Proposed Syllabus and Evaluation Scheme

for

M.Sc. Biochemistry

2022-2023

Department of Life science & Biotechnology

Chhatrapati Shahu Ji Maharaj University, Kanpur

(Formerly Kanpur University)

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, Head & Convenor	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. Anuradha Kalani	Associate Professor	Life Sciences & Biotechnology	CSJM University Kanpur
Dr. Neerja Srivastava	Assistant Professor	Life Sciences & Biotechnology	CSJM University Kanpur

IST YEAR / IST 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
	PROJECT	RESEARCH PROJECT				-
		TOTAL	20			500
IST YEAR / IIND SEM						
L020801T	CORE	BIOENERGETICS AND INTERMEDIARY METABOLISM	4	25	75	100
L020802T	CORE	ENZYMOLOGY	4	25	75	100
L020803T	CORE	PLANT BIOCHEMISTRY	4	25	75	100
L020804T	CORE	CLINICAL BIOCHEMISTRY	4	25	75	100
	MINOR ELECTIVE*	MEDICAL LABORATORY MANAGEMENT	4	25	75	100
		BASICS OF EXERCISE PHYSIOLOGY AND NUTRITION				
L020805P	PRACTICAL	PRACTICAL-2	4	25	75	100
L020806R	PROJECT	RESEARCH PROJECT	8	25	75	100
		TOTAL	32			700
IIND YEAR / IIIRD SEM						
L020901T	CORE	MOLECULAR AND CELLULAR IMMUNOLOGY	4	25	75	100
L020902T	CORE	MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY	4	25	75	100
L020903T	ELECTIVE (Elect any two)	BIOINFORMATICS AND BIOSTATISTICS	4	25	75	100
L020904T		HUMAN PHYSIOLOGY AND PATHOLOGY				

Neerja

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: M.Sc., SUBJECT: Biochemistry

L020905T		BIOMEDICAL SKILL DEVELOPMENT	4	25	75	100
L020906T		GENE-BASED DIAGNOSIS AND THERAPY				
L020907P	PRACTICAL	LABORATORY COURSE 3	4	25	75	100
	PROJECT	(RESEARCH PROJECT/DISSERTATION)				-
	TOTAL		20			500
IIND YEAR / IVTH SEM						
L021001T	ANY FOUR ELECTIVES TO BE CHOSEN	ENVIRONMENTAL BIOCHEMISTRY	5	25	75	100
L021002T		INDUSTRIAL BIOCHEMISTRY				
L021003T		CELL AND TISSUE CULTURE	5	25	75	100
L021004T		BIOCHEMICAL ENGINEERING AND FERMENTATION TECHNOLOGY				
L021005T		PHARMACOLOGY AND TOXICOLOGY	5	25	75	100
L021006T		HUMAN GENETICS				
L021007T		MOLECULAR MEDICINE	5	25	75	100
L021008T		OMICS TECHNOLOGIES				
L021009R	PROJECT	RESEARCH PROJECT / DISSERTATION	8			200
	TOTAL		28			600
GRAND TOTAL						**2300**

NOTE:

1. *A MINOR ELECTIVE FROM OTHER FACULTY SHALL BE CHOSEN IN 1ST YEAR (EITHER Ist / IInd SEMESTER) AS PER AVAILABILITY.
2. In both years 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 credits and 100 marks
3. Research project can be done in form of Internship/Survey/Field work/Research project/ Industrial training, and a report/dissertation shall be submitted that shall be evaluated via seminar/presentation and viva voce.
4. The student straight away will be awarded 25 marks if he publishes a research paper on the topic of Research Project or Dissertation.

➢ *Biochemistry I Semester*

L020701T (Core): General Biochemistry

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; colligative properties of solution-freezing point depression, boiling point elevation, vapor pressure lowering, and osmotic pressure, Unit of concentration.

Unit – II

Carbohydrates: Classification, structures, characteristics and functions of simple and complex carbohydrates; Structure and general function of amino sugars, blood sugar, 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. Structure of model membrane, organization of lipid bilayer and membrane protein; Specific properties as- osmosis, diffusion, ion movement and channels, active transport, membrane pumps, mechanism and regulation of intracellular transport, membrane-electrical properties).

Unit – IV

Proteins: Basic structure and functions of amino acids and proteins; Secondary, tertiary and quaternary structure of proteins; Conformation of proteins (secondary structure, domains, motif and folds-Ramachandran plot), Protein folding; Interactions stabilizing the proteins (Vander Waals, hydrogen bonding, electrostatic, hydrophobic interaction); Protein structure evolution; Structure-function relationships of some model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin, muscular proteins. 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; Hormones- Properties and function of plant and animal hormones.

