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: BIOCHEMISTRY

(With effect from 2020-21)

(Update From I to IV Semesters)

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
PROPOSED SCHEME –MSc BIOCHEMISTRY – 2020 -21 ONWARDS

I SEM M.Sc. – BIOCHEMISTRY

SL	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING						SCHEME OF EVALUATION	
				L	T	P	S/P	C		CIA	END EXAM
1	20MSC5101	FUNDAMENTALS OF CHEMISTRY	CR	4	-	-	-	4	50	60	40
2	20MSC5102	BIOMOLECULES	CR	4	-	-	-	4	50	60	40
3	20MSC5103	MOLECULAR GENETICS	CR	4	-	-	-	4	50	60	40
4	20MSC5104	GENERAL MICROBIOLOGY	CR	4	-	-	-	2	50	60	40
5	20MSC5105	BIOINFORMATICS – I (PROTEOMICS)	CR	2	-	-	-	2	50	60	40
6	20MSC5106	BIOSTATISTICS	CR	2	-	-	-	3	50	60	40
7	20MSC5171	ANALYSIS OF BIOMOLECULES– LAB	CR	-	-	6	-	3	50	100	0
8	20MSC5172	TECHNIQUESIN MICROBIOLOGY AND GENETICS – LAB	CR	-	-	6	-	3	50	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. – BIOCHEMISTRY – 2020-2021

II SEM M.Sc. – BIOCHEMISTRY

SL	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	20MBC5201	METABOLISM –I	CR	4	-	-	-	4	60	40
2	20MBC5202	HUMAN PHYSIOLOGY	CR	4	-	-	-	4	60	40
3	20MSC5201	MOLECULAR BIOLOGY	CR	4	-	-	-	4	60	40
4	20MSC5202	ANALYTICAL TECHNIQUES	CR	4	-	-	-	4	60	40
5	20MSC5203	BIOINFORMATICS –II (GENOMICS)	CR	2	-	-	-	2	60	40
6	20MSC5204	EVOLUTION AND DEVELOPMENTAL BIOLOGY	CR	2	-	-	-	2	60	40
7	20MBC5271	CLINICAL BIOCHEMISTRY - LAB	CR	-	-	6	-	3	100	0
8	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. – BIOCHEMISTRY – 2020-2021 ONWARDS

III SEM M.Sc. – BIOCHEMISTRY

SL	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	END EXAM
1	20MBC5301	METABOLISM –II	CR	4	-	-	-	4	60	40
2	20MBC5302	ENZYMOLOGY	CR	4	-	-	-	4	60	40
3	20MBC53XX	ELECTIVE– I	CR	3	-	-	-	3	60	40
4	20MBC53XX	ELECTIVE– II	CR	3	-	-	-	3	60	40
5	20MBC53XX	ELECTIVE– III	CR	3	-	-	-	3	60	40
6	20MSC5301	CLINICAL RESEARCH	CR	2	-	-	-	2	60	40
7	20MSC5302	SCIENTIFIC WRITING AND IPR	CR	2	-	-	-	2	60	40
8	20MSC5303	RESEARCH METHODOLOGY	CR	2		-	-	2	60	40
9	20MBC5371	ENZYMOLOGY AND PROTEIN PURIFICATION - LAB	CR	-	-	6	-	3	100	0
10	20MBC5372	PRACTICAL BASED ON ELECTIVES (I To III)	CR	-	-	6	-	3	100	0
	GRAND TOTAL = 1000			**23**	**-**	**12**	**-**	**29**	**680**	**320**

LIST OF PROGRAM ELECTIVE COURSES

S. No.	Course Code	Course
1	20MBC5321	Immunology
2	20MBC5322	Molecular Physiology
3	20MBC5323	Genetic Engineering
4	20MBC5324	Membrane Biochemistry& Nanoscience
5	20MBC5325	Phytochemicals and Microbial secondary metabolites

SCHEME – M.Sc. – BIOCHEMISTRY – 2020-2021 ONWARDS
IV SEM M.Sc. – BIOCHEMISTRY

SL	COURSE CODE	COURSE TITLE	CR / AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
				L	T	P	S/P	C	CIA	SEE
1	20MBC5481	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

M.Sc. – BIOCHEMISTRY SYLLABUS
SEMESTER – I

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:

1.Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
3. Physical Biology of the Cell, 2nd Ed. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Proteins Structures and Molecular Properties 2nd Ed. Thomas E. Creighton, W H Freeman and Co. (1993).
5. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
6. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
7. Biochemistry 6th Ed; Jeremy M Berg, John L Tymoczko and LubertStryer, W H Freeman and Co. (2006).
8. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5103**					
TITLE OF THE COURSE	**MOLECULAR GENETICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES:

- Laying foundation in genetics with classical Mendelian and Non-Mendelian genetics.
- Understanding central principles and fundamental mechanisms for the organization, replication, expression, variation, and evolution of the genetic material.
- Theoretical knowledge about modern molecular genetic methods and tools.
- Insights into how molecular genetics contributes to progress in areas like medical genetics, cancer, and population genetics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will exhibit a comprehensive knowledge base in Molecular Genetics.	L2
CO2	The course will emphasize commonalities between different types of organisms, and will therefore be useful for students with many different types of specializations or interests.	L3
CO3	A main theme of the course is to understand molecular genetics as an experimental discipline, and to appreciate how knowledge in the field is based on experimental evidence.	L3
CO4	Students will appreciate the interplay between genotype and phenotype and how it affects complex disease traits.	L4

COURSE CONTENT:	
MODULE 1 Concepts in Genetics and Genomics	**13 Hrs**
Mendelian genetics: Concepts and theories, gene interactions, Morgan's linkage analysis, chromosome theory of inheritance. Features of *E. coli.* and Human genome, C-	

value paradox, Fine structure of gene, Split genes and overlapping genes. Concept of Epigenetics and Genomic imprinting. Population Genetics, Hardy-Weinberg Equilibrium, Quantitative traits, QTLs and their significance.

Organization of Chromosomes: Structure and organization of eukaryotic chromosomes: Nucleosomes, Super coiled loops, domains andscaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres. Staining techniques of chromosomes.

MODULE 2 Molecular Mechanisms of Recombination	**13 Hrs**

Bacterial Recombination: plasmids and episomes. Molecular mechanism of gene transfer by Transformation, conjugation, and transduction, Application in genome mapping of *E. coli*.

Mechanism of Recombination: Single strand and Double strand break- repair model; Synapsis of homologous duplexes, Holliday Junction, Rec BCD pathway in *E. coli*; role of Rec A in recombination. Homologous recombination in eukaryotes: Role of Spo 11 and MRX protein in Meiotic recombination; Gene Conversion. Site-specific recombination: integration of lambda genome in *E. coli*. Topological manipulation of DNA

MODULE 3 Molecular Basis of Mutation and Transposable Genetic Elements.	**13 Hrs**

Mutations: Chromosomal aberrations, types of mutations. Mechanisms of mutagenesis: Spontaneous and induced mutation, role of mutations in evolution. Detection of mutation: Ames test, Mutations in mitochondrial genome and related disorders. Karyotype - normal and abnormal karyotype analysis for genetic disorders.

Transposons and Molecular mechanism of transposition: Transposable elements in prokaryotes and eukaryotes – IS elements, CompositeTransposons, Tn3 elements, *Ac* and *Ds* elements, P elements, Retrotransposon and theirsignificance. Transposable elements in human and their genetic and evolutionary significance. Molecular mechanism of transposition, Transposon mutagenesis

MODULE 4 Sex Determination and Cancer Genetics	**13 Hrs**

Sex Determination: Factors affecting sex determination, Mechanism of sex determination in *Drosophila* (role of *sxl* gene) and mammals (role of *sry* gene). Secondary sex determination in mammals.Mechanism of dosage compensation in *Drosophila* (role of MSL genes) and mammals (X-chromosome inactivation, role of Xist RNA).

