Second Year Curriculum

Admission Year 2026-27

Bachelor of Technology
Biotechnology

Faculty of Engineering & Technology

Parul University

Vadodara, Gujarat, India

Semester 3

a. Course Name: Biochemistry

b. Course Code: 03014403PC01

c. Prerequisite: Basic knowledge of chemistry and biology at the undergraduate level.

d. Rationale: This course provides a comprehensive understanding of the chemical processes and molecules that sustain life. It covers the structure and function of biomolecules such as carbohydrates, proteins, lipids, and nucleic acids, along with metabolic pathways. This foundational knowledge is essential for students pursuing biotechnology, as it underpins molecular biology, genetic engineering, and bioprocess technology.

e. Course Learning Objective:

CLOBJ 1 Understand the structure, properties, and functions of major biomolecules.

CLOBJ 2 Learn the principles of enzyme kinetics and mechanisms.

CLOBJ 3 Study major metabolic pathways including glycolysis, TCA cycle, and oxidative phosphorylation.

CLOBJ 4 Apply biochemical concepts to biotechnological applications.

f. Course Learning Outcomes:

CLO 1 Describe the structure and function of carbohydrates, proteins, lipids, and nucleic acids.

CLO 2 Explain enzyme kinetics, mechanisms, and regulation.

CLO 3 Analyze metabolic pathways and their regulation in living systems.

CLO 4 Relate biochemical principles to practical applications in biotechnology.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
4	-	0	4	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Biochemistry and Water Chemistry:** Importance and scope of biochemistry; Water as a biological solvent; pH, buffers, Henderson-Hasselbalch equation; Ionization of water; Biological significance of water properties.	10	6
2	**Carbohydrates:** Classification of carbohydrates: monosaccharides, disaccharides, polysaccharides; Stereoisomerism; Reactions of monosaccharides; Structure of starch, glycogen, cellulose, chitin; Glycoproteins and glycolipids; Biological functions.	15	9
3	**Amino Acids and Proteins:** Classification and properties of amino acids; Peptide bond; Levels of protein structure: primary, secondary, tertiary, quaternary; Protein folding and denaturation; Ramachandran plot; Methods of protein purification and characterization.	20	12
4	**Lipids and Biological Membranes:** Classification of lipids: fatty acids, triacylglycerols, phospholipids, sphingolipids, steroids; Biological membranes: structure, fluid mosaic model; Membrane transport mechanisms.	15	9
5	**Enzymes:** Enzyme classification and nomenclature; Enzyme kinetics: Michaelis-Menten equation, Lineweaver-Burk plot; Enzyme inhibition: competitive, non-competitive, uncompetitive; Allosteric enzymes; Coenzymes and cofactors; Regulation of enzyme activity.	20	12
6	**Metabolism:** Overview of metabolism: catabolism and anabolism; Glycolysis; TCA cycle; Electron transport chain and oxidative phosphorylation; Gluconeogenesis; Pentose phosphate pathway; Beta-oxidation of fatty acids; Amino acid metabolism; Integration of metabolic pathways.	20	12
	Total	**100**	**60**

i. Text Book and Reference Book:

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox; W.H. Freeman
2. Biochemistry by J.M. Berg, J.L. Tymoczko, and L. Stryer; W.H. Freeman
3. Harper's Illustrated Biochemistry by V.W. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennelly, P.A. Weil; McGraw-Hill
4. Textbook of Biochemistry for Undergraduates by D.M. Vasudevan; Jaypee Brothers

j. Experiment List:

Sr. No.	Experiment List
1	Preparation of buffers and verification of buffer capacity
2	Qualitative tests for carbohydrates (Molisch's, Benedict's, Barfoed's, Seliwanoff's tests)
3	Estimation of reducing sugars by DNS method
4	Qualitative tests for amino acids (Ninhydrin, Biuret, Xanthoproteic, Millon's tests)
5	Estimation of protein by Lowry's method and Bradford method
6	SDS-PAGE for protein separation
7	Qualitative tests for lipids (solubility, saponification, acrolein test)
8	Determination of saponification value and iodine number of fats
9	Enzyme assay: estimation of amylase activity
10	Effect of pH and temperature on enzyme activity
11	Study of enzyme kinetics: determination of Km and Vmax
12	Estimation of cholesterol by Liebermann-Burchard reaction

a. Course Name: Basics of Microbiology

b. Course Code: 03014403PC03

c. Prerequisite: Basic understanding of biology and cell structure.

