PERIYAR UNIVERSITY

SALEM – 636011

DEGREE OF MASTER OF SCIENCE

(CHOICE BASED CREDIT SYSTEM)

M.Sc. BIOCHEMISTRY

OBE REGULATIONS AND SYLLABUS

SEMESTER PATTERN

(For Candidates admitted in the Colleges affiliated to

Periyar University from 2026-2027 onwards)

REGULATIONS

1. PREAMBLE AND OBJECTIVES OF THE COURSE

The Master of Science in Biochemistry is designed to provide advanced knowledge of the molecular basis of life and to integrate concepts from chemistry, biology, and biotechnology. Biochemistry plays a pivotal role in understanding cellular processes, genetic regulation, metabolism, and disease mechanisms. The program emphasizes both theoretical foundations and practical applications, preparing graduates for careers in research, industry, healthcare, and academia. With a strong focus on interdisciplinary learning, critical thinking, and innovation, the program nurtures intellectual independence, ethical responsibility, and lifelong learning, enabling students to contribute meaningfully to scientific advancement and societal development.

The Primary objectives of M.Sc. Biochemistry are

- **Knowledge Integration:** To provide students with a comprehensive understanding of biochemical principles, molecular biology, and biotechnology.
- **Research Competence:** To train students in modern experimental techniques, data analysis, and independent research methodologies.
- **Critical Thinking:** To develop analytical and problem-solving skills for addressing complex biological phenomena.
- **Professional Skills:** To equip students with communication, teamwork, and leadership abilities essential for scientific and industrial environments.
- **Applied Knowledge:** To enable application of biochemical concepts in diagnostics, drug development, clinical chemistry, and industrial biotechnology.
- **Ethics and Lifelong Learning:** To instil professional ethics, social responsibility, and a commitment to continuous learning.
- **Entrepreneurship:** To encourage innovation and self-employment opportunities in biotechnology, healthcare, and allied sectors.

2. GENERAL GRADUATE ATTRIBUTES

Graduates of the **M.Sc. Biochemistry program** are expected to develop a blend of disciplinary knowledge, professional skills, and ethical values. These attributes ensure that students are not only academically competent but also capable of contributing meaningfully to research, industry, and society.

- **Comprehensive disciplinary knowledge:** Ability to demonstrate a deep and systematic understanding of biochemical principles, theories, and experimental findings.
- **Effective communication skills:** Capacity to articulate scientific ideas clearly and concisely in both written and oral formats.
- **Critical and reflective thinking:** Skill to analyze, interpret, and evaluate scientific data while reflecting on outcomes for continuous improvement.
- **Problem-solving and analytical reasoning:** Competence to apply biochemical knowledge to real-world challenges and design evidence-based solutions.
- **Research and data interpretation skills:** Ability to design experiments, collect and analyze data, and draw valid scientific conclusions.
- **Teamwork and cooperation:** Capability to collaborate effectively in interdisciplinary and group research settings.
- **Scientific reasoning and digital literacy:** Skill to evaluate scientific evidence logically and use ICT tools for data analysis and communication.
- **Self-directed and lifelong learning:** Motivation to pursue independent learning and adapt to new scientific developments.
- **Moral and ethical awareness:** Commitment to uphold integrity, honesty, and ethical practices in research and professional work.
- **Leadership readiness:** Ability to guide teams, manage projects, and inspire peers towards achieving scientific and professional goals.

3. PROGRAM-SPECIFIC QUALIFICATION ATTRIBUTES

The program emphasizes intellectual development through progressive levels of cognitive skills, based on Bloom's taxonomy. These attributes ensure that graduates not only acquire knowledge but also develop the ability to apply, analyze, evaluate, and synthesize information in Biochemistry and related fields.

- **Knowledge and Understanding (K1–K2):** Ability to recall, comprehend, and explain fundamental concepts, theories, and principles in Biochemistry.
- **Application (K3):** Skill to apply acquired knowledge to practical situations, laboratory experiments, and real-world biochemical problems.
- **Analytical Ability (K4):** Competence to break down complex biochemical processes, interpret data, and identify relationships among variables.
- **Evaluation Capability (K5):** Capacity to critically assess scientific evidence, experimental outcomes, and theoretical models to make informed judgments.
- **Scientific Synthesis (K6):** Ability to integrate knowledge from diverse areas, design innovative experiments, and propose new hypotheses or applications in Biochemistry.

4. PROGRAMME OUTCOMES – M.Sc., BIOCHEMISTRY

On successful completion of the program, students will be able to:

PO Number	Programme Outcome	Description
PO1	**Comprehensive Knowledge**	Demonstrate systematic and coherent understanding of major concepts, theoretical principles, and experimental findings in Biochemistry.
PO2	**Emerging Skills**	Acquire competencies in areas related to current and evolving developments in molecular biology, biotechnology, and clinical Biochemistry.
PO3	**Problem-Solving Ability**	Identify, analyze, and apply appropriate biochemical principles and methodologies to address diverse scientific and industrial challenges.
PO4	**Effective Communication**	Present research findings and scientific concepts clearly and accurately in both written and oral formats across academic and professional contexts.

PO Number	Programme Outcome	Description
PO5	**Experimental Competence**	Plan, design, and execute experiments, analyze data rigorously, and interpret results in relation to relevant biochemical theories.
PO6	**Critical Thinking**	Employ logical reasoning, scientific inquiry, and efficient problem-solving skills in core and applied areas of Biochemistry.
PO7	**Generic and Transferable Skills**	Demonstrate investigative, analytical, ICT, and teamwork skills, with the ability to work independently or collaboratively.
PO8	**Professional Ethics**	Uphold integrity, honesty, and ethical practices in research and professional work, while contributing responsibly to society.
PO9	**Lifelong Learning**	Cultivate self-directed learning habits, adaptability to new scientific advancements, and continuous personal and professional growth.
PO10	**Leadership & Social Responsibility**	Exhibit leadership qualities, guide teams effectively, and apply biochemical knowledge to address issues of societal and environmental importance.

5. PROGRAMME SPECIFIC OUTCOMES – M.Sc. BIOCHEMISTRY

PSO Number	Programme Specific Outcome	Explanation
PSO1	**Core Knowledge**	Acquire essential knowledge and skills in the fundamental themes, principles, and components of biochemistry.
PSO2	**Cellular & Molecular Understanding**	Demonstrate a clear understanding of biochemical processes at the cellular and molecular levels.
PSO3	**Integration of Techniques**	Apply and integrate biochemical techniques across diverse scientific fields, comparing and contrasting their depth and scope.
PSO4	**Applied Biochemistry**	Analyze and apply biochemical concepts in diagnostics, pathway regulation, and drug development, with practical applications in laboratory settings.
PSO5	**Entrepreneurship & Innovation**	Develop knowledge and skills that enable self-employment, entrepreneurship, and innovation in biotechnology, healthcare, and allied sectors.

6. CONDITION FOR ADMISSION

Candidates who have passed a **B.Sc. degree in Biochemistry, Chemistry, Nutrition, Nutrition and dietetics, Microbiology, Biotechnology, Genetics, Botany, Zoology, or equivalent disciplines are eligible. Graduates of Medical Laboratory Technology / Clinical Laboratory Technology** or equivalent B.Sc. programs recognized by the University Syndicate may also be admitted.

7. DURATION OF THE COURSE

The program extends over **two academic years**, divided into **four semesters**.

8. COURSE OF STUDY

The curriculum includes:

- **Core: Biochemistry**
- **Core practical**
- **Elective**
- **Skill Enhancement Course**
- **Non-Major Elective Course**
- **Human Rights**
- **Internship**
- **Project with Viva Voce**
- **Extension Activity**

Note: The **Non-Major Elective Course** is chosen in the **Second and Third semester** from other Departments by the respective colleges and must be communicated to the University.

9. EXAMINATIONS

- **Four semester examinations**: Two in the First Year, Two in the Second Year.
- **Schedule:**
  - I & III semesters → November/December
  - II & IV semesters → April/May
- **Practical Examinations:**
  - Practicals I→ Semester I
  - Practicals II → Semester II
  - Practicals III → Semester III
- **Internship:** will be carried out during the summer vacation of the first year and credit will be added in the Third Semester Mark Statement
- **Project and Viva Voce:** Conducted in Semester IV, with dissertation submission and Viva-Voce Examination**.**

Note: Candidates who fail in one or more subjects may reappear for those subjects in subsequent examinations until they secure the required pass marks.

10. PASSING MINIMUM

A minimum of 50% marks is required in each paper/practical. Practical pass marks include record notebook evaluation. Submission of a record notebook is mandatory, though no minimum marks are prescribed for it.

11. GRADING SYSTEM

Evaluation follows a **Ten-Point scale:**

Marks Range	Grade Points	Letter Grade	Description
90–100	9.0–10.0	O	Outstanding
80–89	8.0–8.9	D+	Excellent
75–79	7.5–7.9	D	Distinction
70–74	7.0–7.4	A+	Very Good
60–69	6.0–6.9	A	Good
50–59	5.0–5.9	B	Average
00–49	0.0	U	Re-appear
Absent	0.0	AAA	Absent

12. RANKING

Only candidates who pass all examinations in the **first attempt within two academic years** are eligible for University Ranking.

13. MAXIMUM DURATION

The maximum duration for completion of the PG Programme **shall not exceed EIGHT semesters.**

14. COMMENCEMENT OF REGULATION

These regulations shall come into force from the academic year **2026–2027** and will apply to all students admitted to the first year of the M.Sc. Biochemistry program during that academic year and thereafter**.**

15. TRANSITORY PROVISION

Candidates admitted before **2023–2024** may appear under the old regulations until **April/May 2027**. After this period, they must follow the regulations then in force.

16. NON – MAJOR ELECTIVE COURSE (NME)

The papers offered to students from other disciplines as NME course by the PG Biochemistry board

Semester II : Biochemistry of Nutrition and Nutraceuticals – Page No: 67

Semester III : Environmental Biochemistry – Page No: 70

17. PATTERN OF QUESTION PAPER – THEORY (CORE, ELECTIVE, SEC, AND NME)

Time: Three Hours **Maximum: 75 marks**

Part – A (15 x 1 = 15 marks)

Answer **ALL** the questions

(Multiple Choice Questions- Three questions from each unit)

(a), (b), (c), (d) Multiple Choice

Part – B (2 x 5 = 10 marks)

Answer any **TWO** questions out of **FIVE**

(One question from each unit)

PART – C (5 x10 = 50 marks)

Answer **ALL** the questions

Either (or) Type **FIVE** questions

(Internal choice from same unit)

18. PATTERN OF QUESTION PAPER AND MARK DISTRIBUTION FOR PRACTICAL EXAMINATION

Question Paper pattern:

- Two experiments - (Internal Choice questions)
  (Experiment I – 25 marks, Experiment II – 20 marks)
- Spotters, Record, Viva included Compulsorily

External Mark Distribution:

Content	Exp I (25 Marks)	Exp II (20 Marks)
Principle	5	5
Procedure	5	5
Table/Graph	5	–
Observation/Calculation	5	5
Result	5	5
Total (Exp I and II)	**25**	**20**

Content	PRACTICAL EXTERNAL MARK DISTRIBUTIONS (60)
Exp I + II	**45**
Spotters	**5**
Record	**5**
Viva	**5**
TOTAL PRACTICAL EXTERNAL MARKS	**60**

19. RESEARCH EVALUATION

S.No.	Particulars	Marks	Examiners
1	**Dissertation**	30%	Internal Examiner
		30%	External Examiner
2	**Viva-voce**	20%	Internal Examiner
		20%	External examiner

20. INTERNAL MARK DISTRIBUTION

For Theory (25 marks)

Content	Internal (25)
Test Marks	10
Assignment	5
Seminar	5
Attendance	5
Total	**25**

For Practical (40 marks)

Content	Internal (40)
Record	10
Model Exam	10
Observation note	10
Attendance	10
Total	**40**

COURSE OF STUDY AND SCHEME OF EXAMINATION

S.No	Semester	Paper Code	Part	Course Group	Paper Type	Subject Title	Hours / Week	Exam Hours	Internal Marks	External Marks	Total Marks	Credit	Page No.
1	I		I	Core I	Theory	Chemistry of Biomolecules	6	3	25	75	100	5	**1**
2	I		I	Core II	Theory	Biochemical Techniques	6	3	25	75	100	5	**4**
3	I		I	Core III	Theory	Enzymology and Enzyme Technology	6	3	25	75	100	5	**7**
4	I		I	Core – Practical – I	Practical	Biochemical Techniques and Enzymology	6	6	40	60	100	4	**10**
5	I		II	Elective – I	Theory	A) Nutritional Biochemistry / B) Medical Lab Technology **Note: Choose any one Elective paper**	4	3	25	75	100	3	**13 / 16**
6	I		II	SEC – I	Theory	Tissue culture	2	3	25	75	100	2	**19**
7	II		I	Core IV	Theory	Intermediary Metabolism	6	3	25	75	100	5	**22**
8	II		I	Core V	Theory	Cell and Molecular Biology	6	3	25	75	100	5	**25**
9	II		I	Core VI	Theory	Plant Biochemistry and Biotechnology	6	3	25	75	100	5	**28**
10	II		I	Core – Practical – II	Practical	Cell and Molecular Biology	5	6	40	60	100	4	**31**
11	II		II	Elective – II	Theory	A) Cancer Biology / B) Biosafety, Lab Safety and IPR **Note: Choose any one Elective paper**	4	3	25	75	100	3	**34 / 37**
12	II		II	NMEC - I	Theory	Choose from other departments	2	3	25	75	100	2	-
13	II		III	Common Paper	Theory	Human Rights	1	3	25	75	100	1	-
14	III		I	Core VII	Theory	Clinical Biochemistry	6	3	25	75	100	5	**40**
15	III		I	Core VIII	Theory	Human Physiology and Endocrinology	6	3	25	75	100	5	**43**
16	III		I	Core IX	Theory	Genetic Engineering	6	3	25	75	100	5	**46**

17	III		I	Core – Practical – III	Practical	Clinical Biochemistry and Genetic Engineering	6	6	40	60	100	4	**49**
18	III		II	Elective – III	Theory	A) Phytochemistry/ B) Microbial Biochemistry **Note: Choose any one Elective paper**	4	3	25	75	100	3	**52 / 55**
19	III		II	NMEC - II	Theory	Choose from other departments	2	3	25	75	100	2	**-**
20	III		II	Common		Internship – Clinical Laboratory or Pharma Industry	-	-	Commended/Highly Commended			1	**-**
21	IV		I	Core X	Theory	Immunology and Immunotechnology	6	3	25	75	100	5	**58**
22	IV		I	Core XI	Theory	Biochemical Pharmacology and Toxicology	6	3	25	75	100	5	**61**
23	IV		I	Core PR	Project	Project and Viva Voce	16	-	40	60	100	5	**-**
24	IV		II	SEC – II	Theory	Stem Cell Biology	2	3	25	75	100	2	**64**
25	IV			Common	-	Extension Activity	-	-	-	-	-	1	**-**
TOTAL							**120**					**92**	

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

CORE – I – CHEMISTRY OF BIOMOLECULES

Course Objectives

- To study carbohydrates in terms of classification, structure, properties, and biological roles.
- To understand lipids including fatty acids, sterols, eicosanoids, amphipathic lipids, and lipoproteins.
- To learn amino acids and proteins covering sequencing methods, structural motifs, and organization at different levels.
- To explore nucleic acids focusing on DNA and RNA structures, conformations, and functional properties.
- To examine vitamins and minerals with emphasis on their biochemical significance and physiological functions.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall and explain the classification, structure, functions, and physicochemical properties of carbohydrates, glycoproteins, proteoglycans, and peptidoglycans.	K1 – Remembering / K2 – Understanding
CO2	Analyze lipid diversity, fatty acid types, amphipathic lipids, sterols, eicosanoids, and lipoproteins in relation to membrane biology and signalling.	K4 – Analyzing
CO3	Apply knowledge of amino acid chemistry and protein structural organization to interpret sequencing methods, folding patterns, and structural motifs.	K3 – Applying
CO4	Evaluate nucleic acid structures, DNA conformations, RNA classes, and their physicochemical properties in relation to genetic information storage and regulation.	K5 – Evaluating
CO5	Create integrative models linking vitamins and minerals with biomolecular functions, emphasizing their biochemical and physiological significance.	K6 – Creating

Unit I - Carbohydrates: Classification, Structure, functions, physical and chemical properties of Monosaccharides, Disaccharides; N-linked, O-linked and GPI linked oligosaccharides, glycoproteins structure, function and recognition, Polysaccharides; Homo & hetero polysaccharides, Bacterial Cell wall Polysaccharides. Structure, location and biological role of Proteoglycans (Glycosaminoglycans) and peptidoglycans.

