 11**Hrs**

Introduction to Green Chemistry: Principles of Green chemistry and its application to the synthesis of paracetamol.

Industrial Materials II

Refractories: Properties, classification, determination of PCE values.

Abrasives – definition and classification with examples, applications, hardness, manufacture and importance of carborundum and tungsten carbide.

Glass: Properties, types, manufacture of soda glass. Composition and applications of borosilicate, metallic glass, optical glasses and polycarbonate glass, safety glass, fire and bullet proof glasses.

Ceramics: Raw materials and their roles, varieties of clay, production of ceramic ware, glazing, ceramic insulators.

Cement: Raw materials grades, manufacture of Portland cement (by wet process), setting of cement.

Paints and Varnishes: Constituents of oil and emulsion paints and their role, constituent's of varnishes.

MODULE 2 09**Hrs**

Industrial Materials III: Fuels: Characteristics, Calorific value and its determination using bomb calorimeter, Coal-Varieties, Gaseous fuels-advantages, constituents and their significance, production of Coalgas and composition of LPG. Octane number.

Explosives: Classification, preparation of dynamite and TNT.

Propellants: Characteristics, classification and their applications.

Synthetic dyes: Introduction and classification. Colour and constitution. Synthesis of congo red, malachite green, alizarin and indigo.

Drugs: Chemotherapy, classification of drugs. Synthesis and uses of paracetamol, diclofenac,ranitidine, sulphanilamide and chloramphenicol.

Zeolites: Introduction, types of zeolites, manufacture of synthetic zeolites and applications.

Metal Organic Frameworks: Introduction, synthesis and important applications.

Dendrimers: Introduction, Synthesis (convergent, divergent and click chemistry) and important applications.

MODULE 3 **11Hrs**

Polymers : Fundamentals of polymers: Monomers, repeat MODULEs, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation,addition, free radical, ionic, co-ordination polymerization and ring opening polymerization,Types of polymerisation methods (Bulk, Solution, Suspension and Emulsion).Molecular weight and size. Polydispersion. Average molecular weight concepts– number,weight and viscosity average molecular weight. Numerical problems. Determination of molecular weights - viscosity method, osmotic pressure method.

Preparation and applications of the following types of polymers

1. Plastics:

i) thermosetting plastics(Phenol-formaldehyde)

ii) thermo softening plastics(PVC)

2. Fibers: Acrylic, polyamide, polyester types: one example for each

3. Rubber: Neoprene,

4. Fluoro Carbons: Teflon

5. Silicones: Polydimethysiloxane (PDMS)

6. Conducting Polymers: Polyaniline

MODULE 4 **10Hrs**

Super conductors and Fullerenes: Introduction, definition, type 1, type 2 and atypical. Preparation of high temperature super conductor-Y1Ba2Cu3Ox±δ, BCS theory (qualitative treatment only) and general applications of high temperature super conductors. Introduction to Fullerenes, definition, preparation and isolation of C60. Structure and Chemical reactions (redox reactions, electrophilic aromatic substitution and bromination) of C60. Commercial uses of C60. Carbon nanotubes: definition, single wall and multi wall carbon nanotubes, applications.

MODULE 5 **04 HRS**

Nanomaterials: Introduction, definition and electronic properties. Different methods of production: top down and bottom up approach with examples. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles (silver oxide with gold composites).Important applications of nanomaterials.

Inorganic and organic nanoporous aerogels. Heat capacity of solids: Einstein and Debye equations.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. B.K Sharma ,Industrial Chemistry,Goyal Publication
2. B.K Sharma , Industrial Chemistry and Chemical Engineering ,Spits Petrochemicals-Wiley
3. V. S. Muraleedharan and A. Subramania, Nanosciece and nanotechnology, Ane Books Pvt.
4. Ltd. New Delhi, 2009
5. C. N. R. Rao and A.Govindraj, Nanotubes and Nanowires, Royal Society of Chemistry (2005)
6. R. Booker and , E. Boysen, Nanotechnology, Wiley India Pvt Ltd, 2008
7. V. R. Gowariker, Polymer Science, Wiley Eastern(Chapters 1,2,9)

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16CH322
TITLE OF THE COURSE : PHARMACEUTICAL CHEMISTRY ELECTIVE -II
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Students are introduced to historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be thought to the students.
3. The students will be introduced to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be introduced to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

COURSE OUTCOMES : 1. Students will be well versed with historical developments regarding pharmaceutical industries, Codes of pharmaceutical ethics, and Important aspects of pharmaceutical chemistry.
2. The various types of diseases (air, and water borne, infectious) will be familiar to students after this course.
3. The students will be familiar to common terminologies used in pharmaceutical chemistry like Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti metabolites etc.,
4. The students will be familiar to various assays involved in pharmaceutical chemistry Chemical, biological, immunological assays.
5. The students will be introduced to designation of drugs, and health promoting medicines.

MODULE 1 **11Hrs**

Introduction Historical development of pharmaceutical chemistry, Codes of pharmaceutical ethics. Important aspects of pharmaceutical chemistry. 4 Hrs

Common diseases Infective diseases - insect-borne, air-borne and water-borne – hereditary diseases.

Terminology Drug, pharmacology, pharmacognosy, pharmacodynamics, pharmacokinetics, anti-metabolites. Absorption of drugs - routes of administration of drugs, factors affecting absorption.

MODULE 2 **10Hrs**

Assay of drugs Chemical, biological, immunological assays, LD50 and ED50 therapeutic index, drug dosage. 4 Hrs MODULE V: Designation of drugs Designation of drugs based on physiological action; Definition and two examples with structure each of: Anesthetics-General and local. Analgesics - Narcotic and synthetic.

MODULE 3 **10 Hrs**

Antipyretics and anti-inflammatory agents. Antibiotics - penicillin, streptomycin, chloramphenicol, tetracyclins. Antivirals. AIDS - symptoms, prevention, treatment. Cancer and neoplastic agents. Health promotingmedicines I Nutracenticals-Vitamins A B C D E and K (structure expected) micronutrients such as Na K Ca Cu Zn I -Medicinally important inorganic compounds of Al, P, As, Hg, Fe – Organic Pharmaceutical acids.

MODULE 4 **10 Hrs**

Health promoting medicines II Agents for kidney function (Aminohippuric acid); Agents for liver function (Sulfobromophthalein); Agents for pituitary function (metyrapone) –

MODULE 5 **4 Hrs**

Organic pharmaceutical bases - antioxidants, treatment of ulcer and skin diseases.

TEXT BOOKS

1. An Introduction to Medicinal Chemistry, Graham L Patrick, Oxford University press, 2017, ISBN-9780198749691.
2. The Organic Chemistry of Drug Design and Drug Action, Richard B Silverman,2014, Acadaemic press, ISBN-13:9780123820303.

REFERENCE BOOKS

1. Jayashree Ghosh, Pharmaceutical chemistry, S.Chand and Company Ltd., 2006, New Delhi.
2. Lakshmi S., Pharmaceutical chemistry, S. Chand & Sons, 1995, New Delhi.
3. Ashutosh Kar, Medicinal chemistry, Wiley Eastern Ltd., 1993, New Delhi.
4. David William & Thomas Lemke, Foyes principles of medicinal chemistry, 5th editon 2005, BI Publishers.

SEMESTER/YEAR : V SEM / III YEAR
COURSE CODE : 16IP391
TITLE OF THE COURSE : BIOSAFETY, BIOETHICS, AND IPR
L: T/A: P: C : 2: 0: 0: 0

Total Credit– 26Hrs

MODULE 1: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's IN INDIA 8 Hrs

Regulatory framework in India governing GMOs-Recombinant DNA Advisory Committee (RDAC), Institutional Biosafety Committee (IBC), Review Committee on Genetic Manipulation, Genetic Engineering Approval Committee (GEAC), Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic Plants (1998), Seed Policy (2002), Prevention Food Adulteration Act (1955), The Food Safety and Standards Bill (2005), Regulation for Import of GM Products Under Foreign Trade Policy (2006-2007), National Environment Policy (2006). Rules for the manufacture, use/import/export and storage of hazardous microorganisms/ genetically engineered organisms or cells (Ministry of Environment and Forests Notification,1989).

MODULE 2: BIOSAFETY-REGULATORY FRAMEWORK FOR GMO's AT INTERNATIONAL LEVEL 6 Hrs

Convention of Biological Diversity (1992) – Cartagena Protocol on Biosafety – Objectives and salient features of Cartagena Protocol – Advanced Information Agreement (AIA) procedure – procedures for GMOs intended for direct use-risk assessment-risk management-handling, transport, packaging and identification of GMOs- Biosafety Clearing House-unintentional transboundary movement of GMOs-Benefits of becoming a party to the Cartagena Protocol-status of implementation in India.

MODULE 3: BIOETHICS 4 Hrs

What is bioethics- The legal and socioeconomic impacts of biotechnology - Public education of the process of biotechnology involved in generating new forms of life for informed decision-making – ethical concerns of biotechnology research and innovation.

MODULE 4: INTELLECTUAL PROPERTY RIGHTS 3 Hrs

Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications-Biodiversity and farmer rights.

MODULE 5: PATENTS AND PATENT LAWS 5 Hrs

Objectives of the patent system - Basic principles and general requirements of patent law-biotechnological inventions and patent law-Legal development-Patentable subjects and protection in biotechnology-The patenting living organisms.

REFERENCE BOOKS

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (1998)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Rights…..Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local CommMODULEies [Paperback],Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 1996).
6. F. H. Erbisch and K. M. Maredia. Intellectual property rights in agricultural Biotechnology, University Press.
7. Sivamiah Shantharam, Jane F. Montegomery. Biotechnology, Biosafety and Biodiversity, Oxford & IBH Publ. New Delhi.
8. Tutelyal, VA. Genetically modified Food Sources, Safety Assessment and Control, Academic Press an Imprint of Elsevier, New Delhi.
9. Jecker Nany S, JohsenAlbert, Perlman, Robert A. Bioethics: An Introduction to the History Methods and Practice, John & Bartlett, New Delhi.
10. Sharma, HC Dhillon, MK, Sahrawat, KN. Environmental Safety of Biotech and Conventional IPM Technology, Stadium Press LLC. USA.
11. Jecker Nany S, Jones & Barlet Bioethics: An Introduction to the History Methods and Practice, New Delhi
12. Sathish MK Bioethics and Biosafety, IK International

SEMESTER -VI

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT302
TITLE OF THE COURSE : RECOMBINANT DNA TECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:

1. To acquaint the student with the significant component of biotechnology -Recombinant DNA technology.

2. To impart knowledge on important tools, techniques, protocols for genetic engineering.

COURSE OUTCOMES:

1. Student will be well equipped with the scientific understanding of the fundamental requirement of recombinant DNA technology

2. Student will gain optimum knowledge of application of recombinant DNA techniques in today's Life science Research.

MODULE- 1 **09Hrs**

Tools for Genetic Engineering: Introduction to Recombinant DNA technology, DNA manipulative and Modifying enzymes – Restriction enzymes, DNA ligases, Alkaline phosphatases, polynucleotide kinase, exonuclease, DNase I, DNA polymerase and Klenow fragment, RNA dependent DNA polymerase, terminal nucleotide transferase.

MODULE- 2 **09Hrs**

Vectors – Basic features, Cloning vectors -Prokaryotic (pBR322, pUC18, Lambda phage, m13, cosmids), Eukaryotic vectors (YAC, shuttle vectors, Ti plasmid, Binary vectors, SV40, Retroviral and Vaccinia viral vectors) Expression vectors in Prokaryotes and Eukaryotes – Basic features, role of promoters. Methods of Gene transfer: Transformation, Transfection, Microinjection, Electroporation, Microprojectile, Liposome Fusion

MODULE- 3 **09Hrs**

Techniques in Recombinant DNA technology**:** Hybridization – Southern, Northern, Western, DNA Sequencing (Sanger's di-deoxy method), Basics of New Generation Sequencing, PCR, Real Time PCR, Construction of genomic library, cDNA library.

MODULE- 4 **09Hrs**

Selection and Screening of Recombinants: Identification and selection of transformed cells, Direct methods – insertional inactivation, blue-white selection, plaque formation, complementation of mutation, Indirect methods – colony hybridization, immunochemical detection, Use of selectable marker genes in eukaryotes for expression, Expression of cloned genes

MODULE- 5 **09Hrs**

Microarray, Yeast two hybrid system, *In vitro* Mutagenesis. Applications of r-DNA technology: Production of Insulin, Recombinant Vaccines, hGH, Role in gene therapy, GM crops, Ethics and Biosafety involved.

REFERENCE BOOKS

1. Glick and Pasternak (1998) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
2. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
3. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
4. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication.
5. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers
6. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
7. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BT303
TITLE OF THE COURSE : PLANT BIOTECHNOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To provide an overview of plant biotechnology with focus on plant tissue culture and their application in modern biology.
2. To equip the student with the fundamental understanding of different processes involved in plant biotechnology

COURSE OUTCOMES: 1. Student will gain fundamental knowledge in different techniques used in plant biotechnology.
2. Student will be familiar with transgenic plants and significant applications of plant biotechnology.

MODULE- 1 **10Hrs**

Introduction to Plant Tissue Culture: Initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinin's, gibberellins), Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications

MODULE- 2 **08Hrs**

Tissue and Organ Culture: Organ culture – anther, embryo, endosperm culture and applications, Ovary and Ovule culture Organogenesis and embryogenesis – technique and applications

MODULE- 3 **12Hrs**

Protoplast culture – isolation, mechanical, enzymatic, culture of protoplast and plant regeneration. Somatic Hybridization and Variations: Somatic hybridization, method of protoplast fusion – chemical and electro fusion, application, cybrids; Somaclonal Variants – production and screening methods of somaclonal variants and their significance.

MODULE- 4 **08Hrs**

Transgenics and Applications of Plant Biotechnology: Transgenic plants – technique of transformation (*Agarobacterium* mediated, physical and chemical methods of gene transfer), application of transgenic plants

MODULE- 5 **07Hrs**

Edible vaccines – vaccine production in plants, Hepatitis B vaccine. Role of Plant tissue culture in agriculture, horticulture and forestry. *In vitro* production of secondary metabolites.

REFERENCE BOOKS

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford

Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

SEMESTER/YEAR **: VI SEM / III YEAR**
COURSE CODE **: 16BT372**
TITLE OF THE COURSE **: GENETIC ENGINEERING AND PLANT TISSUE CULTURE**
L: T/A: P: C **: 0: 0: 6: 3**

COURSE OBJECTIVES: 1. To skill students for basic techniques required to establish plant tissue culture
2. To equip the students with protocols in genetic engineering

COURSE OUTCOMES: 1. Student should be able to prepare and sterilize culture media and establish callus growth.
2. Student will able to carry out basic techniques of transformation, restriction digestion and ligation.

1. Preparation of competent cells
2. Transformation of Plasmid DNA in competent cells and screening of transformants
3. Isolation of plasmid DNA and analysis using gel electrophoresis
4. Restriction digestion and ligation
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus
10. Production of synthetic seeds.

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC302**
TITLE OF THE COURSE : **BIOENERGETICS AND MOLECULAR PHYSIOLOGY**
L: T/A: P: C : **3: 0: 0: 3**
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Course Objective:

1. Production of energy through movement of electron rich substrates.
2. Learning about biological oxidation and production of ATP. 3. Introduction to hormones and their functionality.
4. Brief idea about cell cycle and programmed cell death

Course Outcome:

1. Once they complete the course, students will have an idea about the energy production processes that occur in a cell.

2. The ultimate goal of this course would be integrate the knowledge obtained in 5^{th} semester (through Enzymology and Carbohydrate metabolism) with the current semester courses (Lipid metabolism) to have an integrated holistic idea about how life functions through reactions.

3. They will also be aware of the various hormones that are synthesized by living systems that regulate metabolism. Students will be able to link this information with whatever has been learnt in the previous semester.

MODULE- 1 **9 Hrs**

BIOENERGETICS
Bioenergetics, Energy transformation in living systems and concept of free energy; Exergonic and endergonic reaction, ATP and other high energy compounds, energy coupling. Biological oxidation, standard reduction potentials of same biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions.

MODULE- 2 **9 Hrs**

BIOLOGICAL OXIDATION: Mitochondrial electron transport chain-components, reactions and structures, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation – ATPase structure (rotor-stator model) and function, Chemiosmotic theory, Regulation of ETC, thermogenin, Isolation of ETC components.

MODULE- 3 **9 Hrs**

ENDOCRINOLOGY: Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms. Signal transduction - G-protein as cellular transducer, adenylate cyclase

system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade. Functions of pancreatic, adrenal, pituitary and GIT hormones. Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.

MODULE- 4 **9 Hrs**

MOLECULAR BIOLOGY: Central dogma, prokaryotic and eukaryotic genomes, complexity of genomes, Enzymes and proteins related to prokaryotic replication and transcription.

MODULE- 5 **9 Hrs**

CELL CYCLE AND APOPTOSIS: Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Apoptosis: Caspases, structure, function and activation. Factors initiating apoptosis and steps leading to cell death. Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16BC303**
TITLE OF THE COURSE : **CHEMISTRY AND METABOLISM OF LIPIDS AND NUCLEIC ACIDS**
L: T/A: P: C : **3: 0: 0: 3**

COURSE OBJECTIVE:

1. Introduction to structure and classification of lipids.
2. Learning about the various reactions in which lipids are broken down by living systems to generate energy.
3. Learning about nucleic acid structures and properties along with synthesis and breakdown.

COURSE OUTCOME:

1. Students will have an idea about the various lipid molecules and how they behave in contact with water.
2. They will be aware of the importance of lipid in energy storage.
3. Students will able to comprehend the synthesis and breakdown of RNA/DNA and the enzymes that assist in the process.

MODULE- 1 **9 Hrs**

LIPID CHEMISTRY

Classification of lipids. Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids. Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid. DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids).

MODULE- 2 **9 Hrs**

ARACHIDONIC ACID DERIVATIVES: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3. Lipoproteins & GPI-linked proteins: Types and functions. Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model. Steroids - Function of hopnoids, cholesterol, androgen and estrogens. Lipid peroxidation and its role as a stressmarker.

MODULE- 3 **9 Hrs**

LIPID METABOLISM: The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation, Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

MODULE- 4 **9 Hrs**

NUCLEIC ACIDS: Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides. DNA: Biological role, structure, polymorphism, denaturation, renaturation and Tm. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins. RNA: Types, secondary structure and biological role of various RNA

MODULE- 5 **9 Hrs**

NUCLEIC ACID METABOLISM: Metabolism of purine and pyrimidine nucleotides. Hyperuricemia & other inborn errors.

REFERENCE BOOKS

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan & Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis & Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th edn

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16BC372
TITLE OF THE COURSE : ESTIMATION OF BIOMOLECULES
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVE: To make students learn quantitative and qualitative methods for study of biomolecules.

COURSE OUTCOME: Student will be equipped with methodology to study biomolecules using spectroscopic and chromatographic techniques.

[1] Qualitative analysis of
a. carbohydrates,
b. amino acids,
c. proteins,
d. lipids and
e. Preparation of solid derivatives of monosaccharides – osazone crystal.
[2] Estimation of amino acids by formal titration.
[3] Estimation of ascorbic acid from biological samples by titrimetric method.
[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN302
TITLE OF THE COURSE : APPLIED GENETICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. To get a glimpse of the role of genetics application
2. Understand and integrate biology and computation

COURSE OUTCOMES:
1. Industrial and agricultural application of genetics
2. Development of key skill such as bioinformatics**.**

MODULE - 1 GENETIC RESOURCES AND BIODIVERSITY 9Hrs

Germplasm, classification, Germplasm activities, and organizations associated with germplasm (NBPGR, IBPGR). Genetic Erosion, biodiversity, centers of Diversity, Vavilovian Centers of Diversity, Law of Parallelism, Gene sanctuaries, Gene bank and Cryopreservation.

MODULE - 2 INTRODUCTION TO PLANT TISSUE CULTURE 9Hrs

Embryo, Anther and Ovary cultures, Shoot and Root Meristem cultures, Callus culture from undifferentiated cells, Protoplast culture. Economic benefits of Tissue Culture: Resistance to pests and Pathogens, Improvement in Nutritive value etc.

MODULE - 3 HETEROSIS IN ANIMALS AND PLANTS 9Hrs

Introduction to Heterosis and characteristics. Introduction to animal breeds, inbreeding, grading, cross breeding. Fish breeding: Selection, Induced Polyploidy, Gynogenesis and Androgenesis, Inbreeding. Production of breeds: crossing of inbred lines for commercial production. Breeding strategies for improvement of livestock for milk, meat, wool production. Breeding strategies for improvement of Poultry. Introduction to plants breeding: Estimation of heterosis-Heterobeltosis, Economic heterosis, Standard heterosis. Hybridization techniques-intergeneric and interspecific hybridization. Identification of hybrid plants. Inbreeding depression. Hybrid vigor exploitation in Rice, Tomato.

MODULE - 4 GENETICS IN MEDICINE & INDUSTRY 9Hrs

Production of recombinant Insulin, Interferon and Human Growth hormone (HGH). Vaccines-Hepatitis B vaccine. Preparation of DNA probes, Monoclonal antibodies and Diagnostic kits (Typhoid, Syphilis). DNA Fingerprinting: Methodology of DNA fingerprinting. Molecular markers-RFLP & RAPD, Micro satellite, SNPs, STR. Applications with examples in forensic science, medico legal aspects, wild life crying.

MODULE – 5 BIOINFORMATICS 9Hrs

Introduction to Bioinformatics Databases, Nucleic acid Sequence databases (NCBI, EBI), Protein Sequence Databases (UNIPROT, SWISS-PROT), Structure Databases (PDB). Applications of bioinformatics.

TEXT BOOKS

1. Gupta P.K. Elements of Biotechnology. Rastogi. 2002-2003.
2. Alcamo I.E. DNA Technology. The Awesome Skill 2nd edition. Harcourt / Academic press. 2000.

REFERENCE BOOKS

1. Singh B. D. Biotechnology. Kalyani Publication. 2002.
2. Glide B.R. and Pasternak, J. J. Molecular Biotechnology, 2nd edition. AS press, Washington. 1998.
3. Nicholl D. S. T. An Introduction to Genetic Engineering Second Edition. Cambridge University Press. 2002.
4. Razdan M. K. An Introduction to plant tissue culture. Oxford & IBH, New Delhi. 1993.
5. Lasley. J.E. Genetics of Livestock Improvement. Prentice India.
6. Phundan Singh , Elements of Plant Breeding. 2nd Edition. Kalyani Pulications. 2001
7. Ravishanker G.A. and Venkataraman L.V. Biotechnology Application of Plant Tissue and cell culture. BH Publications. 1997.
8. Brown, T. A. Genetics: A Molecular Approach (2nd Ed.), Garland Science, New York. 2002.
9. Baxevanis and Bff Oluellette. Bioinformatics : A practical guide to the analysis of genes and proteins, Ad Wiley Interscince – new York. 2001.
10. Stephen Misener and Stephan A. Krawetz. Bioinformatics: Methods and protocol. Humana press, New Jersey. 2000
11. Des Higgins and Willie Tylore. Bioinformatics: sequence, structure and databanks, Oxford University press. 2000.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16GN303
TITLE OF THE COURSE : GENOMICS AND PROTEOMICS
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES:
1. Basic knowledge on genome organization, mapping and the impact of the human genome project.
2. Understand the protein structure and analysis

COURSE OUTCOMES:
1. Students will understand the diversity of the genome organization and its implication
2. Students will learn how to apply the information to study at protein levels using various techniques.

MODULE 1 PROKARYOTIC AND EUKARYOTIC GENOME ORGANIZATION 9Hrs

Prokaryotes: Bacteria and Bacteriophages. Eukaryotic nuclear genomes: *Arabidopsis*, rice, yeast, *Drosophila*, *C. elegans* and mouse genome. Eukaryotic organelle genomes - Chloroplast and Mitochondria.

MODULE 2 GENOME MAPPING TECHNIQUES 9Hrs

Genetic mapping: Cross breeding and pedigree analysis, DNA markers – RFLPs, SSLPs, SNPs. Physical mapping: Restriction mapping, Fluorescent in situ hybridization.

MODULE 3 HUMAN GENOME PROJECT AND COMPARATIVE GENOMICS 9Hrs

History, organization and goals of human genome project. DNA segment nomenclature, Human genome diversity, Organization of human genome, Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical genes, Diversity in size and organization of genes. Whole genome analysis, Genome sequence, micro assay, molecular phylogeny, C-value, number of genes and complexity of genomes, Conservation and diversity of genomes, Comparative genomics as an aid to gene mapping and study of human disease genes. Comparative genomics of mitochondria and chloroplast genomes.

MODULE 4 PROTEIN PROPERTIES AND STRUCTURE ANALYSIS 9Hrs

Classification of proteins, Backbone flexibility- Φ and ψ. Properties of amino acids - Hydrophobicity, Molecular weight, α and β propensities etc. Inter-atomic forces and protein structure, covalent interaction, hydrogen bonds, hydrophobic and hydrophilic interaction, charge/dipole interaction, Van der Waals forces, steric interaction. Prediction of primary, secondary and tertiary structure of proteins- SCOP, DALIDD, CATH classification. Determining protein structure, Homology modeling.

MODULE 5 PROTEIN PROFILING 9Hrs

Introduction to proteome and proteomics, protein separation and analysis using 2D Gel Electrophoresis, Liquid chromatography, Mass spectrometry, Interacting proteins by phage display and Yeast two hybrid system.

TEXT BOOKS

1. T.A. Brown, Genomes, Bios, 2002.
2. Liebler, Introduction to Proteomics, Humana, 2002.

REFERENCE BOOKS

1. Coleman and Tsongalis, Molecular Diagnosis, Humana, 1997.
2. Dale and Schartz, From Genes to Genomes, Wiley, 2003.
3. Dunham, I., Genome Mapping and sequencing. Horizon Scientific. 2003.
4. Hawley and Mori, The Human Genome, Academic, 1999.
5. Lewis, Human Genetics, WCB, 1999.
6. Pasternak, An Introduction to Molecular Human Genetics, Fritzgerald, 2000.
7. Primrose and Twyman, Principles of Genome Analysis & Genomics, Blackwell, 2003.
8. Strachan and Read, Human Molecular Genetics, Wiley, 1999.
9. Sudbery, Human Molecular Genetics, Prentice Hall, 2002.
10. The Drosophila Genome. Science Vol. 267. 2000.
11. The Caenorhabditiselegans genome Science. Vol. 282. 1998.
12. The Arabidopsis Genome. Nature vol. 408. 2000

SEMESTER/YEAR : **VI SEM / III YEAR**
COURSE CODE : **16GN372**
TITLE OF THE COURSE : **APPLIED GENETICS, GENOMICS AND PROTEOMICS PRACTICALS**
L: T/A: P: C : **0: 0: 6: 3**

COURSE OBJECTIVES:
1. To understand the tissue culture techniques for genetic manipulation of plants/crops.
2. Use different genomic and proteomic approaches to genetics.

COURSE OUTCOMES:
1. Broaden horizon on the potential applications of plant and animal genome and proteome.
2. Hands on skills on the usage of bioinformatics tools to study genomic and proteomic data.

APPLIED GENETICS

1. Tissue culture techniques:

- Sterilization
- Explants preparation
- Media Composition and preparation
- Culturing of all kinds of explants for callus induction, multiple shoot proliferation.
- Synthetic seed preparation

2.Study of different techniques in plant hybridization

3. Study of pollen fertility

4. Study of diagnostic kits - WIDAL & VDRL

5. Study of hybrid plants - Rice, Cotton, Chilly, and Tomato.

6. Study of hybrid animals - Poultry, dairy, fishery.

7. Homology sequence analysis using Blast and Fasta.

GENOMICS AND PROTEOMICS:

1) Physical mapping by Restriction mapping of plasmid DNA
2) Genetic mapping by RFLP analysis
3) RAPD analysis
4) DNA fingerprinting analysis: Parentage detection
5) Homogenization, fractionation and separation of enzymes/ proteins in plants and animals by SDS- PAGE method
6) Protein database study SCOP, DALIDD, CATH

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB302
TITLE OF THE COURSE : IMMUNOLOGY AND MEDICAL MICROBIOLOGY
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

PART A: IMMUNOLOGY

MODULE 1: ELEMENTS OF IMMUNE SYSTEM 9Hrs

History and scope of immunology, Definition and types of immMODULEy (innate and adaptive).Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT . Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immMODULEy, tolerance. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

MODULE 2: ANTIGENS AND ANTIBODIES 9Hrs

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types,Haptens, Super antigens, Epitopes (T & B cell epitopes), T-dependent and T-independent antigens, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic), clonal selection theory of antibody production; Production and application of Monoclonal antibodies

MODULE 3: IMMUNOLOGICAL DISORDERS, ONCOLOGY AND TECHNIQUES 9Hrs

Definition, Hypersensitivity reactions (Definition and types), auto immune disorders, immunodeficiencies, graft vs host diseases.Brief concept of cancer immunology. Principles and applications of Precipitation, Agglutination, Complement fixation, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry andImmunoelectron microscopy.

PART B: MEDICAL MICROBIOLOGY

MODULE 4: INTRODUCTION TO MEDICAL MICROBIOLOGY 9Hrs

Normal flora of skin, oral cavity and other body regions.Relationship between normal microbiota and host. Pathogenecity, Virulence,Invasion,Toxins: Exotoxins, Enterotoxins and Endotoxins.Evasion.

MODULE 5: PATHOGENICITY AND ANTIMICROBIAL CHEMOTHERAPY 9Hrs

Epidemiology, etiology, pathogenesis and prophylaxis of the following: **Bacteria**–*Salmonella typhi*, *Staphylococcus aureus, Clostridium tetani, Mycobacterium tuberculosis, Treponemapallidum, Corynebacteriumdiphtheriae, Chlamydiae.* **Fungi–***Tricophytonspp.* and *Candida albicans.* **Viruses –**Hepatitis, Rabies, HIV and Ebola. **Prion diseases. Protozoa** – *Plasmodium vivax* and *Entamoebahistolytica*

Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration).Immunoprophylaxis- Vaccines and immunization schedule.

REFERENCE BOOKS

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press.
2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York.
3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill.
5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings.
6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson.
7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag.
8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone.
9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
11. Kufe (2003) Cancer Medicine. BC Decker Inc.
12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical Medical Microbiology, Churchill living stone.
14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc.
15. Nester Roberts Pearsall Anderson (1997) Microbiology- a human perspective, 2nd Edition, McGraw-Hill.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB303
TITLE OF THE COURSE : MICROBIAL FERMENTATION
L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection
2. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans.
2.To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

MODULE 1: INDUSTRIAL MICROBIOLOGY 9Hrs

Introduction to fermentation technology, history and development of fermentation technology. Isolation, Screening (Primary and Secondary), Enrichment, Preservation (storage at low temperature (liquid nitrogen), storage in soil, silica, mineral oil, Lyophilization) and Strain improvement of industrially important microorganisms. Culture collection centres

MODULE 2: FERMENTERS 9Hrs

Design, Construction and Components of a typical fermenter, types of fermenter-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

MODULE 3: FERMENTATION PROCESS 9Hrs

Introduction, Batch, continuous, surface, submerged and solid state fermentation. Control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

MODULE 4: DOWNSTREAM PROCESSES 9Hrs

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying, purification and concentration of products by chromatographic techniques.

MODULE 5: FERMENTATION PRODUCTS AND ECONOMICS 9Hrs

Industrial production of organic acids (Citric acid), Amino acid (glutamic acid), Alcohol (wine), Vitamin (vit B12), Antibiotics (penicillin), Enzymes (Amylase), Vaccines (Hepatitis B) and

hormones (human insulin). Market potential, fermentation and product recovery costs. General concepts and importance of IPR.

REFERENCE BOOKS

1. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
2. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
3. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
4. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology- An Introduction, Blackwell Science. Delhi
5. McNeil B and Harvey LM. Fermentation. A Practical Approach, IRL press, New York.
6. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
7. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication.
8. HolgerPalzelt, Thomas Brenner (2008) Handbook of Bioentrepreneurship. Springer Sciences.
9. Pandey A, Soccol RC and Larroche C (2008) Current Developments in Solid state Fermentation, Springer.
10. Robert H (2006) Microbiology and Technology of Fermented Foods. Blackwell Publishers.
11. Santaniello V, Evenson RE, ZibermanDand Carlson GA (2003) Agriculture and Intellectual Property Rights: Economic, Institutional and Implementation Issues in Biotechnology. Universities Press.
12. Carlos M, Correa (2010) Research Handbook on the protection of Intellectual Property Under WTO Rules. Intellectual Property in the WTO Volume I and II Edward Elgar Publishing.
13. Matthew Rimmer (2008) Intellectual Property and Biotechnology: Biological Inventions Edward Elgar.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16MB372
TITLE OF THE COURSE : IMMUNOLOGY, MEDICAL MICROBIOLOGY AND MICROBIAL FERMENTATION
L: T/A: P: C : 0: 0: 6: 3

COURSE OBJECTIVES: 1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents

COURSE OUTCOMES: 1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.

1. Isolation of normal microflora from skin and oral cavity
2. Snyders test for dental caries detection
3. Blood grouping and Rh typing
4. Dot ELISA
5. Precipitation reactions: Ouchtlerlony Double Diffusion, Radial Immune Diffusion, Rocket Immuno electrophoresis
6. Antibiotic sensitivity test
7. Determination of effectiveness of antiseptics by thumb impression method
8. Identification of different types of blood cells
9. Production and determination of amylase activity
10. Preparation of wine
11. Study of different types of fermenters (Models/ Charts)
12. Cell immobilization techniques (yeast cells)
13. Sterility assays of pharamaceutical products

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH302
TITLE OF THE COURSE : INORGANIC & ANALYTICAL CHEMISTRY
L: T/A: P: C : 3: 0:0: 3

COURSE OBJECTIVES: 1.The students will be introduced to the concepts of coordination and organometallic chemistry.
2. The students will be introduced to the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be introduced to the basic concepts and principles of various chromatographic and electroanalytical techniques.

COURSE OUTCOMES: 1. The students will be well versed with the concepts of coordination and organometallic chemistry.
2. The students will be well versed with the basic concepts and principles of various spectroscopic techniques like IR, Raman NMR, ESR etc.,
3. The students will be well versed with the basic concepts and principles of various chromatographic and electroanalytical techniques.

MODULE 1 **11Hrs**

Co-ordination and Organometallic compounds

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra,penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclatureof coordination compounds. Theories of structure and bonding (Explanation for the formationof complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bondtheory-postulates, low spin and high spin complexes with examples (cobalt and nickel based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and squareplanar complexes). Magnetic properties of [CoF6]3-, [Fe(CN)6]4Spectral properties of [Ti(H2O)6]3+, [Co(H2O)6]3+Isomerism-Structural: ionization, linkage, hydrate andcoordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.

Organometallic compounds

Ligands, classification (hapticity). Synthesis and structure of K[PtCl3(η2-C2H4)] Metal carbonyls – Cr(CO)6, Mn2(CO)10; eighteen electron rule and its deviations with examples. Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na2Ca,EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation.

MODULE 2 **10Hrs**

Chemical Spectroscopy I

The interaction of electromagnetic radiation radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular absorption spectra: Born-Oppenheimer approximation.

Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy.Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO2 and H2O molecules.

Raman spectroscopy

Concept of polarisability. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.

Spectroscopy II

UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and redshift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free andH-bonded), alkyl –C-H, C=C, C=C C=O, C-X and C-O groups (by taking suitable examples).

NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spinquantum number I, influence of the magnetic field on the spin of nuclei, spin population,saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclearshielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons.Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMRspectroscopy including identification of simple organic molecules.

MODULE 3 10**Hrs**

Chromatography

Principles of chromatography: Distribution coefficients, types of chromatography, selection of stationary and mobile phases in TLC, analyte development and elution. Chromatographic performance parameters-Retention time and volume, capacity factor, plate height and resolution.

Thin layer chromatography: Principle, apparatus-preparation of plates, sample application, plate development, detection of analytes. Applications.

Gas-liquid chromatography: Principle. Instrumentation, columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, and detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography**:** Principle and applications.

MODULE 4 10**Hrs**

Electroanalytical Methods

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME.Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential.Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

MODULE 5 04 **Hrs**

Analytical chemistry

Analytical chemistry- scope of analytical chemistry. Errors and treatment of analytical data: Limitations of analytical methods-Error-determinate and indeterminate errors, minimization

of errors. Accuracy and precision. Distribution of random errors, the normal error curve. Statistical treatment of finite samples-measures of central tendency and variability-mean, median, range, standard deviation and variance. Student's t-test.

TEXT BOOKS

1. College Chemistry, L. Indira and Chatwal G.R.
2. New College Chemistry, Y.R. Sharma L Gomathi Devi.

REFERENCE BOOKS

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
5. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH303
TITLE OF THE COURSE : BASICS IN BIOCHEMISTRY
L: T/A: P: C : 3 :0:0 : 3

COURSE OBJECTIVES:
1. The students will be introduced to various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be introduced to various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students will be introduced to bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be introduced to concepts of protein metabolism.

COURSE OUTCOMES:
1. The students will be well versed with various biomolecules of energy like sugars, proteins, lipids etc.,
2. The students will be well versed with various biomolecules of genetic materials like DNA, RNA and biological functional molecules called enzymes.
3. The students well versed with bioenergetics concepts like metabolism and catabolism aspects.
4. The students will be well versed concepts of protein metabolism.