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

Unit – I

Cell classification, cell variability (size, shape, complexity, function), Structural organization of prokaryotic and eukaryotic cells, cell types, differences in plant and animals. Structural organization and function of cell and cell organelles; Structure and function of membrane; Cell division and cell cycle (Mitosis and meiosis-Steps, regulation and control of cell cycle); concepts related to compartmentalization in eukaryotic cells; stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions:

Unit – II

Detailed descriptions of eukaryotic cell structure. The ultra-structure of nucleus. Mitochondria, Chloroplast, Endoplasmic reticulum, Golgi apparatus, Lysosomes, peroxisomes and their function.

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.

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

Unit – I

Imaging techniques. pH metry, 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.

Unit – II

Chromatography - Theory and general techniques of absorption, Partition coefficient, partition, ion exchange, gel filtration, TLC, paper chromatography, chromatofocussing, covalent, affinity, Gas chromatology, Affinity, FPLC, HPLC and reverse phase HPLC.; General technique of absorption and partition chromatography; TLC and Paper chromatography; Criteria of protein purity.

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: Different types of microscopic techniques and X-ray crystallography. Techniques- concept of buffers; Introduction to detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques; Some advance techniques: Protein crystallization; Theory and methods; APl-electrospray and MALDI-TOF-and ESI-Mass spectrometry.

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.

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

Unit – I

General characteristics of main groups of microorganisms. Criteria used in the classification of microorganisms. Physiology, nutrients and growth of microbes. Special feature of bacterial metabolism, EDP and modified EDP pathway, role of microorganisms in food spoilage.

Unit – II

General properties of medically important bacteria. Biosynthesis of bacterial cell wall and biochemistry of bacterial sporulation. Microbial pathogenicity, virulence factors and their effect on pathogenesis. Methods for estimation of antimicrobial activity. Recommendation for collection, transport of specimens, isolation of bacteria from clinical specimens- Primary media for isolation and their quality control – Antibiotic sensitivity disc, testing procedure and their quality control. Mechanisms of Antibiotic resistance. Literature for new emerging antibiotics. Virulence factors, treatment regimens and immunity.

Unit – III

Microbial genetics differentiation-adaptation and mutation, transformation, conjugation, sex types, transduction, transfection, protoplast fusion, genetic recombination. Introduction to medical mycology. Spore formation in fungi, Economic importance of fungi. Detection and recovery of fungi from clinical specimens. Mycoses, Tenia Versicolor, White Piedra, Black Piedra. Dermatophytes, Dermatophytids, Candidiasis, Cryptococcosis. Opportunistic Fungi, Ostomycosis. Fungal Contaminants. Yeast of medically importance – candida and Cryptococcus.

Unit – IV

Medical parasitology overview and classification of medically important parasites. Nematodes: Ascaris sp., Necator americanus. Lymphatic filariasis: *Wuchereria bancrofti, Brugia malayi, Mansonia ozardi Cestodes: Taenia solium, Taenia saginata, Diphyllobotherium latum,* Trematode: *Faciola hepatica, Faciolopsis buskii* Medically important protozoans: Malaria, medically important protozoans: Trypanosoma, Leishmania Medically important protozoans: Giardia, Entamoeba, Toxoplasma, Trichomonas, Cryptosporidium. Laboratory techniques in parasitology- Examination of faeces for ova and cysts – Concentration methods.

Unit – V

General properties of viruses –Morphology and replication of viruses -definition, virus structure, viral protein, virus classification emphasizing importance of bacteriophage and virus as tool in modem biological research. Replication of RNA viruses negative strand (VSV) positive strand (polio), retroviruses (Infection cycle) replication of DNA (adnoviruses or SV40). Detection of viruses and antigens in clinical specimens – Serological diagnosis of virus infections. Life cycle of various viruses as per Baltimore system of classification. Virus-host infection- Acute virus infection - Smallpox, Polio, and AIDS, Arboviruses, their genetics, pathogenesis, epidemiology, diagnosis and clinical features with emphasis on influenza, hepatitis, Dengue, Zika, Chikungunya viruses, oncogenic and Human Immuno Defiency (HIV) viruses. Viral vaccines – their preparation and Immunization schedules. `

Suggested reading:

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury,
   Massachusetts, 2006.
3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur
   Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

L020705P: Practical-1

Based on theory subjects
Research Project and review article

➢ *Biochemistry II Semester*

L020801T (Core): Bioenergetics and Intermediary Metabolism

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.

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, lnborne 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.

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.

L020802T (Core): Enzymology

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.

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. Use of initial velocity, inhibition and exchange studies to differentiate between multi substrate reaction mechanism. Reversible and irreversible inhibition. Competitive, non- competitive, uncompetitive, linear-mixed type inhibitions and their kinetics, determination of Ki and numerical practice. Suicide inhibitor.

