# CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

## PROGRAM: M.Sc., SUBJECT: BIOCHEMISTRY

| Syllabus Developed by | | | |
|---|---|---|---|
| **Name of BoS Convenor / BoS Member** | **Designation** | **Department** | **College/University** |
| Prof S K Awasthi | Dean, Faculty of Life Sciences | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Nand Lal | Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Neelam Pathak | External Expert | Biochemistry | RMLAU, Ayodhaya |
| Prof. Ram Narain | External Expert | Biotechnology | VBS Purvanchal University, Jaunpur |
| Prof. B N Mishra | External Expert | Biotechnology | Instt. Of Engineering &Technology, Lucknow |
| Prof. Varsha Gupta | Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Prof. Rolee Sharma | Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Dr. Shilpa Deshpande Kaistha | Associate Professor | Life Sciences & Biotechnology | CSJM University Kanpur |
| Dr. Akhilendra Pratap Bharati | Assistant Professor | Life Sciences & Biotechnology | CSJM University Kanpur |

| Semesterwise titles of Papers in M.Sc. Microbiology | | | | | | |
|---|---|---|---|---|---|---|
| **I YEAR / I SEM** | | | | | | |
| **COURSE CODE** | **TYPE** | **COURSE TITLE** | **MIN CREDITS** | **CIA** | **ESE** | **MAX. MARKS** |
| L020701T | Core | General Biochemistry | 4 | 25 | 75 | 100 |
| L020702T | Core | Cell biology and Membrane Biochemistry | 4 | 25 | 75 | 100 |
| L020703T | Core | Biophysical chemistry, techniques and application | 4 | 25 | 75 | 100 |
| L020704T | Core | General Microbiology | 4 | 25 | 75 | 100 |
| L020705P | Practical | Practical-1 | 4 | 25 | 75 | 100 |
| | Minor Elective | Open Elective - Physiology of Exercise/Drug Delivery System/Indian Ethos and Value | 4 | 25 | 75 | 100 |
| | Project | Research Project | | | | - |
| | | **Total credit** | 24 | | | 600 |
| **I YEAR/ II SEM** | | | | | | |
| L020801T | Core | Molecular Biology and Genetics | 4 | 25 | 75 | 100 |
| L020802T | Core | Bioenergetics and Intermediary Metabolism | 4 | 25 | 75 | 100 |
| L020803T | Core | Enzymology | 4 | 25 | 75 | 100 |
| L020804T | Elective | Human genetics | 4 | 25 | 75 | 100 |
| L020805T | (Elect any one) | Recombinant DNA Technology | | | | |
| L020806P | Practical | Practical -2 | 4 | 25 | 75 | 100 |
| L020807R | Project | Research Project/Seminar | 8 | 25 | 75 | 100 |
| | | **Total Credit** | 28 | | | 600 |
| | **TOTAL FOR YEAR I** | | 52 | | | 1200 |

# CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

## PROGRAM: M.Sc., SUBJECT: BIOCHEMISTRY

| | | | | | | |
|---|---|---|---|---|---|---|
| **II YEAR / III SEM** | | | | | | |
| L020901T | Core | Plant Biochemistry | 4 | 25 | 75 | 100 |
| L020902T | Core | Physiology and Clinical Biochemistry | 4 | 25 | 75 | 100 |
| L020903T | Core | Molecular and Cellular Immunology | 4 | 25 | 75 | 100 |
| L020904T | ELECTIVE (elect any two) | Bioinformatics and Biostatistics | 4 | 25 | 75 | 100 |
| L020905T | | Proteomics and Genomics | | | | |
| L020906T | | Biochemical Engineering and fermentation technology | 4 | 25 | 75 | 100 |
| L020907T | | Pharmacology and toxicology | | | | |
| L020908P | | Practical-3 | 4 | 25 | 75 | 100 |
| | | (Research Project/Dissertation) | | | | |
| | | **Total credit** | 24 | | | 600 |
| **II YEAR / IV SEM** | | | | | | |
| L021001T | Core | Environmental Biochemistry | 4 | 25 | 75 | 100 |
| L021002T | Any one | Industrial Biochemistry | 4 | 25 | 75 | 100 |
| L021003T | Electives to be chosen | Cell and Tissue Culture | | | | |
| L021004P | Presentation (Compulsory) | Summer internship/training/review/case study[#] | 4 | 25 | 75 | 100 |
| L021005R | Project | (Research Project/Dissertation)[##] | 12 | 50 | 150 | 200 |
| | | | 24 | | | 500 |
| | | **TOTAL FOR YEAR III** | 48 | | | 1100 |
| **GRAND TOTAL** | | | 100 | | | 2300 |

CIA: Continuous Internal Assessment ESE: End Semester Examination

**NOTE:**

1. *A MINOR ELECTIVE FROM OTHER FACULTY SHALL BE CHOSEN IN 1ST YEAR (EITHER Ist / IInd SEMESTER) AS PER AVAILABILITY.
2. In First year of PG program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier, and will be of 4 credit (4 hr/week), in each semester. The student shall submit a report/dissertation for evaluation at the end of the year, which will be therefore of 8 credit s and 100 marks
3. #Summer internship will be undertaken during summer vacation that falls between II and III semester of the programmme, the report along with certificate shall be submitted and evaluated in IV semester, and its credit will also be counted in IV semester.

4. Summer Internship can be done in form of Internship/Survey/Field work/Research project/ Industrial training/ Review, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voice.

5. Any course from MOOCS of the relevant discipline may be selected after approval from coordinator & Head / Director as 10th semester elective paper.

6. ##In second years of M.Sc. Microbiology program, there will be a Research Project or equivalently a research-oriented Dissertation as per guidelines issued earlier and will be of 6 credit (6 hr/week), in each semester. Student will submit Project Report/ Dissertation at the end of 4th semester that will be evaluated for 12 credit hours for a total of 200 marks. The evaluation shall be done by seminar/presentation and viva voice.

7. The student straight away will be awarded 25 marks if he/she publishes a research paper on the topic of Research Project or Dissertation.

## Semester-I

**L020701T (Core): General Biochemistry**

**Course Objectives:**

1. Gain knowledge about various macromolecules present in biological system.
2. Understand structure, linkage and functions of macromolecules

**Unit – I**

Introduction of Biochemistry, Structure of atoms, molecules and chemical bonds; Structure of water, its physico- chemical properties and interaction with ions. nature significance of week acids and bases. Henderson Hasselbalach equation. pH and buffers; Biochemistry through Ayurveda (Indian Knowledge system).

**Unit – II**

Carbohydrates: Classification, structures, characteristics and functions of simple and complex carbohydrates; Structure and general function of amino sugars, sugar nucleotides and mucopolysaccharides. Stereoisomerisms and optical isomerism of sugar, Ring structure and anomeric forms, mutarotation. Important biological importance of monosaccharaides, oligosaccharides and polysaccharides.