MODULE 1 11Hrs

Carbohydrates: Structure and biological importance of derivatives of monosaccharides. Amino sugars: ß-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramicacid (NAMA); N-acetylneuraminic acid (NANA) Sugar acids–structure and biological importance of D-gluconic acid, D-glucuronic acid and D glucaricacid. Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P,Fructose-1,6-di-P, ß-D-ribose-5-P and ß-D-deoxyribose-5-P. Structure and biological importance of oligosaccharides – isomaltose, cellobiose, trehalose. Polysaccharides -source, comparative account of partial structure and biological function of starch, glycogen, cellulose, chitin and insulin.

Lipids: Introduction, Classification. Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides-acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides. Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Cholesterol – definition,

types (HDL, LDL and VLDL) Sphingolipids–structure and biological significance of ceramide.

MODULE 2 **6Hrs**

Proteins α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non- essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Levels of organizations of Protein: Primary structure, Secondary structure (a-helix, triple helix eg., Collagen and ß-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure. Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with, ribonuclease. Classification of proteins based on structure, composition and biological function (enzymes, hormones, transport agents, antibodies, structural materials with examples).

MODULE 3 **11Hrs**

Nucleic Acids: Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures. Partial structure of polynucleotide. Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs. Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Hormones: Definition. Classification -a) amino acid derivatives (epinephrine and thyroxine); b) peptide (oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis. Mediators of hormone action – Ca2+, cyclic AMP.

Enzymes: Introduction, Holo enzyme (apo enzyme and co enzyme).Active site, specificity. Classification of enzymes (EC code number not required). Enzyme substrate interaction-Fischer and Koshland models. Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration, substrate concentration, pH and temperature (mention M. M. equation). Allosteric enzymes–definition and example. Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one example for each.

MODULE 4 **10Hrs**

Biological Oxidation: Bioenergetics-Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and Keq. High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation ofATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reaction. Comparison of oxidation with combustion using glucose as an example. Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).Mitochondrial electro transport chain, oxidative phosphorylation. Substrate level phosphorylation.

MODULE 5 **8 Hrs**

Metabolism, Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic. Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, ß-oxidation pathway, energetics.
Protein metabolism– General aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.
Molecular Biology : Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation. DNA finger printing – Definition and its applications.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000. .
2. Biochemistry A. L. Lehningeret. al., CBS, 2000.
3. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.
4. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.
5. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.

SEMESTER/YEAR : VI SEM / III YEAR
COURSE CODE : 16CH372
TITLE OF THE COURSE : INORGANIC CHEMISTRY AND BASICS IN BIOCHEMISTRY
L: T/A: P: C : 0:0: 6: 3

COURSE OBJECTIVES:

1. Conducting colorimetric estimations of biomolecuels viz., crabohydrates, lipids and proteins by various procedures.

COURSE OUTCOMES:

1. The students will be aware of the estimations and calculations invovlevd in estimating various biomolecules.

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na_2CO_3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.
11. Preparation of buffers and determination of their pH values using pH meter.
12. Estimation of reducing sugars by Hegdorn-Jensen method.
13. Estimation of lactose in milk by Nelson-Somyogi's method.
14. Estimation of creatinine by Jaffe's method.
15. Estimation of inorganic phosphate by Fiske-Subbarow method.
16. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
17. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
18. Identification of α-amino acids by paper chromatography.
19. Isolation of DNA from onions.
20. Estimation of cholesterol by colorimetric method.

TEXT BOOKS

1. College Chemistry, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Textbook of Practical Organic Chemistry 5th ed, Vogel, Arthur I.
2. Textbook of Practical Inorganic Chemistry 5th ed, Vogel, Arthur I.

SEMESTER/

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1101
TITLE OF THE COURSE : CELL BIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To equip students with the basic understanding of structures and functions of organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES:

1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control, and different stages in cell division.

MODULE 1: ULTRA STRUCTURE OF CELL 11 Hrs

Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences.Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model).Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).

MODULE 2: CELL ORGANELLES -I 11 Hrs

Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.

MODULE 3: CELL ORGANELLES-II 11 Hrs

Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus).Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4: **CELL GROWTH AND CELL DIVISION** **11 Hrs**

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases).Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis.Introduction to programmed cell death (Apoptosis & Necrosis).

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1102
TITLE OF THE COURSE : BASIC CHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
2. To make the students to familiarize with the basic concepts related to modern atomictheory, quantum chemistry, periodic table, gaseous state of matter, chemical kinetics and organic molecules and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
2. The student will understand the importance of the modern atomic theory, quantum chemistry, Periodic Table of the Elements, chemical kinetics and basics of organic chemistry.

MODULE 1: GENERAL CHEMISTRY – I **11 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Quantum mechanics and Structure of an atom:
Wave particle duality - de Broglie equation (derivation), The Heisenberguncertainty principal. Numerical problems. Quantum theory (basic concepts of quantization of energy). The Schrodinger wave equation (second order differential equation) and elaboration of terms involved, significance of wave function (Ψ) and Ψ^2. Atomicorbitals definition and shapes s, p, and d) orbitals. Quantum numbers and their significance. The Pauli's exclusion principal, Hund's multiplicity rules (pairing energy and exchange energy need to be discussed), Electronic Configuration atoms up to atomic no 36.

MODULE 2: GENERAL CHEMISTRY – II **11 Hrs**

Periodicity of chemical properties: Review of periodic table and periodic properties (definition), definitions and Periodic trends in the following periodic atomic radii, ionic radii, ionization energy, electro negativity, electron affinity and oxidation numbers.

Chemical Bonding: *Introduction:* Need for the atoms to form molecules, and types of chemical bonds with examples

IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and $CaCl_2$).

Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. Such as NH_3, H_2O, H_3O+, SF_4, ClF_3.

Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6 molecules.

Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H_2, N_2, O_2, HF and CO).

Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.

MODULE 3: ORGANIC CHEMISTRY **11 Hrs**

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).

Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.

Reactive intermediates: Types of bond cleavage, electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes – generation, structures, stability and examples. *Types of organic reactions:* Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.

Reaction mechanism: single step and multi-step reactions, definition, potential energy diagrams, transition state and reaction intermediate, explanation using S_N1 and S_N2 reactions as examples, Elimination reaction, Zaitsev's rule, dehydrohalogenation**.**

MODULE 4: BIOPHYSICAL CHEMISTRY 11 Hrs

Gaseous State: Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity, relationships between them. Problems. Definition and derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagat's mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b.
Law of corresponding states: statements, reduced equation of state and explanation, Problems. Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). Liquefaction of air and hydrogen by Linde's process.

Chemical Kinetics:
***Review of terms*:** Rate, Order and Molecularity. Derivation of an expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.
Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method. Effect of temperature on rate of reaction, Arrhenius equation (Derivation), concept of activation energy. Problems.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1103
TITLE OF THE COURSE : BASIC GENETICS
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To gain insight as to the historical perspective of the evolution of genetics.
2. To comprehend and identify the different types of mendelian and non-mendelian inheritance.
3. Understand how sex determines the inheritance pattern of genes.
4. To learn the contribution and influence of extrachromosomal inheritance.
5. Understand and apply the Hardy Weinberg theory on population genetics.

COURSE OUTCOMES:

1. Students will have clarity to the background of genetics before getting into details in the forthcoming semesters.
2. They will be capable differentiate between mendelian and non mendelian inheritance sources.
3. Ability to relate phenotype to genotype and potential factors influencing the interaction.
4. Comprehensive understanding of genetic methodology and how quantification of heritable traits in populations provides insight into cellular and molecular mechanisms.

MODULE 1: HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11 Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance (Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.

MODULE 2: EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11 Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.

MODULE 3: SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE 11 Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and

dosage compensation (Drosophila and Man). Sex linked and sex limited traits in Humans-

Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in Paramecium, sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 4: POPULATION GENETICS 11 Hrs

Allele frequencies - deriving genotypic & allelic frequencies, introduction to quantitative genetics, changes in allele frequencies. Classical Ecological Genetics & Polymorphism - phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms. Introduction to Hardy-Weinberg method & its applications – calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium, Random & Non-random mating – positive & negative assortative mating, role in population size & change in gene frequency.

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.
3. Mathew Hamilton , (2009) Population Genetics, Wiley-Blackwell
4. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
5. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
6. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
7. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
8. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
9. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
10. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
11. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
12. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
13. Stubbe H., History of Genetics (1972). Harper and Row New York.
14. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
15. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with the basic techniques used in cell biology
2. To facilitate the study of cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES:

1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1172
TITLE OF THE COURSE : VOLUMETRIC ESTIMATIONS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. Students will learn about good laboratory practices, various glassware used in the chemistry
   laboratory and the methods to calibrate them.
2. Students will be introduced to various volumetric titrations such as acid-base, redox and idometric etc.

COURSE OUTCOMES:

1. Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.
2. Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given.

1. Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.)
2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7. Estimation of free alkali present in different soaps/detergents
8. Estimation of carbonate and bicarbonate in a given mixture.
9. Determination of percentage of manganese dioxide in pyrolusite ore.
10. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1173
TITLE OF THE COURSE : BASIC GENETICS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To gain insight as to the different genetic interactions and their effect on phenotype.
2. Understand the role of allele frequency in evolution and genetic diversity.

COURSE OUTCOMES:

1. Students will be capable to recognise various gene interactions, predict crosses and decipher the role of alleles in inheritance.
2. Ability to calculate allele frequency and its role in genetic diversity.

1) Temporary squash preparation of: (2 Units)
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing (1 Unit)
3) Study of: (1 Unit)
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Problems on Probability and Allele Frequency. (1 Units)
5) Genetic problems on: (2 Units)
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1205
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To know the importance of microorganisms for our global society
2. To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
3. To study the basic techniques for isolation, culturing and identification of microorganisms

COURSE OUTCOMES:

1. Provides a strong acquaint in fundamental aspects of basic microbiology
2. Enable to understand the diversity of microbial, structure, function and their environment
3. Awareness about economic importance of microorganisms

MODULE 1: HISTORY AND MICROBIAL SYSTEMATICS 11hrs

Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome

MODULE 2: MICROBIAL TECHNIQUES 11hrs

Microscopy: Principles of resolution and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM).

Staining techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).

Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: BASIC BIOLOGY OF PROKARYOTIC MICROORGANIS 11hrs

Difference between prokaryotic and eukaryotic microorganisms. Virus: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples, significance of viruses. Bacteria: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (*Kelbsiella*), Flagella, Pilus/ Fimbriae (*E.*

coli), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (*Bacillus /Clostridium*). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction). Study of special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaebacteria and extremophiles.

MODULE 4: BASIC BIOLOGY OF EUKARYOTIC MICROORGANISMS 11hrs

Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi, Type study of Zygomycetes (*Rhizopus*), Ascomycetes (*Saccharomyces*), Basidiomycetes (*Agaricus*) and Deuteromycetes (*Fusarium*).

Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

Protozoa: General characteristics with special reference to *Amoeba, Trypanosoma, Plasmodium, Entamoeba*.

REFERENCES:

1. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
2. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company
4. Edward Alcamo. Microbiology. Cliffs Notes 1996.
5. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
6. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
7. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
8. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
9. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
10. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
11. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
12. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1206
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To create general understanding about theoretical concepts of techniques used to detect and assay biomolecules.
2. To familiarize students with basic concepts principles and application of cutting-edge techniques.

COURSE OUTCOME:

1. Students will receive adequate knowledge of basic techniques like Potentiometry & Chromatography along with high end techniques like Mass spectroscopy & NMR
2. Students will be able to have a basic understanding of biomedical equipment like CAT scanner
   and PET scanner general used in hospitals.

MODULE 1 **11Hrs**

Spectroscopy: Properties of light, Electromagnetic spectrum and their interaction with matter and types, electronic transitions, Chromic shifts, concepts of chromophore and auxochrome with their applications. -Beer Lambert's law, Determination of Absorbance and extinction coefficients for biomolecules. Principle, schematics and applications of Colorimeter and UV-Vis Spectroscopy; Assay of biomolecules (carbohydrates, proteins and nucleic acids). Luminometry. Basics of IR spectroscopy including frequencies and vibrations.
Centrifugation: Basic principles, theory and types of centrifugation -Preparative and analytical with their applications in biology.

MODULE 2 **11Hrs**

Chromatography General principles of chromatography and its types (planar and column). Types of matrices used for separation of biomolecules. Paper, thin layer, gel permeation, ion exchange, adsorption and affinity chromatography with applications. Brief idea about HPLC and GC – working principle and instrumentation of packed columns.

MODULE 3 **11Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Vertical (PAGE) and Horizontal (Agarose) electrophoresis and its applications. Detection (by staining and UV), Recovery (homogenization and electro elution) & characterization of macromolecules (molecular weight and pI determination). Principle and application of Isoelectric

focusing (IEF) and 2D PAGE. Application in proteomics and genomics.

MODULE 4 **11Hrs**

Electro-Analytical Techniques: Strong and weak electrolytes, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- , Standard electrode potentials. Reference electrodes: Calomel and Glass. Basics of pH metry, potentiometry and conductometry. Cyclic Voltametry – basic concepts. Radiochemical Techniques : Tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique) and Autoradiography.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1207
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To familiarize the students with basic concepts and principles of conformation and energy transfer in biological systems.
2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:

1. The students will know about pH, buffer and will be able to decide the feasibility of biological reactions.
2. The students will have an understanding of structure and property of biomolecules so that they will have a better understanding of metabolism of these biomolecules in higher semesters.

MODULE 1: WATER AND BUFFERS 11 Hrs

Properties of acids and bases explained through Arrhenius, Lowry-Bronsted, and Lewis concepts; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation using H-H equation and buffer types. Numerical problems on preparation of buffer solutions; Biological buffers.

MODULE 2: STEREOCHEMISTRY AND THERMODYNAMICS 11 Hrs

Stereoisomerism: Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energychange, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3: CARBOHYDRATES AND LIPIDS 11 Hrs

Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid. *Lipids*: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine

number.

MODULE 4: AMINO ACIDS AND NUCLEIC ACIDS 11 Hrs

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins *Nucleic acids*: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1208
TITLE OF THE COURSE : ENVIRONMENTAL STUDIES
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 2

COURSE OBJECTIVES:

1. Have a broad knowledge of the field of environmental health including an understanding of the interaction of principles contained in fundamental environmental chemistry, biology, toxicology, epidemiology and general environmental health.
2. Assess risks from either environmental or occupational exposures and identify measures to mitigate the risks.
3. Describe the legal and ethical bases for public health and health services
4. Apply principles of strategic planning and marketing to public health.

COURSE OUTCOMES:

1. Using this fundamental knowledge the students will then develop a refined knowledge related to their particular field of study within environmental or occupational health.
2. The course will enable students to Identify the causes of social and behavioural factors that affect health of individuals and populations.
3. Understand the strengths and limitations of various laboratory methodologies to make value use of scientific data and their application to environmental health problems.
4. Become part of a public health team, using scientific knowledge and communication skills to solve public health problems.

MODULE 1 3Hrs

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 4 Hrs

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 5 Hrs

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic

and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4 Hrs**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4 Hrs**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6 Hrs**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.

- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.
- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore

3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1274
TITLE OF THE COURSE : BASIC TECHNIQUES IN MICROBIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with basic microbiological techniques
2. To understand working principles of instruments
3. To understand microbial structure, functions and their environment

COURSE OUTCOMES:

1. Enable students to isolate, culture and identify microorganisms
2. Educate students about principles and applications of instruments used in microbiological techniques

1) Study of basic instruments in Microbiology laboratory (1/2 Unit)

- Autoclave
- Hot air oven
- Incubator
- pH meter
- High speed centrifuge
- Colorimeter / Spectrophotometer
- Anaerobic jar
- Bacterial Filters
- Laminar air flow

2) Microscopic examination of bacterial smear (3 Units)

- Gram's staining
- Capsule staining
- Endospore staining

3) Preparation of culture media and transfer of media (3 Units)

- Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
- Selective media (EMB-agar and McConkey agar)
- Enriched media (Blood agar)
- Slant culture technique
- Broth culture technique
- Stab culture technique

4) **Methods of pure culture techniques** - Pour plate technique, Spread plate technique and Streak plate technique **(2 units)**

5) **Microscopic observation of temporary slides:** **(2 Units)**

Algae: *Chlamydomonas* and *Spirulina*

Fungi: *Rhizopus*, *Aspergillus, Penicillium,* Yeast and *Fusarium*

Protozoa: *Amoeba, Paramecium* and *Plasmodium*

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1275
TITLE OF THE COURSE : BIO-ANALYTICAL CHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To create general understanding about practical concepts of techniques used to detect and assay biomolecules.
2. To familiarize students with laboratory equipment use.

COURSE OUTCOME:

1. Students will have a general idea about acid-base and amino-acid titration and also be familiar with viscometer and pH meter.
2. Students will be able to detect and resolve bio-molecular mixtures based on their physical and chemical properties.

1. pH metric titrations of HCl-NaOH / Acetic acid-NaOH.
2. Determination of pI of amino acid (glycine).
3. Determination of density & viscosity of given unknown liquid.
4. Determination of density & surface tension of given unknown liquid.
5. Circular paper chromatography of amino acids / carbohydrates.
6. Ascending/Descending paper chromatography of amino acids / carbohydrates.
7. Separation of amino acid by TLC.
8. Column chromatography of pigments on adsorbent.
9. Paper electrophoresis for separation of biomolecules (Demo).

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1276
TITLE OF THE COURSE : BASIC BIOCHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To familiarize the students with good lab practise and basic laboratory instruments.
2. To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

1. The students will be familiarized with handling laboratory equipment like weighing balance,
   pH meter and potentiometer.
2. They will have an understanding of biomolecule composition of edible materials.

1. Preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Conductometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Estimation of protein/lipid/carbohydrates in vegetables
5. Estimation of protein/lipid/carbohydrates in milk
6. Estimation of iodine number of edible oils
7. Estimation of ascorbic acid in fruits by titrimetric method.

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19AU0003
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 0

COURSE OBJECTIVES:

1. Define a constitution
2. Describe the salient features of the Indian Constitution
3. Explain different ways of acquiring Indian Citizenship
4. List the Fundamental Rights and Fundamental Duties of Indian citizens
5. Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

1. Students will appreciate the fundamental law of the land
2. Students will be aware of what kind of government the country will have.
3. Aid in understanding what lays down the rules to govern the country
4. It also tells about the rights and also the duties of its citizens

MODULE 1: 5 Hrs

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6 Hrs

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5 Hrs

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5 Hrs

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.

MODULE 5: 5 Hrs

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES:

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1101
TITLE OF THE COURSE : CELL BIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To equip students with the basic understanding of structures and functions of organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES:

1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control, and different stages in cell division.

MODULE 1: ULTRA STRUCTURE OF CELL 11 Hrs

Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model).Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).

MODULE 2: CELL ORGANELLES -I 11 Hrs

Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.

MODULE 3: CELL ORGANELLES-II 11 Hrs

Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus).Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4: **CELL GROWTH AND CELL DIVISION** **11 Hrs**

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases).Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis.Introduction to programmed cell death (Apoptosis & Necrosis).

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1102
TITLE OF THE COURSE : BASIC CHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
2. To make the students to familiarize with the basic concepts related to modern atomictheory, quantum chemistry, periodic table, gaseous state of matter, chemical kinetics and organic molecules and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
2. The student will understand the importance of the modern atomic theory, quantum chemistry, Periodic Table of the Elements, chemical kinetics and basics of organic chemistry.

MODULE 1: GENERAL CHEMISTRY – I **11 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Quantum mechanics and Structure of an atom:
Wave particle duality - de Broglie equation (derivation), The Heisenberguncertainty principal. Numerical problems. Quantum theory (basic concepts of quantisation of energy). The Schrodinger wave equation (second order differential equation) and elaboration of terms involved, significance of wave function (Ψ) and Ψ^2. Atomicorbitals definition and shapes s, p, and d) orbitals. Quantum numbers and their significance. The Pauli's exclusion principal, Hund's multiplicity rule (pairing energy and exchange energy need to be discussed), Electronic Configuration atoms up to atomic no 36.

MODULE 2: GENERAL CHEMISTRY – II **11 Hrs**

Periodicity of chemical properties: Review of periodic table and periodic properties (definition),definitions and Periodic trends in the following periodic atomic radii, ionic radii, ionization energy, electro negativity, electron affinity and oxidation numbers.

Chemical Bonding: *Introduction:* Need for the atoms to form molecules, and types of chemical bonds with examples

IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and $CaCl_2$).

Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH_3, H_2O, H_3O+, SF_4, ClF_3.

Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6molecules.

Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H_2, N_2, O_2, HF and CO).

Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.

MODULE 3: ORGANIC CHEMISTRY **11 Hrs**

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).

Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.

Reactive intermediates: Types of bond cleavage, electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples. *Types of*

organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.
Reaction mechanism: single step and multi-step reactions, definition, potential energy diagrams, transition state and reaction intermediate, explanation using S_N1 and S_N2 reactions as examples, Elimination reaction, Zaitsev's rule, dehydrohalogenation**.**

MODULE 4: BIOPHYSICAL CHEMISTRY 11 Hrs

Gaseous State: Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity, relationships between them. Problems. Definition and derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagat's mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b.
Law of corresponding states: statements, reduced equation of state and explanation, Problems. Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). Liquefaction of air and hydrogen by Linde's process.

Chemical Kinetics:
***Review of terms*:** Rate, Order and Molecularity. Derivation of an expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.
Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method. Effect of temperature on rate of reaction, Arrhenius equation (Derivation), concept of activation energy. Problems.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1103
TITLE OF THE COURSE : BASIC GENETICS
L : T : P : S/P : C :4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To gain insight as to the historical perspective of the evolution of genetics.
2. To comprehend and identify the different types of mendelian and non-mendelian inheritance.
3. Understand how sex determines the inheritance pattern of genes.
4. To learn the contribution and influence of extrachromosomal inheritance.
5. Understand and apply the Hardy Weinberg theory on population genetics.

COURSE OUTCOMES:

1. Students will have clarity to the background of genetics before getting into details in the forthcoming semesters.
2. They will be capable differentiate between mendelian and non mendelian inheritance sources.
3. Ability to relate phenotype to genotype and potential factors influencing the interaction.
4. Comprehensive understanding of genetic methodology and how quantification of heritable traits in populations provides insight into cellular and molecular mechanisms.

MODULE 1: HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11 Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance(Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.

MODULE 2: EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11 Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.

MODULE 3: SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE 11 Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and dosage compensation (Drosophila and Man).Sex linked and sex limited traits in Humans-

Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in Paramecium, sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 4: POPULATION GENETICS 11 Hrs

Allele frequencies - deriving genotypic & allelic frequencies, introduction to quantitative genetics, changes in allele frequencies.Classical Ecological Genetics & Polymorphism - phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms. Introduction to Hardy-Weinberg method & its applications – calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium,Random & Non-random mating – positive & negative assortative mating, role in population size & change in gene frequency.

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.
3. Mathew Hamilton , (2009) Population Genetics, Wiley-Blackwell
4. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
5. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
6. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
7. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
8. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
9. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
10. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
11. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
12. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
13. Stubbe H., History of Genetics (1972). Harper and Row New York.
14. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
15. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with the basic techniques used in cell biology
2. To facilitate the study of cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES:

1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1172
TITLE OF THE COURSE : VOLUMETRIC ESTIMATIONS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. Students will learn about good laboratory practices, various glassware used in the chemistry
   laboratory and the methods to calibrate them.
2. Students will be introduced to various volumetric titrations such as acid-base, redox and idometric etc.

COURSE OUTCOMES:

1. Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.
2. Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given.

1. Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.)
2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7. Estimation of free alkali present in different soaps/detergents
8. Estimation of carbonate and bicarbonate in a given mixture.
9. Determination of percentage of manganese dioxide in pyrolusite ore.
10. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1173
TITLE OF THE COURSE : BASIC GENETICS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To gain insight as to the different genetic interactions and their effect on phenotype.
2. Understand the role of allele frequency in evolution and genetic diversity.

COURSE OUTCOMES:

1. Students will be capable to recognise various gene interactions, predict crosses and decipher
   the role of alleles in inheritance.
2. Ability to calculate allele frequency and its role in genetic diversity.

1) Temporary squash preparation of: (2 Units)
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing (1 Unit)
3) Study of: (1 Unit)
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Problems on Probability and Allele Frequency. (1 Units)
5) Genetic problems on: (2 Units)
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1205
TITLE OF THE COURSE : GENERAL MICROBIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To know the importance of microorganisms for our global society
2. To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
3. To study the basic techniques for isolation, culturing and identification of microorganisms

COURSE OUTCOMES:

1. Provides a strong acquaint in fundamental aspects of basic microbiology
2. Enable to understand the diversity of microbial, structure, function and their environment
3. Awareness about economic importance of microorganisms

MODULE 1: HISTORY AND MICROBIAL SYSTEMATICS 11hrs

Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome

MODULE 2: MICROBIAL TECHNIQUES 11hrs

Microscopy: Principles of resolution and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM).

Staining techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).

Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: BASIC BIOLOGY OF PROKARYOTIC MICROORGANIS 11hrs

Difference between prokaryotic and eukaryotic microorganisms. Virus: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples, significance of viruses. Bacteria: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (*Kelbsiella*), Flagella, Pilus/ Fimbriae (*E.*

coli), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (*Bacillus /Clostridium*). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction). Study of special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaebacteria and extremophiles.

MODULE 4: BASIC BIOLOGY OF EUKARYOTIC MICROORGANISMS 11hrs

Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi, Type study of Zygomycetes (*Rhizopus*), Ascomycetes (*Saccharomyces*), Basidiomycetes (*Agaricus*) and Deuteromycetes (*Fusarium*).

Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

Protozoa: General characteristics with special reference to *Amoeba, Trypanosoma, Plasmodium, Entamoeba*.

REFERENCES:

1. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
2. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company
4. Edward Alcamo. Microbiology. Cliffs Notes 1996.
5. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
6. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
7. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
8. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
9. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
10. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
11. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
12. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1206
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To create general understanding about theoretical concepts of techniques used to detect and
   assay biomolecules.
2. To familiarize students with basic concepts principles and application of cutting-edge techniques.

COURSE OUTCOME:

1. Students will receive adequate knowledge of basic techniques like Potentiometry & Chromatography along with high end techniques like Mass spectroscopy & NMR
2. Students will be able to have a basic understanding of biomedical equipment like CAT scanner
   and PET scanner general used in hospitals.

MODULE 1 **11Hrs**

Spectroscopy: Properties of light, Electromagnetic spectrum and their interaction with matter and types, electronic transitions, Chromic shifts, concepts of chromophore and auxochrome with their applications. -Beer Lambert's law, Determination of Absorbance and extinction coefficients for biomolecules. Principle, schematics and applications of Colorimeter and UV-Vis Spectroscopy; Assay of biomolecules (carbohydrates, proteins and nucleic acids). Luminometry. Basics of IR spectroscopy including frequencies and vibrations.
Centrifugation: Basic principles, theory and types of centrifugation -Preparative and analytical with their applications in biology.

MODULE 2 **11Hrs**

Chromatography General principles of chromatography and its types (planar and column). Types of matrices used for separation of biomolecules. Paper, thin layer, gel permeation, ion exchange, adsorption and affinity chromatography with applications. Brief idea about HPLC and GC – working principle and instrumentation of packed columns.

MODULE 3 **11Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Vertical (PAGE) and Horizontal (Agarose) electrophoresis and its applications. Detection (by staining and UV), Recovery (homogenization and electro elution) &

characterization of macromolecules (molecular weight and pI determination). Principle and application of Isoelectric focusing (IEF) and 2D PAGE. Application in proteomics and genomics.

MODULE 4 **11Hrs**

Electro-Analytical Techniques: Strong and weak electrolytes, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- , Standard electrode potentials. Reference electrodes: Calomel and Glass. Basics of pH metry, potentiometry and conductometry. Cyclic Voltametry – basic concepts. Radiochemical Techniques : Tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique) and Autoradiography.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1207
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To familiarize the students with basic concepts and principles of conformation and energy transfer in biological systems.
2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:

1. The students will know about pH, buffer and will be able to decide the feasibility of biological reactions.
2. The students will have an understanding of structure and property of biomolecules so that they will have a better understanding of metabolism of these biomolecules in higher semesters.

MODULE 1: WATER AND BUFFERS 11 Hrs

Properties of acids and bases explained through Arrhenius, Lowry-Bronsted, and Lewis concepts; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation using H-H equation and buffer types. Numerical problems on preparation of buffer solutions; Biological buffers.

MODULE 2: STEREOCHEMISTRY AND THERMODYNAMICS 11 Hrs

Stereoisomerism: Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energychange, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3: CARBOHYDRATES AND LIPIDS 11 Hrs

Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid.

Lipids: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.

MODULE 4: AMINO ACIDS AND NUCLEIC ACIDS 11 Hrs

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins *Nucleic acids*: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

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REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1208
TITLE OF THE COURSE : ENVIRONMENTAL STUDIES
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 2

COURSE OBJECTIVES:

1. Have a broad knowledge of the field of environmental health including an understanding of the interaction of principles contained in fundamental environmental chemistry, biology, toxicology, epidemiology and general environmental health.
2. Assess risks from either environmental or occupational exposures and identify measures to mitigate the risks.
3. Describe the legal and ethical bases for public health and health services
4. Apply principles of strategic planning and marketing to public health.

COURSE OUTCOMES:

1. Using this fundamental knowledge the students will then develop a refined knowledge related to their particular field of study within environmental or occupational health.
2. The course will enable students to Identify the causes of social and behavioural factors that affect health of individuals and populations.
3. Understand the strengths and limitations of various laboratory methodologies to make value use of scientific data and their application to environmental health problems.
4. Become part of a public health team, using scientific knowledge and communication skills to solve public health problems.

MODULE 1 3Hrs

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 4 Hrs

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 5 Hrs

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic

and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4 Hrs**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4 Hrs**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6 Hrs**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.

- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.
- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore

3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1274
TITLE OF THE COURSE : BASIC TECHNIQUES IN MICROBIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with basic microbiological techniques
2. To understand working principles of instruments
3. To understand microbial structure, functions and their environment

COURSE OUTCOMES:

1. Enable students to isolate, culture and identify microorganisms
2. Educate students about principles and applications of instruments used in microbiological techniques

1) Study of basic instruments in Microbiology laboratory (1/2 Unit)

- Autoclave
- Hot air oven
- Incubator
- pH meter
- High speed centrifuge
- Colorimeter / Spectrophotometer
- Anaerobic jar
- Bacterial Filters
- Laminar air flow

2) Microscopic examination of bacterial smear (3 Units)

- Gram's staining
- Capsule staining
- Endospore staining

3) Preparation of culture media and transfer of media (3 Units)

- Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
- Selective media (EMB-agar and McConkey agar)
- Enriched media (Blood agar)
- Slant culture technique
- Broth culture technique
- Stab culture technique

4) **Methods of pure culture techniques** - Pour plate technique, Spread plate technique and Streak plate technique **(2 units)**

5) **Microscopic observation of temporary slides:** **(2 Units)**

Algae: *Chlamydomonas* and *Spirulina*

Fungi: *Rhizopus*, *Aspergillus, Penicillium,* Yeast and *Fusarium*

Protozoa: *Amoeba, Paramecium* and *Plasmodium*

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1275
TITLE OF THE COURSE : BIO-ANALYTICAL CHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To create general understanding about practical concepts of techniques used to detect and assay biomolecules.
2. To familiarize students with laboratory equipment use.

COURSE OUTCOME:

1. Students will have a general idea about acid-base and amino-acid titration and also be familiar with viscometer and pH meter.
2. Students will be able to detect and resolve bio-molecular mixtures based on their physical and chemical properties.

1. pH metric titrations of HCl-NaOH / Acetic acid-NaOH.
2. Determination of pI of amino acid (glycine).
3. Determination of density & viscosity of given unknown liquid.
4. Determination of density & surface tension of given unknown liquid.
5. Circular paper chromatography of amino acids / carbohydrates.
6. Ascending/Descending paper chromatography of amino acids / carbohydrates.
7. Separation of amino acid by TLC.
8. Column chromatography of pigments on adsorbent.
9. Paper electrophoresis for separation of biomolecules (Demo).

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1276
TITLE OF THE COURSE : BASIC BIOCHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To familiarize the students with good lab practise and basic laboratory instruments.
2. To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

1. The students will be familiarized with handling laboratory equipment like weighing balance,
   pH meter and potentiometer.
2. They will have an understanding of biomolecule composition of edible materials.

1. Preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Conductometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Estimation of protein/lipid/carbohydrates in vegetables
5. Estimation of protein/lipid/carbohydrates in milk
6. Estimation of iodine number of edible oils
7. Estimation of ascorbic acid in fruits by titrimetric method.

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19AU0003
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 0

COURSE OBJECTIVES:

1. Define a constitution
2. Describe the salient features of the Indian Constitution
3. Explain different ways of acquiring Indian Citizenship
4. List the Fundamental Rights and Fundamental Duties of Indian citizens
5. Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

1. Students will appreciate the fundamental law of the land
2. Students will be aware of what kind of government the country will have.
3. Aid in understanding what lays down the rules to govern the country
4. It also tells about the rights and also the duties of its citizens

MODULE 1: 5 Hrs

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6 Hrs

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5 Hrs

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5 Hrs

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.

MODULE 5: 5 Hrs

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES:

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1101
TITLE OF THE COURSE : CELL BIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To equip students with the basic understanding of structures and functions of organelles of prokaryotic and eukaryotic cells.
2. To impart understanding on the process of cell division, cell cycle and its control.

COURSE OUTCOMES:

1. Students should have basic knowledge on the structure and functions of cellular organelles.
2. Students should be able to understand the concept of cell cycle, its control, and different stages in cell division.

MODULE 1: ULTRA STRUCTURE OF CELL 11 Hrs

Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences.Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model).Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).

MODULE 2: CELL ORGANELLES -I 11 Hrs

Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.

MODULE 3: CELL ORGANELLES-II 11 Hrs

Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella. Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus).Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4: **CELL GROWTH AND CELL DIVISION** **11 Hrs**

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases).Mitosis: Mitotic phases; Cytokinesis; Significance of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis.Introduction to programmed cell death (Apoptosis & Necrosis).

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1102
TITLE OF THE COURSE : BASIC CHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.
2. To make the students to familiarize with the basic concepts related to modern atomictheory, quantum chemistry, periodic table, gaseous state of matter, chemical kinetics and organic molecules and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, Organic and Physical Chemistry.
2. The student will understand the importance of the modern atomic theory, quantum chemistry, Periodic Table of the Elements, chemical kinetics and basics of organic chemistry.

MODULE 1: GENERAL CHEMISTRY – I **11 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Quantum mechanics and Structure of an atom:
Wave particle duality - de Broglie equation (derivation), The Heisenberguncertainty principal. Numerical problems. Quantum theory (basic concepts of quantisation of energy). The Schrodinger wave equation (second order differential equation) and elaboration of terms involved, significance of wave function (Ψ) and Ψ^2. Atomicorbitals definition and shapes s, p, and d) orbitals. Quantum numbers and their significance. The Pauli's exclusion principal, Hund's multiplicity rule (pairing energy and exchange energy need to be discussed), ElectronicConfiguration atoms up to atomic no 36.

MODULE 2: GENERAL CHEMISTRY – II **11 Hrs**

Periodicity of chemical properties: Review of periodic table and periodic properties (definition),definitions and Periodic trends in the following periodic atomic radii, ionic radii, ionization energy, electro negativity, electron affinity and oxidation numbers.

Chemical Bonding:*Introduction:* Need for the atoms to form molecules, and types of chemical bonds with examples

IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and $CaCl_2$).

Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules ($BeCl_2$, BF_3, PCl_5, SF_6).

Geometry of covalent molecules:(VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH_3, H_2O, H_3O+, SF_4, ClF_3.

Theories of covalent bonds (VBT and MOT):Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to $BeCl_2$, BF_3, $SiCl_4$, PCl_5, SF_6molecules.

Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H_2, N_2, O_2, HF and CO).

Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.

MODULE 3: ORGANIC CHEMISTRY **11 Hrs**

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).

Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.

Reactive intermediates: Types of bond cleavage, electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples. *Types of*

organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.
Reaction mechanism: single step and multi-step reactions, definition, potential energy diagrams, transition state and reaction intermediate, explanation using S_N1 and S_N2 reactions as examples, Elimination reaction, Zaitsev's rule, dehydrohalogenation**.**

MODULE 4: BIOPHYSICAL CHEMISTRY 11 Hrs

Gaseous State: Derivation of expression for most probable speed from Maxwell-Boltzmann equation. Definitions and expressions for rms velocity and average velocity, relationships between them. Problems. Definition and derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagat's mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b.
Law of corresponding states: statements, reduced equation of state and explanation, Problems. Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition (no derivation). Liquefaction of air and hydrogen by Linde's process.

Chemical Kinetics:
***Review of terms*:** Rate, Order and Molecularity. Derivation of an expression for the rate constant of a second order reaction with $a = b$ and $a \neq b$. Expression for half-life of a second order reaction. Mean life for first order reaction to be mentioned. Problems on rate constant, half-life period, mean life period and order of reaction.
Determination of order of reaction: differential method, method of integration, method of half-life period and isolation method. Effect of temperature on rate of reaction, Arrhenius equation (Derivation), concept of activation energy. Problems.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1103
TITLE OF THE COURSE : BASIC GENETICS
L : T : P : S/P : C :4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To gain insight as to the historical perspective of the evolution of genetics.
2. To comprehend and identify the different types of mendelian and non-mendelian inheritance.
3. Understand how sex determines the inheritance pattern of genes.
4. To learn the contribution and influence of extrachromosomal inheritance.
5. Understand and apply the Hardy Weinberg theory on population genetics.

