ANNEXURE – III A

DAYANANDA SAGAR UNIVERSITY

SCHOOL OF BASIC & APPLIED SCIENCES

SCHEME & SYLLABUS
FOR
MASTER OF SCIENCE (M.Sc.) – 2025-2027

SPECIALIZATION: BIOCHEMISTRY

(With effect from 2025-26)
(From I to IV Semesters)

DAYANANDA SAGAR UNIVERSITY
INNOVATION CAMPUS, KUDLU GATE, HOSUR ROAD,
BENGALURU -560114.

DAYANANDA SAGAR UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
PROPOSED SCHEME- M. SC. BIOCHEMISTRY- 2025-26 ONWARDS

I SEM – M.Sc.- BIOCHEMISTRY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	206	25MSC5101	Essentials of Chemistry	CR	4	-	-	-	4	60	40
2	206	25MBC5101	Biomolecules	CR	4	-	-	-	4	60	40
3	206	25MBC5102	Cytology	CR	4	-	-	-	4	60	40
4	206	25MBC5103	Human Physiology	CR	4	-	-	-	4	60	40
5	206	25MBC5104	Bioinformatics - I	CR	2	-	-	-	2	60	40
6	206	25MSC5102	Biostatistics	CR	2	-	-	-	2	60	40
7	206	25MBC5171	Analytical Biochemistry-Practical	CR	-	-	6	-	3	60	40
8	206	25MBC5172	Clinical and Cellular Biochemistry -Practical	CR	-	-	6	-	3	60	40
			GRAND TOTAL = 800		**20**	**-**	**12**	**-**	**26**	**480**	**320**

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

II SEM – M.Sc.- BIOCHEMISTRY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	206	25MBC5201	Principles of Molecular Biology	CR	4	-	-	-	4	60	40
2	206	25MBC5202	Analytical Techniques	CR	4	-	-	-	4	60	40
3	206	25MBC5203	Metabolism - I	CR	4	-	-	-	4	60	40
4	206	25MBC5204	Plant Biochemistry	CR	4	-	-	-	4	60	40
5	206	25MBC5205	Applied Microbiology	CR	4	-	-	-	4	60	40
6	206	25MBC5206	Bioinformatics- II	CR	2	-	-	-	2	60	40
7	206	25MBC5271	Instrumentation and Phytobiochemistry - Practical	CR	-	-	6	-	3	60	40
8	206	25MBC5272	Molecular and Applied Microbiology -Practical	CR	-	-	6	-	3	60	40
			GRAND TOTAL = 800		**22**	**-**	**12**	**-**	**28**	**480**	**320**

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

III SEM – M.Sc.- BIOCHEMISTRY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	206	25MBC5301	Enzymology	CR	4	-	-	-	4	60	40
2	206	25MBC5302	Metabolism II	CR	4	-	-	-	4	60	40
3	206	25MBC5303	Immunobiology	CR	3	-	-	-	3	60	40
4	206	25MBC5304	Cell signalling	CR	3	-	-	-	3	60	40
5	206	25MBC5305	Toxicology and regulatory clinical research	CR	3	-	-	-	3	60	40
6	206	25MSC5301	Research methodology, scientific writing and IPR	CR	3	-	-	-	3	60	40
7	206	25MBC5306	Nutrition	CR	2	-	-	-	2	60	40
8	206	25MBC5307	Bioassay models and techniques	CR	2	-	-	-	2	60	40
9	206	25MBC5371	Enzyme Kinetics- Practical	CR	-		6		3	60	40
10	206	25MBC5372	Immunobiology and Toxicology - Practical	CR	-		6		3	60	40
			Grand Total= 1000		**24**	**-**	**12**	**-**	**30**	**600**	**400**

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

IV SEM – M.Sc.- BIOCHEMISTRY

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	CR/ AU	SCHEME OF TEACHING					SCHEME OF EVALUATION	
					L	T	P	S/P	C	CIA	END EXAM
1	206	25MSC5401	Project	CR	-	-	-	36	14	60	40
2	206	25MSC5402	MOOC/NPTEL/ Swayam	CR	-	-	-	-	2		
			Grand Total					**36**	**16**		

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

SL	CREDIT (CR)	MARKS	
		CIA MARKS	END EXAM MARKS
1	4	60	40
2	3	60	40
3	2	30	20
4	14	240	160

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MSC5101**					
TITLE OF THE COURSE	**ESSENTIALS OF CHEMISTRY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To help students grasp fundamental chemical principles—such as stoichiometry, chemical bonding, electrochemistry, and organic reactivity—specifically as they relate to biological systems.
- To enable students to apply theoretical knowledge in solving quantitative and mechanistic problems involving solution chemistry, redox reactions, and biomolecular interactions.
- To introduce students to the chemical structures and reaction mechanisms within biological contexts, including enzymatic catalysis, metabolic pathways, and molecular transport.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will become familiar with fundamental chemical concepts, including mole calculations, acid-base theories, bonding types, and stereochemistry, particularly as they apply to biological molecules.	L2
CO2	Students will be able to apply chemical equations and quantitative tools—such as dilution formulas (e.g., N1V1=N2V2) and the Henderson-Hasselbalch equation—along with mechanistic understanding, to tasks such as buffer preparation, molecular weight determination.	L3
CO3	Students will be able to analyze the roles of metals in biological systems, the influence of stereochemistry on bioactivity, and reaction mechanisms related to metabolic processes.	L3

COURSE CONTENT:

MODULE 1: STOICHIOMETRY AND CHEMICAL BONDING — **14 Hrs**

Stoichiometry: Atomic weights, molecular weights, mole concept, molarity, molality, normality, mole fraction, ppt, ppb and ppm. Numerical problems related to the above concepts. Classification, preparation and dilution of reagents/solutions. Preparation of ppm level solutions from source materials (salts), conversion factors.

Chemical bonding: Ionic bonds, Covalent bonds, Vander walls forces, Electrostatic interactions, Hydrophobic interactions, Hydrogen bonding & their relevance in biological systems, importance of water in biological systems. Coordination bonds in biomolecules - bonding of iron in haemoglobin, magnesium in chlorophyll. Types of chemical bonds in biological molecules (Glycosidic, phosphdiester, peptide).

MODULE 2: PHYSICAL CHEMISTRY — **14 Hrs**

Bio-Electrochemistry: Oxidation and Reduction reactions, Electrode potential, standard & reference electrode, calculation of biological standard potential & biological equilibrium constant, Nernst's' equation. Biological electrochemical series (ETC).

Liquids and solutions: Acid and bases (Brønsted-Lowry Theory, Lewis Theory), pKa, pKb, pH, pOH, preparation of buffers, Henderson-Hasselbalch equation and numerical problems associated with buffer preparation. Density and Relative Density, Viscosity, Surface tension, Colligative properties (brief). Calculation of molecular weight of proteins and nucleic acids.

MODULE 3: BIOINORGANIC CHEMISTRY	**14 Hrs**

Stereochemistry: Introduction, Different types of isomerism, chirality & optical activity (enatiomers and diastereoisomers; Fischer, Sawhorse, and Newman Projection formulae of simple molecules containing one and two asymmetric carbon atom). Symmetry elements, E and Z, D and L nomenclature (for carbohydrates and aminoacids only).

Role of metals: Introduction, Classification, role of metal in various biological system: Enzyme Activity (zinc with carbonic anhydrase) Examples for metal activated enzymes and metalloenzymes, Energy Transfer and Redox Reactions (cytochrome c complex- Fe), Oxygen Transport (Iron in hemoglobin, Copper in hemocyanin) Nerve Signal Transmission (role of Sodium and potassium ions), Structural Roles, Metallothionins, metals as essential nutrients, nutritional Immunity. Regulatory Roles (Magnesium and calcium ions play crucial roles in cell regulation and signalling pathways.

MODULE 4: BIOORGANIC CHEMISTRY	**14 Hrs**

Basics: Properties of carbon, brief classification of organic compounds based on functional groups with examples. Delocalisation of electrons: Inductive effect, electrometric effect, resonance (mesomeric effect, EWG and EDG, +M and –M effects). Curly arrow rules in representation of mechanistic steps, types of bond cleavage; electrophiles, nucleophiles, Reactive intermediates: carbocations, carbanions, free radicals and carbenes– generation, structures, stability and examples.

Reaction mechanisms: SN1 (formation of PRPP in nucleotide biosynthesis), SN2 (eg. DNA polymerization, phosphorylation), E1 (histidine/aromatic aminoacid biosynthesis), E2 reactions (fatty acid biosynthesis). Metabolic reactions- aldol condensation (collagen), esterification of acids (triglycerides), oxidation and reduction reactions (NAD^+ to NADH during cellular respiration.).

TEXT BOOKS AND REFERENCES:

1. General Chemistry (2022) Linus Pauling, Dover Publications, New York, USA.
2. Quantitative Chemical Analysis 10th Edition (2022) Daniel C. Harris, Macmillan Learning, New York, USA.
3. Lehninger Principles of Biochemistry 8th Edition (2021) David L. Nelson and Michael M. Cox, W.H. Freeman & Company, New York, USA.
4. Physical Chemistry for the Life Sciences 2nd Edition (2014) Peter Atkins and Julio de Paula, Oxford University Press, Oxford, UK.
5. Principles of Physical Chemistry (2023) Puri, Sharma, and Pathania, Vishal Publishing Co., Jalandhar, India.
6. Biophysical Chemistry: Principles and Techniques (2022) Upadhyay, Upadhyay, and Nath, Himalaya Publishing House, Mumbai, India.

7. Bioinorganic Chemistry: A Short Course 2nd Edition (2014) Rosette M. Roat-Malone, Wiley, Hoboken, USA.
8. Inorganic Chemistry 6th Edition (2021) Gary L. Miessler, Paul J. Fischer, and Donald A. Tarr, Pearson Education, Boston, USA.
9. Stereochemistry of Organic Compounds 1st Edition (1994) Ernest L. Eliel and Samuel H. Wilen, Wiley India Pvt. Ltd., New Delhi, India.
10. Organic Chemistry 9th Edition (2021) Paula Yurkanis Bruice, Pearson Education, Boston, USA.
11. Organic Chemistry 8th Edition (2022) Morrison and Boyd, Pearson India Education Services Pvt. Ltd., Noida, India.
12. Principles of Biochemistry 8th Edition (2021) David L. Nelson and Michael M. Cox, W.H. Freeman & Company, New York, USA.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MBC5101**					
TITLE OF THE COURSE	**BIOMOLECULES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To understand the chemical structure, classification, and biological functions of key biomolecules.
- To describe the structural organization and folding mechanisms of proteins, including the roles of amino acids, peptide bonds, and molecular chaperones.
- To demonstrate knowledge of nucleic acid structure, types, and sequencing techniques.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	The students will be able to draw structures of biomolecules and comprehend their properties based on the structures.	L2
CO2	They will have a better understanding of metabolism of these biomolecules in second and third semesters.	L3
CO3	The students will have an experimental based approach to learn the structure of Biomolecules	L3

COURSE CONTENT:

MODULE 1: CARBOHYDRATES AND LIPIDS — **14 Hrs**

Simple Carbohydrates: Structure and classification of carbohydrates. Configuration and conformational aspects of monosaccharides. Glycosidic linkages in disaccharides and glycosides. **Complex Carbohydrates:** Homopolysachharides and heteropolysachharides - starch, glycogen, cellulose chitin, glycosaminoglycans and proteoglycans - O and N linked oligosaccharides, Lectins, lipo-polysaccharides. **Lipids:** Classification, Structure, and biological importance of lipids. Properties (Saponification number, acid number and iodine number). Simple lipids - free fatty acids (saturated, cis-unsaturated, trans-unsaturated) acyl glycerols. Complex lipids - phospholipids, sphingolipids, galactolipids and Derived lipids – sterols and eicosanoids including prostaglandins, thromboxanes and leukotrienes. Lipid peroxidation.

MODULE 2: STRUCTURAL ORGANIZATION OF PROTEINS — **14 Hrs**

Primary structure – structure, classification and acid-base properties of amino acids, Non-standard Amino acids and amino acid derivatives, Peptide bond.

Secondary structure: α-helix, β pleated sheet, Ramachnadran plot, Super secondary structures: motifs and domains.

Tertiary structure: Interactions stabilizing tertiary structure. Examples.

Quaternary structure: Hemoglobin Structure and mechanism of co-operativity,

Protein Classification: fibrous proteins (α-keratin, silk fibroin and collagen), globular proteins (Myoglobin and chymotrypsin).

