



BSc **BIOTECHNOLOGY**

2025 - 2026

Biotechnology | Microbiology | Bioinformatics

National College (Autonomous), Trichy

BSc Biotechnology
(For Students admitted from 2025-26)

Sl. No.	Course Code	Part	Hrs/Wk	Credit	Course Type	Course Title	Course Kind	Hrs of Exam		Int. (25)	Ext. (75)
								T	P		
Semester - I											
1	U25T1	I	6	3	Theory	Language		3	-	25	75
2	U25E1	II	6	3	Theory	Professional English for Life Sciences - I		3	-	25	75
3	U25BT1	III	5	5	Theory	Cell Biology and Genetics	Core I	3	-	25	75
*4	U25BT2P	III	3	-	Practical	Lab in Cell and Molecular Biology	Core II	-	3	25	75
5	U25ABT1	III	5	4	Theory	Biochemistry – I: Biomolecules	Allied I	3	-	25	75
*6	U25ABT2P	III	3	-	Practical	Lab in Biochemistry	Allied II	-	3	25	75
7	U25ES	IV	2	2	Theory	Environmental Studies		3	-	25	75
			30	17							

Semester - II											
8	U25T2	I	6	3	Theory	Language		3	-	25	75
9	U25E2	II	6	3	Theory	Professional English for Life Sciences - II		3	-	25	75
*4	U25BT2P	III	3	4	Practical	Lab in Cell and Molecular Biology	Core II	-	3	25	75
10	U25BT3	III	5	5	Theory	Molecular Biology	Core III	3	-	25	75
*6	U25ABT2P	III	3	4	Practical	Lab in Biochemistry	Allied II	-	3	25	75
11	U25ABT3	III	5	4	Theory	Intermediary Metabolism	Allied III	3	-	25	75
12	U25BTSBE1	IV	2	2	Theory	Analytical Techniques I	SBE I	3	-	25	75
			30	25							

* Carry-over Practical: Practical exam for these Lab courses are conducted in the even semester.

Semester - III											
13	U25T3	I	6	3	Theory	Language		3	-	25	75
14	U25E3	II	6	3	Theory	English		3	-	25	75
15	U25BT4	III	4	4	Theory	Immunology	Core IV	3	-	25	75
*16	U25BT5P	III	3	-	Practical	Lab in Immunology and rDNA Technology	Core V	-	3	25	75
17	U25ABT4	III	4	4	Theory	General Microbiology	Allied IV	3	-	25	75
*18	U25ABT5P	III	3	-	Practical	Lab in Microbiology	Allied V	-	3	25	75
19	U25BTSBE2	IV	2	2	Theory	Analytical Techniques II	SBE II	3	-	25	75
20	U25BTSBE3P	IV	2	2	Practical	Lab in Analytical Techniques	SBE Practical	-	3	25	75
			30	18							

Semester - IV											
21	U25T4	I	6	3	Theory	Language		3	-	25	75
22	U25E4	II	6	3	Theory	English		3	-	25	75
*16	U25BT5P	III	3	4	Practical	Lab in Immunology and rDNA Technology	Core V	-	3	25	75
23	U25BT6	III	4	4	Theory	rDNA Technology	Core VI	3	-	25	75
*18	U25ABT5P		3	4	Practical	Lab in Microbiology	Allied V	-	3	25	75
24	U25ABT6	III	4	4	Theory	Applied Microbiology	Allied VI	3	-	25	75
25	U25BTNME1	IV	2	2	Theory	Basic Biotechnology	NME I	3	-	25	75
26	U25VE	IV	2	2	Theory	Value Education		3	-	25	75
			30	26							

* Carry-over Practical: Practical exam for these Lab courses are conducted in the even semester.

Semester - V											
27	U25BT7	III	5	5	Theory	Bioprocess Technology	Core VII	3	-	25	75
28	U25BT8	III	5	5	Theory	Enzyme Technology	Core VIII	3	-	25	75
29	U25BT9P	III	6	4	Practical	Lab in Bioprocess and Enzyme Technology	Core IX	-	3	25	75
30	U25BT10E	III	5	4	Theory	Environmental Biotechnology	Elective I	3	-	25	75
31	U25BT11E	III	5	4	Theory	IPR, Biosafety and Bioethics	Elective II	3	-	25	75
32	U25BTNME2	IV	2	2	Theory	Food Biotechnology	NME II	3	-	25	75
33	U25SS	IV	2	2	Theory	Soft Skills		3	-	25	75
			30	26							

Semester VI											
34	U25BT12	III	6	6	Theory	Plant Biotechnology	Core X	3	-	25	75
35	U25BT13	III	6	6	Theory	Animal Biotechnology	Core XI	3	-	25	75
36	U25BT14	III	6	6	Theory	Bioinformatics	Core XII	-	3	25	75
37	U25BT15P	III	6	4	Practical	Lab in Plant and Animal Biotechnology and Bioinformatics	Core XIII	3	-	25	75
38	U25BT16E	III	5	4	Theory	Biostatistics	Elective III	3	-	25	75
39	U25GS	V	1	1	Theory	Gender Studies		3	-	25	75
40	Extension Activity	V	-	1							
			30	28							
Grand Total			180	140							

Programme Outcomes for BSc Graduates

1. **Disciplinary Knowledge:** Demonstrate a strong foundation in the core principles and concepts within their chosen scientific discipline.
2. **Communication Proficiency:** Communicate scientific information effectively, both orally and in writing, to diverse audiences.
3. **Critical Thinking and Problem-Solving:** Apply critical thinking skills to analyze complex problems, evaluate evidence, and develop effective solutions.
4. **Collaboration and Teamwork:** Work effectively as part of a team, demonstrating leadership skills and respecting diverse perspectives.
5. **Ethical and Social Responsibility:** Understand and address the ethical, social, and environmental implications of scientific advancements.
6. **Lifelong Learning and Adaptability:** Cultivate a commitment to continuous learning and adapt to the evolving landscape of scientific knowledge and technology.

Program Specific Outcome (PSOs) for BSc Biotechnology

These objectives highlight the specific knowledge, skills, and attributes that graduates of a BSc Biotechnology program should possess at the completion of BSc Degree:

1. **Biotechnology Expertise:** Attain comprehensive knowledge of fundamental and advanced concepts in biotechnology, including genetic engineering, molecular biology, cell culture, and bioprocessing.
2. **Technical Proficiency:** Develop hands-on skills in essential biotechnological techniques and instrumentation, enabling them to perform experiments and analyze data effectively.
3. **Research and Innovation:** Foster a research-oriented mindset, enabling them to design experiments, interpret results, and contribute to innovative solutions in biotechnology.
4. **Biomanufacturing and Industrial Applications:** Understand the principles of biomanufacturing, quality control, and regulatory aspects relevant to the biotechnology industry.
5. **Bioethics and Biosafety:** Demonstrate a strong understanding of ethical considerations and biosafety regulations in biotechnology research and applications.
6. **Entrepreneurship and Career Readiness:** Prepare for diverse career paths in biotechnology, including research, industry, healthcare, and entrepreneurship, with the skills to contribute to the bioeconomy.