COURSE OUTCOMES:

1. Students will have clarity to the background of genetics before getting into details in the forthcoming semesters.
2. They will be capable differentiate between mendelian and non mendelian inheritance sources.
3. Ability to relate phenotype to genotype and potential factors influencing the interaction.
4. Comprehensive understanding of genetic methodology and how quantification of heritable traits in populations provides insight into cellular and molecular mechanisms.

MODULE 1: HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 11 Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance(Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.

MODULE 2: EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 11 Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.

MODULE 3: SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE 11 Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and

dosage compensation (Drosophila and Man).Sex linked and sex limited traits in Humans-

Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in Mirabilis jalapa, kappa particle in Paramecium, sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize.

MODULE 4: POPULATION GENETICS 11 Hrs

Allele frequencies - deriving genotypic & allelic frequencies, introduction to quantitative genetics, changes in allele frequencies.Classical Ecological Genetics & Polymorphism - phenotypic & genotypic polymorphisms, transient polymorphism, balanced polymorphisms. Introduction to Hardy-Weinberg method & its applications – calculating allelic frequencies, assumptions of Hardy-Weinberg equilibrium,Random & Non-random mating – positive & negative assortative mating, role in population size & change in gene frequency.

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.
3. Mathew Hamilton , (2009) Population Genetics, Wiley-Blackwell
4. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
5. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
6. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
7. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
8. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
9. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York.
10. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
11. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
12. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
13. Stubbe H., History of Genetics (1972). Harper and Row New York.
14. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
15. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1104
TITLE OF THE COURSE : COMMUNICATIVE ENGLISH
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 2

COURSE OBJECTIVES:

1. To encourage the students to speak English confidently and enable them to communicate for day-to-day needs
2. To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

1. Students are confident in oral and written communication
2. Have enhanced competence for competitive exams

22Hrs

MODULE 1: COMMUNICATION SKILLS

Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment

MODULE 2: ELEMENTS OF COMMUNICATION

Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication;

Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations;

Interview skills: purpose of an interview, do's and dont's of an interview;

Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery;

Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion;

Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.

MODULE 3: EFFECTIVE WRITING SKILLS

Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication

Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing),Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.

MODULE 4: GRAMMAR

Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection;

Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis;

Phrases: Noun Phrase, Verb Phrase, Genetive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics;

Clauses: Clause Elements, Clause Types, Kinds, Concord;

Sentences: Simple Sentences, Compound Sentences, Complex Sentences;

Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses;

Co-ordination: Linked and Unlinked Coordination, Synthesis;

Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity;

Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.

REFERENCES:

1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman
2. Bakshi, R. N. A Course in English Grammar. Orient Longman
3. Close, R. A. Reference Grammar for Students of English. Orient Longman
4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd.
5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman

6. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press
7. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011.
8. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
9. Brilliant – Comminication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
10. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc GrawHill Education, 2011.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with the basic techniques used in cell biology
2. To facilitate the study of cell size, cell count, stages in cell division, staining of cells.

COURSE OUTCOMES:

1. Students should be able to perform staining of cells, identify stages of mitosis and meiosis, and be well versed with the use of simple and compound microscope.

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 19BS1172
TITLE OF THE COURSE : VOLUMETRIC ESTIMATIONS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. Students will learn about good laboratory practices, various glassware used in the chemistry
   laboratory and the methods to calibrate them.
2. Students will be introduced to various volumetric titrations such as acid-base, redox and idometric etc.

COURSE OUTCOMES:

1. Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.
2. Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given.

1. Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.)
2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7. Estimation of free alkali present in different soaps/detergents
8. Estimation of carbonate and bicarbonate in a given mixture.
9. Determination of percentage of manganese dioxide in pyrolusite ore.
10. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 19BS1173
TITLE OF THE COURSE : BASIC GENETICS - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To gain insight as to the different genetic interactions and their effect on phenotype.
2. Understand the role of allele frequency in evolution and genetic diversity.

COURSE OUTCOMES:

1. Students will be capable to recognise various gene interactions, predict crosses and decipher
   the role of alleles in inheritance.
2. Ability to calculate allele frequency and its role in genetic diversity.

1) Temporary squash preparation of: (2 Units)
   Grasshopper Testes
   Onion Flower Bud
2) Blood Typing (1 Unit)
3) Study of: (1 Unit)
   Flower color in Antirrhinum / Mirabilis
   Coat color in Mice
   Comb pattern in fowl
4) Problems on Probability and Allele Frequency. (1 Units)
5) Genetic problems on: (2 Units)
   Multiple Alleles
   Gene Interaction
   Sex Linkage

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1205
TITLE OF THE COURSE : GENERAL MICROBIOLOGY **44 Hrs**
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To know the importance of microorganisms for our global society
2. To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
3. To study the basic techniques for isolation, culturing and identification of microorganisms

COURSE OUTCOMES:

1. Provides a strong acquaint in fundamental aspects of basic microbiology
2. Enable to understand the diversity of microbial, structure, function and their environment
3. Awareness about economic importance of microorganisms

MODULE 1: HISTORY AND MICROBIAL SYSTEMATICS 11hrs

Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome

MODULE 2: MICROBIAL TECHNIQUES 11hrs

Microscopy: Principles of resolution and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM).

Staining techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).

Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes.

MODULE 3: BASIC BIOLOGY OF PROKARYOTIC MICROORGANIS 11hrs

Difference between prokaryotic and eukaryotic microorganisms. Virus: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic

cycle with examples, significance of viruses. Bacteria: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (*Kelbsiella*), Flagella, Pilus/ Fimbriae (*E.*

coli), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (*Bacillus /Clostridium*). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction). Study of special forms of bacteria: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaebacteria and extremophiles.

MODULE 4: BASIC BIOLOGY OF EUKARYOTIC MICROORGANISMS 11hrs

Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi, Type study of Zygomycetes (*Rhizopus*), Ascomycetes (*Saccharomyces*), Basidiomycetes (*Agaricus*) and Deuteromycetes (*Fusarium*).

Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*).

Protozoa: General characteristics with special reference to *Amoeba, Trypanosoma, Plasmodium, Entamoeba*.

REFERENCES:

1. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
2. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company
4. Edward Alcamo. Microbiology. Cliffs Notes 1996.
5. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
6. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
7. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
8. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
9. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
10. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
11. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
12. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1206
TITLE OF THE COURSE : ANALYTICAL TECHNIQUES
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To create general understanding about theoretical concepts of techniques used to detect and
   assay biomolecules.
2. To familiarize students with basic concepts principles and application of cutting-edge techniques.

COURSE OUTCOME:

1. Students will receive adequate knowledge of basic techniques like Potentiometry & Chromatography along with high end techniques like Mass spectroscopy & NMR
2. Students will be able to have a basic understanding of biomedical equipment like CAT scanner
   and PET scanner general used in hospitals.

MODULE 1 **11Hrs**

Spectroscopy: Properties of light, Electromagnetic spectrum and their interaction with matter and types, electronic transitions, Chromic shifts, concepts of chromophore and auxochrome with their applications. -Beer Lambert's law, Determination of Absorbance and extinction coefficients for biomolecules. Principle, schematics and applications of Colorimeter and UV-Vis Spectroscopy; Assay of biomolecules (carbohydrates, proteins and nucleic acids). Luminometry. Basics of IR spectroscopy including frequencies and vibrations.
Centrifugation: Basic principles, theory and types of centrifugation -Preparative and analytical with their applications in biology.

MODULE 2 **11Hrs**

Chromatography General principles of chromatography and its types (planar and column). Types of matrices used for separation of biomolecules. Paper, thin layer, gel permeation, ion exchange, adsorption and affinity chromatography with applications. Brief idea about HPLC and GC – working principle and instrumentation of packed columns.

MODULE 3 **11Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Vertical (PAGE) and Horizontal (Agarose) electrophoresis and its applications. Detection (by staining and UV), Recovery (homogenization and electro elution) &

characterization of macromolecules (molecular weight and pI determination). Principle and application of Isoelectric focusing (IEF) and 2D PAGE. Application in proteomics and genomics.

MODULE 4 **11Hrs**

Electro-Analytical Techniques: Strong and weak electrolytes, activity coefficient, concept of potential, cells and half cells, Electrochemical series and applications, Nernst equation- , Standard electrode potentials. Reference electrodes: Calomel and Glass. Basics of pH metry, potentiometry and conductometry. Cyclic Voltametry – basic concepts. Radiochemical Techniques : Tracer techniques: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: - Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique) and Autoradiography.

REFERENCES:

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (1983)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (1990)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (1994)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1207
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

44 Hrs

COURSE OBJECTIVES:

1. To familiarize the students with basic concepts and principles of conformation and energy transfer in biological systems.
2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:

1. The students will know about pH, buffer and will be able to decide the feasibility of biological reactions.
2. The students will have an understanding of structure and property of biomolecules so that they will have a better understanding of metabolism of these biomolecules in higher semesters.

MODULE 1: WATER AND BUFFERS 11 Hrs

Properties of acids and bases explained through Arrhenius, Lowry-Bronsted, and Lewis concepts; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation using H-H equation and buffer types. Numerical problems on preparation of buffer solutions; Biological buffers.

MODULE 2: STEREOCHEMISTRY AND THERMODYNAMICS 11 Hrs

Stereoisomerism: Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energychange, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3: CARBOHYDRATES AND LIPIDS 11 Hrs

Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid. *Lipids*: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine

number.

MODULE 4: AMINO ACIDS AND NUCLEIC ACIDS 11 Hrs

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins *Nucleic acids*: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1208
TITLE OF THE COURSE : ENVIRONMENTAL STUDIES
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 2

COURSE OBJECTIVES:

1. Have a broad knowledge of the field of environmental health including an understanding of the interaction of principles contained in fundamental environmental chemistry, biology, toxicology, epidemiology and general environmental health.
2. Assess risks from either environmental or occupational exposures and identify measures to mitigate the risks.
3. Describe the legal and ethical bases for public health and health services
4. Apply principles of strategic planning and marketing to public health.

COURSE OUTCOMES:

1. Using this fundamental knowledge the students will then develop a refined knowledge related to their particular field of study within environmental or occupational health.
2. The course will enable students to Identify the causes of social and behavioural factors that affect health of individuals and populations.
3. Understand the strengths and limitations of various laboratory methodologies to make value use of scientific data and their application to environmental health problems.
4. Become part of a public health team, using scientific knowledge and communication skills to solve public health problems.

MODULE 1 3Hrs

Linkages between Environment and Health: Understanding linkages between Environment and Public Health: Effect of quality of air, water and soil on health. Perspective on Individual health: Nutritional, socio-cultural and developmental aspects, Dietary diversity for good health; Human developmental indices for public health

MODULE 2 4 Hrs

Climate Change and Implications on Public Health: Global warming - Agricultural practices (chemical agriculture) and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Manifestations of Climate change on Public Health- Burning of Fossil fuels , automobile emissions and Acid rain.

MODULE 3 5 Hrs

Diseases in Contemporary Society Definition- need for good health- factors affecting health. Types of diseases - deficiency, infection, pollution diseases- allergies, respiratory, cardiovascular, and cancer Personal hygiene- food - balanced diet. Food habits and cleanliness, food adulterants, avoiding smoking, drugs and alcohol. Communicable diseases: Mode of transmission -epidemic

and endemic diseases. Management of hygiene in public places - Railway stations, Bus stands and other public places. Infectious diseases: Role of sanitation and poverty case studies on TB, diarrhea, malaria, viral diseases .Non-communicable diseases: Role of Lifestyle and built environment. Diabetes and Hypertension.

MODULE 4 **4 Hrs**

Perspectives and Interventions in Public Health Epidemiological perspectives — Disease burden and surveillance; Alternative systems of medicine - Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH); Universal Immunization Programme (UIP); Reproductive health-Youth Unite for Victory on AIDS (YUVA) programme of Government of India. Occupational health hazards-physical-chemical and biological. Occupational diseases- prevention and control.

MODULE 5 **4 Hrs**

Environmental Management Policies and Practices Municipal solid waste management: Definition, sources, characterization collection and transportation and disposal methods. Solid waste management system in urban and rural areas. Municipal Solid waste rules. Policies and practices with respect to Environmental Protection Act, Forest Conservation Act, Wild life protection Act, Water and Air Act, Industrial, Biomedical and E waste disposal rules.

MODULE 6 **6 Hrs**

Assignment /Field Work (from the list)

- Examining local cuisines for dietary diversity.
- Examining National Health Survey data e.g. National Family Health Survey, Annual Health surveys.
- Survey of Immunization coverage in a particular area.
- To establish if there is a relation between GDP and life expectancies/Health parameters.
- Survey of Respiratory allergies.
- Examining household/institutional/market/neighborhood wastes and their disposal mechanism.
- Survey of households along the Arkavathi and Cauvery River for life expectancy and common ailments and diseases.
- Determine the extent of use of paper and suggest means of reducing the use of paper and paper products.
- Documentation of festival/fasting and mapping of agro-ecological cycles.
- Definitions of poverty - Governmental policies on poverty mitigation - facts and fiction.
- Health indicators vis- a-vis income groups.
- Deforestation and flooding - myth or fact?
- Smoking and Lung Cancer
- Estimation of water-demands of a city/town.
- Adapting water-harvesting technology - survey, sustainability.
- Quantitative relation between bio-resource and consumer products - bathing soap, paper, furniture & construction as related to trees.

- Differential access to water - demand and actual access.
- Transport losses in water supply.
- Storage losses in food grain.
- Study of sewage treatment plants.
- Social perspective - child-health and small scale industries.
- Document infant immunization.
- Studying effective programme implementation - Reproductive health.
- Opportunities of physical activities in neighborhood - Study of built environment - Land-use pattern in Urban Settlements.
- Air quality in Delhi.
- Changing transport means in Delhi - CNG.
- Rituals and environmental pollution e.g. water, noise, air.
- Dialogue with doctors and paramedics.
- Methods of consultation of doctors.
- Population pressure/growth and resource degradation.
- Nutritional disorders/deficiencies in different populations groups-surveys.
- Compose and enact street plays. Create posters/ audio-video materials/ greeting cards highlighting environmental issues.
- Collecting information on medicinal plants.
- Collecting information from elders and other prominent persons.
- Occupational hazards and health issues.
- Water-borne diseases - exacerbation by irrigation projects.
- Alternate medicines - use of therapies for different diseases categories.
- Lifestyle diseases.
- Pollutants in air/water/soil and their effect on health.
- FDI in specific manufacturing Industries and local health problems.
- Differential pricing policy of petroleum products and environmental pollution - case studies.
- Wildlife Protection Act - case studies.
- Bhopal Gas Tragedy- Science, Laws and Public Health
- Changing Human Development Indices over time – in India/other countries.
- Supply, demand and gap filling –role of ground water.

REFERENCES:

1. Indian Academy of Paediatrics. (2011). Guidebook on Immunization. mfc bulletin, 45-50.
2. Nandini N, Sunitha N. and Sucharita Tandon, (2007), Environmental Studies, Sapna Book House, Bangalore

3. Michel, Mckinney, Robert and Logan (2007). Environmental Science – Systems & Solutions. Jones & Barlett Publishers, Canada.
4. Minkoff, E., & Baker, P. (2003). Biology Today: An Issues Approach (3 ed.).
5. Park, K. (2011). Preventive and Social Medicine. Benarsi Das Publications, (pp. 16-19,24-27).
6. Public Health Nutrition in Developing Countries Part-2). Wood head Publishing India.
7. Sadgopal, M., & Sagar, A. (2007, July-September). Can Public Health open up to the AYUSH Systems and give space for People's views of health and disease?.
8. Sekhsaria, P. (2007). Conservation in India and the Need to Think Beyond 'Tiger vs. Tribal'. Biotropica, 39(5), 575-577.
9. Tyler Miller and Scott E. Spoolman 'Environmental Science' (2012) 13th edition First Indian Reprint Chapters 14-17
10. UNDP. (2013). The Human Development Report, The Rise of the South: HumanProgress in Diverse World. New York: UNDP, (also available in Hindi),
11. Wani, M., & Kothari, A. (2007, July 15). Protected areas and human rights India: the impact of the official conservation model on local communities. Policy Matters, 100-114.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1274
TITLE OF THE COURSE : BASIC TECHNIQUES IN MICROBIOLOGY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To equip students with basic microbiological techniques
2. To understand working principles of instruments
3. To understand microbial structure, functions and their environment

COURSE OUTCOMES:

1. Enable students to isolate, culture and identify microorganisms
2. Educate students about principles and applications of instruments used in microbiological techniques

1) Study of basic instruments in Microbiology laboratory (1/2 Unit)

- Autoclave
- Hot air oven
- Incubator
- pH meter
- High speed centrifuge
- Colorimeter / Spectrophotometer
- Anaerobic jar
- Bacterial Filters
- Laminar air flow

2) Microscopic examination of bacterial smear (3 Units)

- Gram's staining
- Capsule staining
- Endospore staining

3) Preparation of culture media and transfer of media (3 Units)

- Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
- Selective media (EMB-agar and McConkey agar)
- Enriched media (Blood agar)
- Slant culture technique
- Broth culture technique
- Stab culture technique

4) **Methods of pure culture techniques** - Pour plate technique, Spread plate technique and Streak plate technique **(2 units)**

5) **Microscopic observation of temporary slides:** **(2 Units)**

Algae: *Chlamydomonas* and *Spirulina*

Fungi: *Rhizopus*, *Aspergillus, Penicillium,* Yeast and *Fusarium*

Protozoa: *Amoeba, Paramecium* and *Plasmodium*

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1275
TITLE OF THE COURSE : BIO-ANALYTICAL CHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To create general understanding about practical concepts of techniques used to detect and assay biomolecules.
2. To familiarize students with laboratory equipment use.

COURSE OUTCOME:

1. Students will have a general idea about acid-base and amino-acid titration and also be familiar with viscometer and pH meter.
2. Students will be able to detect and resolve bio-molecular mixtures based on their physical and chemical properties.

1. pH metric titrations of HCl-NaOH / Acetic acid-NaOH.
2. Determination of pI of amino acid (glycine).
3. Determination of density & viscosity of given unknown liquid.
4. Determination of density & surface tension of given unknown liquid.
5. Circular paper chromatography of amino acids / carbohydrates.
6. Ascending/Descending paper chromatography of amino acids / carbohydrates.
7. Separation of amino acid by TLC.
8. Column chromatography of pigments on adsorbent.
9. Paper electrophoresis for separation of biomolecules (Demo).

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19BS1276
TITLE OF THE COURSE : BASIC BIOCHEMISTRY - LAB
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To familiarize the students with good lab practise and basic laboratory instruments.
2. To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

1. The students will be familiarized with handling laboratory equipment like weighing balance,
   pH meter and potentiometer.
2. They will have an understanding of biomolecule composition of edible materials.

1. Preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Conductometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Estimation of protein/lipid/carbohydrates in vegetables
5. Estimation of protein/lipid/carbohydrates in milk
6. Estimation of iodine number of edible oils
7. Estimation of ascorbic acid in fruits by titrimetric method.

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 19AU0003
TITLE OF THE COURSE : CONSTITUTION OF INDIA AND HUMAN RIGHTS
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 0

COURSE OBJECTIVES:

1. Define a constitution
2. Describe the salient features of the Indian Constitution
3. Explain different ways of acquiring Indian Citizenship
4. List the Fundamental Rights and Fundamental Duties of Indian citizens
5. Describe the Directive Principles of State Policy and their significance

COURSE OUTCOMES:

1. Students will appreciate the fundamental law of the land
2. Students will be aware of what kind of government the country will have.
3. Aid in understanding what lays down the rules to govern the country
4. It also tells about the rights and also the duties of its citizens

MODULE 1: 5 Hrs

Framing of the Indian Constitution: Role of the Constituent Assembly. Philosophy of the Constitution: Objectives, resolution, preamble, fundamental Rights and Duties. Human rights and Environmental protection.

MODULE 2: 6 Hrs

Special Rights created in the Constitution of Dalits, Backward Classes, Women and Children, and religious and linguistic minorities. Directive Principles of State policy: The need to balance fundamental rights with directive principles.

MODULE 3: 5 Hrs

Union Executive: President, Prime Minister and Council of Ministers; powers and functions, coalition Government, problems in their working.
Union Legislature: Lok Sabha and Rajya Sabha, powers and functions. Recent trends in their functioning.

MODULE 4: 5 Hrs

State Government: Governor, Chief Minister and Council of ministers, Legislature. Centre – State relations: Political, financial, administrative: Recent Trends.

MODULE 5: 5 Hrs

Judiciary: Supreme Court, Judicial Review, Writs, Public interest litigations. Enforcing rights through writs. Emergency provisions (Article 356)

REFERENCES:

1. D.D. Basu – Introduction to the Indian Constitution.
2. A.S. Narang – Indian Constitution, Government and Politics.
3. Nani Palkhivala – We, the People, UBS Publishers, New Delhi, 1999.
4. A.G. Noorani – Indian Government and Politics.
5. J.C. Johari – Indian Government and Politics Vol. I & II, Vishal, New Delhi.
6. Gran Ville Austin – The Indian Constitution – Corner stone of a Nation, Oxford, New Delhi, 2000.
7. M.U. Pylee, Constitutional Government in India.
8. K.K. Ghai, Indian Constitution.

SEMESTER/YEAR	**:**	**I SEM / I YEAR**
COURSE CODE	**:**	**20BT1101**
TITLE OF THE COURSE	**:**	**FUNDAMENTALS OF CELL BIOLOGY**
L : T : P : S/P : C	**:**	**4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES

1. To familiarize the students with the basic components of prokaryotic and eukaryotic cells with special focus on the physiological processes of the cell organelles and cell.
2. To introduce the students to the cell membrane and cell wall and to the very basics of cell cycle and cell death pathways.

COURSE OUTCOMES

1. Students will understand the basic concepts of cell structure and cell organelles and cell physiology.
2. Students will get a strong foundation in the field of cell cycle and cell death pathways.

TOTAL HOURS: 48

MODULE 1 -ULTRA STRUCTURE OF CELL **12 Hrs**

Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model). Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).

MODULE 2 -CELL ORGANELLES -I **12 Hrs**

Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.

MODULE 3 -CELL ORGANELLES-II **12 Hrs**

Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella.Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4- CELL GROWTH AND CELL DIVISION **12 Hrs**

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases). Mitosis: Mitotic phases; Cytokinesis; Significance of

Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis.Introduction to programmed cell death (Apoptosis & Necrosis).

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BC1101
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To familiarize the students with basic concepts, principles of conformation and energy transfer in biological systems.

2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:

1. The students will understand basic concepts like properties of Water, pH, buffers, conformation, energy transfer and know the chemistry behind metabolic biological reactions.

2. The students will have an understanding of structure and property of biomolecules so that they will have a better understanding of metabolism of biomolecules in higher semesters.

TOTAL HOURS: 48

MODULE 1 **12 Hrs**

Water and Buffers: Modern concepts of acids and bases; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation by H-H equation, buffer types. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.

MODULE 2 **12 Hrs**

Conformation and energy transfer

Stereoisomerism: Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3 **12 Hrs**

Carbohydrates and lipids

Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid

Lipids: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.

MODULE 4 **12 Hrs**

Amino acids and nucleic acids

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins

Nucleic acid: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 20GN1101
TITLE OF THE COURSE : BASIC GENETICS
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To gain insight on the historical perspective of the evolution of genetics.
2. To comprehend and identify the different types of mendelian and non-mendelian inheritance.
3. Understand how sex determines the inheritance pattern of genes and the influence of extrachromosomal inheritance.

COURSE OUTCOMES:

1. Students will have clarity to the background of genetics before getting into details in the forthcoming semesters.
2. They will be capable differentiate between mendelian and non mendelian inheritance sources along with associated intricacies.
3. Student will gain the ability to analyse and relate phenotype to genotype and potential factors influencing the interaction.

TOTAL HOURS: 48

UNIT I : HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 12 Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance(Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.

UNIT II : EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 12 Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.

UNIT III : SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE 12 Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and dosage compensation (Drosophila and Man).Sex linked and sex limited traits in Humans. Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in Mirabilis jalapa,

kappa particle in Paramecium, sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize.

UNIT IV : MODEL ORGANISMS IN GENETICS **12 Hrs**

Bacteria - *E.coli*; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- Neurospora species , *N crassa*, *Saccharomyces cerevisiae;* Nematode - *Caenorhabditis elegans*, Plant - Arabdosis thaliana, Fly - *Drosophila melanogaster*, Fish - Zebra fish (*Danio rerio*) , Mammal - Mice (*Mus musculus*) and Rat (*Rattus rattus*) .

TEXT BOOK :

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFERENCES:

1. Mathew Hamilton , (2009) Population Genetics, Wiley-Blackwell
2. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
3. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
4. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
5. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
6. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
7. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **20BS1101**
TITLE OF THE COURSE : **BASIC CHEMISTRY**
L : T : P : S/P : C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.

2. To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, and Organic.

2. The student will understand the importance of the modern atomic theory, quantum chemistry, acids & bases and basics of organic chemistry.

TOTAL HOURS: 48

MODULE 1: GENERAL CHEMISTRY **12 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Acids and Bases:
Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.

MODULE 2: ATOMIC STRUCTURE **12 Hrs**
Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's

equation-derivation, Heisenberg's uncertainty principle.
Hydrogen atomic spectra. Need of a new approach to Atomic structure.
Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.

MODULE 3: CHEMICALBONDING **12 Hrs**

Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples
IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect onstability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl2).
Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl2, BF3, PCl5, SF6).
Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH3, H2O, H3O+, SF4, ClF3.
Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulatesanditslimitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6molecules.
Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H2, N2, O2, HF and CO).
Metallic Bond: Definition, properties of metals and band theory.
Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.
Hydrogen Bond: Definition, types, importance

MODULE 4: BASICS OF ORGANIC CHEMISTRY **12 Hrs**
Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).
Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.
Reactive intermediates: Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples.
Types of organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.

Aromaticity: Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromaticmolecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three , four, five, six, seven and eight-membered systems - annulenes.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BT1171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY
L: T/A: P: C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES

1. To familiarize the students with the concepts of microscopy, basic staining procedures to enable them to get hands on experience
2. To make the students understand how to measure cell size and identify different blood cells

COURSE OUTCOMES

1. Students will understand the basic concepts of microscopy, get clear picture of concept they study in theory like mitosis and an inactivated X- chromosome
2. Students will understand how to measure cell size and identify different blood cells

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
6. Blood smear-differential staining.
7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

REFERENCES

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)

2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.

3. Cell division: Study of mitosis using onion root tips.

4. Preparation of Buccal smears for study of barr bodies.

5. Vital Staining of mitochondria (yeast).

6. Blood smear-differential staining.

7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BC1171
TITLE OF THE COURSE : BASIC BIOCHEMISTRY PRACTICAL
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To familiarize the students with good lab practise and how to make buffers.
2. To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

1. The students will be familiarized with handling laboratory equipment like weighing balance, pH meter and potentiometer and learn the importance and preparation of buffers.
2. They will have an understanding of biomolecule composition of edible materials.

1. Calculation and preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Potentiometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Potentiometric titration of amino acid against NaOH and HCl
5. Estimation of proteins milk.
6. Estimation of carbohydrates in vegetables (Potatoes etc)
7. Estimation of lipids in milk/vegetables (avocadoes etc)
8. Estimation of iodine number of edible oils
9. Estimation of ascorbic acid in fruits by titrimetric method.

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 20GN1171
TITLE OF THE COURSE : BASIC GENETICS PRACTICAL
L: T/A: P: C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To differentiate between the various stages of meiosis in animal and plant cells.
2. To gain insight as to the different genetic interactions and their effect on phenotype.

COURSE OUTCOMES:

1. Students will gain skills to process tissue into slides and distinguish various meiotic stages.
2. Students will be capable to analyse and identify gene interactions, predict crosses and understand its role in inheritance.

1) Temporary squash preparation of : Grasshopper Testes, Onion flower bud [2 units]
2) Observation of meiotic stages in permanent slides [1 unit]
3) Blood Typing [1 unit]
4) Sex differentiation in Drosophila [2 units]
5) Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
6) Genetic problems on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage [2 units]
7) Study of : (a) Flower color in *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl. [2 units]

REFERENCES :

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC.New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BS1102
TITLE OF THE COURSE : COMMUNICATIVE ENGLISH
L : T : P : S/P : C : 2 : 0 : 0 : 0 : 2

COURSE OBJECTIVES:

1. To encourage the students to speak English confidently and enable them to communicate for day-to-day needs
2. To build up their confidence in the usage of English and to enhance their written communicative competence also helping them for competitive exams

COURSE OUTCOMES:

1. Students are confident in oral and written communication
2. Have enhanced competence for competitive exams

24Hrs

MODULE 1: COMMUNICATION SKILLS

Definition, importance of communication, communication process – source, message, encoding, channel, decoding, receiver, feedback, context, levels of communication, Flow of Communication, Verbal and Non-Verbal Communication, Barriers to Communication - physiological, physical, cultural, language, gender, interpersonal, psychological, emotional. Perspective in communication/ Communication styles: introduction, visual perception, language, other factors affecting our perspective – past experiences, prejudices, feelings, environment

MODULE 2: ELEMENTS OF COMMUNICATION

Elements of communication – introduction, face to face communication – tone of voice, body language (non-verbal communication), verbal communication, physical communication;

Basic listening skills: introduction, self-awareness, active listening, becoming an active listener, listening in difficult situations;

Interview skills: purpose of an interview, do's and dont's of an interview;

Giving presentations: dealing with fears, planning your presentation, structuring your presentation, delivering your presentation, techniques of delivery;

Group discussion: introduction, communication skills in group discussion, do's and don't's of group discussion;

Phonetics: The Organs of Speech, The Description and Classification of Speech Sounds, The Description and Classification of Vowels, The Description and Classification of Consonants, Phonetic symbols and the IPA, Phonemic and Phonetic Transcription Phonology, Phoneme sequences and Consonant Cluster, The Syllable, Word Accent, Accent and Rhythm in Connected Speech, Intonation, Varieties of English Pronunciation.

MODULE 3: EFFECTIVE WRITING SKILLS

Effective written communication: introduction, when and when not to use written communication – complexity of the topic, amount of discussion required, shades of meaning, formal communication

Writing effectively: subject lines, put the main point first, and know your audience, organisation of the message, Paragraph Writing, Letter Writing, Report Writing, Book Review, Scientific writing, Making a message – Transitivity/ intransitivity – complementation – talking about closely linked action – using two verbs together (eg: She started laughing),Transforming messages – Making statements, questions, orders and suggestions – denying – rejecting – disagreeing – possibility – ability, permission, obligation etc.

MODULE 4: GRAMMAR

Word Classes: Open Word Classes: - Nouns, Verbs, Adjectives, Adverbs, Pronouns; Closed Word Classes: - Pre-determiners, Determiners, Numerals, Enumrators, Prepositions, Conjunctions, Auxiliary Verbs, Interjection;

Morphology: Bound and Free Morphemes; Affixes, Stems and Roots; Morphological Analysis;

Phrases: Noun Phrase, Verb Phrase, Genetive Phrase, Adjective Phrase, Adverb Phrase, Prepositional Phrase, Phrases and its types, Clauses and its types, Sentences and its types, Common errors, phonetics;

Clauses: Clause Elements, Clause Types, Kinds, Concord;

Sentences: Simple Sentences, Compound Sentences, Complex Sentences;

Sub Ordination: Sub-Clauses, Finite and Non-Finite Sub-Clauses;

Co-ordination: Linked and Unlinked Coordination, Synthesis;

Ambiguity: Types of Ambiguity, Structural and Lexical Ambiguity;

Common Errors: Nouns and Pronouns, Articles, Verbs, Concord, Adjectives, Adverbs, Prepositions, Vocabulary, Expressing time, Referring to present, past and future time - use of adjuncts - frequency and duration, Talking about manner and place, Information about place, manner - position of adjuncts - types of adverbs (time, frequency, duration etc), Reporting what people say/think, Reporting verbs - reporting someone's actual words - reporting in one's own words, The structure of information, Focusing on the thing affected (passive voice) - selecting focus (left structure) taking the focus off the subject (impersonal 'it' etc.) – Introducing something new (with 'there') - focusing on information using adjuncts.

REFERENCES:

1. Crystal, David. 1985, Rediscover Grammar with David Crystal. Longman
2. Bakshi, R. N. A Course in English Grammar. Orient Longman
3. Close, R. A. Reference Grammar for Students of English. Orient Longman
4. Krishnaswamy, N. Modern English – A Book of Grammar, Usage & Composition. Macmillan India Ltd.
5. Aroor, Usha (Ed.) WordMaster Learner's Dictionary of Modern English. Orient Longman

6. Hewings, M. 1999, Advanced English Grammar. Cambridge University Press
7. Basic communication skills for technology, Andreja J. Ruther Ford, 2nd Edition, Pearson Education, 2011.
8. Communication Skills, Sanjay Kumar, Pushpalata, 1st Edition, Oxford Press, 2011.
9. Brilliant – Comminication Skills, Gill Hasson, 1st Edition, Pearson Life, 2011.
10. Soft Skill and Professional Communication, Francis Peters SJ, 1st Edition, Mc GrawHill Education, 2011.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BT1201
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGY
L: T/A: P: C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To provide basic understanding on Immune system: Cells and organs of the immune system and its fundamentals.
2. To give basic framework and knowledge on structure and functions of antibodies, , antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response and to equip the students with knowledge on immunological techniques, vaccines

COURSE OUTCOMES:

1. Student will be acquainted with the basic understanding of immune system in its entirety and student will be competent with basic knowledge of the structure and basic working of antibodies, functions of antibodies and their antigen specificity
2. Student will have basic understanding of immunological techniques involving antibodies and vaccines as disease preventive agents

TOTAL HOURS: 48

MODULE I: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM 12 Hrs

Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell) branches of immunity. Immunological memory.

MODULE II: ANTIGENS AND ANTIBODIES 12 Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE III: IMMUNE RESPONSES 12 Hrs

Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 12Hrs

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and Recombinant vaccines – Peptide and DNA Vaccines.

REFERENCES:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. Kuby Immunology 7th edition. macmillan Publishers 2014.
4. Kuby Immunology, 8th Edition | macmillan Publishers 2019.
5. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. https://doi.org/10.1201/9781315533247
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BC1201**
TITLE OF THE COURSE : **BIOANALYTICAL TECHNIQUES**
L: T/A: P: C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES:

1. To create general understanding about fundamentals of biomolecules, their structure, function and analysis.
2. To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences.
3. To give holistic view for understanding the screening, isolation, separation and characterization of molecules.

COURSE OUTCOMES:

1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.
3. Students will be empowered for better prospects leading to project design and execution.

Total Hours: 48

MODULE 1 **12 Hrs**

Spectroscopy: Wave particle duality, the concepts of electromagnetic spectrum, Concepts of Absorbance and Emission Spectroscopy, Beer-Lambert's law, application and its limitations. Extinction coefficient, Concepts of chromophore/auxochrome and Chromic shifts. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscopy. Assay of biomolecules (Carbohydrates and Proteins). Principle, schematics and application of Luminometry, Tubidometry, Klett Photometry, Flame photometry and IRspectroscopy.

MODULE 2 **12 Hrs**

Chromatography

History and principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (Rf & Rt concepts). Types: Planar and columnar, S-L, L- L, G-S, G-L and G-G. Paper and thin layer chromatography, types and their application in separationof biomolecules. Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules using gel permeation, ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).

MODULE 3 **12 Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Cellulose acetate electrophoresis, High voltage electrophoresis and their Applications. Gel electrophoresis - Types of gels, Procedure, for gel making. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration). Principle and application of Poly acralamide Gel Electrophoresis (PAGE), Iso-electric focussing (IEF) and 2D-PAGE, Submerged agarose gel electrophoresis (SAGE). Application of electrophoresis in molecular biology (genomics, transcriptomics and proteomics).

MODULE 4 **12 Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations.

Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules.

Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.

REFERENCE BOOKS:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Handbook of Analytical Techniques – Gunzler and Williams. Wiley &Sons.
4. Immunology – Kuby. Freeman Publishers.
5. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER /YEAR : II SEM / I YEAR
COURSE CODE : 20GN1201
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 4 : 0 : 0 : 0 :4

COURSE OBJECTIVES :

1. Understand the characteristics of chromosome and its related anomalies.
2. Elucidation on the versatility of the chromosomes and its different interactions.

COURSE OUTCOMES :

1. Students will learn details on chromosomes , its conformations to bring about genetic variability.
2. The students will get insight on chromosome abnormality which leads to cytogenetic aberrations and disease.

TOTAL HOURS: 48

MODULE I - CHROMSOME CHARACTERISTICS 12Hrs

Physical basis of inheritance : chromosome theory of inheritance, Eukaryotic Chromosome- Macro-molecular organisation. Primary and Secondary constriction, Sat-bodies, telomeres, chromosome types. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Ideogram. Special types of chromosomes : Polytene chromosome- Salivary gland chromosome in Drosophila, Lamp-brush chromosome in amphibian Oocyte, B Chromosome.

MODULE II - LINKAGE 12 Hrs

Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc. Sex Linkage : Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in Drosophila.

MODULE III - CROSSING OVER 12Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in Drosophila. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks.

MODULE IV - CHROMOSOMAL ABERRATIONS 12Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

TEXT BOOK :

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFRENCES :

1. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
2. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
3. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
4. Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
5. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
6. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
7. Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
8. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
9. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BS1201
TITLE OF THE COURSE : BIOINFORMATICS AND BIOSTATISTICS
L: T/A: P: C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:
1. To create general interest in applied domain towards using computers forbiological applications.
2. To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.