**Unit – III**

Classification of lipids, Fatty acids: introduction classification, nomenclature and properties of saturated and unsaturated fatty acids. Essential fatty acids prostaglandins. Triacylglycerols: nomenclature, physical properties, chemical properties and characterization of fats-hydrolysis saponification. rancidity of fats. Sphingolipids, Glycolipids, Properties and function of phospholipids, isoprenoid and sterols.

**Unit – IV**

Proteins: Basic structure and functions of amino acids and proteins; Secondary, tertiary and quaternary structure of proteins; Protein folding; Interactions stabilizing the proteins (Vander Waals, hydrogen bonding, electrostatic, hydrophobic interaction); Protein structure evolution; Structure-function relationships of some model proteins like myoglobin, hemoglobin. Essential amino acids.

**Unit – V**

Nature of genetic materials; evidence that DNA genetic material. Structure, chemistry and biological properties of purine and pyrimidine, nucleosides and nucleotides, DNA and RNA structure, physico-chemical properties and their various functions. Vitamins- Structure, properties and functions including biochemical reactions and deficiency symptoms;

**Course Outcomes:**

1. Understanding fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms.
2. Exposure with the nature of various biomolecules present in living cells.
3. To know about the unique property of water as a universal solvent and its importance in biological system
4. Understanding of concepts of acids, bases, indicators, pKa values, etc.

5. To understand the properties of carbohydrates, proteins, lipids, DNA, RNA, and their importance in biological systems

**Suggested reading:**

1 V. Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

**L020702T (Core): Cell biology and Membrane Biochemistry**

**Course Objectives:**

1. Study structure and functions of bio membranes, structure-function relationships, membrane biogenesis.
2. Demonstrate knowledge on membrane associated cellular events.

**Unit – I**
Cell classification, cell variability (size, shape, complexity, function), Structural organization of prokaryotic and eukaryotic cells, cell types, differences in plant and animals. concepts related to compartmentalization in eukaryotic cells; cell-ECM and cell-cell interactions; Basics of IKS.

**Unit – II**
Detailed descriptions of eukaryotic cell structure. The ultra-structure of nucleus. Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi apparatus, Lysosomes, peroxisomes and their function. Cell division and cell cycle (Mitosis and meiosis-Steps, regulation and control of cell cycle);

**Unit – III**
Cellular communication; general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, Actin-binding proteins and their significance; Extracellular matrix in plants and animals.

**Unit – IV**
Chemical composition of biomembranes. Gap and tight junctions. Physical and biochemical methods to study membrane structure and properties. Different models of cell membrane-historical perspective. Function of biomembranes with examples. Energy transduction-mitochondria and chloroplast, signal recognition. Programmed cell death, aging and senescence.

**Unit – V**
Transport across bio membrane, Simple diffusion, Fick's law, porins, facilitated diffusion, porter molecules, kinetics of facilitated transport, symport, antiport, uniport. Red cell-membrane proteins, anion porter and glucose porter. Active transport, proton and Na+-K+ pumps- examples and metabolic significance, Donan's membrane equilibrium.

**Course Outcomes:**

1. Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. Students will understand how these cellular components are used to generate and utilize energy in cells

3. Students will understand the cellular components underlying mitotic cell division.
4. Students will apply their knowledge of cell biology to selected examples of changes in cell function.

**Suggested reading:**


1. Lodish et al., Molecular cell Biology, 4th Edition, W.H. Freeman & Company, 2000.
2. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.
3. Watson et al., Molecular Biology of the gene, 5th Edition, Pearson Prentice Hall. USA, 2003.
4. Benjamin Lewin, Gene IX, 9th Edition, Jones and Barlett Publishers, 2007.


**L020703T (Core): Biophysical Chemistry, Techniques and Applications**

**Course Objectives:**

1. Understand theoretical and practical knowledge about various techniques used in purification, characterization.
2. Identify and apply the knowledge in estimation of cellular constituents.
3. Develop key skills like practical research required in scientific work.

**Unit – I**

pH meter, centrifugation techniques and their application: Basic principles (RCF, RPM, Sedimentation coefficient etc); Technique and applications; Types of centrifuges- Microcentrifuge, High speed and Ultracentrifuges; Types of Rotors: fixed angle, swinging bucket. Preparative centrifugation; Differential and density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods. Introduction of Indian Scientist (IKS).

**Unit – II**

Chromatography - Theory and general techniques of absorption, partition, ion exchange, gel filtration, TLC, paper chromatography, chromatofocussing, covalent, Gas chromatology, Affinity, FPLC, HPLC and reverse phase HPLC.

**Unit – III**

Electrophoresis, Basic principle of agarose electrophoresis, PAGE and SDS-PAGE and their applications. Capillary electrophoresis, Two-dimensional electrophoresis, disc gel electrophoresis; Pulsed field gel electrophoresis and its importance Isoelectricfocussing, immunodiffusion and immunoelectrophoresis (different types).

**Unit – IV**

Spectroscopic Techniques - Theory, principle and applications of UV-Visible, Raman Spectroscopy, fluorimetry, Circular Dichroism; NMR, PMR, ESR and Plasma Emission spectroscopy, Mass Spectroscopy. Different types of microscopic techniques and X-ray crystallography.

**Unit – V**

Tracer techniques- Detection measurement of isotopes and application of isotopes in biochemistry, RIA, IRMA, and ELISA. Units of radioactivity, biological hazards of radiation and safety measures in handling radioisotopes.

**Course Outcomes:**

1. The objective of this course is to familiarize students with the basic concepts and applications of modern techniques used in Biochemistry, Biophysics, Cell and Molecular Biology.
2. To learn the application of different techniques and tools in different areas of scientific research.
3. The students will be able to understand the principle and working of different chromatography techniques.
4. The students will be able to understand the principle and working of different centrifugation techniques.
5. The students will be able to understand the principle and working of different Electrophoretic and molecular biology techniques.

**Suggested reading:**

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman and Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.
3. D. Holme and H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

**L020704T (Core): General Microbiology**

**Course Objectives:**

The objective of the course is to understand basic working principles in microbiology and have knowledge for differentiating different microbial forms.

**Unit-I**

History, development and scope of microbiology. Major contributions of scientist to microbiology (Antony van Leeuwenhoek, Lazzaro Spallanzani, John Tyndall, Louis Pasteur, Joseph Lister, Iwanowski, Robert Koch). #Contribution of Indian researchers, Indian Knowledge System, Pure culture Isolation Techniques; Microscopy and preparation of microbial samples: wet mount, smear; Staining: types; simple and differential staining, Introduction of Indian Scientist (IKS)

**Unit-II**

Nutritional requirement and Growth of microorganism: culture media- types, factors affecting growth, Measurement of growth, growth phases, growth kinetics, diauxic growth, synchronous and asynchronous culture; batch, fed batch and continuous culture; Growth of aerobic and anaerobic bacteria. Culture preservation and Culture Collection.