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 chymotrypsin, lysozyme, aldolase, carboxypeptidase and alcohol dehydrogenase.

Unit – IV

Enzyme Regulation - General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. Feedback inhibition and feed forward stimulation. 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.

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): 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

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.

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 (Core): Clinical Biochemistry

Unit – I
Structure and properties of water. Buffers-Acid Base in biological system. Henderson-Hasselbach equation. Biological importance of Buffers. Bioenergetics-Laws of thermodynamics, standard free energy, enthalpy, and entropy. Exergonic and endergonic reactions. Role of high energy compounds. Electron transport chain (ETC)-Components and reactions of ETC. Oxidative phosphorylation, P/O ratio. Inhibitors of ETC and uncouplers of oxidative phosphorylation. Basic biochemistry. Classification, structure and functional studies of Carbohydrates, amino acids, protein, and lipids.

Unit – II
Specimen collection and processing (Blood, Urine, Stool etc.). Blood Collection system, anti-coagulants, Urine preservatives. Composition of blood and formed elements, functions of plasma proteins, lipoproteins and hyperlipoprotenemia. Anaemia and its types. Iron deficiency, Megaloblastic, Pernicious and Haemolytic anaemia. Disorders of hemoglobin Thalassemia and Sickle cell anemia. Bleeding disorders-Laboratory diagnosis of Platelet disorders and Coagulation disorders.

Unit – III
Liver Function Tests: Tests of excretion by the liver-Metabolism of bilirubin, test based on bile pigments -bilirubin, urobilinogen and bile acids in blood and urine. Jaundice - types, clinical features and differential diagnosis of jaundice. Evaluation of synthesis in liver, Evaluation of enzyme activity. Hepatic cholestasis, cirrhosis, fatty liver and gallstones. Renal Function Tests: Clearance Tests-Inulin, Creatinine and Urea clearance test. Concentration and dilution tests. Phenol red (PSP) test. Urine analysis-Composition of urine, Chemical examination and special urine tests. Microscopy examination of Urinary sediment. Gastric Functional Tests: Gastric secretions and Composition. Examination of duodenal contents. Diagnostic tests for hypo and hyper acidity. Fractional gastric analysis. Gastric ulcer Steatorrhea.

Unit – IV
Enzymes and its classification, enzyme structure and function, enzyme kinetics and inhibition. Clinical enzymology - Enzyme patterns in acute pancreatitis, liver diseases, bone disorders, myocardial infraction and muscle wasting. Clinically important enzymes: AST, ALT, LDH, creatine kinase, alkaline phosphatase and Isoezyme changes. Endocrine Disorders: Hypo and hyper secretion of hormones. Assessment of pituitary function, thyroid function and adrenal function.

Unit – V

Metabolic disorders: Carbohydrate Metabolism-Diabetes mellitus, types, clinical features, diabetic complications and its management. Diagnostic tests-Glucose tolerance test (GTT), Assay of Glycosylated haemoglobin (HbA1C). Glycosuria, Fructosuria and Galactosemia. Glycogen storage diseases. Amino acid metabolism Phenylketonuria, Tyrosinemia, Alkaptonuria and Maple Syrup Urine Disease. Nucleic acid metabolism-Lesch Nyhan syndrome and gout. Lipid metabolism-Tay-Sachs's disease, Gaucher disease, Nieman-Pick disease and Fabry disease.

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

Minor elective*

- **Medical Laboratory Management**
- **Basics of Exercise Physiology and Nutrition**

L020805P: Practical-2

Based on theory subjects

L020806R: Research Project

Research Project

➢ *Biochemistry III Semester*

L020901T (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.

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.

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.

L020902T (Core): Molecular Biology and Recombinant DNA technology

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.

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 Iysogeic 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

Recombinant DNA technology and cloning. Restriction enzymes used in genetic engineering. Statement vectors- prokaryotic and eukaryotic Detection and identification of cloned DNA sequences Polymerase chain reaction, utilities in gene cloning and diagnostics, RT –PCR. Application of recombinant DNA technology in industry, human genome analysis.

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

L020903T (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 etc.

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.

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.

L020904T (Elective): Human Physiology and Pathology

Unit – I

Skin and its derivatives. Special sense organs: Eye, ear, nose, taste buds, subcutaneous sense organs. Nervous system: Structure of nerve cell, Brain, spinal cord and peripheral nerves. Muscular system: Structure and type of muscles in human body. Cellular responses to injury, Acute inflammation, Healing and Repair, Chronic inflammation, infections of histological importance, Amyloidosis, disorders of growth, Neoplasia. Microtome, Fixation of tissues, Dehydration, Clearing, Embedding and sectioning Routine staining of section and stained sections- Decalcification and staining of bone, staining of organisms, parasites and fungi in sections, histological methods for nervous system, Cryo sections in histopathological analysis.