3. To give holistic view for understanding the scientific validation and biomodeling.

COURSE OUTCOMES:
1. Student will be aware of various applied and allied scientifically domains to innovative and creative think.
2. Student will be aware of the computer tools andapplications which can be implemented in biological sciences.
3. Students will be empowered for better prospects leading to project design and execution.

Total Hours: 48

MODULE 1 **12 Hrs**

Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). **Introduction to networks:** LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire-walls. Concepts on encryption of data.

Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).

MODULE 2 **12 Hrs**

Bioinformatics (Genomics):

Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.

MODULE 3 **12 Hrs**

Bioinformatics (Proteomics):

Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis.

Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.

MODULE 4 **12 Hrs**

Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods forenvironmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc. NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BT1271**
TITLE OF THE COURSE : **IMMUNO-TECHNIQUES – PRACTICAL**
L: T/A: P: C : **0: 0: 4: 2**

COURSE OBJECTIVES:

1. To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
2. To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES:

1. Student will be familiarized with immunological techniques utilized for diagnostic assays.
2. Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.

1. Blood group identification and Rh Typing
2. Precipitation Reactions –
    I. Radial Immuno Diffusion
    II. Ouchterlony double diffusion
    III. Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
7. Study of different cells in whole blood using Giemsa/Leishman stain.

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
3. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BC1271**
TITLE OF THE COURSE : **BIOANALYTICAL SEPARATIONS PRACTICAL**
L : T : P : S/P : C : **0: 0: 4: 0 : 2**

COURSE OBJECTIVES:

1. To make students learn quantitative and qualitative methods for study of biomolecules.
2. To provide hands-on training to physico-chemical methods.
3. To give insights on isolation, separation and characterization of biomolecules.

COURSE OUTCOME:

1. Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic and chromatographic techniques.
2. Students will have a complete understanding on methods to analyse biomolecules.
3. Students will be empowered for better prospects leading to project design and execution.

1. Determination of extinction coefficient using colorimetry.
2. Determination of lambda maximum of biomolecules using UV spectroscopy.
3. Estimation of protein by Lowry method or Estimation of sugar by Miller method.
4. Estimation of pKa of amino acid (glycine).
5. Determination of density & viscosity of given unknown solution.
6. Circular Paper chromatography for amino acid/ sugars and Rf calculations.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

REFERENCES

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
5. Handbook of Analytical Techniques - Gunzler and Williams. Wiley & Sons.
6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER /YEAR : II SEM / I YEAR
COURSE CODE : 20GN1271
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES :

1. Identifying chromosome features and their status in animal and plants.
2. Analyse linkage and crossing over problems by mapping method.
3. Understanding cytogenetics using Drosophila as a model organism

COURSE OUTCOMES :

1. The student will gain skill to prepare and visualise chromosomal slides from various sources.
2. Students can solve genetic linkage analysis by construct ion of cytogenetic maps on linkage.
3. Students will become skilled in handling and maintaining Drosophila cultures.

1. Micronuclei from buccal cell (H&E basic staining)
2. Preparation of Metaphase spreads from blood for Karyotyping.
3. Genetic Problems on linkage & crossing over - Drosophila, Maize, Human (Sex Linkage)
4. Study of chromosomal aberration using karyotype information by observation of permanent slides of chromosomal aberrations.

Cytogenetics using Drosophila as a model organism.

5. Culturing and Handling of Drosophila - Media preparation, Handling drosophila.
6. Study of different types of Drosophila- Body color mutant- Ebony body and Yellow body,Wing mutant- Curly wing and vestigial wing and Eye color mutant- Bar eye, white eye, sepia eye.
7. Mounting of Sex Comb and Genital plate of Drosophila melanogaster
8. Salivary gland Chromosome - Dissection of Salivary glands and preparation of polytene chromosome.

REFERENCES:

1. Drosophila Cytogenetics Protocols, Methods in Molecular Biology, Volume 247, Daryl S Henderson, Humana Press.
2. The AGT Cytogenetics Laboratory Manual, Marilyn S Arsham, Margaret J , March , Helen J Lawce, Fourth Edition, Wiley Blackwell.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BS1202
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L : T : P : S/P : C : 0: 0: 4: 0 : 2

TOTAL HOURS: 24

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems 4 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: 8Hrs

Data processing & presentation: Introduction, Office Automation Software (Open Source Software).

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 4: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational

gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCES:

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BT1101
TITLE OF THE COURSE : FUNDAMENTALS OF CELL BIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES

1. To familiarize the students with the basic components of prokaryotic and eukaryotic cells with special focus on the physiological processes of the cell organelles and cell.
2. To introduce the students to the cell membrane and cell wall and to the very basics of cell cycle and cell death pathways.

COURSE OUTCOMES

1. Students will understand the basic concepts of cell structure and cell organelles and cell physiology.
2. Students will get a strong foundation in the field of cell cycle and cell death pathways.

TOTAL HOURS: 48

MODULE 1 -ULTRA STRUCTURE OF CELL 12 Hrs

Prokaryotic (Bacteria) and Eukaryotic cells (Animal and Plant) - Characteristics and differences. Cell Wall: Ultrastructure, chemical composition and function. Plasma membrane: Chemical composition (Lipids, Proteins, Carbohydrates), Structure (Fluid mosaic model). Mode of transport across membrane: Active Transport (Pumps) and Passive transport (Osmosis, Diffusion).

MODULE 2 -CELL ORGANELLES -I 12 Hrs

Structure and general functions: Chloroplast (Envelope, Stroma, Thylakoids); Endoplasmic Reticulum (Smooth and Rough); Golgi complex (Cisternae, Tubules, Vesicles); Mitochondria; Ribosomes; Lysosomes (Primary and Secondary); Microsomes.

MODULE 3 -CELL ORGANELLES-II 12 Hrs

Structure and general functions: Cytoskeleton (Microtubules, Microfilaments and Intermediate Filaments); Cilia and Flagella.Structure and general functions of Nucleus (Nuclear envelope, Nucleoplasm and Nucleolus). Chromosomes- Discovery, Structure and functions (Centromere, Secondary constrictions, Telomere). Types of Chromatin (Euchromatin and Heterochromatin); Dosage Compensation. Organization of Chromatin: Nucleosomes and Solenoid Model; Giant Chromosomes (Polytene and Lampbrush).

MODULE 4- CELL GROWTH AND CELL DIVISION 12 Hrs

Cell cycle: Introduction to cell cycle stages (Interphase and M phase); Introduction to Cell cycle control (Cyclins and Cyclin dependent kinases). Mitosis: Mitotic phases; Cytokinesis; Significance

of Mitosis. Meiosis: First meiotic division; Second meiotic division, Synaptonemal complex; Significance of meiosis.Introduction to programmed cell death (Apoptosis & Necrosis).

REFERENCES:

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Gerald Karp. Cell and Molecular Biology. 6th Edition (2009) Wiley Publications.
3. Bruce Alberts et al. Molecular Biology of the cell - (2002) Garland Publications. Ambrose and Esty D. M. Cell Biology - (1997) ELBS Publications.
4. Robertis E. D. F. and Robertis E. M. F. Genetics and Molecular Biology - (2001) Saunders College.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20CY1101
TITLE OF THE COURSE : ADVANCED CHEMISTRY - I
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To develop basic and advance concepts regarding the three states of matter.
2. To derive the expressions for determining the physical properties of gases.
3. The course is infused with the recapitulation of fundamentals of organic chemistry and the introduction of a new concept of visualizing the organic molecules in a three-dimensional space.
4. To establish the applications of these concepts, the functional groups- alkanes, alkenes, alkynes and aromatic hydrocarbons are introduced. The constitution of the course strongly aids in the paramount learning of the concepts and their applications.
5. Derive mathematical expressions for different properties of gas understand their physical significance.

COURSE OUTCOMES:

1. Students be able to Understand and explain the different nature and behavior of organic compounds based on fundamental concepts learnt.
2. Formulate the mechanism of organic reactions by recalling and correlating the fundamental properties of the reactants involved.
3. Apply the concepts of gas equations, pH and electrolytes while studying other chemistry courses and everyday life.

TOTAL HOURS: 48

MODULE 1: PERIODICITY OF ELEMENTS 12 Hrs

Classification of elements into s, p, d, and f-blocks, cause of periodicity. Brief discussion of the following properties of the elements, with reference to *s*- & *p*-block and the trends shown:
(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.
(b) Atomic and ionic radii
(c) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization enthalpy and trends in groups and periods.
(d) Electron gain enthalpy and trends in groups and periods.
(e) Electronegativity, Pauling's/ Allred Rochow's scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.

MODULE 2: E **12 Hrs**

Gaseous state - laws of gaseous state- gas constant R in different units – deviation from ideal behaviour- Van der waals equation for real gasesNeed for Maxwell-Boltzmann distribution law, mathematical expression for both based on this law (no derivation). Mean free path, collision frequency and collision number. Definition and expressions using SI units (no derivations). Derivation of expression for most probable speed from Maxwell-Boltzmann equation Definitions and expressions for rms velocity and average velocity, relationships between them. Problems . Andrew's isotherm on carbon dioxide and explanation of the curves (no experimental details). Mole and molecule-explanation of the terms only. Explanation of velocity distribution curves. Derivation of critical constants Tc, Pc and Vc from van der Waal's equation and their experimental determination by Cagniard de La Tour method for Tc and Pc. Amagats mean density method for Vc. Problems on the calculation of Tc, Pc and Vc, a and b. *Law of corresponding states* - statements, reduced equation of state and explanation, Joule-Thomson effect-explanation. Joule-Thomson co-efficient, inversion temperature-definition(no derivation).The application of Joule-Thomson effect to the liquefaction of air and hydrogen by Linde's process.

MODULE 3: ALIPHATIC HYDROCARBONS **12 Hrs**

Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits.
Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds.
Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Antimarkownikov's rule with mechanism. Reactions: Hydroboration- oxidation, reduction, oxymercuration - demercuration, epoxidation. Mechanism of oxidation with $KMnO_4$ and OsO_4.Ozonolysis- mechanism and importance.
Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.
Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with $KMnO_4$, acidic nature of terminal alkynes.

MODULE 4: Y **12 Hrs**

Configurational isomers - concept of chirality (asymmetry) - stereogenic centres –enantiomers - diastereomers with multiple chiral centres - Fischer projection - predicting the number of stereoisomers of compounds - absolute configuration, (R-S system of nomenclature) - relative

configuration (D-L system of nomenclature) optical activity - racemic mixtures - chirality in molecules without a stereocentre. Geometrical isomerism: cis -trans isomerism and E,Z nomenclature in alkenes and oximes.

Conformations of ethane – propane and butane – Newmann - Sawhorse and Wedge- Dash representations - Conformational isomerism in cycloalkanes – cyclopropane and cyclobutane - Conformations of cyclohexanes - Monosubstituted, and disubstituted cyclohexanes.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20MB1101
TITLE OF THE COURSE : BASIC MICROBIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

Total Hours: 48

COURSE OBJECTIVES:

1. To know the importance of microorganisms for our global society

2. To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
3. To study the basic techniques for isolation, culturing and identification of prokaryotic microorganisms and their importance
4. To study eukaryotic microorganisms in detail and to know their importance

COURSE OUTCOMES:

1. Provides a strong acquaint in fundamental aspects of basic microbiology
2. Enable to understand the diversity of microbial, structure, function and their environment
3. Awareness about economic importance of microorganisms
4. Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.

MODULE 1: HISTORY AND MICROBIAL SYSTEMATICS 12Hrs

Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome.

MODULE 2: MICROBIAL TECHNIQUES 12Hrs

Microscopy: Principles of resolution and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM).

Staining techniques: Principles of staining, bacterial and fungal staining methods.

Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).

Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes. Measurement of microbial growth.

MODULE 3: PROKARYOTIC MICROBIOLOGY 12Hrs

Difference between prokaryotic and eukaryotic microorganisms.

Virology: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples (TMV and Lambda phage), significance of viruses, viroids and prions.

Bacteriology: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (*Kelbsiella*), Flagella, Pilus/ Fimbriae (*E. coli*), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (*Bacillus /Clostridium*). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction).

Special microbial forms: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaebacteria and extremophiles.

MODULE 4: EUKARYOTIC MICROBIOLOGY 12Hrs

Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi. Type study of Zygomycetes (*Rhizopus*), Ascomycetes (*Aspergillus*), Basidiomycetes (*Agaricus*) and Deuteromycetes (*Fusarium*).

Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*), Rhodophyta (*Gracillaria*).

Protozoa: General characteristics with special reference to *Amoeba, Trypanosoma, Plasmodium, Paramecium.*

REFERENCES:

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
6. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
7. Dubey, R.C. Microbiology 1st Edition. Chand and company
8. Edward Alcamo. Microbiology. Cliffs Notes 1996.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.

10. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
13. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
14. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
15. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
16. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
17. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
18. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
19. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
20. Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **20BS1101**
TITLE OF THE COURSE : **BASIC CHEMISTRY**
L : T : P : S/P : C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.

2. To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, and Organic.

2. The student will understand the importance of the modern atomic theory, quantum chemistry, acids & bases and basics of organic chemistry.

TOTAL HOURS: 48

MODULE 1: GENERAL CHEMISTRY **12 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Acids and Bases:
Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.

MODULE 2: ATOMIC STRUCTURE **12 Hrs**
Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's

equation-derivation, Heisenberg's uncertainty principle.
Hydrogen atomic spectra. Need of a new approach to Atomic structure.
Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.

MODULE 3: CHEMICALBONDING 12 Hrs

Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples
IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl2).
Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl2, BF3, PCl5, SF6).
Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH3, H2O, H3O+, SF4, ClF3.
Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6molecules.
Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H2, N2, O2, HF and CO).
Metallic Bond: Definition, properties of metals and band theory.
Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.
Hydrogen Bond: Definition, types, importance

MODULE 4: BASICS OF ORGANIC CHEMISTRY 12 Hrs

Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).
Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.
Reactive intermediates: Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples.
Types of organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.

Aromaticity: Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromaticmolecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three
, four, five, six, seven and eight-membered systems - annulenes.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BT1171
TITLE OF THE COURSE : TECHNIQUES IN CELL BIOLOGY
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES

1. To familiarize the students with the concepts of microscopy, basic staining procedures to enable them to get hands on experience
2. To make the students understand how to measure cell size and identify different blood cells

COURSE OUTCOMES

1. Students will understand the basic concepts of microscopy, get clear picture of concept they study in theory like mitosis and an inactivated X- chromosome
2. Students will understand how to measure cell size and identify different blood cells

1 y (Bright Field, Dark Field, Phase Contrast Microscopy)
2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.
3. Cell division: Study of mitosis using onion root tips.
4. Preparation of Buccal smears for study of barr bodies.
5. Vital Staining of mitochondria (yeast).
1. Blood smear-differential staining.
2. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

REFERENCES

1. Introduction to Microscopy (Bright Field, Dark Field, Phase Contrast Microscopy)

2. Microscopic measurements using micrometry – calibration of ocular and stage, measurement of onion epidermal cells and yeast by Micrometry.

3. Cell division: Study of mitosis using onion root tips.

4. Preparation of Buccal smears for study of barr bodies.

5. Vital Staining of mitochondria (yeast).

6. Blood smear-differential staining.

7. Study of model organisms - -Tobacco Mosaic Virus, Lambda Phage, *Neurospora crassa, Caenorhabditis elegans, Arabidopsis thaliana, Drosophila*.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20CY1171
TITLE OF THE COURSE : VOLUMETRIC ESTIMATIONS - PRACTICAL
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. Students will learn about good laboratory practices, various glassware used in the chemistry laboratory and the methods to calibrate them.
2. Students will be introduced to various volumetric titrations such as acid-base, redox and iodometric etc.

COURSE OUTCOMES:

1. Students will be well versed with various laboratory practices, usage of different glassware and methods to calibrate them.
2. Students will be able to use the principles of titration experiments to estimate carbonate, nitrogen, chlorine etc. from the various matrices given.

1. Good laboratory practices and calibration of glassware (pipette, burette and standard volumetric flasks etc.)
2. Setting up of titration unit, reflux, distillation, steam distillation apparatus from the basic parts and preparation of a standard solution.
3. Estimation of potassium permanganate using standard sodium oxalate solution.
4. Estimation of ferrous sulphate using standard potassium dichromate solution with ferroin indicator.
5. Estimation of ferrous sulphate using standard potassium dichromate solution using external indicator.
6. Estimation of ferrous and ferric iron in a given mixture using standard potassium dichromate solution.
7. Estimation of free alkali present in different soaps/detergents
8. Estimation of carbonate and bicarbonate in a given mixture.
9. Determination of percentage of manganese dioxide in pyrolusite ore.
10. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.

REFERENCES:

1. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 2015
2. Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition, P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. The Elements of Physical Chemistry, 3rd Edition, Peter Atkins, OxfordUniv. Press, 2000.
5. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
6. Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
7. Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20MB1171
TITLE OF THE COURSE : BASIC TECHNIQUES IN MICROBIOLOGY
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To enable students to understand the microbial structure, microbial growth pattern and techniques to measure cell size.

2. To help them understand the isolation of various microorganisms from different sources.

COURSE OUTCOMES:

1. Students are aware of microbial diversity and isolation techniques.

2. Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.

1. Study of basic instruments in Microbiology laboratory (2 Units)
   Autoclave, Hot air oven, Incubator, pH meter, High speed centrifuge, Colorimeter / Spectrophotometer, Anaerobic jar, Bacterial Filters, Laminar air flow

2. Preparation of culture media:
a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
b) Selective media (EMB agar and McConkey agar),
c) Enriched media (Blood agar).

3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air.

4. Methods of pure culture techniques
a) Pour plate technique
b) Spread plate technique
c) Streak plate technique

5. Transfer of media and inoculum
a) Slant culture technique
b) Broth culture technique
c) Stab culture technique

6. Microscopic examination of bacterial smear
a) Simple staining
b) Gram's staining
c) Capsule staining
d) Endospore staining

7. Isolation and identification of fungi (Lactophenol cotton blue mount)

8. Micrometry: Microscopic measurement of bacterial cell (*Bacillus*), yeast (*Saccharomyces).*

9. Microscopic observation of temporary slides
   - *a.* Algae: *Chlamydomonas* and *Spirulina*
   - *b.* Fungi: *Rhizopus*, *Aspergillus, Penicillium,* Yeast and *Fusarium*
   - *c.* Protozoa: *Amoeba, Paramecium* and *Plasmodium*

10. Study of growth curve of bacteria by turbidometric method

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BT1201
TITLE OF THE COURSE : PRINCIPLES OF IMMUNOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To provide basic understanding on Immune system: Cells and organs of the immune system and its fundamentals.
2. To give basic framework and knowledge on structure and functions of antibodies, , antigens and antigen specificity of antibodies. antigen -antibody interactions, generation of immune response and to equip the students with knowledge on immunological techniques, vaccines

COURSE OUTCOMES:

1. Student will be acquainted with the basic understanding of immune system in its entirety and student will be competent with basic knowledge of the structureand basic working of antibodies, functions of antibodies and their antigen specificity
2. Student will have basic understanding of immunological techniques involving antibodies and vaccines as disease preventive agents

TOTAL HOURS: 48

MODULE I: COMPONENTS, CELLS AND TISSUES OF THE IMMUNE SYSTEM 12 Hrs

Elements of Immune System: History and scope of Immunology, Innate, and Acquired immunity, Humoral and Cell mediated Immunity. Cells and organs of immune system and their functions – Primary and secondary lymphoid organs, T cells, B Cells, macrophage, NK cells Basic outline or scheme of clonal selection in the humoral (B cell) and cellular (T cell) branches of immunity. Immunological memory.

MODULE II: ANTIGENS AND ANTIBODIES 12 Hrs

Antigens and Antibodies: Antigens – types, epitopes, haptens, factors affecting immunogenicity, adjuvant concept; Antibodies – structure, isotypes, and functions of Immunoglobulins. Antibody production: Polyclonal and monoclonal. Complement system – components, functions, activation pathways (classical, alternative, lectin mediated).

MODULE III: IMMUNE RESPONSES 12 Hrs

Antigen processing and presentation, antigen presenting cells (APCs), target cell concept; Major Histocompatibility Complex (MHC) – MHC I and II. Interleukins and Interferons – brief introduction and their important functions. Products and factors produced by T-cell activation; dendritic cells; cytokines (interleukins and interferons) Primary and secondary Immune response.

MODULE IV: IMMUNOLOGICAL TECHNIQUES AND VACCINES 12Hrs

Antigen-Antibody reactions – Precipitation, Immuno electrophoresis, Hemagglutination – Blood grouping, ELISA, RIA, Immunofluorescence. Vaccines and Immunization: Passive and Active immunization, immunization schedules. Types of Vaccines – Inactivated, Attenuated, and

Recombinant vaccines – Peptide and DNA Vaccines.

REFERENCES:

1. Kindt TJ, Osborne BA, Goldsby RA. Kuby Immunology, Sixth Edition. 6th edition. New York: W. H. Freeman & Company; 2006.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. Kuby Immunology 7th edition. macmillan Publishers 2014.
4. Kuby Immunology, 8th Edition | macmillan Publishers 2019.
5. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London. Murphy, K., Weaver, C., Weaver, C., 2016. Janeway's Immunobiology. W.W. Norton & Company. https://doi.org/10.1201/9781315533247
6. Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., Jr, C.A.J., Travers, P., Walport, M., Shlomchik, M.J., 2001. Immunobiology, 5th ed. Garland Science.
7. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier

SEMESTER/YEAR : II SEM / II YEAR
COURSE CODE : 20CY1201
TITLE OF THE COURSE : ADVANCED CHEMISTRY - II
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To impart knowledge of advanced chemistry topics such as *s* & *p* block elements, liquid and solutions, thermodynamics and aliphatic organic compounds.
2. To make students to understand about liquid state of matter, different properties of liquids, laws governing liquids and colligative properties and their applications.
3. To make the students to know about the salient features of alkali and alkaline earth metals and also the chemistry behind p-block elements.
4. To make students understand fundamental concepts of thermodynamics, thermodynamic laws, heat engine, efficiency, entropy etc.
5. To give knowledge about aromatic organic compounds & alkyl halides, their properties, synthesis, reactions and important applications.

COURSE OUTCOMES :

1. Students will be familiar with the basic knowledge of the liquids and solutions and their applications in analytical chemistry. Students will develop the ability of effectively solving practical problems of analytical chemistry of non-aqueous solutions.
2. Students will learn the descriptive chemistry of representative elements of s- and p-block elements and recognize the differences in their reactivity, chemical and physical properties
3. Students will get the knowledge of different concepts of thermodynamics, thermodynamic laws, heat engines, efficiency, entropy etc.
4. Students will gain knowledge about aromatic organic compounds and alkyl halides their properties, synthesis methods, reactions and applications in different fields.

TOTAL HOURS: 48

MODULE 1: s & p BLOCK ELEMENTS 12 Hrs

Hydrogen: Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and para hydrogen, Industrial production of hydrogen by chemically assisted electrolysis and Steam reforming. *Heavy water:* Physical properties (with comparison to light water), Applications.
Hydrates: Chemical nature and their stability.
s- block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density,

melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. Complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.*p – block elements:* Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.

Halogens: Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

Noble gases: Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF2, XeF4, XeF6, XeO3, XeO4).

MODULE 1: LIQUIDS AND SOLUTIONS 12 Hrs

Properties of liquids-Viscosity, Surface tension and Parachor-Definition, mathematical expression, numerical problems and factors affecting them. Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it. Surface Tension-Definition, mathematical expression, effect of temperature and solute on it Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions. Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples. Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system. Immiscible liquids-Steam distillation and its applications. Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction. Dilute solutions- Review of colligative properties and concentration terms. Determination of molecular mass of a solute by: (i) Berkeley- Hartley method(ii) Beckmanns method Tf) and (iii) Landsberger's method. Numerical problems.

MODULE2: THERMODYNAMICS - I 12 Hrs

First law of thermodynamics: Review of terms, Exact and inexact differentials, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).

Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Numerical problems. Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity.

Other forms of II law of thermodynamics. Concept of entropy and its physical significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency. Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes.

MODULE 4: AROMATIC HYDROCARBONS & ORGANIC HALOGEN COMPOUNDS 12 Hrs

Aromatic Hydrocarbons: General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol.

Aromatic nucleophilic substitution *via* benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction.Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, *cis*- and *trans*-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.

Alkyl halides: Nomenclature. Nucleophilic substitution reactions - SN1 andSN2 mechanisms with energy profile diagrams. Effect of (i) nature of alkyl groups,(ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on SN1 and SN2 mechanisms. Elimination reactions - E1 and E2 mechanisms; Hofmann and Saytzeff eliminations with mechanism.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

REFERENCES:

1. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 2015
2. Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition, P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. The Elements of Physical Chemistry, 3rd Edition, Peter Atkins, OxfordUniv. Press, 2000.
5. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
6. Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
7. Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001

SEMESTER/YEAR : II SEM/ I YEAR
COURSE CODE : 20MB1201
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:
1. The major features of growth and metabolism of microorganisms including determination of growth with environmental influence on the microbial growth and primary and secondary metabolism

2. Energy source for microorganisms and relationship between metabolism and energy source

COURSE OUTCOMES:
1. To understand the complexity of microbial structures, and metabolism

2. Enable to grasp the mechanisms the microbial transport systems and the modes and mechanisms of energy conservation

Total Hours: 48

MODULE 1: ENZYMOLOGY 12 Hrs
Introduction, properties, nomenclature and classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups and IsozymesEffect of temperature, pH and substrate concentration on reaction rate.
Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Regulation of enzymes - Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors – competitive non-competitive and uncompetitive. Ribozymes and abzyme

MODULE 2: MICROBIAL METABOLISM 12 Hrs
Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways, HMP shunt/pentose phosphate pathway and ED. TCA and Electron transport chain TCA: Substrate and oxidative phosphorylation. Transamination, oxidative deamination, decarboxylation, Urea cycle.
Fermentation: Anaerobic respiration, Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid.
Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: PHOTOSYNTHESIS AND BIOENERGETICS 12 Hrs
Bacterial photosynthesis: Photosynthetic micro-organisms photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation (purple and green bacteria), Carbon dioxide fixation pathways. Chemoautotrophy oxidation of inorganic compounds – Nitrate and sulphate.
Bioenergetics: Free energy, ATP, NAD, FAD, FMN and its production, other high energy compounds, Oxidation – Reduction reactions. Electron transport chains in some anaerobic bacteria.

MODULE 4: MICROBIAL CELL MEMBRANE PHYSIOLOGY 12 Hrs

Metabolite transport: Structure of biological membranes, Function of membrane proteins, solute transport across cell membranes (osmosis), regulation of ion concentrations (Hypotonic, Hypertonic and Isotonic solution), Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion - PTS, and role of permeases in transport

Stress physiology: Osmotic stress and osmoregulation, Oxidative stress – superoxide dismutase and catalase, pH stress and acid tolerance, Thermal stress and heat shock response, Nutrient stress and starvation stress

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
7. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
8. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
10. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
11. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BS1201
TITLE OF THE COURSE : BIOINFORMATICS AND BIOSTATISTICS
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To create general interest in applied domain towards using computers for biological applications.

2. To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.

3. To give holistic view for understanding the scientific validation and biomodeling.

COURSE OUTCOMES:

1. Student will be aware of various applied and allied scientifically domains to innovative and creative think.
2. Student will be aware of the computer tools andapplications which can be implemented in biological sciences.
3. Students will be empowered for better prospects leading to project design and execution.

Total Hours: 48

MODULE 1 **12 Hrs**

Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer software, operating system (Windows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). **Introduction to networks:** LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire- walls. Concepts on encryption of data.

Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).

MODULE 2 **12 Hrs**

Bioinformatics (Genomics):

Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.

MODULE 3 **12 Hrs**

Bioinformatics (Proteomics):

Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis.

Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.

MODULE 4 **12 Hrs**

Biostatistics: Introduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc.NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BT1271**
TITLE OF THE COURSE : **IMMUNO-TECHNIQUES – PRACTICAL**
L : T : P : S/P : C : **0: 0: 4: 0 : 2**

COURSE OBJECTIVES:

1. To acquaint the student with some basic techniques in immunology, to sensitize them to antigen antibody reactions and their applications
2. To enable the students to get hands on learning to count viable cell in a hemocytometer and enable them to learn staining and identification of different white blood cells from the peripheral blood.

COURSE OUTCOMES:

1. Student will be familiarized with immunological techniques utilized for diagnostic assays.
2. Student will be able to use hemocytometer to do cell counting and be able to stain and identify leucocytes from peripheral blood.

1. Blood group identification and Rh Typing
2. Precipitation Reactions –
    I. Radial Immuno Diffusion
    II. Ouchterlony double diffusion
    III. Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins
5. Introduction to instruments and laboratory set up for animal biotechnology
6. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
7. Study of different cells in whole blood using Giemsa/Leishman stain.

REFERENCES:

1. Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
2. Hay, F.C., Westwood, O.M.R., 2002. Practical Immunology, 4th edition. ed. Wiley-Blackwell, Malden, MA.
3. Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20CY1271
TITLE OF THE COURSE : SYNTHESIS AND ANALYSIS OF ORGANIC COMPOUNDS PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES:

1. Students will determine various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. Students will determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. Students will perform Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

COURSE OUTCOMES:

1. The students will be able to perform the various physical properties like density, specific gravity, molar mass, and transition temperature of some of the organic compounds.
2. The students can determine distribution coefficients of binary mixtures, effect of surfactants on surface tension of water, determination of hardness of water. and dissolved oxygen. 3. The students will be sell versed with Paper chromatography, TLC and Column Chromatography for separation of organic dyes.

1. Determination of the density using specific gravity bottle and viscosity of a liquid using Ostwald's viscometer.
2. Determination of the density using specific gravity bottle and surface tension of a liquid using Stalagmometer.
3. Determination of molar mass of a non-electrolyte by Walker-Lumsden method.
4. Determination of transition temperature of a salt hydrate by thermometric method.
5. Determination of distribution coefficient of benzoic acid between water and toluene.
6. Effect of surfactants on the surface tension of water (Stock solution to be given).
7. Estimation of hardness of water by EDTA method.
8. Study the variation of co-efficient of viscosity with different concentration of Poly Vinyl Alcohol (PVA) and determine molar mass of PVA.
9. Determination of percentage of sodium chloride by miscibility temperature method.
10. Paper chromatography: Separation of Methyl red and methylene blue.
11. Thin layer chromatography: Separation of green leaf pigments/separation of a mixture of two organic compounds.
12. Column Chromatography: Separation of Methyl red and methylene blue.

REFERENCES:

1. Advanced Organic Chemistry, O. S. Bahl and A. Bahl., S. Chand & Co. 1995

2. Advanced Organic Chemistry, J. March, John Wiley & Sons, 2008.
3. Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
4. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 2015
5. Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.

SEMESTER/YEAR : II SEM/ I YEAR
COURSE CODE : 20MB1271
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY - PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES:
1. To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES:
1. Student will be equipped with coloured based changes given out by microbial tests

1. Starch hydrolysis (1 unit)
2. Gelatin hydrolysis (1 unit)
3. Catalase test (1 unit)
4. Sugar/Triple fermentation test (1 unit)
5. Nitrate reduction test (1 unit)
6. H_2S production test (1 unit)
7. IMViC test (4 Unit)
8. Oxidase test (1 unit)
9. Isolation of antibiotics resistant mutant by gradient plate technique (1 unit)
10. Demonstration of replica plating method for selection of antibiotic resistant mutants (1 unit)

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
5. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
6. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BS1202
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L : T : P : S/P : C : 2: 0: 04: 0 : 2

TOTAL HOURS: 24

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems 4 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: 8Hrs

Data processing & presentation: Introduction, Office Automation Software (Open Source Software).

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 4: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological

databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCES:

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20MB1101
TITLE OF THE COURSE : BASIC MICROBIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

Total Hours: 48

COURSE OBJECTIVES:

1. To know the importance of microorganisms for our global society

2. To understand the structural and functional characteristics of prokaryotic and eukaryotic cells with their classification
3. To study the basic techniques for isolation, culturing and identification of prokaryotic microorganisms and their importance
4. To study eukaryotic microorganisms in detail and to know their importance

COURSE OUTCOMES:

1. Provides a strong acquaint in fundamental aspects of basic microbiology
2. Enable to understand the diversity of microbial, structure, function and their environment
3. Awareness about economic importance of microorganisms
4. Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.

MODULE 1: HISTORY AND MICROBIAL SYSTEMATICS 12Hrs

Development of microbiology as a discipline, spontaneous generation and biogenesis. Contributions of Antony von Leeuwenhoek, Joseph Lister, Edward Jenner, Louis Pasteur, Robert Koch, Alexander Fleming, Sumbunath Dey, Ananda Chakroborty and Sir Ronald Ross in the field of Microbiology. Scope and disciplines of microbiology. Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems. Brief account of Bergey's manual of bacteriology. Criteria for the classification of bacteria. General account of microbiome.

MODULE 2: MICROBIAL TECHNIQUES 12Hrs

Microscopy: Principles of resolution and magnification. Types- optical and electron microcopy – Basic principle, sample preparation, applications and limitations of Simple, Compound, Dark field, Phase contrast, Confocal, Atomic force microscope (Toppling & sliding mode), Fluorescence and Electron Microscope-TEM and SEM).

Staining techniques: Principles of staining, bacterial and fungal staining methods.

Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic).

Microbial Nutrition and kinetics: Growth curve, Macro- and Micronutrients, Factors influencing the growth of microbes. Measurement of microbial growth.

MODULE 3: PROKARYOTIC MICROBIOLOGY **12Hrs**

Difference between prokaryotic and eukaryotic microorganisms.

Virology: General structure and characteristics of viruses, cultivation of viruses, general replication of viruses – lytic and lysogenic cycle with examples (TMV and Lambda phage), significance of viruses, viroids and prions.

Bacteriology: Size, shape and arrangement. Ultrastructure of bacteria and functions in detail - Slime layer & Capsule (*Kelbsiella*), Flagella, Pilus/ Fimbriae (*E. coli*), Cell wall (Gram positive and negative), Cytoplasmic membrane, Cytoplasmic inclusion bodies, Nuclear material, Plasmids and episomes, Ribosomes and Endospore (*Bacillus /Clostridium*). Reproduction – Binary fission and genetic exchange in bacteria (Conjugation, transformation and transduction).

Special microbial forms: Actinomycetes, Spirochetes, Rickettsia, Chlamydiae. Introduction to Archaebacteria and extremophiles.

MODULE 4: EUKARYOTIC MICROBIOLOGY **12Hrs**

Fungi: General account of Fungi - General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization. Reproduction - asexual and sexual. Economic importance of fungi. Type study of Zygomycetes (*Rhizopus*), Ascomycetes (*Aspergillus*), Basidiomycetes (*Agaricus*) and Deuteromycetes (*Fusarium*).

Algae: General characteristics of algae including occurrence, thallus organization, algae cell ultrastructure. Reproduction and life cycles-vegetative, asexual and sexual reproduction. Economic importance of algae. Type study of Cyanophyta (*Spirulina*), Chlorophyta (*Chlamydomonas and Spirogyra*), Rhodophyta (*Gracillaria*).

Protozoa: General characteristics with special reference to *Amoeba, Trypanosoma, Plasmodium, Paramecium.*

REFERENCES:

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
6. Cappuccino and Sherman Microbiology. A Laboratory Manual. 4thEdtn 1999.
7. Dubey, R.C. Microbiology 1st Edition. Chand and company
8. Edward Alcamo. Microbiology. Cliffs Notes 1996.
9. Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.

10. Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.
11. Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005
12. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1986.
13. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
14. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.
15. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
16. Salle, A.J. Principles of Microbiology, 2nd edition., 1997, Mc Graw Hill.1997.
17. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
18. Stainer, R.Y., et al., General Microbiology 5th edition MacMillan Press.2005
19. Tortora, Funke and Case. Microbioloy, 9th Edition. Benjamin Cummings. 2009
20. Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : I SEM / I YEAR

COURSE CODE : 20BC1101
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:
1. To familiarize the students with basic concepts, principles of conformation and energy transfer in biological systems.

2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:
1. The students will understand basic concepts like properties of Water, pH, buffers, conformation, energy transfer and know the chemistry behind metabolic biological reactions.

2. The students will have an understanding of structure and property of biomolecules so that they will have a better understanding of metabolism of biomolecules in higher semesters.

TOTAL HOURS: 48

MODULE 1 **12 Hrs**

Water and Buffers: Modern concepts of acids and bases; Ionization of acids. Dissociation of water and ionic product of water, Hydrogen bonding properties of water, Definition and determination of pH and associated numerical; Common ion effect with examples, Buffer preparation by H-H equation, buffer types. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.

MODULE 2 **12 Hrs**

Conformation and energy transfer

Stereoisomerism: Optical isomerism: Chirality, Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula. Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3 **12 Hrs**

Carbohydrates and lipids

Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples;

Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid
Lipids: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.

MODULE 4 **12 Hrs**

Amino acids and nucleic acids

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins

Nucleic acid: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7th Ed
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 20GN1101
TITLE OF THE COURSE : BASIC GENETICS
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To gain insight on the historical perspective of the evolution of genetics.
2. To comprehend and identify the different types of mendelian and non-mendelian inheritance.
3. Understand how sex determines the inheritance pattern of genes and the influence of extrachromosomal inheritance.

COURSE OUTCOMES:

1. Students will have clarity to the background of genetics before getting into details in the forthcoming semesters.
2. They will be capable differentiate between mendelian and non mendelian inheritance sources along with associated intricacies.
3. Student will gain the ability to analyse and relate phenotype to genotype and potential factors influencing the interaction.