Medical Molecular Genetics: Single factorial (Sickle cell anemia and Cystic Fibrosis) and Multi-factorial genetic disorders (Alzheimer's), Teratogenes and Congenital Malformations (Developmental Diseases), Diagnosis: Karyotyping, Fluorescent in situ hybridization (FISH), Cancer Genetics: Mechanism of transformation of cells. Physical and chemical carcinogenic agents, Viral and cellular oncogenes, tumor suppressor genes (examples from breast/colon cancer)

List of Laboratory/Practical Experiments activities to be conducted (if any) :
5. No
6. 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.
2.

TEXT BOOKS :

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2 Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3 Dubey, R.C. Microbiology 1st Edition. Chand and company.
4 Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.
5 Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. 2005.

REFERENCES :

1 Edward Alcamo. Microbiology. Cliffs Notes 1996.
2 Jacquelyn, G., Black, Larry, M and Lewis. Microbiology. Principles and Explorations. 6th Edition. Wiley, John and sons. 2015.
3 Lengeler, Joseph W/Drews, Gerhart. Biology of the prokaryotes Blackwell Pub. 1999.

4 Nigel Dimmock, Andrew Easton and Keith Leppard. Introduction to Modern Virology: 5th edition, Blackwell Publishing, 2005.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5105**					
TITLE OF THE COURSE	**BIOINFORMATICS – I (PROTEOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

- To understand proteins at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating proteomic targets

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be familiarized with detection and assay techniques for various biomolecules.	L2
CO2	They will have an understanding of composition of inorganic materials.	L3

COURSE CONTENT:	
MODULE 1	**13 Hrs**
History, scope, definitions and basic concepts in bioinformatics and its relation with 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) :
1. No
2. No

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Dhananjaya (2002) Introduction to Bioinformatics, www.sd-bio.com series
7. Higgins & Taylor (2000). Bioinformatics, OUP.
8. Baxavanis (2098). Bioinformatics.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MSC5106**					
TITLE OF THE COURSE	**BIOSTATISTICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

- To demonstrate the significance of statistical analysis in biology.
- To understand basic definitions, usage of proper mathematical calculations to analyse the biological data

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to execute and understand proteins at a virtual platform which will enable them for pharmaco-proteomic studies	L3

COURSE CONTENT:	
MODULE 1 Measures of Central Tendencies, Dispersion And Correlation	**13 Hrs**
Introduction to Bio-statistics and its significance, use of replicates, Tabulation and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance	
MODULE 2 Probability Distributions and Testing of Hypothesis	**13 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	**21MSC5172**					
TITLE OF THE COURSE	**TECHNIQUES IN MICROBIOLOGY AND GENETICS - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	0	**-**	**6**	**-**	**-**	**3**

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

COURSE OBJECTIVES :

- To equip students with the basic microbiological techniques
- To gain insight to different genetic interactions and their effect on phenotype
- To understand the role of allele frequency in evolution and genetic diversity

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand microbial structure, functions and their environment	L3
CO2	Students will be capable to recognise various gene interactions, predict crosses and decipher the role of alleles in inheritance.	L3
CO3	Ability to calculate allele frequency and its role in genetic diversity.	L4

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

1. Preparation of culture media: Autotrophic, Heterotrophic, Selective, Enriched and Differential culture media.
2. Isolation of Microorganisms from different sources (Soil, water and air): Serial dilution and Pure culture techniques.
3. Staining- simple, differential - Gram's, acid fast, endospore, capsular and flagella. Motility test by Hanging-drop method.
4. Study of fungi: *Aspergillus, Penicillium, Fusarium, Yeast, Mucor, Rhizopus, Agaricus* and *Puccinia*.
5. Study of algae (permanent slides): *Spirulina, Nostoc, Spirogyra, Microcystis, Scytonema, Oscillatoria and Rivularia.*
6. Study of Protozoa (permanent slides): *Euglena, Plasmodium, Paramecium* and *Amoeba.*
7. Study of mitosis in onion root tips
8. Study of *Drosophila* mutant types.
9. Mounting of polytene chromosomes – in *Drosophila.*
10. Preparation of buccal smear to study Barr bodies.

TEXT BOOKS :

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

REFERENCES :

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

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

3. K. R. Aneja. (2017) Experiments in Microbiology, Plant Pathology and Biotechnology.

M.Sc. – BIOCHEMISTRY SYLLABUS
SEMESTER – II

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5201**					
TITLE OF THE COURSE	**METABOLISM – I**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- Learning structure and reactions of carbohydrates and amino acids used in metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown carbohydrates and amino acids for release of energy.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to draw structure of mono, di and polysaccharides and amino acids. They will have an in depth idea about the role these biomolecules play in energy storage and usage.	L3
CO2	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by carbohydrates and amino acids to fuel to living systems.	L3

COURSE CONTENT:	
MODULE 1 Carbohydrate metabolism	**13 Hrs**
Introduction to anabolic, catabolic, amphibolic pathways and intermediary metabolism. Glycolytic pathway; energetics and regulation, aerobic and anaerobic fates of pyruvate, entry of sugars other than glucose into metabolism, Gluconeogenesis, reciprocal regulation, anapleurotic reaction and Cori cycle, substrate cycle, Pyruvate dehydrogenase complex, TCA cycle: amphibolic nature and regulation, pentose phosphate pathway, Glyoxylate cycle- scheme; Degradation, synthesis and regulation of glycogen. Role of RER and Golgi complex in synthesis of glycoproteins and GPI anchored proteins.	

MODULE 2 Disorders of Carbohydrate metabolism	13 Hrs
Regulation of blood glucose level by organs and hormones, hypo and hyper glycemia. Diabetes mellitus- classification, biochemical and clinical changes associated with DM. Diagnosis by glycated hemoglobin test (A1-C test), Glucose tolerance test curves, and management of DM by medication, exercise and meal planning. Glycogen storage disorders, galactosemia, fructose and lactose intolerance, pentosuria.Introduction to metabolomics.	
MODULE 3 Amino acids and peptides	**13 Hrs**
General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines, glutathione, physiologically active amines (serotonin and α – histamine) and catecholamines (dopamine, epinephrine and norepinephrine). Synthesis of porphyrin rings and their breakdown into billirubin. Biogenic amines – polyamines. Bioactive peptides – Bradykinin, angiotensin, oxytocin and vasopressin.	
MODULE 4 Metabolism of standard amino acids	**13 Hrs**
Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of twenty standard amino acids – A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y. Disorders associated with amino acid metabolism	

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

TEXT BOOKS :

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rdEd. John Wiley and Sons(2099).
2. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
3. Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and LubertStryer, W H Freeman and Co. (2006).
4. Textbook of Biochemistry with Clinical Correations – Thomas M. Devlin, John Wiley & Sons; 7th edition (22 January 2010)
5. Biochemistry of Foods, Eskin, Elsevier (2012).
6. Biochemistry and Molecular Biology; 5thEd. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014).
7. Harpers Illustrated Biochemistry; 30th Ed. V.W. Rodwell , D. Bender , K.M. Botham , P. J. Kennelly, P. A. Weil (2015)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5202**					
TITLE OF THE COURSE	**HUMAN PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To give a detailed idea about various physiological systems in human beings.
- To make the students understand the biochemical reactions and physical process that underline biological systems

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be equipped with knowledge about several physiological processes.	L3
CO2	The student will be aware of the biochemical basis of human physiology	L3

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Tissue level of organization Types of tissues, cell junctions, tight junctions, adherens junctions, desmosomes , hemi desmosomes, gap junctions comparison between epithelial and connective tissues , epithelial tissues, classification of epithelial tissues, covering and lining epithelium, glandular epithelium, connective tissues, general features of connective tissues, connective tissue cells, connective tissue extracellular matrix, classification of connective tissues , embryonic connective tissues, mature connective tissues. **The muscular system** Overview of muscular tissue; types, functions & properties. Microscopic anatomy of skeletal, smooth & cardiac muscle; muscle proteins; mechanism of muscle contraction, Contraction and relaxation of skeletal muscle fibers. Neuromuscular Junction. Muscle metabolism.	
MODULE 2	**13 Hrs**

Nervous system: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, nerve impulse transmission, function of voltage-dependent and neurotransmitter-gated ion channels; the role of these ion channels in synaptic transmission, synaptic modification, and neuromodulation; neurotransmitters: glutamate, acetyl CoA, glycine, dopamine & serotonin **Endocrine system:** Introduction to endocrinology, classification, general properties and mechanism of action of hormones. Glands – Pituitary, Adrenal, pancreas & thyroid; hormones – action, regulation, tests and disorders. Control of calcium metabolism by parathyroid hormone, calcitonin and vitamin D.

