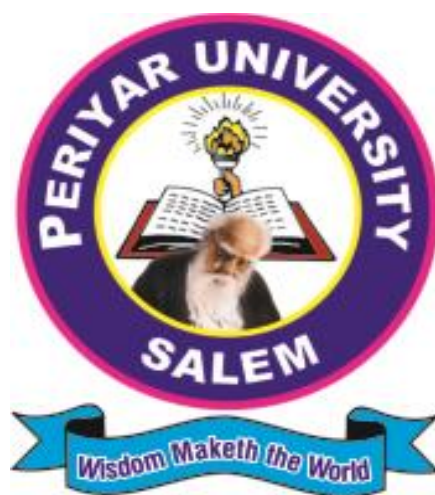


PERIYAR UNIVERSITY

SALEM – 636011



DEGREE OF BACHELOR OF SCIENCE

(CHOICE BASED CREDIT SYSTEM)

B.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 B.Sc. Biochemistry program is designed to provide students with a strong foundation in the molecular basis of life. It emphasizes the study of biomolecules, metabolic pathways, enzymology, genetics, and cellular processes that govern biological systems. The course integrates theoretical knowledge with practical laboratory skills, enabling students to analyze, interpret, and apply biochemical principles in health, disease, and biotechnology. By fostering critical thinking, research aptitude, and ethical responsibility, the program prepares graduates for diverse careers in academics, healthcare, pharmaceuticals, and life sciences industries, while also encouraging lifelong learning and adaptability to emerging scientific advancements.

The major objectives of B.Sc., Biochemistry course are

- To study the structures, properties, and biological functions of carbohydrates, proteins, lipids, nucleic acids, vitamins, and minerals.
- To understand the principles, instrumentation, and applications of chromatography, electrophoresis, spectroscopy, and molecular diagnostic tools.
- To learn the major metabolic pathways, enzyme catalysis, and bioenergetics essential for cellular function.
- To explore molecular techniques, regulation of gene expression, recombinant DNA technology, and genome editing.
- To update molecular concepts of immune responses, host defense mechanisms, and immunodiagnostic applications.
- To learn the principles and applications of biochemical assays in disease diagnosis, prognosis, and monitoring.
- To gain knowledge of drug design, biopharmaceuticals, fermentation technology, and industrial enzyme applications.
- To acquire practical skills through hands-on laboratory experiments, data analysis, and interpretation of biochemical results.
- To prepare graduates for careers in clinical research laboratories, healthcare industries, biotechnology firms, and academic research.
- To introduce computational biology, database analysis, and molecular modeling for understanding biomolecular interactions.
- To emphasize laboratory safety, ethical practices in biomedical research, and responsible handling of biological materials.
- To connect fundamental biochemical knowledge with clinical applications, personalized medicine, and public health.
- To encourage innovation, start-up culture, and product development in biotechnology and healthcare sectors.
- To promote eco-friendly biochemical practices, green chemistry approaches, and sustainable use of biological resources.

2. PROGRAMME OUTCOME AND KNOWLEGE LEVEL

PO No	PROGRAMME OUTCOME	Knowledge Level
PO1	Disciplinary knowledge: Ability to understand fundamental concepts of Biochemistry; Ability to apply basic principles of chemistry to Biological Systems and Molecular Biology; Ability to relate various interrelated physiological and metabolic events; A general awareness of current developments at the forefront in Biochemistry and Allied subjects; Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts; Zeal and ability to work safely and effectively in a laboratory; Good experimental and quantitative skills encompassing preparation of laboratory reagents, conducting experiments, satisfactory analyses of data and interpretation of results; Awareness of resources, and their conservation; Ability to think laterally and in an integrating manner and develop interdisciplinary approach; Overall knowledge of the avenues for research and higher academic achievements in the field of Biochemistry and allied subjects.	K3
PO2	Communication Skills: Ability to speak and write clearly in English; Ability to listen to and follow scientific viewpoints and engage with them.	K2
PO3	Problem solving: ability to closely observe the situation, and apply lateral thinking and analytical skills.	K4
PO4	Analytical reasoning: Ability to evaluate the strengths and weaknesses in scholarly texts spotting flaws in their arguments; Ability to use critics and theorists to create a framework and to substantiate one's argument in one's reading of scientific texts.	K4
PO5	Team work /Time Management: Ability to participate constructively in class room discussions; Ability to contribute to group work; Ability to meet a deadline.	K6
PO6	Scientific reasoning: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. Ability to formulate logical and convincing arguments.	K4
PO7	Self-directed learning: Ability to work independently in terms of organizing laboratory, and critically analyzing research literature; Ability to postulate hypothesis, questions and search for answers.	K6
PO8	Digital literacy: Ability to use digital sources, and apply various platforms to convey and explain concepts of Biochemistry	K3
PO9	Moral and ethical awareness/reasoning: Ability to interrogate one's own ethical values and to be aware of ethical and environmental issues; Ability to read values	K3

	inherited in society and criticism vis a vis, the environment, religion and spirituality as also structures of power	
PO10	Leadership readiness: Ability to lead group discussions, to formulate questions related to scientific and social issues.	K6

K1 – Remember; K2-Understand; K3-Apply; K4-Analyse; K5-Evaluate; K6-Create
(Ref: UGC Document on LOCF – Biochemistry – UG – 2019)

3. ELIGIBILITY FOR ADMISSION

Candidate for admission to the first year of B.Sc., Degree Course in Biochemistry shall be required to have passed the Higher Secondary Examination **with Chemistry and Biology or Chemistry, Botany and Zoology or Biochemistry and Chemistry/ Vocational group (Agri and Nursing)**

4. DURATION OF THE COURSE

The duration of the course is three academic years comprising six semesters.

5. COURSE OF STUDY

The B.Sc. Biochemistry course comprises the following subjects in the syllabus,

- Foundation Courses : Languages - I, II, III, IV and English – I, II, III, IV
- Core Theory : Core I to Core XI
- Core Practical : Core Practical I to IV
- Allied I : Chemistry
- Allied Practical I : Chemistry
- Allied II : Microbiology
- Allied Practical II : Microbiology
- Elective : I, II, III
- Skill Enhancement Course (SEC) : I, II, III
- Non - Major Elective Course (NME) : I, II

(NME may be chosen by the respective colleges and the same must be communicated to the University).

- Summer Internship / Industrial Training: 15 days (at the end of Second year)

(Attendance should be submitted to the department (Attendance & Mini report mandatory))

- Common Papers for all UG Programmes :
 - Value Education
 - Disaster Management
 - Health and Wellness
 - NMSDC and
 - Extension Activity

6. EXAMINATIONS

There shall be six semester examinations for three years – two semester examination per year. Candidates failing in any subject / subjects will be permitted to reappear for failed subject / subjects in subsequent examinations. The syllabus has been divided into six semesters. The odd semester examinations (I, III and V) will be held in November/ December and even semester examinations (II, IV and VI) will be held in April / May. The practical examination I will be held at the end of I year (II-semester). II will be held at the end of II year (IV-semester). III and IV will be held at the end semester of III year (VI-semester).

7. PASSING MINIMUM

A candidate shall be declared to be passed the examination if he /she secure not less than 40% of the marks in each paper and practical. The candidates who do not secure the required minimum marks for pass in a paper and practical shall be required to reappear to pass the same at a subsequent appearance. For the practical the minimum pass includes the record mark too. There is no passing minimum for the record. However, submission of a record notebook is a must.

8. CLASSIFICATION OF SUCCESSFUL CANDIDATES

Candidates who secured not less than 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in First Class. Candidates secured above 50% less than 60% shall be declared to have passed in Second Class.

Candidates who obtain 75% and above in the aggregate shall be declared to have passed the examination in First Class with Distinction provided they pass all the examination in prescribed period at first appearance.

9. RANKING

Candidates who pass all the examinations for the prescribed course in the first attempt/appearance and within a period of three academic years from the year of admission to the course only are eligible for University Ranking.

10. MAXIMUM DURATION FOR THE COMPLETION OF THE UG PROGRAMME:

The maximum duration for completion of the UG Programme shall not exceed twelve semesters.

11. COMMENCEMENT OF THIS REGULATION

These regulations shall be effect from the academic year 2026-27 onwards for candidates admitted during the academic year 2026-27 and thereafter.

12. TRANSITORY PROVISION

Candidates who were admitted to the UG course of study before 2023-2024 shall be permitted to appear for the examinations under those regulations for a period of three years i.e. up to April / May 2028 examination. Thereafter, they will be permitted to appear for the examination only under the regulations therein force.

13. COURSES GIVEN BY THE BOARD AS NON – MAJOR ELECTIVE COURSE (NME)

Semester - I

- NME – I - Biochemistry in Nutrition - Page No: 94

Semester - II

- NME – II - Biochemistry and Health - Page No: 97

14. LIST OF ELECTIVE PAPERS (Colleges can choose any one of the paper as Elective)

Elective – I

- A) Plant Biochemistry
- B) Plant Therapeutics

Elective – II

- A) Pharmaceutical Biochemistry
- B) Medical Lab Technology

Elective – III

- A) Genetic Engineering
- B) Bioinformatics

15. ALLIED SUBJECT:

(for B. Sc., MICROBIOLOGY / BIOTECHNOLOGY / CLT - First Year - Semester – I)

- Allied Theory – I – Biochemistry - Page No: 88
- Allied Practical – I – Biochemistry - Page No: 91

16. A) ** NAAN MUDHALVAN – Courses external 25 marks will be assessed by Industry and Internal will be offered by respective course teacher.

B) ** Alternate SKILL Papers for Naan Mudhalvan reappear students:

- Semester II - Good Laboratory Practices – Page No: 13
- Semester III - Health And Hygiene – Page No: 28
- Semester IV - Diet and Nutrition – Page No: 46
- Semester V - Lifestyle diseases – Page No: 67
- Semester VI - Diet Therapy – Page No: 85

17. COURSE OF THE STUDY AND SCHEME OF EXAMINATIONS

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	Foundation	Theory	Language – I	6	3	25	75	100	3	
2			II	Foundation	Theory	English – I	6	3	25	75	100	3	
3			III	Core I	Theory	Cell Biology	5	3	25	75	100	5	1
4			III	Core II	Theory	Biomolecules	5	3	25	75	100	5	4
5			IV	Allied – I	Theory	Chemistry	5	3	25	75	100	4	
6			IV	NMEC	Theory	Choose any one paper offered by other departments	2	3	25	75	100	2	
7			IV	Value Added	Theory	Value Education	1	3	25	75	100	1	
8	II		I	Foundation	Theory	Language - II	6	3	25	75	100	3	
9			II	Foundation	Theory	English – II	6	3	25	75	100	3	
10			III	Core – III	Theory	Bio-analytical Techniques	5	3	25	75	100	5	7
11			III	Core Practical - I	Practical	Practical – I - Cell Biology and Biomolecules	4	6	40	60	100	5	10
12			IV	Allied Practical - I	Practical	Allied Chemistry practical I	3	3	40	60	100	4	
13			IV	NMEC	Theory	Choose any one paper offered by other departments	2	3	25	75	100	2	
14			IV	Common Paper	Theory	Disaster Management	2	3	25	75	100	1	
15			IV	NMSDC	NMSD		2					2	-
16	III		I	Foundation	Theory	Language - III	6	3	25	75	100	3	
17			II	Foundation	Theory	English - III	6	3	25	75	100	3	
18			III	Core – IV	Theory	Enzymes	5	3	25	75	100	5	16
19			III	Allied – II	Theory	Microbiology	4	3	25	75	100	4	
20			III	Elective - I	Theory	A) Plant Biochemistry/ B) Plant Therapeutics Note: Choose any ONE Elective paper	3	3	25	75	100	3	19 / 22
21			IV	Skill Enhancement Course (SEC)	Theory	First Aid	2	3	25	75	100	2	25
22			IV	Common Paper	Theory	Health and Wellness	2	3	25	75	100	1	
23				NMSDC	NMSD		2	3	25	75	100	2	
24	IV		I	Foundation	Theory	Language - IV	6	3	25	75	100	3	
25			II	Foundation	Theory	English - IV	6	3	25	75	100	3	

26			III	Core - V	Theory	Intermediary Metabolism	5	3	25	75	100	5	31
27			III	Core Practical - II	Practical	Practical – II - Enzymes and Biochemical Techniques	3	6	40	60	100	5	34
28			III	Allied Practical - II	Practical	Allied Microbiology Practical	3	6	40	60	100	4	
29			III	Elective - II	Theory	A) Pharmaceutical Biochemistry/ B) Medical Lab Technology Note: Choose any ONE Elective paper	3	3	25	75	100	3	37 / 40
30			IV	Skill Enhancement Course (SEC)	Theory	Medical Coding	2	3	25	75	100	2	43
31					NMSDC	NMSD		2					2
32	V		III	Core - VI	Theory	Clinical Biochemistry	6	3	25	75	100	5	49
33			III	Core - VII	Theory	Molecular Biology	6	3	25	75	100	5	52
34			III	Core - VIII	Theory	Human Physiology	6	3	25	75	100	5	55
35			III	Elective - III	Theory	A) Genetic Engineering/ B) Bioinformatics Note: Choose any ONE Elective paper	5	3	25	75	100	3	58 / 61
36			IV	Skill Enhancement Course (SEC)	Theory	Forensic Science	3	3	25	75	100	2	64
37			IV	Summer Internship / Industrial Training	Internship/Training	Summer Internship / Industrial Training Note: 15 days internship or Industrial training should be carried out at the end of 2nd Year (4th semester vacation)	-	Commended / Highly Commended					2
38			IV	Common Paper	Theory	Environmental Studies	2	3	25	75	100	2	
39			IV	NMSDC	NMSD		2					2	-
40		VI		III	Core - IX	Theory	Nutritional Biochemistry	6	3	25	75	100	5
41			III	Core - X	Theory	Immunology	6	3	25	75	100	5	73
42			III	Core - XI	Theory	Endocrinology	6	3	25	75	100	5	76
43			III	Core – Practical III	Theory	Practical – III – Clinical Biochemistry	5	6	40	60	100	5	79

44			III	Core – Practical IV	Theory	Practical – IV – Molecular Biology and Immunology	5	6	40	60	100	5	82
45			IV	Common	-	Extension Activity	-	-	-	-	-	1	-
46				NMSDC	NMSD		2	-	-	-	-	2	-

18. TOTAL PAPERS-46 (41+5 NM)

Part - I	Total Papers	Part – II	Total Papers	Part – III	Total Papers - 22		Part - IV	Total Papers
Language	4	English	4	Core	15	11 (Theory) 4 (Practical)	NME	2
				Allied	4	2 (Theory) 2 (Practical)	SEC	3
				Elective	3	Theory	VE	1
							DM	1
							HW	1
							Extn	1
							Internship	1
							NM	5
							EVS	1

Language Part - I – Total Papers - 4

Language Part - II – Total Papers - 4

Part - III – Core – Total Papers – 15 [11 (Theory) & 4 (Practical)]

Part - III – Allied – Total Papers – 4 [2 (Theory) & 2 (Practical)]

Part - III – Elective – 3

Part - IV – SEC – Total Papers – 3

Part - IV – Value Education – 1

Part - IV – Disaster Management – 1

Part - IV – Health and Wellness – 1

Part - IV – NMSDC – 5

Part - IV – NME – Total Papers – 2

Part - IV – EVS – 1

Part - IV – Extension – 1

Part - IV – Internship – 1

19. CREDIT DISTRIBUTION

Part	Title of the Course	Total No.of Papers	Credits	Total credits
Part I	Language	4	12 (Each 3 credits)	24 credits
Part II	English	4	12 (Each 3 credits)	
Part III	Core Courses	15 [11 Theory + 4 Practical]	75 (Each 5 credits)	100 credits
Part III	Allied Courses	4 [2 Theory + 2 Practical]	16 (Each 4 credits)	
Part III	Elective	3 [Theory]	9 (Each 3 credits)	
Part IV	Non Major Elective	2 [Theory]	4 (Each 2 credits)	18 credits
Part IV	Skill Enhancement Course	3 [Theory]	6 (Each 2 credits)	
Part IV	Value Education	1 [Theory]	1 credit	
Part IV	Disaster Management	1 [Theory]	1 credit	
Part IV	Health and Wellness	1 [Report]	1 credit	
Part IV	EVS	1 [Theory]	2 credits	
Part IV	Extension Activity	-	1 credit	
Part IV	Internship	Training Report – Commended/Highly Commended	2 credits	
Part IV	Naan Mudhalvan	5 [Exam Online] Theory (Offline)	10 (Each 2 credits)	10 credits
Total credits for UG Programmes				142+10=152

20. QUESTION PAPER PATTERN (For Core, Allied, 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 the same unit)

21. INTERNAL MARKS AND EXTERNAL MARKS

Study component	Internal Marks	External Marks
Theory	25	75
Practical	40	60
Internship / Health and Wellness	Commended / Highly Commended	

B. Sc., BIOCHEMISTRY
FIRST YEAR - SEMESTER – I
CORE – I - CELL BIOLOGY

Objectives

- To introduce the basic concepts of cells, their types, and differences between plant, animal, prokaryotic, and eukaryotic cells.
- To explain the structure and functions of cell membranes, cell walls, and important organelles.
- To describe how chromosomes are organized and highlight special types of chromosomes.
- To outline the stages of the cell cycle and explain the processes of mitosis and meiosis.
- To understand the role of the extracellular matrix and cell interactions in maintaining tissue structure and communication.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the fundamental concepts of cell biology, including cell theory, types of cells, and basic structures of prokaryotic and eukaryotic cells.	K1 – Remember
CO2	Explain the structure and functions of cell organelles, membranes, and cell walls, and differentiate between plant and animal cells.	K2 – Understand
CO3	Apply knowledge of chromosome organization and cell division to interpret cellular processes such as growth, reproduction, and genetic variation.	K3 – Apply
CO4	Analyze the differences between mitosis and meiosis, and evaluate the role of chromatin organization and special chromosomes in gene regulation.	K4 – Analyze
CO5	Evaluate the significance of extracellular matrix components and cell–cell/ECM interactions in tissue organization.	K5 – Evaluate
CO6	Design conceptual models to illustrate extracellular matrix composition and cell–cell/ECM interactions, integrating knowledge of proteins and junctional complexes.	K6 – Create

UNIT I

Cell: Introduction, cell theory, types of cell - Prokaryotic cell and eukaryotic cell structure, difference between plant cell and animal cell. Structure, composition, functions of the cell membrane, bacterial cell wall and plant cell wall.