SEM- I	Prog. Code BITUG2016	Core Course I	Course Code - U25BT1
CELL BIOLOGY AND GENETICS			
CREDITS - 5		Theory Type	HOURS - 5

Course Description

This course provides an essential foundation in the fields of cell biology and genetics, crucial for students pursuing a degree in biotechnology. It explores the fundamental concepts of cellular structure, function, and genetic mechanisms that govern biological processes.

Objectives:

- To describe the structural organization of cells.
- To interpret the diversified functions of every organelle in the cell.
- To understand cell cycle.
- To discuss the laws of Mendelian genetics.
- To understand the patterns of inheritance.
- To synthesize knowledge from cell biology and genetics to propose innovative solutions to contemporary biological problems

Units	Course Content	Hours per Week (5x15)*
Unit I	<p>CELL AS A BASIC UNIT OF LIFE</p> <p>Introduction to Cells</p> <ul style="list-style-type: none"> ○ Discovery of cells: Contributions of Robert Hooke, Antonie van Leeuwenhoek, and others. ○ Development of the cell theory: Schleiden, Schwann, and Virchow's contributions. <p>Prokaryotic vs. Eukaryotic Cells</p> <ul style="list-style-type: none"> ○ Structural and functional differences between prokaryotic and eukaryotic cells. ○ Overview of cellular organization in bacteria, archaea, plants, and animals. <p>Structure of Plant and Animal Cells</p> <ul style="list-style-type: none"> ○ Comparative analysis of plant and animal cell structures. ○ Unique features: Cell wall, chloroplasts (in plants), and centrioles (in animals). <p>Cell Membrane: Structure and Function</p> <ul style="list-style-type: none"> ○ Architecture of the cell membrane: Fluid mosaic model. ○ Membrane transport mechanisms: Passive (diffusion, osmosis, facilitated diffusion) and active transport (primary and secondary). ○ Role of membrane proteins: Transporters, receptors, and adhesion molecules. 	15

Unit II	<p>ULTRASTRUCTURE AND FUNCTION OF ORGANELLES</p> <p>Nucleus</p> <ul style="list-style-type: none"> ○ Structure: Nuclear envelope, nucleolus, and chromatin. ○ Functions: DNA storage, transcription, and ribosome assembly. <p>Energy-Related Organelles</p> <ul style="list-style-type: none"> ○ Mitochondria: Structure, function, and role in cellular respiration. ○ Chloroplasts: Structure, function, and role in photosynthesis (in plants). <p>Endomembrane System</p> <ul style="list-style-type: none"> ○ Endoplasmic Reticulum (ER): Rough ER (protein synthesis) and smooth ER (lipid synthesis, detoxification). ○ Golgi Apparatus: Protein modification, sorting, and secretion. ○ Lysosomes: Intracellular digestion and waste disposal. <p>Other Organelles</p> <ul style="list-style-type: none"> ○ Ribosomes: Protein synthesis (free and membrane-bound). ○ Vacuoles: Storage and maintenance of turgor pressure (in plants). ○ Peroxisomes and Glyoxisomes: Detoxification and lipid metabolism. 	<p>15</p>
Unit III	<p>CYTOSKELETON AND CELLULAR INTERACTIONS</p> <p>Cytoskeletal Elements</p> <ul style="list-style-type: none"> ○ Microfilaments (Actin): Structure, function, and role in cell motility. ○ Intermediate Filaments: Structural support and cell integrity. ○ Microtubules: Structure, function, and role in cell division (spindle formation). <p>Cellular Interactions</p> <ul style="list-style-type: none"> ○ Cell-Cell Junctions: Tight junctions, adherens junctions, gap junctions, and desmosomes. ○ Cell-Extracellular Matrix (ECM) Interactions: Role of integrins and ECM components (collagen, fibronectin). <p>Cell Cycle and Division</p> <ul style="list-style-type: none"> ○ Phases of the cell cycle: Interphase (G1, S, G2) and mitotic phase (mitosis and cytokinesis). ○ Meiosis: Stages and significance in genetic diversity. ○ Regulation of the cell cycle: Cyclins, CDKs, and checkpoints. ○ n. 	<p>15</p>
Unit IV	<p>MENDELIAN GENETICS</p> <p>Introduction to Mendelian Inheritance</p> <ul style="list-style-type: none"> ○ Mendel's laws: Law of segregation and law of independent assortment. ○ Monohybrid and dihybrid crosses: Punnett squares and phenotypic ratios. 	<p>15</p>

	<p>Genetic Crosses</p> <ul style="list-style-type: none"> ○ Test cross and backcross: Applications in genetic analysis. ○ Incomplete dominance and codominance: Examples and genetic ratios. <p>Extensions of Mendelian Genetics</p> <ul style="list-style-type: none"> ○ Multiple alleles: ABO blood group system. ○ Pleiotropy: Single gene affecting multiple traits. 	
Unit V	<p>ADVANCED GENETICS AND APPLICATIONS</p> <p>Genetic Interactions</p> <ul style="list-style-type: none"> ○ Complementary genes, lethal genes, and epistasis. ○ Linkage and crossing over: Mapping genes using recombination frequencies. ○ Polygenic inheritance: Examples in humans (skin color, height) and plants (kernel color in wheat). <p>Chromosomal Basis of Inheritance</p> <ul style="list-style-type: none"> ○ Sex-linked inheritance: Examples in Drosophila and humans. ○ Chromosomal disorders: <ul style="list-style-type: none"> ▪ Allosomal disorders: Klinefelter syndrome (XXY), Turner syndrome (XO). ▪ Autosomal disorders: Down syndrome (trisomy 21). <p>Population Genetics</p> <ul style="list-style-type: none"> ○ Hardy-Weinberg equilibrium: Assumptions and applications. ○ Factors affecting genetic variation: Mutation, migration, genetic drift, and natural selection. 	15

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcome	Knowledge Level
C01	Define the cell structure and its functions	K1
C02	Describe the structural and functional aspects of cellular organelles	K2
C03	Discuss the significance of cytoskeletal elements in cell division	K3
C04	Analyse Mendelian genetics concepts with real-world applications	K4
C05	Evaluate mechanisms of linkage and crossing over with practical examples	K5
C06	Synthesize knowledge from cell biology and genetics to propose innovative solutions to contemporary biological problems	K6

Textbooks

1. Verma, P. S. (2022). *Cell Biology*. S Chand & Company Ltd. (Accn. No: 33013122)
2. Verma, P. S. (2022). *Cell Biology, Molecular Biology Evolution And Ecology*. S Chand & Company Ltd. (Accn. No: 33013123)
3. Plopper, G. (2012). *Principles of Cell Biology*. Jones & Bartlett Learning. (Accn. No: 00063774)
4. Brown, T. A. (2020). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn. No: 33013104)
5. Singh, B. D. (2016). *Genetics*. Kalyani Publishers. (Accn. No: 55014748)