Unit – II

Skeletal and Neurobiology and related pathology. Membrane Physiology, Nerve and Muscle, Membrane potentials and action potentials & Excitation and Contraction of muscles (Molecular mechanisms of muscle contraction). A brief introduction to bones, joints and muscles of the body – A brief introduction to organ systems of the body – Skeletal system: Bones of the upper limb – Bones of the lower limb – the vertebral column – the sternum, ribs and joints – the skull. A brief study of neurobiology and pathobiology, neuro transmitters, Neurohormones, Neuromodulators & Neuroactive peptides. Neurodegenerative disorders.

Unit – III

Circulatory system and related pathology: Blood Physiology Hemostasis, Blood cells, Blood Clotting & Regulation of Blood pH. Blood groups, transfusion. Blood-related pathology studies. Structure of heart and blood vessels, systematic circulation, pulmonary circulation, portal circulation, and coronary circulation. Lymphatic system: Lymph vessels, lymph and lymphoid

organs. Cardio-vascular Physiology, Physiology of cardiac muscle, Rhythmical excitation of heart, Regulation of heart pumping, Cardiac cycle, Cardiac output and Venous Return, Microcirculation, Capillary fluid exchange. Circulatory regulation: Nervous, humoral and chemical regulation of circulation. Cardiac abnormalities: Normal electrocardiogram, Cardiac Arrhythmias, Heart sounds, Dynamics of valvular and congenital heart defects, Cardiac failure and circulatory shock. Atherosclerosis, Thrombosis, Embolism and Infarction.

Unit – IV

Respiratory and gastrointestinal Physiology and pathology. Pulmonary ventilation: Mechanisms of pulmonary ventilation, Pulmonary volumes and capacities, Alveolar ventilation, Functions of respiratory passageways. External & Internal Respiration: Principle of Gas exchange, Diffusion of gases through respiratory membrane, Transport of O2 and CO2 in blood and body fluids. Bohr effect, Chloride Shift, Haldane effect. Regulation of respiration: Respiratory Control Center, Peripheral chemoreceptor system, Nervous and chemical regulation of respiration. Gastrointestinal Physiology and pathophysiology. General principles of gastrointestinal function: Ingestion of food, Motility, Nervous control, Transport and mixing of food in the alimentary tract. Secretary functions of alimentary tract: Secretion of saliva, Gastric secretion, Pancreatic Secretion, Bile secretion, Secretions of small and large intestine. Digestion and absorption in gastrointestinal tract: Digestion of various foods, Absorption in small intestine.

Unit – V

Excretory and reproductive physiology and pathology. Urine formation by kidneys a) Glomerular filtration, Renal blood flow and their control, Determinants of Glomerular Filtration Rate (GFR). b) Reabsorption and secretion along different parts of nephron. Regulation a) Regulation of Extracellular Fluid osmolarity and sodium concentration: Role of thirst. b) Renal regulation of potassium, calcium, phosphate and magnesium. Acid- base balance. Reproductive system: Structure of female reproductive gonads and tract. Structure of male reproductive and accessory organs.

Suggested Readings:

1. Anatomy and Physiology for Nurses, Jaypee Brothers Medical Publishers (P) Ltd.
2. Gray, Henry. Anatomy of the Human Body. Philadelphia: Lea & Febiger
3. Human Anatomy, Inderbir singh, Jaypee Brothers Medical Publishers (P) Ltd.
4. Alans Stevens, James S. Lowe and Barbara Young (2002). Wheater's Basic Histopathology, 4th Edition, Churchill Livingtone pub.
5. Charles F. A. Culling, T. A. Hyde, Martin J. Inwood, Leslie D. Mellor, F. Sergovich, Frank Spencer, Sam Thomson (1976). Lynch's Medical Laboratory Technology, 3rd Edition, W.B. Saunder Company (Section 3 only).

L020905T (Elective): Biomedical Skill development

Unit – I

Biosafety in the Laboratory: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, biological containment, Principles of Biosafety Cabinets and Chemical Fume Hoods, Principles of Disinfection, Waste Handling and Disposal Procedures, Risks Associated with Biological/Chemical Exposures, Transportation of Biological Materials (infectious & non-infectious), Principles of Personal Protective Equipment (PPE), Emergency

Procedures. **Regulations:** Biosafety regulations and national and international guidelines with regard to recombinant DNA technology- bioterrorism and convention on biological weapons (UN-Cartagena Biosafety Protocol). Good manufacturing Practice and Good lab practices (GMP and GLP).