**Unit-III**

Physical and Chemical control of microorganisms: Disinfectants and Sterilization principles. Antimicrobial chemotherapy

**Unit-IV**

Microbial Taxonomy, Systematics, Phylogeny and Nomenclature. Hierarchial organization of organisms- Haeckel, Whittaker and Woese classification. Numerical and Chemotaxanomy of microorganism. Salient features of archaebacteria and eubacteria. Classification of bacteria according to Bergey's Manual of Determinative Bacteriology.

**Unit-V**

Differentiating features, habitats, reproduction and classification of Mollicutes, Slime Molds, Algae, Fungi, Viruses

**Course Outcomes:**

1. Demonstrate theory and practical skills in microscopy and their handling techniques and staining procedures
2. Identify use of different culture media and their applications and microbial techniques for microbial growth estimation, cultivation and culture preservation for routine microbiological skill handling
3. Develop methods associated with the various physical and chemical growth requirements of bacteria and get equipped with various methods of disinfection and sterilization.
4. Understand different systems for microbial classification and nomenclature for study of biodiversity.
5. Apply the knowledge to understand the differentiating microbial characteristics for their identification and further characterization

**Suggested reading**

1. Microbiology. Prescott LM, Hurley JP, Klein DA. Microbiology- Edition. McGraw Hill Publication, New York
2. Microbiology. M J Pelczar, Chan, Krieg. 5th Edition. Mc Graw Hill
3. Microbiology. RP Singh. Kalyani Publisher
4. Textbook of Microbiology. Dubey & Maheshwari. S Chand Publications.

**L020705P: Practical-1**

Based on theory subjects
Research Project and review article

1. Biochemical estimation of carbohydrates
2. Biochemical tests for amino acids and proteins.
3. Isolation of proteins.
4. Separation and estimation of lipids by using TLC.
5. Separation of proteins by SDS-PAGE.
6. Estimation of protein by Lowry's and Bradford methods.
7. Estimation of DNA by DPA method.
8. Estimation of RNA by orcinol.
9. Preparation of various culture media for growing microorganism.

10. Gram staining of Bacteria.

## Semester-II

**L020801T (Core): Molecular Biology and Genetics**

**Course Objectives:**

1. Understand the mechanism of replication, transcription and regulation.
2. Understand the features of Genetic code and translation mechanism.
3. Understand and the cellular mechanism of Gene expression and regulation.
4. Application of molecular biology in gene manipulation.

**Unit – I**

**DNA replication and its regulation:** Mechanism of DNA Replication: Structure and function of DNA polymerases. Role of Replisome, Primosome, Okazaki fragments, helicase, primase, gyrase, topoisomerase and other proteins in DNA replication in E. coli and eukaryotes, initiation of replication, elongation and termination of DNA synthesis. DNA Repair -Mutation, mutagenes, paramutations, molecular basis of gene mutation, Disease associated with repair mechanisms, DNA replication inhibitors. Introduction of Indian Scientist related to molecular biology (IKS).

**Unit – II**

***Transcription*:** Prokaryotic and eukaryotic transcription: Initiation, elongation and termination; Structure and function of RNA -mRNA, tRNA, rRNA, snRNA, Concept of intron & exon, DNA - dependent RNA polymerase (RNA Pol in prokaryotes and RNA Pol I, II, III). Promoter; Enhancer and other regulatory elements; Transcription factors; Reverse transcription; Post- transcriptional / Co-transcriptional processing: Regulation of transcription in prokaryotes and eukaryotes.

**Unit – III**

Genetic code, Translation: Translation in Prokaryotes & Eukaryotes. Inhibition of protein synthesis by antibiotics. Regulation of protein synthesis, post translation modification. Protein targeting in prokaryotes and eukaryotes, Chaperones, heat shock proteins, inhibitors of protein synthesis.

**Unit – IV**

Regulation of gene expression in prokaryotes, Coordinated control of clustered genes-operon model, with example of inducible Systems like lac-Operon. Arabinose operon and repressible systems like Trp operon. Role of repressors and activators of transcription in regulation of phage-lytic and lysogeic pathways, lambda repressor. Regulation of gene expression in eukaryotes, Organization of genes in eukaryotic DNA- Repititive DNA sequences, activators, enhancers. Post transcriptional regulation splicing, capping, methylation, acetylation, heat shock protein. Diseases linked with gene expression.

**Unit – V**

Linkage and crossing over, Linkage mapping, Sex determination and sex-linked inheritance, Sex determination in plant and animal, Population and evolutionary genetics.

**Course Outcomes:**

1. The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
2. The course has been devised to familiarize students with molecular biology which mainly deals with interactions among various systems of the cell, including those between DNA, RNA and proteins and learning how these are regulated.
3. To illustrate creative use of modern tools and techniques and expose students to application of recombinant DNA technology in scientific research.
4. To train students in strategizing research methodologies employing genetic engineering techniques.

**Suggested reading:**


1. Freifelder, DM "Molecular Biology".
2. Brown, TA "Genomes".
3. Rastogi &Pathak Genetic Engineering
4. Brown, T.A. "Gene cloning: An introduction"
5. Old & Primrose "Principles of Gene Manipulation"
6. Primrose, SB "Molecular Biotechnology"
7. The Cell - by Geoffrey M. Cooper


**L020802T (Core): Bioenergetics and Intermediary Metabolism**

**Course Objectives:**

1. This course aims to develop a thorough knowledge among the students about metabolism.
2. To enable students, visualize energy production and utilization in biological processes.
3. The course gives metabolism of different biomolecules that can help students in understanding chemical pathway living system.

**Unit – I**

Bioenergetics- Energy transduction, Law of thermodynamics, Biological Oxidation. Gibb's energy, energy changes and redox potential, electrochemical and membrane potential, High energy compounds and low energy compounds, ATP cycle. Introduction of Indian Scientist (IKS).

**Unit – II**

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, cytochromes and their characterization. Respiratory control and oxidative phosphorylation. Fractionation and reconstitution of respiratory chain complex, oxidative phosphorylation and theories.

**Unit – III**

Methods and Techniques in the study of Intermediary metabolism. Multienzyme complex. Metabolism of carbohydrates and its regulation. Biosynthesis of glycogen and starch. Fatty acids biosynthesis & oxidation; lipid biosynthesis; biosynthesis of triglycerols, phasphoglycerides and sphingolipids. Biosynthesis of steroids, ketone bodies formation and utilization.

**Unit – IV**

Biosynthesis and degradiation of amino acids and their regulation, Specific aspects of amino acid metabolism. Urea cycle and its regulation, Inborne error of metabolism.

