DAYANANDA SAGAR UNIVERSITY

SHAVIGE MALLESHWARA HILLS, KUMARASWAMY LAYOUT
BENGALURU–560 111, KARNATAKA.

SCHOOL OF BASIC & APPLIED SCIENCES

SCHEME & SYLLABUS
FOR
MASTER OF SCIENCE (M.Sc.) – 2021

SPECIALIZATION: BIOTECHNOLOGY

(With effect from 2020-21)

(Update From I to IV Semesters)

SCHEME –M.Sc.– BIOTECHNOLOGY– 2020-21 ONWARDS

I SEM M.Sc. – BIOTECHNOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	207	20MSC5101	FUNDAMENTALS OF CHEMISTRY	CR	4	-	-	-	4	60	40
2	207	20MSC5102	BIOMOLECULES	CR	4	-	-	-	4	60	40
3	207	20MSC5103	MOLECULAR GENETICS	CR	4	-	-	-	4	60	40
4	207	20MSC5104	GENERAL MICROBIOLOGY	CR	4	-	-	-	4	60	40
5	207	20MSC5105	BIOINFORMATICS – I (PROTEOMICS)	CR	2	-	-	-	2	60	40
6	207	20MSC5106	BIOSTATISTICS	CR	2	-	-	-	2	60	40
7	207	20MSC5171	ANALYSIS OF BIOMOLECULES – LAB	CR	-	-	6	-	3	100	0
8	207	20MSC5172	TECHNIQUES IN MICROBIOLOGY AND GENETICS – LAB	CR	-	-	6	-	3	100	0
					20	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME –M.Sc.– BIOTECHNOLOGY– 2020-21 ONWARDS

IISEM M.Sc. – BIOTECHNOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	207	20MBT5201	GENETIC ENGINEERING	CR	4	-	-	-	4	60	40
2	207	20MBT5202	ADVANCED CELL BIOLOGY	CR	4	-	-	-	4	60	40
3	207	20MSC5201	MOLECULAR BIOLOGY	CR	4	-	-	-	4	60	40
4	207	20MSC5202	ANALYTICAL TECHNIQUES	CR	4	-	-	-	4	60	40
5	207	20MSC5203	BIOINFORMATICS – II (GENOMICS)	CR	2	-	-	-	2	60	40
6	207	20MSC5204	EVOLUTION AND DEVELOPMENTAL BIOLOGY	CR	2	-	-	-	2	60	40
7	207	20MBT5271	CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB	CR	-	-	6	-	3	100	0
8	207	20MSC5271	BIO-ANALYTICAL TECHNIQUES - LAB	CR	-	-	6	-	3	100	0
GRAND TOTAL = 800					**20**	**-**	**12**	**-**	**26**	**560**	**240**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME –M.Sc.– BIOTECHNOLOGY– 2020-21 ONWARDS

III SEM M.Sc. – BIOTECHNOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
1	207	20MBT5301	IMMUNOLOGY	CR	4	-	-	-	4	60	40
2	207	20MBT5302	INDUSTRIAL BIOTECHNOLOGY	CR	4	-	-	-	4	60	40
3	207	20MBT53XX	ELECTIVE – I	CR	3	-	-	-	3	60	40
4	207	20MBT53XX	ELECTIVE – II	CR	3	-	-	-	3	60	40
5	207	20MBT53XX	ELECTIVE – III	CR	3	-	-	-	3	60	40
6	207	20MSC5301	CLINICAL RESEARCH	CR	2	-	-	-	2	60	40
7	207	20MSC5302	SCIENTIFIC WRITING AND IPR	CR	2	-	-	-	2	60	40
8	207	20MSC5303	RESEARCH METHODOLOGY	CR	2	-	-	-	2	60	40
8	207	20MBT5371	BIOPROCESS TECHNOLOGY AND IMMUNO-TECHNIQUES - LAB	CR	-	-	6	-	3	100	0
9	207	20MBT5372	PRACTICAL BASED ON ELECTIVES (I To III)	CR	-	-	6	-	3	100	0
					23	**-**	**12**	**-**	**29**	**680**	**320**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

SCHEME –M.Sc.– BIOTECHNOLOGY– 2020-21 ONWARDS

IV SEM M.Sc. – BIOTECHNOLOGY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	SEE
2	207	20MSC5401	PROJECT WORK	CR	-	-	36	-	18	240	160
					-	**-**	**36**	**-**	**18**	**240**	**160**