Reference Books

1. Turner, P. C. (2010). *Instant Notes in Molecular Biology*. Viva Books Private Limited. (Accn. No: 00057910)
2. Curran, B. G. (2012). *Bioinformatics*. Cbs Publication & Distribution. (Accn. No: 33013170)
3. Liljas, A. (2014). *Text Book of Structural Biology*. World Scientific. (Accn. No: 33013180)
4. Mount, D. W. (2004). *Bioinformatics sequence and Genome Analysis*. CBS Publishers & Distributors. (Accn. No: 33013177)
5. Abbas, K. A. (1994). *Cellular And Molecular Immunology*. Saunders College, Harcourt Brace College. (Accn. No: 33013124)

Weblink to Learning Resources

1. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBMA1101.pdf
2. [https://socialsci.libretexts.org/Bookshelves/Anthropology/Biological Anthropology/Book%3A Biological Anthropology \(Saneda and Field\)/I%3A Evolutionary Theory/1.5%3A Cell Biology and Basic Genetics](https://socialsci.libretexts.org/Bookshelves/Anthropology/Biological%20Anthropology/Book%3A%20Biological%20Anthropology%20(Saneda%20and%20Field)/I%3A%20Evolutionary%20Theory/1.5%3A%20Cell%20Biology%20and%20Basic%20Genetics)
3. <https://dnaftb.org/>

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	9	3	3	1	0
CO2	9	9	3	3	1	0
CO3	9	9	9	3	3	1
CO4	9	9	3	3	9	3
CO5	9	9	3	1	9	3
CO6	9	9	1	0	9	9
Weightage	54	54	22	13	32	16
Weighted Percentage Contribution	31%	31%	13%	8%	18%	9%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1, PO2	PO3, PO4	PO5	PO6
CO2 / K2	PO1, PO2	PO3, PO4	PO5	PO6
CO3 / K3	PO1, PO2, PO3	PO4, PO5	-	-
CO4 / K4	PO1, PO2	-	-	-
CO5 / K5	-	-	-	-
CO6 / K6	-	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in Cell Biology and Genetics in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- I	Prog. Code BITUG2016	Allied Course I	U25ABT1
BIOCHEMISTRY-I: BIOMOLECULES			
CREDITS - 4	Theory Type		HOURS - 5

Course Description for Biochemistry

This course in Biochemistry provides an in-depth exploration of biomolecules, focusing on their structure, function, and significance in biological systems. Students will study the fundamental building blocks of life, including carbohydrates, proteins, lipids, nucleic acids, and vitamins. The course emphasizes the chemical properties and biological roles of these biomolecules, equipping students with the knowledge necessary to understand complex biochemical processes.

Course Objectives

1. To describe the structural organization and properties of atoms, molecules, and bonds.
2. To understand the classification, structure, and functions of carbohydrates.
3. To analyse the general structure of amino acids and the levels of protein organization.
4. To classify lipids and understand biological functions.
5. To describe the structure and biological importance of nucleic acids.
6. To understand vitamins, their types, functions and deficiency conditions.

Units	Course Content	Hours per Week (5x15)*
Unit I	<p>FOUNDATIONS OF BIOCHEMISTRY AND CARBOHYDRATES</p> <p>Introduction to Biomolecules:</p> <ul style="list-style-type: none"> • Atoms and molecules: Structure and bonding (covalent, ionic, hydrogen, Van der Waals). Importance of chemical bonds in biological systems. • Properties of water: Polarity, hydrogen bonding, solvent properties, its role in biological reactions and cellular environment. • Acids, Bases, and Buffers: pH scale, acid-base equilibria, buffer systems in biological systems (e.g., bicarbonate buffer), importance of pH regulation in cells. <p>Carbohydrates: Structure, Properties, and Functions: Definition and Classification: Monosaccharides, disaccharides, oligosaccharides, and polysaccharides. Examples and biological roles.</p> <ul style="list-style-type: none"> • Monosaccharides: <ul style="list-style-type: none"> ○ Occurrence and structure of common monosaccharides (glucose, fructose, galactose). ○ Linear and ring forms: Haworth projections, anomers, mutarotation. ○ Isomerism: Stereoisomers, enantiomers, diastereomers. ○ Chemical Reactions: Oxidation (reducing sugars), reduction, esterification, and glycoside formation. • Disaccharides: <ul style="list-style-type: none"> ○ Structure and properties of sucrose, lactose, maltose, and cellobiose. Glycosidic bonds. ○ Hydrolysis of disaccharides. 	15

	<ul style="list-style-type: none"> • Polysaccharides: <ul style="list-style-type: none"> ○ Storage polysaccharides: Starch (amylose and amylopectin), glycogen. Structure and function. ○ Structural polysaccharides: Cellulose, chitin. Structure and function. <p>Functions of Carbohydrates:</p> <ul style="list-style-type: none"> • Energy storage (glycogen, starch). • Structural components (cellulose, chitin). • Cell signaling and recognition (glycoproteins, glycolipids). 	
Unit II	<p>AMINO ACIDS, PEPTIDES, AND PROTEIN</p> <ul style="list-style-type: none"> • Amino Acids: Building Blocks of Proteins • General structure of amino acids: Alpha carbon, amino group, carboxyl group, and R group. • Classification of amino acids: Based on R-group properties (nonpolar, polar uncharged, acidic, basic). • Amino acid abbreviations and codes (three-letter and one-letter codes). <p>Peptides and the Peptide Bond:</p> <ul style="list-style-type: none"> • Peptide bond formation: Mechanism and properties (partial double bond character, rigidity, planarity). <p>Levels of Protein Structure:</p> <ul style="list-style-type: none"> • Primary structure • Secondary structure • Tertiary structure • Quaternary structure <p>Ramachandran Plot:</p> <ul style="list-style-type: none"> • Phi and psi angles: Definition and significance. • Ramachandran plot 	15
Unit III	<p>LIPIDS: STRUCTURE AND FUNCTION</p> <p>Introduction to Lipids:</p> <ul style="list-style-type: none"> • Definition and classification of lipids: Simple lipids (triacylglycerols, waxes), complex lipids (phospholipids, glycolipids), and derived lipids (steroids, terpenes). • General properties of lipids: Solubility, amphipathic nature. <p>Fatty Acids:</p> <ul style="list-style-type: none"> • Definition and classification: Saturated, unsaturated (monounsaturated and polyunsaturated). • Nomenclature: Omega-3 and omega-6 fatty acids. • Structure and properties: Chain length, degree of unsaturation, cis and trans isomers. • Essential fatty acids: Importance in human health. <p>Triacylglycerols (Triglycerides):</p> <ul style="list-style-type: none"> • Structure and properties: Glycerol backbone esterified with three fatty acids. • Simple and mixed triacylglycerols. • Functions: Energy storage, insulation. <p>Membrane Lipids:</p> <ul style="list-style-type: none"> • Phospholipids: Structure (glycerophospholipids and sphingolipids) and function in biological membranes. 	15