**Unit – V**

Biosynthesis and regulation of purines and pyrimidines. degradation of purines and pyrimidines., structure and regulation of ribonucleotides deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Disorders of purine and pyrimidine metabolism.

**Course Outcomes:**

1. Explain the role of catabolic and anabolic pathways in cellular metabolism.
2. Distinguish between kinetic and potential energy.
3. Distinguish between exergonic and endergonic reactions in terms of available energy change.
4. Describe the structure of ATP and identify the major class of macromolecules to which ATP belongs.

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L020803T (Core): Enzymology**

**Course Objectives:**

1. Understand the Thermodynamic terms and basic concepts.
2. Understand the classification, structure, properties and functions of enzymes.
3. Understand the mechanism of action of enzymes and analyse the different types of Catalysis.
4. Understand and apply the kinetic studies in the derivation of the M.M equation and their modification and understand different types of inhibition.
5. Apply and evaluate the role of enzymes in different areas like industries, clinical labs etc.

**Unit – I**

Isolation and purification of enzymes, purity of enzymes, enzyme activity and specific activity, native, inactive and denature state of enzymes. Nomenclature and classification of enzymes, general structure and properties of enzymes, enzyme assay, factors affecting enzyme activity, Introduction of Indian Scientist (IKS).

**Unit – II**

Kinetics of enzyme action - Concept of ES complex, active site, specificity, derivation of Michaelis-Menten equation for uni-substrate reactions. Different plots for the determination of Km & Vmax and their physiological significances. Importance of Keat/Km. Kinetics of zero & first order reactions. Classification of multi substrate reactions with examples. Derivation of the rate of expression for Ping Pong, random & ordered BiBi mechanisms. Reversible and irreversible inhibition. Competitive, non- competitive, uncompetitive, type inhibitions and their kinetics.

**Unit – III**

Mechanism of Enzyme Action - Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of ribonuclease, chymotrypsin, lysozyme and carboxypeptidase.

**Unit – IV**

Enzyme Regulation - General mechanisms of enzyme regulation. Reversible and irreversible covalent modifications of enzymes. Feedback inhibition, Allosteric enzymes, qualitative description of "concerted" & "sequential" models for allosteric enzymes. Half site reactivity, Flipflop mechanism. positive and negative co-

operativity with special reference to aspartate transcarbamoylase & phosphofructokinase. Protein- ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

**Unit – V**

Multienzyme system - Occurrence, isolation & their properties: Mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzyme-enzyme interaction, isoenzymes with special reference to lactate dehydrogenase and phasphocreatine kinase.

**Course Outcomes:**

1. To learn about general properties of enzymes like activation energy, active site, etc.; definition of enzyme activity and its various units; classes of enzymes and international nomenclature, the types of enzyme assays; and the various kinds of techniques employed for purification
2. To know about the concepts of enzyme kinetics
3. To study about Mechanism of enzyme action
4. To understand the concept of Enzyme Regulation
5. To know about Multienzyme complexes and isozymes

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L020804T (Elective): Human Genetics**

**Course Objectives:**

**Unit – I**

Introduction to Human Genetics: History; Early perception, development and documentation; Genome organization; Chromosome structure, function and implications for disease. Study tools in Human Genetics: Pedigree analysis- Mendelian inheritance and exceptions; Chromosomal analysis (in vitro, in vivo), Biochemical analysis; Somatic cell genetics (somatic cell hybrids, monochromosome hybrid panels, gene mapping); Molecular genetic analysis.

**Unit – II**

Human genome mapping methods: Physical mapping: Introduction to physical map markers Chromosomal, G/Q-banding, radiation hybrid, Fluorescence in situ hybridization, comparative genome hybridization, long range restriction mapping, high resolution mappingSTS/EST/MS/SNP/sequencing; Genetic mapping: Linkage analysis (RFLP/MS/SNP); Applications of mapping in normal and disease genome analysis; Gene identification using positional and functional cloning approach.

**Unit – III**

Human genome analysis: Conception, mapping, cloning and sequencing, Outcome-Generation of `OMICS' era, significant leads. Genetic variation in health and disease: Human genetic diversity- Methods of study-Biochemical/molecular genetic markers; some examples. Tracing human migrations with autosomal, Y-chromosomal and mitochondria] markers

**Unit – IV**

Diseases and disorders: Chromosomal disorders: Structural and numerical; Autosomal/sex chromosomal/sex reversal; Mechanisms- mitotic/meiotic non-disjunction/ chromosomal rearrangements; Some examples (Syndromes/Cancer/Infertility); Single gene and disease: Inborn errors of metabolism,

Haemoglobinopathies; Multifactorial disorders: Introduction; Methods of study (Epidemiological, Twin/ adoption and Family studies); Etiology - genetic and non-genetic determinants; Common examples.

**Unit – V**

Epigenetics and disease: Mechanisms (Imprinting/methylation; chromatin remodeling); Current understanding; examples. Mitochondria' myopathies. Ethical, legal and social issues in Human genetics: Prenatal/adult (individual/family/population) screening of mutation/risk factor for genetic diseases; Confidentiality/privacy, Discrimination, Ethical dilemma, Human rights, Surrogate mothers; Human cloning and eugenics; Organ banking and transplantation; Research ethics; Medical ethics in India.

**Course Outcomes:**

1. The student will learn and understand the genome organization, cytogenetics, genetic control of development.
2. The student will learn and understand the principles of Mendelian inheritance, linkage and genetic mapping; extrachromosomal inheritance, sex-linked inheritance and genetic disorders, somatic cell genetics, population genetics.
3. The course will aid to learn about physical and chemical mutagens, drug metabolism and detoxification; DNA damage, DNA repair mechanisms, oncogenes, proto-oncogenes, and tumour suppressor genes from humans.
4. The student will learn and understand the Human Genome Project, gene therapy, genetic testing, and genetic counselling.

**Suggested Reading:**


1. The Cell: A Molecular Approach, by Geoffrey M Cooper, Robert E Hausman, 15 Dec 2015
2. Molecular Cell Biology Hardcover –by Harvey Lodish (Author), Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, 1 Apr 2016
3. Molecular Biology of THE CELL: by Bruce Alberts, Alexander Johnson, Julian Lewis. Publisher Garland Science, December 2014
4. Human Molecular Genetics, 3rdEdittion, Tom Strachan, Andrew P. Read.
5. Emery 's Elements of Medical Genetics 12th edition, Peter Turnpeeny Sian Ellard, Elsevier publications.
6. Human Molecular Genetics, Jack J Pasternak 2nd Edition, John Wiley and sons


**L020805T (Elective): Recombinant DNA Technology**

**Course Objectives:**

1. Understand the principles of the techniques of Gene transfer methods.
2. Analyze the methods of cloning and screening.
3. Evaluate the various techniques used in gene manipulation.
4. Analyze and evaluate the different applications of RDT.