Unit – II

Bioethics: Principles of bioethics - ethical criteria in biotechnology- animal ethics; Guidelines for use of Laboratory animals in medical research, IAEC – Alternatives for animal models in research and testing- Human cloning: Ethics of adult human DNA cloning - Ethical issues in research involving human subjects.

Unit – III

Know Thyself/ Understanding Self, Interpersonal Skills/ Understanding Others, Team building-group dynamics-Networking-Improved work relationship, Communication Skills / Communication with others, Corporate Skills / Working with Others, Selling Self / Job Hunting Writing resume, Career planning.

Unit – IV

Artificial Intelligence (AI), Robotics and Computational fluid dynamics: General overview, Pharmaceutical Automation, Pharmaceutical applications, Advantages and Disadvantages. Current Challenges and Future Directions. Biotechnology (Pharma): Ecological safety assessment of recombinant organisms and transgenic. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc. Biosafety issues in Clinical Trials.

Unit – V

Patents: Introduction - IPR – Definition, Basis of Patentability - Patenting Biological Products-Non-Patentable Inventions - Classification of patents-WIPO- Patent Application Procedure in India-WTO: Definition and Objectives-Different forms of IPR - Benefits of IPR system: Copyright - Designs - Trade Mark –Trade Secret Patent Agent.

Suggested Readings:

1. M. K. Sateesh (2014), Bioethics and Biosafety, I.K International publishing house pvt. ltd, New Delhi.
2. Singh K. Intellectual Property Rights on Biotechnology, BCII, New Delhi.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. Fleming, D.A., Hunt, D.L., (2000). Biological safety Principles and practices (3rd Ed).ASM Press, Washington.
4. www.patentoffice.nic.in/ipr/patent/patents.htm
5. Manual of patent practice and procedure. IPR India, 2005. Ministry of commerce and industry, New Delhi, pp.163.

L020906T (Elective): Gene-based Diagnosis and Therapy

Unit – I

History of human genetics Autosomal dominant inheritance (HD, MD, CDD etc), Autosomal recessive inheritance (SCA, CF, etc), Sex linked and mitochondrial (DMD, hemophilia, LHON), PKU, Alzheimer, Parkinsonism, Tay-Sachs, Mongolism, Cri-du-chat, Edwards, X and Y chromosomal, Prenatal and Postnatal studies, Chromosome analysis, Genetic mapping, Haplotype, Physical and Cytogenetic mapping, SNP, RFLP, TRE, PCR-OLA, SSCP, RAPD

Unit – II

Gene environment interaction in complex diseases, Genetics of Alzheimer's disease- Causative genes for familial Alzheimer's disease (APP, PSEN1, PSEN2)-Alzheimer's disease susceptibility genes (APOE, BACE1, BACE2, NCSTN, PEN2, SORL1), Environmental factors in Alzheimer's disease pathogenesis, Genetics of Parkinson's disease-Causative genes for familial Parkinson's disease susceptibility genes, Environmental factors in Parkinson's disease pathogenesis, Genetics of Amyotrophic lateral sclerosis-Causative genes for familial Amyotrophic lateral sclerosis-Amyotrophic lateral sclerosis susceptibility genes and Environmental factors, Amyotrophic lateral sclerosis pathogenesis, Role of environment on epigenetics of neurodegenerative diseases, Teratology, Molecular genetics of coronary heart disease, Schizophrenia, Diabetes mellitus.

Unit – III

Identifying human disease genes, General gene therapy strategies, Targeted killing of specific cells, Targeted mutation correction, Targeted inhibition of gene expression. Gene replacement therapy by viral vectors: Oncovirus, Lentivirus, Adenovirus, Adeno-associated virus, Herpes Simplex virus, Naked DNA or direct injection or particle bombardment-gene gun, Liposome mediated DNA transfer, Receptor mediated endocytosis, Repair of mutations in situ through the cellular DNA repair machinery, Antisense induced exon splicing, In-utero fetal gene therapy.

Unit – IV

Gene blocking therapies, Gene Knockouts, Gene disruption-p53, prion diseases, immunological, short RNA, Gene therapy for non-inheritable diseases, stem cell therapy, somatic cell gene therapy and germ line gene therapy, Gene therapy: problem, solutions and future prospects, Controversial issues in medical genetics.

Unit – V

In vitro fertilization, Prenatal sex determination, Surrogate therapy, Genetic counseling, Germline gene therapy, ELSI, NBAC, IPR, Patenting, Human transgene

Suggested Readings:

1. Human Molecular Genetics- Tom Strachan
2. Concepts of Genetics- William s. Klug
3. Emery's Elements of Medical Genetics- Robert F. Mueller & Ian D. Young

L020907P: Laboratory course 3

Based on theory papers

Project: Research project/Dissertation

- ***Biochemistry IV Semester***

L021001T (Elective): 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.

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.

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.

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.

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.

L021004T (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.