	<ul style="list-style-type: none"> • Glycolipids: Structure (cerebrosides and gangliosides) and function in cell recognition and signaling. • Cholesterol: Structure and role in membrane fluidity and as a precursor for steroid hormones. <p>Lipid Characterization:</p> <ul style="list-style-type: none"> • Saponification value: Definition and significance. • Iodine value: Definition and significance in assessing unsaturation. • Acid value: Definition and significance in assessing rancidity. <p>Biological Functions of Lipids:</p> <ul style="list-style-type: none"> • Energy storage (triacylglycerols). • Structural components of cell membranes (phospholipids, cholesterol). • Hormones (steroid hormones, eicosanoids). • Vitamins (fat-soluble vitamins). • Insulation and protection. 	
Unit IV	<p>NUCLEIC ACIDS: INFORMATION CARRIERS</p> <ul style="list-style-type: none"> • Introduction to Nucleic Acids: <ul style="list-style-type: none"> ○ Central dogma of molecular biology: DNA → RNA → Protein. ○ Building blocks of nucleic acids: Nucleobases, nucleosides, and nucleotides. • Nucleobases: <ul style="list-style-type: none"> ○ Purines: Adenine (A) and guanine (G). Structure and properties. ○ Pyrimidines: Cytosine (C), thymine (T), and uracil (U). Structure and properties. ○ Tautomeric forms of nucleobases. • Nucleosides and Nucleotides: <ul style="list-style-type: none"> ○ Nucleoside: Base + sugar (ribose or deoxyribose). ○ Nucleotide: Base + sugar + phosphate(s). ○ Nomenclature and numbering. ○ Functions of nucleotides: Energy currency (ATP), signaling molecules (cAMP), enzyme cofactors (NAD⁺). • DNA Structure: <ul style="list-style-type: none"> ○ Primary structure: Nucleotide sequence. ○ Secondary structure: <ul style="list-style-type: none"> ○ Double helix model (Watson and Crick). ○ Base pairing: A-T (or A-U in RNA) and G-C. ○ Antiparallel strands. ○ Major and minor grooves. ○ Types of DNA: A-DNA, B-DNA, and Z-DNA. Structural differences and biological significance. • DNA Organization: <ul style="list-style-type: none"> ○ Supercoiling: Positive and negative supercoiling. Topoisomerases. ○ Chromatin structure: Histones and nucleosomes. • DNA Properties: 	15

	<ul style="list-style-type: none"> ○ Hypochromic effect: Decrease in UV absorbance upon base stacking in DNA. ○ Hyperchromic effect: Increase in UV absorbance upon DNA denaturation. ○ Melting temperature (T_m): Factors affecting T_m (GC content, salt concentration). ○ Denaturation and renaturation: Hybridization. ○ Cot curves: Complexity of DNA. ● RNA Structure: <ul style="list-style-type: none"> ○ Types of RNA: mRNA, tRNA, rRNA, and small RNAs (miRNA, siRNA). ○ Secondary and tertiary structures of RNA. ○ Ribozymes: Catalytic RNA molecules. 	
Unit V	<p>VITAMINS AND MINERALS: ESSENTIAL MICRONUTRIENTS</p> <ul style="list-style-type: none"> ● Introduction to Vitamins: <ul style="list-style-type: none"> ○ Definition and classification: Water-soluble and fat-soluble vitamins. ○ Historical perspective and discovery of vitamins. ○ General functions of vitamins: Coenzymes, antioxidants, hormones. ● Water-Soluble Vitamins: <ul style="list-style-type: none"> ○ B Vitamins: ○ Thiamine (B1): Structure, biochemical role (TPP), deficiency (beriberi). ○ Riboflavin (B2): Structure, biochemical role (FAD), deficiency (ariboflavinosis). ○ Niacin (B3): Structure, biochemical role (NAD⁺), deficiency (pellagra). ○ Pantothenic Acid (B5): Structure, biochemical role (CoA), deficiency (rare). ○ Pyridoxine (B6): Structure, biochemical role (PLP), deficiency (dermatitis, neurological symptoms). ○ Biotin (B7): Structure, biochemical role (carboxylation reactions), deficiency (rare). ○ Folic Acid (B9): Structure, biochemical role (tetrahydrofolate), deficiency (megaloblastic anemia, neural tube defects). ○ Cobalamin (B12): Structure, biochemical role (methylcobalamin, adenosylcobalamin), deficiency (pernicious anemia). ○ Vitamin C (Ascorbic Acid): ○ Structure, biochemical role (antioxidant, collagen synthesis), deficiency (scurvy). ● Fat-Soluble Vitamins: <ul style="list-style-type: none"> ○ Vitamin A (Retinol): ○ Structure, biochemical role (vision, cell differentiation), deficiency (night blindness, xerophthalmia). 	15

	<ul style="list-style-type: none"> ○ Vitamin D (Calciferol): ○ Structure, biochemical role (calcium homeostasis), deficiency (rickets, osteomalacia). ○ Vitamin E (Tocopherol): ○ Structure, biochemical role (antioxidant), deficiency (rare). ○ Vitamin K (Phylloquinone): ○ Structure, biochemical role (blood clotting), deficiency (bleeding disorders). 	
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CO Level	Course outcome	K Level
CO1	Define the structure and properties of atoms, molecules, and the types of bonds that form biomolecules.	K1
CO2	Describe the classification, structure, and functions of carbohydrates, including their occurrence and various forms.	K2
CO3	Discuss the general structure of amino acids and analyze the levels of protein organization, including their biological functions.	K3
CO4	Interpret the classification and biological functions of lipids, including fatty acids and triglycerides and correlate it with health and disease.	K4
CO5	Evaluate the structure and biological importance of nucleic acids and their properties by analytical methods.	K5
CO6	Synthesize knowledge of vitamins, analyzing their biochemical roles and evaluating their impact on health and deficiency diseases.	K6

Textbooks

- 1 Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn. No: 00064191)
- 2 Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn. No: 00063764)
- 3 Lehninger. (n.d.). *Biochemistry*. Kalyani Publishers. (Accn. No: 33013012)
- 4 Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn. No: 33013168)
- 5 Berg, J. M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn. No: 33013190)

Reference Books

- 1 Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn. No: 1010)
- 2 Buchanan, B. B. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn. No: 33013103)
- 3 Mathews, H. R. (n.d.). *Biochemistry A Short Course*. (Accn. No: 33013163)
- 4 Singh S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn. No: 55015155)
- 5 Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn. No: 33012996)

Weblink to Learning Resources<https://app.lecturio.com/#/course/s/8060/5990><https://open.umn.edu/opentextbooks/textbooks/866><https://www.ninjanerd.org/note-category/biochemistry/>**Course Articulation Matrix (CO-PO Mapping)**

CO/PO	P01	P02	P03	P04	P05	P06
C01	9	9	3	3	1	0
C02	9	9	3	3	1	0
C03	9	9	9	3	3	1
C04	9	9	3	3	9	3
C05	9	9	3	1	9	3
C06	9	9	1	0	9	9
Weightage	54	54	22	13	32	16
Weighted Percentage Contribution	31%	31%	13%	8%	18%	9%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
C01 / K1	P01, P02	P03, P04	P05	P06
C02 / K2	P01, P02	P03, P04	P05	P06
C03 / K3	P01, P02, P03	P04, P05	P06	-
C04 / K4	P01, P02	P05	-	-
C05 / K5	P01, P02	-	-	-
C06 / K6	-	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in Biochemistry-I: Biomolecules in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

***** End of Semester I*****

SEM- II	Prog. Code BITUG2016	Core Course III	U25BT3
MOLECULAR BIOLOGY			
CREDITS - 5	Theory Type		HOURS - 5

Course Description for Molecular Biology

This course describes the fundamental processes of DNA replication, transcription, and translation. It helps students to analyze the structure and function of genetic material and its role in protein synthesis. It describes the evolutionary impact of mutations and mutation associated genetic changes. They will also apply molecular biology concepts to real-world biological and biotechnological scenarios.