Unit II - Lipids: Classification, structure, function, physical and chemical properties of lipids. Fatty acids - saturated, unsaturated and hydroxyl fatty acids. Amphipathic lipids- micelles, emulsion, liposomes. Lipids in cell membrane, Diversity of biological membranes. Sterols – Structure, Properties and functions of cholesterol. Eicosanoids - Structure and biological role of Prostaglandins, Leukotrienes, Prostacyclins, Thromboxanes and lipoxins. Lipoproteins classification and functions.

Unit III - Aminoacids and Proteins: Classification, structure, properties (physical and chemical) of amino acids and proteins. Amino acid sequencing, Ramachandran plot, Peptide bond link. Polypeptide synthesis. Protein sequencing (Sanger's method & Edmand reaction), Dansyl chloride protein degradation and evolution. Proteins: Primary structure, secondary structure: α- helix, β-sheets & turns, Keratin: Coil, Collagen-Triple helix, fibrous protein secondary structure, Tertiary structure: Super secondary structures; β α β motifs, - heparin**,** αα motif, Greek Key motif. Quaternary Structure: Structure and functions of Hb, actin, myosin, elastin.

Unit IV - Nucleic Acids: DNA: Physical (Buoyant density, viscosity) and chemical properties (renaturation and denaturation). Structure of nitrogenous bases, nucleosides, nucleotides, DNA Double helix - Watson & Crick model of DNA, Other forms; A, B and Z DNA, Triple helix, Palindromes, Inverse repeats, cruciform and hairpins & quadruplex structures, Cot value. Histone proteins, chromatin and non-histone proteins. Miscellaneous alternative confirmation of DNA - slipped mispaired DNA, parallel stranded DNA and anisomorphic DNA. **RNA** Classes; mRNA, tRNA and rRNA, hnRNA, SnRNA, miRNA structure and functions.

Unit V - Vitamins and Minerals: Classification, structure and function of fat soluble and water soluble vitamins (including antioxidant properties). Minerals of biological significance: Na, K, Ca, Mg, Mn, P, Fe, Cu, I, Zn, Se, CO.

Reference Books

Title	Authors	Edition	Year	Publisher
Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	8th	2021	W.H. Freeman
Biochemistry	Donald Voet, Judith G. Voet	5th	2018	Wiley
Biochemistry	Reginald H. Garrett, Charles M. Grisham	6th	2017	Cengage Learning
Molecular Biology of the Cell	Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter	6th	2015	Garland Science
Biochemistry	Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer	8th	2019	W.H. Freeman
Principles of Biochemistry	Horton, Moran, Scrimgeour, Perry, Rawn	5th	2011	Pearson
Harper's Illustrated Biochemistry	Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, Anthony Weil	31st	2018	McGraw Hill

🌐 Web Resources

- NCBI Bookshelf – Biochemistry Texts (ncbi.nlm.nih.gov in Bing) PubChem – Biomolecular Data (pubchem.ncbi.nlm.nih.gov in Bing)
- Protein Data Bank (PDB)
- ScienceDirect – Biochemistry Journals (sciencedirect.com in Bing) EMBL-EBI – Bioinformatics Resources
- Khan Academy – Biomolecules (khanacademy.org in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	1	2	1	2	2	2
CO2	3	3	2	3	2	2	2	2	3	2
CO3	3	3	2	2	2	3	3	2	2	2
CO4	3	2	2	3	3	2	2	2	2	3
CO5	3	3	3	3	3	2	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

CORE – II – BIOCHEMICAL TECHNIQUES

Course Objectives

- To understand the principles and applications of buffers, dialysis, viscosity, and microscopy including advanced electron microscopy methods.
- To acquire knowledge of chromatographic and electrophoretic techniques for biomolecule separation and analysis.
- To analyze spectroscopic methods such as UV, IR, NMR, ESR, mass spectrometry, and atomic absorption for biomolecular characterization.
- To evaluate centrifugation principles and applications in subcellular fractionation, molecular weight, and density determination.
- To apply radioisotope techniques, circular dichroism, and X-ray diffraction in biochemical and structural research.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Explain buffer systems, dialysis, viscosity, and microscopy principles including electron microscopy.	K2 – Understanding
CO2	Apply chromatographic and electrophoretic techniques for biomolecule separation and analysis.	K3 – Applying
CO3	Analyze spectroscopic methods including UV, IR, NMR, ESR, and mass spectrometry for biomolecular characterization.	K4 – Analyzing
CO4	Evaluate centrifugation techniques for subcellular fractionation and molecular property determination.	K5 – Evaluating
CO5	Integrate radioisotope techniques, circular dichroism, and X-ray diffraction in biochemical and structural research.	K6 – Creating

Unit I – Buffers and Microscopy: Buffers: Definition, determination of pH, Henderson–Hasselbalch equation. Dialysis, surface tension, and viscosity. Microscopy: Principle and instrumentation of light, bright field, phase contrast, and fluorescence microscopes. Electron microscopy: TEM, SEM, AFM – principles and specimen preparation. Organ and tissue slice technique. Microtomy: staining and fixation.

Unit II – Chromatography and Electrophoresis: Chromatography: Fundamental concepts, types, principles, instrumentation, and applications of paper chromatography, thin layer chromatography, ion-exchange chromatography, molecular sieving, affinity chromatography, adsorption chromatography, gas–liquid chromatography, HPLC, and FPLC. Electrophoresis: Separation methods and fundamental concepts. Types, principles, instrumentation, and applications of paper electrophoresis, gel electrophoresis (starch, agarose, polyacrylamide), SDS-PAGE, native gel electrophoresis, isoelectric focusing, pulse-field electrophoresis, and capillary electrophoresis.

Unit III – Spectroscopy: Flame and flameless spectrophotometry and fluorimetry: basic principles, instrumentation, and applications. UV, visible, and FT-IR spectrophotometers: principles, instrumentation, and applications. Basic principles of NMR, mass spectrometry, and ESR: types and applications. Instrumentation and applications of atomic absorption spectroscopy and luminometry.

Unit IV – Centrifugation: Sedimentation: principles and instrumentation of low-speed and high-speed centrifuges. Types of rotors. Types of centrifugation: ultracentrifuge, analytical and preparative centrifuges with applications. Ultracentrifuge instrumentation and applications in molecular weight and density determination. Density-gradient centrifugation: rate-zonal and isopycnic types. Subcellular fractionation, cellular disruption, homogenization, and extraction of membrane-bound proteins.

Unit V – Radioisotopes and Structural Methods: Radioisotopes: stable and radioactive isotopes, units of radioactivity, detection, quantification, and measurement using GM counter, liquid and solid scintillation counters, and autoradiography. Radiation hazards and safety measures. Diagnostic and therapeutic uses of radioactive isotopes. Applications in DNA, RNA, and protein isolation. Applications in biological research. Circular dichroism (CD): principle, theory of operation, and applications. X-ray diffraction: principle, theory of operation, and applications.

Reference Books

Title	Authors	Edition	Year	Publisher
Principles and Techniques of Biochemistry and Molecular Biology	Keith Wilson, John Walker	7th	2010	Cambridge University Press
Biophysical Chemistry (Parts I–III)	Charles R. Cantor, Paul R. Schimmel	1st	1980	W.H. Freeman
Biochemistry Laboratory: Modern Theory and Techniques	Rodney F. Boyer	2nd	2011	Pearson
Practical Biochemistry	Harold Varley	4th	1988	CBS Publishers
Biochemical Techniques: Theory and Practice	John F. Robyt, Bernard J. White	1st	1987	Waveland Press
Biochemistry	Debajyoti Das	19th	2019	Academic Publishers, India
Biochemistry	U. Satyanarayana, U. Chakrapani	5th	2017	Books & Allied Pvt. Ltd.

🌐 Web Resources

- AIIMS Free Course – Analytical Techniques in Biochemistry (SWAYAM) (classcentral.com in Bing)
- Zenodo – Comprehensive Review of Fundamental Biochemical Techniques
- ScienceDirect – Trends in Biochemical Sciences (sciencedirect.com in Bing)
- PubMed – Biochemical Techniques Articles (pubmed.ncbi.nlm.nih.gov in Bing)
- NCBI Bookshelf – Biochemical Methods (ncbi.nlm.nih.gov in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	2	2	1	2	2	2
CO2	3	3	2	3	3	2	2	2	3	2
CO3	3	3	2	3	3	2	2	2	2	3
CO4	3	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

CORE – III – ENZYMOLOGY AND ENZYME TECHNOLOGY

Course Objectives

- To understand enzyme fundamentals, classification, and turnover.
- To apply kinetic principles and catalytic mechanisms in enzyme studies.
- To analyze enzyme regulation, inhibition, and allosteric control.
- To evaluate multi-enzyme complexes, immobilization techniques, biosensors, and enzyme technology.
- To integrate enzyme applications in industry, medicine, biotechnology, and engineering.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Explain enzyme fundamentals, classification, turnover, and methods of extraction and purification.	K2 – Understanding
CO2	Apply enzyme kinetics principles (MM equation, LB plot, Hofstee plot) and catalytic mechanisms including coenzymes and metalloenzymes.	K3 – Applying
CO3	Analyze enzyme regulation, inhibition kinetics, and allosteric control using Hill's equation and Scatchard plot.	K4 – Analyzing
CO4	Evaluate multi-enzyme complexes, immobilization techniques, and biosensor applications in enzyme technology.	K5 – Evaluating
CO5	Integrate enzyme applications in industry, diagnostics, therapeutics, biotechnology, and enzyme engineering.	K6 – Creating

Unit I – Enzyme Fundamentals: Factors affecting rate of reactions: activation energy, transition state theory, and catalysis. IUB classification and nomenclature. Intracellular location of enzymes. Enzyme units. Active site: determination of 3D structure, enzyme turnover, and its significance. Extraction, purification, and characterization of enzymes: sources and extraction procedures. Isoenzymes. Antioxidant enzymes.

Unit II – Enzyme Kinetics and Catalysis: Steady state theory. Michaelis–Menten equation. Lineweaver–Burk plot, Eadie–Hofstee plot, Briggs–Hanes plot. Effect of pH, temperature, and substrate concentration on enzyme activity. Enzyme catalysis and mechanisms: serine proteases (chymotrypsin) and lysozyme. Mechanism of bi-substrate reactions. Metalloenzymes and metal-activated enzymes. Coenzymes: structure and functions of TPP, NAD, NADP, FAD, FMN, Coenzyme A.

Unit III – Enzyme Regulation and Inhibition: Mechanisms of regulation. Feed-forward stimulation. Feedback inhibition. Allosteric enzymes, sigmoidal kinetics, and their significance. Hill's equation. Scatchard plot and applications. Reversible and irreversible inhibition: types, kinetics, determination of inhibitor constant, Lineweaver–Burk plot.

Unit IV – Multi-Enzyme Complexes & Enzyme Technology: Structure, mechanism of action, and regulation of pyruvate dehydrogenase complex. Enzyme immobilization: sources, techniques, and effects on enzyme activity. Applications of immobilized enzymes. Enzymes as biosensors: calorimetric, amperometric, optical, and immuno-biosensors. Enzyme technology: large-scale production, downstream processing, enzyme reactors, and industrial biocatalysis.

Unit V – Applications and Future Prospects: Enzymes as analytical reagents. Industrial applications in textile, food, and detergent industries. Diagnostic and therapeutic uses of enzymes. Biotechnological applications. Enzyme engineering: artificial enzymes, directed evolution, and future prospects of enzyme engineering.