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.

L021005T (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.

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

L021006T (Elective): Human Genetics

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. Epigenetics and disease: Mechanisms (Imprinting/methylation; chromatin remodeling); Current understanding;

examples. Mitochondrial 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.

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 mapping STS/EST/MS/SNP /sequencing; Genetic mapping: Linkage analysis (RFLP/MS/SNP); Applications of mapping in disease genome analysis; Gene identification using positional and functional cloning approach. Transposable genetic elements in bacteria, yeast, maize and drosophila. Hereditary disorders with altered drug response, Gene Therapy-Ex-vivo and in vivo gene therapy, Gene delivery systems (i) viral and (ii) non-viral. Ethical issues in medical genetics.

Unit – III

Mendelian genetics, its application. Deviations from Mendel's laws. Expression and interaction of genes, allelic and non-allelic interaction; Multiple alleles, pseudo alleles. Sex linked inheritance; sex determination, extra nuclear genetics- maternal inheritance. Linkage, Crossing over and chromosome mapping. chromosomal alterations. 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 mitochondrial 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. Clinical Genetics – Congenital abnormalities and dysmorphic syndromes, Genetic counseling, Chromosomal breakage syndromes. Single gene disorders – Huntington disease, neurofibromatosis, cystic fibrosis, cardiomyopathies, Duchenne muscular dystrophy and Hemophilia. Genetic instability (Aneuploidy, Telomere's attrition).

Unit – V

Human and population genetics. Pedegree analysis, Human chromosomes, Anomalies in autosomes and sex chromosomes, Congenital malformation, Heredity of twins. Structure and life cycle of DNA and RNA viruses, Common viral diseases, Oncogenes: Retroviral, and cellular oncogenes, their function and mechanism of action. AIDS. Interferon. Population Genetics, Definition, aim, scope of population genetics, factors maintaining population, boundaries, effective breeding size, gene pool, genetic drift, Genetic equilibrium and Hardy- Weinberg law and its application. Human Polymorphism, relationship between sickle cell polymorphism and malaria, Duffy blood groups,

Thalassemia and color blindness. Population screening and genetic registers. Probability theory, Autosomal dominant/recessive inheritance, Bayes' theorem and empiric risks.

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

L021007T (Elective): Molecular Medicine

Unit – I

Molecular basis of diseases-Human genetics relevant to diseases, DNA polymorphism, Single (Cystic fibrosis, Huntington's diseases, Familial hypercholesterolemia, Dunchenne muscular dystrophy, red-green colour blindness, Tay-Sachs's diseases, Pearsons' syndrome & Xeroderma pigmentosum) and polygenic diseases (Asthma and Diabetes Mellitus), Omics, Genetic and physical mapping of human genome and identification of genes in diseases.

Unit – II

Molecular Diagnostic Technologies: PCR-Based Methods, DNA finger printing, Next generation sequencing techniques, Microarray Approaches to Gene Expression Analysis-CGH, Prenatal and postnatal genetic tests-Fluorescence In situ hybridization.

Unit – III

Signal transduction and its role in human diseases, Cellular and tissue microenvironment in diseases, Defects in G protein-coupled signal transduction in human disease, NF-kB, TGFβ, Wnt-β, MAPK & The serine–threonine kinase Akt signalling pathways in human diseases, JAK-STAT signalling in asthma. Inhibiting signalling pathways through rational drug design.

Unit – IV

Therapeutic Strategies: Mechanism of action and clinical application of Antisense Oligonucleotides, Ribozymes and its medical applications, RNA interference: Mechanism, delivery and preclinical applications, MicroRNAs and disease-Aptamers-Gene therapy: types, methods of gene transfer, Applications- AYUSH, Plants and microbes as sources of natural metabolites, Establishing bioactive potential and screening of natural compounds against different targets, Healing herbs in Traditional medicinal system (*Butea monosperma, Curcuma longa and Yukyung Karne*).

Unit – V

Molecular Mechanism and Challenges: Breast cancer and its subtypes, HER2 targeted therapy- HIV; diagnostics, strategies for treatment and vaccines- Heart failure and cardiac repair- Human African

trypanosomiasis of the CNS- Dengue, Influenza Virus-Human embryonic stem cells for regenerative medicine. Antimicrobial resistance (Staphylococcus aureus)- Multidrug resistance issues.

Suggested Readings:

1. Jens Kurreck and Cy A. Stein, Molecular Medicine an Introduction, 2016, Wiley-VCH Verlag GmbH & Co. KGaA, Germany.
2. Andrew R.Marks and Ushma S Neill, Text book of Molecular Medicine2010, Jones and Bartlett Publishers, New Delhi.
3. Elles, R., Mountfield, R. (2011). Molecular Diagnosis of Genetic Diseases. Springer Publication.
4. Audet, J., Stanford, W. and Stanford,W. L. (2009) Stem cells in regenerative medicine. New York, Humana press.