MODULE 3	**13 Hrs**

Cardiovascular system: Functions and properties of blood, functions of blood, physical characteristics of blood, components of blood. Formation of blood cells. Red blood cells, anatomy & physiology. White blood cells, types & functions. Platelets- Hemostasis, vascular spasm, platelet plug formation, blood clotting, role of vitamin K in clotting, hemostatic control mechanisms, Disorders of clotting. Systemic and pulmonary circulations, coronary circulation. Cardiac cycle. Cardiac output. ECG – its principle and significance. Structure and function of blood vessels. Blood pressure. Role of the cardiovascular center. **Respiratory system:** Respiratory system anatomy. Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on O2 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and alkalosis. Dyspnoea, Asphyxia, Cyanosis, Decompression sickness, artificial respiratory methods

MODULE 4	**13 Hrs**

Digestive system: Overview of digestive system. Composition, function and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of breakdown and absorption of sugar, fat, protein, carbohydrate, vitamins and drugs. Structure of esophagus, liver, stomach and intestine. Absorption of food **The urinary system:** Overview of kidney functions. Urine formation: glomerular filtration, tubular reabsorption and tubular secretion. Evaluation of kidney function: urinalysis, blood tests, renal plasma clearance. Fluid, electrolyte, and Acid–Base homeostasis. Kidney hormones.

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

TEXT BOOKS :

1. Guyton and Hall Textbook of Medical Physiology; 12th Ed., J.E.Hall , Saunders Elsevier (2010)
2. Biochemistry 4th Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin. Wiley–Liss (2097).
4. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox, 6th Ed. Macmillan Publications (2012).
5. Molecular Cell Biology, Harvey Lodish , David Baltimore and Arnold Berk, Scientific American Publication (2095).
6. Molecular Biology of Cell; Albertis et. al., Garland Science (2002).
7. Harper's Review of Biochemistry, 24th Ed , Murray et. al., , Lange (2097)
8. Cellular Physiology of Nerve and Muscle. Gary G Mathew , Blackwell Scientific Inc. (2098)
9. Review of Medical Physiology, Gannong, W.F.15th Ed. Maruzen Asial, (2091).
10. Human Biochemistry, Orten and Neuhans, 10th Ed. Mosbey International, (2083).
11. Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (2086).
12. Principles of Human Physiology; 4th Ed. Cindy L. Stanfield Pearson, (2010).

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5201**					
TITLE OF THE COURSE	**MOLECULAR BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To introduce the basic concepts of central dogma of molecular biology
- To provide in-depth knowledge of DNA replication and repair mechanisms with proteins involved in these processes.
- To give substantial knowledge on the processes involved in gene expression and its regulation in prokaryotes and eukaryotes.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will understand the key events of central dogma comprising mechanism of replication, transcription and translation.	L1
CO2	Student will understand the molecular mechanisms of expression, regulation, and maintenance of genetic information, within a biological system.	L2
CO3	Student will be able to critically think in the field of application of molecular biology.	L3

COURSE CONTENT:

MODULE 1: DNA replication and repair **13Hrs**

Structure and functions of DNA and RNA: Central dogma. Watson and Crick model of DNA and other forms (A, B and Z). Denaturation and renaturation kinetics of DNA. Structure and functions of different types of RNA.C-value paradox, repetitive DNA sequences and gene families.

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl

experiment, mapping origin of replication. DNA polymerase I and III (structure and functions), use of conditional lethal mutants in identification of replicative polymerase, Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication.
Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes Telomere synthesis- telomerases regulation of replication in eukaryotes and inhibitors of replication. Replication of viral DNA, rolling circle model.
Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: Gene expression – Transcription 13Hrs
Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination- Rho dependent and Rho independent.
Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, Linker scanning mutagenesis, mechanism of transcription initiation –with RNA Pol I, II, III, elongation and termination.
Post transcriptional modifications of mRNA (5' cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and processing of tRNA and rRNA. Small regulatory RNAs, Inhibitors of transcription. RNA editing.

MODULE 3: Gene expression- Translation 13Hrs
Protein synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis, codon usage, Inhibitors of protein synthesis. Co and post translational modifications of proteins, translation control in eukaryotes.
Protein targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE 4: Regulation of gene expression in prokaryotes and eukaryotes. 13Hrs
Regulation of prokaryotic gene expression: Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression Regulation of tryptophan operon by attenuation, concept of riboswitch action, regulation of lytic and lysogeny cycle in lambda phage.
Regulation of eukaryotic gene expression: Chromatin structure and its effect on transcription, nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications, transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, post-transcriptional control.
Gene Silencing: transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), Applications of Antisense RNA & Ribozymes.

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

TEXT BOOKS :

1. Gerald Karp. Cell and Molecular Biology. 2010. (6th Edition)
2 James D. Watson. Molecular Biology of the Gene (7th Edition)

3 Benjamin A Pierce. Genetics A conceptual approach (5th Edition)
4 Robert Weaver. Molecular Biology. (4th Edition)
5 Nancy L Craig. Molecular Biology: Principles of Genome Function.

REFERENCES :

1 Pukkila P J., 2001. Molecular Biology: The Central Dogma. (https://doi.org/10.1038/npg.els.0000812)
2 Mejía-Almonte, C., Busby, S. J. W., Wade, J. T., van Helden, J., Arkin, A. P., Stormo, G. D., … Collado-Vides, J. (2020). Redefining fundamental concepts of transcription initiation in bacteria. Nature Reviews Genetics. (doi:10.1038/s41576-020-0254-8)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5202**					
TITLE OF THE COURSE	**ANALYTICAL TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES :

- To create detailed understanding about theoretical concepts of techniques used to detect and assay biomolecules.
- To acquaint students with concepts, principles and advanced application of cuttingedge techniques.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will receive adequate knowledge of high-end techniques like Microarray, Mass spectroscopy & NMR	L3
CO2	Students will be able to have a basic understanding of techniques used in drug discovery.	L3