Reference Books

Title	Authors	Edition	Year	Publisher
Enzymes	Dixon, E.C. Webb, CJR Thorne, K.F. Tipton	3rd	1979	Longmans, London
Fundamentals of Enzymology	Nicholas C. Price, Lewis Stevens	2nd	1998	Oxford University Press
Understanding Enzymes	Trevor Palmer	3rd	1991	Ellis Horwood Limited
Protein Biotechnology	Gary Walsh, Denis Headon	1st	1994	John Wiley and Sons
Protein Biochemistry and Biotechnology	Gary Walsh	2nd	2002	John Wiley and Sons Ltd.
Enzyme Kinetics: Principles and Methods	Hans Bisswanger	2nd	2008	Wiley-VCH
Biochemistry	Donald Voet, Judith G. Voet	5th	2018	Wiley
Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	8th	2021	W.H. Freeman

🌐 Web Resources

- NCBI Bookshelf – Enzymology Texts (ncbi.nlm.nih.gov in Bing)
- PubMed – Enzyme Technology Articles (pubmed.ncbi.nlm.nih.gov in Bing)
- Protein Data Bank (PDB)
- ScienceDirect – Biochemistry Journals (sciencedirect.com in Bing)
- NPTEL – Enzyme Technology Lectures

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	2	2	1	2	2	2
CO2	3	3	2	3	3	2	2	2	3	2
CO3	3	3	2	3	3	2	2	2	2	3
CO4	3	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M.Sc., BIOCHEMISTRY

FIRST YEAR – SEMESTER – I

CORE PRACTICAL - I - BIOCHEMICAL TECHNIQUES AND ENZYMOLOGY

Course objectives

- To provide hands-on training in biochemical techniques for protein, nucleic acid, and metabolite analysis.
- To develop practical skills in chromatography, electrophoresis, and spectrophotometry.
- To train students in enzyme isolation, assay, and kinetic characterization.
- To introduce enzyme immobilization techniques for applied biochemistry.
- To strengthen analytical and problem-solving skills through experimental design and data interpretation.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Demonstrate preparation of buffers and measurement of pH	K3 – Apply
CO2	Perform protein estimation using Biuret and Lowry methods	K3 – Apply
CO3	Apply chromatography techniques for biomolecule separation	K4 – Analyze
CO4	Execute electrophoresis for protein separation	K3 – Apply
CO5	Determine protein concentration using spectrophotometry	K4 – Analyze
CO6	Isolate and assay enzymes such as peroxidase and amylase	K3 – Apply
CO7	Analyze enzyme kinetics under varying conditions	K4 – Analyze
CO8	Evaluate enzyme immobilization using alginate beads	K5 – Evaluate
CO9	Interpret experimental data for biochemical processes	K5 – Evaluate
CO10	Integrate biochemical techniques for applied research	K6 – Create

I - BIOCHEMICAL TECHNIQUES

A) Buffer Preparation and pH Measurement

- Preparation of different buffer systems
- Measurement of pH using pH meter

B) Colorimetric Estimation

- Protein estimation by Biuret method
- Protein estimation by Lowry method

C) Chromatography Techniques

- Separation of amino acids by Paper chromatography
- Separation of lipids by Thin-layer chromatography
- Separation of proteins by Gel filtration chromatography

D) Electrophoresis Methods

- Separation of proteins by Polyacrylamide gel electrophoresis (PAGE)

E) Spectrophotometric Analysis

- Determination of protein concentration by spectrophotometry

II – ENZYMOLOGY

A) Enzyme Isolation and Assay

- Extraction and purification of Peroxidase
- Determination of specific activity of Peroxidase
- Determination of specific activity of Amylase

B) Enzyme Kinetics

- Effect of pH, temperature, substrate and enzyme concentration on Peroxidase
- Effect of pH, temperature, substrate and enzyme concentration on Amylase

C) Enzyme Immobilization

- Immobilization of Peroxidase by matrix entrapment using alginate beads

References

Title	Author(s)	Publisher	Year
Practical Biochemistry	Plummer D.T.	Tata McGraw Hill	Latest Edition
Biochemistry Laboratory: Modern Theory and Techniques	Rodney Boyer	Pearson	Latest Edition
Principles and Techniques of Biochemistry and Molecular Biology	Wilson & Walker	Cambridge University Press	Latest Edition
Lehninger Principles of Biochemistry	Nelson & Cox	W.H. Freeman	Latest Edition

🌐 Web Resources

- NCBI Bookshelf – Biochemistry (ncbi.nlm.nih.gov in Bing)
- Khan Academy – Biochemistry (khanacademy.org in Bing)
- Nature Protocols – Biochemical Methods
- Biochemistry Free and Easy (Oregon State University) (biochem.science.oregonstate.edu in Bing)
- PubMed – Biochemistry Research Articles (pubmed.ncbi.nlm.nih.gov in Bing)

Mapping with Programme Outcomes

POs	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
PO1	3	3	3	3	3	3	3	3	3	3
PO2	2	2	3	2	3	2	3	3	3	3
PO3	2	2	3	2	2	3	3	3	3	3
PO4	1	2	3	2	3	3	3	3	3	3
PO5	2	2	3	3	3	2	2	2	3	3
PO6	1	1	2	1	2	2	2	2	3	3
PO7	1	1	2	1	2	2	2	2	2	3
PO8	1	1	2	1	2	2	2	2	2	2
PO9	2	2	2	2	2	2	2	2	3	3
PO10	2	2	2	2	2	2	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

ELECTIVE – I – A) NUTRITIONAL BIOCHEMISTRY

Course Objectives

- To understand nutrition and food groups and their role in balanced diet.
- To explain macronutrients and micronutrients and their biological significance.
- To study vitamins and minerals including fat-soluble and water-soluble types, their functions and deficiencies.
- To analyze malnutrition and deficiency disorders and strategies for prevention.
- To evaluate nutrition in diseases and explore current trends in nutrigenomics and nutrigenetics.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall basic concepts of nutrition, food groups, balanced diet, calorific value, BMR, SDA, energy requirement	K1 – Remember
CO2	Explain sources, functions, and significance of carbohydrates, fats, proteins, fibre, essential amino acids and fatty acids	Ka 2 – Understand
CO3	Apply knowledge of fat-soluble and water-soluble vitamins, minerals, and their role in health	K3 – Apply
CO4	Analyze malnutrition, protein-calorie deficiency, vitamin and mineral deficiency diseases, and fortification strategies	K4 – Analyze
CO5	Evaluate nutrition in diseases such as fever, jaundice, ulcers, hypertension, kidney disorders, diabetes, obesity, and starvation	K5 – Evaluate
CO6	Create insights into personalized nutrition through nutrigenomics and nutrigenetics	K6 – Create

Unit I – Basic Concepts: Nutrition, Food groups and balanced diet, Novel foods, Calorific value of foods – direct and indirect calorimetry, Empty calories, Basal metabolic rate – factors affecting BMR, Specific dynamic action and physical activity, Calculation of daily energy requirement, Assessment of nutritional status, Lactose intolerance, Nutritional requirement and biochemical changes in infancy, childhood, pregnancy, lactation and ageing, Sports nutrition.

Unit II – Elements of Nutrition: Plant and animal sources of simple and complex carbohydrates, fats and proteins and their requirement, Biological significance, deficiency and toxicity of macronutrients and micronutrients, Role of dietary fibre, Protein sparing action of carbohydrates and fats, Essential amino acids, Essential fatty acids, Effects of naturally occurring food toxins, preservatives, additives, alcohol and tobacco on health.

Unit III – Vitamins and Minerals: Fat-soluble vitamins (A, D, E, K) – dietary sources, biochemical functions, requirements, absorption, metabolism and excretion. Water-soluble vitamins (Vitamin C and Vitamin B complex) – dietary sources, biochemical functions, requirements, absorption, metabolism and excretion, Vitamin B complex as coenzyme. Minerals – dietary sources, biochemical functions, requirements, absorption, metabolism and excretion, Nutritional significance of calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Unit IV – Malnutrition: Protein calorie malnutrition and undernutrition (Kwashiorkor and Marasmus), Prevention of malnutrition, Deficiency diseases associated with vitamin B complex, vitamin C, vitamins A, D, E and K, Mineral deficiency diseases – aetiology, signs and symptoms, dietary supplementation, Enrichment and fortification of foods with vitamins and minerals.

Unit V – Nutrition in Diseases and Current Trends: Nutrition in diseases – aetiology, signs and symptoms, treatment and dietary management during fever (Typhoid and Malaria) and infectious diseases (COVID-19), Jaundice, hyperacidity (Ulcer), Atherosclerosis, Hypertension, Kidney diseases, Diabetes in adults, Starvation and Obesity, Inter-relationship of nutrition, infection, immunity and poverty, Nutritional therapy for diseases, Nutrigenomics and Nutrigenetics.

Reference Books

Title	Author	Edition	Year	Publisher
Nutritive Value of Indian Foods	C. Gopalan, B.V. Ramasastri, S.C. Balasubramanian	2nd	2019	National Institute of Nutrition (ICMR)
Advanced Textbook on Food & Nutrition	M. Swaminathan	2nd	2018	Bangalore Printing & Publishing Co.
Krause's Food, Nutrition & Diet Therapy	L.K. Mahan, S. Escott-Stump	14th	2020	Elsevier
Textbook of Human Nutrition	S. Bamji, N. Krishnaswamy, G.N.V. Brahmam	4th	2019	Oxford University Press
Introduction to Human Nutrition	S. Gibney, M. Lanham-New, A. Cassidy, H. Vorster	3rd	2019	Wiley-Blackwell

🌐 Web Resources

- WHO Nutrition (who.int in Bing)
- FAO Food and Nutrition
- ICMR-NIN
- FSSAI – Eat Right India (eatrightindia.gov.in in Bing)
- PubMed Nutrition Resources (pubmed.ncbi.nlm.nih.gov in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

ELECTIVE – I – B) MEDICAL LABORATORY TECHNOLOGY

Course Objectives

- To understand fundamentals of medical laboratory practice including safety, specimen handling, and quality assurance.
- To explain hematology and blood banking techniques and their clinical applications.
- To apply Clinical Biochemistry and molecular diagnostics in disease investigation.
- To analyze microbiology, immunology, and pathology for infectious and non-infectious conditions.
- To evaluate professional practice and ethics in laboratory medicine, including accreditation and legal aspects.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of laboratory practice, safety, specimen handling, and biomedical waste management	K1 – Remember
CO2	Explain hematology and blood banking procedures including transfusion medicine	K2 – Understand
CO3	Apply biochemical and molecular diagnostic techniques in clinical investigations	K3 – Apply
CO4	Analyze microbiological, immunological, and pathological findings for disease diagnosis	K4 – Analyze
CO5	Evaluate professional practice, ethics, accreditation, and legal aspects in laboratory medicine	K5 – Evaluate
CO6	Create innovative approaches in laboratory automation, molecular diagnostics, and interdisciplinary collaboration	K6 – Create

Unit I – Fundamentals of Medical Laboratory Practice: Introduction to medical laboratory science, Laboratory safety protocols and biosafety levels, Specimen collection, labeling, transport and storage, Documentation and reporting of results, Biomedical waste management, Laboratory automation, Quality control and assurance.

Unit II – Hematology and Blood Banking: Blood sample preparation and analysis, Hematological tests (CBC, ESR, peripheral smear), Determination of blood group and Rh factor, Cross-matching and compatibility testing, Blood transfusion procedures and hazards, Coagulation studies, Immunohematology, Blood component separation and transfusion medicine.

Unit III – Clinical Biochemistry and Molecular Diagnostics: Principles of biochemical analysis, Estimation of blood glucose and HbA1C, Renal function tests (urea, creatinine, uric acid), Liver function tests (bilirubin, ALT, AST, ALP), Lipid profile and cardiac markers, CSF, urine and other body fluid analysis, Enzyme assays, Hormone estimation, Tumor markers, Molecular diagnostics (PCR, RT-PCR, DNA sequencing, emerging technologies).

Unit IV – Microbiology, Immunology and Pathology: Collection and culture of specimens (urine, sputum, feces, pus, CSF), Staining techniques (Gram, Ziehl–Neelsen, special stains), Immunodiagnostic tests (Widal, VDRL, ASO, RA, CRP), ELISA, RIA and rapid diagnostic kits, Skin tests (Mantoux, Lepromin), Antimicrobial sensitivity testing, Routine urine and stool examination, Semen analysis, Cytological techniques (Pap smear, FNAC), Histopathology (tissue processing, sectioning, staining), Immunohistochemistry, Digital pathology.

Unit V – Professional Practice and Ethics: Role of medical laboratory technologists in healthcare, Quality control and assurance in laboratories, Ethical issues in laboratory practice, Communication skills and teamwork in clinical settings, Laboratory accreditation standards (NABL, ISO, CAP, CLIA), Patient confidentiality and data protection, Professional responsibility and accountability, Legal aspects of laboratory medicine, Continuing professional education, Leadership and management in laboratory practice, Interdisciplinary collaboration in healthcare teams.

Reference Books

Title	Author	Edition	Year	Publisher
Textbook of Medical Laboratory Technology	Ramnik Sood	2nd	2019	Jaypee Brothers Medical Publishers
Clinical Diagnosis and Management by Laboratory Methods	John Bernard Henry	22nd	2018	Elsevier
Medical Laboratory Technology Methods and Interpretations	Kanai L. Mukherjee	7th	2020	Tata McGraw Hill
Clinical Chemistry: Principles, Techniques, and Correlations	Michael L. Bishop, Edward P. Fody, Larry E. Schoeff	8th	2018	Wolters Kluwer
Textbook of Microbiology	Ananthanarayan & Paniker	10th	2017	Universities Press

🌐 Web Resources

- WHO – Laboratory Quality Standards (who.int in Bing)
- ICMR – National Accreditation Board for Testing and Calibration Laboratories (NABL)
- CDC – Laboratory Safety Guidelines
- PubMed – Laboratory Medicine Resources (pubmed.ncbi.nlm.nih.gov in Bing)
- FSSAI – Laboratory Practices in India

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – I

SEC – I – TISSUE CULTURE

Course Objectives

- To understand principles of plant and animal tissue culture.
- To explain laboratory requirements, aseptic techniques, and media preparation.
- To apply cell culture methods for research and diagnostics.
- To analyze applications of tissue culture in biotechnology, medicine, and agriculture.
- To evaluate ethical, biosafety, and regulatory aspects.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of tissue culture, aseptic techniques, and media preparation	K1 – Remember
CO2	Explain plant tissue culture methods and their applications in crop improvement	K2 – Understand
CO3	Apply animal cell culture techniques in diagnostics and research	K3 – Apply
CO4	Analyze specialized techniques including cloning, IVF, and genetic engineering	K4 – Analyze
CO5	Evaluate biosafety, ethical, and regulatory aspects of tissue culture	K5 – Evaluate
CO6	Create innovative applications of tissue culture in biotechnology and medicine	K6 – Create

Unit I – Fundamentals of Tissue Culture: History and scope of tissue culture, Laboratory design and requirements, Aseptic techniques, Sterilization methods, Preparation of culture media, Role of growth regulators.

Unit II – Plant Tissue Culture: Callus culture, Suspension culture, Organ culture, Micropropagation techniques, Somatic embryogenesis, Protoplast isolation and fusion, Haploid culture, Somaclonal variation, Applications in crop improvement.

Unit III – Animal Cell Culture: Primary culture, Continuous cell lines, Stem cell culture, Hybridoma technology, Cryopreservation, Cell viability assays, Applications in diagnostics, vaccine production, and cancer research.

Unit IV – Specialized Techniques: Embryo culture, In vitro fertilization, Cloning techniques, Genetic engineering using cultured cells, Bioreactors for large-scale culture, Molecular diagnostics using cultured cells.