**UNIT-I**

Restriction Enzymes DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Labelling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes.

**UNIT-II**

Plasmids, Phagemids and Expression Vectors M13 mp vectors; pUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Yeast vectors, Shuttle vectors, siRNA technology.

**UNIT-III**

**Expression strategies for heterologous genes** vector engineering, codon optimization, host engineering, in vitro transcription & in vitro translation, expression in bacteria, expression in yeast, Inclusion bodies; Methodologies to reduce formation of inclusion bodies.

**UNIT-IV:**

**Linkers and Adaptors** Homopolymeric tailing, strategies for cDNA libraries; Transformation; Northern, Southern and Colony hybridization, Southwestern and Far-western cloning; Phage display; cloning differentially expressed genes (mRNA differential display and subtractive cloning). DNA-Protein Interactions (Electromobility shift assay; DNasel footprinting)

**UNIT-V:**

**PCR and Its Applications** Primer design; Fidelity of thermostable enzymes (Taq & Pfu polymerases); DNA polymerases; Types of PCR — multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in gene recombination; SOEing; Site specific mutagenesis; deletion; addition.

**Course Outcomes:**

1. Understand the concept of recombinant DNA technology, technique, application and limitations.
2. Understand the concept of gene manipulation.
3. Explain the general principles and applications of RDT

**Suggested Reading:**

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. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

**L020806P: Practical-2**

Based on theory subjects

1. Isolation of enzymes from different sources.
2. Assay of enzyme activity (acid phosphatase, peroxidase).
3. Enzyme kinetics calculation of Km and Vmax using MM graph and LB plot.
4. Purification of protein by column chromatography.

5. Plasmid isolation by alkaline lysis method.
6. Bacterial genomic DNA isolation by CTAB
7. RNA isolation from plant tissue
8. Separation of DNA and RNA by Agarose Gel Electrophoresis.
9. Microbial cultures, competent cell preparation and cloning.
10. PCR

**L020806R: Research Project**

Research Project/synopsis presentation

**Semester-III**

**L020901T (Core): Plant Biochemistry**

**Unit – I**
Structure and function of plant cell (including cell-wall, plasmodesmata, meristmetic cells, vacuoles, secretory system root quiescent zone), Isolation of cell organelles, absorption, transport of water & ions in plants, Evapotranspiration, Introduction of Indian Plant Biochemist (IKS)

**Unit – II**
Photosynthesis, Photosystem I & II their location, Mechanism of quantum capture & energy transfer between photo system. hill reaction, photophosphorylation, & reduction of C02, C3, C4, and CAM metabolism, light and dark reaction. Light activation of enzymes, Regulation of photosynthesis, Photorespiration.

**Unit – III**
Biological nitrogen fixation and ammonia assimilation, nitrate and sulphate reduction and their incorporation into amino acids translocation of inorganic and organic substances. Role of microbes in nitrogen, sulphur, carbon and phosphorous cycles.

**Unit – IV**
Special features of secondary plant metabolism, formation of phenolic acids, tannins, lignins, lignans, pigments, terpenes, terpenoids, plant, phenolic, alkaloids and surface waxes -their biosynthesis and function.

**Unit – V**
Plant hormones - growth regulating substances and their mode of action. Biological and Molecular aspects of auxins, Gibberllins, abscisic acid, cytokinins and ethylene. Biochemistry of seed development and fruit ripening. Defense system in plants.

**Course Outcomes:**

1. The course is designed to know the structure and function of plant cell and role of different organelles.
2. Students will be able to learn the general process of photosynthesis in the plants and energy transfer.

3. To know the general metabolism in plants such as respiration, lipid biosynthesis and other key process such as nitrogen metabolism
4. Students will also gather information on metabolites and hormones, important in the development of plants.

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L020902T (Core): Physiology and Clinical Biochemistry**

**Unit – I**

Nutrition and balanced diet vitamins and minerals. Digestion and Absorption of food (Carbohydrates, Lipid and protein), Chemistry of respiration, homeostasis, regulation of acid base balance. factor affecting acid base balance, Introduction of Indian Scientist (IKS).

**Unit – II**

Body fluids — Composition and functions, Blood groups, Rh factor, Plasma protein, coagulation, clotting formation, Anemia, Urine — Composition & function, formation in health and disease.

**Unit – III**

A brief outline of various endocrine glands. Classification, Structure, and function of Hormones. Feedback regulation of hormone secretion. Mechanism of extracellular and intracellular hormone action. Metabolic and physiologic role of hormones secreted by pituitary, thyroids, parathyroid, adrenals, pancreas and gonad, disorders due to over and under secretion.

**Unit – IV**

Biochemical basis of drugs action. Biotransformation and detoxification mechanism, Role of glutathione in drug resistance.

**Unit – V**

Clinical and Bio-chemical aspects of disease- cancer, AIDS, jaundice, cushing, syndrome, diabetes mellitus, atherosclerosis, protein calorie malnutrition.

**Course Outcomes:**

1. Understand and explain the acid-base, water-electrolyte and redox biology balance in the body.
2. Understand the difference between plasma, serum, normal and abnormal constituents in various body fluids. blood clotting mechanism and anticoagulants.
3. Explain the nature and function of various enzymes, normal levels and elevated levels in various diseases. Also, learning on various systems of the body.
4. Studies on blood and urine other circulatory systems and related disorders.
5. Learn that many diseases result from imbalance in certain biomolecules and helps in diagnosis of liver, cardiac, gastrointestinal, kidney diseases.
6. The course will also aid to learn about kidney diseases liver diseases and other metabolic disorders.

**Suggested Readings:**

1. Textbook of Medical Biochemistry by M.N. Chatterjee and Raneshinde (7thEdn.)
2. Textbook of Medical Laboratory Technology by DP. Godkar and PB. Godkur.

3. Concise Book of Medical Laboratory Technology by Ramnik Sood.
4. Textbook of Biochemistry with Clinical Correlation by Thomas M Devlin.
5. Tietz Textbook of Clinical Chemistry & Molecular Diagnostics by CA. Burtis et al
6. Textbook of Medical physiology by Guyton & Hall

**L020903T (Core): Molecular and Cellular Immunology**

**Unit – I**

Immunology- Fundamental concepts and anatomy of the immune system; Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system- primary and secondary lymphoid organs-Bone marrow, thymus, lymph nodes, spleen; Lymphatic system; Lymphocyte circulation; Lymphocyte homing; Mucosal and Cutaneous associated Lymphoid tissue (MALT and CALT); Mucosal Immunity. Toll-like receptors, inflammation. Antigens - haptens, antigenicity and immunogenicity, Introduction of Indian Scientist (IKS).