L021008T (Elective): Omics Technology

L021009R : Research Project / Dissertation

Chhatrapati Shahu Ji Maharaj University

M.Sc. Biochemistry 2022

M.Sc. Biochemistry Program

Program Outcomes (POs)

PO1: To develop analytical and technical skills: Students will acquire ability to handle/use appropriate tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO2: Resource Utilisation: The program will help in learning the resources including library, e-learning resources, ICT and novel tools to enhance knowledge base and stay learn recent developments.

PO3: Critical thinking and Problem solving: Identify and critically analyse relevant problems in biochemistry and scientific discipline using appropriate tools and techniques as well as explore and work on approaches to address conclusions/solutions.

PO4: Domain knowledge: Demonstrate knowledge of basic concepts, principles and applications of the science-specific discipline.

PO5: Project Management: To develop the zeal and ability to work safely and effectively in a laboratory. Acquire knowledge in technical and scientific areas to identify research problems, design experiments, use appropriate methodologies, analyse and infer the data and explore the solutions. The program will also enhance the ability of organizational skills and management of time and resources.

PO6: Individual and team work: The program will enhance the skills to effectively accomplish tasks independently and as a team member in multidisciplinary areas of research and development.

PO7: Effective Communication: M. Sc. Biochemistry program will educate and develop the ability to write dissertations, reports, make effective presentations and documentation. In addition to that the program will educate and build the ability to effective communication with scientific community as well as society at large.

PO8: Environment and Society: To analyse the impact of scientific and technological advances on the environment and society and the need for sustainable development.

PO9 Life-long learning: Ability to engage in life-long learning in the context of the rapid developments in the discipline.

PO10 Ethics: Program has a very important part to learn and develop professional ethics and responsibility and serve the society.

M.Sc. Biochemistry (Two-Year)

Programme Specific Outcome

At the end of the programme, the student will be able to

PSO1: Acquire deep scientific knowledge in subjects like cell biology, enzymology, biotechnology, Metabolism, endocrinology, immunology, genetics, genetic engineering and clinical biochemistry.

PSO2: Describe the biochemical basis of diseases, regulation of metabolic pathways and gene expression regulation.

PSO3: Undertake biochemical / scientific experiments using classical and modern instruments of biochemistry and molecular biology, record and interpret the results, draw the conclusions.

PSO4: Learn and develop work collaboratively as a team in classroom and scientific laboratory.

PSO5: Communicate biochemical concepts through effective written, dissertation and oral presentation.

M.Sc. Biochemistry (Two-Year)

Course Outcomes

L020701T: General Biochemistry

- Understanding fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms.
- Exposure with the nature of various biomolecules present in living cells.
- To know about the unique property of water as a universal solvent and its importance in biological system
- Understanding of concepts of acids, bases, indicators, pKa values, etc.
- To understand the properties of carbohydrates, proteins, lipids, DNA, RNA, and their importance in biological systems

L020702T: Cell Biology and Membrane biochemistry

- Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
- Students will understand how these cellular components are used to generate and utilize energy in cells
- Students will understand the cellular components underlying mitotic cell division.
- Students will apply their knowledge of cell biology to selected examples of changes in cell function.

L020703T: Biophysical chemistry techniques and application

- 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.
- To learn the application of different techniques and tools in different areas of scientific research.

- The students will be able to understand the principle and working of different chromatography techniques.
- The students will be able to understand the principle and working of different centrifugation techniques.
- The students will be able to understand the principle and working of different Electrophoretic and molecular biology techniques.

L020704T: General Microbiology

- To illustrate the characteristic features of microorganisms and the disease they cause.
- To explore mechanism by which microorganisms cause disease.
- To show how the human immune system counteracts infection by specific and non-specific mechanisms.
- To explore the routes of transmission of infection in hospital, communities and populations and the methods used to control the spread of infection.
- To demonstrates the principles of vaccine preparation and the use of vaccine in immunization.
- To shows the methods for sterilization of equipments.
- To shows the antimicrobial activity of disinfectants.
- To demonstrates the contribution of the microbiologists and the microbiology laboratory to the diagnosis of infection including specimen collection and the role of nurse in carrying this out.
- Enable students to acquire expertise in the field of microbiology.

L020705P: Practical-1

Practical as per theory papers

Project: Research Project

L020801T: Bioenergetics and Intermediary Metabolism

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

L020802T: Enzymology

- 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
- To know about the concepts of enzyme kinetics

- To study about Mechanism of enzyme action
- To understand the concept of Enzyme Regulation
- To know about Multienzyme complexes and isozymes

L020803T: Plant Biochemistry

- The course is designed to know the structure and function of plant cell and role of different organelles.
- Students will be able to learn the general process of photosynthesis in the plants and energy transfer.
- To know the general metabolism in plants such as respiration, lipid biosynthesis and other key process such as nitrogen metabolism
- Students will also gather information on metabolites and hormones, important in the development of plants.