Unit V – Applications, Biosafety and Ethics: Applications in agriculture, medicine, and pharmaceuticals, Production of secondary metabolites, Transgenic plants and animals, Biosafety guidelines, Ethical issues in tissue culture, Regulatory aspects and intellectual property rights.

Reference Books

Title	Author	Edition	Year	Publisher
Plant Tissue Culture: Theory and Practice	S.S. Bhojwani, M.K. Razdan	1st	1996	Elsevier
Animal Cell Culture: A Practical Approach	R. Ian Freshney	7th	2016	Wiley-Blackwell
Plant Cell and Tissue Culture	J. Reinert, Y.P.S. Bajaj	1st	2012	Springer
Essentials of Cell and Tissue Culture	Jennie P. Mather, David Barnes	2nd	2018	Academic Press
Biotechnology: Principles and Applications	C.S. Prasad	3rd	2020	Narosa Publishing House

🌐 **Web Resources**

- FAO – Plant Biotechnology (fao.org in Bing)
- NCBI – Cell Culture Techniques (ncbi.nlm.nih.gov in Bing)
- ICMR – Biosafety Guidelines
- WHO – Laboratory Biosafety Manual (who.int in Bing)
- Springer – Tissue Culture Journals

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – II

CORE – IV – INTERMEDIARY METABOLISM

Course Objectives

- To understand the biochemical pathways of carbohydrate metabolism including glycolysis, gluconeogenesis, glycogen metabolism, citric acid cycle, and associated shunts.
- To explain fatty acid oxidation and biosynthesis, cholesterol metabolism, and arachidonic acid pathways with regulatory mechanisms.
- To analyze amino acid catabolism, nitrogen metabolism, urea cycle, and conversion of amino acids into specialized products.
- To evaluate bioenergetics of metabolism including electron transport chain, oxidative phosphorylation, and mitochondrial transport systems.
- To apply knowledge of porphyrin and nucleotide metabolism in understanding biosynthesis, degradation, and clinical regulation.
- To integrate carbohydrate, lipid, protein, and nucleotide metabolism to explain metabolic interrelationships and regulation.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall pathways of carbohydrate metabolism and regulation of blood glucose.	K1 – Remembering
CO2	Explain fatty acid oxidation, biosynthesis, and cholesterol metabolism.	K2 – Understanding
CO3	Apply knowledge of amino acid metabolism to interpret nitrogen balance and specialized product formation.	K3 – Applying
CO4	Analyze bioenergetics, electron transport chain, and oxidative phosphorylation mechanisms.	K4 – Analyzing
CO5	Evaluate porphyrin and nucleotide metabolism including clinical inhibitors.	K5 – Evaluating
CO6	Create integrated metabolic maps linking carbohydrate, lipid, protein, and nucleotide metabolism.	K6 – Creating

Unit I – Carbohydrate Metabolism: Introduction to metabolism of cells. Aerobic and anaerobic glycolysis with energetics. Gluconeogenesis, substrate cycles, regulation of glycolysis and gluconeogenesis. Metabolism of glycogen and its regulation. Maintenance of blood sugar by liver. Citric acid cycle and energetics, Amphibolic nature of the cycle, and anaplerotic mechanisms. Hexose monophosphate shunt, uronic acid pathway, Cori's cycle and glyoxylate pathway. Metabolism of fructose, galactose and mannose.

Unit II – Lipid Metabolism: Fatty acid metabolism and regulation. Oxidation of saturated, unsaturated fatty acids, oxidation of even and odd numbered fatty acids. Alpha, beta, and omega oxidation. Ketogenesis, Biosynthesis of saturated and unsaturated fatty acids. Regulation of fatty acid metabolism. Mitochondrial and microsomal chain elongation. Metabolism of triacylglycerol, phospholipids, and sphingolipids. Cholesterol biosynthesis and regulation, degradation of cholesterol, and lipoprotein metabolism. Cyclic and linear pathways of arachidonic acid metabolism including prostaglandins, prostacyclins, and thromboxanes.

Unit III – Amino Acid Metabolism: Degradation of amino acids: transamination, oxidative and non-oxidative deamination, and decarboxylation. Urea cycle and its regulation. Catabolism of amino acids: conversion of carbon skeletons to amphibolic intermediates. Key role of glutamate dehydrogenase in nitrogen metabolism. Conversion of amino acids to specialized products such as serotonin, gamma-aminobutyric acid, dopamine, epinephrine, norepinephrine, melanin, creatinine, and creatine. Integration of metabolism: interrelationship of carbohydrate, protein, and fat metabolism. Metabolism of selected individual amino acids.

Unit IV – Bioenergetics in Metabolism: High-energy phosphates. Components of the electron transport chain and sequence of electron transport. Mechanism of ATP synthesis and oxidative phosphorylation with chemiosmotic theory. Uncoupling of oxidative phosphorylation. Inhibitors of respiratory chain and oxidative phosphorylation. Mitochondrial transport systems including ATP/ADP exchange and malate/glycerol phosphate shuttle.

Unit V – Porphyrin and Nucleotide Metabolism: Metabolism of porphyrins: biosynthesis and degradation, heme formation, bilirubin biosynthesis, transport, and excretion of bile pigments. Metabolism of nucleotides: de novo synthesis and salvage pathways of purine nucleotides, degradation of purines. De novo synthesis and salvage pathways of pyrimidine nucleotides, degradation of pyrimidines, and inhibitors of nucleotide metabolism.

Reference Books

Title	Authors	Edition	Year	Publisher
Biochemistry	Donald Voet, Judith G. Voet	5th	2018	Wiley
Lehninger Principles of Biochemistry	David L. Nelson, Michael M. Cox	8th	2021	W.H. Freeman
Harper's Illustrated Biochemistry	Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, Anthony Weil	31st	2018	McGraw Hill
Fundamentals of Biochemistry	Donald Voet, Judith G. Voet, Charlotte W. Pratt	5th	2019	Wiley
Textbook of Biochemistry with Clinical Correlations	Thomas M. Devlin	7th	2010	Wiley
Biochemistry	Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer	9th	2019	W.H. Freeman
Metabolic Regulation: A Human Perspective	Keith N. Frayn	3rd	2010	Wiley-Blackwell

🌐 Web Resources

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books
- PubMed – https://pubmed.ncbi.nlm.nih.gov
- Protein Data Bank (PDB) – https://www.rcsb.org
- ScienceDirect – https://www.sciencedirect.com/journal/biochemistry
- Khan Academy Biology – https://www.khanacademy.org/science/biology

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	2	1	2	2	2
CO2	3	3	2	3	3	2	2	2	3	2
CO3	3	3	2	3	3	2	2	2	2	3
CO4	3	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3
CO6	3	3	3	3	3	3	3	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – II

CORE – V – CELL AND MOLECULAR BIOLOGY

Course Objectives

- To understand the structure and organization of prokaryotic and eukaryotic cells, organelles, and extracellular matrix.
- To explain chromosome organization, cell cycle regulation, apoptosis, CAMs, junctions, and stem cell biology.
- To analyze DNA replication, repair, recombination, and telomere biology.
- To evaluate transcription, translation, protein folding, and degradation.
- To apply gene regulation concepts, epigenetic mechanisms, and non-coding RNA functions in prokaryotes and eukaryotes.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the structure and functions of cell organelles, membranes, and extracellular matrix.	K1 – Remembering
CO2	Explain chromosome organization, cell cycle regulation, apoptosis, CAMs, junctions, and stem cell biology.	K2 – Understanding
CO3	Apply knowledge of DNA replication, repair, recombination, and telomere biology to molecular processes.	K3 – Applying
CO4	Analyze transcription, translation, protein targeting, folding, and degradation mechanisms.	K4 – Analyzing
CO5	Evaluate gene regulation, epigenetic mechanisms, and roles of non-coding RNAs.	K5 – Evaluating
CO6	Create integrated models linking cell structure, genetic regulation, and developmental outcomes.	K6 – Creating

Unit I – Cell Structure and Organization: Introduction to cell biology. Structure and functions of prokaryotic and eukaryotic cells. Plasma membrane organization and models of membrane structure. Transport across membranes including passive, active, facilitated diffusion, endocytosis, and exocytosis. Cell organelles such as nucleus, mitochondria, chloroplast, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, and ribosomes. Cytoskeleton components including microtubules, microfilaments, and intermediate filaments. Extracellular matrix and its role.

Unit II – Chromosome Organization and Cell Cycle: Structure and organization of chromosomes. Nucleosome and higher-order chromatin structure. Cell cycle phases and regulation. Molecular events in mitosis and meiosis. Checkpoints and control mechanisms. Apoptosis and programmed cell death. Cell adhesion molecules (CAMs) and intercellular junctions including tight junctions, gap junctions, and desmosomes. Stem cell biology and cell differentiation.

Unit III – DNA Replication, Repair, and Recombination: Mechanism of DNA replication in prokaryotes and eukaryotes. Enzymes involved in replication. DNA damage and repair mechanisms including mismatch repair, nucleotide excision repair, base excision repair, and recombinational repair. Homologous and non-homologous recombination. Telomeres, telomerase, and their role in aging and cancer.

Unit IV – Transcription and Translation: Mechanism of transcription in prokaryotes and eukaryotes. RNA polymerases and transcription factors. Post-transcriptional modifications including capping, splicing, and polyadenylation. Genetic code and its properties. Mechanism of translation in prokaryotes and eukaryotes. Post-translational modifications and protein targeting. Role of chaperones in protein folding and degradation.

Unit V – Gene Regulation: Regulation of gene expression in prokaryotes such as lac operon and trp operon, and in eukaryotes. Epigenetic regulation including DNA methylation and histone modification. RNA interference and microRNAs. Chromatin remodeling complexes, long non-coding RNAs, and regulation of developmental genes.

Reference Books

Title	Authors	Edition	Year	Publisher
Molecular Biology of the Gene	J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick	7th	2014	Pearson
Molecular Biology of the Cell	Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter	7th	2022	W.W. Norton & Company
Genes XI	Benjamin Lewin	11th	2014	Jones & Bartlett Learning
Cell and Molecular Biology: Concepts and Experiments	Gerald Karp	9th	2021	John Wiley & Sons
Molecular Cell Biology	Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin	9th	2021	W.H. Freeman
The Cell: A Molecular Approach	Geoffrey M. Cooper, Robert E. Hausman	9th	2022	Oxford University Press
Cytology: Cell Biology and Molecular Biology	V.K. Agarwal, P.S. Varma	4th	2000	S. Chand & Company

Web Resources

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books
- PubMed – https://pubmed.ncbi.nlm.nih.gov
- Protein Data Bank (PDB) – https://www.rcsb.org
- ScienceDirect – https://www.sciencedirect.com/journal/cell
- Khan Academy Biology – https://www.khanacademy.org/science/biology

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	2	2	1	2	2	2
CO2	3	3	2	3	2	2	2	2	3	2
CO3	3	3	2	3	3	2	2	2	2	3
CO4	3	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3
CO6	3	3	3	3	3	3	3	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – II

CORE – VI – PLANT BIOCHEMISTRY AND BIOTECHNOLOGY

Course Objectives

- To understand photosynthetic pathways, water absorption, and transpiration
- To explain nutrient roles, nitrogen fixation, and assimilation;
- To analyze phytohormones, seed germination, dormancy, and senescence
- To evaluate secondary metabolites and plant tissue culture applications; and
- To apply plant biotechnology tools for crop improvement and GM food development.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall concepts of photosynthesis, water absorption, and transpiration.	K1 – Remembering
CO2	Explain nutrient metabolism, nitrogen fixation, and assimilation processes.	K2 – Understanding
CO3	Apply knowledge of phytohormones and seed physiology to plant growth regulation.	K3 – Applying
CO4	Analyze biosynthetic pathways of secondary metabolites and tissue culture techniques.	K4 – Analyzing
CO5	Evaluate plant biotechnology methods including transgenic plants and GM foods.	K5 – Evaluating
CO6	Create integrated models linking photosynthesis, nutrient metabolism, hormones, and biotechnology.	K6 – Creating

Unit I – Photosynthesis and Water Transport in Plants: Photosynthesis: apparatus and role of photosynthetic pigments; biochemistry of light and dark reactions; photosystems I and II; factors affecting photosynthesis; cyclic and non-cyclic photophosphorylation. Reactions in C3, C4, and CAM plants including Calvin cycle and Hatch–Slack pathway. Water absorption: mechanism of water absorption, symplast and apoplast concepts. Transpiration: types, mechanism, and factors affecting transpiration.

Unit II – Nutrient Metabolism and Nitrogen Fixation: Role of macro and micronutrients in plants; hydroponics. Nitrogen fixation and its types; biochemistry of symbiotic and asymbiotic nitrogen fixation; physiology of nodule formation; genetics and genetic manipulation of nitrogen fixation genes. Nitrogen assimilation and the interrelationship between photosynthesis and nitrogen metabolism.

Unit III – Plant Hormones and Development: Biosynthesis, transport, distribution, mechanism of action, and physiological effects of phytohormones: auxins, gibberellins, cytokinins, abscisic acid, and ethylene. Phytochrome and biological clock. Physiology and biochemistry of seed germination. Dormancy: types and methods to overcome dormancy. Senescence.

Unit IV – Secondary Metabolites and Tissue Culture: Basic biosynthetic pathways of secondary metabolites. Functions of flavonoids, alkaloids, terpenoids, anthocyanins, tannins, steroids, and lignin. Applications of secondary metabolites in drug development, biopesticides, and biofertilizers. Plant tissue culture: micropropagation, callus induction, cell and protoplast culture, organogenesis, and somatic embryogenesis. Applications of tissue culture for crop improvement in agriculture, horticulture, and forestry. Haploid production through anther, pollen, embryo, and ovule culture; somaclonal variation.

Unit V – Plant Biotechnology and Genetic Engineering: Agrobacterium and crown gall tumors; Ti plasmid and Ri plasmid vectors; mechanism of T-DNA transfer to plants. Plant viral vectors. Direct transformation of plants by physical methods. Selectable markers and reporter genes used in plant vectors. Transgenic plants: resistance to bacteria, fungi, viruses, pests, and herbicides. Transgenic plants for improved nutrition, crop yield, and as bioreactors. GM foods.