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Spectroscopy: Electromagnetic radiation & its interaction with matter, Lambert- Beer's law, extinction coefficient & its importance, design of colorimeter & spectrophotometer, chemiluminescence, thermoflourescence, principles & biological applications of UV& visible spectroscopy, Principles & applications of fluorescence, nephelometry, AAS. **Structural elucidation:** CD, IR, NMR, ESR, Raman spectroscopy & their applications in biology, x-ray Diffraction & their application in structural analysis of macro molecules.	
MODULE 2	**13 Hrs**
Electrophoresis: Moving boundary & zonal electrophoresis, paper & agarose gel	

electrophoresis, native and SDS PAGE, isoelectric focusing, 2D gel electrophoresis. Concepts and instrumentation of pulse field electrophoresis and capillary electrophoresis, Western, Northern and Southern blotting techniques. **Mass spectrometry:** principles, ionization mechanisms, mass analysis TOF, ion trap quadrapole, Ionization methods: electron impact, chemical ionization, fast atom bombardment, field desorption, electron spray ionization, MALDI, protein identification using MS. Microarrays, protein biochips.
MODULE 3 **13 Hrs**
Chromatography: partition coefficient, paper& thin layer chromatography, adsorption chromatography, gel permeation & affinity chromatography, ion exchange chromatography, amino acid analyzer, gas chromatography, GCMS, HPLC, hydrophobic interaction chromatography, covalent, metal chelate & hydroxyapatite chromatography, special chromatographic techniques for nucleic acids, FPLC **Radioactivity:** Disintegration of radionuclides, half-life, detection & measurement, liquid scintillation counter, isotopic tracer techniques, preparation of labeled compounds & their use in biology, autoradiography.
13 Hrs
MODULE 4
Centrifugation: principle, Svedberg's constant, types of centrifuges, differential & density gradient centrifugation, preparative & analytical centrifuges, sedimentation velocity, equilibrium analysis & its applications. **Techniques in drug discovery:** General protocol of classical drug discovery and clinical trials, In-Silico Drug Designing, Ligand-based drug designing approaches: Lead Designing, combinatorial chemistry, QSAR, Database generation and Chemical libraries, ADMET property.

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

TEXT BOOKS :

1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van Holde, Prentice Hall.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5203**					
TITLE OF THE COURSE	**BIOINFORMATICS – II (GENOMICS)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

- To understand genes at in-silico platform and to explore the possibilities in drug design and development
- To establish structure activity relationship for elucidating genomic targets

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to execute and understand genes at a virtual platform which will enable them for pharmaco-genomic studies	L2

COURSE CONTENT:	
MODULE 1	**13 Hrs**
Introduction to data types and Source. Population and sample, Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Specialized Genome databases: (SGD, TIGR, and ACeDB). Microbial genomic database (MBGD), Cell line database (ATCC), Virus data bank (UICTVdb). Restriction mapping - NEB CUTTER. Global and Local, Similarity searching, Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids, Identification of ORFs,	

Identification of motifs	
MODULE 2	**13 Hrs**
Translating DNA into proteins reading DNA from files in FASTA format, reading frames, Regular expressions, restriction maps and restriction enzymes, Genbank files, Genbank libraries, separating sequence and annotation parsing, Annotations indexing, parsing PDB files, parsing BLAST files. General introduction to Gene expression in prokaryotes and eukaryotes, transcription factorsbinding sites. SNP, EST, STS. Introduction to Regular Expression, Hierarchies and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.	

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

TEXT BOOKS:

1. Bioinformatics. Keith, J. Humana Press, 2008.
2. Computer methods for macromolecular sequence analysis. R.F.Doolittle, Academic Press, 2096.
3. Bioinformatics. Sequence and genome analysis. D.W.Mount. Cold Spring Harbor Lab. press. 2004.
4. Bioinformatics and functional genomics. J. Pevsner. Wiley-Liss, 2003.
5. Encyclopedia of Genetics, Genomics, Proteomics & Bioinformatics, Jorde et al., (eds.) John Wiley and Sons, 2005.
6. Baxavanis (2098). Bioinformatics.
7. Fry, J.C. (2093). Biological Data Analysis. A practical Approach. IRL Press, Oxford.
8. Rosenbloom KR et al, The UCSC Genome Browser database: 2015 update. Nucleic Acids Res. 2015 Jan 28; 43(Database issue): D670-81

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5204**					
TITLE OF THE COURSE	**EVOLUTION AND DEVELOPMENTAL BIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

- Demonstration of how the lives originate from the a-biotic factors in the universe and learn the dynamics of different populations, their interactions with the ecosystems, intricacies and integration of the ecosystems with the populations.
- Understanding of the mechanisms of cell metamorphosis into different cell types, tissues, organs and life

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Have an enhanced skills and knowledge of origin of life, evolution, and development	L2
CO2	Be able to critically analyse the basic concepts and fundamentals of the course and integrate the related fields and pursue this area in the future.	L3

COURSE CONTENT:	
MODULE 1 Ecology and Evolution	**13 Hrs**
Ecology: Introduction, biotic and abiotic factors, Biomes **Population ecology:** Dynamics of population, Population growth-Exponential model Logistic growth model **Community ecology**: Interactions, Biogeography, Speciation, Ecological succession,	

Disturbances Structure- Contrasting views **Ecosystems:** Energy flow and trophic levels, Biological and geochemical processes (BC cycles, B Pyramids etc) Human impacts on ecosystems **Evolution:** Introduction, Early ideas of evolution, Darwinian view of life. **Speciation and Evolutionary Rates:** The nature of evolutionary units; the modern synthesis and biological speciation, rates of evolutionary change. **Natural selection:** Stabilizing, directional, and disruptive selection. **Microevolutionary and Macroevolutionary phenomena:** insights into genetic drift, mutation and gene flow, Ontogeny and phylogeny

MODULE 2 Developmental Biology	**13 Hrs**
Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; **Gametogenesis, fertilization and early development:** Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination **Morphogenesis and organogenesis in plants:** Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum **Morphogenesis and organogenesis in animals:** Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in *Drosophila*.	

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

TEXT BOOKS:

1. Concepts of Ecology, Edward.J.Kormondy
2. Ecology and environmental science, S.V.S. Rana
3. Cell biology, Genetics, Molecular biology, evolution and ecology
4. Minkoff, E. C. (2083). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company.
5. Sober, E. (2094). Conceptual issues in evolutionary biology. Cambridge, MA: MIT Press.
6. Fundamentals of ecology by Eugene Odum,Cengage; 5 edition (2005).
7. Ecology & Environment by P.D. Sharma, Rastogi Publications (3 August 2015).
8. Development Biology by Scott F Gilbert, Sinauer Associates; 10th edition (10 July 2013)
9. Development Biology by N Arumugam,Saras Publication (2014)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MBC5271**					
TITLE OF THE COURSE	**CLINICAL BIOCHEMISTRY - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

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

COURSE OBJECTIVES:

- To give a practical idea about various physiological systems in human beings
- To make the students understand the biochemical reactions that underline biological systems and the reactions used to detect them

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	The students will be equipped with practical knowledge about several physiological processes and their detection techniques	L3
CO2	The student will be aware of discrepancies in biomolecular levels and thereby detect diseases.	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. Estimation of sugar from blood and urine
2. Estimation of Hemoglobin in blood by Wong's method
3. Estimation of blood albumin: globulin ratio
4. Estimation of blood cholesterol by Zak and Zlatkis method
5. Estimation of uric acid in urine by Caraway's method
6. Estimation of creatinine in urine by Jaffe's method

7. Estimation of urea in urine by Nessler's reagent
8. Estimation of bilirubin in urine
9. Titratable acidity of urine
10. Serum SGOT/SGPT assay

TEXT BOOKS:

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

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**20MSC5271**					
TITLE OF THE COURSE	**BIO-ANALYTICAL TECHNIQUES - LAB**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

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

COURSE OBJECTIVES:

- Practical exposure for biomolecules and their quantification using standard estimations and spectroscopy
- Biophysical equipments will be explored for the analysis of biomolecules

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have hands on practical exposure for quantitation of biomolecules using modern techniques and equipments	L3

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

1. Isolation of plant genomic DNA using SDS/CTAB method and its analysis.
2. Isolation of genomic DNA from bacteria/animal tissue and its analysis.
3. Isolation of total RNA from biological source and its analysis
4. Study of conjugation in *E. coli.*
5. Study of mutation in *E. coli* by Physical method (UV).
6. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
7. Separation of biomolecules (amino acids/carbohydrates) using TLC.
8. Separation of phytomolecules (secondary metabolites) using silica column chromatography

9. Separation of proteins using SDS-PAGE and molecular weight determination.
10. Separation of cell organelles using density gradient centrifugation.