MODULE 3: PROTEIN FOLDING AND CHARECTERIZATION	**14 Hrs**

Protein folding: Molecular chaperones, Thermodynamics of Protein folding- Levinthol paradox, models of protein folding (Classical and Landscape model), misfolding diseases (Alzheimer's and Prion diseases), Sequencing-N and C terminal analysis and solid phase Merrifield synthesis of peptides.

MODULE 4: NUCLEIC ACIDS	**14 Hr**

Nucleic acids: Nucleosides, nucleotides and polynucleotides (DNA, RNA); Types of DNA (A, B and Z forms) Specialized sequences: stem-loops, G-quadruplexes, palindromic and mirror repeats; repetitive DNA sequences: tandem repeats (Satellites, minisatellites, and microsatellites), Types of RNA - mRNA, tRNA, SiRNA, microRNA (structure and function); denaturation and renaturation- cot curve analysis; Oligonucleotide synthesis by phosphoramidite method.

Nucleic acid sequencing by Sanger's method and NGS methods (illumina and 454 sequencing).

TEXT BOOKS AND REFERENCES:

1. Voet, D. & Voet, J.G. (2021). *Biochemistry*. Wiley.
2. Nelson, D.L. & Cox, M.M. (2021). *Lehninger Principles of Biochemistry* (8th Edition). Macmillan Learning.
3. Phillips, R., Kondev, J., Theriot, J., & Garcia, H. (2013). *Physical Biology of the Cell* (2nd Edition). Garland Science.
4. Creighton, T.E. (1993). *Proteins: Structures and Molecular Properties* (2nd Edition). W.H. Freeman and Co.
5. Dickerson, R.E. & Geis, I. (1983). *Principles of Protein Structure, Function, and Evolution* (2nd Edition). Benjamin-Cummings.
6. Berg, J.M., Tymoczko, J.L., & Stryer, L. (2023). *Biochemistry* (10th Edition). W.H. Freeman and Co.
7. Van Holde, K.E. (1985). *Physical Biochemistry: Principles and Applications*. Prentice Hall.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MBC5102**					
TITLE OF THE COURSE	**CYTOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- Understand the structure and function of prokaryotic and eukaryotic cells, including cellular organelles and membranes.
- Analyze mechanisms of membrane transport and cytoskeletal dynamics in relation to cell physiology.
- Evaluate chromosomal organization and interpret the significance of cell division in health and disease.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Compare and contrast prokaryotic and eukaryotic cell structures and their specific cellular organelles.	L3
CO2	Illustrate different membrane transport mechanisms and relate them to nutrient uptake and ion balance.	L4
CO3	Assess chromosomal structure and perform karyotyping to identify genetic abnormalities.	L5

COURSE CONTENT:

MODULE 1: CELLULAR ORGANIZATION — **14 Hrs**

Cell types: Structure of prokaryotic and eukaryotic cells, ultrastructure of animal and plant cell. Brief introduction to cell organelles (structure and function).
Types of tissues: Epithelial cells classification, covering, lining, glandular epithelium. Connective tissue-general features, classification, types of cells.
Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

MODULE 2: MEMBRANE STRUCTURE AND TRANSPORT — **14 Hrs**

Biological membranes: Structure and properties, models of cell membrane, membrane constituents-phospholipids, glycolipid, cholesterol, membrane proteins.
Transport of nutrients: transport of ions and macromolecules, diffusion, osmosis, reverse osmosis.
Types of transport mechanisms: active and passive transport, symport, antiport, co-transport, endocytosis and exocytosis.
Transport Pumps and Proteins: Ionophores, permeases, Na+/K+ Pump, Ca^{2+} Pump. ABC transporter and multidrug resistant proteins.

MODULE 3: CYTOSKELETON AND CELL-CELL INTERACTIONS — **14 Hrs**

Cytoskeletal elements: Microtubules, microfilaments and intermediate filaments, microtubule polymerization dynamics, MAPs, actin polymerization dynamics, muscle contraction, cilia and flagella of prokaryotes and eukaryotes. Cytoskeletal diseases,

Extracellular matrix (ECM) and its biomolecules: Collagen, proteoglycans, fibronectin and lamins.

Cellular junctions: cell junctions (tight junctions, adherens junctions, desmosomes, hemi desmosomes, gap junctions and plasmodesmata).

MODULE 4: GENOME ORGANIZATION	**14 Hrs**

Structure and organization of eukaryotic chromosomes: Watson and Crick model of DNA, Nucleosomes, Super coiled loops, domains and scaffolds in eukaryotic chromosome. Heterochromatin, euchromatin and telomeres.

Cell division: Mitosis, meiosis and their genetic significance.

Karyotyping and analysis: normal and abnormal karyotype analysis for genetic disorders (Down syndrome, Turner syndrome, Klinefelter syndrome). Chromosome banding: G-banding, Q-banding, R-banding, and C-banding. Structural chromosomal abnormalities: deletions, duplications, inversions, translocations. Telomere shortening and aging/genetic diseases.

TEXT BOOKS AND REFERENCES:

1. Alberts, B. et al. (2023). Molecular Biology of the Cell (7th Edition). Garland Science.
2. Lodish, H., Berk, A., Kaiser, C.A., et al. (2023). Molecular Cell Biology (9th Edition). W.H. Freeman.
3. Karp, G. (2024). Cell and Molecular Biology: Concepts and Experiments (9th Edition). Wiley.
4. Geoffrey M. Cooper and Kenneth W (2022) *The Cell: A Molecular Approach* by (9th Edition), Oxford University Press.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**20MBC5103**					
TITLE OF THE COURSE	**HUMAN PHYSIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To recall and describe the structure and function of human organ systems.
- To explain physiological processes and their role in maintaining homeostasis.
- To utilize physiological principles to interpret data and solve real-world problems.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to recall and list basic concepts of human physiology, including terminology and functions of organ systems.	L1
CO2	Students will be able to interpret how various physiological systems coordinate to maintain balance in the body.	L2
CO3	Students will use acquired knowledge to solve problems and make decisions based on physiological data.	L3

COURSE CONTENT:

MODULE 1: BLOOD AND CARDIOVASULAR SYSTEM — **14 Hrs**

Hematology: Blood components and their functions, Formation, and function of blood cells- red blood cells, white blood cells, platelets. Hemostasis and blood clotting: factors affecting blood clotting, role of vitamin K in clotting, Disorders of clotting, Blood groups: the ABO system. role of hemoglobin in oxygen transport. Various buffer systems of the blood, acid base balance, factors affecting acid-base balance.

Cardiovascular System: Systemic and pulmonary circulations, coronary circulation, Basic understanding of Cardiac cycle. Cardiac output, ECG - its principle and significance. Structure and function of blood vessels. Blood pressure and its regulation. Brief outline of cardiovascular disorder (hypertension, arteriosclerosis, myocardial infarction, and congestive heart failure.

MODULE 2: MUSCULAR, SKELETAL AND ENDOCRINE SYSTEM — **14 Hrs**

Muscular System: Overview of muscular tissue; types, functions & properties. Contractile and regulatory proteins of muscle structure of actin and myosin. Mechanism of muscle contraction, Contraction, and relaxation of skeletal muscle fibres- sliding filament model, Neuromuscular junction, Muscle metabolism.

Skeletal System: Extracellular matrix and its components, Bone-ultrastructure, composition, cells: osteoblasts, osteocytes, and osteoclasts. Bone growth, remodelling, and regulation by hormones.

Endocrine System: Introduction to endocrinology, classification and mechanism of action of hormones. Glands - Pituitary, Adrenal, Pancreas &Thyroid; hormones - action, regulation, tests, and disorders.

Control of calcium metabolism byparathyroid hormone, calcitonin, and vitamin D.

MODULE 3: DIGESTIVE AND RESPIRATORY SYSTEM	**14 Hrs**

Digestive System: GIT and accessory organs, Composition, function, and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, Mechanism of breakdown and absorption of carbohydrates, lipids, and proteins.

Respiratory System: Components of respiratory system and their functions.Pulmonary ventilation, Lung volumes and capacities, Bohr and Haldane effect, chloride shift; effect of 2, 3- BPG on 02 affinity of Hb; Clinical importance of 2, 3 BPG. Respiratory center. Respiratory Acidosis and Alkalosis.

MODULE 4: NERVOUS AND EXCRETORY SYSTEM	**14 Hrs**

Nervous System: Organization of nervous system - CNS, PNS. ANS, somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron and glial cells, Synapse, generation of action potential, function of voltage-dependent and neurotransmitter-gated ion channels- role in synaptic transmission, neurotransmitters: glutamate, acetylcholine, glycine, dopamine & serotonin.

Excretory system: Structure of nephron, mechanism of urine formation: Glomerular filtration, Tubular re-absorption & active secretion, Fluid, electrolyte, and Acid-Base homeostasis, Kidney hormones. Roles of skin, lungs liver and intestine in excretion.

REFERENCES:

1. Sherwood, L. (2024*). Human Physiology: From Cells to Systems* (9th ed.). Cengage Learning.
2. Silverthorn, D. U. (2024). *Human Physiology: An Integrated Approach* (8th ed.). Pearson.
3. Widmaier, E., Raff, H., & Strang, K. (2023). *Vander's Human Physiology* (16th ed.). McGraw-Hill Education.
4. Khurana, I., & Khurana, A. (2022). *Concise Textbook of Human Physiology* (4th ed.). Elsevier India.
5. Barrett, K. E., Barman, S. M., Brooks, H. L., & Yuan, J. X.-J. (2019). *Ganong's Review of Medical Physiology* (26th ed.). McGraw-Hill Education.
6. Pal, G. K., Pal, P., & Nanda, N. (2023). *Comprehensive Textbook of Medical Physiology* (3rd ed., 2 Volumes). Jaypee Brothers Medical Publishers.
7. Chatterjee, C. C. (2025). *Human Physiology* (15th ed., Vol. 2). CBS Publishers & Distributors Pvt. Ltd.
8. Murugesh, N. (2025). *Anatomy, Physiology, and Health Education* (6th ed.). Sathya Publications

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MSC5102**					
TITLE OF THE COURSE	**BIOSTATISTICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**28**	**2**

COURSE OBJECTIVES:

- **Build a strong foundation in statistical theory and methods** with a focus on applications in health sciences, clinical research, epidemiology, and public health.
- **Develop analytical skills** to manage, analyze, and interpret biomedical data.
- **Enable critical evaluation of scientific literature** and the application of appropriate statistical methodologies in research design and analysis.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**To use statistical tools** proficiently for data management, analysis, and reporting.	L2
CO2	**Apply core statistical concepts and techniques** in biological and health-related contexts.	L3
CO3	**Interpret and communicate statistical results** clearly in written and oral form, suitable for scientific publications and presentations.	L4

COURSE CONTENT:

MODULE 1: MEASURES OF CENTRAL TENDENCIES, DISPERSION AND CORRELATION	**14 Hrs**

Introduction to Bio-statistics and its significance, use of replicates, Tabulation, and graphical representations of data. Different models of data presentations. Frequency distribution. Measures of Central tendency: Arithmetic mean, mode & median. Measures of variability: Range, mean deviation, and percentiles. Standard deviation and co-efficient of variation, Standard error Properties of the data: linear regression and correlation-test of significance, skewness and kurtosis and their various measures, Simple linear correlation and regression analysis. Analysis of variance. Sampling methods and their significance.

MODULE 2: PROBABILITY DISTRIBUTIONS AND TESTING OF HYPOTHESIS	**14 Hrs**

Probability: Definition, types of events, sample space, conditional probability, addition and multiplication rules of probability and some simple problems. Probability distributions- Binomial, Poisson and Normal distributions with simple numerical. Testing of hypothesis: basic concepts and definitions, types of errors, confidence intervals. Tests based on Normal, student's t, chi-square and F distributions, interpretation of "p" value. Anova- one way and two- way, Statistical package- Features of statistical software, SPSS for various applications in Biostatistical program.