UNIT II

Cell Organelles: Structure and functions of nucleus, mitochondria, chloroplast, endoplasmic reticulum, golgi bodies, ribosomes, lysosomes, peroxisomes and cytoskeleton.

UNIT III

Chromosome Organisation: Structure of chromatin, types of euchromatin and heterochromatin, structure of chromosome, special types of chromosome – Lamp Brush Chromosomes and Polytene Chromosomes.

UNIT IV

Cell Cycle: Stages of cell cycle, cell division - various stages and significance of Mitosis and Meiosis, Differences between Mitosis and Meiosis.

UNIT V

Extracellular Matrix and Cell Interactions: ECM: - Collagen, Elastin, Fibronectin, Laminins, Cell – ECM interactions: - Integrins, Focal adhesions, Hemidesmosomes. Cell – cell interactions: - Cadherins, IgSF, Selectins, Intracellular junctions: Gap junctions, tight junctions, adherens junctions, and desmosomes.

Reference Books

- **Cell Biology** – T. Devasena; 1st Edition; Oxford University Press; **2012**.
- **Cytology (Cell Biology and Molecular Biology)** – V.K. Agarwal, P.S. Varma; 4th Edition; S. Chand & Company, New Delhi; **2000**.
- **Cell and Molecular Biology** – Prakash S. Lohar; 1st Edition; MJP Publishers; **2007**.
- **The Cell: A Molecular Approach** – Geoffrey M. Cooper, Robert E. Hausman; 9th Edition; Oxford University Press; **2022** (*latest edition, updated from 5th in 2009*).
- **Cell and Molecular Biology** – Gerald Karp; 9th Edition; John Wiley & Sons; **2021** (*latest edition, updated from 3rd in 2002*).

Web Resources

- **Easy Biology Class** – Free tutorials, notes, and diagrams for cell biology concepts.
<https://www.easybiologyclass.com>
- **NCBI Bookshelf** – Open-access reference materials on molecular and cell biology.
<https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing) ([bing.com](https://www.bing.com) in Bing)

- **Khan Academy – Cell Biology** – Interactive lessons on cell structure, organelles, and cell cycle. <https://www.khanacademy.org/science/biology/cell-biology> (khanacademy.org in Bing) ([bing.com](https://www.bing.com) in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	L	M	L	M	M	L
CO3	S	S	M	M	M	M	L	M	M	L
CO4	S	S	S	M	M	M	L	M	M	M
CO5	S	M	S	M	L	M	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
FIRST YEAR - SEMESTER – I
CORE – II - BIOMOLECULES

Objectives

- To introduce the basic types and roles of biomolecules – carbohydrates, proteins, lipids, and nucleic acids.
- To explain the structures, properties, and functions of these biomolecules in living systems.
- To understand how biomolecules interact and contribute to metabolism and energy storage.
- To describe the organization of proteins and nucleic acids in relation to genetic information.
- To provide a foundation for Apply biochemical knowledge in biology, medicine, and biotechnology.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the classification, structures, properties, and biological functions of carbohydrates (mono-, di-, and polysaccharides).	K1 – Remember
CO2	Explain the classification, structure, properties, and chemical reactions of amino acids, including their nutritional significance.	K2 – Understand
CO3	Apply knowledge of peptide bonds and protein structures to interpret their biological roles and functions.	K3 – Apply
CO4	Analyze the classification and properties of fatty acids and lipids, and evaluate the functions of phospholipids, glycolipids, sphingolipids, cholesterol, and lipoproteins.	K4 – Analyze
CO5	Evaluate the structural organization of nucleic acids (DNA and RNA), nucleotides, and nucleoproteins, and their role in genetic information storage and transfer.	K5 – Evaluate
CO6	Evaluate conceptual models to illustrate the interrelationships among biomolecules (carbohydrates, proteins, lipids, nucleic acids) in metabolism and cellular processes.	K6 – Create

UNIT I

Carbohydrates: Introduction and general classification of carbohydrates.

Monosaccharides: Structures, properties and biological functions of monosaccharides. Isomerism - structural and stereo isomerism, interconversion of sugars, muta-rotation.

Oligosaccharides: Dissaccharides - structures, properties and biological functions of maltose, Lactose and Sucrose.

Polysaccharides: Classifications of polysaccharides, Structures, properties and biological functions of Homo-polysaccharides - starch, cellulose, glycogen, pectin and Hetero-polysaccharides -Hyaluronic acid, Chondroitin sulphate, chitin and Heparin.

UNIT II

Amino acids: Amino acids -Classification based on composition of side chain and nutritional significance. General structure of amino acids. 3 - and 1- letter abbreviations. Modified amino acids in protein, Non - protein amino acids.

Physical and Chemical properties of amino acids: isoelectric point, optical activity. Chemical reactions due to carboxyl group, amino group and side chains. Colour reactions of amino acids.

UNIT III

Peptides: Features of peptide bond, naturally occurring peptides – Glutathione, enkaphalins and endorphins.

Proteins: Classification, physical and chemical properties of proteins, structural organization of proteins - Primary, secondary, tertiary and quaternary structures, Forces stabilizing each level of structure.

UNIT IV

Fatty acids: Definition, nomenclature, classification of fatty acids-saturated and unsaturated fatty acids. Essential fatty acids.

Lipids: Classification of lipids- simple, conjugated and derived lipids, occurrence, structure and physical and chemical properties of phospholipids, glycolipids, sphingolipids and cholesterol.

Lipoproteins: Types and functions of lipoproteins – Chylomicrons, VLDL, LDL and HDL.

UNIT V

Nitrogenous bases: - purines and pyrimidines, nucleosides, nucleotides, formation of phosphodiester bonds. **DNA:** - Types of DNA, Structure of DNA – Watson and Crick double helix model, physico-chemical properties and functions of DNA. Special base sequences of DNA – palindromic sequence, cruciforms. **RNA:** - Types and basic structural features of RNA – mRNA, tRNA and rRNA, properties and functions of RNA.

Nucleoproteins: structure and functions of Histones and protamines.

Reference Books

- **Lehninger Principles of Biochemistry** – David L. Nelson, Michael M. Cox, Aaron Hoskins; 8th Edition; W.H. Freeman & Co.; 2021.
- **Biochemistry** – Lubert Stryer, Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr.; 7th Edition; W.H. Freeman & Co.; 2010.
- **Biochemistry** – Donald Voet, Judith Voet; 4th Edition; Wiley Publishers; 2021.
- **Biochemistry** – Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto Jr., Lubert Stryer; 10th Edition; W.H. Freeman & Co.; 2023.
- **Outlines of Biochemistry** – E.E. Conn, P.K. Stumpf, G. Bruening, R.H. Doi; 5th Edition; John Wiley & Sons; 2009.
- **Biochemistry** – Debajyoti Das; 14th Edition; Academic Publishers, India; 2022.
- **Biochemistry** – U. Satyanarayana, U. Chakrapani; 7th Edition; Books & Allied Pvt. Ltd.; 2025.
- **Biochemistry** – Geoffrey L. Zubay; 4th Edition; McMillan Publishing; 1998.

🌐 Web Resources

1. **NCBI Bookshelf – Biochemistry & Molecular Biology** – Free access to biochemistry and molecular biology references. <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing) (bing.com in Bing)
2. **Khan Academy – Biochemistry** – Interactive lessons and videos. <https://www.khanacademy.org/science/biology/biochemistry> (khanacademy.org in Bing)
3. **Easy Biology Class – Biochemistry** – Notes, diagrams, and tutorials for biochemistry topics. <https://www.easybiologyclass.com>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	L	M	L	M	M	L
CO3	S	S	S	M	M	M	L	M	M	L
CO4	S	S	S	M	M	M	L	M	M	M
CO5	S	M	S	M	L	M	M	M	S	M
CO6	S	S	S	M	M	M	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
FIRST YEAR - SEMESTER – II
CORE – III – BIO-ANALYTICAL TECHNIQUES

Objectives

- To introduce the principles and applications of chromatography techniques.
- To explain the fundamentals of centrifugation and its types.
- To describe electrophoresis methods and their uses in biomolecule separation.
- To understand the principles and applications of spectroscopy in biochemical analysis.
- To provide knowledge of radioisotope techniques, detection methods, and safety aspects.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the principles and procedures of chromatography, centrifugation, electrophoresis, spectroscopy, and radioisotope techniques.	K1 – Remember
CO2	Explain the working principles, instrumentation, and applications of biochemical techniques.	K2 – Understand
CO3	Apply knowledge of separation and detection methods to analyze biomolecules in laboratory experiments.	K3 – Apply
CO4	Analyze the differences among various techniques (chromatography types, centrifugation methods, electrophoresis systems) and evaluate their suitability for specific applications.	K4 – Analyze
CO5	Evaluate the advantages, limitations, and safety aspects of spectroscopy and radioisotope techniques in biochemical research.	K5 – Evaluate
CO6	Design experimental approaches using combinations of biochemical techniques to solve research problems.	K6 – Create

UNIT I

Chromatography: Principles, procedure and applications of Paper chromatography, Thin layer chromatography, column chromatography - Ion exchange chromatography, gel filtration chromatography, affinity chromatography. Gas Liquid Chromatography, High performance Liquid Chromatography.

UNIT II

Centrifugation: Basic principles of sedimentation, Svedberg's constant, sedimentation velocity and sedimentation equilibrium. Types of centrifuges – desk top, high speed and ultracentrifuges. Types of Rotors - swinging bucket, fixed angle, vertical tube and zonal rotor. Types of centrifugation: Preparative centrifugation - differential and density gradient centrifugation with applications, Analytical centrifugation – molecular weight determination.

UNIT III

Electrophoresis: Principles, techniques and applications of paper electrophoresis, gel electrophoresis - agarose, SDS- PAGE, Capillary electrophoresis, isoelectric focusing, Factors affecting electrophoresis.

UNIT IV

Spectroscopy: Laws of absorption -Beer - Lambert's law and its limitations. Principles, instrumentations and applications of colorimeter, spectrophotometer, spectrofluorimeter and flame photometer.

UNIT V

Radioisotope Techniques: Radioactivity, stable and radioactive isotopes, Radioactive decay - rate of radioactive decay and $t_{1/2}$ of radioactivity. Methods of detection of radioisotopes: - GM counter, Scintillation counter. Autoradiography and its applications. Advantages, disadvantages and safety aspects of radio isotopic techniques.

Reference Books

- **Principles and Techniques of Biochemistry and Molecular Biology** – Keith Wilson & John Walker, Cambridge University Press.
- **Biophysical Chemistry** – Charles R. Cantor & Paul R. Schimmel, W.H. Freeman.
- **Biochemistry Laboratory: Modern Theory and Techniques** – Rodney Boyer, Pearson.
- **Practical Biochemistry** – Harold Varley, CBS Publishers.
- **Biochemical Techniques: Theory and Practice** – John F. Robyt & Bernard J. White, Waveland Press.
- **Biochemistry** – Debajyoti Das, Academic Publishers.
- **Biochemistry** – Satyanarayana & U. Chakrapani, Books & Allied Pvt. Ltd.

Web Resources

- **NCBI Bookshelf – Biochemistry Methods** [https://www.ncbi.nlm.nih.gov/books/ncbi.nlm.nih.gov in Bing\)](https://www.ncbi.nlm.nih.gov/books/ncbi.nlm.nih.gov%20in%20Bing)
- **Khan Academy – Biochemistry & Lab Techniques** <https://www.khanacademy.org/science/biology>
- **Easy Biology Class – Biochemical Techniques Notes** <https://www.easybiologyclass.com>
- **Springer – Principles and Techniques of Biochemistry and Molecular Biology** <https://link.springer.com>
- **Coursera – Biochemistry Courses & Lab Methods** <https://www.coursera.org>
- **NPTEL (IIT Online Lectures) – Biochemistry & Biotechnology** <https://nptel.ac.in>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	L
CO3	S	S	S	M	M	M	L	M	M	L
CO4	S	S	S	M	M	M	L	M	M	M
CO5	S	M	S	M	M	S	M	M	S	M
CO6	S	S	S	S	S	M	M	M	S	M

S- Strong

M- Medium

L-Low

B. Sc., BIOCHEMISTRY
FIRST YEAR - SEMESTER – II

CORE PRACTICAL – I - CELL BIOLOGY AND BIOMOLECULES

Objectives

- To demonstrate the basic principles and handling of the compound microscope.
- To train students in preparation, staining, and identification of prokaryotic and eukaryotic cells.
- To develop skills in cytological techniques such as Barr body identification, mitotic squash preparation, and organelle visualization.
- To provide hands-on experience in isolation and qualitative analysis of biomolecules like carbohydrates, proteins, and amino acids.
- To enable students to perform quantitative estimations of biomolecules using classical titrimetric and dye-based methods.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO 1	Demonstrate parts, working principle, focusing, and calibration of compound microscope	K1 – Remembering, K2 – Understanding
CO 2	Prepare smears, identify prokaryotic/eukaryotic cells, measure cell size, and detect Barr body	K2 – Understanding, K3 – Applying
CO 3	Apply staining techniques to visualize mitochondria and nuclei	K3 – Applying
CO 4	Perform onion root tip squash preparation to observe mitotic stages	K4 – Analyzing
CO 5	Isolate starch and casein from natural sources	K3 – Applying
CO 6	Identify carbohydrates and amino acids through classical tests	K4 – Analyzing
CO 7	Estimate glycine and ascorbic acid using titrimetric/dye methods	K5 – Evaluating, K6 – Creating

I. Demonstration of Microscopic Basics

Parts, working principle, proper handling, focusing techniques, and calibration of the compound microscope

II. Cell Biology

1. Preparation of smear and identification of Prokaryotic and Eukaryotic cells.
2. Determination of cell size using the ocular stage micrometer.
3. Identification of Barr body in the female Buccal cavity epithelial smear.
4. Staining and visualization of mitochondria by Janus green stain.
5. Staining and visualization of the nuclear fraction by the Acetocarmine stain.
6. Squash preparation of onion root tips to observe mitotic stages.

III. Biomolecules

1. Preparation of starch from a plant source.
2. Preparation of casein from milk.
3. Qualitative analysis of Carbohydrates.
4. Qualitative analysis of Aminoacids.
5. Estimation of Glycine by Sorensen's titrimetric method.
6. Estimation of Ascorbic acid by the Dichloro Phenol Indophenol dye method.

IV. Spotters

1. Microscope
2. Micrometer
3. Prokaryotic cell/Eukaryotic cell
4. Plant cell/Animal cell
5. Mitochondria/Chloroplast/Nucleus
6. Mitotic stages/Meiotic stages
7. Starch
8. Egg albumin
9. Lecithin
10. DNA/RNA

Practical Reference Books

- Practical Biochemistry – D.T. Plummer; 3rd Edition; Tata McGraw-Hill Publishing; 1998.
- Laboratory Manual of Biochemistry – Ranjna Chaudhry; 2nd Edition; Jaypee Brothers Medical Publishers; 2014.
- Essentials of Practical Microbiology – R.C. Dubey, D.K. Maheshwari; 1st Edition; S. Chand & Company Ltd.; 2002.
- Practical Manual in Biochemistry – D.K. Jain; 1st Edition; Jaypee Brothers Medical Publishers; 2016.

- Cell Biology Laboratory Manual – K. Sivarajan; 1st Edition; Himalaya Publishing House; 2011.
- Practical Clinical Biochemistry – R. Varma; 2nd Edition; CBS Publishers; 2018.
- Biochemistry Laboratory Techniques – H.D. Kumar; 1st Edition; Vikas Publishing House; 2005.

Web Resources

1. **NCBI Bookshelf** – Free textbooks and references
<https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
2. **Khan Academy Biology** – Interactive lessons
<https://www.khanacademy.org/science/biology> (khanacademy.org in Bing)
3. **PubMed** – Research articles <https://pubmed.ncbi.nlm.nih.gov>
(pubmed.ncbi.nlm.nih.gov in Bing)
4. **Biology Online** – Tutorials and lab techniques <https://www.biologyonline.com>
5. **ScienceDirect** – **Biology Journals** – Peer-reviewed journals
<https://www.sciencedirect.com/journal> (sciencedirect.com in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	S	M	L	L	L	M	L
CO2	S	S	S	M	M	M	L	M	M	L
CO3	S	M	S	S	M	M	L	M	M	L
CO4	S	S	S	S	M	M	L	M	M	M
CO5	S	M	S	S	M	M	M	M	S	M
CO6	S	S	S	S	M	M	M	M	S	M
CO7	S	S	S	S	S	M	M	M	S	M

S - Strong

M - Medium

L - Low

B.Sc., BIOCHEMISTRY

SEMESTER – II

SKILL ENHANCEMENT COURSE (SEC) – GOOD LABORATORY PRACTICES

(Only for NMSDC Reappear Students)

Objectives

- To introduce the principles of GLP and international guidelines (OECD, WHO).
- To familiarize students with laboratory infrastructure, equipment, and materials.
- To instill awareness of safety practices and hazard prevention.
- To provide knowledge on biosafety levels, risk assessment, and compliance.
- To develop skills in hazard identification, workplace inspection, and control measures.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain the fundamentals of GLP and international guidelines	K2 – Understanding
CO2	Identify laboratory facilities, glassware, chemicals, and equipment	K1 – Remembering
CO3	Apply general safety practices and interpret safety symbols	K3 – Applying
CO4	Analyze biosafety levels, risk assessment, and compliance measures	K4 – Analyzing
CO5	Evaluate hazards and propose appropriate control measures	K5 – Evaluating

UNIT I

Fundamentals of GLP, Overview of OECD - GLP principles and WHO GLP in brief.

UNIT II

General Science Laboratory facilities, glass wares, chemicals and common science lab equipments.

UNIT III

Safety practice in the laboratory - Laboratory safety rules – general good laboratory safety practices, personnel protection, chemical safety instructions, Do's and Don'ts in laboratory, Laboratory safety symbols.

UNIT IV

History of biosafety, Risk assessment, Biosafety levels, Personal protective equipment, Disinfection, decontamination, and sterilization, Regulatory compliance, Laboratory security and emergency response.

UNIT V

Collection of existing information and Inspection of the workplace for safety hazards, Identification of health hazards associated with emergency and non-routine situations, Characterization and control measures.