TEXT BOOKS:

1. 1. Principles and Techniques of Biochemistry and Molecular Biology 7th Ed. Keith Wilson and John Walker, Cambridge University Press, (2010).
2. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
3. Techniques in Molecular Biology, Walker and Gastra, Croom Helm, (2083)
4. Protein Purification Applications, S.L.V. Harris and Angal, IRL Press, (2090)
5. Nucleic Acid Blotting, D C Darling, P M Bricknell; Garland Science; (2094)
6. Biophysical Tools for Biologists In Vivo Techniques; John Correia H. Detrich, III Elsevier (2008).
7. Physical Biochemistry, Kensal Edward Van *Holde*, Prentice Hall.

M.Sc. – BIOCHEMISTRY SYLLABUS
SEMESTER – III

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5301**					
TITLE OF THE COURSE	**METABOLISM II**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES:

- Learning the role electron transport chain plays in connecting fuel breakdown and metabolism.
- Learning about the metabolic reactions undertaken by living systems to breakdown lipids and nucleic acids for release of energy

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to comprehend the integration of metabolism, oxidative phosphorylation and ATP production.	L3
CO2	They will have an in-depth idea about the role lipids play in energy storage and usage.	L3
CO3	Students will be able to comprehend the metabolic, enzyme assisted reactions undergone by nitrogen bases and fat to fuel to living systems.	L3

COURSE CONTENT:	
MODULE 1 Bioenergetics	**13 Hrs**
Reduction Potential, Biological redox couplers, Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, Coupling of electron transfer to ATP synthesis. Mechanism of oxidative phosphorylation. P/O ratios and their use in localization of sites of ATP synthesis along the chain. Uncouplers, inhibitors and ionophores. Microsomal electron transport. Proton motive force in Halobacteria, H^+ pumping by bacteriorhodopsin.	
MODULE 2 Nucleotide Metabolism	**13 Hrs**
Nitrogen Cycle, nitrogen fixation, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and disorders associated with degradation: gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies.	
MODULE 3 Lipid metabolism	**13 Hrs**
Basic scheme of fat absorption, mobility, degradation and synthesis; Degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, scheme and energetics of β-oxidation, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol, phospholipids and sphingolipids, sphingolipid storage disorders**.**	
	13 Hrs
MODULE 4 Cholesterol and Circulating lipids	
Cholesterol structure, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase and utilization as hormones and bile salts, normal and abnormal levels in the body; Insoluble lipid mobilization by lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers and metabolic fate; Receptor mediated endocytosis of LDL. Regulation of cholesterol metabolism; Biochemistry of obesity, atherosclerosis and hypercholesterolemia; synthesis of prostaglandins and related compounds, Non steroidal anti-inflammatory drugs (NSAIDs).	

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

TEXT BOOKS :

1. Principles of Biochemistry – Lehninger, Nelson and Cox. Freeman Publishers, 6th Ed.
2. Principles of Biochemistry – Zubay, Parson and Vance. Brown Publishers, 1st Ed.
3. Biochemistry – Voet and Voet. Wiley & Sons 2011, 4th Ed
4. Textbook of Biochemistry with clinical correlations - Devlin, John Wiley & Sons, 7th Ed, 2010

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5302**					
TITLE OF THE COURSE	**ENZYMOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	4	**-**	**-**	**-**	**52**	**4**

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

COURSE OBJECTIVES:

- Learning about enzyme properties and coenzymes
- Knowledge of enzyme assay, enzyme kinetics and drawing enzyme assisted reaction plots.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Brief idea about regulation of enzyme activity along with enzyme Inhibition.	L3
CO2	Studying active site structure and catalysis.	L3

COURSE CONTENT:	
MODULE 1 Introduction to Enzymes	**13 Hrs**
Introduction to enzymes: Classification, Specificity, active site groups, theories of enzyme action, enzyme assay – principle and types, enzyme units, Enzyme localization (chemical and immune-fluorescence method) and purification. Criteria of purity. Enzyme classification and nomenclature. Monomeric, oligomeric and multifunctional enzymes, multienzyme complexes. **Coenzymes**: The mechanistic role of the following coenzymes in enzyme catalysed reactions –nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme-A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B	
MODULE 2 Enzyme Kinetics	**13 Hrs**
Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Effect of substrate, temperature, pH and modulators on enzyme activity. **Kinetic data evaluation**: linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Methods used in the investigation of the kinetics of enzyme-catalyzed	

reactions, initial velocity studies and rapid reaction techniques. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Arrhenius plot and determination of activation energy
MODULE 3 Enzyme Inhibition **13 Hrs**
Types of reversible inhibitors; competitive, non-competitive, uncompetitive, and mixed inhibitors. Partial, substrate, allosteric and Irreversible inhibition. Regulation of enzyme activity: Allostery & Sigmoidal kinetics -- Binding of ligands to proteins, Cooperativity, Hill equation, Adair equation, Scatchard plot and equilibrium dialysis techniques. MWC and KNF models. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation reversible covalent modifications, proteolytic cleavage (zymogen activation – digestive enzymes, blood clotting cascade), transcriptional and translational regulation
13 Hrs
MODULE 4 The investigation of active site structure
The identification of binding sites and catalytic sites –trapping the E-S complex, use of substrate analogs, enzyme modification by treatment with proteolytic enzymes, photo – oxidation and chemical modification of amino acid side chains. Affinity labelling studies, super-reactive amino acid side chains, X-ray crystallographic and NMR studies. Enzyme catalysis**:** Chemical nature of enzyme catalysis-General acid/base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Mechanisms of action of specific enzymes: lysozyme, serine proteases (chymotrypsin), sulphydryl enzymes (alcohol dehydrogenase), Metal – activated and metallo-enzymes (mechanism of action of creatine kinase).

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

TEXT BOOKS :

1. Enzymes - Biochemistry, Biotechnology, Clinical Chemistry, Palmer and Bonner, Elsevier Press (2007).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
3. Fundamentals of Enzymology, Price and Stevens, Oxford University Press (2099).
4. Fundamentals of Enzyme Kinetics, Bowden, Portland Press (2004).
5. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2080).
6. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
7. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).
8. Biochemical Calculations, 2nd Ed. Irwin H. Segel, John Wiley and Sons (2076).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5321**					
TITLE OF THE COURSE	**IMMUNOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student will be acquainted with the basic understanding of immune system as a whole and critically think about its role in diagnosis and control.	L2
CO2	Student will gain fundamental knowledge about the consequences of immune system failure. They will also gain insights about the spread of cancer and its therapeutics	L3

COURSE CONTENT:	
MODULE 1 Introduction and Innate Immunity	**10 Hrs**
Introduction: Basic concepts in immunology, role of immune system, principles of innate and adaptive immunity. **Innate immunity**: Different lines and layers of defence, secretions: skin, lysozyme, pH, mucous. Pattern recognition in innate immune system, the complement system: activation through classical, alternate and lectin pathway, Induced innate responses to infections. Functions of natural killers, monocytes, macrophages, eosinophils, neutrophils and basophils.	
MODULE 2 Antigen Antibody interactions	**10 Hrs**
Antigen recognition by B-cells: Clonal selection, effector and memory cells, Antibody types, structure, functions, isotypes, allotype, idiotype, Interaction between the antibody	

and specific antigen, epitope, paratope, affinity, avidity, radio-equilibrium dialysis study, Diversity of Immunoglobulins. **Antigen recognition by T cells**: T_H, T_C and T_{Reg} cells, T-specific markers, TCR, MHC, Types, functions, gene structure, receptor structure, antigen processing and presentation, exogenous and endogenous antigen.
MODULE 3 Lymphocyte development and inflammation **10 Hrs**
Development and survival of lymphocytes: Lymphocytes in bone marrow and thymus, positive and negative selection of lymphocytes, survival and maturation of lymphocytes, self/non self-recognition. **Transplantation and Network theory**: Transplant rejection, immunosuppressants. Immuno-surveillance, idiotypes and immune network theory
10 Hrs
MODULE 4 Pathoimmunology & immunotechniques
Pathoimmunology: Effector mechanisms in allergic reactions and IgE, hypersensitivity diseases; Autoimmune diseases- Rheumatoid arthritis, multiple sclerosis **Immuno-techniques**: Generation of monoclonal antibodies, Immuno-diffusion techniques, RIA, ELISA. Immuno-electrophoresis, immuno-staining techniques, Immuno-florescence and flow cytometry.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. No
2. No
TEXT BOOKS :

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).