TEXT BOOKS AND REFERENCES:

1. Daniel, M. (1999). Biostatistics (3rd ed.). Panima Publishing Corporation.
2. Khan, I. A., & Khanum, A. (2024). Fundamentals of Biostatistics (6th rev. ed.). Ukaaz / BSP Books.Wardlaw, A.C. (1985).
3. Wardlaw, A. C. (2000). Practical Statistics for Experimental Biologists (2nd ed.). Wiley-Blackwell.
4. Campbell, R.C. (2012) Statistics for Biologists, Cambridge Univ. Press, Cambridge

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MBC5104**					
TITLE OF THE COURSE	**BIOINFORMATICS-I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**28**	**2**

COURSE OBJECTIVES:

- To introduce the fundamental concepts of bioinformatics, biological databases, and computational tools.
- To enable students to analyse genomic and proteomic data for biological interpretation.
- To apply bioinformatics approaches to understand gene and protein function, structure, and evolution.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe the structure and functions of major biological databases and tools used in genomics	L1
CO2	Apply bioinformatics tools for sequence analysis, gene annotation, and protein modeling	L3
CO3	Analyze and interpret genomic and proteomic data to draw meaningful biological conclusions	L4

COURSE CONTENT:

MODULE 1: INTRODUCTION TO BIOINFORMATICS AND GENOMICS **14 Hrs**

Introduction to Genomics: Scope and applications; Biological databases: NCBI, EMBL, DDBJ, UniProt; Microbial genomic database (MBGD), Cell line database (ATCC), construction of databases. Sequence formats and database retrieval tools (BLAST, FASTA); Gene Sequence alignment - Global and Local, Similarity searching; Pair wise comparison of sequences, Multiple Sequence alignment of sequences, alignment, scoring matrices. (ClustalW, MUSCLE); Gene prediction and annotation tools; Genome browsers: UCSC, Ensembl; Comparative genomics and SNP analysis; Identification of genes in genomes and Phylogenetic analysis with reference to nucleic acids; Identification of ORFs; Restriction mapping - NEB CUTTER.

MODULE 2: PROTEOMICS **14 Hrs**

Introduction to Proteomics-Definition, workflows, Applications of proteomics in drug discovery and systems biology. Protein sequence analysis and motif prediction (Pfam, PROSITE), Protein structure databases: PDB, SCOP, CATH; Protein sequence databank – NBRF-PIR, UNIPROT and Swiss ExPASy. Structure validation tools (Ramachandran plot, PROCHECK). Protein Structure Prediction and Evolutionary Analysis- Principles of homology modeling (SCOP), Comparative modeling techniques, Tools for protein modeling (e.g., SWISS-MODEL, MODELLER), Evaluation of predicted protein

structures, Basics of phylogenetics: sequence alignment, evolutionary trees, Phylogenetic tools (MEGA, Clustal Omega).

TEXT BOOKS AND REFERENCES:

1. Mount, D.W., (2004). Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
2. Lesk, A.M., (2019). Introduction to Bioinformatics (5th ed.). Oxford University Press.
3. Pevsner, J., (2015). Bioinformatics and Functional Genomics (3rd ed.). Wiley Blackwell.
4. Baxevanis, A.D. and Ouellette, B.F.F., (2005). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (3rd ed.). Wiley-Interscience.
5. Campbell, A.M. and Heyer, L.J., (2006). Discovering Genomics, Proteomics, and Bioinformatics (2nd ed.). Benjamin Cummings.
6. Gibas, C. and Jambeck, P., (2001). Developing Bioinformatics Computer Skills. O'Reilly Media.
7. Xiong, J., 2006. Essential Bioinformatics. Cambridge University Press.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MBC5171**					
TITLE OF THE COURSE	**ANALYTICAL BIOCHEMISTRY PRACTICALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To prepare buffer solutions of known pH and understand their buffering capacity in various chemical systems.
- To determine the dissociation constant (pKa) of weak acids using pH metric methods and analyze acid-base equilibria.
- To quantitatively estimate sugars, lipids and proteins in biological samples using colorimetric methods such as DNS
- To estimate nucleic acids (DNA, RNA) and vitamins using specific chemical assays and relate their concentration to biological functions.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to accurately prepare buffer solutions and explain their role in maintaining pH stability in chemical and biological systems.	L3
CO2	Students will be able to determine total hardness of water and phosphorus content in samples, applying titrimetric and colorimetric methods, and interpret environmental significance.	L5
CO3	Students will be able to perform quantitative estimation of biomolecules (sugars, proteins, nucleic acids, vitamins) and analyze the results for biological relevance.	L4
CO4	Students will be able to interpret assay results to assess nutritional or biochemical status of samples such as fruit vitamin content or nucleic acid concentration.	L5

EXPERIMENTS:

1. Preparations of Buffers.
2. Determination of pKa of a weak acid by pH metric method.
3. Determination of Phosphorus in aerated Drinks.
4. Determination of total hardness of water.
5. Determination of pKa of amino acid (glycine).
6. Estimation of lactose from milk.
7. Estimation of proteins from cereals by Bradford method.
8. Estimation of Iodine number of oil/ghee.
9. Estimation of RNA/DNA by Orcinol/DPA method.
10. Quantitative estimation of ascorbic acid in fruit samples.

TEXT BOOKS AND REFERENCES:

1. Vogel's Textbook of Quantitative Chemical Analysis 5th Edition (1989) A. I. Vogel, Longman, London, UK.
2. Principles of Instrumental Analysis 7th Edition (2014) Douglas A. Skoog, F. James Holler, Stanley R. Crouch, Cengage Learning, Boston, USA.
3. Vogel's Quantitative Chemical Analysis 6th Edition (2000) J. Mendham, R. C. Denney, J. D. Barnes, M. Thomas, Pearson Education, London, UK.
4. Introductory Practical Biochemistry (2001) S. K. Sawhney, Randhir Singh, Narosa Publishing House, New Delhi, India.
5. An Introduction to Practical Biochemistry 3rd Edition (2004) D. T. Plummer, Tata McGraw Hill, New Delhi, India.
6. Principles and Techniques of Biochemistry and Molecular Biology 7th Edition (2010) Keith Wilson, John Walker, Cambridge University Press, Cambridge, UK.
7. Biochemical Methods 3rd Edition (2008) S. Sadasivam, A. Manickam, New Age International Publishers, New Delhi, India.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**25MBC572**					
TITLE OF THE COURSE	**CLINICAL AND CELLULAR BIOCHEMISTRY PRACTICALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To estimate and interpret biochemical parameters such as glucose, cholesterol, urea, and creatinine in biological fluids using standard colorimetric methods.
- To correlate abnormal biochemical values with possible clinical conditions (e.g., hyperglycemia, kidney or liver dysfunction).
- To calibrate microscopic tools, prepare and examine cell structures (e.g., nucleus, chloroplast, mitochondria) and identify stages of mitosis using microscopy and staining techniques.
- To analyze and assess cell viability, organelle structure, and stages of mitosis from prepared or stained samples.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to accurately estimate clinical parameters like sugar, urea, creatinine, cholesterol in blood and urine samples using standard methods.	L3
CO2	Students will be able to interpret biochemical test results and relate them to potential pathological conditions (e.g., diabetes, liver or kidney disorders).	L5
CO3	Students will be able to identify and analyze cellular structures such as nuclei, chloroplasts, and mitochondria using appropriate staining and microscopy techniques.	L4
CO4	Students will demonstrate proficiency in handling microscopes and identifying histological structures (epithelium, muscle, connective tissue).	L3

EXPERIMENTS:

1. Estimation of sugar from blood and urine by DNS method.
2. Estimation of hemoglobin in blood by Wong's method.
3. Estimation of blood cholesterol by Zak and Zlatkis method.
4. Estimation of creatinine in urine by Jaffe's method.
5. Estimation of urea in urine by DAM reagent.
6. Estimation of bilirubin in urine.
7. Micrometry: calibration of stage and ocular micrometer and measurement of the given biological sample.
8. Trypan blue exclusion test to evaluate cell viability (after UV treatment).

9. Chloroplast isolation and their microscopic examination.
10. Mitosis study in onion root tip.
11. Vital staining of mitochondria (yeast).
12. Histology slide identification of epithelial cells, connective tissue, muscle tissue.

TEXT BOOKS AND REFERENCES:

1. Varley, H. (1988). Practical Clinical Biochemistry (6th ed.). CBS Publishers.
2. Chawla, R. (2025). Practical Clinical Biochemistry: Methods & Interpretations (6th ed.). Jaypee Brothers Medical Publishers.
3. Pattabhiraman, T. N. (2014). Practical and Clinical Biochemistry for Medical Students. Gajanna Publishers.
4. Oser, B. L. (1965). Hawk's Physiological Chemistry (14th ed.). Tata McGraw-Hill.
5. Plummer, D. T. (1971). An Introduction to Practical Biochemistry. Tata McGraw-Hill.
6. De Robertis E D P, De Robertis E M F, 2001, Cell and Molecular Biology, 8th Edn.
7. Karp G, 2021, Cell and Molecular Biology: Concepts and Experiments, 9th Edn.
8. Balakrishna Shetty, H Sweekritha Poonja 2018, Textbook of Practical Physiology (5Th Edn)
9. Hina Sharma Practical Manual of Histology (2nd Edn)

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5201**					
TITLE OF THE COURSE	**PRINCIPLES OF MOLECULAR BIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To explain the mechanisms of DNA replication, repair, transcription and translation in both prokaryotic and eukaryotic systems.
- To differentiate between prokaryotic and eukaryotic mechanisms of gene expression and regulation.
- To assess the impact of epigenetic modifications such as histone acetylation and DNA methylation on transcriptional activity.
- To apply knowledge of gene regulatory elements to explain how environmental or cellular signals affect gene expression.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Summarize key processes of DNA replication, including enzyme functions and regulatory mechanisms in prokaryotes and eukaryotes.	L2
CO2	Illustrate the transcription and translation processes and compare these events in prokaryotic and eukaryotic cells.	L3
CO3	Interpret the roles of RNA processing, RNA interference, and epigenetic modifications in regulating gene expression.	L4
CO4	Evaluate different models of gene regulation, including operon-based systems in prokaryotes and chromatin-level regulation in eukaryotes.	L5

COURSE CONTENT:

MODULE 1: DNA REPLICATION AND REPAIR	**14 Hrs**

Mechanism of DNA Replication: Replicon model, unidirectional and bidirectional replication, semi-conservative and semi-discontinuous replication, Messelson & Stahl experiment. DNA polymerase I and III (structure and functions). Mechanism of DNA replication in prokaryotes (trombone model), regulation of replication. Eukaryotic DNA polymerases and mechanism of replication in Eukaryotes. Telomere synthesis-telomerases. regulation of replication in eukaryotes. Rolling circle model.

Mechanism of DNA Repair: DNA damages, Direct repair, excision repair (BER and NER), mismatch repair and SOS repair.

MODULE 2: TRANSCRIPTION	**14 Hrs**

Prokaryotic Transcription: Characteristics and function of bacterial RNA polymerases, Components of basal transcriptional unit, prokaryotic promoters. Role of sigma factor in initiation, Mechanism of Initiation, Elongation and Termination: Rho dependent and Rho independent.

Eukaryotic Transcription: Composition of eukaryotic RNA polymerases, Role of Enhancers, eukaryotic promoters, coactivators, silencers and transcription factors, mechanism of transcription initiation –with RNA Pol I, II, III, Elongation and Termination. Post transcriptional modifications of mRNA (5' Cap formation, poly adenylation, mechanism of splicing), mRNA stability. Synthesis and Processing of tRNA, rRNA, Small regulatory RNAs (SiRNA and MiRNA), Inhibitors of transcription. RNA editing.

MODULE 3: TRANSLATION	**14 Hrs**

Protein Synthesis: Genetic code, Wobble hypothesis. Prokaryotic Ribosome assembly, mechanism of activation of amino acids. Mechanism of translation in Prokaryotes and Eukaryotes. Differences between Prokaryotic and Eukaryotic protein synthesis. Post translational modifications of proteins.

Protein Targeting and localization: Export of secretory proteins- signal hypothesis, transport and localization of proteins to mitochondria, chloroplast, peroxisomes and membrane.

MODULE 4: REGULATION OF GENE EXPRESSION IN PROKARYOTES AND EUKARYOTES	**14 Hrs**

General Principles of Gene Regulation. **Regulation of prokaryotic gene expression:** Inducible and repressible systems, lactose operon (negative and positive regulation), role of cAMP and CRP in the expression of lac genes and catabolite repression. Regulation of tryptophan operon by Attenuation.

Regulation of eukaryotic gene expression: Chromatin structure and its effect on gene regulation (nucleosome positioning, DNase hypersensitive sites and locus control regions, chromatin remodeling, histone modifications (acetylation and methylation), transcriptional control, *cis* control elements, promoters, enhancers, transacting factors, DNA binding motifs of transcription factors, posttranscriptional control. Translational and posttranslational control.