Objectives

- To understand the key experiments and principles that established the understanding of genetic material
- To describe the processes of DNA replication, transcription, and translation in both prokaryotes and eukaryotes
- To discuss how the process of transcription and RNA processing (e.g., splicing and capping) are crucial for the regulation of gene expression
- To analyze the role of different types of RNA (mRNA, rRNA, tRNA) in protein synthesis
- To synthesize the understanding of molecular mechanisms to propose strategies for genetic engineering or therapeutic interventions.

Units	Course Content	Hours per Week (5x15)*
Unit I	<p>Experiments on Genetic Material and Genome Organization</p> <ul style="list-style-type: none"> ○ History of molecular biology, Experiments to prove DNA as genetic material- Griffith's, Hershey-Chase and Avery and McLeod experiments ○ Properties of Genetic material-structure and function- DNA&RNA ○ Structure of DNA (A, B, Z forms) ○ Structure and types of RNA- rRNA, tRNA and mRNA. ○ Structure of ribosomes and their role in gene expression. 	15
Unit II	<p>Central Dogma of Life</p> <ul style="list-style-type: none"> ○ DNA replication mechanisms in prokaryotes and eukaryotes. ○ Transcription process and post-transcriptional modifications: capping, polyadenylation, and splicing. ○ Translation: Genetic code, mechanisms of translation in prokaryotes and eukaryotes, and post-translational modifications (e.g., phosphorylation, methylation, ubiquitination). 	15

Unit III	DNA Repair, Mutations, and Transposable Elements <ul style="list-style-type: none"> ○ Mechanisms of DNA repair. ○ Mutagenesis, mutation types, mutational hotspots, and reversion. ○ Role of transposable elements, including insertion sequences and integrons. 	15
Unit IV	Gene Regulation Mechanisms <ul style="list-style-type: none"> ○ Overview of gene regulation in prokaryotes and eukaryotes. ○ Operon models: Lac, trp, and gal operons. ○ Concepts of feedback inhibition and RNA interference (RNAi). 	15
Unit V	Chromosomal Aberrations and Oncogenesis <ul style="list-style-type: none"> ○ Chromosomal number and structural abnormalities: Ploidy, structural aberrations, and the position effect. ○ Chromosome mapping techniques. ○ Oncogenesis: Development and causes of cancer, oncogenes, and tumor suppressor genes. 	15

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	COURSE OUTCOMES	K Level
CO1	Define key experiments and principles that established the understanding of genetic material	K1
CO2	Describe the processes of DNA replication, transcription, and translation in both prokaryotes and eukaryotes.	K2
CO3	Discuss the role of mutations and DNA repair mechanisms in maintaining genomic integrity.	K3
CO4	Analyze the relationship between chromosomal aberrations and their effects on cellular functions.	K4
CO5	Evaluate the role of oncogenes, tumor suppressor genes, chromosomal aberrations and oncogenesis	K5
CO6	Synthesize the understanding of molecular mechanisms to propose strategies for genetic engineering or therapeutic interventions.	K6

Textbooks

1. Pal, J. K. (n.d.). *Fundamentals of Molecular Biology*. Oxford University Press. (Accn No: 33012931)
2. Pal, J. K. (n.d.). *Fundamentals of Molecular Biology*. Oxford University Press. (Accn No: 33012932)

3. Primrose, S. M. (n.d.). *Principles of Gen Manipulation and Genomics*. Wiley India Pvt. Ltd. (Accn No: 33013080)
4. Glick, R. B. (n.d.). *Molecular Biotechnology*. SCIENTIFIC INTERNATIONAL PVT LTD. (Accn No: 33013095)
5. Verma, P. S. (n.d.). *Cell Biology, Molecular Biology Evolution And Ecology*. S Chand & Company Ltd. (Accn No: 33013123)

Reference Books

1. Turner, P. C. (n.d.). *Instant Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Ramawat, K. G. *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
3. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)
4. Brown, T. A. (n.d.). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn No: 33013104)
5. Abbas, K. A. (n.d.). *Cellular And Molecular Immunology*. Saunders College, Harcourt Brace College. (Accn No: 33013124)

Weblink to Learning Resources

1. <https://praxilabs.com/en/blog/2023/05/24/what-is-molecular-biology/>
2. https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBC2101.pdf
3. https://www.aphl.org/programs/infectious_disease/tuberculosis/TBCore/Molecular_Biology_101-WithNotes.pdf

Course Articulation Matrix (CO-PO Mapping)

CO/PO	P01	P02	P03	P04	P05	P06
C01	9	3	0	0	0	0
C02	9	9	3	0	0	0
C03	9	9	9	3	0	1
C04	9	9	9	3	3	1
C05	9	9	9	9	9	3
C06	9	9	9	9	9	9
Weightage	54	48	39	24	21	14
Weighted Percentage Contribution	35.7%	31.6%	25.7%	15.8%	13.8%	9.2%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	PO1	PO2	-	PO3, PO4, PO5, PO6
CO2 / K2	PO1, PO2	PO3	-	PO4, PO5, PO6
CO3 / K3	PO1, PO2, PO3	PO4	PO6	PO5
CO4 / K4	PO1, PO2, PO3	PO4, PO5	PO6	-
CO5 / K5	PO1, PO2, PO3, PO4, PO5	PO6	-	-
CO6 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in **Molecular Biology** in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code BITUG2016	Allied Course III	CODE - U25ABT3
Biochemistry-II: Intermediary Metabolism			
CREDITS - 4	Theory		HOURS - 5

Course Description for Biochemistry II: Intermediary Metabolism

This Biochemistry course provides an in-depth exploration of the biochemical processes that underpin life. Students will study the thermodynamics of biological systems, metabolic pathways of carbohydrates, and the anabolic and catabolic mechanisms related to proteins. The course also covers the biological significance of nucleic acids, co-factors, and co-enzymes.

Objectives:

- To understand the thermodynamics of biological systems.
- To interpret the metabolic pathways of carbohydrates and their significance in energy production.
- To differentiate anabolic and catabolic pathways and to interpret the relative outcome.
- To understand and analyse the regulation of metabolic pathways.
- To differentiate the biological significance of nucleic acids, co-factors and co-enzymes.
- To evaluate the implications of biochemical processes in health and disease.