Reference Books

Title	Authors	Edition	Year	Publisher
Plant Biochemistry	Hans-Walter Heldt, Birgit Piechulla	4th	2011	Academic Press
Biochemistry & Molecular Biology of Plants	Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones	2nd	2015	Wiley Blackwell
Plant Physiology and Development	Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, Angus Murphy	6th	2015	Sinauer Associates
Plant Biotechnology: The Genetic Manipulation of Plants	Nigel Slack	2nd	2000	Oxford University Press
Plant Tissue Culture: Theory and Practice	M.K. Razdan	1st	2003	Science Publishers
Plant Secondary Metabolites	Alan Crozier, Michael N. Clifford, Hiroshi Ashihara	1st	2006	Blackwell Publishing
Plant Biotechnology and Genetics	Indra Vasil	1st	2008	Wiley

🌐 Web Resources

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books
- PubMed – https://pubmed.ncbi.nlm.nih.gov
- Protein Data Bank (PDB) – https://www.rcsb.org
- ScienceDirect – https://www.sciencedirect.com/journal/plant-science
- NPTEL (IIT Online Lectures) – https://nptel.ac.in
- FAO Biotechnology Resources – https://www.fao.org/biotechnology

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	2	2	2	1	2	2	2
CO2	3	3	2	3	3	2	2	2	3	2
CO3	3	3	2	3	3	2	2	2	2	3
CO4	3	2	2	3	3	2	2	2	2	2
CO5	3	3	3	3	3	3	2	2	3	3
CO6	3	3	3	3	3	3	3	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M.Sc., BIOCHEMISTRY

FIRST YEAR – SEMESTER – II

CORE PRACTICAL - II – CELL AND MOLECULAR BIOLOGY

Course objectives

- To train students in microscopy and staining techniques for cell observation.
- To provide practical exposure to organelle isolation and functional assays.
- To develop skills in DNA and RNA isolation from biological samples.
- To strengthen analytical ability through nucleic acid quantification and electrophoresis.
- To integrate classical and modern Molecular Biology techniques for applied research.

Course Outcomes (CO)

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Demonstrate handling and calibration of compound microscope	K3 – Apply
CO2	Prepare smears and perform Gram staining of prokaryotic cells	K3 – Apply
CO3	Study mitosis using onion root tip squash preparation	K4 – Analyze
CO4	Perform organelle isolation and functional assays	K4 – Analyze
CO5	Isolate glycogen and mitochondria from liver tissue	K3 – Apply
CO6	Isolate genomic DNA and total RNA	K3 – Apply
CO7	Quantify DNA and RNA using classical methods	K4 – Analyze
CO8	Apply spectrophotometric methods for nucleic acid quantification	K4 – Analyze
CO9	Execute agarose gel electrophoresis for nucleic acid separation	K3 – Apply
CO10	Interpret and integrate cell and Molecular Biology data	K5 – Evaluate

I - CELL BIOLOGY PRACTICAL

A) Basic Microscopy and Cell Observation

- Handling and calibration of compound microscope
- Smear preparation of prokaryotic (bacteria) and eukaryotic (cheek cells)
- Simple and Gram staining for prokaryotic cells
- Study of mitosis using onion root tip squash preparation

B) Organelle isolation and functional Studies

- Cell fractionation by differential centrifugation (nuclei, mitochondria, cytosol)
- Demonstration of osmosis and plasmolysis in plant cells
- Isolation of mitochondria from liver tissue and assay of succinate dehydrogenase
- Isolation of Glycogen from Liver tissue and its determination by Anthrone method

II - MOLECULAR BIOLOGY PRACTICAL

A) Nucleic Acid Isolation

- Isolation of genomic DNA from plant/animal tissue
- Isolation of total RNA from yeast or plant tissue

B) Nucleic Acid Analysis

- Quantification of isolated DNA by Diphenylamine method
- Quantification of isolated RNA by Orcinol method
- Spectrophotometric quantification of DNA (A260/A280 ratio)
- Agarose gel electrophoresis of nucleic acids

References

Title	Author(s)	Publisher	Edition / Year
Cell Biology: A Laboratory Handbook	J.E. Celis	Academic Press	3rd Edition, 2006
Molecular Cloning: A Laboratory Manual	Sambrook & Russell	Cold Spring Harbor Laboratory Press	3rd Edition, 2001
Practical Biochemistry	Plummer D.T.	Tata McGraw Hill	5th Edition, 2010
Principles and Techniques of Biochemistry and Molecular Biology	Wilson & Walker	Cambridge University Press	7th Edition, 2010

Web Resources

- NCBI Bookshelf – Molecular Biology (ncbi.nlm.nih.gov in Bing)
- Nature Protocols – Cell Biology Methods
- Khan Academy – Cell Biology (khanacademy.org in Bing)
- Biochemistry Free and Easy (Oregon State University) (biochem.science.oregonstate.edu in Bing)
- PubMed – Cell & Molecular Biology Research (pubmed.ncbi.nlm.nih.gov in Bing)

Mapping with Programme Outcomes

POs	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
PO1	3	3	3	3	3	3	3	3	3	3
PO2	2	2	3	3	3	2	3	3	3	3
PO3	2	2	3	3	3	3	3	3	3	3
PO4	1	2	3	3	3	3	3	3	3	3
PO5	2	2	2	3	3	2	2	3	3	3
PO6	1	1	2	2	2	2	2	2	3	3
PO7	1	1	2	2	2	2	2	2	2	3
PO8	1	1	2	2	2	2	2	2	2	2
PO9	2	2	2	2	2	2	2	2	3	3
PO10	2	2	2	2	2	2	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – II

ELECTIVE – II – A) CANCER BIOLOGY

Course Objectives

- To understand fundamentals of cancer biology including hallmarks, cell cycle regulation, and apoptosis.
- To explain tumor biology and transformation including benign vs malignant tumors and metastasis.
- To analyze mechanisms of carcinogenesis and risk factors.
- To apply molecular knowledge of oncogenes and tumor suppressors in understanding cancer progression.
- To evaluate diagnostic tools and therapeutic strategies including personalized medicine and ethical aspects.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of cancer biology, hallmarks, cell cycle, and apoptosis	K1 – Remember
CO2	Explain tumor biology, transformation, and metastasis	K2 – Understand
CO3	Analyze carcinogenesis, aberrant metabolism, and risk factors	K4 – Analyze
CO4	Apply molecular knowledge of oncogenes, tumor suppressors, and signaling pathways	K3 – Apply
CO5	Evaluate diagnostic tools, therapeutic strategies, and ethical aspects	K5 – Evaluate
CO6	Create innovative approaches in cancer research and therapy	K6 – Create

Unit I – Fundamentals of Cancer Biology: Definition, causes, properties, classification, clonal nature of cancer, hallmarks of cancer, cell cycle regulation and checkpoints, S-phase, mitotic phase and cytokinesis, control of cell division and cell growth, programmed cell death (apoptosis) – mechanism, regulation, pro-apoptotic factors and regulators.

Unit II – Tumor Biology and Transformation: Benign and malignant tumors – characteristics and differences, cancer transformation, types of cancer cells and their morphological architecture, metastatic tumor cells – alterations in cell–cell interactions, angiogenesis, tumor microenvironment influence, isolation of DNA from tumor cells, transformation of normal cultured cells.

Unit III – Carcinogenesis: Aberrant metabolism in cancer, paraneoplastic syndromes, stages in chemical carcinogenesis – initiation, promotion, progression, theories of carcinogenesis, chemical and physical carcinogens, radiation carcinogenesis.

Unit IV – Molecular Mechanisms in Cancer: Oncogenes, proto-oncogenes, viral oncogenes – mechanisms of activation, growth factors (EGF, TNFα, TNFβ) and growth factor receptors, tumor suppressor genes – loss of heterozygosity, overexpression of glycoproteins, roles of p53, Bcl-2, and retinoblastoma gene in carcinogenesis, telomerase and retroviruses.

Unit V – Cancer Diagnosis, Therapy and Current Trends: Tumor markers and their clinical applications, cancer screening and prevention, imaging techniques, biomarkers, genetic counseling, surgery, chemotherapy, radiation therapy, immunotherapy, monoclonal antibodies, gene therapy, stem cell targeted therapy, personalized medicine, therapeutic vaccines, nanotechnology-based drug delivery, ethical and regulatory aspects.

Reference Books

Title	Author	Edition	Year	Publisher
The Biology of Cancer	Robert A. Weinberg	2nd	2013	Garland Science
Molecular Biology of Cancer	Lauren Pecorino	4th	2016	Oxford University Press
Oxford Textbook of Cancer Biology	Francesco Pezzella, Mahvash Tavassoli, David J. Kerr	1st	2019	Oxford University Press
Handbook of Oncobiology: From Basic to Clinical Sciences	R.C. Sobti, N.K. Ganguly, Rakesh Kumar	1st	2024	Springer Nature
Cancer Biology: How Science Works	Carsten Carlberg, Eunike Velleuer	Latest	2026	Springer

Web Resources

- WHO – Cancer Fact Sheets
- American Cancer Society
- NCBI – Cancer Biology Resources (ncbi.nlm.nih.gov in Bing)
- PubMed – Cancer Biology Journals (pubmed.ncbi.nlm.nih.gov in Bing)
- NPTEL Cancer Biology Course – IIT Madras

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	3	2	3	2	2	3	2	2
CO4	2	3	2	2	3	2	1	2	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

FIRST YEAR - SEMESTER – II

ELECTIVE – II – B) BIOSAFETY, LABORATORY SAFETY AND IPR

Course Objectives

- To understand principles of biosafety and laboratory safety practices.
- To explain biosafety levels and risk assessment.
- To apply laboratory safety protocols including chemical, biological, and radiation safety.
- To analyze regulatory compliance and emergency response.
- To evaluate intellectual property rights and healthcare research.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall principles of biosafety, laboratory safety rules, and PPE	K1 – Remember
CO2	Explain biosafety levels, risk assessment, and hazard control	K2 – Understand
CO3	Apply laboratory safety protocols in chemical, biological, and radiation contexts	K3 – Apply
CO4	Analyze regulatory compliance, laboratory security, and emergency response	K4 – Analyze
CO5	Evaluate intellectual property rights in life science and healthcare	K5 – Evaluate
CO6	Create innovative approaches to biosafety management and IPR protection	K6 – Create

Unit I – Fundamentals of Biosafety: History and principles of biosafety, Risk assessment, Biosafety levels (BSL-1 to BSL-4), Personal protective equipment (PPE), Disinfection, decontamination, sterilization.

Unit II – Laboratory Safety Practices: General laboratory safety rules, Chemical safety, Radiation safety, Biological hazard management, Laboratory safety symbols, Do's and Don'ts in laboratory practice, Biomedical waste management.

Unit III – Laboratory Security and Emergency Response: Regulatory compliance (WHO, NIH, OSHA, ICMR), Laboratory security, Emergency response to accidents, Fire safety, First aid, Handling spills and exposures.

Unit IV – Intellectual Property Rights (IPR): Introduction to IPR, Types of IPR – patents, copyrights, trademarks, trade secrets, Plant breeders' rights, Patents, Patent filing process, Case studies in biomedicine.

Unit V – Ethics, Regulations and Global Perspectives: Ethical issues in biosafety, International conventions (Cartagena Protocol, Nagoya Protocol), National biosafety guidelines, IPR in healthcare innovations, Role of regulatory bodies, Future perspectives in biosafety and IPR.

Reference Books

Title	Author	Edition	Year	Publisher
Laboratory Biosafety Manual	WHO	E	2020	World Health Organization
Biosafety in Microbiological and Biomedical Laboratories	CDC & NIH	6th	2020	U.S. Government Printing Office
Laboratory Safety: Principles and Practices	Diane O. Fleming, Debra L. Hunt	3rd	2014	ASM Press
Intellectual Property Rights: Unleashing Innovation	Prabuddha Ganguli	2nd	2019	Tata McGraw Hill
Biotechnology and IPR	P. Narayanan	1st	2018	Eastern Book Company

Web Resources

- WHO Laboratory Biosafety Manual (who.int in Bing)
- CDC Laboratory Safety Guidelines
- NIH Biosafety Resources (osp.od.nih.gov in Bing)
- ICMR Biosafety Guidelines
- WIPO – Intellectual Property Rights

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – III

CORE – VII – CLINICAL BIOCHEMISTRY

Course Objectives

- To understand principles of clinical biochemistry, specimen collection, and laboratory automation.
- To explain biochemical basis of carbohydrate, lipid, amino acid, and nucleic acid disorders.
- To analyze liver, renal, pancreatic, and gastrointestinal function tests with clinical relevance.
- To evaluate advanced biomarkers, molecular diagnostics, and metabolomics in disease management.
- To apply molecular genetics and personalized medicine approaches to hemoglobinopathies and clotting disorders.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall principles of accuracy, precision, specimen collection, and quality control in clinical biochemistry.	K1 – Remembering
CO2	Explain biochemical basis and clinical features of carbohydrate and lipid metabolic disorders.	K2 – Understanding
CO3	Apply knowledge of amino acid and nucleic acid metabolism to interpret inborn errors and genetic disorders.	K3 – Applying
CO4	Analyze liver, renal, pancreatic, and gastrointestinal function tests with advanced biomarkers.	K4 – Analyzing
CO5	Evaluate hemoglobinopathies, porphyrias, and clotting disorders using molecular and genetic approaches.	K5 – Evaluating
CO6	Create integrated diagnostic strategies combining biochemical assays, molecular diagnostics, and personalized medicine.	K6 – Creating

Unit I – Approaches to Clinical Biochemistry: Concepts of accuracy, precision, sensitivity, specificity, reproducibility, and predictive values. Automation in Clinical Biochemistry laboratory, laboratory information systems (LIS), and factors in quality control. Specimen collection and processing: blood collection methods, anticoagulants, pre-analytical variables. Collection of urine – preservatives, timed urine specimens. Tests and clinical significance of urinary compounds: sugars, proteins, ketone bodies, bilirubin, porphyrins, and microalbuminuria. Stool – chemical examination, occult blood tests, and clinical significance. CSF – collection, composition, chemical examination, and clinical significance. Amniotic fluid: origin, collection, composition, biochemical and genetic analysis.

Unit II – Disorders of Carbohydrate and Lipid Metabolism: Disorders of carbohydrate metabolism: Diabetes mellitus – type I, type II, and gestational DM; metabolic abnormalities, diagnosis, biomarkers, and management; acute and long-term complications. Glycogen storage diseases and mucopolysaccharidoses. Disorders of lipid metabolism: lipid storage diseases (Tay-Sachs, Niemann-Pick), fatty liver, and lipoproteinemias. Atherosclerosis – risk factors, biochemical findings, inflammatory markers, and management. Obesity – types, metabolic changes, and adipokines. Metabolomics in diabetes and obesity, lipidomics, and molecular genetics of metabolic disorders.

Unit III – Disorders of Amino Acid and Nucleic Acid Metabolism: Disorders of amino acid metabolism: inborn errors of branched-chain, aromatic, and aliphatic amino acids. Disorders of nucleic acid metabolism: purine and pyrimidine metabolism – hyperuricemia, gout, Lesch-Nyhan syndrome, hereditary orotic aciduria. Inborn errors of metabolism detected by tandem mass spectrometry (MS/MS), newborn screening, and molecular basis of metabolic disorders.