Gene Silencing: Transcriptional and post transcriptional gene silencing, RNAi pathway (siRNA and mi RNA), riboswitches and RNA-mediated repression, Antisense RNA and its applications

TEXT BOOKS AND REFERENCES:

1. Pierce, B.A. (2023), Genetics: A Conceptual Approach, 7th Edition, Macmillan Learning.
2. Alberts B., Johnson A., Lewis J., Raff M., Roberts K., and Walter P. (2022), Molecular Biology of the Cell, 7th Edition, Garland Science.
3. Lewin B., Krebs J.E., Goldstein E.S., and Kilpatrick S.T. (2018), Lewin's Genes XII, 12th Edition, Jones & Bartlett Learning.
4. Karp, G**.** (2021), *Cell and Molecular Biology: Concepts and Experiments*, 9th Edition, Wiley.
5. Lodish H., Berk A., Kaiser C.A., Krieger M., Bretscher A., Ploegh H., Amon A., and Scott M.P. (2021), Molecular Cell Biology, 9th Edition, W.H. Freeman and Company.
6. Watson J.D., Baker T.A., Bell S.P., Gann A., Levine M., and Losick R. (2017), Molecular Biology of the Gene, 7th Edition, Pearson Education.
7. Cooper, G.M., & Hausman, R.E. (2022), *The Cell: A Molecular Approach*, 9th Edition, Oxford University Press.
8. Nelson, D.L., & Cox, M.M**.** (2021), *Lehninger Principles of Biochemistry*, 8th Edition, W.H. Freeman and company (Macmillan Learning).

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5202**					
TITLE OF THE COURSE	**ANALYTICAL TECHNIQUES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- Understand the principles and instrumentation of key biomolecular separation and analytical techniques used in molecular biology and biochemistry.
- Apply appropriate electrophoretic, chromatographic, and spectroscopic techniques for analysis and quantification of biological samples.
- Analyze and evaluate the data generated from advanced bioanalytical tools like NMR, mass spectrometry, microarrays, and radioisotope labelling techniques.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Describe the working principles and applications of different techniques used to analyze biomolecules.	L1
CO2	Perform and interpret results from techniques such as electrophoresis, spectrophotometry, microscopy.	L3
CO3	Evaluate and compare the utility of different analytical and separation techniques for solving biological problems.	L5

COURSE CONTENT:

MODULE 1: ELECTROPHORESIS	**14 Hrs**

Migration of ions in the electric field. Factors affecting electrophoretic mobility. Principle, schematics and application of Agarose gel electrophoresis (DNA), Native and SDS-PAGE (Proteins). Isoelectric focusing (IEF), 2D-Electrophoresis and capillary electrophoresis and applications. Principle of Southern, Northen, Western Blotting and applications.

MODULE 2: CHROMATOGRAPHY AND SPECTROPHOTOMETRY	**14 Hrs**

Chromatography: Principle of chromatography. Distribution/partition coefficient. Types of matrices used in different chromatographic techniques, Separation of proteins using gel permeation, ion exchange, affinity chromatography (recombinant proteins, glycans) and applications. High Performance Liquid Chromatography (HPLC), FPLC (proteins, secondary metabolites), Gas Chromatography (GC) (Fatty acids)) and applications.

Spectrophotometry: Principle, schematics and applications of Colorimeter (all 4 biomolecules) and UV-Vis spectrophotometer (proteins and nucleotides).

MODULE 3 IMAGING AND BIOPHYSICAL TECHNIQUES	**14 Hrs**

Microscopy and its applications: Light microscopy, phase contrast and fluorescence microscopy, electron microscopy (TEM & SEM), confocal microscopy, cryo electron microscopy and cryo electron tomography.

Biophysical techniques: Basic principles, schematics and brief applications: CD, XRD, IR, NMR, MALDI & LC-MS, flowcytometry.

MODULE 4: SEPARATION, DETECTION, AND QUANTIFICATION TECHNIQUES	**14 Hr**

Centrifugation: Basic principles, RCF, svedberg constant and sedimentation coefficient.

Preparative centrifugation: Differential & density gradient centrifugation with their applications. Analytical centrifugation: Determination of molecular weight of biomolecules.

Radioisotope Techniques: Principles of radioactivity, types of radiation and detection, Geiger-Muller counter, solid & liquid scintillation counters (Basic principle, instrumentation & technique), autoradiography and their advantages and limitations.

Labelling and Quantification: Fluorescence and luminescence. Fluorophores, conjugation applications. ELISA and radioimmunoassay.

TEXT BOOKS AND REFERENCES:

1. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology, 7th Edition, Cambridge University Press.
2. Upadhyay, A., Upadhyay, K., & Nath, N. (2019). Biophysical Chemistry, 5th Edition, Himalaya Publishing House.
3. Katoch, R. (2011). Analytical Techniques in Biochemistry and Molecular Biology, 1st Edition, Springer.
4. Skoog, D. A., Holler, F. J., & West, D. M. (2014). Fundamentals of Analytical Chemistry, 9th Edition, Saunders (an imprint of Cengage Learning)
5. Günzler, H., & Williams, A. (2001). Handbook of Analytical Techniques, 1st Edition, Wiley-VCH (Wiley & Sons).
6. Joshi, A., & Saraswat, D. (2012). A Textbook of Practical Biochemistry, 1st Edition, Jain Publishers.
7. Glick, D., & Moore, D. H. (2000). Centrifugation and Centrifuges, 1st Edition, CRC Press.
8. Wild, D. (2013). The Immunoassay Handbook: Theory and Applications of Ligand Binding, ELISA and Related Techniques, 4th Edition, Elsevier.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5203**					
TITLE OF THE COURSE	**METABOLISM - I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To u**nderstand** the biochemical pathways involved in carbohydrate and lipid metabolism, including glycolysis, TCA cycle, β-oxidation, and biosynthesis of fatty acids and cholesterol.
- **To analyze** the regulatory mechanisms governing metabolic processes, such as hormonal control of blood glucose levels and enzyme regulation in metabolic pathways.
- **To apply** knowledge of metabolic pathways to understand clinical conditions like diabetes mellitus, obesity, and hypercholesterolemia.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to remember and understand key metabolic pathways and their regulatory mechanisms.	L2
CO2	Students will be able to apply concepts of metabolism to analyze metabolic disorders and their clinical implications.	L3
CO3	Students will be able evaluate the impact of metabolic alterations on health and disease, and create strategies for managing metabolic disorders.	L4

COURSE CONTENT:

MODULE 1: CARBOHYDRATE METABOLISM	**14 Hrs**

Introduction to metabolism. Glycolysis - energetics and regulation, fates of pyruvate - aerobic and anaerobic, cori cycle, entry of sugars other than glucose into metabolism, pyruvate dehydrogenase complex, TCA cycle: anaplreotic, amphibolic nature and regulation, gluconeogenesis, reciprocal regulation, glycogen metabolism - degradation, synthesis and regulation. Hormonal regulation of blood glucose (insulin and glucagon), Diabetes Mellitus.

MODULE 2: LIPID METABOLISM	**14 Hrs**

Basic scheme of fat absorption, mobility, degradation and synthesis; degradation of triacylglycerol and phospholipids- lipases and phospholipases. Fatty acid oxidation- even, odd and unsaturated fatty acids by β-oxidation, scheme and energetics, peroxisomal β-oxidation, branched chain fatty acids by α-oxidation, medium chain fatty acids by ω-oxidation. Metabolism of ketone bodies with physiological significance, Fatty acid biosynthesis, FAS- multi functional enzyme, chain elongation and desaturation. Biosynthesis of triacylglycerol.

MODULE 3: CHOLESTEROL AND CIRCULATING LIPIDS	**14 Hrs**

Cholesterol structure and function, brief idea of synthesis from acetyl CoA, regulation through HMG CoA reductase. Mobilization of lipoproteins- chylomicrons, HDL, LDL, and VLDL – composition, markers, and metabolic fate, Regulation of cholesterol metabolism. Biochemistry of obesity, atherosclerosis, and hypercholesterolemia, synthesis and function of prostaglandins and related compounds, non-steroidal anti-inflammatory drugs (NSAIDs).

MODULE 4: BIOENERGETICS	**14 Hrs**

Brief introduction to standard reduction potential of electron carriers. Mitochondrial electron transfer system- Sequence and structure of electron carriers. Proton motive force and the Mitchell hypothesis. F_0F_1-ATPase- structure and mechanism, mechanism of oxidative phosphorylation, P/O ratios and their use in localization of sites of ATP synthesis along the chain. Couplers (Thioredoxin, Fe-S), Uncouplers (thermogenin, Valinomycin and DNP), inhibitors and ionophores.

TEXT BOOKS AND REFERENCES:

1. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. **(**2024). *Textbook of Biochemistry for Medical students*. Jaypee Brothers Medical Publishers. 10th edition.
2. Voet, D., Voet, J. G., & Pratt, C. W. **(**2016). *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 5th edition.
3. Naik, P. 2024. *Essentials of Biochemistry*. Jaypee Brothers Medical Publishers. 3rd edition.
4. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. **(**2015*). Stryer's Biochemistry*. W.H. Freeman and Company. 8th edition.
5. Nelson, D. L., Cox, M. M. **(**2017). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company. 7th edition.
6. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., & Rodwell, V. W. **(**2018). *Harper's Illustrated Biochemistry*. McGraw-Hill Education. 31st edition.
7. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. **(**2024). *Textbook of Biochemistry for Medical Students.* Jaypee Brothers Medical Publishers. 10th edition.
8. Voet, D., Voet, J. G., & Pratt, C. W. **(**2016). *Fundamentals of Biochemistry: Life at the Molecular Level*. Wiley. 5th edition.
9. Naik, P. **(**2024). *Essentials of Biochemistry*. Jaypee Brothers Medical Publishers. 3rd edition.
10. Berg, J. M., Tymoczko, J. L., & Gatto, G. J**. (**2015). *Stryer's Biochemistry*. W.H. Freeman and Company. 8th edition.
11. Nelson, D. L., Cox, M. M. **(**2017). *Lehninger Principles of Biochemistry*. W.H. Freeman and Company. 7th edition.
12. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., & Rodwell, V. W. **(**2018). *Harper's Illustrated Biochemistry*. McGraw-Hill Education. 31st edition.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5204**					
TITLE OF THE COURSE	**PLANT BIOCHEMISTRY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To understand the fundamental biochemical processes involved in plant metabolism and their physiological relevance.
- To apply knowledge of plant biochemistry to explain hormonal regulation, stress responses, and metabolic pathways.
- To analyse the molecular mechanisms of plant signalling and interaction with environmental and biological factors.
- To evaluate the use of modern genetic engineering and gene-editing techniques for plant improvement and biotechnology applications.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to describe the structure and function of plant organelles and metabolic pathways including photosynthesis and nitrogen metabolism.	L2
CO2	Students will be able to compare the roles of plant hormones and secondary metabolites in growth, development, and stress adaptation.	L4
CO3	Students will be able to apply concepts of plant signaling pathways and stress responses to real-world agricultural or ecological contexts.	L3
CO4	Students will be able to analyze the strategies and techniques used in plant genetic transformation, gene silencing, and recombinant protein production.	L4

COURSE CONTENT:

MODULE 1: INTRODUCTION TO PLANT BIOCHEMISTRY AND METABOLISM	**14 Hrs**

Structure and function of plant cell wall, chloroplasts and vacuoles, photosynthesis including light and dark reactions, photophosphorylation, photorespiration, C3, C4, and CAM pathways, starch and sucrose biosynthesis.

Brief introduction to secondary metabolites- Nature and distribution of plant metabolites- alkaloids, flavonoids, terpenoids, phenolics, and glycosides, along with their ecological roles and applications.

Nitrogen metabolism: Nitrogen fixation, nitrogenase complex, biochemistry and genetics of nitrogen fixation and ammonium assimilation, structure of 'NIF' genes and its regulation, structural features of nitrate reductase and nitrite reductase, regulation of nitrate and sulphate assimilation.

MODULE 2: PLANT GROWTH REGULATORS AND STRESS BIOCHEMISTRY	**14 Hrs**

Overview of plant hormones such as auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, jasmonates, and salicylic acid, and their physiological effects. Seed dormancy and germination, flowering and senescence. Abiotic stress responses including drought, salinity, cold and heat stress, oxidative stress, reactive oxygen species, and stress-responsive genes. Protective mechanisms like antioxidant enzymes and osmolyte accumulation.