**Unit – II**

Humoral and Cell-Mediated Immune responses, primary and secondary immune modulation, Immunoglobulins: Basic structure, Classes and Subclasses of immunoglobulins, ADCC; antigenic determinants; Band T cell epitopes; Band T cell receptors; Immune responses generated by B and T lymphocytes; activation and differentiation of B and T cells, Memory B cell maturation, activation and differentiation; Cell-mediated effector functions; Functional T Cell Subsets; Cell-mediated immune responses, Cytokines-properties, receptors and therapeutic uses. Structure and function of antibody molecules; Multigene organization of immunoglobulin genes; Immunoglobulin superfamily; Generation of antibody diversity.

**Unit – III**

Major Histocompatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing; MHC molecules, antigen processing and presentation, endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.

**Unit – IV**

Antigen-antibody interactions- Kinetics of immune response; Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques; RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosensor assays for assessing ligand-receptor interaction, CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Microarrays.

**Unit – V**

Clinical Immunology: Immunity to Infection Hypersensitivity - Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; Treatment of autoimmune diseases; Transplantation immunology- Immunological basis of graft rejection; congenital and acquired immunodeficiencies. Cancer: Tumor immunology; Oncogenes, Tumor Suppressor Genes; Immune response to tumors and tumor evasion of the immune system.

**Course Outcomes:**

1. This course is focused upon molecular and cellular aspects of immunology.
2. This course will cover the basic concepts underlying the mechanisms of innate and adaptive immunity, as well as key experimental methods currently used in the field.

3. The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
4. The students will be able to describe immunological responses and how they are triggered and regulated.
5. The students will be able to transfer knowledge of immunology into clinical decision- making through case studies presented in class.

**Suggested Readings:**


1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., & Kuby, J. (2006). Kuby Immunology. New York: W.H. Freeman.
2. Brostoff J, Seaddin JK, Male D, Raitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
3. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.
4. Paul, Fundamental of Immunology, 4th edition, Lippencott Raven, 1999.
5. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
6. Goding, Monoclonal antibodies, Academic Press. 1985.


**L020904T (Elective): Bioinformatics and Biostatistics**

**Unit – I**

Basics of bioinformatics. Origin and Overview of bioinformatics- Application of bioinformatics - National and International bioinformatics Institutes and Industries - Research in bioinformatics –Define-Homologs, Orthologs, Paralogs and Xenologs - various OMES and OMICS. Role of computers in biology (biocomputing), Basics of computers – block diagram of computer, input and output devices, storage devices, operating systems – DOS, Windows, Linux. Basics of networking and their types, topologies, INTERNET: TCP/IP, World Wide Web, e-mail.

**Unit – II**

Biological databases, biological data file formats: *. FASTA, *.PIR, *.GDE, *.PDB, Alignment files (*.ALN) etc. access bibliographic resources and literature databases: PubMed, PMC and Public library of Sciences (PLoS) - Sequences Databases: GenBabk, DDBJ, EMBL, PIR and Swiss-Port- Pattern and Motif Searches: PROSITE, BLOCKS, PRINTS, PFAM- Structuren: PDB and NDB Structural classification databases: SCOP, CATH- Metabolic pathways and enzymatic database: KEGG, MetaCyc, BRENDA. Microbiology DATABASES: ICTV, Animal Virus Information System (AVIS).

**Unit – III**

Sequence analysis –Pair wise Sequence Alignment: Needleman wunsch, Smith Watermann algorithms, Sequence similarity search programs – BLAST and FASTA. Substitution matrices: PAM, BLOSSUM. Multiple sequence alignments: Center Star method, Clustal, PRAS. Phylogenetic analysis: Character based (Parsimony) and distance-based methods (UPGMA, neighbor joining), Protein structure prediction: Homology modeling, Primer Designing, Multi dimentional protein identification technology – identification using database. Phylogenic analysis: Sequence – based taxonomy – From Multiple Alignment to Phylogeny – methods for Construction & representation of phylogenetic tree using MEGA software.

**Unit – IV**

Genomics and proteomics. Genome Database: GOLD –Gene finders: GLIMMER and GENSCAN –Genome projects: Human. Features of protein sequence and structure – Proteomics tools in Expasy Server- Protein secondary structure prediction: GOR and SOPMA – Tertiary structure prediction: Homology modeling – protein structure Visualization tools: RasMol Viewer, UCSF-CHIMERA. Advancement of bioinformatics: Overview- Systems biology- E. Coil, Chemoinformatics-drug database: ZINC, PubChem, DRUGBANK- Protein engineering- CUPSAT, SDB.

**Unit – V**

Biostatistics: Measures of central tendency – mean (arithmetic, harmonic & geometric) median and mode; Measures of dispersion- range, quartile deviation, mean deviation and standard deviation. Coefficient of variation. Correlation analysis: positive and negative correlation, Karl Pearson's coefficient of correlation, Spearman's rank correlation. Regression analysis: regression line Y on X and X on Y, angle between two regression lines. Test of significance: null and alternative hypothesis, level of significance, Z-test, Student's 't'-test, Chi-square test for goodness of fit and independence of attributes.

**Course Outcomes:**

1. Develop learning and experience on computers, and biostatistics in students for their future personal and professional development.
2. Construct knowledge about the various applications of softwares and statistics to the students.
3. Solve mathematical and statistical problems with fellow class mates as well as individually.
4. To understand the alignment between two sequences.
5. To learn different bioinformatics tool and techniques and gain knowledge of their use in different scientific problems.
6. To demonstrate the role of computer in genomics and proteomics.

**Suggested reading:**

1. Developing Bioinformatics Computer Skills: Cynthia Gibas & Per Jambeck – 2001 Shroff
2. Bioinformatics Basics: Applications in Biological Science and Medicine – 2002 - HH Rashidi & LK Buehler, CRC Press, London
3. Bioinformatics: Sequence, structure and databanks – 2000 - Des Higgins & Willie Taylor 4. Bioinformatics: A practical guide to the analysis of genes and proteins – 2001 - AD Baxevanis & BFF Ouellette – Wiley Interscience – New York
5. Biostatistics (1996) Arora PN & Malhon PK – Imalaya Publishing House, Mumbai.
6. Primer of Biostatistics – Stanton A & Clantz – The McGraw Hill Inc., New York.

**L020905T (Elective): Proteomics and Genomics**

**Course Objectives:**

1. The objective of this paper is to train students in the analysis of genomics and proteomics data.
2. The course covers topics related to molecular biology, genome analysis, functional and structural genomics, recombinant DNA technology, and DNA & protein sequence data analysis.
3. Students will learn several experiments in wet-lab and computational methodologies.

**UNIT - I: Whole genome analysis**

Preparation of genomic library in vectors, ordered cosmid libraries, BAC libraries, shotgun libraries, comparative genomes (Arabidopsis, rice and panda).