Unit IV – Clinical Function Tests: Liver function tests: clinical significance of AST, ALT, ALP, GGT, bilirubin fractions, and novel biomarkers (FibroTest, ELF score). Jaundice – types and differential diagnosis. Renal function tests: clearance tests, renal blood flow, concentration and dilution tests. Acute and chronic renal failure, glomerulonephritis, nephrotic syndrome, urinary calculi, dialysis, and renal biomarkers (NGAL, cystatin C). Pancreatic function tests. Gastrointestinal function tests: fractional gastric analysis, stimulation tests. Detection of inborn errors in fetus and heterozygous carriers by enzyme assay in amniotic fluid. Molecular diagnostics in liver and renal diseases, biomarker discovery, and non-invasive imaging techniques.

Unit V – Disorders of Mineral and Hemoglobin Metabolism Disorders of mineral metabolism: porphyrins and porphyrias. Hemoglobin – disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, and anemia. Classification of anemia, biochemical markers, and blood clotting disorders. Molecular genetics of hemoglobinopathies, next-generation sequencing (NGS) in anemia diagnosis, coagulation factor assays, and personalized medicine approaches.

Reference Books

Title	Authors	Edition	Year	Publisher
Clinical Biochemistry	Michael Murphy, Rajeev Srivastava, Kevin Deans	7th	2023	Elsevier
Clinical Biochemistry: Illustrated Colour Text	Michael Murphy, Rajeev Srivastava	6th	2023	Elsevier
Tietz Textbook of Clinical Chemistry and Molecular Diagnostics	Carl A. Burtis, David E. Bruns	6th	2022	Elsevier
Clinical Chemistry: Principles, Techniques, and Correlations	Michael L. Bishop, Edward P. Fody, Larry E. Schoeff	8th	2022	Wolters Kluwer
Clinical Biochemistry and Metabolic Medicine	Martin Crook	8th	2019	CRC Press
Clinical Chemistry: Fundamentals and Laboratory Techniques	Nader Rifai, Andrea Rita Horvath	2nd	2018	Elsevier
Clinical Chemistry: Concepts and Applications	Lawrence Kaplan, Amadeo Pesce	5th	2017	Mosby/Elsevier

Web Resources

- **NCBI Bookshelf – Clinical Biochemistry (ncbi.nlm.nih.gov in Bing)**
- **PubMed – Clinical Biochemistry Literature (pubmed.ncbi.nlm.nih.gov in Bing)**
- **Khan Academy – Biochemistry (khanacademy.org in Bing)**
- **IUBMB – Biochemistry Resources**
- **MedlinePlus – Clinical Chemistry & Lab Tests**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	3	1	2	2	1
CO2	2	3	3	2	2	3	2	1	1	2
CO3	3	2	3	3	2	2	2	2	3	2
CO4	3	2	3	3	3	2	2	2	3	2
CO5	3	2	3	3	3	2	2	2	3	3
CO6	2	3	2	3	3	2	2	3	3	2

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – III

CORE – VIII – HUMAN PHYSIOLOGY AND ENDOCRINOLOGY

The Course Objectives of this course are

- To understand the structural and functional organization of major organ systems.
- To explain physiological mechanisms underlying digestion, respiration, circulation, excretion, reproduction, and nervous control.
- To analyze muscle physiology and neuromuscular transmission.
- To study hormonal regulation, receptor mechanisms, and endocrine axes.
- To evaluate endocrine disorders and their clinical significance.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Demonstrate understanding of the physiology of the digestive, respiratory, and circulatory systems	K1 – Remember, K2 – Understand
CO2	Explain the physiology of the excretory and reproductive systems, including hormonal regulation and gametogenesis	K2 – Understand, K3 – Apply
CO3	Analyze the organization of the nervous system and mechanisms of muscle contraction and neuromuscular transmission	K2 – Understand, K3 – Apply, K4 – Analyze
CO4	Evaluate the classification, mechanisms of action of hormones, and regulation of the hypothalamus-pituitary axis	K3 – Apply, K4 – Analyze, K5 – Evaluate
CO5	Assess the synthesis, regulation, and pathophysiology of thyroid, parathyroid, adrenal, and pancreatic hormones	K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

Unit I – Digestive, Respiratory, and Circulatory Systems: Digestive system – Structure, digestive juices, composition and functions, digestion and absorption of carbohydrates, lipids, proteins. Intestinal and bile secretion and functions. Respiratory system – Components and functions, transport and exchange of respiratory gases. Circulatory system – Structure and functions of heart, functions of blood, blood coagulation mechanism.

Unit II – Excretory and Reproductive Systems: Excretory system – Structure of nephron, formation of urine, tubular reabsorption of glucose, water, electrolytes, tubular secretion. Normal and abnormal constituents of urine. Reproductive system – Structure and functions of male and female reproductive system, physiology of pregnancy and lactation, spermatogenesis and oogenesis. Biological actions of testosterone, progesterone, and estrogen.

Unit III – Nervous System and Muscle Physiology: Nervous system – Organization, conduction of nerve impulse, neurotransmission, action potential. Anatomical structure and function of nervous system. Gross anatomical structure of brain – cerebral hemisphere, diencephalon, brain stem, spinal cord. Muscle – Types of muscle, structure of skeletal muscle, proteins (myosin, actin, troponin, tropomyosin). Action potential, reflex action, contraction and relaxation of skeletal muscle. Neuromuscular junction – role of acetylcholine and Ach receptor.

Unit IV – Hormones and Pituitary Axis: Hormones – Classification and mechanism of action of peptide hormones. Receptors – G protein coupled receptors, adenylate cyclase. Second messengers – types and mechanism of action. Neurohormones. Steroid hormones – Mechanism of action, structure of steroid receptors, functional domains, DNA binding sites, nuclear transport, transcriptional and post-transcriptional mechanisms. Hypothalamus-pituitary axis – Hypothalamic hormones, anterior and posterior pituitary hormones, biological functions and regulation.

Unit V – Thyroid, Parathyroid, Adrenal, and Pancreatic Hormones: Thyroid hormones – Synthesis, secretion, regulation, biological actions, hyperthyroidism and hypothyroidism. Parathyroid hormones – Synthesis, secretion, mechanism of action, pathophysiology. Adrenal cortical hormones – Synthesis, secretion, regulation, biological actions, Cushing's syndrome, Addison's disease. Adrenal medullary hormones – Catecholamines, synthesis, secretion, regulation, biological actions. Pancreatic hormones – Insulin and glucagon, synthesis, regulation, biological actions.

Reference Books

Title	Authors	Edition	Year	Publisher
Textbook of Medical Physiology	Guyton & Hall	14th	2021	Elsevier
Review of Medical Physiology	Ganong	26th	2019	McGraw Hill
Essentials of Medical Physiology	Sembulingam & Sembulingam	8th	2022	Jaypee
Human Physiology: From Cells to Systems	Lauralee Sherwood	9th	2020	Cengage
Basic & Clinical Endocrinology	Greenspan & Gardner	10th	2018	McGraw Hill
Endocrinology: Adult and Pediatric	Jameson & De Groot	7th	2022	Elsevier

🌐 Web Resources with Links

- NCBI Bookshelf – https://www.ncbi.nlm.nih.gov/books
- PubMed – https://pubmed.ncbi.nlm.nih.gov
- Khan Academy – https://www.khanacademy.org/science/biology/human-biology
- American Physiological Society – https://www.physiology.org
- MedlinePlus – https://medlineplus.gov/endocrinediseases.html

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	2	2	2	2
CO2	3	2	3	2	2	2	2	2	2	3
CO3	3	2	3	3	2	2	2	2	3	2
CO4	3	2	3	3	3	2	2	3	3	2
CO5	3	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – III

CORE – IX – GENETIC ENGINEERING

Course Objectives

- To provide advanced knowledge of recombinant DNA technology, DNA manipulative enzymes, ligations, linkers, and adaptors.
- To analyze the design, properties, and applications of cloning vectors including plasmids, phages, cosmids, YAC, BAC, viral vectors, and marker systems.
- To apply gene transfer methods and screening techniques for the identification and selection of recombinant clones.
- To evaluate gene expression systems in prokaryotes and mammalian cells, and assess therapeutic applications such as recombinant proteins and gene therapy.
- To design and utilize molecular techniques including PCR, sequencing, blotting, hybridization, and genomic/cDNA library construction for applications in medicine, agriculture, and biotechnology.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Explain the principles of recombinant DNA technology and the role of DNA manipulative enzymes, ligations, linkers, and adaptors	K1 – Remember, K2 – Understand
CO2	Analyze the characteristics and applications of cloning vectors (plasmids, phages, cosmids, YAC, BAC, viral vectors) and marker systems	K2 – Understand, K3 – Apply
CO3	Apply gene transfer methods and screening techniques to identify and select recombinant clones	K3 – Apply, K4 – Analyze
CO4	Evaluate gene expression systems in prokaryotes and mammalian cells, and assess therapeutic applications including recombinant proteins and gene therapy	K4 – Analyze, K5 – Evaluate
CO5	Design and utilize molecular techniques (PCR, sequencing, blotting, hybridization, genomic/cDNA libraries) and assess applications of recombinant DNA technology	K5 – Evaluate, K6 – Create

Unit I – DNA Manipulative Enzymes and Recombinant DNA Technology: Restriction-modification enzymes in recombinant DNA technology and cloning. Enzymes in gene cloning including ligases, linkers, and adaptors. Principles of recombinant DNA technology. DNA replication, restriction-modification systems, and DNA repair.

Unit II – Cloning Vectors and Marker Systems: Plasmid vectors: pBR322, pUC18. Bacteriophage vectors, cosmids, phagemids, YAC and BAC vectors. Viral vectors: SV40 and retrovirus as vectors. Marker genes: selectable and screenable markers, aptamers. Expression vectors for prokaryotes and eukaryotes, shuttle vectors, inducible promoters, reporter genes.

Unit III – Gene Transfer Methods and Screening of Recombinants: Transformation, transduction, conjugation, electroporation, microinjection, liposome-mediated transfer, Agrobacterium-mediated transfer. Screening techniques: blue-white selection, antibiotic resistance markers, colony hybridization, PCR-based screening.

Unit IV – Gene Expression and Therapeutic Applications: Gene expression in prokaryotes: tissue-specific promoters, wound-inducible promoters, strong and regulatable promoters, fusion proteins. Mammalian cell expression: two-vector expression, two-gene expression vectors, host cell types. Transformation, selection of transformed cells, identification of recombinants. Therapeutic applications: recombinant insulin, growth hormones, hepatitis B vaccines. Gene therapy: stem cell gene therapy, somatic cell gene therapy, gene therapy for inherited diseases including familial hypercholesterolemia, ADA deficiency, and cystic fibrosis.

Unit V – Molecular Techniques and Applications of rDNA Technology: Isolation and purification of nucleic acids. Hybridization techniques: RAPD, RFLP, types of probes and applications. Blotting techniques: Southern, Northern, Western. FISH, DNA fingerprinting, DNA footprinting. DNA sequencing: Sanger's method. PCR – principle, types, and applications. DNA transfer techniques: chemical induction, electroporation, gene targeting, and gene tagging. Construction of genomic and cDNA libraries. Applications of recombinant DNA technology in medicine, agriculture, and biotechnology.

Reference Books

Title	Authors	Edition	Year	Publisher
Gene Cloning and DNA Analysis	T.A. Brown	7th	2023	Wiley
Recombinant DNA: Genes and Genomes	J.D. Watson et al.	3rd	2020	W.H. Freeman
Principles of Gene Manipulation and Genomics	S.B. Primrose & R.M. Twyman	7th	2019	Wiley-Blackwell
Molecular Biotechnology: Principles and Applications	B.R. Glick & J.J. Pasternak	5th	2021	ASM Press
Molecular Cell Biology	H. Lodish et al.	9th	2021	W.H. Freeman

🌐 **Web Resources**

- **NCBI – National Center for Biotechnology Information** https://www.ncbi.nlm.nih.gov (ncbi.nlm.nih.gov in Bing)
- **PubMed – Biomedical Literature Database** https://pubmed.ncbi.nlm.nih.gov (pubmed.ncbi.nlm.nih.gov in Bing)
- **European Molecular Biology Laboratory (EMBL)** https://www.embl.org
- **Nature Reviews Genetics** https://www.nature.com/nrg
- **Khan Academy – Biotechnology Tutorials** https://www.khanacademy.org/science/biology/biotech-dna-technology (khanacademy.org in Bing)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	2	2	2	2
CO2	3	2	3	2	2	2	2	2	2	3
CO3	3	2	3	3	2	2	2	2	3	2
CO4	3	2	3	3	3	2	2	3	3	2
CO5	3	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M.Sc., BIOCHEMISTRY

SECOND YEAR – SEMESTER – III

CORE PRACTICAL - III – CLINICAL BIOCHEMISTRY AND GENETIC ENGINEERING

Course Objectives

- To train students in Clinical Biochemistry methods for blood and urine analysis.
- To provide hands-on experience in enzyme assays relevant to clinical diagnostics.
- To develop skills in genetic engineering techniques including DNA manipulation and recombinant screening.
- To strengthen analytical ability through PCR, blotting methods, and molecular diagnostics.
- To integrate biochemical and Molecular Biology techniques for applied healthcare and research.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Estimate blood glucose, urea, creatinine, cholesterol, triglycerides, bilirubin, and A:G ratio	K3 – Apply
CO2	Perform qualitative and quantitative urine analysis for normal and abnormal constituents	K3 – Apply
CO3	Conduct enzyme assays for AST, ALT, ALP, and ACP	K4 – Analyze
CO4	Demonstrate restriction digestion and transformation of *E. coli*	K3 – Apply
CO5	Screen recombinant colonies using blue–white selection	K4 – Analyze
CO6	Perform PCR and RT-PCR for nucleic acid amplification	K4 – Analyze
CO7	Execute Southern and Western blotting for DNA and protein detection	K5 – Evaluate
CO8	Interpret biochemical and molecular diagnostic data	K5 – Evaluate
CO9	Integrate Clinical Biochemistry with genetic engineering techniques	K6 – Create
CO10	Apply laboratory skills to healthcare and biomedical research	K6 – Create

I - CLINICAL BIOCHEMISTRY PRACTICAL

A) Blood Analysis

- Estimation of blood glucose by Glucose oxidase/peroxidase method
- Estimation of urea by Diacetyl monoxime method
- Estimation of creatinine by Jaffe's method
- Estimation of serum cholesterol by Zak's method
- Estimation of serum triglycerides by Enzymatic method
- Determination of A:G ratio by Biuret method
- Estimation of serum bilirubin by Van den Bergh Method