Units	Course Content	Hours per Week (5x15)*
Unit I	<p>Bioenergetics and Central Carbon Metabolism in Microbes</p> <ul style="list-style-type: none"> • Introduction to Microbial Energy Metabolism <ul style="list-style-type: none"> ○ Molecular basis of energy conservation in microbes ○ Role of ATP as the universal energy currency ○ Thermodynamics of microbial metabolism: Free energy, enthalpy, and entropy • Carbohydrate Metabolism in Microbes <ul style="list-style-type: none"> ○ Glycolysis: Embden-Meyerhof-Parnas (EMP) pathway and its regulation ○ Alternative glycolytic pathways in microbes: Entner-Doudoroff (ED) pathway and phosphoketolase pathway ○ Citric Acid Cycle (TCA cycle): Role in energy production and biosynthesis ○ Pentose Phosphate Pathway (PPP): Role in NADPH production and nucleotide biosynthesis ○ Glyoxylate shunt: Importance in microbes utilizing acetate or fatty acids as carbon sources ○ Fermentation pathways: Lactic acid, ethanol, and mixed-acid fermentation in microbes • Regulation of Central Carbon Metabolism 	15

	<ul style="list-style-type: none"> ○ Allosteric regulation and feedback inhibition in microbial pathways ○ Role of oxygen and redox balance in metabolic regulation ○ Anaplerotic reactions: Replenishing TCA cycle intermediates 	
Unit II	<p>AMINO ACIDS METABOLISM AND PHOTOSYNTHESIS</p> <ul style="list-style-type: none"> • General reactions of amino acid breakdown and synthesis • Mechanisms: Transamination, decarboxylation, oxidative & non-oxidative deamination • Urea cycle and its regulation • Photosynthesis – Light and Dark reactions 	15
Unit III	<p>LIPIDS METABOLISM</p> <ul style="list-style-type: none"> • Hydrolysis of triacylglycerols • Oxidation of fatty acids • Fatty acid biosynthesis: Acetyl CoA carboxylase, fatty acid synthase • Cholesterol metabolism and regulation 	15
Unit IV	<p>NUCLEOTIDE METABOLISM</p> <ul style="list-style-type: none"> • Biosynthesis and degradation of purine and pyrimidine nucleotides • Purine salvage pathway • Biosynthesis of deoxyribonucleotides and polynucleotides • Inhibitors of nucleic acid biosynthesis • Porphyrins: Biosynthesis and degradation 	
Unit V	<p>COENZYMES AND COFACTORS</p> <ul style="list-style-type: none"> • Role and mechanism of action of NAD⁺/NADP⁺, FAD, lipoic acid • Coenzymes: Thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 • Role of metal ions in enzymatic reactions 	

Course Outcomes:

At the completion of the course, the student would be able to:

CO Level	COURSE OUTCOMES	COGNITIVE LEVEL
CO1	Interpret the thermodynamic principles in any biological system.	K2
CO2	Interpret the functions of carbohydrates relative to their structure and metabolic pathways.	K3
CO3	Describe the various mechanisms involved in the synthesis and degradation of amino acids.	K2

C04	Utilize the structure of nucleic acids for the understanding of central dogma of life.	K3
C05	Explain the mechanism of co-factors and co-enzymes in biological processes.	K3
C06	Analyze regulatory mechanisms that control metabolic pathways in response to physiological changes.	K4

Textbooks

1. Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn No: 00063764)
2. Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn No: 00064191)
3. Berg, J. M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn No: 33013190)
4. Lehninger. (n.d.). *Biochemistry*. Kalyani Publishers. (Accn No: 33013012)
5. Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn No: 33013168)

Reference Books

1. Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn No: 1010)
2. Buchanan, B. B. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn No: 33013103)
3. Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn No: 33012996)
4. Mathews Harry R. (n.d.). *Biochemistry A Short Course*. (Accn No: 33013163)
5. Singh, S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn No: 55015155)

Weblink to Learning Resources

<https://bio.libretexts.org/Bookshelves/Biochemistry>

<https://open.umn.edu/opentextbooks/textbooks/866>

<https://www.ninjanerd.org/note-category/biochemistry/7>

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	3	0	0	0	0
C02	9	9	3	0	0	0
C03	9	9	9	3	0	1
C04	9	9	9	3	3	1
C05	9	9	9	9	9	3
C06	9	9	9	9	9	9
Weightage	54	48	39	24	21	14

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
Weighted Percentage Contribution	35.7%	31.6%	25.7%	15.8%	13.8%	9.2%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K2	P01	P02	-	P03, P04, P05, P06
CO2 / K3	P01, P02	P03	-	P04, P05, P06
CO3 / K2	P01, P02, P03	P04	P06	P05
CO4 / K3	P01, P02, P03	P04, P05	P06	-
CO5 / K3	P01, P02, P03, P04, P05	P06	-	-
CO6 / K4	P01, P02, P03, P04, P05, P06	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the course in Biochemistry-Intermediary Metabolism in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code BITUG2016	Core Course	U25BT2P
Core Course II: LAB IN CELL AND MOLECULAR BIOLOGY			
CREDITS - 3	Laboratory		HOURS - 3+3

Course Description for Cell and Molecular Biology Lab

This course is designed to provide microbiology students with a comprehensive understanding of cell biology and molecular biology principles, emphasizing practical applications relevant to microbiological research and diagnostics. Students will explore the fundamental concepts of cell division, DNA isolation, and analysis techniques, including UV spectrophotometry and agarose gel electrophoresis.

Objectives:

- To familiarize students with the basic equipment and practices used in cell biology and molecular biology laboratories, emphasizing safety and maintenance.
- To identify and describe the stages of mitosis and meiosis using microscopic techniques.
- To isolate and purify genomic DNA from bacterial cultures and plant tissues.
- To quantify DNA using UV spectrophotometry and interpret the results.
- To separate and analyses DNA on agarose gel electrophoresis
- To apply theoretical knowledge of cell biology and molecular biology to practical problems and experiments.

List of Laboratory Experiments

1. Equipment used in laboratory, general practice and maintenances
2. Identification of various stages of cell division (mitosis and meiosis).
3. Mitosis and Meiosis – onion root tip and grasshopper testis squash methods
4. Isolation of genomic DNA from bacterial culture
5. Isolation of genomic DNA from plant tissue.
6. Quantification of DNA using UV spectrophotometer.
7. Agarose gel electrophoresis of genomic DNA.