**UNIT - II: DNA sequencing**

Conventional sequencing (Sanger, Maxam and Gilbert), pyrosequencing, next generation sequencing, automated sequencing, translation to large scale projects, epigenomics, cancer genomes. FISH, Comparative Genomic Hybridization (CGH), SKY (Spectral Karyotyping).

**UNIT - III: DNA Microarrays**

Chemical DNA synthesis, Printing of oligonucleotides and PCR products on glass slides, nitrocellulose paper. Fluorescence based assay formats and signal amplification strategies, Analysis of single nucleotide polymorphism using DNA chips. Gene Identification and Expression Analysis: DNA microarrays, ESTs, SAGE, MPSS.

**UNI- IV: Proteome analysis**

Two-dimensional separation of total cellular proteins, isolation and sequence analysis of individual protein spots by mass spectroscopy. Protein microarrays, differential display proteomics, yeast 2-hybrid system, FRET, bimolecular fluorescence complementation assay.

**UNIT-V**

Advantages and disadvantages of DNA and protein microarrays. Total expression vs functional proteomics, oligosaccharide microarrays for glycomics, pharmacogenomics, introduction to metabolomics.

**Course outcomes**

1. Demonstrate the importance of proteomics
2. Develop an understanding of data analysis
3. Assess the uses of proteomics
4. Assess & analyze the genomic study of organisms

**L020906T (Elective): Biochemical Engineering and Fermentation technology**

**Unit – I**

Biochemical engineering principals, range of fermentation process: microbial biomass, microbial enzyme, microbial metabolites recombinant products transformation process. Chronological development of fermentation industry, component part of the fermentation process.

**Unit – II**

Microbial fermentation kinetics: growth cycle, phase for batch cultivation, kinetics of garden type I and II fermentation system, determination of kinetics parameter using batch reactor with and without inhibition. thermal death kinetics.

**Unit – III**

Transport phenomena in bioprocess: Mixing and agitation, mechanical and non-mechanical agitation and oxygen - substrate mass transfer equipment, heat transfer energy balanced and transfer correlation, sterilization centrifugation filtration and drying.

**Unit – IV**

Introduction of bio reactors: Batch, CSTR and plug flow bioreactors performance equation, fermenter design, elementary treatment of non-ideal bioreactors - TD function and their application.

**Unit – V**

Dynamic modeling of batch and CSTR type bioreactors dimensional analysis and scale up fermentation economics.

**Course Outcomes:**

1. Learn about Genetic engineering and prospects of improving crop productivity, resistance, resistance to disease and environmental stresses, methods for production of transgenic animals.
2. Students will learn sterilization of air and medium; sterilization of fermenters, thermal death kinetics of microorganisms.
3. The course will develop knowledge on enzyme kinetics with one or two substrates, modulation and regulation of enzyme activity, enzyme reactions in heterogeneous systems, immobilized enzyme technology, and industrial application of enzymes.
4. This course will help students to acquire basic knowledge of microbial fermentation kinetics, bioreactors bioprocess system and commercial production of bioproducts.

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L020907T (Elective): Pharmacology and Toxicology**

**Unit – I**

General Pharmacology: Introduction to Pharmacology, Sources of Drugs, Dosage forms, Routes of Drug administration, Pharmacokinetics (ADME), Pharmacodynamics- (Receptors-Classification of receptors), Combined effect of drugs, Factors modifying drug action, Drug interactions, Overview of drug discovery and development.

**Unit – II**

Drug metabolism and basic understanding metabolic pathways renal excretion of drugs, factors affecting renal excretion of drugs, renal clearance, Nonrenal routes of drug excretion of drugs.
Bioavailability and Bioequivalence: Definition and Objectives of bioavailability, absolute and relative bioavailability, measurement of bioavailability, in-vitro drug dissolution models, in-vitro-in-vivo correlations, bioequivalence studies, methods to enhance the dissolution rates and bioavailability of poorly soluble drugs.

**Unit – III**

Pharmacology of Central Nervous System: General anesthetics, sedatives, hypnotics, Analgesics and anti-inflammatory agents, Anti-Anxiety. Pharmacology of Peripheral Nervous System: Local Anaesthetics, Skeletal Muscle Relaxants. Pharmacology of Gastrointestinal tract system: Antacids, anti-ulcer drugs, Laxatives and Antidiarrhoeal drugs, Emetics and anti-emetics. Pharmacology of Urinary System: Diuretics and Anti-diuretics.

**Unit – IV**

Chemotherapy: General principles of chemotherapy, Antibiotics – Penicillins, Chloramphenicol, Chemotherapy of malignancy. Pharmacology of Cardiac Vascular System: Cardiac glycosides and drugs for heart failure, Antihypertensive drugs. Pharmacology of Respiratory system: Anti-asthmatic drugs including bronchodilators, Anti-tussives and expectorants. Pharmacology of Endocrine System: Insulin, oral hypoglycaemic agents & glucagon.

**Unit – V**

Toxicology: a). Principles of toxicology. Definition for acute, sub-acute and chronic toxicity, Types of toxic reaction, Definition of poison, general principles of treatment of poisoning. Heavy metals poisoning.

Incidence of acute poisoning, prevention and treatment of poisoning. b). Abnormal action of drugs such as tolerance, addiction, habituation, idiosyncracy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylaxis. Adverse drug reactions.

**Course Outcomes:**

1. Demonstrate the principles of pharmacodynamics and pharmacokinetics
2. Discuss drug dosage, exposure and target specificity
3. Demonstrate the basic principles of toxicology
4. Illustrate toxicity risk assessment and fate of toxicants in humans
5. Demonstrate the experimental approach for analyzing drug action
6. Evaluate acute and chronic toxicity of environmental chemicals
7. Develop competence in handling drugs and toxic materials
8. Integrate theoretical and practical knowledge acquired in pharmacology and toxicology for advanced studies

**Suggested Readings:**

1. Satoskar, RS, Bhandarkar, SD., and Rege, NN., — Phamacology and Pharmacotherapeutics‖ Popular Prakashan (P) Ltd 2006.
2. Tripathi, KD, —Essentials of Medical Pharmacology‖ 4th Edition, Jaypee Brothers Medical Publishers (P) Ltd 1000.
3. Hardman, JG and Limbrid, LE —Goodman and Gilman‖s: The Pharmacological Basis of Therapeutics 10th edition, Medical Publishing Division, 2001.
4. Murugesh. N, —A concise textbook of Pharmacology‖, fifth edition, Prabhu offset printers.
5. Das, MM, Pharmacology for second professional students 5th edition, Books and allied (P) Ltd 2004.
6. Lawrence, DR, Bennett, PN, and Brown, MJ., Clinical Pharmacology‖ 8th Edition, Churchill

**L020908P: Practical-3**

Based on theory papers

1. Total leukocytes count
2. Differential leukocyte count
3. Haemagglutination assay
4. Separation of serum from blood
5. Double immunodiffusion test and dot immunoblot assay
6. Estimation of chlorophyll

**Project: Research project/Dissertation**

**Semester-IV**

**L021001T (Core): Environmental Biochemistry**

**Unit – I**

Introduction of ecology, Environmental factors. Biosphere, food web, trophic level and their pyramids. Ecosystem - types, development and evolution, habitat and niche. Concept of productivity and standing crops. Biome ecological indicators, ecology efficiency, edge effect, Biogeochemical cycles, Introduction of Indian Scientist (IKS).