B) Urine Analysis

- Qualitative analysis of normal constituents (urea, uric acid, creatinine) by standard chemical tests
- Qualitative analysis of abnormal constituents (glucose, ketone bodies, proteins, bile salts, bile pigments) by diagnostic chemical tests
- Quantitative estimation of urea by Diacetyl monoxime method
- Quantitative estimation of creatinine by Jaffe's method
- Estimation of Titrable acidity by Acid–Base Titration method
- Estimation of Phosphate by Fiske–Subbarow Method
- Estimation of Chloride by Vanslyke's method

C) Enzyme Assays

- Determination of Aspartate transaminase (AST) activity by Reitman–Frankel method
- Determination of Alanine transaminase (ALT) activity by Reitman–Frankel method
- Determination of Alkaline phosphatase (ALP) activity by King–Armstrong method
- Determination of Acid phosphatase (ACP) activity by King–Armstrong method

II - GENETIC ENGINEERING PRACTICAL

A) Recombinant DNA Techniques - Demonstration

- Restriction digestion of DNA
- Transformation of *E. coli* with plasmid DNA
- Screening of recombinant colonies (blue-white selection)
- Polymerase Chain Reaction (PCR)
- Southern blotting and Western blotting

References

Title	Author(s)	Publisher	Edition / Year
Biochemical Methods	S. Sadasivam & A. Manickam	New Age International	2nd Edition, 1992
Laboratory Manual in Biochemistry	J. Jayaraman	New Age International	1st Edition, 1981
Introductory Practical Biochemistry	S.K. Sawhney & Radhir Singh	Alpha Science International	2nd Edition, 2005
Cell Biology: A Laboratory Handbook	J.E. Celis	Academic Press	3rd Edition, 2006
Molecular Cloning: A Laboratory Manual	Sambrook & Russell	Cold Spring Harbor Laboratory Press	3rd Edition, 2001
Principles and Techniques of Biochemistry and Molecular Biology	Wilson & Walker	Cambridge University Press	7th Edition, 2010

Web Resources

- Nature Protocols – Biochemistry & Molecular Biology
- NCBI Bookshelf – Clinical Biochemistry (ncbi.nlm.nih.gov in Bing)
- Khan Academy – Molecular Biology (khanacademy.org in Bing)
- PubMed – Biochemistry & Genetic Engineering Research (pubmed.ncbi.nlm.nih.gov in Bing)

Mapping with Programme Outcomes

POs	CO1	CO2	CO3	CO4	CO5	CO6	CO7	CO8	CO9	CO10
PO1	3	3	3	3	3	3	3	3	3	3
PO2	2	2	3	2	3	3	3	3	3	3
PO3	2	2	3	2	3	3	3	3	3	3
PO4	2	2	3	2	3	3	3	3	3	3
PO5	2	2	2	3	3	3	3	3	3	3
PO6	1	2	2	2	2	2	2	3	3	3
PO7	1	1	2	2	2	2	2	2	2	3
PO8	1	1	2	2	2	2	2	2	2	2
PO9	2	2	2	2	2	2	2	2	3	3
PO10	2	2	2	2	2	2	2	2	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – III

ELECTIVE – III – A) PHYTOCHEMISTRY

Course Objectives

- To understand fundamentals of phytochemistry including primary and secondary metabolites.
- To explain biosynthesis and functions of plant metabolites.
- To apply methods of extraction, isolation, and characterization of phytochemicals.
- To analyze therapeutic roles of phytochemicals in healthcare and nutrition.
- To evaluate modern applications of phytochemistry including biotechnology, nutraceuticals, and safety aspects.
- To create innovative approaches in phytochemical research for drug discovery and development.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of phytochemistry and classification of metabolites	K1 – Remember
CO2	Explain biosynthesis and functions of alkaloids, flavonoids, terpenoids, glycosides, and other metabolites	K2 – Understand
CO3	Apply extraction, isolation, and characterization techniques for phytochemicals	K3 – Apply
CO4	Analyze therapeutic roles of phytochemicals in healthcare, nutrition, and traditional medicine	K4 – Analyze
CO5	Evaluate modern applications, safety, regulatory aspects, and IPR in phytochemistry	K5 – Evaluate
CO6	Create innovative approaches in phytochemical research, metabolite engineering, and drug development	K6 – Create

Unit I – Introduction to Phytochemistry: Scope and importance, primary and secondary metabolites, classification of phytochemicals, role of phytochemistry in drug discovery, phytochemical diversity in medicinal plants.

Unit II – Plant Metabolites: Alkaloids, flavonoids, terpenoids, glycosides, tannins, phenolics, saponins, lignans, coumarins; biosynthesis pathways, ecological roles, and pharmacological significance.

Unit III – Extraction and Isolation Techniques: Methods of extraction (solvent extraction, Soxhlet, distillation, supercritical fluid extraction, microwave-assisted extraction), isolation and purification, chromatographic techniques (TLC, HPLC, GC-MS, LC-MS), spectroscopic characterization (UV, IR, NMR, MS), metabolomics approaches.

Unit IV – Pharmacological and Nutraceutical Applications: Therapeutic roles of phytochemicals (anticancer, antimalarial, antimicrobial, antioxidant, cardiac glycosides), nutraceuticals and functional foods, plant-derived drugs and their clinical relevance, phytochemicals in traditional medicine systems (Ayurveda, Siddha, TCM).

Unit V – Modern Applications and Safety Aspects: Biotechnological approaches (plant tissue culture, metabolic engineering, synthetic biology for metabolite production), herbal formulations and standardization, regulatory aspects, toxicity and safety evaluation, intellectual property rights in phytochemistry, ethical issues in herbal drug development.

Reference Books

Title	Author	Edition	Year	Publisher
Pharmacognosy	Trease & Evans	16th	2019	Elsevier
Textbook of Pharmacognosy	C.K. Kokate, Purohit & Gokhale	2nd	2018	Nirali Prakashan
Medicinal Plants: Chemistry and Properties	C.K. Atal & B.N. Kapoor	1st	2017	CRC Press
Plant Secondary Metabolites	J.B. Harborne	1st	2014	Academic Press
Herbal Medicine: Biomolecular and Clinical Aspects	I.F.F. Benzie & S. Wachtel-Galor	2nd	2011	CRC Press
Phytochemistry of Medicinal Plants	T.E. Wallis	5th	2020	Springer

🌐 Web Resources

- WHO – Traditional Medicine and Herbal Research (who.int in Bing)
- ICMR – Medicinal Plants and Phytochemistry
- FAO – Plant Biotechnology (fao.org in Bing)
- PubMed – Phytochemistry Journals (pubmed.ncbi.nlm.nih.gov in Bing)
- Springer – Phytochemistry Research Articles

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – III

ELECTIVE – III – B) MICROBIAL BIOCHEMISTRY

Course Objectives

- To understand microbial diversity and growth.
- To explain microbial metabolism including photosynthesis, fermentation, and nitrogen fixation.
- To apply fermentation technology for industrial purposes.
- To analyze industrial production of biochemicals.
- To evaluate environmental applications of microbes.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall microbial diversity, cell structure, and growth methods	K1 – Remember
CO2	Explain microbial metabolism including photosynthesis, fermentation, and nitrogen fixation	K2 – Understand
CO3	Apply fermentation technology for production of microbial products	K3 – Apply
CO4	Analyze industrial production of antibiotics, vitamins, amino acids, enzymes, and fermented foods	K4 – Analyze
CO5	Evaluate environmental applications including wastewater treatment, bioremediation, biofertilizers, and biopesticides	K5 – Evaluate
CO6	Create innovative approaches in microbial biotechnology and environmental sustainability	K6 – Create

Unit I – Microbial Diversity and Growth: Bacteria, fungi, algae, protozoa and viruses; cyanobacteria and archaebacteria; microbial cell structure; microbial growth curve, measurement and continuous culture; sterilization and culture media.

Unit II – Microbial Metabolism: Photosynthesis in microbes, Calvin cycle and pigments; chemolithotrophy; nitrate and sulfate reduction; methanogenesis and acetogenesis; fermentation pathways including Entner–Doudoroff and Stickland reactions; nitrogen metabolism and fixation; hydrocarbon transformation; amino acid biosynthesis.

Unit III – Fermentation Technology: Isolation and screening of industrial microbes; inoculum preparation and strain improvement; submerged and solid-state fermentation; fermenter types; downstream processing; production of biomass, single-cell protein, organic acids and solvents; bioleaching and biosorption.

Unit IV – Industrial Products: Production of antibiotics, vitamins, amino acids and enzymes; immobilization techniques; food microbiology including fermented foods and beverages such as yoghurt, cheese, beer, wine and vinegar.

Unit V – Environmental Microbiology: Wastewater and effluent treatment; bioremediation of oil spills and xenobiotics; microbial mining; biofertilizers; biopesticides; soil microbiota and biogeochemical cycles.

Reference Books

Title	Author	Edition	Year	Publisher
Microbial Biochemistry	G.N. Cohen	2nd	2011	Springer
Brock Biology of Microorganisms	Madigan, Bender, Buckley	15th	2018	Pearson
Microbial Physiology	Moat, Foster, Spector	4th	2002	Wiley-Liss
Fundamentals of Microbiology	Jeffrey C. Pommerville	11th	2020	Jones & Bartlett Learning
Industrial Microbiology	L.E. Casida	1st	2019	Wiley-Blackwell

🌐 Web Resources

- ASM – American Society for Microbiology
- NCBI – Microbial Biochemistry Resources (ncbi.nlm.nih.gov in Bing)
- WHO – Antimicrobial Resistance and Microbial Research (who.int in Bing)
- PubMed – Microbial Biochemistry Journals (pubmed.ncbi.nlm.nih.gov in Bing)
- Springer – Microbial Biochemistry Research Articles

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – IV

CORE – X – IMMUNOLOGY AND IMMUNOTECHNOLOGY

Course Objectives

- To provide advanced knowledge of the immune system, its organization, and the structural and functional aspects of antigens and immunoglobulins.
- To analyze T and B cell biology, receptor interactions, maturation, activation, effector mechanisms, and cytokine-mediated responses.
- To evaluate the organization and functions of MHC molecules, hypersensitivity reactions, transplantation immunology, autoimmunity, and immunodeficiency.
- To assess tumor immunology, immunization strategies, vaccine technologies, hybridoma techniques, and antibody production methods.
- To apply immunotechnology approaches including experimental models, antigen-antibody reactions, blotting techniques, immunoassays, and flow cytometry.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Demonstrate understanding of immune system organization, antigens, and immunoglobulin structure and function	K1 – Remember, K2 – Understand
CO2	Explain T and B cell biology, receptor interactions, maturation, activation, and effector mechanisms	K2 – Understand, K3 – Apply
CO3	Analyze MHC organization, hypersensitivity reactions, transplantation immunology, autoimmunity, and immunodeficiency	K3 – Apply, K4 – Analyze
CO4	Evaluate tumor immunology, immunization strategies, vaccine technologies, and hybridoma techniques for antibody production	K4 – Analyze, K5 – Evaluate
CO5	Design and apply immunotechnology approaches including experimental models, immunoassays, and flow cytometry	K5 – Evaluate, K6 – Create

Unit I – Concepts of Immunology: Overview of the immune system: non-specific and specific components of immunity. Cells, primary and secondary organs of the immune system. Hematopoiesis. Antigens – immunogenicity, haptens, adjuvants, epitopes (T cell and B cell epitopes). Immunoglobulins – structure, classes, biological activities, antigenic determinants, Ig superfamily, organization and expression of Ig genes, abzymes.

Unit II – T and B Cell Biology, Effector Mechanisms: T cell and B cell receptors, interaction of T cells and B cells. T cell and B cell maturation, activation and differentiation. Effector mechanisms – macrophage activation, cytokine-mediated immunity. Clonal selection theory, immunoglobulin rearrangements, class switching. Complement system and regulation. Cytokines and cell-mediated effector responses.

Unit III – MHC, Hypersensitivity, Transplantation, Autoimmunity: Organization and functions of MHC, structure of MHC molecules, antigen processing and presentation. Classes of MHC molecules. Hypersensitivity reactions (Types I–V). Immune response to infectious diseases. Transplantation types, MHC antigens in transplantation, mechanism of graft rejection, immunosuppressive therapy. Autoimmunity and immunodeficiency diseases – types, mechanism of HIV organization and pathogenesis.

Unit IV – Tumor Immunology, Vaccines, Hybridoma Technology: Oncogenes, tumor antigens and cancer induction, metastasis, immune response to tumors, cancer immunotherapy. Immunization – active and passive immunization, types of vaccines and vaccine technology: peptide vaccines, toxoids, recombinant vector vaccines, DNA vaccines, synthetic peptide vaccines. Hybridoma techniques – HAT media, production of monoclonal and polyclonal antibodies. Gene transfer into mammalian cells – cultured cells and mouse embryos.

Unit V – Experimental Models and Immunotechnology: Experimental animal models – inbred strains, adaptive-transfer systems, hemolytic plaque assay, SCID mice. Cell culture systems – primary, cloned and hybrid lymphoid cell lines. Protein labeling techniques. Antigen-antibody reactions – agglutination and precipitation, immunoelectrophoresis, immunoblotting techniques, RIA, ELISA (principle, types, applications). Immunofluorescence, avidin-biotin mediated assay, flow cytometry.