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcome	Knowledge Level
C01	Identify and explain the function of various laboratory equipment used in cell biology and molecular biology experiments.	K1
C02	Describe the stages of mitosis and meiosis and demonstrate their understanding through microscopic observations.	K2
C03	Students will be able to isolate and purify genomic DNA from bacterial and plant sources using appropriate protocols.	K2

C04	Accurately quantify DNA samples using UV spectrophotometry and interpret the results in the context of DNA purity and concentration. [K Level: 3 – Application.	K3
C05	Perform agarose gel electrophoresis to separate and visualize genomic DNA, interpreting the results to identify DNA fragments.	K3
C06	Analyze and evaluate the results of cell biology and molecular biology experiments, relating them to broader biological concepts and applications.	K4

Textbooks

1. Plopper, G. (n.d.). *Principles of Cell Biology*. Jones & Bartlett Learning. (Accn No: 00063774)
2. Verma, P. S. (2022). *Cell Biology*. S Chand & Company Ltd. (Accn No: 33013122)
3. Verma, P. S. (2022). *Cell Biology, Molecular Biology Evolution And Ecology*. S Chand & Company Ltd. (Accn No: 33013123)
4. Singh, B. D. (n.d.). *Genetics*. Kalyani Publishers. (Accn No: 55014748)
5. Aneja, K. R. (n.d.). *Experiments in Microbiology Plant Pathology Tissue Culture and Microbial Biotechnology*. New Age International Publishers. (Accn No: 55014790)

Reference Books

1. Turner, P. C. (n.d.). *Instant Notes in Molecular Biology*. Viva Books Private Limited. (Accn No: 00057910)
2. Bajpai, P. K. (n.d.). *Biological Instrumentation and Methodology*. S.Chand and Co., (Accn No: 00061096)
3. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co. (Accn No: 3309224)
4. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)
5. Brown, T. A. (n.d.). *Gene Cloning & DNA Analysis*. Wiley Black Well. (Accn No: 33013104)

Weblink to Learning Resources

1. <http://vlabs.iitkgp.ac.in/biochem/loe.html>
2. https://bio.libretexts.org/Bookshelves/Biotechnology/Lab_Manual%3A_Introduction_to_Biotechnology/01%3A_Techniques
3. <https://www.labster.com/blog/7-molecular-biology-techniques-in-classroom>

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	9	3	3	3	1
C02	9	9	3	9	3	1
C03	9	9	9	3	3	1

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
C04	9	9	9	9	3	3
C05	9	9	9	9	9	3
C06	9	9	9	9	9	9
Weightage	54	54	42	42	30	18
Weighted Percentage Contribution	31.03%	31.03%	24.14%	24.14%	17.24%	10.34%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
C01 / K1	PO1, PO2	PO3, PO4, PO5	PO6	-
C02 / K2	PO1, PO2, PO4	PO3, PO5	PO6	-
C03 / K2	PO1, PO2, PO3	PO4, PO5	PO6	-
C04 / K3	PO1, PO2, PO3, PO4	PO5	PO6	-
C05 / K3	PO1, PO2, PO3, PO4, PO5	-	PO6	-
C06 / K4	PO1, PO2, PO3, PO4, PO5	-	-	PO6

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the Lab course in Cell and Molecular Biology in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code BITUG2016	Lab in Allied Course	U25ABT2P
Allied Course II: LAB IN BIOCHEMISTRY			
CREDITS - 3	Laboratory		HOURS - 3+3

Course Description for Biochemistry Lab

The Biochemistry Lab course provides hands-on experience in essential techniques and experiments that are fundamental to the study of biochemistry. Students will engage in a variety of experiments designed to enhance their understanding of biochemical principles, including basic calculations, buffer preparation, protein extraction, and chromatography techniques. The course emphasizes the application of theoretical knowledge in practical settings, enabling students to develop critical laboratory skills and analytical thinking.

Course Objectives

- To perform basic calculations in biochemistry, including normality, molarity, and percent solutions.
- To calibrate a pH meter and prepare biological buffers.
- To operate spectrophotometers and colorimeters for biochemical analysis.
- To extract and estimate proteins from biological materials using various methods.
- To separate and analyze biomolecules using chromatography techniques.
- To demonstrate key biochemical processes such as photosynthesis and enzyme action.

List of Laboratory Experiments

1. Basic calculations in Biochemistry - Normality, Molarity, Molality percent solutions (v/v, w/v).
2. Calibration of pH meter and pH measurements
3. Preparation of biological buffer – phosphate, Acetate, citrate buffer
4. Working of a Spectrophotometer and Colorimeter
5. Verification of Beer's law
6. Extraction and estimation of Proteins from biological materials (Biuret/Lowry/Spectrophotometric)
7. Purity check of DNA & RNA by UV Spectrophotometry - A260/280
8. Isolation and estimation of reducing sugars, total sugar from natural sources
9. SDS PAGE – Group Experiment
10. Separation of amino acids by Paper Chromatography
11. Separation of sugars by Paper Chromatography
12. Separation of plant pigments by paper chromatography
13. Separation of sugars by Thin layer chromatography
14. Demonstration of Photosynthesis and factors affecting the rate of photosynthesis
15. Demonstration of Glucose Tolerance Test
16. Demonstration of Glycemic Index of selected food material
17. Demonstration of enzyme action (Salivary Amylase)

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcome	Knowledge Level
C01	To perform basic calculations in biochemistry, including normality, molarity, and percent solutions.	K1
C02	To calibrate a pH meter and prepare biological buffers.	K2
C03	Utilize spectrophotometric techniques to analyze biochemical substances and verify Beer's law.	K3
C04	Extract and estimate proteins from biological samples using established methods like Biuret or Lowry assays.	K4
C05	Separate biomolecules using chromatography techniques (paper and thin-layer chromatography) and analyze the results.	K5
C06	Demonstrate understanding of metabolic processes through practical experiments such as glucose tolerance tests and enzyme action demonstrations.	K6

Textbooks

1. Veerakumari, L. (n.d.). *Biochemistry*. Mjp Publication. (Accn No: 00063764)
2. Dulsy Fathima. (n.d.). *Biochemistry* (7th ed.). Saras Publication. (Accn No: 00064191)
3. Mani Sharma. (n.d.). *Biochemistry A Short Course* (1st ed.). International Book Distributing Co. (Accn No: 33013168)
4. Boyer, R. F. (n.d.). *MODERN EXPERIMENTAL BIOCHEMISTRY* (3rd ed.). Pearson. (Accn No: 33012996)
5. Singh S. P. (n.d.). *Viva Voce in Biochemistry*. CBS Publishers & Distributors. (Accn No: 55015155)

Reference Books

1. Weil, J. H. (n.d.). *General Biochemistry*. New Age International (p) Limited. (Accn No: 1010)
2. Bajpai P K. (n.d.). *Biological Instrumentation and Methodology*. S.Chand and Co. (Accn No: 00061096)
3. Buchanan B Bob. (n.d.). *Biochemistry & Molecular Biology of Plants* (2nd ed.). Wiley Black Well. (Accn No: 33013103)
4. Berg Jeremy M. (n.d.). *Biochemistry* (10th ed.). Macmillan Publish. (Accn No: 33013190)
5. Mathews Harry R. (n.d.). *Biochemistry A Short Course*. (Accn No: 33013163)

Weblink to Learning Resources

1. <http://vlabs.iitkgp.ac.in/biochem/loe.html>
2. https://bio.libretexts.org/Bookshelves/Biotechnology/Lab_Manual%3A_Introduction_to_Biotechnology/01%3A_Techniques