REFERENCES

- 1. **OECD. *Principles of Good Laboratory Practice***, 2nd Edition, 2021, OECD Publishing.
- **World Health Organization. *Handbook: Good Laboratory Practice (GLP)***, 1st Edition, 2010, WHO Press.
- **Carson, P.A. & Mumford, C.J. *Hazardous Laboratory Chemicals Disposal Guide***, 3rd Edition, 2012, Wiley-Interscience.
- **Fleming, D.O. & Hunt, D.L. *Biological Safety: Principles and Practices***, 5th Edition, 2014, ASM Press.
- **Collins, C.H. & Kennedy, D.A. *Laboratory-Acquired Infections and Biosafety***, 4th Edition, 1999, Butterworth-Heinemann.
- **Gad, S.C. *Safety Evaluation of Pharmaceuticals and Medical Devices***, 2nd Edition, 2016, Springer.
- **Sax, N.I. *Dangerous Properties of Industrial Materials***, 11th Edition, 2004, Wiley.

Web Resources

- **OECD GLP Guidelines –**
<https://www.oecd.org/chemicalsafety/testing/oecdprinciplesofgoodlaboratorypractice.htm> ([oecd.org in Bing](#))
- **WHO Laboratory Biosafety Manual –**
<https://www.who.int/publications/i/item/9789240011311> ([who.int in Bing](#))

- **NIH Biosafety Resources** – <https://osp.od.nih.gov/biotechnology/biosafety/> ([osp.od.nih.gov](#) in Bing)
- **CDC Laboratory Safety** – <https://www.cdc.gov/labsafety/index.html>
- **OSHA Laboratory Safety Guidance** – <https://www.osha.gov/laboratory-safety> ([osha.gov](#) in Bing)
- **FAO Biosafety Resources** – <https://www.fao.org/biosafety/en/>
- **EPA Chemical Safety** – <https://www.epa.gov/chemical-research> ([epa.gov](#) in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	M	S	M	L	L	M	L	L	M	L
CO3	M	S	S	M	M	M	L	M	S	M
CO4	S	M	S	S	M	S	M	M	S	M
CO5	M	M	S	S	M	S	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – III
CORE – IV – ENZYMES

Objectives

- To introduce the history, classification, and basic concepts of enzymes.
- To explain enzyme active sites, catalytic mechanisms, and theories of enzyme–substrate interaction.
- To understand enzyme kinetics, factors affecting activity, and types of inhibition and regulation.
- To describe coenzymes, isoenzymes, allosteric enzymes, and multienzyme complexes with examples.
- To provide knowledge of immobilized enzymes, isolation/purification methods, and industrial/medical applications.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall enzyme history, terminology, classification, and basic concepts such as holoenzymes and ribozymes.	K1 – Remember
CO2	Explain enzyme active sites, catalytic mechanisms, and theories of enzyme–substrate interaction.	K2 – Understand
CO3	Apply enzyme kinetics equations (Michaelis–Menten, Lineweaver–Burk, etc.) to calculate parameters like V_{max} and K_m .	K3 – Apply
CO4	Analyze the effects of pH, temperature, inhibitors, and activators on enzyme activity and regulation.	K4 – Analyze
CO5	Evaluate the role of coenzymes, isoenzymes, and allosteric enzymes in biochemical reactions and clinical contexts.	K5 – Evaluate
CO6	Design experimental approaches using immobilized enzymes and purification methods, and propose industrial/medical applications.	K6 – Create

UNIT - I

Introduction to Enzymes: History and terminology, nomenclature and IUB classification of enzymes. Holoenzymes, Apoenzymes, metalloenzymes, metalactivated enzymes, monomeric enzymes, oligomeric enzymes, and ribozymes. Enzyme specificity, specific activity, units of enzyme activity – IU and Katal. Enzyme turn over.

UNIT - II

Active Site: Structure of active site and its characteristics, theories of ES complex - Lock and key, induced fit and substrate strain theory.

Nature of Enzyme Catalysis: Acid - base catalysis, covalent catalysis, Metal ion catalysis, Electrostatic catalysis.

Mechanism of Action of Specific Enzyme: - lysozyme.

UNIT - III

Enzyme Kinetics: Michaelis-Menten Equation: - Initial velocity and steady state approach, V_{max} , K_m and their significance, Linear transformation of Michaelis-Menten Equation; - Lineweaver-Burk Plot, Eadie-Hofstee Plot, Hanes Plot.

Factors Affecting Enzyme Activity: - Effect of pH, temperature, enzyme concentration, substrate concentration, and the presence of inhibitors and activators.

Enzyme Inhibition: - Types of inhibition - Reversible inhibition - Competitive, Non-competitive and Uncompetitive inhibition. Irreversible inhibition, Feedback inhibition.

Regulation of Enzyme Activity: Allosteric inhibition, covalent modification.

UNIT - IV

Coenzymes: The structure and function of following coenzymes in enzyme catalyzed reactions – Thiamine pyrophosphate, nicotinamide nucleotides, Flavin nucleotides, Coenzyme A, Lipoate, Folate and biotin.

Isoenzymes: Definition, features and clinical significance with examples – Lactate dehydrogenase (LDH) and creatine kinase (CK).

Allosteric Enzymes: Definition, structure and properties with example - Aspartate transcarbamoylase.

Multienzyme Complex – Pyruvate dehydrogenase complex (PDH complex)

UNIT - V

Immobilized Enzymes: Principles, methods and applications of immobilized enzymes.

Isolation and Purification of Enzymes: Methods of isolation and purification of enzymes from microbial, plant and animal sources, determination of purity of isolated enzymes.

Applications of enzymes- in food, textile and leather industries and role of enzymes in medicine.

Reference Books

1. **Enzymes** – Dixon, E.C. Webb, CJR Thorne, K.F. Tipton, Longmans, London.
2. **Fundamentals of Enzymology** – Nicholas C. Price & Lewis Stevens, Oxford University Press (2nd Edition, 1998).
3. **Understand Enzymes** – Trevor Palmer, Ellis Horwood Limited (3rd Edition, 1991).
4. **Protein Biotechnology** – Gary Walsh & Denis Headon, John Wiley and Sons (1994).
5. **Protein Biochemistry and Biotechnology** – Gary Walsh, John Wiley and Sons Ltd. (2002).

🌐 Web Resources

1. **University of Wisconsin Biochemistry Symposium (Steenbock Abstracts)**
https://biochem.wisc.edu/sites/default/files/symposia/steenbock/36th/36th_Steenbock_Abstract_Book_web.pdf ([biochem.wisc.edu](#) in Bing)
2. **NCBI Bookshelf – Enzyme Function and Kinetics**
<https://www.ncbi.nlm.nih.gov/books> ([ncbi.nlm.nih.gov](#) in Bing)
3. **Khan Academy – Enzyme Structure and Function**
<https://www.khanacademy.org/science/biology>
4. **Easy Biology Class – Enzymology Notes** <https://www.easybiologyclass.com>
5. **NPTel (IIT Online Lectures) – Enzyme Technology** <https://nptel.ac.in>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	L	M	L	M	M	L
CO3	S	S	S	M	M	M	L	M	M	L
CO4	S	S	S	M	M	M	L	M	M	M
CO5	S	M	S	M	M	S	M	M	S	M
CO6	S	S	S	S	S	M	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – III
ELECTIVE – I – A) PLANT BIOCHEMISTRY

Objectives

- To introduce the principles of water relations in plants including diffusion, osmosis, water potential, and transpiration.
- To explain the mechanisms of photosynthesis, photorespiration, and alternative pathways in plants.
- To describe nitrogen metabolism, nitrogen fixation, and nutrient cycles in plants.
- To understand the biochemical basis of seed development, dormancy, germination, and plant growth regulation.
- To provide knowledge of plant growth regulators and secondary metabolites with their physiological and medicinal importance.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall concepts of diffusion, osmosis, water potential, transpiration, and ascent of sap.	K1 – Remember
CO2	Explain photosynthetic pigments, light reactions, Calvin cycle, photorespiration, and C4/CAM pathways.	K2 – Understand
CO3	Apply knowledge of nitrogen metabolism and nutrient cycles to interpret plant nutrient utilization.	K3 – Apply
CO4	Analyze biochemical processes in seed development, dormancy, germination, and photoperiodism.	K4 – Analyze
CO5	Evaluate the role of plant growth regulators and secondary metabolites in physiology and medicine.	K5 – Evaluate
CO6	Evaluate integrated models of plant metabolic pathways linking water relations, photosynthesis, nutrient cycles, and growth regulation.	K6 – Create

UNIT - I

Physiology of Plants: Diffusion and Osmosis in plants and their significance, relationship among turgor pressure, wall pressure and osmotic pressure, water potential concept. Mechanism of water absorption, Ascent of sap, Transpiration: - types, mechanism of transpiration and factors affecting transpiration.

UNIT - II

Photosynthesis: Photosynthetic apparatus, Photosynthetic pigments, Light reactions - cyclic and non-cyclic phosphorylation, Calvin cycle, Photorespiration, C4 plants, CAM plants. Glyoxylate cycle.

UNIT - III

Nitrogen Metabolism and Nitrogen Cycle: Nitrogen in soil, nitrate reduction in plants, Nitrogen fixation: - Non-biological and biological nitrogen fixation, biochemistry of symbiotic and non-symbiotic nitrogen fixation, nitrogen cycle, sulphur cycle, phosphorus cycle.

UNIT – IV

Biochemistry of Plant Growth: Biochemistry of seed development: - dormancy and germination. Phytochrome, photoperiodism and vernalization.

UNIT - V

Plant Growth Regulators and Secondary metabolites: Chemistry, biosynthesis, storage, and distribution, mode of action and physiological effects of Auxins, Gibberellins, Cytokinins, ABA and Ethylene. Medicinal value of Alkaloids, Flavonoids, Terpenoids with examples.

Reference Books

- Lincoln Taiz & Eduardo Zeiger – *Plant Physiology*, 5th Edition, 2010, Sinauer Associates.
- Bob B. Buchanan, Wilhelm Gruissem & Russell L. Jones – *Biochemistry & Molecular Biology of Plants*, 2nd Edition, 2015, John Wiley & Sons (American Society of Plant Biologists).
- Frank B. Salisbury & Cleon W. Ross – *Plant Physiology*, 3rd Edition, 1985, Wadsworth Publishing Company.
- Hans-Walter Heldt & Birgit Piechulla – *Plant Biochemistry*, 5th Edition, 2021, Academic Press (Elsevier).
- William G. Hopkins & Norman P.A. Hüner – *Introduction to Plant Physiology*, 4th Edition, 2008, Wiley.

Web Resources

- **NCBI Bookshelf – Plant Biochemistry** <https://www.ncbi.nlm.nih.gov/books/ncbi.nlm.nih.gov.in/Bing>
- **Khan Academy – Photosynthesis & Plant Biology** <https://www.khanacademy.org/science/biology>
- **Easy Biology Class – Plant Physiology Notes** <https://www.easybiologyclass.com>
- **NPTEL (IIT Online Lectures) – Plant Physiology & Biochemistry** <https://nptel.ac.in>
- **Plant Physiology Journal (ASPB)** <https://academic.oup.com/plphys>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	M
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	S
CO4	S	S	S	M	M	M	L	M	M	M
CO5	S	M	S	M	M	S	M	M	S	S
CO6	S	S	S	S	S	M	M	M	S	S

S – Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – III
ELECTIVE – I – B) PLANT THERAPEUTICS

Objectives

- To introduce the importance of medicinal plants and traditional systems of plant therapeutics.
- To explain the chemistry and role of primary and secondary metabolites in plants.
- To understand methods of identification, authentication, and quality control of medicinal plants.
- To describe plant-derived drugs, their therapeutic uses, and nutraceutical applications.
- To provide knowledge of modern biotechnological approaches, herbal formulations, and safety aspects in plant therapeutics.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the scope of plant therapeutics, traditional medicine systems, and classification of medicinal plants.	K1 – Remember
CO2	Explain the chemistry, biosynthesis, and functions of plant metabolites such as alkaloids, flavonoids, and terpenoids.	K2 – Understand
CO3	Apply knowledge of pharmacognosy to identify, authenticate, and evaluate medicinal plants for purity and quality.	K3 – Apply
CO4	Analyze the therapeutic roles of plant-derived drugs, nutraceuticals, and functional foods in healthcare.	K4 – Analyze
CO5	Evaluate modern biotechnological approaches, herbal formulations, and safety aspects of plant therapeutics.	K5 – Evaluate
CO6	Evaluate integrated models linking traditional knowledge, phytochemistry, and biotechnology for drug development.	K6 – Create

UNIT I

Introduction: Scope and importance of plant therapeutics, Traditional systems of medicine (Ayurveda, Siddha, Unani), Classification of medicinal plants

UNIT II

Phytochemistry: ,Primary and secondary metabolites Alkaloids, flavonoids, terpenoids, glycosides, tannins, phenolics. Extraction and isolation methods

UNIT III

Pharmacognosy: Identification and authentication of medicinal plants, Microscopic and macroscopic features, Adulteration and quality control

UNIT IV

Plant-Derived Drugs: Therapeutic uses of plant-based compounds, Examples: anticancer (vincristine, taxol), antimalarial (quinine, artemisinin), cardiac glycosides (digoxin), Role of nutraceuticals and functional foods

UNIT V

Modern Applications: Biotechnological approaches in plant therapeutics, Plant tissue culture for secondary metabolite production, Herbal formulations, standardization, and regulatory aspects, Safety, toxicity, and ethical issues

Reference Books

- Trease & Evans – *Pharmacognosy*, 16th Edition, 2009 (reprint 2022), Elsevier/Saunders Ltd.
- C.K. Kokate, A.P. Purohit & S.B. Gokhale – *Textbook of Pharmacognosy*, Revised Edition, 2018/2020, Nirali Prakashan.
- C.K. Atal & B.N. Kapoor – *Medicinal Plants: Chemistry and Properties*, Reprint Edition, 2020, CBS Publishers & Distributors Pvt. Ltd.
- J.B. Harborne – *Plant Secondary Metabolites*, 1993, Academic Press (Elsevier).
- Iris F.F. Benzie & Sissi Wachtel-Galor – *Herbal Medicine: Biomolecular and Clinical Aspects*, 2nd Edition, 2011, CRC Press (Taylor & Francis Group).

Web Resources

- **NCBI Bookshelf – Herbal Medicine** → <https://www.ncbi.nlm.nih.gov/books/ncbi.nlm.nih.gov.in/Bing>
- **Khan Academy – Plant Biology Basics** → <https://www.khanacademy.org/science/biology>
- **Easy Biology Class – Medicinal Plants Notes** → <https://www.easybiologyclass.com>

- NPTEL (IIT Online Lectures) – Pharmacognosy & Plant Biotechnology → <https://nptel.ac.in>
- WHO Monographs on Medicinal Plants → <https://www.who.int/publications> (who.int in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	M
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	S
CO4	S	S	S	M	M	M	L	M	M	S
CO5	S	M	S	M	M	S	M	M	S	S
CO6	S	S	S	S	S	M	M	M	S	S

S – Strong

M - Medium

L - Low

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B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – III
SKILL ENHANCEMENT COURSE – I – FIRST AID

Objectives

- To understand the fundamental principles, aims, and legal aspects of first aid.
- To learn essential emergency response techniques for various situations.
- To acquire practical skills in CPR, airway management, and life support.
- To develop competence in handling injuries, trauma, and medical emergencies.
- To gain awareness of environmental hazards, poisoning, and disaster evacuation methods.

Course Outcome

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

CO No.	Learning Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain the aims, principles, and legal aspects of first aid; identify contents of a first aid kit	K1 - Remember & K2 Understand
CO2	Demonstrate CPR, AED use, Heimlich maneuver, and management of breathing emergencies	K3 - Application
CO3	Apply first aid techniques for trauma, fractures, burns, and shock	K3 - Application & K4 - Analysis
CO4	Recognize and respond to medical emergencies like stroke, seizures, heart attack, and diabetic crises	K4 - Analysis & K5 - Evaluation
CO5	Provide first aid for poisoning, bites, environmental hazards, and electrical injuries	K3 - Application & K5 - Evaluation

UNIT I

Fundamentals of First Aid & Emergency Response: Aims, principles, and legal aspects of first aid, dealing with emergency, types and content of a first aid kit. First aid techniques – Dressing and bandaging techniques, safe lifting, moving, and transportation of victims, Evacuation during disasters (fire, earthquake basics).

UNIT II

Airway, Breathing & Life Support: Basics of respiration and oxygen supply, CPR (Cardiopulmonary Resuscitation) – adult, child, infant, Use of AED (Automated External Defibrillator), First aid for Choking (Heimlich maneuver) , Drowning , Asthma attacks (use of inhalers), Allergic reactions (anaphylaxis awareness), Smoke inhalation and gas poisoning, Strangulation and hanging cases, Managing breathing difficulty in crowded/public places.

UNIT III

Injuries & Trauma Management: First aid for Cuts, wounds, and bleeding control, Head, chest, and abdominal injuries, Burns, Fractures, sprains, and dislocations, Amputations, Shock management, Road accident response basics.

UNIT IV

Medical Emergencies: First aid related to unconsciousness, Stroke recognition (FAST method), Seizures and epilepsy care, Fainting and dizziness, Heart attack, Diabetic emergencies (low/high blood sugar), Panic attacks and basic mental health first aid, Heat stroke and hypothermia.

UNIT V

Poisoning, Bites & Environmental Emergencies: First aid for Snake bites and insect stings, Animal bites (rabies awareness), Food poisoning, Chemical poisoning (acids, alkalis, household cleaners), Drug and alcohol poisoning, Handling contamination and use of disinfectants. First aid for environmental emergencies:- Electric shock, Lightning injuries, Water-related accidents.

Reference Books

- American Red Cross – *First Aid/CPR/AED Participant's Manual*, Revised Edition, 2025, American Red Cross.
- St. John Ambulance, St. Andrew's First Aid & British Red Cross – *First Aid Manual*, 10th Edition, 2014, Dorling Kindersley (DK).
- J.E. Tintinalli – *Emergency Medicine: A Comprehensive Study Guide*, 9th Edition, 2019, McGraw-Hill Education.
- J. Brady – *First Aid and Emergency Care for Nurses*, Latest Edition, 2020, Pearson (Brady Series).