2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).

3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).

4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).

5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).

6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).

7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).

REFERENCE PAPERS

8. Research paper: The Hallmarks of Cancer, by Hanahan and Weinberg, Cell, Vol. 100, 57–70 (2000).

9. Research paper: Hallmarks of Cancer: Next generation, D.Hanahan and R.A.Weinberg, Cell, 144(5):646-74 (2011).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5322**					
TITLE OF THE COURSE	**MOLECULAR PHYSIOLOGY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES:

- To understand the role of different cells and organs of immune system.
- To provide basic understanding on antigen recognition by B and T cells, development of immune cells and various immunotechniques.
- To understand the importance of immune system in disease and therapeutics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have an idea as to how hormones control the physiology of an organism via signalling mechanisms.	L3
CO2	They will have a greater understanding of how the homeostasis of a body is maintained and a slight change in the system could tip the balance which could lead to disease.	L3

COURSE CONTENT:	
MODULE 1 Endocrine signaling	**10 Hrs**
Cell Signaling: Endocrine organs in human, classification and chemistry of hormones. Principles of cell signaling, Classification of hormones. Signal transduction, Signal transduction pathways of – G – protein linked (epinephrine / serotonin); Ion– channel (ACh); Tyrosine kinase (RTK), [insulin] and Intrinsic enzyme / cytokine, receptors. **Intracellular signaling proteins**: adaptors, activators, bifurcators, integrators and effectors. Second messengers: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca^{2+}, and NO. Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase and guanylate cyclase.	
MODULE 2 Nerve signalling and neurotransmitters	**10 Hrs**

Nerve signaling: Morphology of a neuron. Types and functions of Nerve fiber. Resting membrane and action potential, Nernst equation. Mechanism of initiation and propagation of action potential. Structure and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate/GABA) and neuropeptides (somatostatin/enkephalins). Exo – and endocytosis of synaptic vesicles. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases (Alzheimer's/ Parkinson/MS).

MODULE 3 Nuclear signaling and Cell Cycle	**10 Hrs**
Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. **Cell Cycle**: Cell cycle (entry of cell from G2 to M – phase) Role of M – Cdk, MPF. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Regulation of M- phase (role of mitogen, survival factor and TGF- β). Role of ubiquitin. Growth factors and cytokines, growth phases and check points of cell cycle (DNA replication and spindle- attachment checkpoint) and their regulation. **Stem Cells**: Embryonic and adult stem cells; unique properties, and potential applications.	
	10 Hrs
MODULE 4 Apoptosis and Cancer	
Apoptosis: Structure and function of caspases in apoptosis. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution, Inhibition of Protein synthesis, DNA damage and removal of dead cells). Cell death receptors and their ligands: Role of MAP/Erk in cell death. Apoptotic signaling by TNRF1 and DR3. Regulation of Bcl-2 and IAP. Necrosis, Role of HeLa cells, hyperactive apoptosis and treatments. **Cancer:** Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Signaling cascades in cancer (MAP kinases and JAK-STAT pathways). Concept of tumor suppressors.	

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

TEXT BOOKS :

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
2. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
3. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.
4. Biochemistry; David Rawn, Panima Publishers, (1989).
5. Biochemistry; Geoffrey Zubey,(1998), WCB Publishers.
6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
8. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)
9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013)

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5323**					
TITLE OF THE COURSE	**GENETIC ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES:

- To understand how DNA can be manipulated using different enzymes.
- Varied vector systems to transfer DNA from one species to another, express recombinant proteins etc.
- Diverse methods to visualise modified genetic materials.
- Applications of genetic engineering.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach techniques to detect the engineered DNA, RNA and protein	L3
CO3	Students will also learn various applications where genetic engineering can be used	L3

COURSE CONTENT:	
MODULE 1 Basic Concepts	**10 Hrs**
DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern and Southern, Fluorescence in situ hybridization.	

MODULE 2 Cloning and expression vectors	10 Hrs
Plasmids; Bacteriophages; M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors.	
MODULE 3 Cloning strategies and study of protein-DNA interactions	**10 Hrs**
Insertion of foreign DNA into host cells; transformation, electroporation, transfection; construction of libraries; isolation of mRNA and total RNA; reverse transcriptase and cDNA synthesis; cDNA and genomic libraries; construction of microarrays – genomic arrays, cDNA arrays and oligo arrays; electrophoretic mobility shift assay; DNase I footprinting; methyl interference assay, chromatin immunoprecipitation; protein-protein interactions using yeast two-hybrid system; phage display.	
	10 Hrs
MODULE 4 Sequencing, PCR and its applications	
Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing, Next Gen Sequencing methods (Illumina and 454 platform). PCR: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Handling PCR reactions, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis, Mutation detection: RFLP, Oligo Ligation Assay (OLA) and ASA (Allele-Specific Amplification).	

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

TEXT BOOKS :

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (1998) Molecular Biotechnology(2nd Ed.),ASM press,Washington DC
5. Gupta PK (2003) Elements of Biotechnology (2nd Ed), Rastogi publication, Merrut,
6. Primrose, Twyman and Old (2002) Principles of Gene Manipulation, (6th Ed) Blackwell Science Ltd.
7. Brown TA (2013) Gene Cloning and DNA analysis (6th edition) Wiley-Blackwell Publication
8. Singh BD (2005) Molecular Biology and Genetic Engg, Kalyani Publishers

9. Satyanarayana U (2008) Biotechnology, Books and Allied Ltd. 10. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5324**					
TITLE OF THE COURSE	**MEMBRANE BIOCHEMISTRY AND NANO SCIENCE**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES:

- Learning the role lipids play in maintaining plasma membranes and techniques to isolate and study membranes.
- Learning about nanotechnology and its application in various fields.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will have a theoretical knowledge about isolating plasma membranes and studying its components to draw conclusions about the multitude of role played by membranes.	L3
CO2	They will have an in-depth idea about nanotechnological solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:	
MODULE 1 Lipid properties	**10 Hrs**
Structure and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, formation of mono, bi-layers and micelles, Langmuir trough. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolpin, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; membrane sidedness. lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.	

MODULE 2 Membrane topology	10 Hrs
Liposomes; preparation, properties and application in membrane biochemistry. Detergent solubilization of membrane proteins. Erythrocyte ghosts; Classification of membrane proteins based on membrane-protein interaction. Techniques for determination of membrane protein topology: Biophysical methods: X-ray crystallography, Freeze-fracture electron microscopy, Lateral and rotational diffusion of integral membrane proteins. Fluorescence photobleaching recovery (FRAP). Membrane transport- passive diffusion, facilitated diffusion, active transport and co-transport.	
MODULE 3 Nanoscience	**10 Hrs**
Definition of Nanoscale, Scientific revolution-Atomic Structure and atomic size. Nanoparticles – properties, emergence and challengs of nanoscience and nanotechnology, carbon age-new form of carbon (CNT to Graphene), influence of nano over micro/macro, size effects and crystals, large surface to volume ration, surface effects on the properties. Nanotechnology for waste reduction and improved energy efficiency, nanotechnology based water treatment strategies. Nanoporous polymers and their applications in water purification, Nanotoxicology.	
	10 Hrs
MODULE 4 Nanobiotechnology	
Synthesis of nanoparticles and nanostructures – bottom-top and top-bottom approaches, Carbon nanotube (CNT), structure of CNT, synthesis and functionalization of CNT, synthesis and functionalization of Graphene, electronic application of Graphene. Applications of nanoscience in biological systems - drug targeting, drug delivery and biomedicine, Bionics and Biomimicry. Scanning Tunneling microscope, Atomic force Microscopy, Zetasizer.	