MODULE 3: PLANT SIGNALING AND MOLECULAR INTERACTIONS	**14 Hrs**

Signal perception and transduction pathways in plants, role of receptor kinases, G-proteins, calcium signaling, reactive oxygen species (ROS) as signaling molecules, MAP kinase cascade, systemic acquired resistance and plant immune responses. Light signaling including phytochromes, cryptochromes, and phototropins. Circadian rhythms, photoperiodism, and plant-microbe interactions including pathogen recognition and defense signaling. Plant elicitors for induction of metabolic pathways.

MODULE 4: PLANT BREEDING AND GENETIC ENGINEERING	**14 Hrs**

Brief introduction to hybridization techniques, marker-assisted selection. Plant tissue culture: micropropagation, totipotency, callus induction, somatic embryogenesis, and organogenesis. Genetic transformation methods such as Agrobacterium-mediated transformation, development, and applications of transgenic plants (Bt cotton, Nif genes). Gene editing- TALENs, and ZFNs, overexpression systems, recombinant protein production in plants, edible vaccines.

TEXT BOOKS AND REFERENCES:

1. Goodwin, T. W., & Mercer, E. I. (1983). Introduction to Plant Biochemistry. Pergamon Press, Oxford.
2. Taiz, L., & Zeiger, E. (2012). Plant Physiology. Amazon Press. 5th edition.
3. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2000). Biochemistry and Molecular Biology of Plants. John Wiley. 2nd edition.
4. Dey, P. M., & Harborne, J. B. (1997). Plant Biochemistry. Academic Press.
5. Heldt, H. W. (1997). Plant Biochemistry and Molecular Biology. Oxford University Press.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5205**					
TITLE OF THE COURSE	**APPLIED MICROBIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To understand the classification, growth, and techniques used in microbiology.
- To develop knowledge of molecular tools, vectors, and techniques used in recombinant DNA technology.
- To analyse the strategies and systems used for microbial strain improvement and recombinant protein production.
- To evaluate the bioprocessing workflow and optimize production and purification of recombinant products.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to explain the classification of microorganisms, microbial growth kinetics, and methods of staining, sterilization, and cultivation.	L2
CO2	Students will be able to apply rDNA techniques including restriction digestion, cloning, gene transfer, and screening methods in microbial systems.	L3
CO3	Students will be able to analyze metabolic engineering approaches, expression systems, and host selection for improved production of microbial metabolites and proteins.	L4
CO4	Students will be able to evaluate fermentation strategies, bioreactor design, and downstream processing techniques for the development of industrial and pharmaceutical bioproducts.	L5

COURSE CONTENT:

MODULE 1: INTRODUCTION TO MICROBIOLOGY **14 Hrs**

Classification of Microorganisms: Overview of major groups: Bacteria, Archaea, Fungi, Protozoa, Algae, Viruses. Basic differences between prokaryotic and eukaryotic microbes.

Microbial Techniques: Principles of staining, bacterial and fungal staining methods. Sterilization and Disinfection- principles - methods of sterilization: physical and chemical methods – mode of action. Culture media and its types (simple, selective, enriched, enrichment and differential media). Isolation and purification techniques of bacteria and fungi (aerobic and anaerobic). Microbial nutrition and kinetics: growth curve, macro and micronutrients, factors influencing the growth of microbes. Measurement of microbial growth (biomass, turbidity, CFU, PFU, radial growth).

MODULE 2: TOOLS AND TECHNIQUES IN rDNA TECHNOLOGY FOR MICROBIAL ENGINEERING	**14 Hrs**
Molecular tools: Restriction endonucleases – Types, DNA ligases, alkaline phosphatase, polynucleotide kinase, DNase I, DNA polymerases, reverse transcriptase and klenow fragment, terminal nucleotidyl transferase. **Vectors**: Properties of an ideal vector. Cloning vectors: Prokaryotic vectors (pBR322; pUC18; Lambda phage, Cosmids). Eukaryotic vectors: YAC vector, shuttle vector, animal vectors: SV 40, retroviral vectors. Expression vectors in prokaryotes and eukaryotes– Basic features, role of promoters (T7, and lac, tac), fusion tags (pMAL, pHAT), and RBS. **Techniques in gene cloning**: Primer design, PCR and its types (qRT-PCR, multiplex, colony), mRNA isolation, cDNA synthesis, site directed mutagenesis, overview of CRISPR-Cas9 gene editing.	
MODULE 3: GENE TRANSFER, SCREENING, AND STRAIN IMPROVEMENT	**14 Hrs**
Methods of Gene transfer: Transformation, transfection, microinjection, electroporation, microprojectile, liposome fusion. **Screening and selection of recombinants** by insertional inactivation, visual screening (blue white and GFP protein), plaque formation, complementation of mutation/nutrition, colony hybridization. **Strain Improvement**: A brief overview of strain improvement to enhance microbial metabolite production (eg. Increase **ethanol production** in yeast). **Methods**: Mutagenesis (random and targeted), gene overexpression. **Microbial Host systems**: *E. coli, Bacillus subtilis, Pichia pastoris, Saccharomyces cerevisiae;* **non-microbial host systems***:* Baculo virus system, mammalian cell expression (CHO cells).	
MODULE 4: BIOPROCESSING AND RECOMBINANT PRODUCT DEVELOPMENT	**14 Hrs**
Fermentation Technology: Types of fermentation: SSF, SmF, media optimisation, applications, batch, fed-batch, and continuous. Design and function of bioreactors. Parameters for scale-up and optimization in industrial fermentation **Downstream Processing and Product Recovery Steps:** cell disruption, separation, purification, and polishing. Protein purification using chromatography, filtration, and precipitation techniques. Use of affinity tags and protease cleavage for product recovery. **Microorganisms in Industrial Processes:** Alcohol production, organic acids (citric acid). Amino acid - L-Glutamic acid, antibiotic (Penicillin). Recombinant Vaccines (Hepatitis B, HPV), hormones (human insulin, human growth hormone).	
TEXT BOOKS AND REFERENCES:	

1. Ananthanarayanan, R. and Jayaram Panicker C.K. (2004) Text book of Microbiology. Orient Longman, Hyderabad.
2. Brock T.D and Madigan M.T. Biology of Microorganisms 6th Edition. Prentice Hall, Eagle wood cliffs N. J.
3. Dubey, R.C. Microbiology 1st Edition. Chand and company.
4. Pelczar, M.J., Chan, E.C.S and Kreig N.R. Microbiology Tata McGraw-Hill 5th Edition.Pub.1998.
5. Prescott, L.M. Microbiology 6th edition. Mc Graw Hill. (2005).
6. Primrose, S.B., Twyman, R.M., & Old, R.W. (2006). Principles of Gene Manipulation and Genomics (7th ed.). Wiley-Blackwell.
7. Sambrook, J., & Russell, D.W. (2001). Molecular Cloning: A Laboratory Manual (3rd ed., Vols. 1–3).

Cold Spring Harbor Laboratory Press.
8. Brown, T.A. (2023). Genomes (5th ed.). CRC Press (Taylor & Francis Group).

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5206**					
TITLE OF THE COURSE	**BIOINFORMATICS-II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**28**	**2**

COURSE OBJECTIVES:

- To provide foundational knowledge and tools for metabolome analysis and pathway interpretation.
- To equip students with computational approaches in modern drug discovery and design.
- To develop analytical and problem-solving skills in omics-driven therapeutic development.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe key tools, workflows, and databases used in metabolomics and drug design	L1
CO2	Apply computational techniques for metabolic profiling, pathway mapping, and virtual drug screening	L3
CO3	Analyze metabolomic data and evaluate drug-likeness and ADMET properties of candidate molecules	L4

COURSE CONTENT:

MODULE 1: METABOLOMICS	**14 Hrs**

Introduction to Metabolomics: Definition, types (targeted vs untargeted), workflows, instrumentation overview: LC-MS, GC-MS, NMR in metabolomics. Metabolomics databases: HMDB, Metlin, KEGG, BioCyc, Metabolomic data processing and normalization, Pathway enrichment and network-based metabolite analysis, Applications: biomarker discovery, disease metabolomics, nutrigenomics.

MODULE 2: COMPUTATIONAL DRUG DISCOVERY AND DESIGN	**14 Hrs**

Target Identification and Retrieval- Retrieve protein sequences and 3D structures of drug targets (UniProt, PDB, Drug Bank). In-silico protein structure modelling (Alpha fold). Explore active site regions using PDB viewer tools (PyMOL or Chimera). Molecular docking: principles, scoring functions (AutoDock, SwissDock. Ligand retrieval and preparation (PubChem, ChemSpider, ZINC Database). Receptor preparation. visualization of binding poses using PyMOL. Virtual screening workflows, QSAR modelling and molecular descriptors by PaDEL-Descriptor, ChemSketch; Pharmacophore modeling by LigandScout; Lipinski's Rule of Five parameters; ADMET and Drug-likeness Prediction by SwissADME, pkCSM, ADMETlab. STRINGs for interaction studies.

TEXT BOOKS AND REFERENCES:

1. Wishart, D.S. et al., (2007). HMDB: The Human Metabolome Database. Nucleic Acids Research.
2. Dettmer, K., Aronov, P.A. and Hammock, B.D., (2007). Mass spectrometry-based metabolomics. Mass Spectrometry Reviews.
3. Gasteiger, J. and Engel, T. (Eds.), (2003). Chemoinformatics: A Textbook. Wiley-VCH.
4. Kitchen, D.B., Decornez, H., Furr, J.R. and Bajorath, J., (2004). Docking and scoring in virtual screening for drug discovery. Nature Reviews Drug Discovery.
5. Todeschini, R. and Consonni, V., (2009). Molecular Descriptors for Chemoinformatics (2nd ed.). Wiley-VCH.
6. Hopkins, A.L., (2008). Network pharmacology: the next paradigm in drug discovery. Nature Chemical Biology.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5271**					
TITLE OF THE COURSE	**INSTRUMENTATION AND PHYTOCHEMISTRY PRACTICALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To introduce students to fundamental biomolecular analysis techniques including spectrophotometry, chromatography, and electrophoresis.
- To train students in the qualitative and quantitative analysis of plant-derived phytochemicals using classical and modern biochemical techniques.
- To develop skills in designing and evaluating biochemical assays for antioxidant and antimicrobial activities of plant extracts.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to describe the principles and working mechanisms of UV spectrophotometry, SDS-PAGE, TLC, and centrifugation.	L2
CO2	Students will be able to apply appropriate extraction and separation methods (e.g., Soxhlet extraction, TLC, GC) for isolating phytochemicals and interpret results.	L3
CO3	Students will be able to analyze and evaluate antioxidant (FRAP assay) and antimicrobial assay results to determine biological activity.	L4

EXPERIMENTS:

1. Quantification of DNA, RNA and Proteins by UV spectrophotometer.
2. Determination of extinction coefficient of biomolecules using UV spectroscopy (Protein/DNA/RNA)
3. Separation of biomolecules amino acids using TLC.
4. Fractionation of blood using density gradient centrifugation.
5. Separation of proteins using SDS-PAGE and molecular weight determination.
6. Extraction of phytocompounds by cold/soxhelet method
7. Separation of plant pigments (secondary metabolites) using TLC or silica column chromatography
8. Qualitative analysis of phytocompounds.
9. Antioxidant activity by FRAP assay of plant extracts
10. Anti-microbial activity of plant extracts

11. Separation of active phytoconstituents using Gas Chromatography.

TEXT BOOKS AND REFERENCES:

1. Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology. 8th edition. Cambridge University Press.
2. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
3. Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. 3rd edition. Springer.
4. Scopes, R. K. (2013). Protein Purification: Principles and Practice. 3rd edition. Springer.
5. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. 3rd edition. New Age International Publishers.
6. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2015). Pharmacognosy. 50th edition. Nirali Prakashan.
7. Prior, R. L., Wu, X., & Schaich, K. (2005). Standardized Methods for the Determination of Antioxidant Capacity and Phenolics in Foods and Dietary Supplements. Journal of Agricultural and Food Chemistry, 53(10), 4290–4302.
8. Doughari, J. H. (2012). Phytochemicals as Antibacterials. In: Science against microbial pathogens: communicating current research and technological advances. Formatex Research Center.
9. Katoch, R. (2011). Analytical Techniques in Biochemistry and Molecular Biology, 1st Edition, Springer.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**25MBC5272**					
TITLE OF THE COURSE	**MOLECULAR AND APPLIED MICROBIOLOGY PRACTICALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To develop hands-on proficiency in key molecular biology techniques such as DNA/RNA isolation.
- To understand and apply recombinant DNA technology techniques in cloning such as PCR, restriction digestion, transformation, screening.
- To enable students to learn fundamental microbiological methods such as media preparation, culturing, and staining for identification and study of microorganisms.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Isolate and analyze** nucleic acids and proteins through various extraction, purification, and electrophoretic techniques	L4
CO2	This course will enable students to learn techniques which can be used to manipulate DNA, to amplify, propagate and express proteins in different host systems.	L5
CO3	Isolate and identify microorganisms using pure culture techniques, and differential staining.	L5

EXPERIMENTS:

1. Isolation of plant genomic DNA.
2. Isolation of animal genomic DNA.
3. Amplification of DNA using PCR and analysis by agarose gel electrophoresis.
4. Restriction digestion of vector/DNA.
5. Ligation of DNA fragments and its analysis
6. Preparation of competent *E. coli*. cells
7. Transformation plasmid in *E. coli* and screening of transformants.
8. Isolation of plasmid DNA from *E. coli* (mini-prep) and its analysis.
9. Preparation of culture media: autotrophic, heterotrophic, selective, enriched and differential culture media.
10. Isolation of pure culture by serial dilution and plating methods (streaking, pour plate, spread plate, slant and stab cultures)
11. Staining- simple, differential - Gram's staining.
12. Biochemical assays for microbial identification.