Web Resources

1. World Health Organization – *Emergency Preparedness*:
<https://www.who.int/emergencies> (who.int in Bing)
2. American Heart Association – *CPR & First Aid*: <https://cpr.heart.org>
3. Red Cross – *First Aid Resources*: <https://www.redcross.org/firstaid>
4. National Safety Council – *First Aid & CPR*: <https://www.nsc.org/first-aid>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	M	L	M	M
CO2	S	M	S	S	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	M	M	M	M	M	S
CO5	S	M	S	M	M	S	M	M	S	S

S – Strong

M - Medium

L - Low

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B.Sc., BIOCHEMISTRY
SEMESTER – III
SKILL ENHANCEMENT COURSE (SEC) – HEALTH AND HYGIENE
(Only for NMSDC Reappear Students)

Objectives

- To introduce foundations of health including determinants, indicators, and healthcare systems.
- To explain nutrition and personal hygiene for disease prevention and healthy living.
- To apply hygiene and sanitation practices in community and occupational health.
- To analyze communicable and non-communicable diseases with emphasis on prevention and management.
- To evaluate public health education and emerging issues including global health challenges and alternative therapies.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	To describe foundations of health including determinants and healthcare systems	K2 – Understanding
CO2	To explain nutrition and hygiene and identify nutritional disorders	K3 – Application
CO3	To apply sanitation practices for disease prevention	K4 – Analysis
CO4	To analyze communicable and non-communicable diseases	K5 – Evaluation
CO5	To evaluate public health education and address emerging global health issues	K6 – Creation

UNIT I

Foundations of Health: Definition and dimensions of health: physical, mental, social, spiritual, environmental, Determinants of health: heredity, environment, lifestyle, socio-cultural factors, Indicators of health and disease burden in India, Public and community health concepts, Healthcare systems: primary, secondary, tertiary care, National health policies and organizations.

UNIT II

Nutrition and Personal Hygiene: Nutrition: definition, nutrients, balanced diet, BMR, Macronutrients (carbohydrates, proteins, fats) – sources, functions, deficiencies, Micronutrients (vitamins, minerals, water) – sources, functions, deficiencies, Malnutrition and nutritional disorders (kwashiorkor, marasmus), Personal hygiene practices:

UNIT III

Hygiene and Sanitation: Importance of sanitation in disease prevention, Safe water supply, sewage disposal, waste management, Food hygiene and safety practices, Environmental hygiene: air, water, soil pollution and health impacts, Occupational health and safety measures.

UNIT IV

Communicable and Non-Communicable Diseases: Epidemiology and modes of disease transmission, Common communicable diseases: tuberculosis, malaria, HIV/AIDS, influenza, Vaccination and immunization programs, Non-communicable diseases: diabetes, hypertension, cancer, cardiovascular diseases, Lifestyle-related illnesses.

UNIT V

Public Health, Education & Emerging Issues: Health promotion and disease prevention programs, Role of health education and awareness campaigns, Behavior change communication and digital health apps, Global health challenges: pandemics, antimicrobial resistance, climate change, Integration of yoga, naturopathy.

Reference Books

- Park K. – Textbook of Preventive and Social Medicine – 2021, Banarsidas Bhanot Publishers, 26th Edition
- Stanhope & Lancaster – Public Health Nursing: Population-Centered Health Care – 2020, Elsevier, 10th Edition
- Marmot & Wilkinson – Social Determinants of Health – 2019, Oxford University Press, 3rd Edition
- WHO – Health and Hygiene Guidelines – 2018, WHO Publications
- CDC – Healthy People 2030 – 2020, U.S. Department of Health and Human Services.

Web Resources

- **WHO Health Topics (who.int in Bing)** – Global health and hygiene guidelines
- **CDC Healthy People 2030 (health.gov in Bing)** – U.S. public health objectives
- **UNICEF Health Programs** – Child and maternal health initiatives
- **ICMR India** – National health research and policy
- **Nutrition and Balanced Diet – NIN** – Indian nutrition guidelines

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	L	L	M	L
CO2	S	S	S	S	M	M	M	M	M	L
CO3	S	S	S	S	M	M	M	M	M	L
CO4	S	S	S	S	M	M	M	M	M	M
CO5	S	M	S	M	S	S	M	M	S	M

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – IV
CORE – V – INTERMEDIARY METABOLISM

Objectives

- To introduce the principles of bioenergetics, thermodynamics, and types of metabolic reactions.
- To explain carbohydrate metabolism including glycolysis, TCA cycle, glycogen metabolism, and alternative pathways.
- To describe biological oxidation, electron transport chain, oxidative phosphorylation, and mitochondrial shuttle systems.
- To understand lipid and protein metabolism including fatty acid oxidation, biosynthesis, cholesterol metabolism, amino acid degradation, and urea cycle.
- To provide knowledge of nucleic acid metabolism including biosynthesis and degradation of purine and pyrimidine nucleotides.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall the principles of bioenergetics, free energy, redox reactions, and high-energy compounds.	K1 – Remember
CO2	Explain carbohydrate metabolic pathways (glycolysis, TCA cycle, glycogen metabolism, gluconeogenesis, HMP pathway).	K2 – Understand
CO3	Apply knowledge of electron transport chain and oxidative phosphorylation to interpret ATP production.	K3 – Apply
CO4	Analyze lipid and protein metabolism, including fatty acid oxidation, biosynthesis, cholesterol metabolism, and amino acid degradation.	K4 – Analyze
CO5	Evaluate regulation and integration of metabolic pathways, including inhibitors, uncouplers, and clinical relevance.	K5 – Evaluate
CO6	Evaluate metabolic maps showing interconnections among carbohydrate, lipid, protein, and nucleic acid metabolism.	K6 – Create

UNIT I

Introduction to metabolism: Types of metabolic reactions. Bioenergetics - Principles of thermodynamics, concepts of free energy, standard free energy, High-energy phosphate compounds.

Carbohydrate metabolism: Glycolysis – Aerobic and Anaerobic glycolysis, Oxidative decarboxylation of pyruvate. Glycogen metabolism: Glycogenesis and Glycogenolysis, Alternative pathways: HMP pathway, gluconeogenesis, glucuronic acid pathway.

UNIT II

Lipid metabolism: Fatty acid oxidation – α , β , ω oxidation. Biosynthesis of saturated and unsaturated fatty acids. Metabolism of cholesterol, triglycerides and ketone bodies.

UNIT III

Protein metabolism: Ketogenic and Glucogenic amino acids. Degradation of proteins: - Deamination, Transamination and Decarboxylation, Urea cycle.

TCA cycle: Pathway, energetics, Amphibolic nature and Anaplerotic reactions. Integration of metabolism

UNIT IV

Biological oxidation: Biological oxidation-reduction reactions, redox potential. Mitochondrial Electron Transport Chain: electron carriers, sites of ATP production, inhibitors of ETC, Oxidative phosphorylation: - structure of ATPase complex, chemiosmotic theory, inhibitors of oxidative phosphorylation and uncouplers, Mitochondrial shuttle system.

UNIT V

Nucleic acid metabolism: Biosynthesis of purine and pyrimidine nucleotides – de novo and salvage pathway. Degradation of Purine and Pyrimidine nucleotides

Reference Books

- David L. Nelson & Michael M. Cox – *Lehninger Principles of Biochemistry*, 8th Edition, 2021, W.H. Freeman.
- Lubert Stryer – *Biochemistry*, 7th Edition, 2010, W.H. Freeman.
- Donald Voet & Judith Voet – *Biochemistry*, 4th Edition, 2021, Wiley Publishers.
- Debajyoti Das – *Biochemistry*, 14th Edition, 2022, Academic Publishers, India.
- U. Satyanarayana & U. Chakrapani – *Biochemistry*, 7th Edition, 2025, Books & Allied Pvt. Ltd.
- E.E. Conn & P.K. Stumpf – *Outlines of Biochemistry*, 5th Edition, 2009, John Wiley & Sons.

Web Resources

1. **NCBI Bookshelf – Metabolism Pathways** <https://www.ncbi.nlm.nih.gov/books/ncbi.nlm.nih.gov.in/Bing>
2. **Khan Academy – Metabolism & Bioenergetics** <https://www.khanacademy.org/science/biology>
3. **Easy Biology Class – Metabolism Notes** <https://www.easybiologyclass.com>
4. **NPTEL (IIT Online Lectures) – Metabolic Pathways** <https://nptel.ac.in>
5. **Biochemistry Free & Easy (Oregon State University)** <https://biochem.science.oregonstate.edu> (biochem.science.oregonstate.edu in Bing).

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	L
CO4	S	S	S	M	M	M	L	M	M	S
CO5	S	M	S	M	M	S	M	M	S	S
CO6	S	S	S	S	S	M	M	M	S	S

S – Strong

M - Medium

L - Low

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B. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – IV

CORE PRACTICAL – II – ENZYMES AND BIOCHEMICAL TECHNIQUES

Objectives

- To develop skills in enzyme isolation, assay, and immobilization.
- To understand the effect of physical and chemical factors on enzyme activity.
- To gain hands-on experience in chromatographic and electrophoretic separation techniques.
- To learn organelle isolation methods using centrifugation.
- To perform colorimetric estimations of biomolecules using classical methods.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Isolate and determine enzyme activity	K2 – Understanding, K3 – Applying
CO2	Study specific activity, pH, temperature, substrate concentration	K3 – Applying, K4 – Analyzing
CO3	Entrap enzymes in sodium alginate gel	K4 – Analyzing, K5 – Evaluating
CO4	Separate biomolecules using paper, TLC, column chromatography	K3 – Applying, K4 – Analyzing
CO5	Separate proteins and organelles	K4 – Analyzing
CO6	Estimate biomolecules using colorimetric methods	K5 – Evaluating, K6 – Creating

I. Enzyme Assay

1. Isolation and Determination of the activity of the following enzymes
 - i. Acid phosphatase
 - ii. Alkaline phosphatase
 - iii. Urease
2. Determination of specific activity, effect of pH, temperature and substrate concentration of Salivary Amylase
3. Immobilization of enzymes by entrapment in sodium alginate gel.

II. Analytical Techniques

1. Separation of amino acids by paper chromatography.
2. Separation of lipids by thin-layer chromatography.
3. Separation of plant pigments by column chromatography
4. Separation of serum proteins by gel electrophoresis.
5. Isolation of cell organelles by differential centrifugation.

III. Colorimetric Analysis

1. Estimation of fructose by Seliwanoff's method.
2. Estimation of Amino Acids by Ninhydrin method.
3. Estimation of Phosphorus by Fiske Subbarow method.

IV. Spotters

1. Mortar and Pestle
2. Homogenizer
3. pH meter
4. Colorimeter
5. Spectrophotometer
6. Electrophoretic unit
7. Centrifuge
8. Micropipette
9. Chromatography chamber
10. TLC sheets

Practical Reference Books

- Practical Biochemistry – **D.T. Plummer; 3rd Edition; Tata McGraw-Hill; 1998.**
- Laboratory Manual of Biochemistry – **Ranjna Chaudhry; 2nd Edition; Jaypee Brothers Medical Publishers; 2014.**
- Essentials of Practical Microbiology – **R.C. Dubey, D.K. Maheshwari; 1st Edition; S. Chand; 2002.**
- Practical Manual in Biochemistry – **D.K. Jain; 1st Edition; Jaypee Brothers Medical Publishers; 2016.**
- Biochemistry Laboratory Techniques – **H.D. Kumar; 1st Edition; Vikas Publishing House; 2005.**

Web Resources

- **NCBI Bookshelf – Biochemistry** Free access to biochemistry textbooks and lab manuals → <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
- **Khan Academy Biology** Tutorials on enzyme kinetics, chromatography, and lab methods → <https://www.khanacademy.org/science/biology> (khanacademy.org in Bing)
- **PubMed – Biochemistry Research** Research articles on enzyme assays and analytical techniques → <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing)

- **Biology Online** Lab protocols, definitions, and tutorials → <https://www.biologyonline.com>
- **ScienceDirect – Biochemistry Journals** Peer-reviewed methods in biochemistry → <https://www.sciencedirect.com/journal> (sciencedirect.com in Bing)

Mapping with Programme Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	L	L	M	M	L
CO2	S	S	S	S	M	M	L	M	S	M
CO3	S	M	S	S	M	M	M	M	S	M
CO4	S	S	S	S	S	M	M	M	S	M
CO5	S	S	S	S	S	M	M	M	S	M
CO6	S	S	S	S	M	M	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY

SECOND YEAR - SEMESTER – IV

ELECTIVE – II – A) PHARMACEUTICAL BIOCHEMISTRY

Objectives

- To understand the sources, dosage forms, and routes of drug administration.
- To learn the principles of pharmacokinetics including absorption, distribution, metabolism, and excretion.
- To explore pharmacodynamics, drug–receptor interactions, and factors modifying drug action.
- To recognize adverse drug reactions, toxicology, and concepts of drug dependence and tolerance.
- To gain knowledge of drug discovery, development, and regulatory frameworks.

Course Outcome

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

CO No.	Learning Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain sources, dosage forms, routes of administration, and drug interactions	K1 - Remember & K2 - Understand
CO2	Analyze pharmacokinetic processes and parameters influencing drug disposition	K4 – Analysing
CO3	Interpret drug–receptor interactions, mechanisms of metabolism, and modifying factors	K3 - Apply & K5 - Evaluate
CO4	Identify and manage adverse drug reactions, poisoning, and drug dependence	K3 - Apply & K4 - Analysing
CO5	Describe drug discovery approaches, research phases, and regulatory authorities	K1 - Remember & K2 - Understand

UNIT I

Sources of Drugs: Natural, synthetic, biotechnological. Routes of Administration: Oral, parenteral, topical, inhalation, etc. Dosage Forms: Tablets, capsules, injections, suspensions, ointments. Drug Dosage: Concepts of therapeutic dose, toxic dose, lethal dose. Bioavailability: Definition, factors influencing bioavailability, bioequivalence. Combined Drug Effects: Synergism, antagonism, potentiation.

UNIT II

Pharmacokinetics: Absorption: Mechanisms, factors influencing absorption. Distribution: Volume of distribution, protein binding, tissue storage. Pharmacokinetic Parameters: Half-life, C_{max}, T_{max}. Drug Elimination: Renal excretion, Fecal and biliary excretion, pulmonary excretion, Minor routes (saliva, sweat, breast milk).

UNIT III

Pharmacodynamics: Drug Receptors: Concepts, receptor theories, receptor–drug interactions. Mechanisms of Drug Action: Receptor-mediated vs. non-receptor mediated. Drug Metabolism: Phase I reactions (oxidation, reduction, and hydrolysis). Phase II reactions (conjugation). Factors affecting metabolism. Placebo Effect. Factors Modifying Drug Action: Age, sex, genetics, disease states, drug interactions.

UNIT IV

Adverse Drug Reactions and Toxicology: Types of ADRs:- Pharmacological, Non-pharmacological, disease – related, multiple drug reactions. Acute poisoning: - General principles and management. Drug dependence – Psychological and physical. Drug tolerance and intolerance:- Mechanisms and Clinical implications.

UNIT V

Drug Discovery and Development: Random screening, serendipity, molecular modification, rational drug design. Research Phases:- Preclinical and clinical research. Regulatory Overview:- Roles of DCGI, NPPA, CDSCO, FDA, ICMR, FSSAI.

Reference Books

- K.D. Tripathi – *Essentials of Medical Pharmacology*, 9th Edition, 2019, Jaypee Brothers Medical Publishers.
- H.P. Rang, M.M. Dale, J.M. Ritter, R.J. Flower – *Rang & Dale's Pharmacology*, 9th Edition, 2020, Elsevier.
- Goodman & Gilman – *The Pharmacological Basis of Therapeutics*, 13th Edition, 2018, McGraw-Hill Education.
- B.G. Katzung – *Basic & Clinical Pharmacology*, 15th Edition, 2021, McGraw-Hill Education.

- H.L. Sharma & K.K. Sharma – *Principles of Pharmacology*, 2nd Edition, 2017, Paras Medical Publisher.

Web Resources

- **World Health Organization – Medicines** <https://www.who.int/medicines>
- **U.S. Food & Drug Administration (FDA)** <https://www.fda.gov>
- **Central Drugs Standard Control Organization (CDSCO, India)** <https://cdsco.gov.in>
- **National Institute of Health – Pharmacology** <https://www.nih.gov>
- **PubMed – Pharmacology Research Articles** <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing) (bing.com in Bing) ([bing.com](https://www.bing.com) in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	S	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	M
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	M	M	L	M	M	M	M	S	S

S – Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – IV
ELECTIVE – II – B) MEDICAL LAB TECHNOLOGY

Objectives

- To understand principles of clinical sample collection, handling, and pre-analytical variables.
- To gain knowledge of laboratory safety, biomedical waste management, and ethical practices.
- To develop skills in urine, stool, and haematology analysis including blood banking techniques.
- To learn biochemical analysis methods and instrumentation for clinical diagnostics.
- To acquire competence in microbiology, cytopathology, and laboratory quality control systems.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Describe general laboratory practices, sample collection, handling, and safety guidelines	K1 – Remember
CO2	Interpret urine and stool analysis results, including chemical and microscopic findings	K2 – Understand
CO3	Apply hematological techniques and blood banking procedures in clinical settings	K3 – Apply
CO4	Analyze biochemical profiles using instruments and evaluate diagnostic results	K4 – Analyze, K5 – Evaluate
CO5	Design and perform microbiological/cytopathological procedures with quality assurance	K6 – Create

UNIT I

Introduction and General Laboratory Practices: Sample Collection & Handling: Guidelines for collection, transportation, and processing of clinical samples (blood, urine, stool, sputum, CSF, fluids). Pre-analytical variables: Factors affecting results (fasting, time of collection, patient preparation). Anticoagulants: Types, uses, and mechanism of action. Safety & Ethics: Lab safety (physical, chemical, biological hazards), biomedical waste management, and ethical considerations.

UNIT II

Urine and Stool Analysis: Urine Analysis: Physical (color, volume, pH), chemical (protein, glucose, ketones, bile salts/pigments), and microscopic examination (cells, casts, crystals). Pregnancy Test: Principles of immunological tests for β -hCG. Stool Analysis: Routine examination for parasites, ova, occult blood (chemical analysis).

UNIT III

Clinical Hematology and Blood Banking: Hematological Indices: Hemoglobin estimation (Sahli's), ESR (Wintrobe/Westergren), Packed Cell Volume (PCV), Red Cell Indices (MCV, MCH, MCHC). Complete Blood Count (CBC): Total WBC, RBC, and Platelet counts, Differential Leukocyte Count (DLC). Blood Banking: ABO and Rh blood grouping, cross-matching techniques, and donor screening.

UNIT IV

Biochemical analysis: Instrumentation: Basics of photometer, colorimeter, and auto-analyzers. Biochemical Profiling: Estimation of blood glucose, renal function tests (serum urea, creatinine), liver function tests (bilirubin, SGOT, SGPT, alkaline phosphatase), and lipid profile. Body Fluids: Analysis of Cerebrospinal Fluid (CSF), pleural, peritoneal, and synovial fluid.

UNIT V

Clinical Microbiology and Cytopathology: Microbiology: Sample collection for bacterial cultures, Gram staining, Acid-Fast Staining (AFB), Albert staining, and sensitivity testing. Cytopathology/Histopathology: Tissue processing, Types of Microtomes, Preparation of smears for Hematoxylin and /eosin /staining and Pap staining, FNAC (Fine Needle Aspiration Cytology) processing. Quality Control: Internal and external quality assurance in clinical laboratories.