d. Rationale: Microbiology forms a cornerstone of biotechnology. This course covers the diversity of microorganisms, their structure, physiology, genetics, and applications. Understanding microbial systems is essential for industrial biotechnology, environmental remediation, pharmaceutical production, and food technology.

e. Course Learning Objective:

CLOBJ 1 Understand the diversity, classification, and structure of microorganisms.

CLOBJ 2 Learn microbial growth, nutrition, and metabolism.

CLOBJ 3 Study microbial genetics and gene transfer mechanisms.

CLOBJ 4 Explore applications of microorganisms in biotechnology and industry.

f. Course Learning Outcomes:

CLO 1 Classify and describe the morphology of bacteria, fungi, algae, and viruses.

CLO 2 Explain microbial growth kinetics, nutrition requirements, and metabolic pathways.

CLO 3 Describe microbial genetics including mutation, recombination, and gene transfer.

CLO 4 Apply microbiological techniques in industrial and environmental contexts.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Microbiology:** History and scope of microbiology; Contributions of Pasteur, Koch, Leeuwenhoek; Classification of microorganisms; Prokaryotic vs eukaryotic cells; Nomenclature and taxonomy.	15	7
2	**Microbial Structure and Function:** Bacterial cell structure: cell wall, cell membrane, flagella, pili, capsule, endospore; Structure of fungi, algae, protozoa; Viral structure and classification; Bacteriophages.	20	9
3	**Microbial Nutrition and Growth:** Nutritional types of microorganisms; Culture media types; Growth curve and growth kinetics; Measurement of microbial growth; Environmental factors affecting growth (pH, temperature, oxygen, osmotic pressure).	20	9
4	**Microbial Metabolism:** Aerobic and anaerobic respiration; Fermentation types; Chemolithotrophy; Photosynthesis in microorganisms; Nitrogen fixation.	15	7
5	**Microbial Genetics:** DNA replication in prokaryotes; Mutation types and mutagenesis; Gene transfer mechanisms: transformation, transduction, conjugation; Plasmids and transposons; Regulation of gene expression: operon concept.	20	9
6	**Applied Microbiology:** Industrial applications of microorganisms; Microorganisms in food production; Bioremediation; Biocontrol agents; Probiotics; Microbial biotechnology in agriculture.	10	4
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Prescott's Microbiology by J.M. Willey, L.M. Sherwood, and C.J. Woolverton; McGraw-Hill
2. Brock Biology of Microorganisms by M.T. Madigan, K.S. Bender, D.H. Buckley; Pearson
3. Microbiology: Principles and Explorations by J.G. Black; John Wiley & Sons
4. General Microbiology by R.Y. Stanier, J.L. Ingraham, M.L. Wheelis, P.R. Painter; Macmillan

j. Experiment List:

Sr. No.	Experiment List
1	Introduction to microbiology laboratory: safety rules, equipment, and sterilization techniques
2	Preparation of culture media (nutrient agar, nutrient broth, selective and differential media)
3	Sterilization methods: autoclaving, dry heat, filtration, UV sterilization
4	Isolation of pure cultures: streak plate, pour plate, and spread plate techniques
5	Gram staining and simple staining of bacteria
6	Motility test and capsule staining
7	Endospore staining (Schaeffer-Fulton method)
8	Enumeration of bacteria: standard plate count and serial dilution method
9	Growth curve study of bacteria using turbidimetric method
10	Biochemical tests for bacterial identification (IMViC, catalase, oxidase, urease)
11	Study of fungal morphology: preparation of lactophenol cotton blue mount
12	Antibiotic sensitivity testing by Kirby-Bauer disc diffusion method
13	Isolation of microorganisms from soil and water samples

a. Course Name: Biological Reaction Engineering

b. Course Code: 03014403PC05

c. Prerequisite: Basic knowledge of chemistry, mathematics, and biology.

d. Rationale: This course bridges biology and engineering by introducing the principles of reaction kinetics applied to biological systems. Students learn to analyze and design bioreactors, understand enzyme kinetics in reactor contexts, and apply mass balance principles to bioprocesses, which are vital for industrial biotechnology.

e. Course Learning Objective:

CLOBJ 1 Understand the fundamentals of reaction kinetics in biological systems.