TEXT BOOKS AND REFERENCES:

1. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
2. Innis, M. A., & Gelfand, D. H. (1999). PCR Applications: Protocols for Functional Genomics. 1st edition. Academic Press.
3. Brown, T. A. (2016). Gene Cloning and DNA Analysis: An Introduction. 7th edition. Wiley-Blackwell.
4. Cappuccino, J. G., & Welsh, C. (2019). Microbiology: A Laboratory Manual. 12th edition. Pearson.
5. Pelczar, M. J., Chan, E. C. S., & Krieg, N. R. (2001). Microbiology: Application Based Approach. 5th edition. McGraw-Hill Education.
6. Gerhardt, P., Murray, R. G. E., Wood, W. A., & Krieg, N. R. (1994). Methods for General and Molecular Bacteriology. 1st edition. American Society for Microbiology Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5301**					
TITLE OF THE COURSE	**ENZYMOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To introduce the fundamental principles of enzyme structure, function, and classification, including the role of coenzymes and catalytic mechanisms.
- To impart an understanding of enzyme kinetics, inhibition, and regulatory mechanisms involved in biochemical processes.
- To familiarize students with enzyme purification methods, enzyme engineering techniques, and their applications in industry and clinical diagnostics.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Understand the structure, classification, and catalytic mechanisms of enzymes, including the role of coenzymes and cofactors.	L2
CO2	Translate the methods of enzyme extraction, purification, and evaluate their industrial and clinical applications, including enzyme engineering and biosensors.	L2
CO3	Apply principles of enzyme kinetics and inhibition to interpret enzymatic activity and regulatory mechanisms.	L4

COURSE CONTENT:

MODULE 1: INTRODUCTION OF ENZYMES — **14 Hrs**

Thermodynamics- 1st and 2nd law, Enthalpy, Entropy, Free energy, activation energy and transition state theory. Holoenzyme, Apoenzyme, coenzymes and cofactors, Theories of enzyme action. Enzyme classification- Enzyme Nomenclature and IUB system of enzyme classification. Monomeric, oligomeric and multifunctional enzymes.

Introduction of co-enzymes: Structure and functions –Thiamine pyrophosphate and flavin nucleotides, NAD/ NADP, coenzyme A, Pyridoxal phosphate and Carrier of one carbon group: tetrahydrofolate.

Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis, Proximity and orientation effects with examples.

MODULE 2: ENZYME KINETICS AND INHIBITION — **14 Hrs**

Order of reaction, progress curve for enzyme catalyzed reactions. Study of the factors affecting the velocity of enzyme catalyzed reaction - enzyme concentration, temperature, pH, inhibitors and activators (explanation with graphical representation), Michaelis Menten equation; Km and Vmax values and their significance, Lineweaver-Burk plot and its physiological significance.

Kinetics of Enzyme inhibition – competitive, non-competitive, uncompetitive and mixed. Allosteric and feedback inhibition with examples, suicide inhibition.

MODULE 3: ENZYME REGULATION	**14 Hrs**

Allosteric control of enzyme activity. Allosteric kinetics- MWC and KNF models, cooperativity and allostery in proteins. Regulation by covalent modification of enzymes with examples- Glycogen phosphorylase, Zymogen activation (Chymotrypsin). Isozymes- Lactate Dehydrogenase, Creatine phosphokinase, Alkaline phosphatase. Multienzyme system –mechanism of action of pyruvate dehydrogenase and fatty acid synthase complexes.

MODULE 4: EXTRACTION, PURIFICATION, INDUSTRIAL AND CLINICAL APPLICATION OF ENZYMES	**14 Hrs**

Large scale extraction and purification of enzymes- isolation, and purification of enzymes - Enzyme assays, criteria of purity. Enzyme engineering and site directed mutagenesis - case study, Designer enzymes. Immobilized enzymes in industrial processes. Biosensors.

Examples of Industrial Enzymes- Thermophilic enzymes, amylases, lipases, proteolytic enzymes in meat and leather industry, enzymes used in various fermentation processes, cellulose degrading enzymes, Metal degrading enzymes.

Examples of Clinical enzymes- Enzymes as thrombolytic agents, Anti-inflamatory agents, streptokinasae, asparaginase, Transaminases (AST, ALT), Amylases, Cholinesterases, Phosphatases.

TEXT BOOKS AND REFERENCES:

1. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry – Trevor Palmer & Philip Bonner 2nd Ed, (2008).
2. Biochemistry, Voet and Voet, 4th Ed, Wiley (2010).
3. Fundamentals of Enzymology- Nicholas C. Price & Lewis Stevens, 3rd Edition (2009).
4. Biophysical Chemistry Part II, Charles R. Cantor, Paul R. Schimmel, W.H. Freeman & Companys (2000).
5. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland, Wiley-VCH Publishers (2000).
6. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, Blackwell Science (2000).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5302**					
TITLE OF THE COURSE	**METABOLISM-II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	4	**0**	**-**	**-**	**56**	**4**

COURSE OBJECTIVES:

- To understand the biochemical pathways involved in amino acid, peptide, and nucleotide metabolism, including synthesis, degradation, and regulation mechanisms.
- To analyze the interrelationships between metabolic pathways and their physiological significance.
- To apply knowledge of metabolic processes to understand and diagnose related metabolic disorder.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to remember and understand key metabolic pathways and regulatory mechanisms of amino acids, peptides, and nucleotides.	L2
CO2	Students will be able apply concepts of metabolism to analyze metabolic disorders and their clinical implications.	L3
CO3	Students will be able to evaluate the impact of metabolic alterations on health and disease, and create strategies for managing metabolic disorders.	L4

COURSE CONTENT:

MODULE 1: AMINO ACIDS AND PEPTIDES	**14 Hrs**

General metabolic reaction of amino acids– transamination, deamination, oxidative and non-oxidative deamination, glucose – alanine cycle. Urea cycle– regulation. Biosynthesis of creatine and creatine phosphate, polyamines, Biogenic amines (seratonin, histamine, GABA, epinephrine, nor-epinephrine, dopamine, acetyl choline), Peptides- glutathione, Bradykinin, angiotensin, enkaplhin, oxytocin and vasopressin, leptin and ghrelin.

MODULE 2: METABOLISM OF STANDARD AMINOACIDS	**14 Hrs**

Regulation of amino acid and purine/pyrimidine levels by Glutamine Synthetase. Biosynthesis and degradation of standard amino acids - A, G, T, S, C, E, N, D, Q, R, H, P, V, I, M, L, K, W, F & Y.

MODULE 3: NUCLEOTIDE METABOLISM	**14 Hrs**

Nitrogen Cycle, nif genes. Structure of nucleoside and nucleotide; Synthesis of purine and pyrimidine nucleotides – the de novo and the salvage pathway and their regulation. Degradation of purine and pyrimidines and Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation.

MODULE 4: METABOLIC DISORDERS	**14 Hrs**
Disorders associated with nucleotide degradation: Gout, Lesch-Nyhan syndrome, adenosine deaminase defieciency, oroticaciduria, and xanthinuria. Disorders associated with amino acid metabolism: phenylketonuria, methyl malonic aciduria, maple syrup urine disease, alkaptonuria, homocystinuria, Jaundice, hepatitis. (cause, symptoms, diagnosis and treatment)	

TEXT BOOKS AND REFERENCES:

1. Vasudevan, D. M., Sreekumari, S., & Vaidyanathan, K. **(**2024). Textbook of Biochemistry for Medical Students. Jaypee Brothers Medical Publishers. 10th edition.
2. Naik, P. **(**2024). Essentials of Biochemistry. Jaypee Brothers Medical Publishers. 3rd edition.
3. Nelson, D. L., & Cox, M. M**. (**2021). Lehninger Principles of Biochemistry. W.H. Freeman and Company. 8th edition.
4. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. **(**2015). Stryer's Biochemistry. W.H. Freeman and Company. 8th edition.
5. Murray, R. K., Bender, D. A., Botham, K. M., Kennelly, P. J., & Rodwell, V. W. **(**2018). Harper's Illustrated Biochemistry. McGraw-Hill Education. 31st edition.
6. Wu, G. **(**2024). Amino Acids: Biochemistry and Nutrition. CRC Press. 2nd edition.
7. Ferrier, D. R. **(**2024). Lippincott Illustrated Reviews: Biochemistry. Wolters Kluwer. 2nd edition.
8. Harris, D. C. **(**2015). Quantitative Chemical Analysis. W.H. Freeman and Company. 9th edition.
9. Berg, J. M., Tymoczko, J. L., & Gatto, G. J. **(**2015). Biochemistry. W.H. Freeman and Company. 8th edition.
10. Stryer, L**. (**2012). Biochemistry. W.H. Freeman and Company. 7th edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5303**					
TITLE OF THE COURSE	**IMMUNOBIOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**42**	**3**

COURSE OBJECTIVES:

- To understand the foundational principles and components of the immune system.
- To analyze the mechanisms of immune response, regulation, and immune tolerance.
- To apply immunological techniques in diagnostic and research settings.
- To evaluate the clinical relevance of immunology in disease, therapy, and vaccination.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to explain the roles of innate and adaptive immunity, antigen-antibody interactions, and MHC in immune responses.	L2
CO2	Students will be able to analyse the development, activation, and regulation of B and T lymphocytes, along with hypersensitivity and autoimmune mechanisms.	L4
CO3	Students will be able to apply immunological methods such as ELISA, flow cytometry, and immunohistochemistry in laboratory diagnostics and research.	L3
CO4	Students will be able to evaluate immunological applications in vaccination, transplantation, immunodeficiencies, and cancer immunotherapy.	L5

COURSE CONTENT:

MODULE 1: FUNDAMENTALS OF IMMUNOLOGY	**14 Hrs**

Overview of the immune system, innate and adaptive immunity, cells and organs of the immune system, antigens and haptens, immunoglobulin structure and function, classes and subclasses of antibodies, antibody diversity and gene rearrangement, antigen-antibody interactions, affinity, avidity and specificity, precipitation and agglutination reactions, and the Major Histocompatibility Complex (MHC), including MHC Class I and II molecules and antigen presentation pathways.

MODULE 2: IMMUNE RESPONSE AND REGULATION	**14 Hrs**

B-cell and T-cell development, lymphocyte maturation and activation, clonal selection and expansion, T-cell receptor complex and signaling, cytokines and chemokines, mechanism of inflammation and its responses, the complement system including classical, alternative, and lectin pathways, immune tolerance and autoimmunity, central and peripheral tolerance, mechanisms of autoimmune diseases, and hypersensitivity reactions including Types I to IV.

MODULE 3: IMMUNOLOGICAL TECHNIQUES AND CLINICAL APPLICATIONS	**14 Hrs**

ELISA, Western blotting, flow cytometry and FACS, immunohistochemistry, immunofluorescence microscopy, radioimmunoassay, immunoprecipitation and co-immunoprecipitation, lymphocyte proliferation assays, cytokine profiling, and monoclonal antibody production. Vaccines and immunization, types of vaccines, adjuvants and delivery systems, immunization schedules, transplantation and immunology, graft rejection and immunosuppressive therapy, immunodeficiency disorders, HIV/AIDS immunopathogenesis, and cancer immunology and immunotherapy including checkpoint inhibitors and CAR-T cell therapy.