Reference Books

- M.L. Bishop, E.P. Fody & L.E. Schoeff – *Clinical Chemistry: Principles, Techniques, and Correlations*, 9th Edition, 2023, Wolters Kluwer/Lippincott Williams & Wilkins.
- J.B. Henry – *Clinical Diagnosis and Management by Laboratory Methods*, 20th Edition, 2001, W.B. Saunders Company.
- J.V. Dacie & S.M. Lewis – *Practical Haematology*, 11th Edition, 2011, Churchill Livingstone/Elsevier.

- M. Cheesbrough – *District Laboratory Practice in Tropical Countries*, Part 1 (2nd Edition, 2005) & Part 2 (2nd Edition, 2006), Cambridge University Press.
- C. Kumar – *Textbook of Medical Laboratory Technology*, Latest Edition, 2018, Jaypee Brothers Medical Publishers.

Web Resources

- World Health Organization (WHO) Laboratory Biosafety Manual (who.int in Bing)
- Centers for Disease Control and Prevention (CDC) Laboratory Safety
- MedlinePlus – Clinical Laboratory Tests
- American Association for Clinical Chemistry (AACC)
- National Center for Biotechnology Information (NCBI) (ncbi.nlm.nih.gov in Bing).

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	M	L	M	M
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	S	M	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY
SECOND YEAR - SEMESTER – IV
SKILL ENHANCEMENT COURSE – II – MEDICAL CODING

Objectives

- To understand the fundamentals of medical coding systems.
- To apply ICD-10-CM, CPT, and HCPCS codes accurately.
- To develop skills in medical billing and compliance documentation.
- To analyze coding practices for reimbursement and auditing.
- To explore advanced coding applications and emerging technologies.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall coding systems and ethical principles	K1 – Remember
CO2	Explain ICD-10-CM guidelines and apply them	K2 – Understand, K3 – Apply
CO3	Perform CPT/HCPCS coding with modifiers	K3 – Apply, K4 – Analyze
CO4	Evaluate billing processes and compliance standards	K5 – Evaluate
CO5	Design coding solutions using advanced tools	K6 – Evaluate

UNIT I

Introduction to Medical Coding: Basics of healthcare delivery systems, Role of medical coding in healthcare reimbursement, Overview of coding systems, Structure and format of ICD-10-CM codes, Medical terminology - specialization I and II, Ethical and legal aspects of medical coding.

UNIT II

ICD-10-CM Coding: Guidelines for diagnosis coding, Coding conventions and sequencing rules, Coding for infectious diseases, neoplasms, endocrine disorders, Coding for circulatory and respiratory system diseases, Case studies and practice exercises.

UNIT III

CPT & HCPCS Coding: Introduction to Current Procedural Terminology (CPT), CPT code structure: Evaluation & Management, Surgery, Radiology, Pathology, Medicine, HCPCS Level II codes: supplies, equipment, and services, Modifiers and their applications, Practical exercises in CPT/HCPCS coding.

UNIT IV

Medical Billing and Compliance: Revenue cycle management, Insurance claim process (CMS-1500 form), Coding for inpatient vs. outpatient services, Fraud, abuse, and compliance regulations (HIPAA, OIG guidelines), Documentation of medical record and auditing.

UNIT V

Advanced Topics and Applications: ICD-10-PCS for inpatient procedures, DRG (Diagnosis Related Groups) and reimbursement models, Electronic Health Records (EHR) integration with coding, Emerging trends: AI in medical coding, automation tools, Quality assurance and accuracy in coding.

Reference Books

- Carol J. Buck – *Medical Coding: ICD-10-CM, CPT, HCPCS*, 2021 Edition, Elsevier.
- Elsevier – *Step-by-Step Medical Coding*, 2022 Edition, Elsevier.
- Centers for Medicare & Medicaid Services (CMS) & Centers for Disease Control and Prevention (CDC) – *ICD-10-CM Official Guidelines for Coding and Reporting*, 2025 Edition, U.S. Government Publication.
- Anne Casto – *Principles of Healthcare Reimbursement*, 6th Edition, 2018, AHIMA Press.

Web Resources

- **American Academy of Professional Coders (AAPC)** <https://www.aapc.com>
- **American Health Information Management Association (AHIMA)** <https://www.ahima.org>
- **Centers for Medicare & Medicaid Services (CMS)** <https://www.cms.gov>
- **World Health Organization – ICD**
<https://www.who.int/standards/classifications/icd> (who.int in Bing)
 (who.int in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	M	L	M	L
CO2	S	S	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	S	S	M	M	M	S	S

S – Strong

M - Medium

L – Low

B.Sc., BIOCHEMISTRY
SEMESTER – IV
SKILL ENHANCEMENT COURSE (SEC) – DIET AND NUTRITION
(Only for NMSDC Reappear Students)

Objectives

- To introduce the fundamentals of nutrition and dietary guidelines.
- To classify food groups and explain their nutritional functions.
- To understand nutritional requirements across different life stages.
- To analyze diet in relation to diseases and deficiencies.
- To apply food safety and regulatory standards in practice.

Course Outcome

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

CO No	Course Outcome	Knowledge Level
CO1	Explain the basic concepts of nutrition and RDA	K2 – Understanding
CO2	Identify food groups and evaluate their nutritional value	K3 – Applying
CO3	Assess nutritional needs across life stages	K4 – Analyzing
CO4	Relate diet to malnutrition and lifestyle diseases	K5 – Evaluating
CO5	Apply food safety and regulatory measures	K3 – Applying

UNIT I

Basics of Nutrition: Definition and scope of nutrition, Nutrients: carbohydrates, proteins, fats, vitamins, minerals, water, Balanced diet and dietary guidelines, Recommended Dietary Allowances (RDA).

UNIT II

Food Groups and Functions: Classification of foods: cereals, pulses, fruits, vegetables, milk, meat, fish, eggs, Nutritional value and role in health, Energy content of foods, Functional foods and nutraceuticals.

UNIT III

Nutrition in Life Stages: Nutritional needs of infants, children, adolescents, Nutrition during pregnancy and lactation, Nutrition for elderly, Nutrition for athletes and special groups.

UNIT IV

Diet and Disease: Malnutrition: undernutrition and overnutrition, Protein energy malnutrition (PEM), Micronutrient deficiencies (iron, iodine, vitamin A, vitamin D), Diet in lifestyle diseases: diabetes, hypertension, obesity, cardiovascular diseases.

UNIT V

Food Safety and Regulations: Food hygiene and sanitation, Food adulteration and safety standards, National and international food regulations (FSSAI, Codex Alimentarius), Food preservation methods.

Reference Books

- Swaminathan, M. *Essentials of Food and Nutrition*, 2nd Edition, 2012, Bangalore Printing & Publishing Co.
- Gopalan, C., Rama Sastri, B.V., & Balasubramanian, S.C. *Nutritive Value of Indian Foods*, Revised Edition, 2011, National Institute of Nutrition (ICMR).
- Bamji, M.S., Krishnaswamy, K., & Brahman, G.N.V. *Textbook of Human Nutrition*, 4th Edition, 2019, Oxford & IBH Publishing.
- Whitney, E. & Rolfes, S.R. *Understanding Nutrition*, 15th Edition, 2018, Cengage Learning.
- Gibney, M.J., Lanham-New, S.A., Cassidy, A., & Vorster, H.H. *Introduction to Human Nutrition*, 3rd Edition, 2013, Wiley-Blackwell.

🌐 Web Resources

- **WHO Nutrition Guidance** – <https://www.who.int/health-topics/nutrition> (who.int in Bing)
- **FAO Nutrition Portal** – <https://www.fao.org/nutrition/en/>
- **ICMR-NIN Resources** – <https://www.nin.res.in/>
- **CDC Nutrition Basics** – <https://www.cdc.gov/nutrition/index.html>

- **Harvard Nutrition Source –**

<https://www.hsph.harvard.edu/nutritionsource/> ([hsph.harvard.edu](https://www.hsph.harvard.edu/) in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	L	L	M	L	L	M	L
CO2	M	S	M	L	L	M	L	L	M	L
CO3	M	S	S	M	M	M	L	M	S	M
CO4	S	M	S	S	M	S	M	M	S	M
CO5	M	M	S	S	M	S	M	M	S	M

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – V
CORE – VI – CLINICAL BIOCHEMISTRY

Objectives

- To understand the principles of clinical specimen collection, preservation, and automation in biochemistry.
- To gain knowledge of hematological parameters and their clinical relevance.
- To study disorders of carbohydrate and lipid metabolism with laboratory investigations.
- To learn inborn errors of amino acid, protein, purine, pyrimidine, and bilirubin metabolism.
- To Acquire skills in liver, renal, gastric function tests and clinical enzymology.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain approaches to clinical biochemistry, specimen handling, and urine analysis	K1 – Remember, K2 – Understand
CO2	Perform hematological investigations and interpret results	K3 – Apply, K4 – Analyze
CO3	Analyze disorders of carbohydrate and lipid metabolism with case studies	K4 – Analyze, K5 – Evaluate
CO4	Interpret inborn errors of amino acid, protein, purine, pyrimidine, and bilirubin metabolism	K2 – Understand, K4 – Analyze
CO5	Evaluate liver, renal, gastric function tests and clinical significance of enzymes	K5 – Evaluate, K6 – Evaluate

UNIT I

Approaches to Clinical Biochemistry: Collection, processing, preservation and transport of clinical specimens. Automation and quality control. Urine: Normal, abnormal constituents and clinical significance. Blood: - composition and their functions, erythrocyte indices. Blood coagulation system, Clotting time, Bleeding time, Prothrombin time, RBC count, WBC count, Platelet count, Differential count, determination of Hemoglobin, PCV and ESR.

UNIT II

Disorders of Carbohydrate Metabolism: Carbohydrate Metabolism: Diabetes mellitus: - Aetiology, classification, Clinical features, complications, laboratory investigations - GTT. Inborn errors of carbohydrate metabolism: - Galactosaemia, Fructosuria, Lactose intolerance, Pentosuria and Glycogen Storage Diseases.

UNIT III

Disorders of Lipid Metabolism: Hyperlipoproteinaemia – classifications, Hypercholesterolemia, ketosis and its significance, Cardiovascular disorders - Atherosclerosis – aetiology, clinical features and its complications. Lipid storage diseases – Niemann-pick disease, Fabry disease, Tay-Sachs disease and Gaucher's disease. Fatty liver – causes, types, symptoms and diagnosis.

UNIT IV

Disorders of Amino Acid and Protein Metabolism: Inborn errors of amino acid metabolism: - Phenylketonuria, alkaptonuria, cystinuria, albinism and tyrosinemia.

Disorders of Nucleotide Metabolism: Gout, Lesch-Nyhan syndrome, xanthinuria, orotic aciduria.

Disorders of Bilirubin Metabolism: Jaundice: - classification, clinical features.

UNIT V

Clinical Function Tests and Enzymology: Liver Function Tests: Tests based on abnormalities of bile pigment metabolism, carbohydrate metabolism, lipid metabolism, amino acid metabolism, detoxification and excretory function of liver. Renal Function Tests: Tests based on Glomerular filtration, renal plasma flow and tubular function. Gastric Function Tests: Examination of resting contents in resting juice, Fractional gastric analysis using test meal and Examination of the contents after stimulation.

Enzymology: Clinical significance of SGOT, SGPT, ALP, ACP, CPK and LDH.

Reference Books

- William J. Marshall & Márta Lapsley – *Clinical Chemistry: Principles, Techniques, and Correlations*, 9th Edition, 2023, Wolters Kluwer/Lippincott Williams & Wilkins.
- D.M. Vasudevan & S. Sreekumari – *Textbook of Biochemistry for Medical Students*, 9th Edition, 2019, Jaypee Brothers Medical Publishers.

- Harold Varley – *Practical Clinical Biochemistry*, 4th Edition, 1988, CBS Publishers & Distributors.
- Ramnik Sood – *Medical Laboratory Technology: Methods and Interpretations*, 7th Edition, 2019, Jaypee Brothers Medical Publishers.
- David L. Nelson & Michael M. Cox – *Lehninger Principles of Biochemistry*, 8th Edition, 2021, W.H. Freeman.

🌐 Web Resources

1. **MedlinePlus – Clinical Biochemistry** <https://medlineplus.gov>
2. **National Center for Biotechnology Information (NCBI)**
<https://www.ncbi.nlm.nih.gov> ([ncbi.nlm.nih.gov](https://www.ncbi.nlm.nih.gov) in Bing) ([ncbi.nlm.nih.gov](https://www.ncbi.nlm.nih.gov) in Bing)
3. **World Health Organization – Laboratory Biosafety**
<https://www.who.int/activities/laboratory-biosafety> ([who.int](https://www.who.int/activities/laboratory-biosafety) in Bing) ([bing.com](https://www.who.int/activities/laboratory-biosafety) in Bing)
4. **American Association for Clinical Chemistry (AACC)** <https://www.aacc.org>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	M	L	M	M
CO2	S	S	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	S
CO4	S	S	S	M	M	M	L	M	M	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – V
CORE – VII – MOLECULAR BIOLOGY

Objectives

- To understand the molecular mechanisms of DNA replication, transcription, and translation.
- To learn the role of enzymes, inhibitors, and regulatory factors in gene expression.
- To explore protein targeting, folding, degradation, and operon regulation in prokaryotes.
- To study DNA damage, mutations, and repair mechanisms with clinical relevance.
- To develop analytical skills to evaluate molecular processes and their applications in biotechnology and medicine.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall and explain DNA replication mechanisms and experimental evidence	K1 – Remember, K2 – Understand
CO2	Describe transcription processes and analyze RNA synthesis regulation	K2 – Understand, K4 – Analyze
CO3	Apply knowledge of genetic code and translation to protein synthesis	K3 – Apply
CO4	Evaluate protein targeting pathways and gene regulation models (Lac, Trp, Ara operons)	K5 – Evaluate
CO5	Evaluate insights into DNA damage, mutation types, and repair mechanisms	K6 – Evaluate

UNIT I

Replication: Experimental evidence to prove DNA as genetic material, Semiconservative replication, experimental evidence for semiconservative replication, replication in prokaryotes and eukaryotes, enzymes involved in replication, mechanism of replication, inhibitors of DNA replication.

UNIT II

Transcription: Basic features of RNA synthesis, E.Coli RNA polymerases, initiation, chain elongation and termination of transcription, RNA processing. Inhibitors of transcription.

UNIT III

Translation: Genetic code and its features, tRNA and aminoacyl tRNA synthetases. Initiation, elongation and termination of translation, post-translational modifications, Inhibitors of protein synthesis.

UNIT VI

Protein Targeting and Processing: Signal sequences, signal recognition particle, signal hypothesis, molecular chaperons, Targeting of proteins – basic targeting pathways. Protein folding. Protein degradation.

Regulation of Gene Expression in Prokaryotes: The Operon model: Concept of positive and negative regulation. Operon concept – study of the structure and regulation of Lac operon, Trp operon and ara operon.

UNIT V

DNA Damage and Repair: Types of mutation: - Base substitution, insertion, deletion, inversion, duplication, translocation, mutagens. DNA Repair mechanisms: - Excision repair, mismatch repair, photoreactivation, direct demethylation, double strand break repair. Regulation of DNA repair: - SOS repair.

Reference Books

- J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine & R. Losick – *Molecular Biology of the Gene*, 7th Edition, 2014, Pearson.
- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts & Peter Walter – *Molecular Biology of the Cell*, 7th Edition, 2022, W.W. Norton & Company.
- Benjamin Lewin – *Genes XI*, 11th Edition, 2014, Jones & Bartlett Learning.
- Gerald Karp – *Cell and Molecular Biology: Concepts and Experiments*, 9th Edition, 2021, John Wiley & Sons.
- Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon & Kelsey C. Martin – *Molecular Cell Biology*, 9th Edition, 2021, W.H. Freeman.

Web Resources

- **NCBI – National Center for Biotechnology Information**
<https://www.ncbi.nlm.nih.gov> (ncbi.nlm.nih.gov in Bing) ([bing.com](https://www.bing.com) in Bing)
- **PubMed – Biomedical Literature Database** <https://pubmed.ncbi.nlm.nih.gov>
 (pubmed.ncbi.nlm.nih.gov in Bing) ([bing.com](https://www.bing.com) in Bing)
- **European Molecular Biology Laboratory (EMBL)** <https://www.embl.org>
- **Nature Reviews Molecular Cell Biology** <https://www.nature.com/nrm>
- **Khan Academy – Molecular Biology Tutorials**
<https://www.khanacademy.org/science/biology/molecular-biology>
 ([khanacademy.org](https://www.khanacademy.org) in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	L	M	M	L
CO2	S	S	S	M	M	M	L	M	M	L
CO3	S	S	S	M	M	M	L	M	M	M
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – V
CORE – VIII – HUMAN PHYSIOLOGY

Objectives

- To understand the physiological basis of digestion, respiration, circulation, excretion, reproduction, and nervous control.
- To learn mechanisms of regulation and homeostasis in organ systems.
- To explore muscle physiology, cardiovascular functions, and skeletal system roles.
- To relate physiological processes to clinical and diagnostic applications.
- To develop analytical skills to interpret physiological data and integrate knowledge across systems.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall digestive physiology and absorption processes	K1 – Remember
CO2	Explain respiratory physiology and gas exchange	K2 – Understand
CO3	Apply knowledge of muscle contraction, cardiac cycle, and skeletal functions	K3 – Apply
CO4	Analyze renal physiology and reproductive processes	K4 – Analyze
CO5	Evaluate nervous system and sensory physiology; integrate knowledge	K5 – Evaluate, K6 – Evaluate

UNIT I

Digestive System: Overview of the digestive system, secretions of digestive tract, digestive hormones, process of digestion, absorption, assimilation of carbohydrates, proteins, fats, nucleic acids. Absorption of vitamins, minerals and water.

UNIT II

Respiratory System: Overview of the respiratory system, pulmonary ventilation, Alveolar ventilation, composition and partial pressure of inspired air, alveolar air and expired air, exchange and transport of respiratory gases.

UNIT III

Muscle physiology and Cardiovascular System: overview of muscle tissue, contraction and relaxation of skeletal muscle, cardiac muscle tissue and cardiac conduction system, cardiac cycle, cardiac output, blood pressure and E.C.G.

Skeletal System: Introduction to human skeletal system, skeletal divisions and functions of skeleton.