CR – Credit, AU – Audit, L – Lecture, T – Tutorial, P – Practical, S/P – Seminar/Project, C – No. of Credits,
CIA – Continuous Internal Assessment

LIST OF PROGRAM ELECTIVE COURSES

SL	COURSE CODE	COURSE
1	20MBT5321	PLANT BIOTECHNOLOGY
2	20MBT5322	ANIMAL BIOTECHNOLOGY
3	20MBT5323	PRINCIPLES OF ENZYMOLOGY AND METABOLISM
4	20MBT5324	HEALTH AND ENVIRONMENTAL BIOTECHNOLOGY
5	20MBT5325	GENOMICS AND PROTEOMICS
6	20MBT5326	HUMAN GENETIC DISEASES

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) :
3. No
4. No

TEXT BOOKS:

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	**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 DNA

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 mutagenesis

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 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. No	
2. No	
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.

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 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.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
3. No
4. 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 Hrs**
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.	

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	**20MSC5172**					
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.

11.	Concept of Multiple Alleles in Humans (Blood group).
11.2.	Genetics problems (Mendelian Genetics, epistasis, Sex-linked inheritance, Lethal Gene inheritance).

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	**20MBT5201**					
TITLE OF THE COURSE	**GENETIC ENGINEERING**					
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
1			

COURSE OBJECTIVES :

- To familiarize the students with the basic concepts in genetic engineering.
- To expose students to the application of recombinant DNA technology in biotechnological research.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understanding the basic concepts in genetic engineering	L2
CO2	Application of recombinant DNA technology in biotechnological research.	L3
CO3	Can use and apply the knowledge of genetic engineering in problem solving and in practice.	L4

COURSE CONTENT:	
MODULE 1 : 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 2: 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 3: 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 4: 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).

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

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. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
3. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication

REFERENCES :

1. Brown TA, Genomes, 3rd ed. Garland Science 2006
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut.
4. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
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 II

YEAR **I**
COURSE CODE **20MBT5202**
TITLE OF THE COURSE **ADVANCED CELL BIOLOGY**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

Perquisite Courses (if any) **Fundamentals of Cell and Developmental Biology**			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To understand an advanced understanding of cell biology.
- To enable the students to understand the process of cell division, cell cycle, cell cycle control, membrane transport, cellular junctions and cellular signaling mechanisms.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students should have basic knowledge on the structure and functions of cellular organelles.	L2
CO2	Students should be able to understand the concept of cell cycle, its control and different stages in cell division.	L2
CO3	Students should be able to understand different types of transport across the plasma membrane	L3
CO4	Students should be understand major processes that occur within cells, including: principles of cell signalling, regulation of cell shape, cell division, apoptosis.	L4

COURSE CONTENT:	
MODULE 1 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 2 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 3 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 4 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).	

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

TEXT BOOKS :

1. Karp, G. (2096). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.

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.

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. NO
2. NO

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	**0**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES :

- To provide students with a deeper insight into the evolutionary processes, both selective and random.
- To provide a comprehensive understanding of the concepts of early animal development.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Describe evolutionary history of complex multicellular life forms	L3
CO2	Explain the molecular and genetic background of animal and plant development	L3
CO3	Describe evolutionary history of complex multicellular life forms	L4
CO4	Interpret, analyse and present experimental results and conclusions in a scientific manner.	L3
CO5	Learning comparative anatomy, developmental mechanisms of organs, and methodologies to integrate genetics	L2

COURSE CONTENT:

MODULE 1	**13Hrs**

Ecology and Evolution

Ecology and Evolution

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	**13Hrs**
Developmental Biology **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 :

Concepts of Ecology, Edward.J.Kormondy

Ecology and environmental science, S.V.S. Rana

Cell biology, Genetics, Molecular biology, evolution and ecology

Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison- Wesley Publishing Company.

Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.

Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).

Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).

Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)

Development Biology by N Arumugam,Saras Publication (2014).

SEMESTER **II**
YEAR **I**

COURSE CODE **20MBT5271**

TITLE OF THE COURSE **CELL BIOLOGY AND RECOMBINANT DNA TECHNOLOGY - LAB**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**52**	**3**

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

COURSE OBJECTIVES :

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

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will understand the basic concepts of microscopy, get clear picture of concept they study in theory like mitosis and an inactivated X- chromosome.	L2
CO2	Students will understand how to measure cell size and identify different blood cells	L3
CO3	Student will understand molecular cloning techniques.	L4

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

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	**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	**20MBT5301**					
TITLE OF THE COURSE	**IMMUNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credi
	4	**1**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- Impart fundamental concepts of Immune system and its workings.
- Instil basic understanding of MHC, TCR, antibodies, antigens, T cells, specific immune response; application of antibodies as reagents.
- instill principles of vaccines as disease preventive agents; principles of hypersensitivity and autoimmune disorders.