CLOBJ 2 Learn the design principles of various types of bioreactors.

CLOBJ 3 Study enzyme and microbial kinetics in reactor configurations.

CLOBJ 4 Apply mass and energy balance concepts to bioprocesses.

f. Course Learning Outcomes:

CLO 1 Formulate rate equations for enzyme-catalyzed and microbial reactions.

CLO 2 Design and analyze batch, continuous, and fed-batch bioreactors.

CLO 3 Apply mass balance and stoichiometry to bioprocess systems.

CLO 4 Evaluate reactor performance and optimize bioprocess parameters.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Reaction Engineering:** Classification of reactions: homogeneous and heterogeneous; Rate of reaction; Order and molecularity; Rate constants; Arrhenius equation; Temperature dependence of reaction rates.	15	7
2	**Enzyme Kinetics in Reactors:** Michaelis-Menten kinetics; Lineweaver-Burk and other linearization methods; Enzyme inhibition kinetics; Immobilized enzyme kinetics; Effectiveness factor; External and internal mass transfer effects.	20	9
3	**Microbial Growth Kinetics:** Monod model; Substrate-inhibited growth; Product-inhibited growth; Maintenance energy; Yield coefficients; Stoichiometry of microbial growth; Structured and unstructured models.	20	9
4	**Ideal Reactor Design:** Batch reactor: design equations, performance analysis; Continuous stirred tank reactor (CSTR): steady-state design; Plug flow reactor (PFR): design and comparison; Fed-batch reactor operation; Reactor comparison for different kinetics.	25	11
5	**Mass and Energy Balance in Bioreactors:** Material balance for biological systems; Oxygen transfer and demand; kLa measurement methods; Aeration and agitation; Heat generation and removal; Scale-up considerations.	20	9
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Bioprocess Engineering: Basic Concepts by M.L. Shuler and F. Kargi; Prentice Hall
2. Chemical Reaction Engineering by O. Levenspiel; John Wiley & Sons
3. Biochemical Engineering Fundamentals by J.E. Bailey and D.F. Ollis; McGraw-Hill
4. Bioprocess Engineering Principles by P.M. Doran; Academic Press

a. Course Name: Genetics and Molecular Biology

b. Course Code: 03014403PC07

c. Prerequisite: Basic understanding of cell biology and biochemistry.

d. Rationale: This course provides a comprehensive foundation in classical and molecular genetics. Understanding gene structure, expression, regulation, and inheritance patterns is fundamental for genetic engineering, genomics, and modern biotechnological applications.

e. Course Learning Objective:

CLOBJ 1 Understand the principles of Mendelian and non-Mendelian inheritance.

CLOBJ 2 Learn the structure, replication, and function of DNA and RNA.

CLOBJ 3 Study gene expression: transcription, translation, and regulation.

CLOBJ 4 Explore recombinant DNA technology and its applications.

f. Course Learning Outcomes:

CLO 1 Solve problems related to Mendelian genetics and linkage analysis.

CLO 2 Describe the molecular mechanisms of DNA replication, transcription, and translation.

CLO 3 Explain gene regulation in prokaryotes and eukaryotes.