TEXT BOOKS AND REFERENCES:

1. Cellular and Molecular Immunology, 7th Ed.Abbas and Lichtman. Saunders Publishers (2011).
2. Immunology, 5th Ed, Golsby, Kindt, Osborne and Kuby. Freeman Publishers (2003).
3. Roitt's Essential Immunology, 12th Ed., Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Wiley-Blackwell (2011).
4. Medical Immunology made memorable, 2nd Ed., John H. L. Playfair and P.M. Lydyard, Churchill Livingstone Publications (2000).
5. Textbook of Immunology – Sai Leela K, Mohanty SK, Veerendra Reddy P. Jaypee Publishers (2007).
6. Cell and Molecular Biology: Concepts and Experiments, 7th Ed., Karp. Wiley & Sons (2013).
7. Molecular Cell Biology, 3rd Ed., by Harvey Lodish, David Baltimore and Arnold Berk, Scientific American Publishers (1995).

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5304**					
TITLE OF THE COURSE	**CELL SIGNALLING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**42**	**3**

COURSE OBJECTIVES:

- To understand the mechanisms by which extracellular ligands activate specific cell surface and intracellular receptors to initiate signal transduction.
- To explain the molecular control of the cell cycle and apoptosis, including the role of regulatory proteins and checkpoints.
- To analyze the signaling abnormalities involved in cancer and neurodegenerative diseases and evaluate their therapeutic implications.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to Identify and differentiate between major receptor types and their associated ligands and secondary messengers.	L1
CO2	Students will be able to apply knowledge of cell cycle and apoptotic signaling pathways to interpret how disruptions can lead to disease.	L3
CO3	Students will be able to evaluate the involvement of key signaling molecules and pathways in cancer progression and neurodegeneration.	L5

COURSE CONTENT:

MODULE 1: RECEPTORS AND THEIR LIGANDS — **14 Hrs**

Overview: autocrine, paracrine, endocrine signaling, Brief overview of endocrine organs and types of signaling molecules: hormones, neurotransmitters, growth factors, cytokines. General principles of signal transduction.

Cell surface receptor pathways: G-protein-coupled receptors (GPCRs) (ex: glucagon, muscarinic Ach), Ion channel-linked receptors (Ach). Intrinsic enzyme receptors: Receptor tyrosine kinases (RTKs) (eg: insulin), Serine threonine kinase receptors (TGF-β), Guanylyl cyclase receptors (membrane-bound: eg-ANF and soluble: eg-NO), Cytokine receptors (IL-1 and interferon receptors). Protein kinases and phosphatases.

Intracellular receptor pathways: Nuclear hormone receptors (eg: steroid hormones, thyroid and retinoic acid receptors).

Second messengers: cAMP, cGMP, IP3, DAG, Ca^{2+}, phosphoinositides, arachidonic acid.

MODULE 2: CELL CYCLE AND APOPTOSIS — **14 Hrs**

Cell Cycle: Phases of the eukaryotic cell cycle (G1, S, G2, M), Cell cycle regulators: Cyclins and cyclin-dependent kinases (CDKs), CDK inhibitors and role of ubiquitin. Entry of cell from G1-S (Rb protein regulation), G2 to M (Regulation of MPF), Cell cycle checkpoints (DNA replication and spindle-attachment checkpoints), Role of tumor suppressors (p53, Rb) in the cell cycle. role of mitogens.

Apoptosis: Overview of apoptosis and necrosis (morphological changes), structure and function of caspases, Molecular mechanisms of apoptosis: Intrinsic pathway (Role of Bcl-2 family proteins, cyt C, APAF-1) and extrinsic pathways **(Fas, TNF and TRAIL receptors).** Regulation and inhibition by IAPs and Smac/DIABLO. Signaling pathways regulating apoptosis [e.g. P^{53}(intrinsic), TNF/NF-κB (extrinsic), PI3K/AKT (anti-apoptotic), JNK(Pro-apoptotic)].

MODULE 3: MOLECULAR MECHANISMS IN DISEASE	**14 Hrs**

Cancer: Hallmarks of cancer and signal transduction deregulation. Oncogenic signalling pathways: Ras-MAPK pathway, PI3K-AKT-mTOR pathway, Wnt/β-catenin pathway, Notch and Hedgehog signaling. Role of signaling in metastasis and angiogenesis. Therapeutic targeting of signaling pathways (e.g., kinase inhibitors).

Neural disorders: Introduction to neurodegenerative diseases: Alzheimer's, Parkinson's, Huntington's. Cell signaling in neurodegeneration: Role of amyloid-β, tau, α-synuclein. Role of ER stress, oxidative stress, and mitochondrial dysfunction. Neurotrophic signaling and neuronal survival pathways (e.g., BDNF-TrkB) and dysregulation in disease.

TEXT BOOKS AND REFERENCES:

1. Alberts et al. (2023). Molecular Biology of the Cell, 7th Edition. Garland Science.
2. Cooper, G.M., Adams, K. (2022). The Cell: A Molecular Approach, 9th Edition. Sinauer/Oxford University Press.
3. Lodish et al. (2023). Molecular Cell Biology, 9th Edition. W.H. Freeman.
4. Bruce Alberts (2022). Essential Cell Biology, 5th Edition. Garland Science.
5. Signal Transduction, Bastien D. Gomperts et al. (2023). 3rd Edition. Academic Press.
6. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc. (2010).
7. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
8. Cell and Molecular Biology Concepts and experiment; 6th Edn., Gerald Karp; Wiley publications.
9. Dickson, D., & Weller, R.O. (2023) Neurodegeneration: The Molecular Pathology of Dementia and Movement Disorders, 3rd Edition, Wiley-Blackwell.
10. Brady, S.T., Siegel, G.J., Albers, R.W., & Price, D.L. (2022) Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology, 9th Edition, Academic Press

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5305**					
TITLE OF THE COURSE	**TOXICOLOGY AND REGULATORY CLINICAL RESEARCH**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**42**	**3**

COURSE OBJECTIVES:

- To understand the fundamental principles of toxicology and the dose-response relationship.
- To understand the mechanisms by which toxicants affect biological systems.
- To apply and evaluate regulatory frameworks and ethical principles governing clinical trials and drug safety.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to describe toxicological terms, agent types, exposure routes, and biological interactions.	L2
CO2	Students will be able to assess and differentiate organ-specific toxicities and interpret acute/chronic toxicity data.	L4
CO3	Students will be able to apply regulatory and ethical guidelines to the design, documentation, and monitoring of clinical trials.	L3

COURSE CONTENT:

MODULE 1: INTRODUCTION TO TOXICOLOGY	**14 Hrs**

General introduction, Chemical, biological, and physical agents, acute vs chronic toxicity,Threshold, LD50, and NOAEL concepts, Factors influencing toxicity (age, genetics, diet, etc.), Routes of Exposure, Mechanisms of Toxicity, ADME: Absorption, Distribution, Metabolism, Excretion. Interaction with biological systems. Hazard identification, dose-response, exposure assessment, risk characterization. Regulatory bodies (EPA, FDA, WHO).

MODULE 2: TOXIC SUBSTANCES, TARGET ORGANS AND TOXICITY STUDIES	**14 Hrs**

Food additives and contaminants, toxicity of pesticides, toxicity of metals, environmental pollutants, nanotoxicity, toxicological evaluation. General Concepts in Organ Toxicity -Target organ specificity, Factors influencing organ vulnerability, Role of metabolism and detoxification pathways. Hepatotoxicity, Nephrotoxicity, Neurotoxicity and Cardiotoxicity - Mechanism, toxicants and Biomarkers. Conventional toxicity studies - Acute, Short and long term.

MODULE 3: REGULATORY CLINICAL RESEARCH	**14 Hrs**

Overview of Clinical Trials: Clinical evaluation of new drug, phases of clinical trial, Preparation of clinical trial. Outline of new drug development process and drugs registration. Regulatory Perspectives of Clinical

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

TEXTBOOKS AND REFERENCES:

1. Casarett, L.J., Doull, J., Klaassen, C.D. (2013). Casarett and Doull's Toxicology: The Basic Science of Poisons. McGraw-Hill Education, 8th Edition.
2. Hayes, A.W., Kruger, C.L. (2021). Hayes' Principles and Methods of Toxicology. CRC Press, 7th Edition.
3. Eaton, D.L., Gilbert, S.G. (2008). Principles of Toxicology. CRC Press, 2nd Edition.
4. Gad, S.C. (2014). Toxicology for non-toxicologists. Academic Press, 3rd Edition.
5. Ballantyne, B., Marrs, T.C., Syversen, T. (2009). General and Applied Toxicology. Wiley-Blackwell, 3rd Edition.
6. Timbrell, J.A. (2008). Introduction to Toxicology. CRC Press, 4th Edition.
7. Hodgson, E. (2010). A Textbook of Modern Toxicology. Wiley, 4th Edition.
8. Tollefsen, K.E., Altenburger, R., Scholz, S. (2021). Environmental Toxicology. Springer, Latest Edition.
9. Kumar, A., Maiti, R. (2023). A Textbook of Clinical Research and Pharmacovigilance. CBS Publishers & Distributors, Latest Edition.
10. Gupta, S.K. (2022). Basic Principles of Clinical Research and Methodology. Jaypee Brothers Medical Publishers, 5th Edition.
11. ICH-GCP (E6 R2) (2016). International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use – Good Clinical Practice Guidelines.
12. Indian Council of Medical Research (ICMR) (2017). National Ethical Guidelines for Biomedical and Health Research Involving Human Participants. ICMR Publications, Latest Edition.
13. World Health Organization (WHO) (2021). Handbook for Good Clinical Research Practice (GCP). WHO Press, Latest Edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MSC5301**					
TITLE OF THE COURSE	**RESEARCH METHODOLOGY, SCIENTIFIC WRITING AND IPR**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	3	**0**	**-**	**-**	**42**	**3**

COURSE OBJECTIVES:

- Students will gain a comprehensive understanding of how to design and conduct research ethically and systematically.
- The course will develop students' ability to communicate research findings effectively through structured and impactful scientific writing.
- Students will learn the fundamentals of innovation protection, including the legal aspects of intellectual property and how to safeguard their work.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to understand and apply principles of research design and methodology.	L3
CO2	Students will be able to design and evaluate research methodologies, including data analysis and ethical considerations	L5
CO3	Students will be able to understand various forms of intellectual property and their legal significance apply ethical principles in research and publication.	L2

COURSE CONTENT:

MODULE 1: RESEARCH METHODOLOGY	**14 Hrs**

Objectives of research. Types of research. Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical. Research process. Criteria of good research. Developing a research plan. Defining the research problem. Techniques involved in defining the problem Survey of literature. Methods of data collection. Primary and secondary sources. Identifying gap areas from literature review. Development of working hypothesis. Testing of hypotheses.

Research design and methods. Features of good design. Time frame. Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan. Exploration, Description, Diagnosis, and Experimentation. Determining experimental and sample designs. Sampling – Steps, size determination and types. Good Laboratory Practices (GLP) and ethics- GLP Principles and SOP documentation.

MODULE 2: SCIENTIFIC WRITING	**14 Hrs**

Introduction to Scientific Writing- common types (articles, reports, reviews, thesis), Sources of scientific literature (PubMed, Scopus, Web of Science, Google Scholar). Structure of a Scientific Paper and Thesis, Literature Review and Referencing, Citation styles- APA and MLA styles of citation. Contents: Abstract, keywords, introduction, results, discussion, conclusion, Figures and Tables. Data Presentation- Effective visuals, legends, formatting, posters and oral presentations. Communication skills and handling Q&A.
Writing Research Proposals. Components of a research proposal. Budgeting and timelines. Tips for writing successful grant applications. Review and Publishing Process. Types of scientific journals and peer review process. Choosing a journal for submission. Dealing with reviewers' comments and revisions. Ethics in Scientific Writing- Plagiarism, authorship, data manipulation, conflict of interest, Peer Review and Publication Process- How to submit a paper, respond to reviewers, predatory journals.

MODULE 3: INTELLECTUAL PROPERTY RIGHTS AND PATENTS	**14 Hrs**

Introduction to Intellectual Property, Types of IPR (patents, copyrights, trademarks, trade secrets), Patents in Biological sciences - Patentability criteria, examples of Life science patents, Indian Patent Act, international treaties (TRIPS, WIPO), Pros and Cons of IP protection.
Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments. Patent Filing and Process- Steps of filing a patent (India and abroad), patent databases and search tools (e.g., WIPO, Espacenet). Prior art search. Types of patent applications. Licensing, IP management, technology transfer and commercialization, role of incubation centres and research institutions, Ethical and Legal Issues- Patent infringement- meaning, scope, litigation, case studies, Rights and Duties of patent owner. Agreements and Treaties: GATT, TRIPS Agreements; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions.