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

TEXT BOOKS :

1. Chemistry of nanomaterials: Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830 831, Cambridge University Press.
4. Processing & properties of structural nanomaterials Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5325**					
TITLE OF THE COURSE	**PHYTOCHEMICALS AND MICROBIAL SECONDARY METABOLITES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**40**	**3**

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

COURSE OBJECTIVES:

- Learning the role of phytochemicals and microbial metabolites.
- Learning the qualitative and quantitative with its application in various fields.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will have a theoretical knowledge about isolation and characterization of phytochemicals and microbial metabolites, this enables the student to draw conclusions about the multitude of role played by phytobioactives.	L3
CO2	They will have an in-depth idea about phytochemical and microbial metabolites solutions used to treat industrial and health related problems.	L3

COURSE CONTENT:	
MODULE 1 Introduction to Phytochemicals	**10 Hrs**
Definition, history, scope and development of phytochemistry. Historical perspectives of herbal medicine: local, national and global level. Phytochemical extraction techniques: Introduction, definition, factors influencing the choice of extraction, principles of extraction methods, types of extraction (Cold and hot extraction methods, concentration and evaporation techniques, lyophilisation.	
MODULE 2 Methods to analyse Phytochemicals	**10 Hrs**
Techniques for quantitative and structural analysis of plant secondary metabolites:	

Application of TLC, column chromatography; gel filtration chromatography, affinity chromatography, ion-exchange chromatography, GLC and HPLC in phytochemistry. Application of UV/Visible, IR, 1H and 13C NMR and Mass spectrometry in structural elucidation of natural products in relation with a specific example (terpenoids/flavonoids).
MODULE 3 Microbial metabolites **10 Hrs**
Industrial viable microbial metabolites: Industrial alcohol production, recovery and applications of ethanol; acetone-butanol production, recovery and application; production of glycerol through microbial process. Organic acids and Enzymes: Citric acid: strains for citric acid production, biosynthesis, nutrient media, production process, product recovery and application. Lactic acid: Nutrient media, production process recovery and purification. Enzymes: Production of Amylases-Fungal and Bacterial Amylase. Production of proteases: Alkaline proteases, Neutral proteases and acid proteases.
10 Hrs
MODULE 4 Special Microbial Metabolites
Metabolites for food fortification: Definition and examples of food additives; strains for amino acid production, methods of production, product recovery (Eg: L-Glutamic acid and L-lysine). **Health care products**: Industrial production and recovery: Penicillin and Streptomycin. **I P R**: Patents: Patent regulations of processes, products and microorganisms.

List of Laboratory/Practical Experiments activities to be conducted (if any) :
7. No
8. No

TEXT BOOKS :

1. Barsanti, L and Gualtieri, P. 2005. Algae: Anatomy, Biochemistry, and Biotechnology. Taylor and Francis New York.

2. Casida, L.E. 1997. Industrial Microbiology. New Age International Publishers.

3. Crueger, W. and Crueger, A. 2003. Biotechnology- A text book of Industrial Microbiology. Panima Publishing corporation.

4. Demain, A. L. 2001. Industrial Microbiology and Biotechnology IInd Edition. ASM Press, Washington.

5. Demain, A.L. and Davies, J.E. 1999. Manual of Industrial Microbiology and Biotechnology II Edition. ASM Press, Washington.

6. El-Mansi, E.M.T. and Bryce, C.F.A. 2004. Fermentation Microbiology and Biotechnology. Taylor and Francis Group.

7. Horton, H.R., Moran, L. A., Scrimgeour, K.G. Perry, M.D and Rawn, J.D. 2006. Principles of Biochemistry, IV Edition. Pearson Education Internationl. London.

8. Julian E Davies and Arnold L Demain 2009 Manual of Industrial Microbiology and Biotechnology ASM Publisher.

9. Maheshwari, D.K., Dubey, R.C. and Saravanamtu, R. 2010. Industrial Exploitation of Microorganisms. I.K. International Publishing House. New Delhi.

10. Mansi El-Mansi, C. F. A. Bryce. 2007. Fermentation microbiology and biotechnology. CRC Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20MBC5371**					
TITLE OF THE COURSE	**ENZYMOLOGY AND PROTEIN PURIFICATION**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

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

COURSE OBJECTIVES:

- Learn about the nature of enzymes and their mode of action along with the analytical techniques of protein purification.
- To learn isolation and purification of enzymes with classical examples.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn enzymology and analytical techniques which can be used to understand biomolecules specific to proteins.	L3
CO2	It will also enable them to learn protein chemistry techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
9. Isolation and assay of phosphatase; effect of dilution
10. Effect of substrate on phosphatase
11. Effect of Temperature & pH on phosphatase
12. Inhibition kinetics of phosphatase by L-B plot
13. Extraction of phosphatase from plants and stepwise purification through organic acid
14. precipitation and re-suspension in buffer - Calculation of activity, specific activity, yield and fold purification at each step.
15. Extraction of phosphatase from plants and stepwise purification through ammonium sulphate precipitation and re-suspension in buffer - Calculation of

activity, specific activity, yield and fold purification at each step.
16. Criteria of purification of phosphatase – chromatography of purified samples – ion exchange/gel permeation.
17. Criteria of purification of phosphatase visualized through SDS-PAGE.
18. Concepts of Isoelectric Focusing (Demonstration)

TEXT BOOKS:

1. Biochemical methods, S Sadasivam, A. Manickam, New Age International (2096)
2. Modern Experimental Biochemistry, 3rd Ed., Rodney F. Boyer, Dorling Kindersley (India) (2000)
3. Biochemistry Laboratory-Modern Theory and Techniques, 2nd Ed., Rodney F. Boyer, Prentice Hall (2011)
4. Principle and techniques in Biochemistry and Molecular biology,(Eds) Keith Wilson and John Walker, Cambridge University Press (2005).
5. Biochemical Calculations, Irwin H. Segel (2076) 2nd Ed. John Wiley and Sons.
6. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2012).
7. Laboratory methods in Enzymology; Part-A; Jon Lorsch, Academic Press (2014).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21MBC5372**					
TITLE OF THE COURSE	**GENETIC ENGINEERING & IMMUNO TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**6**	**-**	**26**	**3**

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

COURSE OBJECTIVES:

- Learn molecular techniques to modify DNA, introduce foreign DNA in *E.coli* host and express proteins.
- To learn immune techniques used as diagnostic tools.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L3
CO2	It will also teach diagnostic immune techniques routinely used in medical laboratories	L4

List of Laboratory/Practical Experiments activities to be conducted (if any) :
1. PCR amplification and analysis by agarose gel electrophoresis.
2. Preparation of plasmid DNA from E. coli.
3. Restriction digestion and Restriction mapping
4. Ligation
5. Preparation of competent E. coli. cells
6. Transformation in E. coli.
7. Induction of protein expression and analysis by SDS-PAGE

8. Serum Separation from whole blood and isolation of immunoglobulins from serum.
9. Study of different cells in whole blood using Giemsa/Leishman stain.
10. Blood grouping
11. ELISA/Dot ELISA
12. Radial Immunodiffusion/Ouchterlony Double Diffusion
13. Rocket Immuno Electrophoresis
14. WIDAL/RPR Test