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will develop a clear basic understanding of the fundamentals of mammalian immune system : cells organs and concepts	L3
CO2	.understand the nature of antigens, immunogenicity, antigenicity, Antibody structure, isotypes and functions	L3
CO3	Immunological receptor diversity concept ;Clonal selection and expansion ; immune response types of specific immune response	L4
CO4	Immune response to infectious disease; autoimmunity concepts	L3
CO5	Immunological techniques and vaccines as our defense against pathogens as well as the concept of vaccines as protective agents	L2

COURSE CONTENT:

MODULE 1 IMMUNE SYSTEM **11Hrs**

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

MODULE 2 ANTIGENS AND ANTIBODIES **11Hrs**

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 3 IMMUNE RESPONSES **11Hrs**

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. Complement activation, Classic, and alternative pathway and biological function. Immune response to infectious diseases ; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis; hypersensitivity reactions

MODULE 4 IMMUNOLOGICAL TECHNIQUES AND VACCINES 11Hrs

Concept of polyclonal vs monoclonal antibodies. Immunofluorescence ELISA ,Western blotting. Fractionation of leukocytes under density gradient.; Hybridomas and their production. Active & Passive immunization, Role of vaccines in prevention of diseases, Types of vaccines.

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

1.
2.

TEXT BOOKS :

1. Abdul, K., Abbas, Andrew K. L., Jordan, S. P. (1998). Cellular and Molecular Immunology. Sanders College Pub.
2. C Vaman Rao (2007) Immunology (2nd Ed), Narosa Publishing.
3. . Kuby, J. (2003). Immunology 5 Edition. WH. Freeman and Company, NY.

REFERENCES :

1. Benjamine, E., Cocoi., Sunshine. (2000). Immunology 4 th edition- Wiley- Liss. Publ.NY.

2. Kuby (2013) 7th Edition WH. Freeman and Company, NY.
3. Roitt, I.M. (1998). Essential Immunology, ELBS, Blackwell Scientific Publishers,London.
4 Kuby Immunology, 8th Edition | Macmillan Publishers 2019.
5 Tizard I.R.(1995). Immunology, 4 edition, Saunder College Pub.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5302**					
TITLE OF THE COURSE	**INDUSTRIAL BIOTECHNOLOGY**					
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
1			

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 :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be able to apply the knowledge in their future with respect to industrial biotechnology processes.	L2
CO2	Students will be updated with the current methods of fermentation process, modern fermenters and strategies for isolation of industrially important strains.	L3
CO3	The students will be able to design any fermentation production process to improve the production on completion of the paper.	L4

COURSE CONTENT:	
MODULE 1 Microbial growth, development and maintenance	**13Hrs**
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 2 Bioreactors and Fermentation **13Hrs**

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 3 **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 4 **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).

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

1.
2.

TEXT BOOKS :

1. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon Press, Oxford, 2097.
2 Prescott, Sc and Dunn, C. Industrial Microbiology, McGraw Hill, New York. 2084

REFERENCES :

1. Incropera, F.P. and DeWitt, D.P(2011). “Fundamentals of Heat and Mass Transfer , John Wiley
2. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 2091.
3 Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood Cliffs, 2002.

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 Michael, L. Shulers and Fikret Kargi. Bioprocess Engineering: Basic concepts (2nd Ed.) Prientice Hall Publishers. 2001
7 Paulins, M. D. Bioprocess Engineering Principles. John Wiley Publishers.2003

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5301**					
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
1	I	-	-

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 :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L3
CO2	Students will gain the concepts of designing and monitoring of clinical research studies.	L4

COURSE CONTENT:	
MODULE I: Concepts of Clinical Research	**13Hrs**
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	**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

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1.**NO**
2. **NO**

TEXT BOOKS :

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. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
7. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
8. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
9. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
10. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MSC5302**					
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
1	I	-	-

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.	L3
CO2	They will also get an idea about patent laws and will know how to file a patent	L4

COURSE CONTENT:	
MODULE I: Scientific writing	**13Hrs**
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	**13Hrs**
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 :

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	**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		**-**	**-**	**40**	**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	**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 II:	**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 III:	**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 IV:	**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.	