TOTAL HOURS: 48

UNIT I : HISTORY OF GENETICS AND MENDELIAN PRINCIPLES 12 Hrs

Pre- formation, History and scope of Genetics, Pre- Mendelian genetic concepts epigenesis, pangenesis, germplasm theory. Mendel- Life and his experiments on pea plants. Principle of Dominance(Dominance and Recessiveness); Laws of Inheritance and their applications. Monohybrid Cross, Dihybrid Cross, Back Cross, Test Cross.

UNIT II : EXTENSIONS OF MENDELISM AND GENE INTERACTIONS 12 Hrs

Co-dominance and incomplete dominance - definition, examples. Multiple allelism- definition, Eye color in Drosophila, Blood groups and Rh factor in Human; Allelic series; Lethal alleles; Multi-factorial inheritance- Skin colour in Humans; Penetrance and Expressivity; Plieotropy. Epistasis-dominant, recessive. Supplementary and Complementary gene interactions; Non epistatic inter allelic gene interaction, Position effect.

UNIT III : SEX DETERMINATION AND EXTRA CHROMOSOMAL INHERITANCE 12 Hrs

Chromosomal theory of Inheritance - Concepts and evidences. Mechanism of sex determination- XX-XY; XX-XO; ZZ-ZW; Bridges genetic balance theory. Environmental and hormonal control of sex determination Gynandromorphs / Intersexes, Super sexes in Drosophila. Sex differentiation and dosage compensation (Drosophila and Man).Sex linked and sex limited traits in Humans. Hemophilia, Hypertrichosis. Extra Chromosomal inheritance, flower colour in Mirabilis jalapa,

kappa particle in Paramecium, sigma factor in Drosophila, Cytoplasmic Male Sterility (CMS) in maize.

UNIT IV : MODEL ORGANISMS IN GENETICS 12 Hrs

Bacteria - *E.coli*; Viruses - Tobacco Mosaic Virus; Bacteriophage - Lambda Phage; Fungi- Neurospora species , *N crassa*, *Saccharomyces cerevisiae;* Nematode - *Caenorhabditis elegans*, Plant - Arabdosis thaliana, Fly - *Drosophila melanogaster*, Fish - Zebra fish (*Danio rerio*) , Mammal - Mice (*Mus musculus*) and Rat (*Rattus rattus*) .

TEXT BOOK :

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFERENCES:

1. Mathew Hamilton , (2009) Population Genetics, Wiley-Blackwell
2. Snustad D. P., Simmons M. J., Principles of Genetics. 5th Edition (2008) John Wiley & Sons.
3. Brooker R. B., Genetics Analysis and Principles. Fourth Edition (2009) McGraw-Hill.
4. Tamarin R. H., Principle of Genetics. Seventh Edition. (2002) Tata-McGraw Hill.
5. Hart D and Jones E.W., Genetics Principles and Analysis. 4th Edition (1998) Jones and Bartlett Publication.
6. Atherly A. G., Girton J. R. and Donald M. C. J. F. The Science of Genetics (1999) Sounders College Publication / Harcourt Brace.
7. Sturtevant A. H., A History of Genetics (1965). Harper and Row New York. Mendel G. The First Geneticist by Orel V. (1996) Oxford University Press, New York.
8. Ross S. A first course in Probability. 4th Edition (1994). McMillan, New York.
9. Stansfield W. D., Theory and problems of Genetics (Schaum s Outline Series). (2002) McGraw Hill.
10. Stubbe H., History of Genetics (1972). Harper and Row New York.
11. Prasad S. Fundamentals of Biostatistics (1993). Emkay publications, New Delhi.
12. Khan and Khanum. Fundamentals of Biostatistics. II Revised Edition. (2004). Ukaaz Publication.

SEMESTER/YEAR : **I SEM / I YEAR**
COURSE CODE : **20BS1101**
TITLE OF THE COURSE : **BASIC CHEMISTRY**
L : T : P : S/P : C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES

1. To make the students to understand basic facts and concepts in chemistry while retaining the exciting aspects of chemistry so as to develop interest in the study of chemistry as a discipline.

2. To make the students to familiarize with the basic concepts related to modern atomic theory, quantum chemistry, acids and bases, chemical bonds in molecules and basics of organic chemistry and different organic reactions.

COURSE OUTCOMES

1. Students will have a firm foundation in the fundamentals and application of Chemistry and Chemical theories including those in Analytical, Inorganic, and Organic.

2. The student will understand the importance of the modern atomic theory, quantum chemistry, acids & bases and basics of organic chemistry.

TOTAL HOURS: 48

MODULE 1: GENERAL CHEMISTRY **12 Hrs**

Handling of analytical data:
SI and CGS units of measurements and physical constants and their inter conversion; Significant figures and calculations, accuracy, precision and errors in quantitative analysis.
Stochiometry: atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts**.**

Acids and Bases:
Theories of acids and bases – Arrhenius - Bronsted-Lowry theory - Lewis theory -Solvent system definition. Relative strengths of acids and bases – Dissociation constant of acids and bases - Levelling effect of water. Hard and soft acids and bases (HSAB). Non-aqueous solvents – classification - Liquid ammonia as solvent. Acid-base equilibria in aqueous solution and pH. Acid- base neutralisation curves; indicator, choice of indicators.

MODULE 2: ATOMIC STRUCTURE **12 Hrs**
Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's

equation-derivation, Heisenberg's uncertainty principle.
Hydrogen atomic spectra. Need of a new approach to Atomic structure.
Elements of Quantum chemistry- Schrodinger wave equation and meaning of various terms in it. Significance of ψ and $\psi 2$, Schrödinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Quantum numbers and their Significance. Shapes of *s*, *p* and *d* atomic orbitals, nodal planes. Rules for filling up of electrons in various orbitals (Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity and n+l rule), Electronic configuration of the elements (up to Z=30) and anomalous electronic configurations. Stability of half-filled and completely filled orbitals- concept of pairing and exchange energy.

MODULE 3: CHEMICALBONDING **12 Hrs**

Introduction: Need for the atoms to form molecules, and types of chemical bonds with examples
IonicBond: Definition and conditions for formation of an ionic bond between atoms, examples of formation of an ionic compound between alkali metal/ alkaline earth metals and chalcogen/halogen group elements. Lattice energy, its effect on stability and solubility of ionic solids, Born – Haber cycle for NaCl, KBr, KI, and MgO and CaCl2).
Covalent Bond: Definition, octet rule, Lewis dot formulae of a few simple molecules and ions, electron deficient and excess molecules (BeCl2, BF3, PCl5, SF6).
Geometry of covalent molecules: (VSEPR concept and hybridisation concepts) basic concepts and definitions: Examples simple inorganic molecules and ions. such as NH3, H2O, H3O+, SF4, ClF3.
Theories of covalent bonds (VBT and MOT): Valence bond theory (VBT): postulates and its limitations, directional characteristics of covalent bonds, Application of VBT to BeCl2, BF3, SiCl4, PCl5, SF6molecules.
Molecular orbital theory: postulates, linear combination of atomic orbitals (LCAO), bonding, nonbonding and antibonding molecular orbitals, pictorial representation of formation of s and p MOs from the corresponding atomic orbitals, Molecular orbital energy level diagram and molecular orbital configuration involving s and p orbitalst heir importance for the following molecules, (H2, N2, O2, HF and CO).
Metallic Bond: Definition, properties of metals and band theory.
Weak Intermolecular interactions: van der walls forces, dipole-dipole interactions and their significance.
Hydrogen Bond: Definition, types, importance

MODULE 4: BASICS OF ORGANIC CHEMISTRY **12 Hrs**
Representation of structural formula of organic compounds: condensed formula and bond line formula of organic compounds, classification of organic compounds based on functional groups with examples.

IUPAC nomenclature: IUPAC nomenclature of organic compounds including Bifunctional compounds and substituted benzenes. (o, p and m).
Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects) and hyper conjugation.
Reactive intermediates: Types of bond cleavage, curly arrow rules in representation of mechanistic steps; electrophiles, nucleophiles, carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples.
Types of organic reactions: Types of organic reactions with examples (electrophilic/ nucleophilic substitution/addition/free radical reaction with examples.

Aromaticity: Kekule structure of benzene - molecular orbital picture of benzene – resonance energy and stability of benzene - Huckel's rule (aromatic, non-aromatic, and antiaromaticmolecules) - aromaticity of benzene and benzenoid compounds – aromaticity of three
, four, five, six, seven and eight-membered systems - annulenes.

REFERENCES:

1. Principles of Inorganic chemistry: Puri and Sharma
2. Principles of Physical chemistry: Puri and Sharma
3. Organic chemistry: T.W. Graham Solomons.
4. A New Concise Inorganic Chemistry", J. D. Lee, 5th Ed, Chapman & Hall, London (1996).
5. Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Ed. Prentice Hall, India (1992)
6. Physical chemistry, 9th Ed., Peter Atkins and Julio de Paula, Oxford University Press (2009)
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Ed. Karen C. Timberlake, Benjamin Cummings, (1999).
9. Reaction Mechanisms at a glance, (Ed.) M. Moloney, Blackwell Science (2000).
10. Basic Inorganic Chemistry", F. A. Cotton, G. Wilkinson, and Paul L. Gaus, 3rd Ed, John Wiley & Sons, New York (1995).

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20MB1171
TITLE OF THE COURSE : BASIC TECHNIQUES IN MICROBIOLOGY
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To enable students to understand the microbial structure, microbial growth pattern and techniques to measure cell size.

2. To help them understand the isolation of various microorganisms from different sources.

COURSE OUTCOMES:

1. Students are aware of microbial diversity and isolation techniques.

2. Students will be equipped with fundamental knowledge of microbial growth patterns and kinetic studies enabling them to apply the same in various allied fields.

1. Study of basic instruments in Microbiology laboratory (2 Units)
   Autoclave, Hot air oven, Incubator, pH meter, High speed centrifuge, Colorimeter / Spectrophotometer, Anaerobic jar, Bacterial Filters, Laminar air flow

2. Preparation of culture media:
a) Basal media (Nutrient agar and broth, Czapekdox media and MRBA)
b) Selective media (EMB agar and McConkey agar),
c) Enriched media (Blood agar).

3. Isolation of bacteria and fungi by serial dilution technique from soil, water and air.

4. Methods of pure culture techniques
a) Pour plate technique
b) Spread plate technique
c) Streak plate technique

5. Transfer of media and inoculum
a) Slant culture technique
b) Broth culture technique
c) Stab culture technique

6. Microscopic examination of bacterial smear
a) Simple staining
b) Gram's staining
c) Capsule staining
d) Endospore staining

7. Isolation and identification of fungi (Lactophenol cotton blue mount)

8. Micrometry: Microscopic measurement of bacterial cell (*Bacillus*), yeast (*Saccharomyces).*

9. Microscopic observation of temporary slides
   - *a.* Algae: *Chlamydomonas* and *Spirulina*
   - *b.* Fungi: *Rhizopus*, *Aspergillus, Penicillium,* Yeast and *Fusarium*
   - *c.* Protozoa: *Amoeba, Paramecium* and *Plasmodium*

10. Study of growth curve of bacteria by turbidometric method

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
5. Prescott, L.M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, NY.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BC1171
TITLE OF THE COURSE : BASIC BIOCHEMISTRY PRACTICAL
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To familiarize the students with good lab practise and how to make buffers.
2. To create general understanding about detection of biomolecules.

COURSE OUTCOMES:

1. The students will be familiarized with handling laboratory equipment like weighing balance, pH meter and potentiometer and learn the importance and preparation of buffers.
2. They will have an understanding of biomolecule composition of edible materials.

1. Calculation and preparation of buffers
2. Potentiometric titration of potassium hydrogen phthalate/HCl and sodium carbonate
3. Potentiometric titration of HCl and sodium bicarbonate/ sodium hydroxide
4. Potentiometric titration of amino acid against NaOH and HCl
5. Estimation of proteins milk.
6. Estimation of carbohydrates in vegetables (Potatoes etc)
7. Estimation of lipids in milk/vegetables (avocadoes etc)
8. Estimation of iodine number of edible oils
9. Estimation of ascorbic acid in fruits by titrimetric method.

REFERENCES:

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7th ed
2. An Introduction to practical Biochemistry—Plummer D. T, Tata Mc Graw Hill

SEMESTER/YEAR : I SEM/ I YEAR
COURSE CODE : 20GN1171
TITLE OF THE COURSE : BASIC GENETICS PRACTICAL
L : T : P : S/P : C : 0 : 0 : 4 : 0 : 2

COURSE OBJECTIVES:

1. To differentiate between the various stages of meiosis in animal and plant cells.
2. To gain insight as to the different genetic interactions and their effect on phenotype.

COURSE OUTCOMES:

1. Students will gain skills to process tissue into slides and distinguish various meiotic stages.
2. Students will be capable to analyse and identify gene interactions, predict crosses and understand its role in inheritance.

1) Temporary squash preparation of : Grasshopper Testes, Onion flower bud [2 units]
2) Observation of meiotic stages in permanent slides [1 unit]
3) Blood Typing [1 unit]
4) Sex differentiation in Drosophila [2 units]
5) Detection of sex chromatin bodies: Preparation of Barr bodies from bucal smears.
6) Genetic problems on : (a) Probability (b) multiple alleles (c) Gene interactions (d) Sex Linkage [2 units]
7) Study of : (a) Flower color in *Mirabilis jalapa* (b) Coat color in Mice (c) Comb pattern in fowl. [2 units]

REFERENCES :

1. Brooker, R. J. 1999. Genetics: Analysis and Principles. Benjamin Cummings, Longman, INC.
2. Gardner E. J. M. J. Simmons and D.P. Snustad 1991 Principles of Genetics. John Wiley & Sons. INC.New York.
3. Klug, W. S. and M. R. Cummings 1994 Concepts of Genetics MacMillan Colley Publishing and Company NY.
4. Strickberger M. W. 1996. Genetics. Mac Millan Publishing Co. NewYork
5. Tamarin,. R H. 1999. Principles of Genetics. McGraw-Hill.

SEMESTER/YEAR : II SEM/ I YEAR
COURSE CODE : 20MB1201
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:
1. The major features of growth and metabolism of microorganisms including determination of growth with environmental influence on the microbial growth and primary and secondary metabolism

2. Energy source for microorganisms and relationship between metabolism and energy source

COURSE OUTCOMES:
1. To understand the complexity of microbial structures, and metabolism

2. Enable to grasp the mechanisms the microbial transport systems and the modes and mechanisms of energy conservation

Total Hours: 48

MODULE 1: ENZYMOLOGY 12 Hrs
Introduction, properties, nomenclature and classification, specificity, active sites, coenzymes, activators and inhibitors, activity unit-prosthetic groups and IsozymesEffect of temperature, pH and substrate concentration on reaction rate.
Enzymes kinetics: Michaelis-Menten equation for simple enzymes, Regulation of enzymes - Covalent and noncovalent modification; Enzyme inhibition - types of inhibitors – competitive non-competitive and uncompetitive. Ribozymes and abzyme

MODULE 2: MICROBIAL METABOLISM 12 Hrs
Primary metabolism: Breakdown of carbohydrates – Glycolytic pathways, HMP shunt/pentose phosphate pathway and ED. TCA and Electron transport chain TCA: Substrate and oxidative phosphorylation. Transamination, oxidative deamination, decarboxylation, Urea cycle.
Fermentation: Anaerobic respiration, Fermentative modes in microorganisms – alcoholic, Lactic acid – hetero and homo and Acetic acid.
Secondary metabolism: Overview and importance of secondary metabolites - antibiotics, aflatoxins, carotenoids

MODULE 3: PHOTOSYNTHESIS AND BIOENERGETICS 12 Hrs
Bacterial photosynthesis: Photosynthetic micro-organisms photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation (purple and green bacteria), Carbon dioxide fixation pathways. Chemoautotrophy oxidation of inorganic compounds – Nitrate and sulphate.
Bioenergetics: Free energy, ATP, NAD, FAD, FMN and its production, other high energy compounds, Oxidation – Reduction reactions. Electron transport chains in some anaerobic bacteria.

MODULE 4: MICROBIAL CELL MEMBRANE PHYSIOLOGY 12 Hrs

Structure of biological membranes, Function of membrane proteins, solute transport across cell membranes (osmosis), regulation of ion concentrations (Hypotonic, Hypertonic and Isotonic solution), Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion - PTS, and role of permeases in transport

Stress physiology: Osmotic stress and osmoregulation, Oxidative stress – superoxide dismutase and catalase, pH stress and acid tolerance, Thermal stress and heat shock response, Nutrient stress and starvation stress

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Atherly, A.G., Girton, J.R. and Mc Donald, J.F. 1999. The Science of Genetics. Diane Pub. Co.
3. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
4. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
5. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
6. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
7. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.
8. Nelson David L. and Cox Michael M. 2007. Lehninger - Principles of Biochemistry. Fourth edition. MacMillan Press/Worth Publishers, New Delhi.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York. Stickberger, M.W. 2012. Genetics, Prentice Hall of India Private Limited, New Delhi.
10. Voet, D. and Voet, J.G. 2010. Biochemistry. John Wiley and Sons, New York.
11. Wilson, K., and Walker, J. 2010. Principles and Techniques of Biochemistry and Molecular Biology. 7th edition. Cambridge University Press.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BC1201**
TITLE OF THE COURSE : **BIOANALYTICAL TECHNIQUES**
L: T/A: P: C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES:

1. To create general understanding about fundamentals of biomolecules, their structure, function and analysis.
2. To familiarize the students with basic concepts and principles of biophysical and biochemical techniques used in biological sciences.
3. To give holistic view for understanding the screening, isolation, separation and characterization of molecules.

COURSE OUTCOMES:

1. Student will be scientifically equipped with understanding of the about the different biomolecules and their important functions.
2. Student will be aware of the analytical tools and their instrumentation used in biotechnology/biological sciences.
3. Students will be empowered for better prospects leading to project design and execution.

Total Hours: 48

MODULE 1 **12 Hrs**

Spectroscopy: Wave particle duality, the concepts of electromagnetic spectrum, Concepts of Absorbance and Emission Spectroscopy, Beer-Lambert's law, application and its limitations. Extinction coefficient, Concepts of chromophore/auxochrome and Chromic shifts. Principle, schematics and applications of Colourimeter and UV-Vis Spectroscopy. Assay of biomolecules (Carbohydrates and Proteins). Principle, schematics and application of Luminometry, Tubidometry, Klett Photometry, Flame photometry and IR spectroscopy.

MODULE 2 **12 Hrs**

Chromatography

History and principle of Chromatography. Distribution/partition coefficient, Absorption and Adsorption phenomenon, Retention factor (Rf & Rt concepts). Types: Planar and columnar, S-L, L- L, G-S, G-L and G-G. Paper and thin layer chromatography, types and their application in separation of biomolecules. Plate theory and Rate of theory; resolution, selectivity and effectiveness of columns, Types of matrices used, separation of biomolecules using gel permeation,ion exchange, affinity and adsorption chromatography with applications. Brief idea about High Performance Liquid Chromatography (HPLC) and Gas Chromatography (GC).

MODULE 3 **12 Hrs**

Electrophoresis: Migration of ions in electric field, Factors affecting electrophoretic mobility. Paper electrophoresis, Cellulose acetate electrophoresis, High voltage electrophoresis and their Applications. Gel electrophoresis - Types of gels, Procedure, for gel making. Detection, Recovery & characterization of macromolecules (molecular weight determination and subunit enumeration). Principle and application of Poly acralamide Gel Electrophoresis (PAGE), Iso-electric focussing (IEF) and 2D-PAGE, Submerged agarose gel electrophoresis (SAGE). Application of electrophoresis in molecular biology (genomics, transcriptomics and proteomics).

MODULE 4 **12 Hrs**

Isotopic tracer technique: Radioactive & stable isotopes, Pattern and rate of radioactive decay. Measurement of radioactivity: Geiger-Muller counter, Solid & Liquid scintillation counters (Basic principle, instrumentation & technique), Autoradiography their advantages and limitations.

Centrifugation: Basic principles, RCF, Svedberg constant and Sedimentation coefficient. Preparative centrifugation: Differential & density gradient centrifugation, Applications. Analytical centrifugation: Determination of molecular weight of biomolecules.

Immunological techniques: Immuno-diffusion, immuno-electrophoresis and immuno-fluorescence.

TEXT BOOKS:

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.

REFERENCE BOOKS:

1. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
2. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
3. Handbook of Analytical Techniques – Gunzler and Williams. Wiley &Sons.
4. Immunology – Kuby. Freeman Publishers.
5. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER /YEAR : II SEM / I YEAR
COURSE CODE : 20GN1201
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 4 : 0 : 0 : 0 :4

COURSE OBJECTIVES :

1. Understand the characteristics of chromosome and its related anomalies.
2. Elucidation on the versatility of the chromosomes and its different interactions.

COURSE OUTCOMES :

1. Students will learn details on chromosomes , its conformations to bring about genetic variability.
2. The students will get insight on chromosome abnormality which leads to cytogenetic aberrations and disease.

TOTAL HOURS: 48

MODULE I - CHROMSOME CHARACTERISTICS 12Hrs

Physical basis of inheritance : chromosome theory of inheritance, Eukaryotic Chromosome- Macro-molecular organisation. Primary and Secondary constriction, Sat-bodies, telomeres, chromosome types. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Ideogram. Special types of chromosomes : Polytene chromosome- Salivary gland chromosome in Drosophila, Lamp- brush chromosome in amphibian Oocyte, B Chromosome.

MODULE II - LINKAGE 12 Hrs

Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc. Sex Linkage : Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in Drosophila.

MODULE III - CROSSING OVER 12Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in Drosophila. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks.

MODULE IV - CHROMOSOMAL ABERRATIONS 12Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes. Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

TEXT BOOK :

1. Verma P. S. Cell Biology, Genetics, Molecular Biology: Evolution and Ecology (2006). S Chand Publishers.
2. Strickberger M. W., Genetics. (1968) Macmilla Publishers.

REFRENCES :

1. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
2. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
3. Weaver R. F., Hendrick P. W. and Brown W.C. 1992. Genetics, 2nd Edition.
4. Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.
5. Snustad D. P. and Simmons M. J. 2009. Principles of Genetics. John Wiley and Sons, INC.
6. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
7. Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
8. Gardener E. J., Simmons M. J. and Snustad D. P. 1998. Principles of Genetics J. Wiley and Sons pubs.
9. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : **II SEM / I YEAR**
COURSE CODE : **20BS1201**
TITLE OF THE COURSE : **BIOINFORMATICS AND BIOSTATISTICS**
L: T/A: P: C : **4 : 0 : 0 : 0 : 4**

COURSE OBJECTIVES:

1. To create general interest in applied domain towards using computers for biological applications.
2. To familiarize the students with basic concepts and principles statistics and their applications in biological sciences.
3. To give holistic view for understanding the scientific validation and biomodeling.

COURSE OUTCOMES:

1. Student will be aware of various applied and allied scientifically domains to innovative and creative think.
2. Student will be aware of the computer tools andapplications which can be implemented in biological sciences.
3. Students will be empowered for better prospects leading to project design and execution.

Total Hours: 48

MODULE 1 **12 Hrs**

Introduction to computers: History of Computers, Components of computers (Hardware, Software and accessories). Concepts on Computer soft indows), tools and applications of MS Office (notepad, word processor, spread sheet & presentation). **Introduction to networks:** LAN, MAN & WAN, Network protocols- Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security- Group polices Fire- walls. Concepts on encryption of data.

Relational Databases Management (RDMS): Codd Rules and concepts of databases, Data mining and applications, accessing bibliographic databases and Basics on citation and indexing (Pub Med and Google scholar).

MODULE 2 **12 Hrs**

Bioinformatics (Genomics):

Nucleic acid sequence databank – NCBI, EMBL and DDBJ. Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Gene Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs.

MODULE 3 **12 Hrs**

Bioinformatics (Proteomics):

Introduction to protein structure – Primary, secondary structure prediction, tertiary structure prediction. Concepts on Protein Data Bank (PDB). Protein Sequence alignment - Global and Local, Similarity searching (FastA and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of proteins, domain and motif and Phylogenetic analysis.

Protein sequence databank – NBRF-PIR, SWISSPROT and Swiss ExPASy. Metabolic pathway data bank (KEGG/Pub gene). Protein modeling - principles of homology and comparative modeling phylogenetics. Applications - Molecular docking – Patchdoc /Autodoc.

MODULE 4 **12 Hrs**

ntroduction to Biostatistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error. Sampling methods and their significance. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Statistical package - Features of statistical software. Introduction to statistical software (SPSS/ Graphpad/ SigmaPlot/ ImageJ) Databases.

TEXT BOOKS:

1. Daniel (1999). Biostatistics (3 edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Bioinformatics. Keith, J. Humana Press, 2008.
4. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.

REFERENCES:

1. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists.
2. Bazin, M.J. (1983). Mathematics in microbiology Academic press.
3. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
4. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge.
5. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York. Wiley and Sons, Inc.NY.
6. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
7. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series.
8. Higgins & Taylor (2000). Bioinformatics, OUP.
9. Baxavanis (1998). Bioinformatics.
10. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford

SEMESTER/YEAR : II SEM/ I YEAR
COURSE CODE : 20MB1271
TITLE OF THE COURSE : MICROBIAL PHYSIOLOGY PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES:
1. To make students learn quantitative and qualitative methods for study of biomolecules in microbiology lab.

COURSE OUTCOMES:
1. Student will be equipped with coloured based changes given out by microbial tests

1. Starch hydrolysis (1 unit)
2. Gelatin hydrolysis (1 unit)
3. Catalase test (1 unit)
4. Sugar/Triple fermentation test (1 unit)
5. Nitrate reduction test (1 unit)
6. H_2S production test (1 unit)
7. IMViC test (4 Unit)
8. Oxidase test (1 unit)
9. Isolation of antibiotics resistant mutant by gradient plate technique (1 unit)
10. Demonstration of replica plating method for selection of antibiotic resistant mutants (1 unit)

REFERENCES

1. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
2. Boyer, R.F. 2003. Modern Experimental Biochemistry. Third Edition. Pearson Education.
3. Cappuccino, J.G., and Sherman, N. 1999. Microbiology a Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
4. David, W. 2000. Physiology and Biochemistry of Prokaryotes. Second Edition. Oxford University Press.
5. Griffin, D.H. 1993. Fungal Physiology. Second Edition. Wiley Liss- A John Willy & Sons, Inc, Publication. USA. p: 1-458.
6. Moat, A.G. and Froster, S.W. 2002. Microbial Physiology. Fourth Edition. John Wiley and Sons, New York.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BC1271
TITLE OF THE COURSE : BIOANALYTICAL SEPARATIONS PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES:

1. To make students learn quantitative and qualitative methods for study of biomolecules.
2. To provide hands-on training to physico-chemical methods.
3. To give insights on isolation, separation and characterization of biomolecules.

COURSE OUTCOME:

1. Student will be equipped with methodology to study biomolecules using spectroscopic, electrophoretic and chromatographic techniques.
2. Students will have a complete understanding on methods to analyse biomolecules.
3. Students will be empowered for better prospects leading to project design and execution.

1. Determination of extinction coefficient using colorimetry.
2. Determination of lambda maximum of biomolecules using UV spectroscopy.
3. Estimation of protein by Lowry method or Estimation of sugar by Miller method.
4. Estimation of pKa of amino acid (glycine).
5. Determination of density & viscosity of given unknown solution.
6. Circular Paper chromatography for amino acid/ sugars and Rf calculations.
7. Separation of amino acid by Thin Layer Chromatography (TLC).
8. Column chromatography of phyto-pigments on adsorbent (silica/alumina).

REFERENCES

1. Principles and Techniques of Practical Biochemistry – Keith Wilson and John Walker. Cambridge low price edition.
2. Biophysical Chemistry – Upadhyay, Upadhyay and Nath. Himalaya Publications.
3. Analytical Techniques in Biochemistry and Molecular biology – Katoch. Springer.
4. Fundamentals of Analytical Chemistry - Skoog, Holler and West. Saunders.
5. Handbook of Analytical Techniques - Gunzler and Williams. Wiley & Sons.
6. A Textbook of Practical Biochemistry- Joshi and Saraswat. Jain Publishers.

SEMESTER /YEAR : II SEM / I YEAR
COURSE CODE : 20GN1271
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS PRACTICAL
L : T : P : S/P : C : 0: 0: 4: 0 : 2

COURSE OBJECTIVES :

1. Identifying chromosome features and their status in animal and plants.
2. Analyse linkage and crossing over problems by mapping method.
3. Understanding cytogenetics using Drosophila as a model organism

COURSE OUTCOMES :

1. The student will gain skill to prepare and visualise chromosomal slides from various sources.
2. Students can solve genetic linkage analysis by construct ion of cytogenetic maps on linkage.
3. Students will become skilled in handling and maintaining Drosophila cultures.

1. Micronuclei from buccal cell (H&E basic staining)
2. Preparation of Metaphase spreads from blood for Karyotyping.
3. Genetic Problems on linkage & crossing over - Drosophila, Maize, Human (Sex Linkage)
4. Study of chromosomal aberration using karyotype information by observation of permanent slides of chromosomal aberrations.

Cytogenetics using Drosophila as a model organism.

5. Culturing and Handling of Drosophila - Media preparation, Handling drosophila.
6. Study of different types of Drosophila- Body color mutant- Ebony body and Yellow body,Wing mutant- Curly wing and vestigial wing and Eye color mutant- Bar eye, white eye, sepia eye.
7. Mounting of Sex Comb and Genital plate of Drosophila melanogaster
8. Salivary gland Chromosome - Dissection of Salivary glands and preparation of polytene chromosome.

REFERENCES:

1. Drosophila Cytogenetics Protocols, Methods in Molecular Biology, Volume 247, Daryl S Henderson, Humana Press.
2. The AGT Cytogenetics Laboratory Manual, Marilyn S Arsham, Margaret J , March , Helen J Lawce, Fourth Edition, Wiley Blackwell.

SEMESTER/YEAR : II SEM / I YEAR
COURSE CODE : 20BS1202
TITLE OF THE COURSE : COMPUTER APPLICATIONS AND INFORMATION TECHNOLOGY
L : T : P : S/P : C : 0: 0: 4: 0 : 2

TOTAL HOURS: 24

MODULE 1: History and Generations of Computers 4 Hrs

Evolution, Generations of computers (I, II, III,IV, V) Classification of computers (mainframes, mini computers, microcomputers, special purpose) Comparison with respect to memory, power, cost and size, Real-Time, Online, Offline ,Overview and functions of a computer systems, Input and output devices, Storage devices: Hard disk, Diskette, Magnetic tape, RAID, ZIP, devices, Digital tape, CD-ROM, DVD (capacity and access time), Main Circuit Board of a PC: Chips, Ports, Expansion.

MODULE 2: Categories of Computers and Operating Systems 4 Hrs

The workstation, The Minicomputer, Mainframe Computers, Parallel processing Computer & the Super Computer, Operating System concepts, Windows 98/XP and later versions, Windows server NT/2000, Unix/Linux & servers. Introduction to networking: various terminologies, Associated hardware devices, gadgets (Router, Switch) tools, services, and resources, Network Topologies and Protocols, LAN, WAN and MAN World Wide Web (WWW) Network security: fire walls.

MODULE 3: 8Hrs

Data processing & presentation: Introduction, Office Automation Software (Open Source Software).

Computer viruses and Internet Searches: An overview of Computer viruses, What is a virus? Virus symptoms, How do they get transmitted? What are the dangers? General Precautions, Search engines: Google, Yahoo, Concepts in text-based searching, searching Medline, PubMed, and bibliographic databases.

MODULE 4: Algorithms, Flowcharts, Programming concepts & Bioinformatics 8 Hrs

Algorithms: Concepts & definitions, Converting algorithms to flowchart; Coding: flowcharts to programs, Comparing algorithms, flowcharts & programs; Introduction & Overview of Biological databases. Introduction to Bio-informatics: Definition, Introduction to data mining, Computational

gene finding – multiple alignment and sequence search (BLAST, FASTA, CLUSTALW). Applications of Bioinformatics

REFERENCES:

1. Computer Fundamentals , 4th edition (2004) P.K. Sinha, BPB publication, India
2. Computer Networks. 4th edition (2008). Tanenbaum. Pearson Education, India
3. Biostatistics: P.N. Arora ,P.K. Malha.
4. Introduction to Database Management Systems, 1st edition, (2004), Atul Kahate, Pearson education, India.

SEMESTER/YEAR: **III SEM**
COURSE CODE: **19MBT5321**
TITLE OF THE COURSE: **PLANT BIOTECHNOLOGY**
L: T: P: C **3: 0: 0: 3**

Course Objectives:

- To equip the students with fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- To familiarize the students with knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Course Outcomes:

- The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.
- The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.

Total hours: 40 Hrs

MODULE I: Plant Tissue Culture **10 Hrs**

Scope and Importance of plant tissue culture; Totipotency; Media composition and types, hormones and growth regulators, Organogenesis; Micropropagation; Somatic embryogenesis and its applications; Somaclonal variation; Anther culture for haploid production and its applications in plant breeding;

Protoplast isolation; Culture and usage; Somatic hybridization - methods and applications; Cybrids. Cell cultures for secondary metabolite production

MODULE II: Genetic Transformation Techniques for plants 10Hrs

Agrobacterium-plant interaction; organization of Ti and Ri plasmids; T-DNA transfer; Disarming the Ti plasmid.

Agrobacterium-mediated transformation; Cointegrate and binary vectors and their utility; viral based vectors. Direct gene transfer PEG-mediated, electroporation, particle bombardment and alternative methods; Screenable and selectable markers; stability of transgene; Transplastomic technology; Marker-free methodologies; Gene editing by TALLEN and Crispr techniques

MODULE III: GM Technology and Plant Trait improvement 10 Hrs

GM Strategies for Biotic and Abiotic Stress Resistance/Tolerance, Herbicide, bacterial and fungal resistance crops

Concept of bio factories; Production of pharmaceutical proteins Plantibodies, vaccines and industrial enzymes in plants. Metabolic engineering for oil

improvement, Crop improvement and fortification of agricultural crops–Bt cotton, Bt brinjal, transgenic sweet potato and Golden rice. Ethical, regulatory and environmental issues associated with GM crops and GM food;

MODULE IV: Molecular Breeding: Molecular Mapping & Marker Assisted Selection 10 Hrs

Molecular markers: RFLP, RAPD, SCAR, STS, AFLP, and SNP markers; Construction of genetic and physical map; Quantitative and qualitative characters. MAS for genes of agronomic importance, e.g. insect resistance, grain quality and grain yield; QTL mapping and cloning. Application of Molecular Markers: Genotyping tools as plant variety protection, hybrid purity tests.

REFERENCES

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and Madhav Aadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
7. Halford N.G. Plant biotechnology: current and future applications of genetically modified crops. John Wiley Publishers.2006

SEMESTER/YEAR : III SEM
COURSE CODE : 19MBT5322
TITLE OF THE COURSE : ANIMAL BIOTECHNOLOGY
L: T: P: C : 4: 0: 0: 4

Course Objectives:

1. To acquaint the students with the basic concepts of animal cell culture set up and conditions.
2. To Equip the students with fundamentals of gene transfer methods for mammalian cells and animal transgenics followed by important applications of animal biotechnology

Course Outcome:

1. Will learn about basic animal cell culture conditions and its uses.
2. Be able to describe techniques and problems both technical and ethical in animal cloning.
3. Will be equipped with the wide area of applications of biotechnology in modern world.

Total hours: 40 Hrs

MODULE I: Basics of Animal Tissue Culture
10 Hrs

Introduction, cell culture laboratory-design and layout. Equipment and Instrumentation. Methods of sterilization, Detection of Mycoplasma and viral contaminants, types of culture media, composition, preparation. Serum and protein free defined media. Role of CO_2, Serum, supplements, Culture and maintenance of primary and established cell lines. Biology of cultured cells: Culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, cytotoxicity.

Module II: Stem Cells
10 Hrs

Stem cells – Adult, embryonic, Induced pluripotent stem cells. Stem cells from adult organs- Characteristics, isolation, culture and characterization protocol, long-term maintenance and characterization. Tissue engineering, biomaterials used in tissue engineering, three-dimensional culture and transplantation of engineered cells

Module III: Transgenic animals
10 Hrs

Methods involved in the production of transgenic animals, importance and applications of transgenic animals. Gene knock out and mice models for tackling human diseases. IVF- technology for livestock and humans. Bioethics associated with developing transgenic animals - Use of cell cultures as alternative for animal models for research. Animal and human cloning- ethical and social issues.

Module IV Applications of Animal Biotechnology
10 Hrs

Disease resistant, recombinant vaccines for poultry, livestock pharming products. Pharmaceutical products produced by mammalian cells - plasminogen activator, erythropoietin, blood clotting factors, interleukins, interferons, Cell culture-based vaccines.

Biosafety: The Cartagena protocol on biosafety. Good manufacturing practice and Good lab practices (GMP and GLP).

REFERENCES:

1. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell.
2. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
4. Molecular Biotechnology: 4th edition. (2010), Glick B.R., Pasternak J.J., Patten C. L., ASM press, USA
5. Ernst-L Winnacker, From Genes to Clones: Introduction to Gene Technology. WILEYVCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi. 2003
6. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pubons - Devlin, John Wiley & Sons, 7th Ed, 2010.

SEMESTER/YEAR : III SEM / 2nd YEAR
COURSE CODE : 19MBC5301
TITLE OF THE COURSE : METABOLISM II
L: T: P: C : 4: 0: 0: 4

Course Objectives:

1. Learning the role electron transport chain plays in connecting fuel breakdown and metabolism.
2. Learning about the metabolic reactions undertaken by living systems to breakdown lipids and nucleic acids for release of energy.