Reference Books

Title	Authors	Edition	Year	Publisher
Kuby Immunology	Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen	9th	2023	W.H. Freeman
Janeway's Immunobiology	Kenneth Murphy, Casey Weaver	10th	2022	Garland Science
Cellular and Molecular Immunology	Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai	10th	2021	Elsevier
Roitt's Essential Immunology	Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt	14th	2021	Wiley-Blackwell
Fundamental Immunology	William E. Paul	7th	2019	Lippincott Williams & Wilkins

Web Resources

- **NCBI Bookshelf – Immunology** https://www.ncbi.nlm.nih.gov/books (ncbi.nlm.nih.gov in Bing)
- **Nature Immunology – Journal** https://www.nature.com/ni
- **Frontiers in Immunology – Open Access Journal** https://www.frontiersin.org/journals/immunology
- **WHO – Vaccines and Immunization** https://www.who.int/health-topics/vaccines-and-immunization (who.int in Bing)
- **CDC – HIV Basics and Immunology** https://www.cdc.gov/hiv/basics

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	2	2	2	2
CO2	3	2	3	2	2	2	2	2	2	3
CO3	3	2	3	3	2	2	2	2	3	2
CO4	3	2	3	3	3	2	2	3	3	2
CO5	3	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – IV

CORE – XI – BIOCHEMICAL PHARMACOLOGY AND TOXICOLOGY

Course Objectives

- To provide advanced knowledge of biopharmaceutical properties of drugs, including physicochemical factors, dissociation, and structural features influencing pharmacological activity.
- To analyze theoretical aspects of drug designing, molecular modeling, receptor pharmacology, and clinically significant drugs.
- To evaluate drug metabolism pathways (Phase I & II), cytochrome P450 enzyme systems, conjugation mechanisms, and drug interactions.
- To understand general toxicology principles, mechanisms of toxic effects, toxicokinetics, and systemic toxic responses to drugs and environmental agents.
- To apply toxicological knowledge in clinical and applied contexts, including poisoning management, antidotes, preclinical studies, analytical toxicology, and toxicovigilance.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Explain biopharmaceutical properties of drugs and the influence of structural features on pharmacological activity	K1 – Remember, K2 – Understand
CO2	Analyze drug designing principles, molecular modeling, receptor pharmacology, and clinically significant drugs	K2 – Understand, K3 – Apply
CO3	Evaluate drug metabolism pathways, cytochrome P450 systems, conjugation mechanisms, and drug interactions	K3 – Apply, K4 – Analyze
CO4	Assess general toxicology principles, mechanisms of toxic effects, toxicokinetics, and systemic toxic responses	K4 – Analyze, K5 – Evaluate
CO5	Apply toxicological knowledge in clinical and applied contexts including poisoning management, antidotes, and toxicovigilance	K5 – Evaluate, K6 – Create

Unit I – Biopharmaceutical Properties of Drugs: Mechanism of drug absorption – physicochemical factors versus drug absorption. Drug dissociation versus drug absorption. Isomerism and pharmacological activity. Structural features influencing pharmacological activity: geometric isomerism, stereochemical configuration, and conformational isomerism.

Unit II – Drug Designing and Receptor Pharmacology: Theoretical aspects of drug designing. Molecular modeling: principles of computational chemistry, molecular mechanics, chemical methods. Hardware and software considerations. Receptors and drug action: affinity, chemical bonding, dose–response relationships, receptor location, receptor subtypes, dynamic nature of receptors. Drugs of clinical significance: nonsteroidal anti-inflammatory drugs, drugs affecting sugar metabolism.

Unit III – Drug Metabolism (Phase I & II): First-pass metabolism, elimination pathways, enterohepatic cycling of drugs. Phase I biotransformation: hepatic cytochrome P450 enzyme system, induction and inhibition of cytochrome P450 cycle. Oxidation catalyzed by cytochrome P450 isoforms – hydroxylation, deamination, dealkylation, dehalogenation. Microsomal and non-microsomal oxidations. Miscellaneous reductions. Phase II conjugation pathways: hyaluronic acid conjugation, sulfate conjugation, amino acid conjugation, acetylation, glutathione conjugation, cyanide conjugation. Extrahepatic metabolism – toxicity from oxidative metabolism. Drug interactions – Ames test.

Unit IV – General Toxicology: Principles of toxicology and diagnosis. Mechanisms of toxic effects. Toxicokinetics – absorption, distribution, metabolism, and excretion of toxicants. Toxic responses of respiratory, reproductive, hepatic, renal, and nervous systems. Toxic effects of metals, solvents, pesticides, and environmental pollutants.

Unit V – Applied Toxicology and Toxicovigilance: Treatment of poisoning. Heavy metals and antagonists. Non-metallic environmental toxicants. Antidotes in poisoning management. Preclinical toxicological studies – acute, sub-acute, and chronic toxicity studies. Determination of LD50 and ED50. Methods in new drug development – toxicological evaluation. Applied analytical toxicology and toxicovigilance. Case studies of drug-induced toxicity.

Reference Books

Title	Authors	Edition	Year	Publisher
Biochemical Pharmacology	Charles R. Craig, Robert E. Stitzel	5th	2019	Lippincott Williams & Wilkins
Goodman & Gilman's The Pharmacological Basis of Therapeutics	Laurence Brunton, Bruce Chabner, Bjorn Knollman	13th	2018	McGraw Hill
Casarett & Doull's Toxicology: The Basic Science of Poisons	Curtis D. Klaassen	9th	2019	McGraw Hill
Principles of Pharmacology	David L. Golan, Armen H. Tashjian, Ehrin J. Armstrong	4th	2021	Wolters Kluwer
Drug Metabolism and Pharmacokinetics	Stephen H. Curry	3rd	2020	CRC Press

Web Resources

- **NCBI Bookshelf – Pharmacology and Toxicology** https://www.ncbi.nlm.nih.gov/books (ncbi.nlm.nih.gov in Bing)
- **PubMed – Biochemical Pharmacology Literature** https://pubmed.ncbi.nlm.nih.gov (pubmed.ncbi.nlm.nih.gov in Bing)
- **FDA – Drug Development and Toxicology Guidance** https://www.fda.gov/drugs
- **WHO – International Programme on Chemical Safety (IPCS)** https://www.who.int/ipcs
- **ScienceDirect – Biochemical Pharmacology Journal** https://www.sciencedirect.com/journal/biochemical-pharmacology (sciencedirect.com in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	3	2	2	2	2	2	2
CO2	3	2	3	2	2	2	2	2	2	3
CO3	3	2	3	3	2	2	2	2	3	2
CO4	3	2	3	3	3	2	2	3	3	2
CO5	3	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

M. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – IV

SEC – II – STEM CELL BIOLOGY

Course Objectives

- To understand fundamentals of stem cell biology.
- To explain types and properties of stem cells.
- To apply stem cell culture techniques for research and therapy.
- To analyze molecular regulation of stem cells.
- To evaluate applications of stem cells in medicine, biotechnology, and ethics.

Course Outcome

On successful completion of this course, students should be proficient to

CO No	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals, properties, and types of stem cells	K1 – Remember
CO2	Explain stem cell culture methods and differentiation assays	K2 – Understand
CO3	Apply stem cell techniques in research and therapy	K3 – Apply
CO4	Analyze molecular regulation and signaling pathways in stem cells	K4 – Analyze
CO5	Evaluate applications, ethical issues, and regulatory aspects	K5 – Evaluate
CO6	Create innovative approaches in stem cell research and regenerative medicine	K6 – Create

Unit I – Introduction to Stem Cells: Definition, history, scope, stem cell niche, properties of stem cells, potency (totipotent, pluripotent, multipotent, unipotent), embryonic vs adult stem cells.

Unit II – Types of Stem Cells: Embryonic stem cells, adult stem cells, hematopoietic stem cells, mesenchymal stem cells, induced pluripotent stem cells (iPSCs), cancer stem cells.

Unit III – Stem Cell Culture and Techniques: Isolation and culture methods, stem cell markers, differentiation assays, cryopreservation, stem cell banking, genetic manipulation, organoid culture.

Unit IV – Molecular Regulation of Stem Cells: Signaling pathways (Wnt, Notch, Hedgehog, BMP), transcription factors (Oct4, Sox2, Nanog), epigenetic regulation, stem cell plasticity, regulation of self-renewal and differentiation.

Unit V – Applications and Ethics: Stem cells in regenerative medicine, tissue engineering, gene therapy, disease modeling, drug screening, clinical trials, ethical issues, biosafety, regulatory aspects, intellectual property rights.

Reference Books

Title	Author	Edition	Year	Publisher
Stem Cells: An Insider's Guide	Paul Knoepfler	2nd	2017	World Scientific
Essentials of Stem Cell Biology	Robert Lanza	3rd	2014	Academic Press
Principles of Regenerative Medicine	Anthony Atala	2nd	2019	Elsevier
Stem Cell Biology	Daniel R. Marshak	1st	2018	Cold Spring Harbor Laboratory Press
Stem Cells Handbook	Stewart Sell	2nd	2019	Springer

🌐 Web Resources

- NIH Stem Cell Basics
- WHO – Stem Cell Research Guidelines (who.int in Bing) (bing.com in Bing)
- PubMed – Stem Cell Biology Journals (pubmed.ncbi.nlm.nih.gov in Bing) (bing.com in Bing)
- International Society for Stem Cell Research (ISSCR)
- Springer – Stem Cell Research Articles (springer.com in Bing) (bing.com in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

NME – COURSE OFFERED TO OTHER DEPARTMENT STUDENTS

FIRST YEAR - SEMESTER – II

NMEC – I – ENVIRONMENTAL BIOCHEMISTRY

Course Objectives

- To understand environmental biochemistry fundamentals and ecosystem processes.
- To explain biogeochemical cycles and microbial roles.
- To apply biochemical principles to pollution and waste management.
- To analyze xenobiotic metabolism and toxicology.
- To evaluate environmental applications for sustainability.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of environmental biochemistry and ecosystem processes	K1 – Remember
CO2	Explain biogeochemical cycles and microbial transformations	K2 – Understand
CO3	Apply biochemical principles to pollution control and waste management	K3 – Apply
CO4	Analyze xenobiotic metabolism, detoxification pathways, and toxicology	K4 – Analyze
CO5	Evaluate environmental applications including bioremediation, biofertilizers, and biopesticides	K5 – Evaluate
CO6	Create innovative approaches for environmental protection and sustainability	K6 – Create

Unit I – Introduction: Scope and importance of environmental biochemistry, biochemical basis of ecosystems, microbial roles in soil and water, environmental compartments.

Unit II – Biogeochemical Cycles: Carbon, nitrogen, sulfur and phosphorus cycles, microbial transformations, greenhouse gases, global climate regulation.

Unit III – Pollution and Biochemical Effects: Air, water and soil pollution, biochemical impact of heavy metals, pesticides, plastics and hydrocarbons, oxidative stress, free radicals, biochemical indicators of pollution.

Unit IV – Xenobiotics and Toxicology: Biotransformation of xenobiotics, Phase I and Phase II reactions, detoxification pathways, bioaccumulation, biomagnification, environmental toxicology and risk assessment.

Unit V – Environmental Applications: Bioremediation, wastewater and effluent treatment, microbial degradation of xenobiotics, microbial mining, biofertilizers, biopesticides, soil microbiota, biogeochemical roles and environmental sustainability.

Reference Books

Title	Author	Edition	Year	Publisher
Environmental Biochemistry	V. Rama Rao	1st	2015	Oxford & IBH Publishing
Environmental Biochemistry and Chemistry	R.C. Sobti	1st	2019	Springer
Principles of Environmental Biochemistry	G. Schlesinger	2nd	2017	CRC Press
Environmental Toxicology	T.W. Clarkson	3rd	2018	Wiley
Bioremediation and Environmental Sustainability	R.C. Ray	1st	2020	Elsevier

🌐 Web Resources

- WHO – Environmental Health (who.int in Bing)
- NCBI – Environmental Biochemistry Resources (ncbi.nlm.nih.gov in Bing)
- EPA – Pollution and Environmental Health
- PubMed – Environmental Biochemistry Journals (pubmed.ncbi.nlm.nih.gov in Bing)
- Springer – Environmental Biochemistry Research

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High

NME – COURSE OFFERED TO OTHER DEPARTMENT STUDENTS

SECOND YEAR - SEMESTER – III

NMEC – II – BIOCHEMISTRY OF NUTRITION AND NUTRACEUTICALS

Course Objectives

- To understand fundamentals of nutrition biochemistry.
- To explain macronutrients and micronutrients and their metabolic roles.
- To apply nutritional assessment methods in health and disease.
- To analyze nutraceuticals and functional foods.
- To evaluate nutrition in disease prevention and therapeutic applications.

Course Outcome

On successful completion of this course, students should be proficient to

CO No.	Course Outcome Statement	Knowledge Level (Bloom's Taxonomy)
CO1	Recall fundamentals of nutrition and dietary guidelines	K1 – Remember
CO2	Explain metabolism of macronutrients and micronutrients	K2 – Understand
CO3	Apply nutritional assessment methods in health and disease	K3 – Apply
CO4	Analyze nutraceuticals and functional foods for health promotion	K4 – Analyze
CO5	Evaluate nutrition in prevention and management of diseases	K5 – Evaluate
CO6	Create innovative approaches in nutrition research and nutrigenomics	K6 – Create

Unit I – Fundamentals of Nutrition: Scope and importance; dietary guidelines; recommended dietary allowances; energy balance; basal metabolic rate; nutritional requirements in different physiological states.

Unit II – Macronutrients and Micronutrients: Carbohydrates, proteins, lipids – digestion, absorption, metabolism, and disorders; vitamins and minerals – biochemical roles, deficiency and toxicity; antioxidants and free radicals.

Unit III – Nutritional Assessment and Clinical Nutrition: Methods of nutritional assessment; biochemical markers; malnutrition; obesity; metabolic syndrome; nutrition in pregnancy, lactation, infancy, childhood, adolescence, and aging.

Unit IV – Nutraceuticals and Functional Foods: Definition and classification; phytochemicals, probiotics, prebiotics, omega-3 fatty acids, dietary fiber, flavonoids, carotenoids; role in health promotion; regulatory aspects and safety evaluation.

Unit V – Nutrition in Health and Disease: Role of nutrition in prevention and management of lifestyle diseases (diabetes, cardiovascular diseases, cancer, osteoporosis); therapeutic nutrition; personalized nutrition; current trends including nutrigenomics and nutrigenetics.

Reference Books

Title	Author	Edition	Year	Publisher
Modern Nutrition in Health and Disease	A. Catherine Ross et al.	11th	2020	Lippincott Williams & Wilkins
Advanced Nutrition and Human Metabolism	Sareen S. Gropper & Jack L. Smith	7th	2017	Cengage Learning
Nutraceuticals: Efficacy, Safety and Toxicity	R.C. Gupta	1st	2016	Academic Press
Nutrition Science	B. Srilakshmi	6th	2019	New Age International
Functional Foods and Nutraceuticals	K. R. Hegde	1st	2018	Springer

🌐 Web Resources

- ICMR – Nutrition Guidelines
- WHO – Nutrition and Health (who.int in Bing) (bing.com in Bing)
- PubMed – Nutrition and Nutraceuticals Journals (pubmed.ncbi.nlm.nih.gov in Bing) (bing.com in Bing)
- FAO – Food and Nutrition
- Springer – Nutrition and Nutraceuticals Research (springer.com in Bing) (bing.com in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	2	1	1	2	1	1
CO2	3	3	2	2	2	1	1	2	2	1
CO3	2	3	2	2	3	2	1	2	2	2
CO4	2	3	3	2	3	2	2	3	2	2
CO5	2	3	3	3	3	2	2	3	2	3
CO6	1	2	3	3	3	2	2	3	3	3

Scale: 1 – Low, 2 – Medium, 3 – High