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	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5321**					
TITLE OF THE COURSE	**PLANT BIOTECHNOLOGY**					
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
1			

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 :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.	L2
CO2	Knowledge on various recombinant DNA techniques to produce genetically modified organisms with novel traits.	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
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 2: 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 3 : GM Technology and Plant Trait improvement	**10Hrs**
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 4 : Molecular Breeding: Molecular Mapping & Marker Assisted Selection	**10Hrs**
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.	

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

TEXT BOOKS :

1. HS Chawla (2009) Introduction to Plant Biotechnology (2nd Ed), Oxford and Ibh Publishing.
2. SD Purohit (2012) Introduction to Plant Cell, Tissue and Organ Culture, Prentice Hall India Learning Pvt Ltd.
3. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd.

REFERENCES :

1. Slater (2008) Plant Biotechnology – genetic manipulation of plants (2nd Ed), Oxford Publishing.
2. Santosh Nagar and MadhavAadhi (2010) Practical Book of Biotechnology and Plant Tissue Culture, S Chand Publications
3. B D Singh (2014) Biotechnology: Expanding horizons, Kalyani Publishers.
4. Halford N.G. Plant biotechnology: current and future applications of

genetically modified crops. John Wiley Publishers. 2006

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5322**					
TITLE OF THE COURSE	**ANIMAL BIOTECHNOLOGY**					
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
1			

COURSE OBJECTIVES :

- To acquaint the students with the basic concepts of animal cell culture set up and conditions.
- To equip the students with fundamentals of gene transfer methods for mammalian cells and animal transgenics followed by important applications of animal biotechnology

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Will learn about basic animal cell culture conditions and its uses.	L2
CO2	Be able to describe techniques and problems both technical and ethical in animal cloning.	L2
CO3	Will be equipped with the wide area of applications of biotechnology in modern world.	L3

COURSE CONTENT:	
MODULE I: Basics of Animal Tissue Culture	**10Hrs**
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 2: Stem Cells	**10Hrs**
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 3 : Transgenic animals	**10Hrs**
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 4 : Applications of Animal Biotechnology	**10Hrs**
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).	

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

TEXT 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.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5323**					
TITLE OF THE COURSE	**PRINCIPLES OF ENZYMOLOGY AND METABOLISM**					
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		

COURSE OBJECTIVES :

- To impart basic concepts of metabolisms of carbohydrates, amino acids, nucleotides and lipids, Oxidative phosphorylation and generation of ATP.
- To equip students with basic understandings of concept of enzymology

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Gain sufficient knowledge on the role of enzymes, Enzyme kinetics	L3
CO 2	Understand the basics of enzyme inhibition and the nature of their action in metabolism.	L3
CO 3	Students will be equipped with the basic concepts of metabolism of biological fuels in biological systems	L4
CO 4	Should have fundamental understanding of the oxidative phosphorylation process involved in ATP synthesis.	L3

COURSE CONTENT:	
MODULE 1 ENZYMES AND BASIC ENZYME KINETIC CONCEPTS	**10Hrs**
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 2 CARBOHYDRATE AND AMINO ACID METABOLISM	**10Hrs**

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 3 NUCLEOTIDE AND LIPID METABOLISM	**10Hrs**
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 4 OXIDATIVE PHOSPHORYLATION	**10Hrs**
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.	

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

TEXT BOOKS :

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. Nelson, D.L., Cox, M.M. Lehninger. (2004). Principles of Biochemistry 4th edition Pub: WH. Freeman Co.
4. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).

REFERENCES :

1. Enzyme kinetics and mechanisms. TAYLOR (Kenneth B). 2009, Kluwer Academic Press
2. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (1999).
3. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
4. Zubay, G.L. Parson, W.W., Vance, D.E. (1994). Principles of Biochemistry WmC Brown publishers. Oxford.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5324**					
TITLE OF THE COURSE	**HEALTH & ENVIRONMENTAL BIOTECHNOLOGY**					
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 impart basic knowledge in environmental science, issues and biotechnological applications in waste management.
- To familiarize students with basic concepts involving health and disease, infectious disease.
- To give conceptual knowledge of the principles behind molecular therapeutics and nanobiotechnology.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be equipped with basic foundation of Biotechnological applications to environmental and medical problems.	L3
CO2	2. Students will gain basic knowledge in application of nanobiotechnology to molecular therapeutics	L3

COURSE CONTENT:	
MODULE 1: Waste Water and Solid Waste Management	**10Hrs**
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 (nonhazardous, hazardous medical and electronic waste), composting and vermicomposting in solid waste management, biogas, biofertilizer, biofuel, bioplastics and biopesticides.	