UNIT IV

Excretory System: Overview of renal system, Renal physiology: - glomerular filtration, tubular reabsorption and secretion, production of dilute and concentrated urine.

Reproductive System: Overview of male and female reproductive system, spermatogenesis, oogenesis and follicular development, menstrual cycle, physiology of pregnancy, parturition and lactation.

UNIT V

Nervous System: Overview of nervous system, classification of nervous system, signal transmission at synapse, neurotransmitters.

Special Senses: Physiology of Olfaction, Gustation, Vision, Hearing and equilibrium.

Reference Books

- John E. Hall & Michael E. Hall – *Guyton & Hall Textbook of Medical Physiology*, 15th Edition, 2025, Elsevier.
- Kim E. Barrett, Susan M. Barman, Heddwen L. Brooks & Jason Yuan – *Ganong's Review of Medical Physiology*, 27th Edition, 2025, McGraw Hill/Lange Medical Books.
- Lauralee Sherwood – *Human Physiology: From Cells to Systems*, 9th Edition, 2015, Cengage Learning (Brooks/Cole).
- K. Sembulingam & Prema Sembulingam – *Essentials of Medical Physiology*, 10th Edition, 2025, Jaypee Brothers Medical Publishers.
- Bruce M. Koeppen & Bruce A. Stanton – *Berne & Levy Physiology*, 8th Edition, 2023, Elsevier.

Web Resources

- **American Physiological Society (APS)** <https://www.physiology.org>
- **MedlinePlus – Human Physiology** <https://medlineplus.gov/physiology.html>
(medlineplus.gov in Bing)
- **Khan Academy – Human Physiology Tutorials**
<https://www.khanacademy.org/science/biology/human-biology>
([khanacademy.org](https://www.khanacademy.org) in Bing) (bing.com in Bing) (bing.com in Bing)
- **PhysiologyWeb** <http://www.physiologyweb.com>
- **NCBI – National Center for Biotechnology Information**
<https://www.ncbi.nlm.nih.gov> ([ncbi.nlm.nih.gov](https://www.ncbi.nlm.nih.gov) in Bing) (bing.com in Bing)
(bing.com in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	M	M	L	M	M	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – V
ELECTIVE – III – A) GENETIC ENGINEERING

Objectives

- To understand the principles of recombinant DNA technology and DNA manipulative enzymes.
- To learn about different types of cloning and expression vectors for prokaryotes and eukaryotes.
- To explore methods of gene transfer and screening of recombinants.
- To gain knowledge of molecular techniques such as blotting, PCR, sequencing, and probe applications.
- To apply genetic engineering concepts to construct libraries and study applications in medicine, agriculture, and biotechnology.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall DNA manipulative enzymes and mechanisms of replication and restriction systems	K1 – Remember
CO2	Explain characteristics and applications of vectors in prokaryotes and eukaryotes	K2 – Understand
CO3	Apply gene transfer techniques and screening methods to identify recombinants	K3 – Apply
CO4	Analyze molecular techniques (DNA isolation, blotting, PCR, sequencing)	K4 – Analyze
CO5	Evaluate and design genomic/cDNA libraries; Evaluate applications in medicine and agriculture	K5 – Evaluate, K6 – Evaluate

UNIT I

Introduction to Genetic Engineering: Introduction to rDNA technology, DNA manipulative enzymes: - Nucleases, Ligases, Polymerases, DNA modifying enzymes, Topoisomerases. Restriction- modification system: Restriction endonucleases and its types.

UNIT II

Vectors: Characteristics of an ideal vector, cloning vectors for E.Coli:- pBR322, pUC8. Vectors based on M13 bacteriophage: - M13, Vectors based on λ phage: - insertion and replacement vectors, Cosmids, Phagemids, Vectors for eukaryotes: - vectors for yeast: - Yep, YAC, Vectors for higher plants: - Ti plasmid, Ri plasmid.

UNIT III

Methods of Gene Transfer: Vector mediated gene cloning, Direct/vectorless methods: - Electroporation, biolistics, microinjection, chemical mediated gene transfer, liposome mediated gene transfer, silicon carbide method. Vector mediated gene transfer: - Agrobacterium mediated gene transfer.

Screening of Recombinants: Reporter gene-based screening, selection by the use of antibiotic resistance, blue white screening, Immunological methods, screening through protein activity.

UNIT IV

Techniques in Genetic Engineering: Isolation and purification of genomic DNA, plasmid DNA and λ phage. Molecular probes: - Types and its uses. Methods of nucleic acid labeling. Blotting techniques: - southern, northern and western blotting. DNA sequencing methods. PCR: - Procedure, important considerations of PCR for primer designing, Applications of PCR.

UNIT V

Genomic and cDNA Libraries: Methods of generating genomic and cDNA library, comparison between two types of libraries, advantages and disadvantages of cDNA library.

Applications of rDNA Technology: Recombinant DNA products in medicine (insulin, GH), recombinant vaccines, gene therapy, DNA finger printing, transgenic plants and transgenic animals.

Reference Books

- T.A. Brown – *Gene Cloning and DNA Analysis: An Introduction*, 7th Edition, 2016, Wiley-Blackwell.
- J.D. Watson, R.M. Myers, A.A. Caudy & J.A. Witkowski – *Recombinant DNA: Genes and Genomes – A Short Course*, 3rd Edition, 2007, W.H. Freeman.
- S.B. Primrose & R.M. Twyman – *Principles of Gene Manipulation and Genomics*, 7th Edition, 2006, Wiley-Blackwell.

- B.R. Glick & J.J. Pasternak – *Molecular Biotechnology: Principles and Applications*, 5th Edition, 2018, Cambridge University Press.
- Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon & Kelsey C. Martin – *Molecular Cell Biology*, 9th Edition, 2021, W.H. Freeman.

Web Resources

- NCBI – National Center for Biotechnology Information (ncbi.nlm.nih.gov in Bing)
- PubMed – Biomedical Literature Database (pubmed.ncbi.nlm.nih.gov in Bing)
- [European Molecular Biology Laboratory \(EMBL\)](https://www.ebi.ac.uk/EMBL/)
- [Nature Reviews Genetics](https://www.nature.com/reviews/genetics)
- Khan Academy – Biotechnology Tutorials ([khanacademy.org](https://www.khanacademy.org) in Bing).

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	S	M	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – V
ELECTIVE – IV – B) BIOINFORMATICS

Objectives

- To understand the scope and applications of bioinformatics in genomics, transcriptomics, and metabolomics.
- To learn about biological databases for nucleotide, protein, structure, metabolism, and literature.
- To gain knowledge of sequence alignment methods and algorithms.
- To explore BLAST tools, DNA microarray techniques, and their applications.
- To apply bioinformatics tools in structural genomics, comparative genomics, molecular visualization, and nutrigenomics.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall definitions of genome, transcriptome, metabolome and describe applications	K1 – Remember
CO2	Explain types of biological databases and their uses	K2 – Understand
CO3	Apply sequence alignment algorithms (Needleman-Wunsch, Smith-Waterman)	K3 – Apply
CO4	Analyze BLAST outputs and interpret DNA microarray results	K4 – Analyze
CO5	Evaluate comparative genomics tools and molecular visualization software; design nutrigenomics applications	K5 – Evaluate, K6 – Evaluate

UNIT I

Introduction to Bioinformatics: Definition and scope of Bioinformatics, Definition and Applications of Genomics, transcriptomics and metabolomics, Metabolome database: E.coli and Human Metabolome database. Overview of Human Genome Project.

UNIT II

Biological Databases: Definition, types, and importance of databases, Nucleotide sequence databases - NCBI, EMBL, Genbank, DDBJ. Protein sequence databases - SwissProt, TrEMBL, Structural Database - PDB, Metabolic databases - KEGG, Literature databases - PubMed, MEDLINE.

UNIT III

Sequence Alignment: Local Vs Global alignment, Dot matrix analysis, Scoring matrices: PAM, BLOSUM. Dynamic Programming methods, Algorithms: Needleman - Wunch and Smith – Waterman. Heuristic methods of alignment.

UNIT IV

BLAST and Microarrays: **BLAST** - features, types (BLASTP, BLASTN, BLASTX), PSI-BLAST, BLAST result format and interpretation. DNA Microarray - Procedure and applications.

UNIT V

Structural and Comparative Genomics: Whole genome sequencing - Shotgun approach, Comparative genomics tools: VISTA servers and precomputed tools. Molecular visualization tools - RASMOL, Swiss PDB viewer. Nutrigenomics: Definition and applications.

Reference Books

- David W. Mount – *Bioinformatics: Sequence and Genome Analysis*, 2nd Edition, 2004, Cold Spring Harbor Laboratory Press.
- Arthur M. Lesk – *Introduction to Bioinformatics*, 5th Edition, 2019, Oxford University Press.
- Jin Xiong – *Essential Bioinformatics*, 1st Edition, 2006, Cambridge University Press.
- Jonathan Pevsner – *Bioinformatics and Functional Genomics*, 3rd Edition, 2015, Wiley-Blackwell.
- Andreas D. Baxevanis & B.F.F. Ouellette – *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd Edition, 2004, Wiley-Interscience.

Web Resources

- **NCBI – National Center for Biotechnology Information**
<https://www.ncbi.nlm.nih.gov> (ncbi.nlm.nih.gov in Bing) (bing.com in Bing) ([bing.com](https://www.bing.com) in Bing)
- **EMBL – European Molecular Biology Laboratory** <https://www.embl.org>
- **Human Metabolome Database** <https://hmdb.ca>
- **KEGG – Kyoto Encyclopedia of Genes and Genomes** <https://www.genome.jp/kegg>
- **PubMed – Literature Database** <https://pubmed.ncbi.nlm.nih.gov>
 (pubmed.ncbi.nlm.nih.gov in Bing) (bing.com in Bing) ([bing.com](https://www.bing.com) in Bing)
- **SwissProt/UniProt** <https://www.uniprot.org>
- **Protein Data Bank (PDB)** <https://www.rcsb.org>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	M
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY

THIRD YEAR - SEMESTER – V

SKILL ENHANCEMENT COURSE – III – FORENSIC SCIENCE

Objectives

- To introduce the definition, scope, and history of forensic science.
- To develop skills in biological and serological evidence analysis.
- To train students in chemical and toxicological examination methods.
- To impart knowledge of ballistics and physical evidence analysis.
- To understand medico-legal aspects and crime scene investigation procedures.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain the scope, divisions, and ethical standards of forensic science	K2 – Understanding
CO2	Identify and analyze biological evidence using DNA and serology techniques	K3 – Applying
CO3	Perform chemical and toxicological analysis of drugs, poisons, and adulterants	K4 – Analyzing
CO4	Examine ballistics, firearms, and physical evidence using microscopy and instruments	K4 – Analyzing
CO5	Interpret medico-legal findings and apply criminalistics in crime scene investigation	K5 – Evaluating

UNIT I

Introduction to Forensic Science: Definition, scope, and history of forensic science, Structure of forensic laboratories and divisions, Role of forensic science in the criminal justice system, Ethical issues and professional standards.

UNIT II

Forensic Biology and Serology: Analysis of biological evidence: blood, semen, saliva, hair, and tissue, Blood grouping, DNA fingerprinting, and PCR techniques, Forensic serology methods and applications, Case studies involving biological evidence.

UNIT III

Forensic Chemistry and Toxicology: Analysis of drugs, narcotics, alcohol, and poisons, Techniques for detection of toxins in biological samples, Chromatography, spectroscopy, and modern analytical tools, Forensic applications in food adulteration and environmental samples.

UNIT IV

Forensic Physics and Ballistics: Principles of ballistics: internal, external, and terminal, Firearms identification, gunshot residues, and trajectory analysis, Forensic examination of glass, soil, fibers, and paint, Use of microscopy and instrumental methods in physical evidence.

UNIT V

Forensic Medicine and Criminalistics: Postmortem examination and medico-legal aspects, Determination of cause, manner, and time of death, Injury analysis: blunt force, sharp force, firearm injuries, Crime scene investigation, evidence collection, chain of custody.

Reference Books

- B.S. Nabar – *Forensic Science in Crime Investigation*, 3rd Edition, 2019, Asia Law House.
- R.C. Sharma & K. Sharma – *Forensic Science: Principles and Applications*, 2nd Edition, 2018, PHI Learning.
- Richard Saferstein – *Criminalistics: An Introduction to Forensic Science*, 11th Edition, 2015, Pearson.
- Jackson & Jackson – *Forensic Science*, 2nd Edition, 2011, Pearson Education.
- A. Kumar – *Fundamentals of Forensic Science*, 1st Edition, 2020, Academic Press.

Web Resources

- **National Forensic Sciences University** – India's premier forensic education hub
<https://www.nfsu.ac.in>
- **NIJ Forensic Sciences** – US National Institute of Justice forensic resources
<https://nij.ojp.gov/topics/forensics>

- **Forensic Science Society** – Professional body for forensic scientists
<https://www.theforensic.org>
- **ScienceDirect – Forensic Journals** – Peer-reviewed articles
<https://www.sciencedirect.com/journal/forensic-science-international>
(sciencedirect.com in Bing) ([bing.com in Bing](#))
- **Interpol Forensics** – Global forensic practices
<https://www.interpol.int/en/Crimes/Forensics> (interpol.int in Bing)
([bing.com in Bing](#))

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	L	L	S	M	L	M	L
CO2	M	S	S	M	M	M	M	M	M	L
CO3	M	S	S	M	S	M	M	M	M	M
CO4	M	S	S	S	S	M	M	M	M	M
CO5	M	S	S	S	M	S	S	S	S	M

S – Strong

M - Medium

L – Low

B.Sc., BIOCHEMISTRY
SEMESTER – V
SKILL ENHANCEMENT COURSE (SEC) – LIFESTYLE DISEASES
(Only for NMSDC Reappear Students)

Objectives

- To introduce lifestyle diseases including definitions, risk factors, and socio-cultural influences.
- To explain cardiovascular and metabolic disorders with preventive strategies and diagnostic tests.
- To analyze respiratory, gastrointestinal, and hepatic disorders and their lifestyle associations.
- To evaluate cancer and mental health disorders with emphasis on psychosocial interventions.
- To apply public health approaches for prevention, management, and awareness of lifestyle diseases.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	To describe lifestyle diseases and calculate BMI, WHR, stress indices	K2 – Understanding
CO2	To explain cardiovascular and metabolic disorders and perform BP, glucose, lipid tests	K3 – Application
CO3	To analyze respiratory, GI, and hepatic disorders with diagnostic tools	K4 – Analysis
CO4	To evaluate cancer and mental health disorders and screening methods	K5 – Evaluation
CO5	To apply preventive and public health strategies including yoga, surveys, and dietary assessments	K6 – Creation

UNIT I

Introduction to Lifestyle Diseases: Definition and scope of lifestyle diseases, Global and Indian scenario, Risk factors: diet, physical inactivity, smoking, alcohol, stress, Socio-economic and cultural influences, BMI and Waist-Hip Ratio calculation, Stress assessment tools.

UNIT II

Cardiovascular and Metabolic Disorders: Hypertension, coronary artery disease, stroke, Diabetes mellitus (Type 2) and metabolic syndrome, Obesity and dyslipidemia, Preventive strategies: diet, exercise, stress management, Blood pressure measurement, Blood glucose estimation, Lipid profile test.

UNIT III

Respiratory, Gastrointestinal, and Hepatic Disorders: Chronic obstructive pulmonary disease (COPD), asthma, Gastroesophageal reflux disease (GERD), Non-alcoholic fatty liver disease (NAFLD), Role of environment and lifestyle in progression, Pulmonary function test, Liver function test

UNIT IV

Cancer and Mental Health Disorders: Lifestyle-related cancers: lung, breast, colorectal, Role of tobacco, alcohol, diet, and environment, Stress, anxiety, depression, sleep disorders, Psychosocial interventions and counseling, Cancer screening methods (awareness-based demonstrations), Mental health assessment tools.

UNIT V

Prevention, Management, and Public Health Approaches: Screening and early detection, Lifestyle modification programs, Role of yoga, meditation, and alternative therapies, National and global health initiatives for NCD control, Community health survey, Dietary assessment tools.

Reference Books

- Park K. – Textbook of Preventive and Social Medicine – 2021, Banarsidas Bhanot Publishers, 26th Edition
- Kumar & Clark – Clinical Medicine – 2020, Elsevier, 10th Edition
- Davidson's Principles and Practice of Medicine – 2022, Elsevier, 24th Edition
- Lifestyle Medicine – Rippe J.M. – 2019, CRC Press, 2nd Edition
- WHO – Global Report on Noncommunicable Diseases – 2020, WHO Publications

Web Resources

- **WHO NCDs** (who.int in Bing) (bing.com in Bing) – Global non-communicable disease initiatives
- **ICMR India** – National health research and NCD programs
- **CDC Lifestyle Diseases** (cdc.gov in Bing) – U.S. chronic disease prevention resources
- **UNICEF Health Programs** – Child and maternal health initiatives
- **PubMed Lifestyle Disease Articles** (pubmed.ncbi.nlm.nih.gov in Bing) (bing.com in Bing) – Research publications

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	S	L	L	M	L
CO2	S	S	S	S	M	M	M	M	M	L
CO3	S	S	S	S	M	M	M	M	M	L
CO4	S	S	S	S	M	M	M	M	M	M
CO5	S	M	S	M	S	S	M	M	S	M

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY

THIRD YEAR - SEMESTER – VI

CORE – IX – NUTRITIONAL BIOCHEMISTRY

Objectives

- To understand nutritional composition of principal foods and their role in health.
- To learn dietary requirements across different life stages and physiological conditions.
- To explore protein metabolism, amino acids, and malnutrition management.
- To study mineral nutrition, trace elements, and nutraceuticals.
- To gain knowledge of food regulation, safety standards, and industry practices.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall nutritional profiles of major food groups and calorific value determination	K1 – Remember
CO2	Explain dietary requirements, BMR, and energy expenditure	K2 – Understand
CO3	Apply knowledge of protein metabolism to clinical nutrition and malnutrition management	K3 – Apply
CO4	Analyze mineral functions, deficiency disorders, and nutraceutical classification	K4 – Analyze
CO5	Evaluate food safety laws, FSSAI regulations, and industry standards	K5 – Evaluate, K6 – Evaluate

UNIT I

Nutritional profile of principal foods: Cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spices. Role of dietary carbohydrates, proteins, fats, fiber and antioxidants.

Energy content of foods: Determination of calorific value by Bomb calorimeter.

UNIT II

Dietary Requirements: Balanced diet, Recommended dietary allowances for infants, children, adolescents, pregnant, lactating women, athletes and geriatrics.