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
C01	9	9	3	3	3	0
C02	9	9	9	3	3	0
C03	9	9	9	9	3	1
C04	9	9	9	9	3	1
C05	9	9	9	9	9	3
C06	9	9	9	9	9	9
Weightage	54	54	48	42	30	14
Weighted Percentage Contribution	30.68%	30.68%	27.27%	23.86%	17.05%	7.95%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
C01 / K1	P01, P02	P03, P04, P05	-	P06
C02 / K2	P01, P02, P03	P04, P05	-	P06
C03 / K3	P01, P02, P03, P04	P05	P06	-
C04 / K4	P01, P02, P03, P04	P05	P06	-
C05 / K5	P01, P02, P03, P04, P05	P06	-	-
C06 / K6	P01, P02, P03, P04, P05, P06	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%

Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the Lab course in Biochemistry in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

SEM- II	Prog. Code BITUG2016	SBE I	U25BTSBE1
ANALYTICAL TECHNIQUES I			
CREDITS - 2	Theory Type		HOURS - 2

Course Description for Analytical Techniques I

This skill base elective course in analytical techniques delivers deep knowledge on the principle and working mechanism of advanced spectroscopic and microscopic techniques. It also provides profound understanding on the working principle of structure elucidation techniques such as NMR and separation techniques such as centrifugation. Moreover, the course focuses on delineating between various experimental performance indicators and experimental errors.

Course Objectives

1. To discuss different types of performance indicators employed in instrumentation.
2. To understand the types of errors that could arise during experimentation.
3. To learn the basic principle and working of advanced spectroscopic and microscopic techniques.
4. To describe the applications of different centrifugation processes.
5. To develop an understanding on elucidating chemical structures using NMR spectroscopy.
6. To evaluate the applications of analytical techniques for elucidating various biological processes.

CO Level	Course outcome	K Level
C01	Define the differences between various performance indicators in instrumentation	K1
C02	Explain experimental errors and troubleshoot them	K2
C03	Apply calibration methods to obtain accurate results	K3
C04	Examine biological samples using various spectroscopic and microscopic techniques	K4
C05	Assess the usability of analytical techniques for specific applications	K5
C06	Develop experimental protocols using analytical techniques	K6

Unit	Course Content	Hours/Unit
I	Concepts in Instrumentation <ul style="list-style-type: none"> • Selection of analytical methods • Performance Indicators: Accuracy, Precision, Detection Limit, Sensitivity and Analytical Range • Types of errors: Random and Systematic • Calibration methods: Standard curve and Internal standard addition 	05
II	Spectroscopic Techniques I : Spectrometric Techniques Working Principle, Instrumentation, and Applications of: <ul style="list-style-type: none"> • UV-Vis spectroscopy • Fluorescence spectroscopy • Mass Spectrometry – Ionization (MALDI, ESI), Analyzer (TOF and Quadrupole), and Detector 	06
III	Spectroscopic Techniques II: Structure Elucidation Working Principle, Instrumentation, and Applications of: <ul style="list-style-type: none"> • FT-IR spectroscopy • NMR spectroscopy 	07
IV	Microscopic Techniques Working Principle, Instrumentation, and Applications of: <ul style="list-style-type: none"> • Scanning Electron Microscopy • Transmission Electron Microscopy • Confocal Microscopy 	07
V	Separation Techniques <ul style="list-style-type: none"> • Centrifugation – Principle and Instrumentation • Types (preparative and analytical) – working principle and applications of (ultra, differential and density gradient) 	05

Textbooks

1. Bajpai, P. K. (n.d.). *Biological Instrumentation and Methodology*. S.Chand and Co., (Accn No: 00061096)
2. Prakash, M. (n.d.). *Understanding Bioinstrumentation*. Discovery Publishing House. (Accn No: 33013025)
3. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co., (Accn No: 3309224)
4. Ramawat, K. G. (n.d.). *Molecular Biology and Biotechnology*. S.Chand and Co., (Accn No: 33009222)
5. Lesk, A. M. (n.d.). *Introduction to Bioinformatics*. Oxford University Press. (Accn No: 33012955)

Reference Books

1. Miller, B. N. (n.d.). *Python Programming in Context*. Jones & Bartlett Learning. (Accn No: 33013188)
2. Green, R. M. (n.d.). *Molecular Cloning*. COLD SPRING HARBOR LABORATORY PRESS. (Accn No: 33013081)
3. Mount, D. W. (n.d.). *Bioinformatics sequence and Genome Analysis*. Cbs Publication & Distribution. (Accn No: 33013177)
4. Liljas, A. (n.d.). *Text Book of Structural Biology*. World Scientific. (Accn No: 33013180)
5. Stromgaard, K. (n.d.). *Textbook of Drug Design and Discovery*. CRC Press. (Accn No: 33013096)

Weblink to Learning Resources

https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBB2104.pdf

[https://www.uou.ac.in/sites/default/files/slm/CHE\(N\)-121.pdf](https://www.uou.ac.in/sites/default/files/slm/CHE(N)-121.pdf)

<https://www.egyankosh.ac.in/bitstream/123456789/79945/1/Unit-12.pdf>

Course Articulation Matrix (CO-PO Mapping)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	9	3	1	0	0	0
CO2	9	9	3	0	0	0
CO3	9	9	9	3	0	1
CO4	9	9	9	9	3	1
CO5	9	9	9	9	9	3
CO6	9	9	9	9	9	9
Weightage	54	48	40	30	21	14
Weighted Percentage Contribution	32.53%	28.92%	24.10%	18.07%	12.65%	8.43%

CO-K Level Mapping with PO Correlations

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
CO1 / K1	P01	P02	P03	P04, P05, P06
CO2 / K2	P01, P02	P03	-	P04, P05, P06
CO3 / K3	P01, P02, P03	P04	P06	-

CO / K-Level	High Correlation	Medium Correlation	Low Correlation	Zero Correlation
C04 / K4	PO1, PO2, PO3, PO4	PO5	PO6	-
C05 / K5	PO1, PO2, PO3, PO4, PO5	PO6	-	-
C06 / K6	PO1, PO2, PO3, PO4, PO5, PO6	-	-	-

Course Outcome (CO) Attainment Assessment Tools & Evaluation Procedure.

K Levels	CIA I (4 Marks)	CIA II (10 Marks)	Assignment 1 (3 Marks)	Assignment 2 (3 Marks)	Total Scholastic Marks	Non Scho. (Attendance - 5 Marks)	Total Marks	% of Assessment
K1	1	2	0.5	0.5	4	0	4	16%
K2	1	2	0.5	0.5	4	0	4	16%
K3	1	2	0.5	0.5	4	0	4	16%
K4	0.5	2	0.5	0.5	3.5	0	3.5	14%
K5	0.5	1	1	1	3.5	0	3.5	14%
K6	0	1			1	0	1	4%
Non Scholastic	--	--	--	--	--	5	5	20%
Total	4	10	3	3	20	5	25	100%

The COs and POs for the Course in Analytical Techniques I in BSc Biotechnology Programme is effectively matched by the Course-in-charge.

Signature of the Course-in-charge

Signature of the Head, BMB

***** End of Semester II*****