Course Outcomes:

1. Students will be able to comprehend the integration of metabolism, oxidative phosphorylation and ATP production.
2. They will have an in-depth idea about the role lipids play in energy storage and usage.
3. Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by nitrogen bases and fat to fuel to living systems.

Total hours: 52 Hrs

MODULE I: Bioenergetics **13** Hrs

Reduction Potential, Biological redox couplers, Mitochondrial electron transfer systemSequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F0F1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H+ pumping by bacteriorhodopsin.

MODULE II: Nucleotide Metabolism **13** Hrs

Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies

MODULE III: Lipid metabolism 13 Hrs.

Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidationeven, odd and unsaturated fatty acids by β-oxidation, scheme and energetics of βoxidation, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders.

MODULE IV: Cholesterol and Circulating lipids **13** Hrs

Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds, Non steroidal anti-inflammatory drugs (NSAIDs).

REFERENCES

1.Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.

2.Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.

3.Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed

4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010.

SEMESTER/YEAR : III SEM/ 2nd YEAR
COURSE CODE : 19MBC5321
TITLE OF THE COURSE : IMMUNOLOGY
L: T: P: C : 3: 0: 0: 3

Course Objectives:

1. To understand the role of different cells and organs of immune system.
2. To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
3. To understand the importance of immune system in disease and therapeutics.

Course Outcomes:

1. Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.
2. Student will gain fundamental knowledge about the consequences of immune system failure. They will also gain insights about the spread of cancer and its therapeutics

Total hours: 40 Hrs

MODULE I: Introduction and Innate Immunity 10 Hrs

Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity.

Innate immunity: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.

MODULE II: Antigen Antibody interactions 10 Hrs

Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins.

Antigen recognition by T cells: TH, TC and TReg cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.

MODULE III: Lymphocyte development and inflammation 10 Hrs

Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition.

Transplantation and Network theory: Transplant rejection, immunosuppressa nts. Immuno-surveillance, idiotypes and immune network theory.

MODULE IV: Pathoimmunology & immunotechniques 10 Hrs

Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis

Immuno-techniques: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immunoflorescence and flow cytometry.

REFERENCES

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).

2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).
8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57– 70 (2000).
9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER/YEAR : III SEM / 2nd YEAR

COURSE CODE : 19MBC5322

TITLE OF THE COURSE : MOLECULAR PHYSIOLOGY

L: T: P: C : 3: 0: 0: 3

Course Objectives:

1. Introduction to hormones and their function.
2. Understanding Nerve signalling and neurotransmitters.
3. To learn different nuclear signalling mechanisms along with importance and regulation of cell cycle.
4. Brief idea about Apoptosis and Cancer.

Course Outcome:

1. Students will have an idea as to how hormones control the physiology of an organism via signalling mechanisms.
2. They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.

Total hours: 40 Hrs

MODULE I: Endocrine signaling **10 Hrs**

Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine / serotonin); Ion– channel (ACh); Tyrosine kinase (RTK), [insulin] and Intrinsic enzyme / cytokine, receptors. Intracellular signaling proteins: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca2+, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.

MODULE II: Nerve signalling and neurotransmitters **10 Hrs**

Nerve signaling: Morphology of a neuron. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential. Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate/GABA) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles.

Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).

MODULE III: Nuclear signaling and Cell Cycle **10 Hrs**

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation.

Cell Cycle: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation.

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

MODULE IV: Apoptosis and Cancer **10** Hrs

Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases and JAK-STAT pathways). Concept of tumor suppressors.

References:

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey,(1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER/YEAR : III SEM
COURSE CODE : 19MMB5321
TITLE OF THE COURSE : ENVIRONMENTAL MICROBIOLOGY
L: T: P: S/P : C : 3: 0: 0: 3

Course Objectives:

1. The course makes students understand distribution of microorganisms in nature, their habitat and interaction with other organisms.
2. The course enables the students to understand the importance of microorganisms in the environment, their role in the biogeochemical cycles and also their applications. The beneficial and harmful microorganisms are studied which helps them to know the impact of microbes in the environment.

Course Outcomes:

1. Students will have fundamental understanding of the distribution and habitat of microorganisms in nature. They can apply the knowledge in studying microbial diversity in various environmental niches.
2. Students are aware of the role of microorganisms in the environment. They will have knowledge about both positive and negative aspects of microorganisms and their interaction with other organisms. The course helps them to apply knowledge in employing microbes in various fields.

Total Hours: 40

MODULE I: Soil Microbiology **10 Hrs**

Soil Microbiology: Soil as Dynamic system, Soil profile, Soil morphology; Biotic and abiotic interactions; Habitat and niche; Diversity and distribution (Rhizosphere, Mycorrhizosphere, Actinorhizae); Soil erosion and soil conservation; Microbial interaction in soil; Soil pathogens and soil microflora and human health. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle; Hg transformation.

Diversity in anoxic eco system: Methanogens-reduction of carbon monoxide- reduction of iron, sulphur, manganese, nitrate and oxygen. Microbial transformations of Carbon, Phosphorus, Sulphur, Nitrogen and Mercury.

MODULE II: Aquatic Biology and Sewage Treatment 10 Hrs

Aquatic Microbiology: Natural waters, Microbial flora of aquatic environment, Zonation of water system, Upwelling; Marine microbiology; Hydrothermal vents, Nutrients in aquatic environments; Water pollution and water borne diseases; Eutrophication; Water purification; Ground water types and contamination; Water quality assays and public health (SPC, MPN, MFT, ONPG and MUG).

Sewage treatment: Primary, Secondary and Tertiary treatment. Solid waste treatment (Landfills and Composting); Biogas production; Role of microbes in sewage treatment; Methanogens and methylotrophs. Newer approaches to sewage treatment and Enzyme technology for treating Industrial waste water; Application of Recombinant DNA Technology in wastewater treatment.

MODULE III: Aerobiology **10 Hrs**

Air microflora in different layers of atmosphere, bioaerosol; Microbiology of indoor and outdoor air; Significance of microorganisms in air; Enumeration of microorganisms in air (Impingement in liquids, Impingement in solids, suction and filtration); Control of air borne microorganisms. Molecular methods of air quality assessment; The Greenhouse effect, Ozone depletion, UV radiation and Acid rain. Aeroallergens and Allergies: Causes and tests for detection of aero allergens.

MODULE IV: Bioleaching and Biodegradation **10 Hrs**

Bioleaching: Principles, microorganisms and microbe-mineral interactions. Bioleaching of copper, uranium and gold; Dump, heap and bioreactor operations. Role of acidophilic microorganisms in environmental pollution.

Biodegradation: Biodegradation of xenobiotic compounds and Recalcitrant compounds, Mechanism and enzymes involved in biodegradation. Role of plasmids in biodegradation. Biodegradation of cellulose, lignin, paper and plastic. Hazards from xenobiotics. Microbiology of environmental remediation- Bioremediation. Soil and water 'in-situ' remediationEngineering developments - Constructed wet lands; Bioremediation of oils from contaminated

soils; Biosorption; Phytoremediation.

REFERENCES

1. Bhatia A.L. Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
2. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
3. Francis H Chapelle. Ground Water Microbiology and Geochemistry. 2nd Edition. ASM press.
4. Baker K.H and Herson D.S. Bioremediation. Mc Graw Hill Inc., New York. 1994.
5. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
6. Patrik, K. Jjemba. Environment Microbiology: principles and applications. Science Publishers.
7. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.
8. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.
9. Robert L Tate, Soil Microbiology,2ndEdition, John Wiley and Sons.
10. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
11. Grant W.D and Long P.E.Environmental Microbiology. Kluwer Academic Publishetrs, 1981.
12. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
13. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
14. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : III SEM
COURSE CODE : 19MMB5322
TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND PLANT PATHOLOGY
L: T: P: S/P : C : 3: 0: 0: 3

Course Objectives:

1. The course aims to impart knowledge about the interaction of microorganisms with plants, mainly crop plants. The beneficiary aspects of the microbes by helping the plant growth and also increasing the plant health by avoiding diseases and disorders are studied.
2. The course also deals with the plant diseases caused by microorganisms, where microorganisms play a major role in plant health and yield. Collectively, the course helps students to gain fundamental knowledge of role of microorganisms in agriculture.

Course Outcome:

1. The students will be equipped with knowledge about the importance of microorganisms in agricultural field. They can understand how to employ microorganisms to enhance agricultural productivity.
2. The knowledge of plant pathology will help students to understand microbial diseases in plants, so they understand disease predictions and the prevention measures.

Total Hours: 40

MODULE I: Plant-Microbe Interactions 10 Hrs

Distribution of microorganisms in soil, soil fertility evaluation and improvement. Role of microorganisms in soil fertility. Decomposition of organic matter by microorganisms: cellulose, hemicellulose, lignin, xylan and pectin. Biological nitrogen fixation: Symbiotic nitrogen fixation, (Rhizobium, Frankia), non-symbiotic nitrogen fixation (Azotobacter, Azospirillum). Concepts of siderophores and VAM with suitable examples. Application of nitrogen fixing genes in rDNA technology in agriculture research.

MODULE II: Bioinoculants and Biological Control 10 Hrs

Bioinoculants: Biofertilizer - types, production and quality control. Cultivation and mass production of bioinoculants- Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Phosphate solubilizing microorganisms and Azolla. Carrier-based inoculants – production, applications and limitations.

Biopesticides: Types and mechanism of application of different varieties. Examples includes Pseudomonas fluroscence, Bacillus thuringiensis, Trichoderma harzianum, Trichoderma viridae, Nuclear Polyhedrosis Virus. Production, applications and limitations.

MODULE III: Host Pathogen Interaction and Defense Mechanism 10 Hrs

Host Pathogen Interaction: Infectious diseases, non-infectious diseases, Koch's postulates. Parasitism and pathogenicity, Host range of pathogens, Disease triangle, Diseases cycle/Infection cycle, Relationship between disease cycles and epidemics; Mode of entry into the host plant-mechanical forces, microbial enzymes, toxins and growth regulators.

Defense Mechanisms: Plant Disease Pre-existing structural and chemical defenses. Induced structural (histological-cork layer, abscission layer, tyloses, gums) and biochemical defences (hypersensitive response), systemic acquired resistance phytoalexins, pathogenesis related (PR) proteins, PGPR and plantibodies.

MODULE IV: Plant Diseases and Their Management 10 Hrs

Plant diseases- Red rust of tea (Algae), Grain and head smut of Sorghum (Fungi), Root knot of mulberry (Nematode). Papaya ring spot (Virus), Sandal Spike Disease (Mycoplasma), Citrus canker (Bacteria).

Plant disease control: Classification of plant diseases and plant diseases control. Principles

and methods in disease control – Legislative methods (quarantine, crop certification), cultural methods (host eradication, crop rotation, and sanitation), soil and sand treatment (Controlling water flow, adding fertilisers, filtering water.), biological control (Suppressive soil and microbial antagonism) and chemical control (fungicides) Control through resistant varieties and quarantine. Plant disease epidemics and forecasting, plant clinic and plant doctor concept.

Diagnosis of plant diseases, regulatory, farming education and awareness.

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi
12. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006
13. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
14. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
15. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004.
16. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer

SEMESTER/YEAR : III SEM
COURSE CODE : 19MMB5371
TITLE OF THE COURSE: IMMUNOLOGY, MEDICAL AND INDUSTRIAL MICROBIOLOGY
L: T: P: S/P : C : 0: 0: 6: 0 : 3

Course Objectives:

1. To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents
2. To impart basic understanding of principles, and key concepts relevant to industrial microbiology

Course Outcomes:

1. To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories.
2. The course will enable the student to apply the knowledge in various aspects of fermentation or industrial microbiology

PRACTICALS

1. Isolation and identification of normal microflora on simple, selective and enrichment media (throat, skin, sputum, nasal and urine sample).
2. Dental caries susceptibility assay by Snyder's agar test
3. Serological reactions:

a) Agglutination - Blood grouping and Rh typing

b) Precipitation reactions:

i. Ouchtlerlony Double Diffusion,

ii. Radial Immune Diffusion

4. Assay for susceptibility and resistance of antibiotics by Kirby Bauer method.
5. Isolation of lymphocytes from peripheral blood
6. Identification of different types of blood cells
7. Production and estimation of amylase from microbial sources
8. Production of organic acids (lactic acid and citric acid) from microbes
9. Detection and quantification siderophore produced by Pseudomonasspp.
10. Study of different types of fermenters (Models/ Charts)
11. Immobilization technique: whole cell or enzyme- sodium alginate gel method

REFERENCES

1. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York.
2. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical
Medical Microbiology, Churchil Livingstone.
3. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press.
4. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher.
5. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd edition. Oxford university press.
6. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, Practical

Medical
Microbiology, Churchill living stone.
7. Casida L.E.J.R (2015) Industrial Microbiology, New Age International, New Delhi.
8. Prescott S.C and Dunn C.C (2005) Industrial Microbiology, 4th Edition CBS Publishers and Distributors, New Delhi.
9. Stanbury PF, Whitakar A and Hall SJ (1999) Principles of Fermentation Technology, 2nd Edition Aditya Books (P) Ltd, New Delhi.
10. Waites Michael J., Morgan Neil., RockeyJohn S and GrayHigton, Industrial Microbiology-An
Introduction, Blackwell Science. Delhi
11. WulfCrueger (2016) A Textbook of Industrial Microbiology First CBS Publishers and Distributors Edition.
12. Robert Mellor (2009) Entrepreneurship for Everyone: A student Textbook. SAGE Publication

SEMESTER/YEAR : IV SEM / II YEAR

COURSE CODE : 19BY2471

TITLE OF THE COURSE : ENZYMOLOGY -LAB

L: T/A: P: C : 0: 0: 4: 2

COURSE OBJECTIVES:

1. To introduce students to various practical aspects of enzymology; and give them hands on learning in function and kinetics of enzyme and their role as catalyst and regulator of cell metabolism.
2. Serve as foundation for more advanced enzymology courses.

COURSE OUTCOMES:

1. The student will be able to perform basic calculations required to determine enzyme activity
2. The student will be able to perform and deduce the effects of various parameters on enzyme activity with reasoning
3. The student will have general idea of enzyme immobilization

PRACTICALS

1. Introduction to enzymology Lab and product curve determination
2. Isolation of enzymes (amylase/ phosphatase) from biological source and activity determination through time curve
3. Determination of kinetic constants through LB plot
4. Effect of pH on enzyme activity
5. Effect of temperature on enzyme activity
6. Determination of Arrhenius constant
7. Effect of enzyme dilution on enzyme activity
8. Effect of activators and inhibitors on enzyme activity
9. Immobilization of enzyme using calcium alginate.

5

5

REFERENCES:

1. Practical enzymology – Hans Bisswanger, Wiley-VCH, 2019, 3 rd Ed
2. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001, 1st Ed
3. Principles and Techniques of Practical Biochemistry – Wilson, Wilson and Walker,

Cambridge University Press 2000, revised Ed
4. Introduction to practical Biochemistry, Plummer, Tata McGraw-Hill Education 2001, 2nd Ed
5. Basics of Enzyme Immobilization – Alka Dwevedi, Springer International Publishing, 2016, 1 st Ed

MESTER/YEAR : III SEM / II YEAR

COURSE CODE : 19BS2403

TITLE OF THE COURSE : BIOINFORMATICS

L: T/A: P: C : 2: 0: 0: 2

COURSE OBJECTIVES:

1. To give students an introduction to the basic practical techniques of bioinformatics and to emphasis on to the application of bioinformatics and biological databases to problem solving in real research problems.
2. To familiarise with the use of a wide variety of internet applications, biological database and to able to apply these methods to research problems.

COURSE OUTCOMES:

1. The students will be able to describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches, and analyze and discuss the results in light of molecular biological knowledge
2. The students will be able to predict the secondary and tertiary structures of protein sequences. Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation.

Total Hours: 26

MODULE I: BASICS ON COMPUTERS AND NETWORKING 13 Hrs

Introduction to Computer: History of Machines. Hardware and software components of computers. Operating system - Windows, Application software - Word processor, Spread sheet and power point presentation. Introduction to statistical software (Graphpad/ ImageJ).

Introduction to Computer Networks: LAN, MAN & WAN, Network protocols - Internal protocol (TCP/IP), File transfer protocols (FTP), WWW, HTTP, HTML, URL. Network Security - Group polices Fire-walls.

Basics on Bioinformatics:Definition, history and scope of Bioinformatics. Introduction to primary and secondary data and their databases. Relational Databases Management (RDMS) and Codd Rules. Data mining and applications, accessing bibliographic

4

9

databases: Google scholar, Pubmed – NCBI EMBL and DDBJ. Protein and genomic sequence databank. Structural databases - protein data Bank (PDB), UniProt, NBRF – PIR and SWISSPROT.

MODULE II: BIOLOGICAL DATABASES AND THEIR APPLICATIONS 13 Hrs

Types of Databases: Metabolic pathway data bank (Pub gene), KEGG, Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb) and Restriction mapping - NEB CUTTER.

Sequence Alignment: Types - Global and Local, Similarity searching (Fasta and BLAST), Pair wise comparison of sequences, Multiple Sequence alignment of sequences (MSA), alignment, scoring matrices. Identification of proteins/genes in genomes and phylogenetic analysis with reference to nucleic acids and protein sequences,

Identification of ORFs, Identification of motifs and domains.
Protein Structure and Molecular Interaction
Introduction to protein structure – primary, secondary structure prediction (GOR), protein modelling - principles of homology and comparative modelling with their applications. Concepts of molecular docking with specific example for drug-target interaction and structure-activity relationship (SAR) studies.

REFERENCES:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F. Doolittle, Academic Press, 1996.
3. Bioinformatics. Sequence and genome analysis. D.W. Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Higgins & Taylor (2000). Bioinformatics, OUP.
7. Fry, J.C. (1993). Biological Data Analysis. A practical Approach. IRL Press, Oxford.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 19CY2371
TITLE OF THE COURSE : ORGANIC SYNTHESIS AND ANALYSIS - LAB
L: T/A: P: C : 0: 0: 4: 2

OBJECTIVES:

1. To train the students in basic laboratory skills such as recrystallization, melting point determination, distillation and sublimation.
2. To train the students in laboratory synthesis techniques through synthesis of simple organic compounds.
3. To train the students in systematic analysis of unknown organic compounds.

OUTCOMES:

1. Students will learn about basic purification techniques such as recrystallisation, sublimation and distillation and finding out purity through melting point determination.
2. Students will gain knowledge about organic synthesis techniques by preparing compounds like aspirin, nitrobenzene, dibenzalacetone.
3. Students will gain knowledge about analysis of organic compounds and finding out given unknown organic compound.

PRACTICALS

1. Recrystallisation and determination of melting point of solids (mixed melting point determination and its importance may be mentioned).
2. Simple distillation and determination of boiling point of liquids (At least five compounds).
3. Purification of solids by sublimation. (Benzoic acid / Napthalene)
4. Systematic analysis of organic compounds.
5. Preparation of aspirin from salicylic acid.
6. Preparation of dibenzalacetone from benzaldehyde
7. Preparation of m-dintrobenzene from nitrobenzene.

REFERENCES:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication.
3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Fransicisco, Elsevier Publication.
4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing.
5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert Academic Publishing.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 19BY2371
TITLE OF THE COURSE : CLINICAL BIOCHEMISTRY -LAB
L: T/A: P: C : 0: 0: 4: 2
COURSE OBJECTIVE:
1. To provide a basic understanding and applied knowledge of the clinical biochemistry
2. To introduce the principle of colourimetric estimation of biomolecules
COURSE OUTCOME:
1. Students will be able to perform colourimetric assays along with handling a colourimeter
2. Students will be able to draw amount vs absorbance graphs and calculate amount of unknown samples, also develop a basic idea about the range of diagnostic techniques relevant to the field of laboratory medicine
PRACTICALS
1. Qualitative analysis of normal and abnormal components of urine –urea, uric acid, creatinine, ketone, sugar and protein.
2. Estimation of acidity of urine by titrimetric method
3. Estimation of Protein/DNA by UV absorption.
4. Estimation of Protein by Folin - Ciocalteu method,
5. Estimation of Iron by Ossian's method
6. Estimation of Phosphate by Fiske – Subbarow's method
7. Estimation of Creatinine by Jaffe's method
8. Estimation of Glucose estimation by Miller's method
9. Estimation of Calcium by Collins and Clark Method
REFERENCES :

1. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house 2001.
2. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
3. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 19GN2301
TITLE OF THE COURSE : FUNDAMENTALS OF CYTOGENETICS
L: T/A: P: C : 4: 0: 0: 4
COURSE OBJECTIVES :
1. To learn the details of the chromosome and its associated anomalies.
2. Elucidation on the versatility of the chromosomes.

COURSE OUTCOMES :
1. Student will learn details on chromosomes and understand its versatile nature to conform genetic variability.
2. The students will get insight as how abnormality in chromosome can have cytogenetic aberrations leading to disease.

Total Hours: 44

MODULE I: CHROMSOME CHARACTERISTICS 11 Hrs

Physical basis of inheritance : chromosome theory of inheritance, Eukaryotic Chromosome- Macro- molecular organisation. Primary and Secondary constriction, Satbodies, telomeres, chromosome types. Heterochromatin and Euchromatin and its significance. Ultra structure of chromosome, Nucleosome model and Nucleosome Structure. Karyotype and Ideogram. Special types of chromosomes : Polytene chromosome- Salivary gland chromosome in Drosophila, Lamp-brush chromosome in amphibian Oocyte, B Chromosome.

MODULE II: LINKAGE 11 Hrs

Introduction and definition of Linkage, Discovery of linkage, Coupling and Repulsion hypothesis, Linkage group- Drosophila, maize and man, Types of linkage-complete linkage and incomplete linkage, Factors affecting linkage - distance between genes, age, temperature, radiation, sex, chemicals, nutrition, etc. Sex Linkage : Meiotic behavior of chromosome and non- disjunction. Bridges theories of non-disjunction. Sex linkage in Drosophila.

MODULE III: CROSSINGOVER 11 Hrs

Crossing over- definition and types of crossing over-germinal and somatic crossing over. Cytological basis of crossing over- Sterns experiments in Drosophila. Mechanism of crossing over - chiasma type theory, the breakage first theory, the contact first theory, strain or torsion theory. Molecular mechanism of crossing over- Holliday model, single strand breaks.

MODULE IV - CHROMOSOMAL ABERRATIONS 11 Hrs

Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy). Polyploidy, Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomes, Nullisomes and Trisomes.

Structural- Deletions, Duplication, Translocation, Inversions, Centric fusion and centric fission. Evolutionary significance of chromosomal aberrations. Genetic diseases and disorders.

REFERENCES :

1. Gupta P. K. 2009. Cytology, Genetics and Molecular Biology. Rastogi Publications.
2. Winter P. C., Hickey G. I. & Fletcher H. L. 2003. Instant notes in Genetics. Viva Books Pvt.Ltd.
3. Weaver R. F., Hendrick P.W. and Brown W.C. 1992. Genetics, 2nd Edition.
4. Sinha U., Sunita and Sunita Sinha.1981 Cytogenetics: Plant Breeding and evolution. Vikas publishing House.

5. Snustad D. P. and Simmons M. J.2009. Principles of Genetics. John Wiley and Sons, INC.
6. Phundan Singh. 2013. Elements of Genetics, Edition 4, Kalyani Publishers.
7. Edgar Altenburg. 1970. Genetics. Oxford & IBH Publications.
8. Gardener E. J., Simmons M. J. and Snustad D. P.1998. Principles of Genetics J.Wiley and Sons pubs.
9. Obe. G. and Natarajan A.T. 1990 Chromosomal Abberrations: Basic and Applied aspects Springer Verlag, Berlin.

SEMESTER/YEAR : III SEM / I YEAR

COURSE CODE : 19MB2301

TITLE OF THE COURSE : MICROBIAL DIVERSITY AND KINETICS

L: T/A: P: C : 4: 0: 0: 4

COURSE OBJECTIVES:

1. Deliberate existing theories about the origin of life, microbial evolution and systematics
2. Make simple calculations of microbial growth kinetics in batch and continuous culture and describe how microbial growth can be controlled

COURSE OUTCOMES:

1. The course will enable students to relate the principles in classifying microbial systems and know their beneficial and harmful effects.
2. Enable to apply this knowledge in microbial biotechnology starting from screening of desired microbe.

MODULE I – PROKARYOTIC MICROBIOLOGY 11Hrs

Bacteriology:Ultra structure of Bacteria: Classification, Structure external to the cell wall- Slime layer, Capsule, Flagella, Pilus/ Fimbriae. Cell wall, Cytoplasmic membrane; Cytoplasmic inclusion bodies. Bacterial Chromosome, Plasmids and episomes, Ribosomes, Exospores, Endospore and Cysts. General account of Archaebacteria, Actinomycetes.

Virology: Classification, General structure, characteristics, cultivation and replication of viruses. Type study: classification, structure, replication, cultivation and application of - TMV and Lamada phage. Viroids and Prions.

MODULE II -PHYCOLOGY 11Hrs

Classification, General characteristics of algae including occurrence, thallus organization. Algal Ultrastructure, pigments, flagella, eyespot food reserves. Reproduction: vegetative, asexual and sexual. Types of life cycles: Haplontic, Diplontic, Haplobiontic and Diplobiontic. Type study of Cyanophyta (Spirulina), Chlorophyta (Spirogyra), Rhodophyta (Gracillaria). Economic importance of algae.

MODULE III –MYCOLOGY AND PROTOZOOLOGY 11Hrs

Fungi: Classification, General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal cell wall structure and synthesis. Reproduction asexual and sexual. Type study of Zygomycetes (Rhizopus), Ascomycetes (Aspergillus), Basidiomycetes (Agaricus) and Deuteromycetes (Fusarium). Economic importance of fungi.

Protozoa: General characteristics of protozoa. Type study - Amoeba, Paramecium, Plasmodium.

MODULE IV- GROWTH KINETICS 11Hrs

Definition of microbial growth, factors affecting microbial growth (pH, temperature, oxygen concentration, pressure and radiations). Cell division, Growth curve of

bacteria, kinetics of growth. Mathematics of growth-generation time and growth rate constant. Measurement of growth: Measurement of cell numbers- Counting chambers, electronic counters, viable counting techniques, membrane filter technique. Measurement of cell mass- dry weight and turbidity measurement. Measurement of cell activity, Batch culture, Continuous culture - Chemostat and Turbidostat. Synchronous culture.

REFERENCES

1. Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2007. Introductory Mycology. ; Fourth edition, Wiley India Private Limited
2. Aneja, K.R. 2014. Laboratory Manual of Microbiology and Biotechnology. Medtec
3. Atlas R.M. Microbiology- Fundamentals and applications, Macmillan Publishing Company, New York.
4. Benson, H. J. 1994. Microbiological Application. WCB McGraw-Hill of India Private Limited.
5. Brock, T. D. and Madigan, M.T. 1996. Biology of Microorganisms. Prentice Hall of India Private Limited.
6. Cappuccino, J.G., and Sherman, N. 1999. Microbiology - A Laboratory Manual. Fourth Edition. The Addison Wesley Longman, Inc England.
7. Pelczar, M. J., Chan E.C.S. and Krieg N.R. 1993. Microbiology. McGraw Hill Book Company, New York.
8. Pommerville, J.C. 2007. Alcamo's Fundamentals of Microbiology. Eighth Edition. Jones and Bartlett Publishers, USA.
9. Prescott, L. M., Harley, J.P. and Klein, D.A. 2011. Microbiology. WCB McGraw-Hill, New York.
10. Salle, A. J. 1984. Fundamental Principles of Bacteriology. Tata McGraw-Hill Publishing Company Limited, New Delhi.
11. Sharma, O. P. 1986. Text Book of Algae. Tata McGraw-Hill Education.
12. Stanier R.Y., and Ingraham J.L. 1991. General Microbiology. Prentice Hall of India PrivateLimited, New Delhi.
13. Vashishta, B.R. 2010. Botany for Degree Students – Algae. S. Chand and Co.

SEMESTER/YEAR : III SEM / II YEAR
COURSE CODE : 19CY2301
TITLE OF THE COURSE : ADVANCED CHEMISTRY-I
L: T/A: P: C : 4: 0: 0: 4
OBJECTIVES:

1. To impart knowledge of advanced chemistry topics such as s & p block elements, liquid and solutions, thermodynamics and aliphatic organic compounds.
2. To make students to understand about liquid state of matter, different properties of liquids, laws governing liquids and colligative properties and their applications.
3. To make the students to know about the salient features of alkali and alkaline earth metals and also the chemistry behind p-block elements.
4. To make students understand fundamental concepts of thermodynamics, thermodynamic laws, heat engine, efficiency, entropy etc.
5. To give knowledge about different aliphatic organic compounds such as alkanes, cycloalkanes, alkenes, alkynes and dies, their properties, synthesis, reactions and important applications.

OUTCOMES

1. Students will be familiar with the basic knowledge of the liquids and solutions and their applications in analytical chemistry. Students will develop the ability of effectively solving practical problems of analytical chemistry of non-aqueous solutions.
2. Students will learn the descriptive chemistry of representative elements of s- and pblock elements and recognize the differences in their reactivity, chemical and physical properties
3. Students will get the knowledge of different concepts of thermodynamics, thermodynamic laws, heat engines, efficiency, entropy etc.
4. Students will gain knowledge about aliphatic hydrocarbons, their properties, synthesis methods, reactions and applications in different fields.

Total Hours: 44

MODULE I: S & P BLOCK ELEMENTS 11 Hrs

Hydrogen:Unique position of hydrogen in the periodic table, isotopes of hydrogen, ortho and para hydrogen, Industrial production of hydrogen by chemically assisted electrolysis and Steam reforming.

Heavy water: Physical properties (with comparison to light water), Applications.

Hydrogen bonding: definition, types, importance.

s – block elements: Occurrence, extraction by igneous fusion methods & uses of s-block elements. Comparative study of alkali & alkaline earth metals with respect to Physical properties: density, melting points & boiling points, flame coloration. Solubility of ionic compounds in relation to lattice energy and hydration energy. complexation tendencies of alkali metals. Characteristics of oxides and basicity of hydroxides.

p – block elements: Halides of boron, relative strength of BF3, BCl3 & BBr3 as Lewis acids, diborane-preparation, structure & bonding.

Halogens:Size of atoms & ions, ionization energy, electronegativity, oxidation states and oxidizing power. Types of interhalogen compounds-preparation and structure of IF3, IF5 & IF7.

Silicates: Structure of SiO_4^{-}
, Classification of silicates based on the structure. Zeolites:
their structure and applications.

MODULE II: LIQUIDS AND SOLUTIONS 11 Hrs

Properties of liquids

Viscosity- Definition, mathematical expression, Coefficient of viscosity, effect of temperature, size, weight, shape of molecules and intermolecular forces on it.

Surface Tension-Definition, mathematical expression, effect of temperature and solute on It Parachor-Definition, Sugen equation, calculation and applications. Numerical problems.

Liquid Mixture: Review of Raoult's law, ideal and non-ideal solutions.

Completely miscible liquids-Fractional distillation Tc curves for all the three types, azeotropic mixtures -examples.

Completely miscible liquids-Critical solution temperature (Three types), examples. Effect of addition of salt on CST of phenol-water system.

Immiscible liquids-Steam distillation and its applications.

Distribution law-Statement, partition coefficient and condition for validity of distribution of distribution law. Application-solvent extraction

Dilute solutions-Review of colligative properties and concentration terms

Determination of molecular mass of a solute by: (i) Berkeley-Hartley's method (ii) Beckmann's method and (iii) Landsberger's method. Numerical problems.

MODULE III: THERMODYNAMICS -I11 Hrs

First law of thermodynamics: Review of terms, Exact and inexact differentials, I law of Thermodynamics. Work done (derivation with problems) in isothermal and adiabatic expansion and compression of an ideal gas (IUPAC sign conventions to be used).

Heat capacity of a gas at constant pressure and constant volume: relation between P, V and T in an adiabatic process to be derived. Numerical problems.

Spontaneous and non-spontaneous processes.

Second law of thermodynamics: Limitations of I law of thermodynamics with illustrations. Need for II law of thermodynamics, different ways of stating II law with respect to heat and spontaneity. Other forms of II law of thermodynamics. Concept of entropy and its physical

significance-illustrations with order, disorder, physical and chemical processes and probability.

Heat engine-Carnot's cycle and derivation of the expression for its efficiency. Problems based on efficiency equation. II law in terms of efficiency. Change in entropy in reversible and irreversible processes (derivations required). Calculation of entropy changes in reversible isothermal and reversible adiabatic processes. Phase transitions in terms of Entropy (Fusion, vaporization, sublimation and polymorphic changes) in terms of entropy. Limitations of the entropy concept of spontaneity.

MODULE IV: ALIPHATIC HYDROCARBONS 11 Hrs

Alkanes: Sources, Nomenclature of branched chain alkanes, preparation of symmetrical and unsymmetrical alkanes- Corey- House reaction and Wurtz reaction - their merits and demerits. Conformational analysis of n-butane - Sawhorse and Newman projection formulae to be used -Energy profile diagram.

Cycloalkanes: Nomenclature. Method of formation. Explanation for stability based on heat of hydrogenation data, Baeyer's strain theory and its limitation, Sachse - Mohr theory of strain-less rings; cyclopropane ring - banana bonds.

Alkenes: Preparation of alkenes by Wittig reaction-stereoselectivity. Addition of HX to unsymmetrical alkene - Markownikov's rule and Anti-Markownikov's rule with mechanism. Reactions: Hydroboration, oxidation, reduction, oxymercuration - demercuration, epoxidation. Oxidation with $KMnO_4$ – mechanism and OsO_4Ozonolysismechanism and importance.

Dienes: Classification- isolated, conjugated, cumulated. Structure of allene and butadiene.1,2 addition and 1,4 addition reactions. Diels Alder reaction-1,3-butadiene with maleic anhydride.

Alkynes: Methods of preparation - Dehydrohalogenation of vicinal and geminal dihalides; and higher alkynes from terminal alkynes. Reactions - metal ammonia reduction – significance. Oxidation with $KMnO_4$, acidic nature of terminal alkynes.

REFERENCES:

1. Advanced Organic Chemistry, O. S. Bahl and A. Bahl., S. Chand & Co. 1995
2. Advanced Organic Chemistry, J. March, John Wiley & Sons, 2008.
3. Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
4. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 201.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 19CY2401
TITLE OF THE COURSE : ADVANCED CHEMISTRY-II
L: T/A: P: C : 4: 0: 0: 4
OBJECTIVES:
1. To make students to understand about advanced thermodynamics concepts such as, free energy, its dependency on temperature and pressure, Clausisus-Clapeyron equation, Gibbs-Helmholtz equation and III law of thermodynamics.
2. To make students understand about the theories related to chemical reaction and learn about chemical kinetic concepts through experiments of inversion of cane sugar and reaction between potassium persulfate and potassium iodide.
3. To make the students to have knowledge about inert gases, their nature and their chemical reactions. To give knowledge about f and d block elements, their properties, reactions and applications.
4. To give knowledge about aromatic organic compounds, alcohols and its derivatives. To Make them understand about their properties, synthesis and different reactions.
OUTCOMES
1. Students will be well versed in with the advanced thermodynamic concepts such as free energy, Clausius-Clapeyron equation, Gibbs-Helmholtz equation, III law of thermodynamics and residual entropy.
2. Students will familiarize with various theories related chemical reactions and understand the chemical kinetics concepts through certain chemical reactions.
3. Students gain knowledge about inert gases and f & d block elements.
4. Students will get to know about aromatic compounds and alcohols, their properties and different reactions.
Total Hours: 44
MODULE I: THERMODYNAMICS &CHEMICALKINETICS 11 Hrs
Thermodynamics – 2: Free energy: Work function, chemical potential. Definition and relationship between free energy and work function. Criteria for equilibrium and spontaneous processes. Gibb's-Helmholtz equation. Change of free energy with respect to temperature and pressure. Mention of temperature coefficient, van't Hoff isotherm (derivations included), $\Delta G = -RT \ln Kp$. Problems.
Derivation of van't Hoff reaction isochore and Clausius-Clapeyron equation. Its applications to ΔTb and ΔTf determination (thermodynamic derivation not required). Qualitative treatment of Nernst heat theorem and III law of thermodynamics-statement only. Elementary concept of residual entropy.
Chemical Kinetics II: Theories of reaction rates:
Simple collisions theory based on hard
sphere model, transition state theory (equilibrium hypothesis).
Expression for the rate constant based on equilibrium constant and thermodynamic aspects. Steady state approximation and Lindemann's hypothesis. Experimental determination of kinetics of: (i) inversion of cane sugar by polarimetric method, (ii) spectrophotometric method for the reaction between potassium persulphate and potassium iodide.

MODULE II: NOBLE GASES AND D & F BLOCK ELEMENTS 11 Hrs

Noble gases: Introduction, electronic configuration, isolation of Helium from Natural gas, applications of Noble gases. Burtlet experiment, Preparation properties and structures (based on VBT) of fluorides and oxides of Xenon (XeF_2, XeF_4, XeF_6, XeO_3, XeO_4).

General study of d and f block elements: Transition elements: electronic configuration, atomic and ionic radii, ionisation energy, oxidation states, redox potentials, spectral and magnetic properties, catalytic activity, interstitial compound formation. 10 Lanthanides and Actinides: Electronic configuration, atomic and ionic sizes, lanthanide contraction and its consequences. Oxidation states, spectral and magnetic properties, comparison of oxidation states, complex formation and magnetic properties of d and f block elements. Ion exchange method for separation of Lanthanides.