**Unit – II**

Population ecology - definition and characters. Regulation of population size by density dependent and independent factors. Quantitative analysis of plant community. Biotic community - characteristics of community. Ecological succession - causes sera climax community. Primary and secondary succession, Evolutionary ecology.

**Unit – III**

Pollution - air, water, lignin, detergent, dyes, heavy metal, drugs, Industrial waste effluents (pulp, sugar, and paper mills), and pollution control device impact analysis of some common pollutants. Harmful effects of rays - UV, gamma, ozone layer, ozone holes. greenhouse effect. Degradation: environmental biodegradable pollutants, non-degradable pollutants Treatment of waste water and industrial effluent.

**Unit – IV**

Metabolism and Toxicity of agro and industrial chemical to plants and animals. Toxicology of free radicals and its scavengers. Xenobiotics, Bioremediation, Venniculture Biochemical aspects environmental Monitoring and ecosystem analysis.

**Unit – V**

Detection of Toxic exposure: acute Toxicity, chronic and sub-acute exposure and their tests. Testing agents for carcinogenic, mutagenic and teratogenic action. The basis of antidotal procedures. Bioremediation: Fundamentals, methods and strategies of application (biostimulation, bioaugmentation) - examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ). Application of bacteria and fungi in bioremediation.

**Course Outcomes:**

1. The Environmental Biochemistry course aims to educate students on the relevance of the environment-human body interaction, analyzing the mechanisms of action by which pollutants and global warming interfere with the regulation of metabolic and physiological processes with relevant consequences for human health.
2. To know and define the biochemical mechanisms responsible for physiological adaptation to different environmental conditions.
3. To learn ecology and effect of different environment factors on ecosystem.
4. To learn population science and analyze different type of pollutants and their effects on humans.
5. To know and define the metabolicm and toxicity, detection of toxics exposure and bioremediation.

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L021002T (Elective): Industrial Biochemistry**

**Unit – I**

Basics of biochemical engineering; material and energy balances, heat transfer, mass transfer, mass transfer correlations with oxygen transfer, fluid flow, non-Newtonian fluids. Bedouin's principle, viscosity, hydraulic conductivity, capillary flow, control and applications of industrial processes, Flux and metabolic control analysis, stoichiometric analysis, strategies for manipulating carbon fluxes in intermediary metabolism.

Fermenters, general design of bioreactor, fermentation processes; type of culture- Batch, Plug-Flow, Chemostat and Fed batch, Growth kinetics of batch and continuous culture.

**Unit – II**

Over production of metabolites, downstream processing, gene dosage and its applications in industrial processes, large scale production of enzymes from traditional sources and genetically engineered organisms, proteases, amylases, cellulases, lipases, industrial scale production of lactic acid, alcohol, amino acids, antibiotics and secondary metabolites. Production of biopesticides, biofertilizers, biopreservatives (Nisin), cheese, biopolymers, (xanthan gum, PHB etc) and dyes

**Unit – III**

Intrinsic and extrinsic parameters affecting quality of Foods, food preservation, characteristics of radiations of interest in food preservation, principles underlying the destruction of microorganisms by irradiation, physical and chemical methods of food preservation, legal status of food preservation, alterations during food processing, Maillard reaction, non-enzymatic browning reaction and nutritional effects, fatty acids hydrogenation, lipid peroxidation and protein degradation.

**Unit – IV**

Pesticides and biopesticides in integrated pest management, physical, chemical and biological treatment of waste water, bioremediation of contaminated soils and waste lands,

**Unit – V**

Development of new drug/molecules and elucidation of their mechanisms of actions; pharmacokinetics and pharmacodynamics, Factors affecting- drug efficacy, drug resistance and biotransformation.

**Course Outcomes:**

1. The course will enhance learning and understanding of the fundamentals of microbiology like important characteristics and biology of bacteria, fungi, mycoplasma, viruses etc.
2. This course will help students to acquire basic knowledge of fermentation process and industrial application of microbes for the production various useful products.
3. Learn different immobilization techniques and Industrial and clinical scope of enzymes.
4. Develop understanding of state-of-the-art technique/instruments used in various reputed research institutions. and industries

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L021003T (Elective): Cell and Tissue Culture**

**Unit – I**

Plant tissue culture: historical perspective; Culture Media: Preparation and Sterilization; nutrients and plant hormones; sterilization techniques; Cell and Tissue culture techniques; Introduction to different types of culture; Subculturing; Cell Induction and Maintenance. totipotency; organogenesis; Somatic embryogenesis; establishment of cultures - callus culture, cell suspension culture.

**Unit – II**

Tissue culture techniques - micropropagation; semicolonial variation; androgenesis and its applications in genetics and plant breeding; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production and uses.

**Unit – III**

Genetic engineering: Agrobacterium-plant interaction; virulence; Ti and Ri plasmids; opines and their significance; T-DNA transfer; disarmed Ti plasmid; Genetic transformation - Agrobacterium-mediated gene delivery; cointegrate and binary vectors and their utility; direct gene transfer - PEG-mediated, electroporation, particle bombardment and alternative methods; screenable and selectable markers;

**Unit – IV**

Characterization of transgenics; chloroplast transformation; marker-free methodologies; advanced methodologies - CIS genesis, intrageneric and genome editing; Secondary metabolites, production and uses

**Unit – V**

Overview of plant genomics - definition, complexity and classification; need for genomics level analysis; methods of analyzing genome at various levels - DNA, RNA, protein, metabolites and phenotype; genome projects and bioinformatics resources for genome research.

**Course Outcomes:**

1. To know and understanding of the principles and applications of cell and tissue culture techniques.
2. To know and understand the cell culture problems and possibilities.
3. To understand advance basis of genetic engineering and transgenic biology.
4. To learn about definition, complexity, classification and overall analysis of plant genomics.

**Suggested Reading:**

1. Stryer, L. (2015). Biochemistry. (8th ed.) New York: Freeman.
2. Lehninger, A. L. (2012). Principles of Biochemistry (6th ed.). New York, NY: Worth.
3. Voet, D., & Voet, J. G. (2016). Biochemistry (5th ed.). Hoboken, NJ: J. Wiley & Sons.

**L021004P: Presentation (Compulsory) Summer internship/training/review/case study**

**L021005R: Research Project / Dissertation**