TEXT BOOKS:

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Glick and Pasternak (2098) Molecular Biotechnology (2nd Ed.), ASM press, Washington DC
5. Watson, Caudy, Myers and Wilkowsky (2007) Recombinant DNA: Genes and Genomes (3rd Ed), WH Freeman.
6. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
7. Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Springer, 2008.
8. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M.Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
9. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21MSC5301**					
TITLE OF THE COURSE	**CLINICAL RESEARCH**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

- To introduce basic principles involved in preclinical evaluation of a drug, basic pharmacokinetics and dynamics of regulatory requirements for a clinical trial.
- To equip students with the proper designing and planning of clinical trial.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will acquire sufficient knowledge on the process and regulatory perspectives of preclinical evaluation studies.	L2
CO2	Students will gain the concepts of designing and monitoring of clinical trial studies.	L3

COURSE CONTENT:

MODULE 1 Concepts of Clinical Research **13 Hrs**

General introduction, routes of drugs administration, Dose, threshold dose, no observed effect level (NOEL), measurement of cumulative effects- time relationship. The *area under the curve (AUC)* of the concentration-time profiles, absolute bioavailability, Volume of Distribution *(Vd)*. maximum tolerated dose (MTD). Basics of pharmacokinetics, calculation of pharmacokinetic estimates. Outline of drug metabolism and elimination. Organ toxicity. Scheme of preclinical evaluation of toxicity study. Calculation of LD_{50} & ED_{50}. Acute, subacute and chronic toxicity studies. Irwin profile test. Lipinski's rule for drug like molecule.

MODULE 2 Regulatory Perspectives of Clinical Research **13 Hrs**

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial,

Preparation of clinical trial. Outline of new drug development process and drugs registration. Regulatory Perspectives of Clinical Trials: Origin and Principles of International Conference on Harmonization - Good Clinical Practice (ICH-GCP) guidelines, Ethical Committee: Institutional Review Board, Ethical Guidelines for Biomedical Research and Human Participant- Schedule Y, ICMR Informed Consent Process: Structure and content of an Informed Consent Process Ethical principles governing informed consent process. Clinical Trials: Types and Design. Experimental Study- RCT and Non RCT, Observation Study: Cohort, Case Control, Cross sectional Clinical Trial Study, Team Roles and responsibilities of Clinical Trial Personnel: Investigator, Study Coordinator, Sponsor, CRO. Clinical Trial Documentation- Trial Monitoring- Safety Monitoring in CT Adverse Drug Reactions.

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

TEXT BOOKS:

1. Central Drugs Standard Control Organization- Good Clinical Practices, Guidelines for Clinical Trials on Pharmaceutical Products in India. New Delhi: Ministry of Health;2001.
2. International Conference on Harmonization of Technical requirements for registration of Pharmaceuticals for human use. ICH Harmonized Tripartite Guideline. Guideline for Good Clinical Practice.E6; May 2096.
3. Ethical Guidelines for Biomedical Research on Human Subjects 2000. Indian Council of Medical Research, New Delhi.
4. Textbook of Clinical Trials edited by David Machin, Simon Day and Sylvan Green, March 2005, John Wiley and Sons.
5. Clinical Data Management edited by R K Rondels, S A Varley, C F Webbs. Second Edition, Jan 2000, Wiley Publications.
6. Handbook of clinical Research. Julia Lloyd and Ann Raven Ed. Churchill Livingstone.
7. Principles of Clinical Research edited by Giovanna di Ignazio, Di Giovanna and Haynes.
8. Essentials of medical pharmacology. TRIPATHI (K D). 6th edition, 2009, Jaypee Brothers Publihsers.
9. Textbook of modern toxicology. HODGSON (Ernest), 4th Ed. 2010, John Wiley.
10. Concepts of toxicology , OMKAR, 2014, Vishal Publishers.
11. Foyes principles of medicinal chemistry, LEMKE (Thomas L);6th edition, 2008, Wolter Klu Publishers.
12. Foyes principles of medicinal chemistry, WILLIAMS (David A); 5th edition, 2002, Wolter Klu Publishers.
13. Introduction to biochemical toxicology, HODGSON (Ernest); 3rd edition, 2001, Wiley Publishers.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**21MSC5302**					
TITLE OF THE COURSE	**SCIENTIFIC WRITING AND IPR**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**-**	**-**	**26**	**2**

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

COURSE OBJECTIVES:

1. To acquaint students with the concepts, types and elements, formats of Report and Proposal writing.
2. To help the students get an idea about intellectual property rights, patent laws and how to file a patent.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of the course students will able to understand the concept and scientific writing. They will be able to draft suitable and effective reports and scientific journal papers.	L2
CO2	They will also get an idea about patent laws and will know how to file a patent	L3

COURSE CONTENT:	
MODULE 1 Scientific writing	**13 Hrs**
Introduction and overview: Types of projects (Hypothesis- driven projects, Discovery-driven projects, Technology- driven projects) Outlining the proposal, Project Summary, background, Specific aims, Hypothesis, Research strategy: Significance, Innovation and Approach, Bibliography and Reference writing. Ethics in proposal writing- Plagiarism. Writing Reports and Proposal: Objectives, Concept of report writing; Elements of report; types of reports; Dos and Don'ts of report writing; Formats for report. Concepts of Proposal writing, Characteristics of proposal, Types of proposal, Elements of proposal writing; Purpose of a research proposal.	

MODULE 2 Intellectual Property Rights	13 Hrs
Intellectual property rights-TRIPS, GATT-International conventions patents and methods of application of patents-Legal implications- Biodiversity and farmer rights. Patents and Patent Laws**:** Concept of Patenting law - Objectives of the patent system (Basic principles and general requirements of patent law), biotechnological inventions and patent law-Legal Development-Patentable subjects and protection in biotechnology-The patenting living organisms.	

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

TEXT BOOKS:

1. Beier, F.K., Crespi, R.S. and Straus, T. Biotechnology and Patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Ganguli Prabuddha Gearing up for Patents…..The Indian Scenario" , Universities Press (2098)
3. Ganguli Prabuddha "Intellectual Property Rights--Unleashing the Knowledge Economy", Tata McGrawHill (2001)
4. Ganguli Prabuddha and Jabade Siddharth, "Nanotechnology Intellectual Property Right Research, Design, and Commercialisation", CRC Press , Taylor and Francis Group, USA (2012)
5. Beyond Intellectual Property: Toward Traditional Resource Rights for Indigenous Peoples and Local commudalies Darrell A. Posey and Graham Dutfield , IDRC Books; annotated edition (June 2096).
6. Vedder, Scott. Signs of a Great Résumé: How to Write a Resume that Speaks for Itself. Veterans Edition. 2014. Print.
7. Block, Jay A. and Michael Betrus. 101 Best Resumes: Endorsed by the Professional Association of Resume Writers . New York: Mcgraw-Hill., 2097. Print.
8. Kulkarni, R. A. (2001). A Handbook of Communication Skills in English. Kolhapur: PhadakePrakashan.
9. Chand, S. (2073). Modern Commercial Correspondence. New Delhi: S. Chand & Company Ltd.

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	**IV**					
YEAR	**II**					
COURSE CODE	**20MSC5401**					
TITLE OF THE COURSE	**PROJECT WORK**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**36**	**-**	**18**

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

COURSE OBJECTIVES :

1. Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations

2. Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To provide a postgraduate level knowledge in Microbiology, including understanding, analysis, management, and handling of real life information technology problems in workplace.	L4
CO2	To provide graduate education that will prepare students to become thoughtful, productive members of the competing profession and community.	L4
CO3	To provide a high-quality post graduate education and training in microbiology which prepares students for productive careers and lifelong learning.	L5