TEXT BOOKS AND REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002). An introduction to Research Methodology. RBSA Publishers.
2. Kothari, C.R. and Garg, G., (2019). Research Methodology: Methods and Techniques (4th ed.). New Age International Publishers.
3. Gurumani, N., (2016). Research Methodology for Biological Sciences (2nd ed.). MJP Publishers.
4. Hofmann, A.H., (2016). Scientific Writing and Communication: Papers, Proposals, and Presentations (2nd ed.). Oxford University Press.
5. Gastel, B. and Day, R.A., (2022). How to Write and Publish a Scientific Paper (9th ed.). Cambridge University Press.
6. Alley, M., (2018). The Craft of Scientific Writing (4th ed.). Springer.
7. Pandey, N. and Dharni, K., (2014). Intellectual Property Rights. PHI Learning Pvt. Ltd.
8. Mishra, J.P., (2012). An Introduction to Intellectual Property Rights. Central Law Publications.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5306**					
TITLE OF THE COURSE	**NUTRITION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**28**	**2**

COURSE OBJECTIVES:

- To understand the chemical composition of foods and the classification of essential nutrients.
- To analyze the biochemical functions and metabolic roles of macronutrients and micronutrients in human health.
- To evaluate the impact of diet and non-nutrient factors on clinical outcomes and nutritional disorders.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to classify and explain the roles of essential nutrients and their metabolism in the human body.	L1
CO2	Students will be able to analyze nutritional needs across life stages and identify symptoms of nutrient deficiencies and toxicities.	L2
CO3	Students will be able to evaluate dietary interventions and formulate appropriate nutrition strategies for clinical and public health settings.	L3

COURSE CONTENT:

MODULE 1: FOOD COMPOSITION	**14 Hrs**

Animal and vegetative foods – chemical composition; essential nutrients and their classification; digestibility, absorption, and biochemical functions of macronutrients. Carbohydrates – dietary requirements, proteins – nitrogen balance studies, determination of biological values of proteins, improvement of protein quality by supplementation and fortification, lipids – dietary needs, essential fatty acids. Calorific values of foods, basal metabolic rate and its determination. Factors influencing BMR. Vitamins – sources, physiological role and deficiency disorders of vitamins. A, D, E, K, vitamin C and B complex vitamins – thiamine, riboflavin, niacin, pantothenic acid, lipoic acid, pyridoxine, biotin, folic acid, and vitamin B12. Biological effects dietary fibre – physiological actions. Antinutrients – protease inhibitors, hemagglutinins, hepatotoxins, goitrogens, cyanogenic glucosides, methyl xanthines, oxalates; toxins from mushrooms.

MODULE 2: CLINICAL NUTRITION AND FOOD SAFETY	**14 Hrs**

Biological effects: food contaminants – hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins. Food additives – saccharin and sodium nitrite. Animal foods and seafoods.

Food allergy: role of allergens, diagnosis and management of food allergy.

Clinical nutrition: Food processing and loss of nutrients during processing and cooking, role of diet and nutrition in prevention of atherosclerosis, cardiovascular disorders and obesity. Role of leptin in regulation of body mass. Protein calorie malnutrition – kwashiorkor and marasmus; nutritional requirements for pregnant, lactating women and aged people. Functions and deficiency of minerals.

TEXT BOOKS AND REFERENCES:

1. Shils, M.E., Shike, M., Ross, A.C., Caballero, B., & Cousins, R.J. (2012). Modern Nutrition in Health and Disease (11th ed.). Lippincott Williams & Wilkins.
2. Gibney, M.J., Lanham-New, S.A., Cassidy, A., & Vorster, H.H. (2009). Introduction to Human Nutrition (2nd ed.). Wiley-Blackwell.
3. Srilakshmi, B. (2021). Nutrition Science (7th ed.). New Age International Publishers.
4. Gopalan, C., Rama Sastri, B.V., & Balasubramanian, S.C. (2012). Nutritive Value of Indian Foods. National Institute of Nutrition, Indian Council of Medical Research (ICMR).
5. Mahan, L.K., & Raymond, J.L. (2017). Krause's Food & the Nutrition Care Process (14th ed.). Elsevier.
6. Whitney, E., & Rolfes, S.R. (2019). Understanding Nutrition (15th ed.). Cengage Learning.
7. Wardlaw, G.M., & Smith, A.M. (2021). Contemporary Nutrition (11th ed.). McGraw Hill Education.
8. Indian Council of Medical Research (ICMR). (2020). Nutrient Requirements for Indians: Recommended Dietary Allowances and Estimated Average Requirements. ICMR-National Institute of Nutrition.
9. FAO/WHO. (2004). Vitamin and Mineral Requirements in Human Nutrition (2nd ed.). World Health Organization and Food and Agriculture Organization of the United Nations.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5307**					
TITLE OF THE COURSE	**BIOASSAY MODELS AND TECHNIQUES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
	2	**0**	**-**	**-**	**28**	**2**

COURSE OBJECTIVES:

- Understand the fundamental principles and techniques of in vitro and in vivo bioassays
- Develop skills in culturing primary cells and cell lines for biological testing.
- Analyse the applications of different bioassays in disease modelling and drug screening.
- Understand the ethical issues and advanced alternatives in animal research.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Describe the principles of bioassays and their significance in biomedical research.	L2
CO2	Illustrate the application of specific cell lines and primary cell culture for toxicity screening and disease modelling.	L2
CO3	Compare and contrast different in vivo models for biomedical research.	L3

COURSE CONTENT:

MODULE 1: PRINCIPLES AND IN VITRO BIOASSAY TECHNIQUES **14 Hrs**

Introduction to bioassays and their importance in various biological and pharmaceutical field. Primary cell cultures- Introduction, isolation and culturing protocols, Applications- Common examples- primary human peripheral blood mononuclear cells (PBMCs), primary rat hepatocytes (drug metabolism and liver toxicity testing), primary cortical neurons (neurodegenerative disease modelling).

Cell lines- Introduction and culturing protocols. Applications- Common examples- MCF-7 (for anticancer screening), HepG2 (for hepatotoxicity assessment), SH-SY5Y (for neurotoxicity and neuroprotection assays) and HEK293, CHO cells (for recombinant protein production).

Cell-based assays- MTT, Scratch, LDH, TUNEL assays, reporter gene assays (e.g., luciferase, GFP).

MODULE 2: IN VIVO MODELS AND APPLICATIONS **14 Hrs**

Commonly used laboratory animals such as mice, rats, zebrafish, rabbits, and alternative models like chick embryo, *Drosophila melanogaster* and *Caenorhabditis elegans*. The ethical principles and guidelines governing the use of animals in research, with specific attention to CPCSEA regulations.

Disease-specific *in vivo* models used in biomedical research- Cancer, Diabetes, Wound repair, Neurodegenerative disorders. Modern alternatives and innovations in animal model systems, including 3D organoid cultures, Microfluidic organ-on-chip systems, humanized mice, transgenic and knockout models.

TEXT BOOKS AND REFERENCES:

1. Freshney, R. I. (2016). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. John Wiley & Sons. 7th edition.
2. Chow, P. K. H. (2008). Using Animal Models in Biomedical Research: A Primer for the Investigator. World Scientific Publishing.
3. Conn, P. M. (2017). Animal Models for the Study of Human Disease. Academic Press. 2nd edition.
4. CPCSEA. Guidelines for the Care and Use of Laboratory Animals. Available at: https://cpcsea.nic.in
5. Venn, R. F. (2015). Principles and Practice of Bioanalysis. CBS Publishers. 2nd edition.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC5371**					
TITLE OF THE COURSE	**ENZYME KINETICS PRACTICALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To introduce students to the principles and methodologies used in enzyme assays and kinetics.
- To develop laboratory skills in the preparation, handling, and quantification of enzymes.
- To enable students to interpret enzyme activity data, including parameters like Km and Vmax, through various experimental approaches.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to identify and explain the role of enzymes and their characteristics using standard laboratory protocols.	L2
CO2	Students will be able to perform enzyme activity assays and calculate kinetic parameters such as Km and Vmax using Lineweaver-Burk and Michaelis-Menten plots.	L3
CO3	Students will be able to design and troubleshoot enzyme-based experiments, interpret the results accurately, and report findings in a scientific format.	L4

EXPERIMENTS

1. Product conc. determination (by standard curve/extinction coefficient).
2. Isolation of enzyme (phosphatase/esterase) from biological source and activity determination through time curve.
3. Effect of pH on enzyme activity.
4. Effect of temperature on enzyme activity.
5. Determination of Arrhenius constant.
6. Determination of kinetic constants through LB plot.
7. Effect of activators and inhibitors on enzyme activity.
8. Partial purification of enzyme by ammonium sulphate precipitation/acetone precipitation.
9. Determination of total activity, specific activity and fold purification of partially purified enzyme.
10. Visualization of purified sample by SDS – PAGE.

TEXT BOOKS AND REFERENCES:

1. Palmer, T., & Bonner, P. (2007). Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Woodhead Publishing.

2. Price, N. C., & Stevens, L. (2011). Fundamentals of Enzymology. Oxford University Press.
3. Plummer, D. T. (1987). An Introduction to Practical Biochemistry. McGraw-Hill.
4. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**25MBC572**					
TITLE OF THE COURSE	**IMMUNOTECHNIQUES AND TOXICOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar / Projects Hours	Total Hours	Credits
		0	**6**	**-**	**72**	**3**

COURSE OBJECTIVES:

- To familiarize students with the principles and protocols of common immunological techniques such as ELISA, immunodiffusion, and immunoelectrophoresis.
- To provide hands-on training in techniques used to evaluate the toxicological effects of chemicals and biological agents
- To enable students to analyze and interpret experimental data obtained from immunological assays and toxicity tests.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students will be able to explain the working principles and applications of immunotechniques such as ELISA, agglutination, and immunoblotting.	L2
CO2	Students will be able to demonstrate the ability to perform basic immunological and toxicological assays, such as ELISA and colorometric estimations.	L3
CO3	Students will be able to critically analyze the results of immunoassays and toxicology experiments.	L4

EXPERIMENTS:

1. Serum Separation from whole blood and isolation of immunoglobulins from serum.
2. Study of different cells in whole blood using Giemsa/Leishman stain.
3. ELISA/Dot ELISA
4. Radial Immunodiffusion/Ouchterlony Double Diffusion
5. Rocket Immuno Electrophoresis
6. WIDAL/RPR Test
7. Determination of toxicity of heavy metal/toxicant on seed germination.
8. Evaluation of acute toxic effect of soft drinks on earthworms.
9. Determination of lead concentration in water by titrimetric method
10. Determination of mercury in fish tissue.
11. Determination of organophosphate toxicity on chick embryo model.

TEXT BOOKS AND REFERENCES:

1. Owen, J. A., Punt, J., & Stranford, S. A. (2022). Kuby Immunology (9th ed.). W. H. Freeman and Company.
2. Roitt, I. M., Brostoff, J., & Male, D. K. (2021). Roitt's Essential Immunology (14th ed.). Wiley-Blackwell.
3. Hudson, L., & Hay, F. C. (2017). Practical Immunology (4th ed.). Wiley-Blackwell.
4. Klaassen, C. D., & Watkins, J. B**.** (2021). Casarett and Doull’s Essentials of Toxicology (3rd ed.). McGraw-Hill Education.
5. Timbrell, J. A**.** (2021). Principles of Toxicology (5th ed.). CRC Press.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**25MSC5401**					
TITLE OF THE COURSE	**PROJECT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**40**	**-**	**14**

OBJECTIVES

- Construct a project from Plan, schedule, monitor and control students' own work and to exhibit ideas in discussions and presentations.
- Apply tools and techniques to the applied courses taught and to communicate their findings through a written report and poster presentation.

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To identify and define research problems relevant to life sciences and develop innovative solutions.	L2
CO2	To review and interpret scientific literature to support research objectives and design experiments using appropriate methodologies and techniques.	L3
CO3	To conduct independent laboratory/field research ethically and systematically and analyze and interpret experimental data using statistical tools.	L5
CO4	To communicate research findings effectively through thesis writing and presentations.	L6
CO5	To equip the students with hands-on training in Basic and applied sciences which prepares students for productive careers in Industries.	L5