Measurement of energy expenditure: Respiratory Quotients of food stuffs, Specific Dynamic Action. BMR: - Measurement of BMR and factors influencing BMR.

UNIT III

Dietary Protein: Biological value of proteins and nitrogen balance. Essential and non-essentials amino acids. Protein energy malnutrition – etiology, management of kwashiorkor and marasmus.

UNIT IV

Minerals: Nutritional significance of dietary macro minerals (Ca, P, Mg, S, K, Na, Cl) and trace minerals (Iron, Iodine, Zinc and copper). Disorders related to the deficiency of minerals.

Nutraceuticals: Introduction and classification of nutraceuticals.

UNIT V

Regulation and Standardization of Foods: Laws governing the food industry in India – PFA, MFPO,

Key Regulations of Food Safety and Standards Authority (FSSA) – packaging and labelling, signage and customer notices, licensing registration and health and sanitary permits. Foreign direct investment in the food processing industry.

Reference Books

- B. Srilakshmi – *Nutrition Science*, 7th Edition, 2019, New Age International Publishers.
- L.K. Mahan & S. Escott-Stump – *Krause's Food, Nutrition, and Diet Therapy*, 13th Edition, 2012, Elsevier/Saunders.
- C. Gopalan, B.V. Ramasastri & S.C. Balasubramanian – *Nutritive Value of Indian Foods*, Revised Edition, 2012, National Institute of Nutrition (ICMR).
- M. Swaminathan – *Advanced Textbook on Food and Nutrition*, Volumes I & II, 2nd Edition, 2012, Bappco Publishers.
- M.E. Shils, M. Shike, A.C. Ross, B. Caballero & R.J. Cousins – *Modern Nutrition in Health and Disease*, 11th Edition, 2006, Lippincott Williams & Wilkins.

Web Resources

1. **National Institute of Nutrition (ICMR-NIN)** <https://www.nin.res.in>
2. **Food Safety and Standards Authority of India (FSSAI)** <https://www.fssai.gov.in>
3. **World Health Organization – Nutrition** <https://www.who.int/health-topics/nutrition> (who.int in Bing) (bing.com in Bing) (bing.com in Bing)
4. **FAO – Food and Nutrition** <https://www.fao.org/nutrition>
5. **Nutrition.gov** <https://www.nutrition.gov>

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	M	M	L	M	M	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – VI
CORE – X – IMMUNOLOGY

Objectives

- To explain types, mechanisms, and components of the immune system.
- To identify immunogens, epitopes, antibodies, and their properties.
- To use antigen-antibody interaction tests such as ELISA and immunofluorescence.
- To assess the role of vaccines, MHC molecules, hypersensitivity, and transplantation.
- To describe complement pathways, autoimmune diseases, immunodeficiency, and HIV infection.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Describe immunity, hematopoiesis, immune cells/organs, and immune responses	K1 – Remember, K2 – Understand
CO2	Analyze immunogens, epitopes, antibodies, and monoclonal antibody applications	K4 – Analyze
CO3	Apply immunological assays to study antigen-antibody interactions	K3 – Apply
CO4	Evaluate vaccines, MHC roles, hypersensitivity, and transplantation immunology	K5 – Evaluate
CO5	Recognize immune disorders and synthesize HIV infection mechanisms	K1 – Remember, K6 – Evaluate

UNIT I

Introduction to Immunology: Immunity, types of immunity, mechanism of immunity, Hematopoiesis, cells and organs of the immune system. Humoral and cell mediated immune response, primary and secondary immune response.

UNIT II

Immunogens and Antigens: Immunogenicity, antigenicity, factors that influencing antigenicity, antigenic specificity, epitopes of an antigen, haptens, adjuvants. **Antibodies:** Structure, Classes, Subclasses, Properties of Immunoglobins, Antigenic determinants – isotypic, allotypic and idiotypic determinants. Production and applications of Monoclonal antibodies.

UNIT III

Antigen - Antibody Interactions: Antigen – antibody binding, strength of binding, Primary binding tests: - Radioimmunoassay, Immunofluorescence assays, Immunoenzyme assays-ELISA. Secondary binding tests: - Agglutination, Precipitation, Immunodiffusion, Immunoelectrophoresis. Complement fixation.

UNIT IV

Immunization: Vaccine and its types.

Major Histocompatibility Complex: Classification and role of MHC in immune response.

Hypersensitivity: Types – I to V. **Transplantation Immunology:** mechanism of graft acceptance and rejection,

UNIT V

Complement System: Classical and Alternative pathway, **Auto immunity:** - History and types of auto immune disorders. Immunodeficiency disorders: - Causes, symptoms, mechanism of HIV infection, HIV replication, transcription and diagnostic methods.

Reference Books

- Kuby Immunology – Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen; 8th Edition; W.H. Freeman / Macmillan Learning; 2018.
- Roitt's Essential Immunology – Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt; 13th Edition; Wiley-Blackwell; 2016.
- Janeway's Immunobiology – Kenneth M. Murphy, Casey Weaver, Leslie Berg; 10th Edition; W.W. Norton & Company; 2022.
- Cellular and Molecular Immunology – Abul K. Abbas, Andrew H. Lichtman, Shiv Pillai, Sarah Henrickson; 11th Edition; Elsevier; 2025.
- Fundamental Immunology – William E. Paul (Editor); 7th Edition; Wolters Kluwer Health / Lippincott Williams & Wilkins; 2013.

Web Resources:

- **NCBI Bookshelf – Immunology** Free online textbooks and chapters on immunology → <https://www.ncbi.nlm.nih.gov/books> ([ncbi.nlm.nih.gov](https://www.ncbi.nlm.nih.gov/books) in Bing)
- **Nature Immunology** Peer-reviewed journal publishing cutting-edge immunology research → <https://www.nature.com/ni>
- **Frontiers in Immunology** Open-access journal covering all aspects of immunology → <https://www.frontiersin.org/journals/immunology>
- **WHO – Vaccines and Immunization** Global guidelines and resources → <https://www.who.int/health-topics/vaccines-and-immunization> ([who.int](https://www.who.int/health-topics/vaccines-and-immunization) in Bing)
- **CDC – HIV Basics** Authoritative information on HIV infection, replication, and prevention → <https://www.cdc.gov/hiv/basics/index.html> ([cdc.gov](https://www.cdc.gov/hiv/basics/index.html) in Bing)
- **American Association of Immunologists (AAI)** Professional society offering educational resources and publications → <https://www.aai.org>
- **Khan Academy – Immunology Tutorials** Free video lessons and practice exercises → <https://www.khanacademy.org/science/biology/human-biology/immunology> ([khanacademy.org](https://www.khanacademy.org/science/biology/human-biology/immunology) in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	S	S	M	M	M	L	M	M	M
CO3	S	S	S	S	M	M	L	M	M	S
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY
THIRD YEAR - SEMESTER – VI
CORE – XI – ENDOCRINOLOGY

Objectives

- To explain classification, mechanisms, receptors, and interactions of hormones.
- To identify hormones of hypothalamus and pituitary, their functions, and related disorders.
- To discuss secretion, circulation, biological roles, and disorders of these glands.
- To assess functions and disorders of gastrointestinal and adrenal hormones.
- To describe gonadotropic hormones, prostaglandins, thromboxanes, and kinins.

Course Outcomes

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Explain hormone classification, receptors, mechanisms, and second messengers	K1 – Remember, K2 – Understand
CO2	Describe hypothalamic and pituitary hormones, their functions, and disorders	K2 – Understand, K3 – Apply
CO3	Analyze thyroid, parathyroid, and pancreatic hormones with clinical relevance	K4 – Analyze
CO4	Evaluate GI tract and adrenal hormones, their regulation and disorders	K5 – Evaluate
CO5	Recognize reproductive and local hormones, synthesizing their roles in physiology	K1 – Remember, K6 – Evaluate

UNIT I

Introduction to Endocrine System: Hormones as messengers, classification of hormones, circulating and local hormones, receptors of hormones, mechanism of action, hormone interactions: - Permissive effect, synergistic effect and antagonistic effect.

Second messengers: - Role of cAMP, cGMP, IP₃, DAG, Ca²⁺ ions and calmodulin in hormonal action.

UNIT II

Hypothalamus and Pituitary Gland: Hypothalamic hormones, hormones of pituitary gland: - chemical nature, secretion, circulation, biological functions, disorders of Adenohypophyseal and neurohypophyseal hormones.

UNIT III

Thyroid and Parathyroid Glands: Chemical nature, secretion, circulation, biological function, disorder of thyroid and parathyroid hormones.

Pancreas: Chemical nature, secretion, circulation, biological function, disorder of Insulin and Glucagon.

UNIT IV

G.I. Tract Hormones: Chemical nature, secretion, circulation, biological function, disorders of Gastrin, Secretin and Cholecystokinin.

Adrenal gland: – Chemical nature, secretion, circulation, biological function, disorders of adrenal medullary and Cortical hormones.

UNIT V

Gonadotropic Hormones: Chemical nature, secretion, circulation, biological function, disorders of male and female reproductive hormones.

Others: Local hormones in tissues – Prostaglandins and Thromboxanes, Local hormones in blood – Kinins.

Reference Books

- Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen & Henry M. Kronenberg – *Williams Textbook of Endocrinology*, 14th Edition, 2020, Elsevier.
- David G. Gardner & Dolores Shoback – *Basic and Clinical Endocrinology*, 10th Edition, 2018, McGraw-Hill.
- James E. Griffin & John E. Griffin – *Endocrine Physiology*, 5th Edition, 2016, McGraw-Hill.
- John E. Hall – *Guyton & Hall Textbook of Medical Physiology*, 14th Edition, 2021, Elsevier.
- George Fink – *Hormones and Human Health*, 1st Edition, 2018, Academic Press.

🌐 Web Resources

- **Endocrine Society** – Professional society with guidelines and resources <https://www.endocrine.org>

- **NCBI Bookshelf – Endocrinology** – Free online chapters on endocrine physiology
<https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
- **Nature Reviews Endocrinology** – Peer-reviewed review articles
<https://www.nature.com/nrendo>
- **Frontiers in Endocrinology** – Open-access journal for endocrine research
<https://www.frontiersin.org/journals/endocrinology> (frontiersin.org in Bing)
- **WHO – Hormonal Health** – Global health perspective on endocrine disorders
<https://www.who.int/health-topics/endocrine-disorders> (who.int in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	L	L	M	L	L	M	L
CO2	S	M	S	M	M	M	L	M	M	M
CO3	S	S	S	M	M	M	L	M	M	S
CO4	S	S	S	M	M	S	M	M	S	S
CO5	S	S	S	S	S	S	M	M	S	S

S – Strong

M - Medium

L – Low

B. Sc., BIOCHEMISTRY

THIRD YEAR - SEMESTER – VI

CORE PRACTICAL – III – CLINICAL BIOCHEMISTRY

Objectives

- To acquire skills in hematological techniques for blood cell evaluation.
- To understand the assay of serum marker enzymes for clinical diagnosis.
- To perform biochemical estimations of blood components using classical methods.
- To analyze urine constituents for normal and pathological conditions.
- To integrate laboratory findings with clinical interpretation.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Perform hemoglobin estimation, bleeding/clotting time, ESR, PCV, RBC/WBC counts	K2 – Understanding, K3 – Applying
CO2	Determine SGOT and SGPT activities	K3 – Applying, K4 – Analyzing
CO3	Estimate glucose, creatinine, proteins, urea, cholesterol	K4 – Analyzing, K5 – Evaluating
CO4	Estimate urea, creatinine, uric acid, and analyze urine constituents	K3 – Applying, K4 – Analyzing, K5 – Evaluating

I. Hematology

- a. Estimation of Hemoglobin – Sahli’s method
- b. Determination of Bleeding Time and Clotting Time
- c. Evaluation of ESR (Erythrocyte Sedimentation Rate) and PCV (Packed Cell Volume)
- d. Enumeration of RBC and WBC counts

II. Assay of Serum Marker Enzymes

- a. Determination of SGOT (AST) activity
- b. Determination of SGPT (ALT) activity

III. Blood Biochemical Analysis

- a. Estimation of Blood Glucose – Orthotoluidine (OT) method
- b. Estimation of Serum Creatine and Creatinine – Alkaline Picrate method
- c. Estimation of Total Proteins – Lowry’s method
- d. Estimation of Urea – DAM–TSC method
- e. Estimation of Cholesterol – Zak’s method

IV. Urine Analysis

- a. Estimation of Urea – DAM–TSC method
- b. Estimation of Creatine and Creatinine – Alkaline Picrate method
- c. Estimation of Uric Acid – Caraway’s method
- d. Qualitative analysis of normal and abnormal constituents of urine

V. Spotters

- 1. Sterile disposable syringes and Needles (different gauges)
- 2. Vacutainers (color-coded tubes: EDTA, citrate, heparin, fluoride, plain)
- 3. Tourniquet
- 4. Alcohol swabs / spirit swabs
- 5. Micropipettes for transfer
- 6. Serum vial
- 7. Vortex mixer
- 8. ESR stand
- 9. PCV tube
- 10. Capillary tube

Practical Reference Books

- **Practical Biochemistry** – D.T. Plummer; 3rd Edition; Tata McGraw-Hill; **1998**
- **Clinical Biochemistry: Techniques and Instrumentation** – R. Varma; 2nd Edition; CBS Publishers; **2018**
- **Laboratory Manual of Biochemistry** – Ranjna Chaudhry; 2nd Edition; Jaypee Brothers Medical Publishers; **2014**
- **Essentials of Practical Biochemistry** – H.D. Kumar; 1st Edition; Vikas Publishing House; **2005**
- **Practical Clinical Biochemistry** – R.C. Gupta; 1st Edition; Jaypee Brothers; **2016**

🌐 Web Resources

- **NCBI Bookshelf – Biochemistry & Hematology** Free access to textbooks and references → <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
- **PubMed – Hematology & Clinical Biochemistry** Research articles on hematology and biochemical assays → <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing)
- **Khan Academy Biology** Tutorials on blood analysis, urine tests, and enzyme kinetics → <https://www.khanacademy.org/science/biology> (khanacademy.org in Bing)
- **ScienceDirect – Clinical Biochemistry Journals** Peer-reviewed methods and case studies → <https://www.sciencedirect.com/journal/clinica-chimica-acta> (sciencedirect.com in Bing)
- **Biology Online** Lab protocols, definitions, and tutorials → <https://www.biologyonline.com>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	M	M	L	M	M	L
CO2	S	M	S	S	M	M	L	M	M	L
CO3	S	S	S	S	S	M	M	M	S	M
CO4	S	S	S	S	M	M	M	M	S	M

S - Strong

M - Medium

L - Low

B. Sc., BIOCHEMISTRY

THIRD YEAR - SEMESTER – VI

CORE PRACTICAL – IV – MOLECULAR BIOLOGY AND IMMUNOLOGY

Objectives

- To develop skills in nucleic acid extraction, estimation, and visualization.
- To understand basic immunological assays for clinical and diagnostic applications.
- To perform quantitative and qualitative analysis of DNA/RNA.
- To gain exposure to immunodiagnostic techniques such as CRP, RA, and WIDAL tests.
- To demonstrate restriction digestion and molecular biology tools.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Extract genomic DNA and RNA from biological sources	K2 – Understanding, K3 – Applying
CO2	Estimate DNA and RNA using classical methods	K3 – Applying, K4 – Analyzing
CO3	Separate and visualize nucleic acids	K4 – Analyzing
CO4	Perform blood grouping, CRP, RA, WIDAL, immunodiffusion	K3 – Applying, K4 – Analyzing
CO5	Demonstrate DNA cleavage by restriction enzymes	K4 – Analyzing, K5 – Evaluating

I. Molecular Biology

- a. Extraction of genomic DNA from plant and animal source.
- b. Isolation of total RNA from yeast and plant tissue.
- c. Estimation of RNA by Orcinol method.
- d. Estimation of DNA by Diphenylamine method.
- e. Separation and visualization of nucleic acids by agarose gel electrophoresis.
- f. Estimation of DNA/RNA concentration and purity (A260/A280).

II. Immunology

- a. Identification of blood group and Rh factor.
- b. Pregnancy test – tube method.
- c. CRP test.
- d. RA test.
- e. WIDAL test.
- f. Single [Radial] Immunodiffusion.

III. Demonstration Experiment

- a. Restriction Digestion – Demonstration of DNA cleavage by restriction enzymes

IV. Spotters

1. Agarose gel
2. SDS
3. TEMED
4. Coomassie Brilliant Blue
5. EtBr
6. Eppendorf tube
7. Gel electrophoresis apparatus
8. UV transilluminator
9. Microcentrifuge
10. Power pack

Practical Reference Books

- **Practical Biochemistry** – D.T. Plummer; 3rd Edition; Tata McGraw-Hill; **1998**
- **Molecular Cloning: A Laboratory Manual** – J. Sambrook, D.W. Russell; 3rd Edition; Cold Spring Harbor Laboratory Press; **2001**
- **Laboratory Manual of Biochemistry** – Ranjna Chaudhry; 2nd Edition; Jaypee Brothers Medical Publishers; **2014**
- **Practical Immunology** – Ian R. Watson; 4th Edition; Blackwell Science; **2002**
- **Essentials of Practical Biochemistry** – H.D. Kumar; 1st Edition; Vikas Publishing House; **2005**

Web Resources

- **NCBI Bookshelf – Molecular Biology & Immunology** Free access to textbooks and references → <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
- **PubMed – DNA/RNA Extraction & Immunological Assays** Research articles on molecular biology and immunology techniques → <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing)
- **Khan Academy Biology** Tutorials on molecular biology and immunology basics → <https://www.khanacademy.org/science/biology> (khanacademy.org in Bing)
- **ScienceDirect – Biochemistry & Immunology Journals** Peer-reviewed methods and case studies → <https://www.sciencedirect.com/journal> (sciencedirect.com in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	M	L	L	M	M	L
CO2	S	S	S	S	M	M	L	M	M	L
CO3	S	S	S	S	S	M	M	M	S	M
CO4	S	S	S	S	M	M	M	M	S	M
CO5	S	S	S	S	S	M	M	M	S	M

S - Strong

M - Medium

L - Low

B.Sc., BIOCHEMISTRY
SEMESTER – VI
SKILL ENHANCEMENT COURSE (SEC) – DIET THERAPY
(Only for NMSDC Reappear Students)

Objectives

- To introduce the principles of diet therapy and scope of nutrition care.
- To understand therapeutic diets and their applications.
- To analyze energy balance and weight management strategies.
- To apply nutrition therapy in gastrointestinal, cardiovascular, metabolic, and renal disorders.
- To gain practical skills in planning and preparing therapeutic diets for special conditions.