L020804T: Clinical Biochemistry

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

Medical Laboratory Management

Course as approved in BOS

Basics of Exercise Physiology and Nutrition

Course as approved in BOS

L020805P: Practical -2

Practical as per theory exams

L020806R: Research Project

- To enable the students to design and execute different projects research.
- To enable students to develop critical research thinking and learn scientific writing.

L020901T: Molecular and Cellular Immunology:

- This course is focused upon molecular and cellular aspects of immunology.
- 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.
- The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease.
- The students will be able to describe immunological responses and how they are triggered and regulated.
- The students will be able to transfer knowledge of immunology into clinical decision-making through case studies presented in class.

L020902T: Molecular Biology and recombinant DNA technology

- The aim of this core-course is to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
- 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.
- To illustrate creative use of modern tools and techniques and expose students to application of recombinant DNA technology in scientific research.
- To train students in strategizing research methodologies employing genetic engineering techniques.

L020903T: Bioinformatics and Biostatistics

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

L020904T: Human Physiology and Pathology

- Human Physiology and Pathology course is focused on the study of functions of particular systems of the organism (Circulatory system, breathing, digestive, urinary, humoral, nervous systems) and their control, from the molecular level up to the study of mutual relations between particular systems under normal conditions and pathologic states.
- The objective of the studies in the study programme Human Physiology and Pathophysiology is training the students in such a way so that they will be capable of independent scientific work as necessary for understanding of physiologic and pathophysiologic mechanisms that can be the cause of major clinical conditions.
- The experimental and analytic approach of learning enables students to use the knowledge gained for prevention, diagnostics, therapy and rehabilitation of the human organism.

L020905T: Biomedical Skill Development

- The Biomedical skill development course provides a comprehensive overview of the biosafety equipment in the research lab.
- One of the major course objectives is to acquaint the students with principal of animal and human ethics.
- The students in this course will groom students by making them learn team building and team work, enhancing communication skills, corporate skills, writing and career advancement sessions.
- Another major objective of the course is to introduce students to artificial intelligence and to the basis and application of copy right and patent in the biomedical sciences.

L020906T: Gene Based Diagnosis and Therapy

- To understand gene environment interaction in complex diseases.
- To learn different genetic diseases and how they are treatable by gene therapy.
- To understand the basic principles of genetic manipulation and gene blocking technology for mechanistic and therapeutic aspects.
- To understand in vitro fertilization, genetic counselling, germline gene therapy, human transgene and IPR.
- To understand how genetics may be used in the design of drugs.

L020907P: Laboratory Course-3

Practical/course as required in theory exams

Project: Research project/dissertation

L021001T: Environmental Biochemistry

- 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.
- To know and define the biochemical mechanisms responsible for physiological adaptation to different environmental conditions.
- To learn ecology and effect of different environment factors on ecosystem.
- To learn population science and analyze different type of pollutants and their effects on humans.
- To know and define the metabolicm and toxicity, detection of toxics exposure and bioremediation.

L021002T: Industrial Biochemistry

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

L021003T: Cell and Tissue Culture

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

L021004T: Biochemical Engineering and Fermentation technology

- Learn about Genetic engineering and prospects of improving crop productivity, resistance, resistance to disease and environmental stresses, methods for production of transgenic animals.
- Students will learn sterilization of air and medium; sterilization of fermenters, thermal death kinetics of microorganisms.
- 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.
- This course will help students to acquire basic knowledge of microbial fermentation kinetics, bioreactors bioprocess system and commercial production of bioproducts.

L021005T: Pharmacology and Toxicology

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

L021006T: Human Genetics

- The student will learn and understand the genome organization, cytogenetics, genetic control of development.
- 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.
- 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.
- The student will learn and understand the Human Genome Project, gene therapy, genetic testing, and genetic counselling.

L021007T: Molecular Medicine

- To describe fundamental functions and molecular mechanisms at the level of the cell and organ in relation to the whole human body and be able to apply the same to the development of disease and treatment,
- To describe the understanding and application of molecular medicine in theory and practice.
- To search for, collect, evaluate, interpret and discuss specialised information in relation to mechanistic and therapeutics.
- To learn molecular basis of diseases and different molecular diagnostic technologies.

L021008T: Omics Technology

Course objectives as approved in BOS

L021009R: Research Project / Dissertation

- To enable the students to design and execute different projects research.
- To enable students to develop critical research thinking and learn scientific writing.