MODULE III: AROMATIC HYDROCARBONS & ORGANIC HALOGEN COMPOUNDS 11 Hrs

Aromatic hydrocarbons:Structure of benzene - using molecular orbital theory. Criteria for aromaticity Huckel's rule (Examples: cyclopentadienyl anion, cycloheptatrieneylcation, benzene, naphthalene, anthracene and phenanthrene). Antiaromaticity. General mechanism of aromatic electrophilic substitution. Mechanism of nitration of benzene including evidence for the formation of nitronium ion, energy profile diagram and isotopic effect. Orienting influence of substituents in toluene, chlorobenzene, nitrobenzene and phenol. Aromatic nucleophilic substitution via benzyne intermediate, mechanism with evidences for the formation of benzyne by trapping with anthracene, Birch reduction. Side chain oxidation of toluene to benzaldehyde and benzoic acid. Oxidation of naphthalene, anthracene and phenanthrene. Diels-Alder reaction of anthracene with 1,2-dichloroethene. Alkenyl benzenes: Styrene, cis- and trans-stilbenes and their preparations. Biphenyl: Preparation-Ullmann reaction.

Organic halogen compounds: Alkyl halides: Nomenclature. Brief overview of nucleophilic substitution reactions - SN1 andSN2 mechanisms. Effect of (i) nature of alkyl groups (ii) nature of leaving groups, (iii) nucleophiles and (iv) solvents on SN1 and SN2 mechanisms.

Aryl halides: Preparation by halogenation. Relative reactivity of alkyl, allyl, vinyl, aryl and aralkyl halides towards nucleophilic substitution.

MODULE IV: ALCOHOLS, THIOLS AND PHENOLS 11 Hrs

Alcohols: Introduction, classification and nomenclature. Acidity of alcohols. Methods of preparation - (i) From carbonyl compounds - reduction of aldehydes and ketones (by Meerwein-Pondorff-Verley reaction); (ii) From acids and esters (by reduction with $LiAlH_4$).

Reactions of alcohols: Comparison of the reactivity of 1°, 2° and 3° alcohols - Lucas test, oxidation with $K_2Cr_2O_7$.

Glycols: Preparation from alkenes using $KMnO_4$ and from epoxides. Pinacol-pinacolone rearrangement.

Glycerol: Preparation from propene and from oils/fats. Uses. Reactions of glycerol: (i) nitration, (ii) action of concentrated H_2SO_4 and (iii) oxidation by periodic acid.

Thiols:Nomenclature. Methods of formation and chemical reactions (with sodium, NaOH, metal oxides, formation of thioesters and oxidation with mild and strong oxidizing agents). Uses of dithianes. Introduction of umpolung character (reversal of polarity) in carbonyl compounds.

Phenols: Classification. Acidic nature - Comparison of acidic strength of phenol with

alcohols and monocarboxylic acids. Effect of electron withdrawing –NO2 group and electron donating –CH3 group on acidity of phenols at o-,m-,p- positions. Pechmann reaction, Mechanisms of Reimer Tiemann and Kolbe-Schmidt reactions. Industrial applications of phenols: Conversion of phenol to (i) aspirin, (ii) methyl salicylate, (iii) salol, (iv) salicyl salicylic acid.

REFERENCES:

1. Advanced Organic Chemistry, O. S. Bahl and A. Bahl., S. Chand & Co. 1995
2. Advanced Organic Chemistry, J. March, John Wiley & Sons, 2008.
3. Organic Chemistry, Paula Yurkanis Bruice, Prentice Hall, 2005.
4. Principles of Physical Chemistry, 4th Edition, B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 2015
5. Text Book of Physical Chemistry, P. L. Soni., S. Chand & Co., 1993.
6. Physical Chemistry, 7th Edition, P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
7. The Elements of Physical Chemistry, 3rd Edition, Peter Atkins, OxfordUniv. Press, 2000.
8. Principles of Inorganic Chemistry, B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
9. Advanced Inorganic Chemistry, 6th Edition, F. A. Cotton, G. Wilkinson, C. A. Murillo and M. Bochmann-John Wiley & Sons, 1999.
10. Concise Inorganic Chemistry, 5th Edition, J. D. Lee, Blackwell Science, 2001.

SEMESTER/YEAR : I SEM / I YEAR
COURSE CODE : 20BC1101
TITLE OF THE COURSE : BASIC BIOCHEMISTRY
L : T : P : S/P : C : 4 : 0 : 0 : 0 : 4

COURSE OBJECTIVES:

1. To familiarize the students with basic concepts, principles of conformation and energy transfer
in biological systems.
2. To create general understanding about fundamentals of biomolecules, their structure and significance.

COURSE OUTCOMES:

1. The students will understand basic concepts like properties of Water, pH, buffers, conformation,
energy transfer and know the chemistry behind metabolic biological reactions.
2. The students will have an understanding of structure and property of biomolecules so that they
will have a better understanding of metabolism of biomolecules in higher semesters.

TOTAL HOURS: 48

MODULE 1 **12 Hrs**

Water and Buffers: Modern concepts of acids and bases; Ionization of acids. Dissociation of water
and ionic product of water, Hydrogen bonding properties of water, Definition and determination of

pH and associated numerical; Common ion effect with examples, Buffer preparation by H-H equation, buffer types. Numerical problems on preparation of buffer solutions, Biological buffers and their reactions.

MODULE 2 **12 Hrs**

Conformation and energy transfer Stereoisomerism: Optical isomerism: Chirality Nomenclature of enantiomers -The RS and the DL system. Optical rotation, racemisation and resolution. Fischer projection formula.Geometrical isomerism: Cis trans-isomerism, examples of chirality in the biological world.

Thermodynamics: First and second law, free energy, entropy, chemical potential, standard free energy change, exergonic and endergonic reactions with examples. Relationship between free energy change and equilibrium constant. Oxidation and reduction reactions in biology

MODULE 3 **12 Hrs**

Carbohydrates and lipids Carbohydrates: Classification– monosachharides, disaccharides, oligosaccharides with examples; Polysaccharides – structural and storage; mucopolysaccharides – peptidoglycan and teichoic acid

Lipids: classification – simple, complex and derived with examples. Properties of lipids: interaction with water; micelle, layer, liposome and membrane formation; Saponification, rancidity and iodine number.

MODULE 4 **12 Hrs**

Amino acids and nucleic acids

Amino acids: General structure of amino acids, acid base property, isoelectric point, peptide bond, classification of proteins based on solubility – fibrous and globular, classification of protein based on location: intracellular, extracellular and membrane bound proteins, introduction to protein hierarchy. Native state and denatured state of proteins

Nucleic acid: Structure of nitrogen base – purine and pyrimidine, general structure of nucleosides and nucleotides. Melting of DNA, melting temperature, renaturation of nucleic acids.

REFERENCES:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed
2. Zubay's Principles of Biochemistry – Rastogi and Aneja. MedTech 5th Edition
3. Biochemistry – Berg, Tymoczko and Stryer. Freeman Publishers, 5th Ed.
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlations – Devlin. Wiley & Sons, 7thEd
6. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHil

SEMESTER	**V**
YEAR	**III**
COURSE CODE	**19CY3501**
TITLE OF THE COURSE	**ELECTROCHEMISTRY AND ADVANCED SPECTROSCOPY**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**44**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make students understand about advanced concepts of electrochemistry and its applications.
- To impart knowledge about different spectroscopic techniques and their important applications.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will get the knowledge of concepts of electrochemistry and it's applications.	L1
CO2	Students will gain knowledge about different spectroscopic techniques and their important applications.	L2

COURSE CONTENT:

MODULE 1 **11Hrs**

ELECTROCHEMISTRY – I

Review of electrolytes and Conductance and related terms. Methods of determination of molar conductance. Conductometric titrations (only acid-base type). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.

Kohlausch's law and its applications: (i) evaluation of $\Lambda\infty$ and $\Lambda+$ $\Lambda-$ (ii) evaluation of degree of dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv) determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and BaSO4). Problems based on the above concepts.

Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory, Debye-Huckel-Onsagar equatation for aqueous solutions of 1:1 electrolyte. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

MODULE 2 **11Hrs**

MODULE 2: ELECTROCHEMISTRY - II

Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of Eo of Zn/Zn2+ and Cu/Cu2+ electrodes. Liquid junction potentials, elimination of liquid junction potential.

Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodes-standard hydrogen electrode, calomel

electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.	
MODULE 3	**11Hrs**
CHEMICAL SPECTROSCOPY I Interaction of electromagnetic radiation with matter. Regions of electromagnetic spectrum and associated spectroscopic techniques. Origin of molecular absorption spectra: Born-Oppenheimer approximation. Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy. Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO2 and H2O molecules. Raman spectroscopy: Concept of polarisability. Stokes and anti-Stoke's lines-selection rules. Advantages of Raman spectroscopy over IR spectroscopy. Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.	
MODULE 4	**11Hrs**
CHEMICAL SPECTROSCOPY II UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and redshift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone. IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free and H-bonded), alkyl –C-H, C=C, C=C C=O, C-X and C-O groups (by taking suitable examples). NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spinquantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclear shielding and deshielding (acetylene and benzene). Equivalent and non-equivalent protons. Effect of electronegativity of adjacent atoms on chemical shift values. Applications of NMR spectroscopy including identification of simple organic molecules.	

TEXT BOOKS:

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987
2. Text Book of Physical Chemistry P. L. Soni., S. Chand & Co., 1993.
3. Physical Chemistry, 7th Edition P. W. Atkins and Julio de Paula, Oxford Univ. Press, 2002.
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch
5. 8th edition, 2005, Saunders College Publishing, New York.
6. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India

REFERENCES:

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987

2. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19CY3571**					
TITLE OF THE COURSE	**PHYSICO-ELECTROCHEMICAL TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**44**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To make the students learn about the usage of various instruments related to electrochemical analysis.
- To make the students to learn about the experiments related to electrochemistry like conductmetric, and potentiometric titrations.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will get theoretical and hands on experience in different analytical instruments.	L1
CO2	Students learn about experiments related to electrochemistry like conductmetric and potentiometric titrations.	L3

COURSE CONTENT:
List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.
2. Determination of velocity constant for the saponification of ethyl acetate (a =b).

3.	The study of kinetics of potassium persulphate and potassium iodide calorimetrically.
4.	Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.
5.	Determination of dissociation constant of monochloroacetic acid by conductivity method.
6.	Conductometric titration of hydrochloric acid with sodium hydroxide.
7.	Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.
8.	Determination of Critical Micellar Concentration (CMC) by conductivity method.
9.	Determination of pKa of a weak acid by pH metric method.
10.	Preparation of buffers and determination of their pH values using pH meter.

TEXT BOOKS :

1. Vogel's TextBookofPracticalOrganicChemistry,5th Edition,A.J.Hannford,A.R.Tatchell,B.S.Hurnis,P.W.G.Smith,PearsonPublication.
2. Enhancingundergraduatechemistrylaboratories,J.Carndoff,N.Reid,RS.C.Publication.
3. ExperimentalOrganicChemistryLaboratoryManual,J.I.Garcia,J.A.Dobado,G.Fransicisco,ElsevierPublication.
4. ChemistryPracticalInorganicQualitaiveAnalysis ForUnderGraduateStudents,M.J. Mamtora, S.C.Karad, J.S.Makasana, LapLambert AcademicPublishing.
5. AdvancedPracticalChemistry,K.Chelladurai,K.Subbian,LapLambertAcademicPublishing.

REFERENCES:

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R. Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication.
2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19OE3502**					
TITLE OF THE COURSE	**HEALTH AND DISEASES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To introduce the role of pathogenic microbes in diseases its occurrence andprevalence.
- To educate the students about the adverse effects of stress and its management.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire knowledge to the various causative agents of variousdiseases.	L1
CO2	Students will be familiarised with the adverse effect of drug use and cope up withmental health.	L2

COURSE CONTENT:	
MODULE 1: INTRODUCTION ON NUTRITION AND HEALTH	**13Hrs**
Nutrition: Concepts of macro and micro nutrients, healthy diet, Atkins diet. Energyvalue of food. Importance of food in Third world disease/Global health. **Science of balanced nutrition**: Introduction to Nutrition & Eating Right (Food Pyramid, ServingSize), the six nutrients, eating for good health & disease prevention. **Health and nutrition**: cancer/heart disease/diabetes & nutrition, obesity, weightmanagement & nutrition, diets and dieting. **Occupational health**: Definition, Ergonomics, Occupational diseases & theirprevention..	
MODULE 2: INFECTIOUS DISEASES, GENETIC DISORDERS AND MENTAL	**13Hrs**
Congenital Diseases: Haemophilia, Down syndrome. **Acquired diseases** (i) Infectiousor communicable disease, (ii) Non-communicable disease (cancer), (iii) Deficiencydisease (anaemia, beriberi) (iv) Allergies. **Specific Infections –** Epidemiology, clinical features, laboratory diagnosis, treatmentand prevention of protozoan infection (malarial), bacterial infection (*Helicobacter pylori*) and virus (Covid-19). **Mental Health and wellness:** Definition, major mental disorders (depressive disorders, suicide, eating disorders, types of therapy and self-help). Legal and IllegalDrugs, Psychoactive Drugs (Stimulants, Depressants, Hallucinogens, Narcotics,Inhalants), Use and Abuse of Drugs, Stress definition, causes of stress (External andInternal stressors), Stress Management - Deep breathing, muscle relaxation, meditation & exercise.	

TEXT BOOKS:

1. Essentials of Food and Nutrition – Volume 2 Swaminathan M, 2nd edition, 2009, Ganesh Publishers.
2. Practical Clinical Biochemistry, Varley (Harold), 4th edition, 2005, CBS Publishers.
3. Review of Medical Physiology – William F Ganong, 22nd edition, 2007, Oxford University Press.
4. Textbook of Medical Physiology – Guyton & Hall, 11th edition, 2006, Elsevier Publications.
5. Community medicine with Recent advances - Suryakantha 5th Edition 2019, Jaypee Brothers Publications.
6. Medical pharmacology, Sengupta (P R), 2010, CBS Publications.
7. Zahir, F. (2019). Introduction to Occupational Health Hazards. Singapore: Bentham Science Publishers.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19OE3603**					
TITLE OF THE COURSE	**TRADITIONAL MEDICINE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**0**	**0**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- To have basic insights on important aspects of ethnomedicine like use in health care, study of important traditional medicines and formulations.
- To bring awareness on the scope of Pharmacognosy; traditional systems of therapy; classification methods of crude drugs, preparation of herbal formulations, organoleptic study of medicinally important plant parts including analytical pharmacognosy.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**

CO1	Upon completion of the course, the student shall be able to know history and scope of ethnomedicine, difference between folk and traditional medicines and use of some routinely used Ayurvedic drugs and formulations.	L1
CO2	The student will be able to analyze different systems of classifying crude drugs, drug adulteration and detection methods and Phytochemical and biological screening of herbal drugs.	L4

COURSE CONTENT:

MODULE 1: ETHNOMEDICINE	**13Hrs**
Definition, history and scope. Collection of ethnic information. Importance of medicinal plants: Role in human health care. Introduction to basic concepts of folk medicine and Ayurveda, Naturopathy and Yoga: methods of disease diagnosis and treatment.Morphology and general anatomy of medicinally important plant parts: Roots, Stem and its modifications, Barks, Leaves, Flowers, Fruits, Seeds. Preparation of herbarium specimens. Study of some medicinally important families (diagnostic features with at least three examples of species of medicinal use): Rutaceae, Fabaceae, Rubiaceae, Solanaceae, Liliaceae. Cultivation methods, Herbal pesticides, Plant growth regulators. Harvesting and Storage. Marketing and general aspects of export of medicinally important plants.	

MODULE 2	**13Hrs**
Definition and history, and scope of Pharmacognosy. Systems of Indian Medicines: Ayurveda, Unani, Siddha and Homeopathy. Classification of Crude drugs: Morphological, Taxonomical, Chemical and Pharmacological. Preparation of crude drugs for commerce. Preparation of herbal infusions, decoctions, lotions, insect repellents, suppositories, tinctures, syrups, poultices, plasters, ointments, oils and salves. Surgical fibres, sutures and dressings. Organoleptic and sensory studies on Ginger, Garlic, Turmeric, Neem, Tulsi, Cinchona, Cinnamon, Arjun, Amla, Castor and Isabgol. Analytical Pharmacognosy: Drug adulteration and its detection. Introduction to phytochemical screening (alkaloids, polyphenolic compounds and glycosides). Introduction to biological testing of herbal drugs (analgesics, anti-inflammatory and antianxiety agents).	

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.
2.

TEXT BOOKS:

1. Pharmacognosy - G. E. Trease and W.C. Evans. Saunders Edinburgh, New York.

2. Pharmacognosy-Tyler, Brady, Robbers. 3. Modem Methods of Plant Analysis Peach& M.V. Tracey, Vol. I&II
3. Awadesh N, Ghoeami A and Sharma R, Indigenous Health Care and Ethnomedicine, Sarup and Sons.
4. Glimpses of Indian Ethano-Pharmacology by P. Pushpangadam. Ulf Nyman. V. George Tropical Botanic Garden & Research Institute.
5. Textbook of Pharmacognosy by C. K. Kokate, Purohit, Ghokhale, Nirali Prakashan.

SEMESTER	**IV**				
YEAR	**II**				
COURSE CODE	**19AU0007**				
TITLE OF THE COURSE	**ENTREPRENEURSHIP**				
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours
	2	**-**	**-**	**-**	**26**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES:

- Students will categorically develop entrepreneurial aptitude that will enable them to design and create business opportunities.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have the ability to understand different entrepreneurial traits.	L2
CO2	Students will know the criterion to assess optimal business opportunities.	L2

COURSE CONTENT:	
MODULE 1	**13Hrs**
Nature and Development of Entrepreneurship, Definition of Entrepreneur Today, Entrepreneurial Decision Process, Role of Entrepreneurship in Economic Development, Intrapreneurship, Entrepreneurship, Entrepreneurial Careers and Education, Develop a Business Plan, Determine the Resources Required, Manage the Enterprise, Managerial versus Entrepreneurial Decision Making, Causes for Interest in Intrapreneurship, Corporate versus Intrapreneurial Culture. Leadership Characteristics, factors affecting entrepreneurship qualities of successful entrepreneurship.	

MODULE 2	**13Hrs**
SMALL & MEDIUM ENTERPRISES, BUSINESS IDEA & INNOVATION Role of SME, concept and definitions of SME, government policy and SME in India, growth and performance of SME sector, problems for SMEs, Sickness in SME, criteria to identity sickness, causes, symptoms and remedial measures of sickness, institutional support for SMEs. Business idea, Recognition, Product Planning and Development Process, Establishing Evaluation Criteria, Idea Stage, Concept Stage Product Stage, Test Marketing Stage, Creativity, Innovation and entrepreneurship, barriers to creativity, techniques for improving the creative process, corporate entrepreneurship, causes, climate, intrapreneurial leadership characteristics, Establishing intrapreneurship in the organization. Various forms of organization, Legal Issues in Setting up the Organization, The various statutory registrations and clearances required.	

REFERENCES:

1. M. Lall, Entrepreneurship, Excel books
2. Vasant Desai:- Dynamics of Entrepreneurial Development and Management. HPH
3. Hisrich, Robert D., Peters, Michael P., and Shephered, dean a: entrepreneurship, Tata McGraw hill; sixth edition, 2007
4. Mathew J Manimala:- Entrepreneurship at the Crossroads - Biztantra
5. Mohanty – Fundamentals of Entrepreneurship, Prentice Hall of India

SEMESTER/YEAR : V SEM / III YEAR COURSE CODE : 16MB301 TITLE OF THE COURSE : AGRICULTURAL MICROBIOLOGY AND ENVIRONMENTAL MICROBIOLOGY L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1. To observe importance for life cycles in the nature, for plants growing, animal husbandry and processing of plant and animal products. 2. Explains geochemically and environmentally significant processes that the activities of microorganisms and the environmental factors controlling and limiting microbial activities

COURSE OUTCOMES: 1. Fundamental concepts and techniques in soil microbiology, soil microbial diversity, basic and applied concepts environmental problems and available solutions towards them. 2. To make use of how microorganisms may be utilised in agricultural biotechnology, including specific techniques such as cloning and expression of genes.

PART A: AGRICULTURAL MICROBIOLOGY

MODULE 1: BIOFERTILIZERS AND BIOLOGICAL CONTROL 9Hrs

Definition, types, characterization, mass cultivation of Rhizobium, Azotobacter, Azospirillum, and Azolla .Mode of application of biofertlizers, advantages and limitations.. ISI standards. Mechanisms of biological control, field applications of Bacillus

thuringiensis, Trichoderma spp. and Nuclear Polyhedrosis Virus. Advantages and limitations.

MODULE 2: PLANT PATHOLOGY-I 9Hrs

Host pathogen interaction, disease triangle, disease cycle, classification of plant pathogens and plant diseases. Defence mechanisms – Concepts of constitutive defense mechanisms in plants, inducible structural defences (histological-cork layer, abscission layer, tyloses, gums), inducible biochemical defences [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies].

MODULE 3: PLANT PATHOLOGY-II 9 Hrs

Plant disease control- Principles and practices in disease control – Regulatory (quarantine, crop certification), Cultural (host eradication, crop rotation, sanitation), Chemical (Protectants and Systemic fungicides), Biological (Suppressive soil and microbial antagonism). Genetic engineering methods Study of different plant diseases- Bacteria – Blight of rice, Fungi – Rust of sorghum, Virus – Tobacco Mosaic Virus, Mycoplasma – Sandal Spike, Nematode- Root knot disease.

PART B- ENVIRONMENTAL MICROBIOLOGY

MODULE 4: AEROBIOLOGY AND SOIL MICROBIOLOGY 9Hrs

Microbiology of indoor and outdoor environment, Significance of microorganisms in air, aerosols, air borne pathogens and aeroallergens. Techniques in aerobiology: Gravity slide, Plate exposure, Rotorod sampler, Anderson Samplers, Hirst Trap, Liquid Impingers and Filteration. Control of Air borne microorganisms – Dust control, Filteration, Fumigation, UV light exposure. Soil profile, Soil microorganisms - Bacteria, fungi, actinomycetes, algae, protozoa and viruses. Biogeochemical cycles - Carbon cycle, Nitrogen cycle and Sulphur cycle. Microbial interactions in soil - Neutralism, Positive interactions (mutualism, commensalism, synergism, syntropism, protocoperation), Negative interactions (amensalism, antagonism and parasitism).General account of bioleaching, biodegradation and bioremediation

MODULE 5: AQUATIC AND WASTE WATER MICROBIOLOGY 9Hrs

Introduction, Natural waters (Atmospheric, Surface and Ground water), Zonation of water system, Factors affecting aquatic flora (Oxygen, Temperature, pH, light, hydrostatic pressure, turbidity and nutrients), general account on water borne diseases and their management. Water Pollution: Sources, Biological indicators and Eutrophication. Water

quality analysis: Collection of water samples, Standard plate count, MPN and membrane filter technique. Municipal treatment of water: Sedimentation, Filteration and Disinfection. Types (sewage and effluent), characteristics of sewage (physical, chemical and biological), BOD and COD. Role of microbes in sewage treatment. Sewage Treatment: Domestic treatment plants (septic tanks), Municipal sewage treatment Primary (coagulation and sedimentation), Secondary (Trickling filter, activated sludge, oxidation pond) and Tertiary treatment (ion exchange, reverse osmosis and dialysis). Brief account on solid waste treatment (Landfills and Composting); Biogas production; Newer approaches to sewage treatment – CETP and Enzyme technology for treating industrial waste water.

REFERENCE BOOKS

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.

2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.

3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.

4. Agrios, G. Plant Pathology, Fifth Edition, Elsevier Academic Press, 2005.

5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.

6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.

7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.

8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.

9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press. 10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.

11. Jabir Singh. Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.

12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers. 13. InduShekhar Thakur, Environmental Microbiology: Basic Concepts and Applications. JNU, New Delhi.

14. Jogdand, Environmental Biotechnology, Himalaya Publishing House, 3rd Revised Edition: 2006.

15. Robert L Tate, Soil Microbiology,2nd Edition, John Wiley and Sons.
16. Christopher S Cox, Christopher M Wathes, Bioaerosols Handbook. Lewis Publishers.
17. Grant W.D and Long P.E. Environmental Microbiology. Kluwer Academic Publishetrs, 1981. 18. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, ASM Press, 2007.
19. Singh A and Ward O.P. Applied Bioremediation, Springer, 2004. 20. Singh A, Kuhad R.C. Ward O.P, Advances in Applied Bioremediation. Springer, 2009.

SEMESTER/YEAR : V SEM / III YEAR COURSE CODE : 16CH 301

TITLE OF THE COURSE : PHYSICAL CHEMISTRY AND CHEMINFORMATICS

L: T/A: P: C : 3: 0: 0: 3

COURSE OBJECTIVES: 1.The basic principles and concepts of electrochemistry, ionic equilibria, photochemistry and chemoinformatics will be taught to the students. 2. In electrochemistry, the terms like equivalent and molar conductivities, their determinations, transport numbers and determinations, Nernst equations, numerical, pH measurements will be tought. 3. The basic concepts of chemoinformatics and its application in drug designing will be thought. **COURSE OUTCOMES**:

1.The students will be well versed with the basic principles, terms and equations and methods to determine conductivities and pH measurements of the solutions. 2. The students will be familiar with buffer solutions, significance, preparations and significance. 3. The students will be familiar with the basic principles, terms ,laws, and equations regarding the photochemistry. 4. The students will be well versed with terms, concepts, and terminalagies used in chemoinformatics and their applications in drug analysis.

MODULE 1 Electrochemistry I:

Review of electrolytes and Conductance and related terms Methods of determination of molar conductance. Conductometric titrations (only acid-basetype). Transport numbers: definition – determination by moving boundary method. Causes of abnormal transport numbers observed in certain systems. Ionic mobility. Problems on transport numbers. Conductivity of water.Kohlausch's law and its applications: (i) evaluation of $\Lambda\infty$ and $\Lambda+$ $\Lambda-$ (ii) evaluation of degreeof dissociation of a weak electrolyte (iii) evaluation of $\Lambda\infty$ of a weak electrolyte (iv)determination of solubility from conductance of saturated solutions of sparingly soluble salts (AgCl and $BaSO_4$). Problems based on the above concepts.Limitations of Arrhenius theory: qualitative account of Debye-Huckel theory,

Debye-Huckel- Onsagar equatation for aqueous solutions of 1:1 electrolytes. Verification of DHO equation. Galvanic cell: conventions of representing galvanic cells-reversible and irreversible cells, derivation of Nearst equation for single electrode potential (free energy concept).

MODULE 2 Electrochemistry II :

Weston-cadmium cell: Determination of emf of a cell by compensation method. Determination of Eo of Zn/Zn2+ and Cu/Cu2+ electrodes. Liquid junction potentials, elimination of liquid junction potential. Types of electrodes: metals and gas electrodes (chlorine), metal/metal insoluble salt electrodes, redox electrodes. Reference electrodesstandard hydrogen electrode, calomel electrode, quinhydrone electrode and glass electrode. Determination of pH using these electrodes. Problems based on the above concepts. Concentration cells: (i) emf of concentration cells (ii) determination of solubility of sparingly soluble salts and numerical problems. Redox electrodes, emf of redox electrodes. Potentiometric titration involving only redox systems.

MODULE 3 Ionic Equilibria :

Hydrolysis of salts of weak acids and weak bases. Ionic product of water. Relationship between Kh, Kw, Ka and Kb. Degree of hydrolysis and its relationship with Kh. Effect of temperature and dilution on degree of hydrolysis. pH of salt solutions. Problems based on the above concepts.Common-ion effect, buffers, buffer action buffer range and buffer capacity. pH of buffers.Henderson's equation and its derivation and applications. Applications of buffer in analyticalchemistry and biochemical processes in human body. Solubility product and ionic product inprecipitation and in qualitative analysis. Theories of indicators; selection of indicators and their limitations. Photochemistry Laws of photochemistry. Grotthus-Drpare law, Stark-Einstein law, differences between photophysical and photochemical processes with examples. Comparison of photochemicaland thermal relations. Quantum yield of photochemical combinations of (i) H2 and Cl2 (ii) H2and Br2 (iii) dissociation of HI (iv) dimerization of anthracene.Photosensitization,photostationary equilibrium. Singlet and triplet states based on Jabloski diagram.Fluorescence, phosphorescence, luminescence, bioluminescence and chemical sensiors. Beer-Lambert's law and its limitataions. Numerical problems on absorption coefficient and molar extinction coefficient.

MODULE 4 Cheminformatics I:

Introduction to cheminformatics, History and Evolution of cheminformatics, Use of cheminformatics, Prospects of cheminformatics, Molecular Modeling and Structure Elucidation. Nomenclature; Different types of Notations; SMILES Coding; Matrix Representations; Structure of Molfiles and Sdfiles; Libraries and toolkits; Different electronic effects; Reaction classification. Database Concepts, Structured Query Language, Design of Chemical Databases, Data.Abstraction; Data Models (Elementary ideas only)

MODULE 5 Cheminformatics II:

Prediction of Properties of Compounds; Linear Free Energy Relations; Quantitative Structure-Property Relations; Descriptor Analysis; Structure-Spectra correlations; Prediction of NMR, IR and Mass spectra;Computer Assisted Structure elucidations; Computer Assisted Synthesis Design, Introduction to drug design; Application of Cheminformatics in Drug Design, Design of combinatorial libraries.

TEXT BOOKS

1. College Chemisyrt, L.Indira and Chatwall.
2. Comprehensive Chemistry, K.Vinodkumar.

REFERENCE BOOKS

1. Principles of Physical Chemistry, 4th Edition B. R. Puri and L. R. Sharma and M. S. Pathania, S. L. N. Chand & Co., 1987 2. Text Book of Physical Chemistry P. L. Son

SEMESTER III YEAR II COURSE CODE 20BS2301

TITLE OF THE COURSE MOLECULAR BIOLOGY

SCHEME OF Instruction Lecture Hours Tutorial Hours Practical Hours Seminar/Projects Hours Total Hours Credits 4 - - - 48 4 Perquisite Courses (if any) # Sem/Year Course Code Title of the Course - - - -

COURSE OBJECTIVES: •

Understand the general principles of central dogma, DNA and RNA types structure and their role in cells. • Explain the mechanisms of DNA replication, RNA synthesis and repair, various levels of gene expression, regulation and protein function.

COURSE OUTCOMES:

CO No. Outcomes Bloom’s Taxonomy Level CO1 Know the importance of recent discoveries and the applications and potential of molecular biology with these

technologies. L1 CO2 Student will gain understanding of chemical and molecular processes that occur in and between cell. L2 COURSE CONTENT:

MODULE 1 THE MOLECULAR BASIS OF LIFE

Central dogma, DNA and RNA as genetic material – experimental proof. Evidences for DNA as the genetic material- Griffith's transformation experiment, Hershey and Chase experiment, evidence for RNA as the genetic material of viruses (TMV, Retroviruses). Nucleic acids: DNA structure and types (A, B and Z model), Denaturation and renaturation kinetics of DNA, Types of RNA – mRNA, tRNA and rRNA, mi RNA and siRNA.

MODULE 2 DNA REPLICATION AND ITS COMPONENTS

Replication of DNA (Conservative, Dispersive and Semi Conservative DNA replication, Meselson and Stahl experiment), theta and rolling circle model of replication. Prokaryotic and Eukaryotic – Enzymes and proteins involved in replication.

MODULE 3 DNA TRANSCRIPTION AND ITS COMPONENTS

RNA polymerases, Mechanism of transcription – initiation, elongation and termination in prokaryotes and eukaryotes. Post-transcriptional modifications of Eukaryotic mRNA (Poly A tailing, 5' capping and splicing mechanisms)

MODULE 4 TRANSLATION AND REGULATION OF GENE EXPRESSION

Genetic code, wobble hypothesis, Mechanism of translation in prokaryotes and eukaryotes, Post translational modification of Proteins. Regulation of Gene expression in Prokaryotes – Operon concepts, induction, repression, attenuation, examples of Lac and Trp operons. Regulation of Gene expression in Eukaryotes –galactose metabolism in yeast.

TEXT BOOKS:

1. Cell & Molecular Biology by Gerald Karp, 3rd Edition, John Wiley & Sons (2009) 2. Molecular Biology of the Gene by James Watson et al, Pearson Education (2013) 3. Molecular Biology of the Cell, Bruce Alberts et al, Garland Science Publication (2007) 4. Principles of Biochemistry by Nelson and Cox, WH Freeman Publications (2008) 5. Textbook of Cell and Molecular Biology by Ajoy Paul, Books and Allied Ltd (2011). 6. Molecular Biology and Genetic Engineering by P K Gupta, Deep and Deep Publications (2008). 7. Cell Biology, Genetics, Molecular Biology, evolution and Ecology by PS Verma and VK Agarwal, S. Chand Publications (2006)

SEMESTER III YEAR II COURSE CODE 20MB2301

TITLE OF THE COURSE IMMUNOLOGY AND MEDICAL MICROBIOLOGY

SCHEME OF INSTRUCTION Lecture Hours Tutorial Hours Practical Hours Seminar/Projects Hours Total Hours Credits 4 –# Sem/Year Course Code Title of the Course - -

COURSE OBJECTIVES: •

Demonstrate an understanding at an advanced level of microbial virulence mechanisms and host response to infection. • To apply molecular techniques to medical microbiology; biochemical and genetic mechanisms of antimicrobial agent activity, microbial susceptibility and resistance to antimicrobial agents.

COURSE OUTCOMES: CO No. Outcomes Bloom's Taxonomy Level CO1 To introduce and describe the classification, structure, classification and physiology of bacteria that infect humans L3 CO2 To introduce basic and molecular techniques employed in diagnostic bacteriology laboratories. To learn about the use of antibiotics and resistant mechanisms encoded in bacteria to neutralise these chemical agents

COURSE CONTENT: MODULE 1 ELEMENTS OF IMMUNE SYSTEM

History and scope of immunology, Definition and types of immunity (innate and adaptive). Structure, Functions and Properties of: Immune Cells (Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell and Dendritic cell) and Immune Organs– Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT and CALT. Immune responses- Primary and Secondary Immune Response, Humoral and cell mediated immunity. Complement system – Components, function and activation pathways, Major Histocompatibility Complex.

MODULE 2 ANTIGENS AND ANTIBODIES

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity), Types, Haptens, Super antigens, Epitopes (T & B cell epitopes), Structure of T-cell and B-cell receptors. Structures of antigen presenting cell. Cluster of differentiation and Costimulatory signals and its role T-dependent and T-independent antigens, Adjuvants. Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic). Hypersensitivity reactions (Definition and types). Immunoglobulin family and class switch mechanism.

MODULE 3 IMMUNOLOGICAL DISORDERS AND TECHNIQUES

Clonal selection theory of antibody production; Production and application of Monoclonal antibodies. Autoimmune disorders (Type-1 diabetics and Myasthenia gravis,) Transplantation immunology – Graft, types and rejection of graft. Brief concept of cancer immunology. Immunological techniques: Types and Principles of Ag-Ab reactions - Precipitation, Agglutination, Complement fixation and its applications. Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Immunofluorescence, Flow cytometry and Immunoelectron microscopy.

MODULE 4 MEDICAL MICROBIOLOGY

Normal flora of skin, oral cavity and other body regions. Relationship between normal pathogens and host. Terminologies- Pathogenicity, Virulence, Invasion, Toxins: Exotoxins, Enterotoxins and Endotoxins. Epidemiology, etiology, pathogenesis and prophylaxis of the following: Bacteria–Salmonella typhi and Mycobacterium tuberculosis. Fungi–Tricophyton spp. And Candida albicans. Viruses –Hepatitis and HIV. Protozoa – Leishmania donovani and Entamoeba histolytica. Antibiotics and their mode of action – Antibacterial, Antifungal, antiviral and antiprotozoal agents. Mechanism of drug resistance. Methods of testing drug sensitivity (Kirby Bauer method, Minimum Inhibitory Concentration). Immunoprophylaxis- Vaccines and its types. Immunization schedule and its significance.

TEXT BOOKS:

1. Anathnarayana and Panikar (2013) Text Book of Microbiology, 9th Edition. University press. 2. Richard A, Goldsby, Thomas J, Kindt, Barbara A and Osborne (2000). Kuby Immunology. 4th Edition. W.H. Freeman and Company, New York. 3. Kuby J (2006) Immunology 6th Edition. W.H. Freeman and company, New York. 4. Warren Levinson (2000) Medical Microbiology and Immunology, Examination and Board Review. 8th Edition. McGraw Hill. 5. Tortora, Funke, Case (2009) Microbiology, 9th Edition. Benjamin Cummings. 6. Connie R Mahon (2010) Text book of diagnostic Microbiology. 3rd edition, Pearson. 7. Fritz H Kayser (2005) Medical microbiology. ThiemeVerlag. 8. Mackie and McCarthey (1996) Medical Microbiology vol 1, Microbial infection, vol 2, Practical Medical Microbiology, Churchil Livingstone. 9. Frank and Steven A (2002) Immunology and evolution of Infectious Diseases. Princeton University Press. 10. Wadher and Bhoosreddy (2005) Manual of Diagnostic Microbiology. Himalaya Publisher. 11. Kufe (2003) Cancer Medicine. BC Decker Inc. 12. Leslic Collier, John Oxford (2000) Human virology a text book for students of medicine, dentistry and microbiology. 2nd

edition. Oxford university press. 13. Jenson, Wright robinson (1997) Microbiology vol 1, Microbial Infection vol 2, PracticalMedical Microbiology, Churchill living stone. 14. Credric, A Mims (2004) Medical Microbiology, 3rd Edition. Mohshy Inc. 15. Nester Roberts Pearsall A

SEMESTER IV YEAR II COURSE CODE 20CY2471

TITLE OF THE COURSE PHYSICO-ELECTROCHEMICAL TECHNIQUES - LAB SCHEME OF INSTRUCTION Lecture Hours Tutorial Hours Practical Hours Seminar/Projects Hours Total Hours Credits 4 0 - - 44 2 Perquisite Courses (if any) # Sem/Year Course Code Title of the Course - - - -

COURSE OBJECTIVES : • To make the students learn about the usage of various instruments related to electrochemical analysis. • To make the students to learn about the experiments related to electrochemistry like conductmetric and potentiometric titrations.