Course Outcomes

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

CO No	Course Outcome	Knowledge Level
CO1	Explain principles of diet therapy and nutrition care process	K2 – Understanding
CO2	Apply therapeutic diets in energy and weight management	K3 – Applying
CO3	Analyze dietary modifications for gastrointestinal and cardiovascular disorders	K4 – Analyzing
CO4	Evaluate nutrition therapy for metabolic and renal disorders	K5 – Evaluating
CO5	Demonstrate practical skills in planning therapeutic diets for special conditions	K6 – Creating

UNIT I

Principles of Diet Therapy & Nutrition Care: Definitions and scope of diet therapy, Types of therapeutic diets: Clear liquid, soft diet, High/low protein, Calorie-restricted diets, Nutrition Care Process (NCP): Assessment, Diagnosis, and Intervention.

UNIT II

Energy & Weight Management: Energy modifications in diet, Diet and management of: Obesity, Overweight, Underweight, Eating disorders: Anorexia nervosa, Bulimia nervosa.

UNIT III

Gastrointestinal & Cardiovascular Disorders: Dietary management for: Constipation, Diarrhea, Peptic ulcers, Ulcerative colitis, Cardiovascular system diets: Hypertension, Atherosclerosis, Congestive heart failure.

UNIT IV

Metabolic & Renal Disorders: Nutrition therapy for: Diabetes Mellitus (Type I & II), Thyroid dysfunction, Inborn errors of metabolism, Renal diseases: Nephritis, Nephrotic syndrome, Acute & chronic renal failure - dialysis diets.

UNIT V

Special Conditions & Practical Applications: Febrile conditions & surgery: Diet for fevers, infections, HIV. Pre-operative & post-operative nutrition, Nutritional management for Anemia & blood disorders, Practical application: Planning and preparation of therapeutic diets (e.g., liquid diets, low-sodium diets)

Reference Books

- Krause, M.V. & Mahan, L.K. *Food & Nutrition Care Process*, 14th Edition, 2017, Elsevier.
- Bamji, M.S., Krishnaswamy, K., & Brahman, G.N.V. *Textbook of Human Nutrition*, 4th Edition, 2019, Oxford & IBH Publishing.
- Gopalan, C., Rama Sastri, B.V., & Balasubramanian, S.C. *Nutritive Value of Indian Foods*, Revised Edition, 2011, National Institute of Nutrition (ICMR).
- Whitney, E. & Rolfes, S.R. *Understanding Nutrition*, 15th Edition, 2018, Cengage Learning.
- Escott-Stump, S. *Nutrition and Diagnosis-Related Care*, 8th Edition, 2015, Wolters Kluwer Health.

Web Resources

- **WHO Nutrition Guidance** – <https://www.who.int/health-topics/nutrition> ([who.int](#) in Bing)
- **FAO Nutrition Portal** – <https://www.fao.org/nutrition/en/>
- **ICMR-NIN Resources** – <https://www.nin.res.in/>
- **CDC Nutrition Basics** – <https://www.cdc.gov/nutrition/index.html>
- **Harvard Nutrition Source** – <https://www.hsph.harvard.edu/nutritionsource/> ([hsph.harvard.edu](#) in Bing)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	L	L	M	L	L	M	L
CO2	M	S	M	L	L	M	L	L	M	L
CO3	M	S	S	M	M	M	L	M	S	M
CO4	S	M	S	S	M	S	M	M	S	M
CO5	M	M	S	S	M	S	M	M	S	M

S – Strong

M - Medium

L – Low

B. Sc., MICROBIOLOGY / BIOTECHNOLOGY / CLT

FIRST YEAR - SEMESTER – I

ALLIED THEORY – I - BIOCHEMISTRY

Objectives

- To understand carbohydrates – their classification, structures, properties, and metabolic pathways.
- To explain amino acids and proteins – classification, properties, structural organization, and metabolism.
- To describe lipids – classification, properties, biosynthesis, and oxidation.
- To analyze nucleic acids – structures, functions, biosynthesis, and degradation.
- To evaluate vitamins and minerals – sources, functions, RDA, and deficiency disorders.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Classify carbohydrates and explain their role in metabolism	K1 – Remembering, K2 – Understanding
CO2	Demonstrate knowledge of amino acids, proteins, and metabolic pathways	K2 – Understanding, K3 – Applying
CO3	Analyze lipid metabolism, including biosynthesis and oxidation	K3 – Applying, K4 – Analyzing
CO4	Evaluate nucleic acid structure and nucleotide metabolism	K4 – Analyzing, K5 – Evaluating
CO5	Assess vitamins and minerals in health and disease	K5 – Evaluating, K6 – Creating

UNIT I

Carbohydrates: Classification of carbohydrates, Monosaccharides: - Structures, physical and chemical properties of glucose and fructose. Oligosaccharides: - Disaccharides - structure and significance of sucrose, Lactose, maltose, Polysaccharides: - Structure and significance of homopolysaccharides – Starch, Glycogen and heteropolysaccharides – Hyaluronic acid, Heparin, Glycolysis and Citric acid cycle.

UNIT II

Amino Acids and Proteins: Structures and Classifications of amino acids properties of amino acids. Classification and functions of proteins, bonds involved in protein structure, structural levels of organization: - primary, secondary, tertiary and quaternary structures with examples. Transamination, oxidative and non-oxidative deamination, decarboxylation, Urea cycle.

UNIT III

Lipids: Classifications of lipids, physical and chemical properties of fats, structure and functions of saturated and unsaturated fatty acids. Biosynthesis of Saturated fatty acids and Beta-oxidation of fatty acids.

UNIT IV

Nucleic Acids: Nitrogenous bases, structures of Ribonucleotides and deoxyribonucleotides, structure and functions of DNA and RNA. Biosynthesis and degradation of purine and pyrimidine nucleotides.

UNIT V

Vitamins: Sources, RDA, biochemical functions, deficiency disorders of fat soluble and water-soluble Vitamins.

Minerals: Sources, Biological importance and disorders of Phosphorus, Calcium, Magnesium and Iron.

Reference Books

- **Lehninger Principles of Biochemistry** – David L. Nelson, Michael M. Cox, 8th Edition, W.H. Freeman, 2021.
- **Biochemistry** – Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, 9th Edition, W.H. Freeman, 2019.
- **Harper's Illustrated Biochemistry** – Victor W. Rodwell, David A. Bender, Kathleen M. Botham, 31st Edition, McGraw Hill, 2021.
- **Biochemistry** – Donald Voet, Judith G. Voet, 5th Edition, Wiley, 2018.
- **Textbook of Biochemistry for Medical Students** – D.M. Vasudevan, Sreekumari S., Kannan Vaidyanathan, 8th Edition, Jaypee Brothers Medical Publishers, 2016.

Web Resources

- **NCBI Bookshelf – Biochemistry** Free access to biochemistry textbooks and references → <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing)
- **PubMed – Biochemical Pathways** Research articles on biochemical pathways → <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing)
- **Khan Academy Biochemistry** Simplified video lectures on biochemistry → <https://www.khanacademy.org/science/biology/biochemistry> (khanacademy.org in Bing)
- **IUBMB Biochemistry Resources** International Union of Biochemistry and Molecular Biology learning materials → <https://iubmb.org/resources>
- **MedlinePlus – Vitamins & Minerals** Reliable health information on micronutrients → <https://medlineplus.gov/vitaminsandminerals.html> (medlineplus.gov in Bing)

Mapping with Programme Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	L	L	S	M	L
CO2	S	M	M	M	L	M	L	M	L	M
CO3	S	S	M	M	M	M	M	L	L	M
CO4	S	S	M	S	M	M	L	L	L	M
CO5	S	M	M	M	L	S	S	M	L	M

S - Strong

M - Medium

L - Low

B. Sc., MICROBIOLOGY / BIOTECHNOLOGY / CLT

**FIRST YEAR - SEMESTER – II
ALLIED PRACTICAL – I – BIOCHEMISTRY**

Objectives

- To perform qualitative analysis of carbohydrates, amino acids, proteins, and lipids.
- To prepare biochemical compounds such as starch and casein.
- To carry out quantitative estimation of biomolecules using titration and colorimetric methods.
- To understand the principles behind biochemical assays and their clinical relevance.
- To develop laboratory skills for accurate observation, recording, and interpretation of results.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Perform qualitative analysis of carbohydrates, amino acids, proteins, and lipids	K3 – Application
CO2	Prepare biochemical compounds (starch, casein) using standard protocols	K3 – Application
CO3	Estimate biomolecules (glycine, ascorbic acid) using titration/colorimetric methods	K4 – Analysis
CO4	Interpret biochemical test results and correlate with clinical applications	K5 – Evaluation
CO5	Demonstrate laboratory skills in handling reagents, recording data, and reporting	K2 – Understanding

I. Qualitative Analysis

- a. Analysis of carbohydrates – Ribose, Glucose, Fructose, Maltose, Sucrose, Starch
- b. Analysis of Amino acids – Tyrosine, Tryptophan, Methionine, Arginine
- c. Analysis of proteins – Egg Albumin
- d. Analysis of lipids – cholesterol

II. Biochemical preparation

- a. Preparation of Starch from Potato
- b. Preparation of Casein from milk

III. Quantitative Analysis

- a. Estimation of Glycine – formal titration method.
- b. Estimation of Ascorbic acid – 2, 6 Dichloro phenol Indophenol method.

Practical Reference Books

- *An Introduction to Practical Biochemistry* - Plummer, D.T. – , 3rd Edition, 2010, Tata McGraw-Hill.
- *Biochemical Methods* – S. Sadasivam & A. Manickam; 2nd Edition; 1992; New Age International Publishers, New Delhi.
- *Laboratory Manual in Biochemistry* – J. Jayaraman; 1st Edition; 1981; New Age International Publishers, New Delhi.
- *Introductory Practical Biochemistry* – S.K. Sawhney & Radhir Singh; 2nd Edition; 2005; Alpha Science International Publishers.

🌐 Web Resources

- **NCBI Bookshelf – Biochemistry Methods** Free access to biochemistry textbooks and laboratory manuals → <https://www.ncbi.nlm.nih.gov/books> (ncbi.nlm.nih.gov in Bing) ([bing.com](https://www.bing.com) in Bing)
- **PubMed – Practical Biochemistry Research** Research articles on biochemical assays, enzyme kinetics, and analytical techniques → <https://pubmed.ncbi.nlm.nih.gov> (pubmed.ncbi.nlm.nih.gov in Bing) ([bing.com](https://www.bing.com) in Bing)
- **Khan Academy Biology – Lab Tutorials** Simplified video lessons on chromatography, enzyme assays, and practical biochemistry → <https://www.khanacademy.org/science/biology> (khanacademy.org in Bing) ([bing.com](https://www.bing.com) in Bing)
- **Easy Biology Class – Biochemical Techniques** Notes and protocols for chromatography, electrophoresis, spectroscopy, and centrifugation → <https://www.easybiologyclass.com>

Mapping with Programme Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	–	–	–	–	–
CO2	M	S	M	M	L	–	–	–	–	–
CO3	S	S	M	S	M	–	–	–	–	–
CO4	M	S	L	S	M	M	L	M	M	S
CO5	M	M	M	S	S	M	–	S	S	S

S - Strong

M - Medium

L - Low

**NON-MAJOR ELECTIVE COURSE (NME) OFFERED TO OTHER
DEPARTMENT STUDENTS
SEMESTER – I
NON-MAJOR ELECTIVE COURSE – I – BIOCHEMISTRY IN NUTRITION**

Objectives

- To understand the nutritional composition of foods and their role in health.
- To learn methods for determining calorific value, energy expenditure, and basal metabolic rate.
- To study dietary requirements across different life stages and clinical conditions.
- To explore drug–nutrient interactions, food toxins, allergies, and nutraceuticals.
- To apply nutritional therapy in the prevention and management of metabolic and lifestyle diseases.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall nutritional profiles of major food groups and their functional roles	K1 – Remember
CO2	Explain calorific value determination, BMR, and energy expenditure	K2 – Understand
CO3	Apply knowledge of RDA to different age groups and clinical conditions	K3 – Apply
CO4	Analyze drug–nutrient interactions, food toxins, and nutraceutical classification	K4 – Analyze
CO5	Evaluate nutritional therapy in disease prevention and management	K5 – Evaluate, K6 – Create

UNIT I

Nutritional Profile of Foods: - Cereals, pulses, vegetables, fruits, nuts, oil seeds, animal foods, milk and milk products, egg, fish, meat, drinks and spices. Role of dietary carbohydrates, proteins, fats, fiber and antioxidants.

UNIT II

Determination of calorific value of foods by Bomb calorimeter. Measurement of energy expenditure, respiratory quotients of food stuffs, specific dynamic action. BMR: - Measurement of BMR and factors influencing BMR. RDA for patients: - Anemic, Diabetic, Blood pressure and obese.

UNIT III

Recommended dietary allowances for infants, children, adolescent, pregnant, lactating women, athletes and geriatrics.

UNIT IV

Drug - nutrient Interactions, food toxins, food allergy, adverse effects of alcohol, tobacco, tea, Acidic and alkaline foods. Nutraceuticals: - Introduction and classification of nutraceuticals.

UNIT V

Nutritional therapy for inborn errors of metabolism, role of diet and nutrition in the prevention and treatment of diseases: - Diabetes mellitus, peptic ulcer, jaundice, hypertension and cardiovascular diseases.

Reference Books

1. Swaminathan, M. – *Advanced Textbook on Food & Nutrition*, Vol I & II, 2nd Edition, 2012, Bappco.
2. Bamji, M.S., Rao, N.P., & Reddy, V. – *Textbook of Human Nutrition*, 3rd Edition, 2009, Oxford & IBH Publishing.
3. Gopalan, C., Rama Sastri, B.V., & Balasubramanian, S.C. – *Nutritive Value of Indian Foods*, 2012, NIN–ICMR.
4. Srilakshmi, B. – *Nutrition Science*, 4th Edition, 2010, New Age International Publishers.
5. Shils, M.E., Shike, M., Ross, A.C., Caballero, B., & Cousins, R.J. – *Modern Nutrition in Health and Disease*, 11th Edition, 2006, Lippincott Williams & Wilkins.

🌐 Web Resources

- ICMR–NIN <https://www.nin.res.in>
- FSSAI <https://www.fssai.gov.in>
- WHO – Nutrition <https://www.who.int/health-topics/nutrition> ([who.int in Bing](#))
- FAO – Food and Nutrition <https://www.fao.org/nutrition>
- Nutrition.gov <https://www.nutrition.gov>

Mapping with Programme Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	–	–	–	–	–
CO2	M	S	M	S	M	–	–	–	–	–
CO3	S	S	M	S	M	–	L	M	M	S
CO4	M	S	L	S	M	M	M	M	M	S
CO5	M	S	M	S	S	M	M	S	S	S

S - Strong

M - Medium

L - Low

**NON-MAJOR ELECTIVE COURSE (NME) OFFERED TO OTHER
DEPARTMENT STUDENTS
SEMESTER – II
NON-MAJOR ELECTIVE COURSE – II – BIOCHEMISTRY AND HEALTH**

Objectives

- To understand the sources, functions, and clinical relevance of carbohydrates, proteins, lipids, vitamins, and minerals.
- To study normal biochemical levels in blood and their physiological significance.
- To analyze nutritional deficiencies and metabolic disorders.
- To explore the role of diet in prevention and management of lifestyle diseases.
- To develop critical thinking in applying biochemical knowledge to clinical nutrition.

Course Outcome

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

CO No.	Course Outcome	Knowledge Level (Bloom's Taxonomy)
CO1	Recall sources, functions, and normal levels of biomolecules	K1 – Remember
CO2	Explain biochemical roles of carbohydrates, proteins, lipids, vitamins, minerals	K2 – Understand
CO3	Apply knowledge to identify nutritional deficiencies and metabolic disorders	K3 – Apply
CO4	Analyze biochemical parameters in relation to clinical conditions	K4 – Analyze
CO5	Evaluate dietary and biochemical interventions in disease management	K5 – Evaluate, K6 – Create

UNIT I

Carbohydrate: Sources of carbohydrates, importance of carbohydrates in living organisms, Normal level of sugar in blood, factors influencing blood glucose, renal threshold value, Diabetes mellitus: - Types, Complications, management-monitoring methods of blood glucose level and GTT.

UNIT II

Proteins: Sources of proteins and amino acids, essential and non-essential amino acids, Importance of proteins in living organisms, normal level of serum proteins, protein deficiency disorders: -Kwashiorkor and Marasmus.

UNIT III

Lipids: Sources of lipids, essential and non-essential fatty acids, importance of fats and lipids in living organism, role of lipoproteins in human body. Normal levels of cholesterol and TG. Disorders: - Hypertension and Atherosclerosis.

UNIT IV

Vitamins: Sources, RDA, importance, deficiency disorders of water-soluble and fat-soluble vitamins in humans.

UNIT V

Minerals: - Sources, Biological importance and deficiency disorders of Na, K, Ca, Mg, P, Fe, Zn, Se and Iodine in humans.

Reference Books

1. Satyanarayana, U. & Chakrapani, U. – *Biochemistry*, 5th Edition, 2017, Elsevier.
2. Nelson, D.L. & Cox, M.M. – *Lehninger Principles of Biochemistry*, 7th Edition, 2017, W.H. Freeman.
3. Deb, A.C. – *Fundamentals of Biochemistry*, 9th Edition, 2018, New Central Book Agency.
4. Gopalan, C. et al. – *Nutritive Value of Indian Foods*, 2012, ICMR–NIN.
5. Shils, M.E. et al. – *Modern Nutrition in Health and Disease*, 11th Edition, 2006, Lippincott Williams & Wilkins.

🌐 Web Resources

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- **PubMed – Biochemistry & Nutrition** Research articles on biochemical pathways and nutrition → <https://pubmed.ncbi.nlm.nih.gov>
- **ICMR–NIN** Indian standards for nutrient requirements and dietary guidelines → <https://www.nin.res.in>
- **WHO – Nutrition** Global guidelines on nutrition and health → <https://www.who.int/health-topics/nutrition>

- **FAO – Food and Nutrition** International food composition and nutrition resources → <https://www.fao.org/nutrition>

Mapping with Programme Outcomes

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	L	–	–	–	–	–
CO2	M	S	M	S	M	–	–	–	–	–
CO3	S	S	M	S	M	–	L	M	M	S
CO4	M	S	L	S	M	M	M	M	M	S
CO5	M	S	M	S	S	M	M	S	S	S

S - Strong

M - Medium

L - Low