MODULE 2: Application of Biotechnology in Environmental Management	10Hrs
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 3: Biology of Human Diseases	**10Hrs**
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 4: Molecular Therapeutics and Nanobiotechnology	**10Hrs**
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	

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

TEXT BOOKS :

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.Incropera, F.P. and DeWitt, D.P(2011). "Fundamentals of Heat and Mass transfer , John Wiley

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5325**					
TITLE OF THE COURSE	**GENOMICS & PROTEOMICS**					
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 course aims to appraise the students to basic and high throughput techniques in Genomics and Proteomics and their applications.
- 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 :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be equipped to infer the basic concepts of genomics, transcriptomics and proteomics.	L1
CO2	List and discuss the use of genomics and proteomics in human health.	L2
CO3	Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.	L3

COURSE CONTENT:	
MODULE 1: Genome Organization, structure and mapping	**10Hrs**
Brief overview of prokaryotic and eukaryotic genome organization; extra-chromosomal DNA: bacterial plasmids, mitochondria and chloroplast. Recognition of coding and noncoding 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 2: Genome sequencing and analysis	**10Hrs**
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 3: Proteomics	**10Hrs**
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 4: Functional and comparative Genomics 10 Hrs	**10Hrs**
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	

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

TEXT BOOKS :

1. 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	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5326**					
TITLE OF THE COURSE	**HUMAN GENETIC DISEASES**					
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 help students in understanding the genetic basis of different diseases.
- To familiarise students with basics of cytogenetic analysis

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will grasp the concepts of genetic basis of different diseases.	L1
CO2	Students will understand the basics of cytogenetic analysis	L2

COURSE CONTENT:	
MODULE 1: Genetic factors in common diseases	**10Hrs**
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 2: Biochemical genetics and pharmacogenetics	**10Hrs**
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 3: Cellular and molecular cytogenetic technologies	**10Hrs**

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 4: Diagnosis of prenatal and haematopoietic disorders	**10Hrs**
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.	

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

TEXT BOOKS :

1. 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 GeneticsOrigins, 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), McGrawHill.
   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	**III**					
YEAR	**II**					
COURSE CODE	**20MBT5371**					
TITLE OF THE COURSE	**BIOPROCESS TECHNOLOGY AND IMMUNOTECHNIQUES-LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			6	**60**		**3**

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

COURSE OBJECTIVES :

- To equip students with techniques for industrial production.
- To learn immune techniques used as diagnostic tools.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Should know the bioprocess techniques which can be used in industrial production.	L3
CO 2	Understand and carryout basic diagnostic immune techniques routinely used in medical laboratories	L3
CO 3	Get basic insights into various applications of Immunotechniques as quantitative tools	L4

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

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,
6. mineral oil and lyophilization.
7. Production of organic acids (citric acid) from microbes
8. Immobilization technique: whole cell or enzyme- sodium alginate gel method and
9. demonstration of its significance.

10. Production of antibiotic (penicillin) by submerged and solid substrate fermentation. Laboratory scale production of wine/beer.

11. Estimation of alcohol by specific gravity method and determination of total acidity and non-reducing sugars (2 units)

12. Sterility tests for pharmaceutical products
13. Production of amylase by solid substrate fermentation.

TEXT BOOKS :

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2 Balakrishnan, Senthilkumar & Karthik, Kaliaperumal & Duraisamy, Senbagam. (2015). Practical Immunology- A Laboratory Manual. 10.13140/RG.2.1.4075.4728.
3 Lab Manual in Biochemistry, Immunology and Biotechnology by Nigam, Arti - AbeBooks." McGraw-Hill Education (India) (2008)

REFERENCES :

1. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
2. 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	**III**
YEAR	**II**
COURSE CODE	**20MBT5372**
TITLE OF THE COURSE	**PRACTICAL BASED ON ELECTIVES (I ToIII)**

SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
			6	**-**	**84**	**3**

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

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 OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO 1	Have fundamental basic knowledge of tissue culture laboratory setting	L2
CO 2	Have sound understanding of tissue culture media preparation and lab practices	L3
CO 3	Have sufficient knowledge to carry out primary cell culture	L4
CO 4	Students will acquire practical knowledge of isolation and purification of enzymes.	L3
CO 5	Students will have fundamental practical knowledge of the techniques to use cell culture.	L4

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

TEXT 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 Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)
4 Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)
5 Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

REFERENCES :

1. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)
2. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).

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 Biotechnology, 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 Biotechnology which prepares students for productive careers and lifelong learning.	L5