COURSE OUTCOMES : CO No. Outcomes Bloom's Taxonomy Level CO1 1. The students will get theoretical and hands on experience in different analytical instruments. L1 CO2 2. Students learn about experiments related to electrochemistry like conductmetric, and potentiometric titrations.

L3 COURSE CONTENT:

List of Laboratory/Practical Experiments activities to be conducted (if any) :

1. Determination of velocity constant for acid catalysed hydrolysis of methyl acetate and determination of energy of activation.

1. Determination of velocity constant for the saponification of ethyl acetate (a =b).

2. The study of kinetics of potassium persulphate and potassium iodide colorimetrically.

3. Determination of equivalent conductivity of 0.1 N sodium chloride and verification of DHO equation.

4. Determination of dissociation constant of monochloroacetic acid by conductivity method.

5. Conductometric titration of hydrochloric acid with sodium hydroxide.

6. Potentiometric titration of potassium dichromate with ferrous ammonium sulphate.

7. Determination of Critical Micellar Concentration (CMC) by conductivity method.

8. Determination of pKa of a weak acid by pH metric method.

TEXT BOOKS :

1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford,

A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. 2. Enhancing undergraduate chemistry laboratories, J. Carndoff, N. Reid, RS. C. Publication. 3. Experimental Organic Chemistry Laboratory Manual, J.I. Garcia, J.A. Dobado, G. Fransicisco, Elsevier Publication. 4. Chemistry Practical Inorganic Qualitaive Analysis For Under Graduate Students, M.J. Mamtora, S.C. Karad, J.S. Makasana, Lap Lambert Academic Publishing. 5. Advanced Practical Chemistry, K. Chelladurai, K. Subbian, Lap Lambert AcademicPublishing.

2. REFERENCES : 1. Vogel's Text Book of Practical Organic Chemistry, 5th Edition, A.J. Hannford, A.R.Tatchell, B.S. Hurnis, P.W.G. Smith, Pearson Publication. 2. Enhancing undergradua

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19BS3601**					
TITLE OF THE COURSE	**NANOSCIENCE**					
SCHEME OF Instruction	Tutorial Hours	Practical Hours	Lecture Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**0**	**0**	**0**	**26**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	NA	NA	NA

COURSE OBJECTIVES:

- To introduce the basic concepts and principles of nanoscience and nanotechnology.
- To teach the students about fabrication, characterization and applications of nano-materials.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will get to know about basic concepts and principles of nanoscience and nanotechnology.	L2
CO2	Students will learn about fabrication, characterization and applications of nano-materials	L3 & L4

COURSE CONTENT:	
MODULE 1 : INTRODUCTION OF NANOMATERIALS	**13Hrs**
Background to Nanoscience: Definition of Nano, Scientific revolution-Atomic Structure and atomic size, emergence and challenges of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of Nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. **Types of nanostructure and properties of nanomaterials:** One dimensional, Two dimensional and Three-dimensional nanostructured materials, Quantum Dots shell structures, metal oxides, semiconductors, composites, mechanical-physical-chemical properties.	
MODULE 2: FABRICATION AND CHARACTERISATION	**13Hrs**
Different methods of production: Top down and bottom-up approach with examples. **Physical**	

Methods; Inert gas condensation, Arc discharge, RF-plasma, Plasma arc technique, Ball Milling, Molecular beam epitaxy, Chemical Vapour deposition (CVD), ALD method and other variants, electrodeposition. **Chemical Methods:** Sol-gel, hydrothermal, solvothermal, combustion method, microwave method, coprecipitation method, Photochemical synthesis, Electrochemical synthesis. **Characterization:** X-ray diffraction, SEM, FESEM, TEM, EDS analysis, AFM, XPS, UV-Visible Spectrophotometers with respect to CNT, graphite, graphene, metal dichalcogenides, Quantum dots, core-shell nanoparticles.

TEXT BOOKS:

1. Carbon nanotubes: properties and applications. M. O'Connell, FL: CRC/Taylor & Francis (2006).
2. Carbon Nanotechnology: Recent Developments in Chemistry, Physics, Materials Science and Device Applications, L. Dai, Elsevier (2006), Amsterdam.
3. Nanotubes and Nanowires, C. N. R. Rao and A. Govindaraj, The Royal Society of Chemistry (London), 2005. Reprinted 2007, Second Edition 2011.

SEMESTER V
YEAR III
COURSE CODE 19GN3501
TITLE OF THE COURSE DEVELOPMENTAL BIOLOGY AND HUMAN GENETICS
SCHEME OF Instruction

COURSE CONTENT:

MODULE 1 HISTORY & BASIC CONCEPTS OF DEVELOPMENT 15Hrs

Overview of how the modern era of developmental biology emerged through multidisciplinary approaches. Stages of development- zygote, blastula, gastrula, neurula. Cell fate & commitment – potency- concept of embryonic stem cells, differential gene expression, terminal differentiation, lineages of three germ layers, fate map. Mechanisms of differentiation- cytoplasmic determinants, embryonic induction, concept of morphogen, mosaic and regulative development. Pattern formation-- axis specification, positional identification (regional specification). Morphogenetic movements

MODULE 2 EARLY DEVELOPMENT IN INVERTEBRATE / VERTEBRATE MODELS

8Hrs

Drosophila, C. elegans, Xenopus, Mouse/ human. Cleavage, gastrulation, Axis specification (Dorsoventral, anterior posterior), & body plan patterning, left right asymmetry in vertebrates.

MODULE 3 HUMAN CHROMOSOMES, INHERITANCE 14Hrs

Human Chromosomes: Normal Human Karyotype: Paris Nomenclature, karyotyping (Quantification of DNA of individual chromosomes).

Pedigree studies: Symbols used in pedigree studies, Pedigree analysis & construction, Pedigree analysis for the inheritance pattern of genetic diseases.

MODULE 4 GENETIC DISEASES AND INHERITANCE PATTERN 7Hrs

Autosomal Dominant Inheritance (Ex.- Adult polycystic kidney, Achondroplasia and Neurofibromatosis).

Autosomal Recessive Inheritance (Ex.- Albinism, Sickle cell anemia, Phenylketonuria).

X-linked Recessive Inheritance (Ex.- Duchenne muscular dystrophy-DMD).

X-linked Dominant Inheritance (Ex.- Xg blood group).

Y-linked inheritance (Holandric gene Ex.- Testes determining factor - TDF).

Multi-factorial inheritance (Ex.-Congenital malformations- Cleft lip and palate, Rheumatoid arthritis and Diabetes).

Mitochondrial diseases (Ex.- Leber's hereditary optic neuropathy).

TEXT BOOK:

1. Developmental Biology, Eighth Edition" by Scott F Gilbert.
2. Essential Developmental Biology by Jonathan Slack
3. Bhatnagar etal S.M. Essentials of Human Genetics. IV edition. Orient Longman. 1999
4. Human Genetics: Concepts and Applications by Lewis R (2001) McGrawHi; Boston.
5. Manage E. J. and Manage A.P. Basic Human Genetics. Rastogi Publications, Meerut.1997

DAYANANDA SAGAR UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF CHEMISTRY

Sixth Semester - Chemistry Syllabus

Paper: Biochemistry

Paper Code: 15CH303 Total Credit Hours: 45

Unit I: Carbohydrates 05h

Structure and biological importance of derivatives of monosaccharides. Amino sugars : ß-D-glucosamine, galactosamine and their N-acetylated forms: Nacetylmuramicacid (NAMA); N-acetylneuraminic acid (NANA)Sugar acids–structure and biological importance of D-gluconic acid, D-glucuronic acid and

Dglucaricacid.Sugar phosphates–structure and biological importance of Glucose-6-P, Fructose-6-P,

Fructose-1,6-di-P, ß-D-ribose-5-P and ß-D-deoxyribose-5-P.Structure and biological importance of oligosaccharides – isomaltose, cellobiose,trehalose. Polysaccharides -source, comparative account of partial structure and biologicalfunction of starch, glycogen, cellulose, chitin and insulin.

Unit II: Lipids 06h

Introduction, Classification.Fatty acids–definition, classification as saturated and unsaturated with examples and structure (lauric, myristic, palmitic, stearic, oleic, linoleic, linolenic and arachidonic acids). Essential fatty acids – definition with examples Triglycerides–Structure of simple and mixed glycerides, properties of triglycerides-acid and alkali hydrolysis, saponification number and its significance, iodine number and its significance, rancidity (oxidative and hydrolytic), biological importance of triglycerides.

Phosphoglycerides – general structure of 3-Sn–phosphatidic acid, lipid bilayer (as in cell membrane), micelles, liposomes and its applications, structure and biological importance of lecithin, cephalin, phosphatidylserine, phosphatidylinositol. Cholesterol – definition, types (HDL, LDL and VLDL)

Sphingolipids–structure and biological significance of ceramide.

Unit III: Proteins 6h

α-amino acids: Introduction, structure, classification on the basis of polarity of R-groups, essential and non essential amino acids, ionic properties and reactions of amino acids with alcohol, nitrous acid and Ninhydrin. Levels of organizations of Protein: Primary structure, Secondary structure (a-helix, triple

helix eg., Collagen and ß-pleated sheet), tertiary structure and forces stabilizing it, quaternary structure.

Denaturation and renaturation: Thermal renaturation-Aufinsen's experiment with ribonuclease.

Classification of proteins based on structure, composition and biological function

(enzymes, hormones, transport agents, antibodies, structural materials with examples).

Unit V: Nucleic Acids 3h

Types–Components of nucleic acids, bases, nucleosides and nucleotides with structures.

Partial structure of polynucleotide.

Structure of DNA (Watson-Crick model) and RNA. Biological roles of DNA and RNAs.

Protein-nucleic acid interaction-chromatin and viral nuclear capsid.

Unit VI: Hormones 03h

Definition. Classification -a) amino acid derivatives (epinephrine and thyroxine); b) peptide

(oxytocin and vasopressin) and polypeptide hormones (insulin and glucagon); c) Steroid

hormones (progesterone, testosterone) with functions.

Role of insulin and glucagon in glucose homeostasis.

Mediators of hormone action – Ca 2+ , cyclic AMP.

Unit VII: Enzymes 05h

Introduction, Holo enzyme (apo enzyme and co enzyme).Active site, specificity.

Classification of enzymes (EC code number not required).

Enzyme substrate interaction-Fischer and Koshland models.

Enzyme kinetics–factors affecting rate of enzymatic reactions – enzyme concentration,

substrate

concentration, pH and temperature (mention M. M. equation).

Allosteric enzymes–definition and example

Enzyme inhibitions-Competitive, noncompetitive and uncompetitive inhibition with one

example for each.

Unit VIII: Biological Oxidation 06h

Bioenergetics-Introduction-stages of energy transformation. Exergonic and endergonic reactions. Relationship between ΔG and Keq.

High energy phosphates–definition, examples, structural features of ATP that makes ATP a high energy phosphate (electro static repulsion, opposing resonance, solvation of ATP). Examples of high energy phosphates other than ATP. Energy coupling in biological reactions

(Explain the concept with suitable examples).

Biological oxidation – comparison of oxidation with combustion using glucose as an example.

Redox potentials of some biological important half reactions. Calculation of energy yield from biological redox reaction (oxidation of NADH by oxygen, reduction of acetaldehyde by NADH).

Mitochondrial electrotransport chain, oxidative phosphorylation. Substrate level phosphorylation.

Unit IX: Metabolism 07h

Catabolism and anabolism (explanation with an example) – Carbohydrate metabolism, glycolysis, fate of pyruvate. TCA cycle, energetic.

Gluconeogenesis–definition, synthesis of glucose from lactate.

Fatty acid metabolism–activation of fatty acids, role of carnitine, ß-oxidation pathway, energetics.

Protein metabolism–general aspects of amino acid degradation – transamination, deamination and decarboxylation. Urea cycle.

Unit X: Molecular Biology 04h

Central dogma of molecular biology–semi conservative replication and mechanism of DNA replication, transcription, translation.

DNA finger printing – Definition and its applications.

References

1. Concise Text Book of Biochemistry T. N. Pattabhiraman, All India Publishers, 2000. .

2. Biochemistry A. L. Lehningeret. al., CBS, 2000.

3. A Text Book of Biochemistry A. V. S. S. Rama Rao, UBSPD, 1998.

4. Biochemistry P. C. Champe and R. A. Harvey, J. B. Lipincott & Co, 1982.

5. Fundamentals of Biochemistry J. L. Jain, S. Chand & Co., 1983.

Practical VI: 15CH372- Inorganic Chemistry and Basics In Biochemistry

1. Estimation of percentage of iron in haematite using barium diphenylamine sulphonateas an internal indicator.
2. Estimation of calcium in lime stone.
3. Estimation of zinc using EDTA.
4. Gravimetric estimation of barium as barium sulphate.
5. Preparation of sodium trioxalatoferrate (III) and estimation of iron.
6. Estimation of nickel using EDTA and standard zinc sulphate.
7. Preparation of ferrous oxalate and its analysis (both iron and oxalate).
8. Determination of total acidity of vinegar and wines by acid-base titration.
9. Determination of purity of a commercial boric acid sample, and of Na_2CO_3 content of washing soda.
10. Titration of chromate-dichromate mixtures by acid-base titration.
11. Preparation of buffers and determination of their pH values using pH meter.
12. Estimation of reducing sugars by Hegdorn-Jensen method.
13. Estimation of lactose in milk by Nelson-Somyogi's method.
14. Estimation of creatinine by Jaffe's method.
15. Estimation of inorganic phosphate by Fiske-Subbarow method.
16. Estimation of total reducing sugars by DNS (dinitrosalicylic acid) method.
17. Isolation of lactose and casein from milk and estimation of lactose by colorimetric method.
18. Identification of α-amino acids by paper chromatography.
19. Isolation of DNA from onions.

20. Estimation of cholesterol by colorimetric method.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGICAL SCIENCES

5TH Semester B.Sc – Zoology Syllabus

Theory: 15ZG301 – Genetics and Evolutionary Biology

Total Credit Hours: 45 hrs

PART A - GENETICS

Unit1:Heredity and Environment12h

Definition of genotype, phenotype, hereditary disease, studies on human twins.

A brief account of Mendel and his works. Simple problems in Mendelism.

Deviations from Mendelism: Incomplete Dominance; Interaction of genes, Linkage and crossing over, chromosome mapping.; Epistasis;Multiple alleles: ABO and Rh blood groups inheritance and their applications - Solving problems.; Sex Linkage: Eye colour in Drosophila, colour blindness and Haemophilia in man - Solving problems; Multiple factor inheritance: Inheritance of skin colour and eye colour in man.

Unit2: Genetic Sex Determination and Human Karyotyping 5h

Genetic determination Sex: XX-XY, XX-XO AND ZZ-ZO types. Genic balance theory of Bridges; Gynandromophs and Free martins.

Human Karyotyping: Non-disjuction of sex chromosomes in man, Klinefelter's and Turner's syndrome. Autosomal anomalies-Down syndrome, Cri-du-chat syndrome.

Unit3: Gene mutations, Concept of gene and Eugenics 5h

Gene Mutations: Spontaneous and induced mutations, CIB Method of detection of mutations, chemical matagens, Effects of radation.

Concept of Gene: Classical concept, dominant and recessive, genome, fine structure of the gene-cistron, muton and recon.;Operon Concept, position effect.

Eugenics: Definition; positive and negative aspects, Genetic counseling euthenics and Euphenics.

Unit4: Genetic Engineering and Biotechnology5h

Endonucleases, Plasmids, cloning, Recombinant DNAtechnology.

DNA finger printing, DNA chip technology, DNA vaccines, PCR and DNA

Sequencing, Applications of genetic engineering in pharmaceuticals, food technology, agriculture and industries. Insulin and Interferon, Useful and harmful effects of Biotechnology

PART B: EVOLUTIONARY BIOLOGY

Unit5: Theories of organic evolution 06h

Lamarckism, Darwinism,Critical account of Darwinism,Neo-Darwinism,Elementary forces of evolution; Mutation, selection and genetic drift. Population genetics and evolution: Hardy-Weinberg law, Origin of New species. Role of isolation.

Unit6: Evidences for evolution 12h

Anatomical and morphological, serological and embryological; Palaentological evidences; Fossils: Definition, their importance, formation types of Fossils; Dating of fossils: Uranium lead method, potassium-argon method, radio Carbon method;Geological time scale-Eras, periods, Epochs with major fauna of each period.

Zoogeographical evidence: Continental drift, Distribution of animals, isolation, mechanisms and speciation

Evolution of horse: Hyracotherium, Mesophippus, Merichippus, Equus.

Evolution of modern man: Australopithecus Ramapithecus, Java Man, Peking man, Neandrethal Man, Cromagnon Man.

DAYANANDA SAGAR UNIVERSITY
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DEPARTMENT OF BIOLOGICAL SCIENCES

5TH Semester B.Sc – Zoology Syllabus

Theory: 15ZG321 – Environmental Biology

Total Credit Hours: 45 hrs

Unit1: Fundamentals in Ecology 0**3h**

Introdution, sub-divisions and scope of ecology.

Concepts of Habitat and Niche: Niche: Definition-Types-Spatial, trophic and multidimensional; Habitat: Definition-microhabitat and macrohabitat.

Unit2: Environmental factors **08h**

Temperature: Thermal stratification, Range of tolerance, Piokilothermy and

Homeothermy.

Light: Distribution, Ecological effects, Photoperiodism and Bioluminescence.

Water: Structure of water, Sources of water, Classification of animals on the basis of

water requirement-Hydrocoles, Xerocoles and Mesocoles. Properties of water.

Liebig's Law of Minimum and Shelford's Law of Tolerance.

Unit3: Energy flow in the ecosystem 0**4h**

Concept of productivity, Laws of thermodynamics, examples of energy flow in nature.

Unit4:Population Ecology **04h**

Population density, Natality, mortality, population growth, Biotic potential, population regulation, Human population explosion.

Unit5:Community Ecology **05h**

Intra and inter-specific interactions, Neutral (Neutralism), Positive (mutualism, protocooperation and commensalism) and negative (antibiosis, exploitation, competition)

Unit6: Animal Adaptations **04h**

Deep sea adaptation in Fish, Aerial adaptation in Insects, Desert adaptation in Camel.

Unit7:Pollution 06h

Definition, types-water, soil and air pollution, with Reference to industrial, thermal, organic and inorganic pollutants Bioremediation-Phytoremediation; Biomining

Unit8:Radiations and chemical hazards 05h

Thermal power projects, Measures of disposal, ozone layer, Green-house effect, global Warming

Unit9:Wildlife conservation and its management 06h

Red data book, Endangered species,Major wild life sanctuaries and national parks Of India. Major organizations involved in wild life conservation. Chipko and Appiko movements.

References

1] Fundamentals of Ecology by Eugene. P. Odum

2] Essential Environment by Dr M.K. Goyal.

Practical: 15ZG371 – Genetics and Evolutionary Biology

Total Credit Hours: 36 hrs

Problem solving practicals:

1. Monohybrid & Dihybrid inheritance

2. Sex linked inheritance in Drosophila

3. Buccal smear preparation for sex chromatin

4. Blood group in man

5.Study of Human Karyotypes (normal) and abnormal- (Turner's, Klinefelter's, Down' s and Cri-du-chat syndrome)

6.Study of Homolgous organs:

a) Forelimb of Frog and Bird

b) Mouthparts of Cockroach and Mosquito

7. Serial Homology: Appendages of prawn

8.Study of Analogous organs: Vertebrate eye and ciphalopod eye, wing of Bird and

insect.

9.Study of Vestigeal Organs: Appendix, coccyx, molar tooth study of fossils. 1unit

10.Whole mount preparations: Fish scales, Colenterate Colonies, mouth parts of

insects

11. Submission of report on: Evolution of Camel, Evolution of Elephant, Evolution of Man 1unit

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF CHEMISTRY
Sixth Semester - Chemistry Syllabus

Paper: Inorganic & Analytical Chemistry

Paper Code: 15CH302 **Total Credit Hours: 45**

Unit 1: Co-ordination and Organometallic compounds **8h**

Coordination compounds, terminologies, ligands and their classification (mono, bi, tri, tetra, penta and hexa dentate ligands) and ambidentate ligands, coordination number, nomenclature of coordination compounds. Theories of structure and bonding (Explanation for the formation of complexes by Werner's Theory taking cobalt amine complexes). EAN rule, Valence bond theory-postulates, low spin and high spin complexes with examples (cobalt and nickel based complexes), limitations of VBT. Crystal field theory (octahedral, tetrahedral and square planar complexes). Magnetic properties of $[CoF_6]^{3-}$, $[Fe(CN)_6]^{4}$Spectral properties of $[Ti(H_2O)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$Isomerism-Structural: ionization, linkage, hydrate and coordination isomerism with examples. Stereoisomerism-geometrical and optical isomerism in cobalt amine complexes.

Unit 2: Organometallic compounds **4h**

Ligands, classification (hapticity). Synthesis and structure of $K[PtCl_3(\eta^2\text{-}C_2H_4)]$

Metal carbonyls – $Cr(CO)_6$, $Mn_2(CO)_{10}$; eighteen electron rule and its deviations with examples.

Applications of coordination/organometallic compounds: cis-platin in cancer therapy, Na_2Ca EDTA in the treatment of heavy metals (Pb, Hg) poisoning, Wilkinson's Catalyst in alkene hydrogenation.

Unit III: Chemical Spectroscopy I **7H**

The interaction of electromagnetic radiation radiation with matter.Regions of electromagnetic spectrum and associated spectroscopic techniques.

Origin of molecular absorption spectra: Born-Oppenheimer approximation.

Vibrational spectroscopy: Hooke's law-Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero point energy.Degrees of freedom of polyatomic molecules– fundamental modes of vibration for CO_2 and H_2O molecules.

Raman spectroscopy

Concept of polarisability. Stokes and anti-Stoke's lines-selection rules.

Advantages of Raman spectroscopy over IR spectroscopy.

Electronic spectroscopy: Electronic spectroscopy of molecules, basic principles, Selection rules and Franck-Condon principle.

Unit IV: Spectroscopy II **6h**

UV-Visible spectroscopy: Principle, Chromophores and auxochormes; blue shift and red shift. Influence of conjugation on UV absorption; graphical representation of spectra of 1,3-butadiene and benzene. Comparison of UV spectra of acetone and methyl vinyl ketone.

IR spectroscopy: Principle and group frequencies Stretching frequencies of -OH (free and H-bonded), alkyl –C-H, C=C, C≡C C=O, C-X and C-O groups (by taking suitable examples).

NMR spectroscopy: Basic principle of proton magnetic resonance: Nuclear magnetic spin quantum number I, influence of the magnetic field on the spin of nuclei, spin population, saturation using radio frequency. Chemical shift (δ values), TMS as reference. Nuclear shielding and deshielding (acetylene and benzene).Equivalent and non-equivalent protons.Effect of electronegativity of adjacent atoms on chemical shift values.Applications of NMR spectroscopy including identification of simple organic molecules.

Unit V: Chromatography **12h**

Principles of chromatography: Distribution coefficients, types of chromatography, selection of stationary and mobile phases in TLC, analyte development and elution. Chromatographic performance parameters-Retention time and volume, capacity factor, plate height and resolution.

Thin layer chromatography: Principle, apparatus-preparation of plates, sample application, plate development, detection of analytes. Applications.

Gas-liquid chromatography: Principle. Instrumentation, columns, sample application, mobile phase, stationary phases, detectors. Applications.

HPLC principles: Instrumentation-columns, stationary phase and matrices, sample application, mobile phases, detectors. Fast protein liquid chromatography [FPLC].

Ion-exchange chromatography: Principle and applications.

Unit VI: Electroanalytical Methods **5h**

Voltammetry at a dropping mercury electrodes (DME)-Types of current obtained at DME. Ilkovic equation and its applications. Current –potential relation for a cathodic process – half wave potential.

Cyclic Voltammetry-Principles-Experimental set up-Quantitative analysis, determination of diffusion coefficients.

Unit VI: Analytical chemistry **3h**

Analytical chemistry- scope of analytical chemistry.Errors and treatment of analytical data: Limitations of analytical methods-Error-determinate and indeterminate errors, minimization of errors. Accuracy and precision.Distribution of random errors, the normal error curve.Statistical treatment of finite samples-measures of central tendency and variability-mean, median, range, standard deviation and variance.Student's t-test.

References

1. Principles of Inorganic Chemistry B. R. Puri and L. R. Sharma, Jauhar S. P-S. N. Chand & Co., 1998
2. Inorganic Chemistry, ELBS 2nd Edition D. F. Shriver, P. W. Atkins and C. H. Langford, Oxford Univ. Press 2002.
3. Inorganic Chemistry, 4th Edition J. E. Huhee, E. A. Keiter and R. I. Keiter, Pearson Education Asia, 2000
4. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
5. Analytical Chemistry, G.D. Christian, 5th ed., 2001 John Wiley & Sons, Inc, India.
6. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 prentice Hall, Inc. New Delhi.

Practical 15MB371: Agricultural Microbiology and Environmental Microbiology

1. Isolation and enumeration of bacteria, fungi and actinomycetes from rhizosphere soil
2. Examination of bacteriodes from legume root nodules
3. Isolation of symbiotic and non-symbiotic nitrogen fixing microorganisms
4. Demonstration of fungal contaminants in ground nut by standard blotter method
5. Effect of seed borne fungi on seed germination and seed vigour.
6. Study of plant pathogens (specimens/charts)- Bacteria (Citrus canker, bacterial blight of rice), Fungi (Tikka Disease of ground nuts, red rot of sugarcane, rust of sorghum), virus (tobacco mosaic virus), mycoplasma (sandal spike)
7. Study of antagonism between soil microorganisms
8. Isolation of air borne microorganism by petriplate exposure method
9. Estimation of dissolved oxygen in water
10. Determination of Biological Oxygen Demand
11. Standard water quality analysis by MPN test
12. Estimation of total solids in sewage
13. Field visit to agriculture fields and sewage treatment plant

REFERENCES

1. Alexander M., Introduction to Soil Microbiology, Wiley Eastern Limited, New Delhi.
2. Alexopoulas C.J and Mims C.W., Intoductory Mycology, New Age International, New Delhi.
3. Aneja K.R., Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation, New Age International, New Delhi.
4. Agrios, G. Plant Pathology
5. Mehrotra R.S., Plant Pathology, Tata McGraw Hill Publications Limited, New Delhi.
6. Subbaroa N.S, Soil Microorganisms and Plant Growth, Oxford and IBH Publishing Company, New Delhi.
7. Bhatia A.L, Textbook of Environmental Biology. I.K. International Publishing Housing Ltd. New Delhi. 2009.
8. Atlas R.M. Handbook of media for environmental microbiology. CRC press.
9. Francis H Chapelle. Ground Water Microbiolgy and Geochemistry. 2nd Edition. ASM press.
10. Baker K.H and Herson D.S. Bioremediation. McGraw Hill Inc., New York. 1994.
11. Jabir Singh Solid Waste Management. I. K. International Publishing House Ltd. New Delhi. 2010.
12. Patrik, K. Jjemba. Environment Microbiolgy: principles and applications. Science Publishers.

DAYANANDA SAGAR UNIVERSITY
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DEPARTMENT OF BIOLOGICAL SCIENCES

Semester VI - B. Sc. Biochemistry syllabus

Paper1: 15BC302 Bioenergetics and Molecular Physiology **45h**

Unit 1Bioenergetics **08h**

Bioenergetics, Energy transformation in living systems and concept of free energy; Exergonic and endergonic reaction, ATP and other high energy compounds, energy coupling. Biological oxidation, standard reduction potentials of same biochemically important half-reactions, calculation of energy yields from biological oxidation reduction reactions.

Unit 2 Biological oxidation **10h**

Mitochondrial electron transport chain-components, reactions and structures, schematic representation indicating sites of ATP synthesis. Oxidative phosphorylation – ATPase-structure (rotor-stator model) and function, Chemiosmotic theory, Regulation of ETC, thermogenin, Isolation of ETC components.

Unit 3Endocrinology **11h**

Hormones - definition, classification, hormone cascade system, target gland, feedback mechanisms.

Signal transduction - G-protein as cellular transducer, adenylatecyclase system, cAMP - synthesis and degradation, cGMP, inositol triphosphate, DAG and calcium release, Protein kinases and signaling cascade – brief idea.

Functions of pancreatic, adrenal, pituitary and GIT hormones.

Structure, biosynthesis, transport of steroid hormones in blood and functions: cortisol, aldosterone, testosterone, 17β - estradiol, progesterone and calcitriol. Steroid hormone receptors, hormone binding domain & DNA binding domain.

Unit 4 Molecular Biology **6h**

Central dogma, prokaryotic and eukaryotic genomes, complexity of genomes, Enzymes and proteins related to prokaryotic replication and transcription.

Unit 5 Cell cycle and Apoptosis **10h**

Cell cycle; Cyclins and cyclin-dependent kinases, entry of cell from G2 to M – phase, Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest.

Apoptosis: Caspases - function and activation. Intrinsic and extrinsic pathway.Factors initiating apoptosis and steps leading to cell death.Anti-apoptotic proteins, tumor suppressor gene proteins and inhibition of cancer.

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DEPARTMENT OF BIOLOGICAL SCIENCES

Semester VI - B. Sc. Biochemistry syllabus

Paper 2: 15BC303 Chemistry and Metabolism of lipids and nucleic acids **45h**

Unit 1 Lipid Chemistry **12h**

Classification of lipids.

Fatty acids: Hydrolysis, Rancidity, acid-, saponification- and iodine-values of fatty acids.

Structures and nomenclature of dodecanoic, stearic, oleic, linoleic, linolenic and docosahexanoic acid.

DAG: Structures and biological roles of phospholipids (phosphoacetyl choline, phosphoethanol amine, phosphoserine, phosphoinositol and cardiolipin), sphingolipids (glycosphingolipids, gangliosides and cerebrosides) and glycolipids (galactolipids, sulpholipids) .

Arachidonic acid derivatives: An overview of biological roles of prostaglandin, thromboxane and leukotrienes, structure of PGE2 and PGE3.

Lipoproteins & GPI-linked proteins: Types and functions.

Membranes: Gel-fluid transition, Behavior of amphipathic lipids in water, formation of bilayer and non-bilayer phases. Fluid-mosaic model.

Steroids - Function of hopnoids, cholesterol, androgen and estrogens.

Lipid peroxidation and its role as a stress marker.

Unit 2 Lipid Metabolism **14h**

The β-oxidation pathway of even and odd numbered, saturated and unsaturated fatty acids along with α and ω-oxidation (only scheme), Calculation of ATP/lipid molecule, Structure and function of fatty acyl synthase, General scheme of biosynthesis of fatty acids. Outline of cholesterol biosynthesis. Ketone bodies, atherosclerosis.

Unit 3 Nucleic acids **13h**

Components of nucleic acids nucleosides, nucleotides and poly nucleotides, properties of nucleic acids, Chemical synthesis of oligonucliotides.

DNA: Biological role, structure, polymorphism, denaturation, renaturation and T_m. Structural organization of prokaryotic and eukaryotic DNA, Nucleoproteins.

RNA: Types, secondary structure and biological role of various RNA

Unit 4 Nucleic Acid Metabolism **6h**

Outline of purine and pyrimidine metabolism. Hyperuricemia& other inborn errors.

Practical: 15BC471 Estimation of biomolecules

[1] Qualitative analysis of
  a. carbohydrates,
  b. amino acids,
  c. proteins,
  d. lipids and
  e. Preparation of solid derivatives of monosaccharides – osazone crystal.
[2] Estimation of amino acids by formal titration.
[3] Estimation of ascorbic acid from biological samples by titrimetric method.
[4] Determination of iodine value of a lipid.
[5] Determination of saponification number of lipid
[6] Determination of cholesterol by Zlatkis and Zak's method
[7] Determination of ketone by Zimmerman's method

References:

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers
2. Principles of Biochemistry – Zubay, Parson and Vance. MedTech Publishers.
3. Biochemistry – Harper. Lange Publications, 2nd Ed
4. Biochemistry – Voet and Voet. Wiley & Sons. 4th Ed
5. Biochemistry with medical correlation – Devlin. Wiley & Sons.
6. Biochemistry – Vasudevan&Srikumari, Jaypee Publishers.
7. Molecular Biology of the Cell – Alberts, Johnson, Lewis &Raaf. Garland Publications.
8. Cell and Molecular Biology: Concepts and Experiments – Karp. Wiley & Sons, 4th Ed
9. Molecular Cell Biology – Baltimore, Scientific American Publishers, 8th Ed,
10. Introductory Practical Biochemistry- Sawhney and Singh. Narosa Publishing house. 2012, 7thed

DayanandaSagar University, Bangalore

B.Sc.- BIOTECHNOLOGY

VI SEMESTER SYLLABUS

15BT303 Plant Biotechnology **45 hours**

Unit 1 Introduction to Plant Tissue Culture **15 hours**

History and Overview, Concepts on differentiation and totipotency, Basic organization of Plant tissue culture lab, Instruments, sterilization of media and explants. Initiating plant tissue culture, Aseptic techniques, Components of tissue culture media, use of growth regulators (auxins, cytokinins, gibberlins).

Unit 2 Different types of tissue culture **12 hours**

Micro-propagation, bud and meristem tip culture, stages, factors affecting micro-propagation, applications. Organ culture – anther and ovule culture. Basic concepts of Organogenesis and embryogenesis

Unit 3 Protoplast culture and Somatic Hybridization **10 hours**

Protoplast culture – isolation, mechanical, enzymatic, culture of protoplast and plant regeneration

Methods of protoplast fusion – mechanical, chemical and electro fusion, application, Concept of Somatic hybridization, Somaclonal Variants – introduction and their significance.

Unit 4 Transgenics and Applications of Plant Biotechnology **08 hours**

Transgenic plants – technique of transformation (*Agarobacterium* mediated, physical and chemical methods of gene transfer), application of transgenic plants. Role of Plant tissue culture in health, agriculture, horticulture and forestry.*In vitro* production of secondary metabolites.

References

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing
2. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.
3. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
4. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
5. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
6. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.

Practicals - 15BT371: Immunology and Animal Biotechnology

1. Blood group identification and Rh Typing
2. Precipitation Reactions - Radial Immuno Diffusion, Ouchterlony double diffusion, Rocket Immuno Electrophoresis
3. Dot ELISA
4. Serum separation and quantification of serum proteins (2 units)
5. Differential Count of WBC
6. Introduction to instruments and laboratory set up for animal biotechnology
7. Preparation of media for animal cell culture (2 units).
8. Isolation of liver parenchyma cells by mechanical method and set up primary culture (2 units)
9. Determination of the concentration of viable cells in a suspension by Haemocytometer counting (trypan blue)
10. Isolation of cells by explant method and Sub-culturing (2 units)
11. Visits to Industry/Mining regions/Waste Water or Sewage treatment plants

References

1. Kuby J (2007) Immunology (6th Ed), WH Freeman & Co.
2. Roitt IM (2001) Essentials of Immunology, Blackwell Scientific Publishers, London.
3. Abbas, Lichtman, Pilliai (2011) Cellular and Molecular Immunology (7th Ed), Elsevier Health
4. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
5. Singh, Gautam, Chauhan, Singla (2013) Textbook of Animal Biotechnology, TERI
6. R Ian Freshney (2010) Culture of Animal Cells (6th Ed), Wiley-Blackwell
7. John Davis (2011) Animal Cell Culture Essential Methods, Wiley & Sons

DayanandaSagar University, Bangalore

B.Sc.- BIOTECHNOLOGY

VI SEMESTER SYLLABUS

Practicals - 15BT372 Genetic Engineering and Plant Biotechnology

1. Preparation of competent cells (2 units)
2. Transformation of Plasmid DNA in competent cells and screening of transformants (2 units)
3. Isolation of plasmid DNA and analysis using gel electrophoresis (2 units)
4. Restriction digestion and ligation (2 units)
5. Amplification of DNA by PCR (Demo)
6. Plant tissue culture laboratory organization and Instruments
7. Preparation of plant tissue culture media – MS media (2 units)
8. Aseptic techniques and surface sterilization of explants
9. Establishment of callus culture, subculture of callus (2 units)
10. Production of synthetic seeds.

***Practical*: 15BC372 Estimation of biomolecules**

1. Qualitative analysis of

a. carbohydrates,
b. amino acids,
c. proteins,
d. lipids and
e. Preparation of solid derivatives of monosaccharides – osazone crystal.

2. Estimation of amino acids by formal titration.
3. Estimation of ascorbic acid from biological samples by titrimetric method.
4. Determination of iodine value of a lipid.
5. Determination of saponification number of lipid
6. Determination of cholesterol by Zlatkis and Zak's method
7. Determination of ketone by Zimmerman's method