CLO 4 Apply molecular biology techniques for gene cloning and analysis.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
4	-	0	4	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Classical Genetics:** Mendelian inheritance; Monohybrid and dihybrid crosses; Deviations from Mendelian ratios: incomplete dominance, codominance, epistasis, pleiotropy; Multiple alleles; Sex-linked inheritance; Linkage and crossing over; Chromosome mapping.	20	12
2	**Molecular Structure of Genes:** Structure of DNA: Watson-Crick model; Types of DNA (A, B, Z forms); Chromosome organization: histones, nucleosomes, chromatin; Genome organization in prokaryotes and eukaryotes; C-value paradox; Repetitive DNA sequences.	15	9
3	**DNA Replication and Repair:** Semiconservative replication; Enzymes and proteins involved in replication; Replication in prokaryotes and eukaryotes; Telomere replication; DNA damage types; DNA repair mechanisms: direct repair, BER, NER, mismatch repair.	15	9
4	**Transcription:** Prokaryotic transcription: RNA polymerase, promoter, initiation, elongation, termination; Eukaryotic transcription: RNA polymerase types, promoters, enhancers, transcription factors; Post-transcriptional processing: capping, polyadenylation, splicing.	20	12
5	**Translation and Protein Processing:** Genetic code properties; tRNA structure and aminoacyl-tRNA synthetases; Ribosome structure; Translation in prokaryotes and eukaryotes: initiation, elongation, termination; Post-translational modifications; Protein targeting and sorting.	15	9
6	**Gene Regulation:** Prokaryotic gene regulation: lac operon, trp operon, attenuation; Eukaryotic gene regulation: chromatin remodeling, epigenetics, transcription factors, miRNA, siRNA; Signal transduction basics.	15	9
	Total	**100**	**60**

i. Text Book and Reference Book:

1. Molecular Biology of the Gene by J.D. Watson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick; Pearson

2. Molecular Biology: Principles and Practice by M.M. Cox, J.A. Doudna, M. O'Donnell; W.H. Freeman

3. Lewin's Genes XII by J.E. Krebs, E.S. Goldstein, S.T. Kilpatrick; Jones & Bartlett

4. Principles of Genetics by E.J. Gardner, M.J. Simmons, D.P. Snustad; John Wiley & Sons

j. Experiment List:

Sr. No.	Experiment List
1	Isolation of genomic DNA from bacterial cells
2	Isolation of plasmid DNA by alkaline lysis method
3	Agarose gel electrophoresis of DNA
4	Restriction enzyme digestion of DNA
5	Estimation of DNA concentration using spectrophotometry (A260/A280)
6	Polymerase Chain Reaction (PCR): primer design and amplification
7	Analysis of PCR products by gel electrophoresis
8	Isolation of RNA from plant/animal tissue
9	Study of bacterial transformation using plasmid DNA
10	Construction of genetic maps using three-point test cross data
11	Karyotyping from photomicrographs
12	Bioinformatics: DNA and protein sequence analysis using online tools

a. Course Name: Introduction to Python Programming

b. Course Code: 03014403ES01

c. Prerequisite: Basic computer literacy and logical thinking skills.

d. Rationale: Python programming is increasingly essential for biotechnologists for data analysis, bioinformatics, computational biology, and automation of laboratory processes. This course provides hands-on skills in Python programming with emphasis on applications relevant to biological data processing.

e. Course Learning Objective:

CLOBJ 1 Learn Python fundamentals including data types, control structures, and functions.

CLOBJ 2 Develop skills in file handling and data manipulation using Python.

CLOBJ 3 Understand object-oriented programming concepts in Python.

CLOBJ 4 Apply Python libraries for scientific computing and data visualization.

f. Course Learning Outcomes:

CLO 1 Write Python programs using variables, operators, and control structures.

CLO 2 Develop functions and modules for modular programming.

CLO 3 Handle files and process data using Python data structures.

CLO 4 Use NumPy, Pandas, and Matplotlib for scientific data analysis and visualization.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
2	-	0	2	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Python Basics:** Introduction to Python; Installation and IDE setup; Variables, data types, operators; Input/output operations; Strings and string operations; Type conversion.	25	7
2	**Control Structures and Functions:** Conditional statements: if, elif, else; Loops: for, while; Break, continue, pass; Functions: definition, arguments, return values; Lambda functions; Recursion; Scope of variables.	25	8
3	**Data Structures:** Lists, tuples, sets, dictionaries; List comprehension; Operations on data structures; Sorting and searching; Stacks and queues using lists.	25	8
4	**File Handling and Modules:** File operations: reading, writing, appending; CSV file handling; Exception handling: try, except, finally; Modules and packages; Introduction to NumPy and Pandas; Data visualization using Matplotlib.	25	7
	Total	**100**	**30**

i. Text Book and Reference Book:

1. Python Programming: An Introduction to Computer Science by J. Zelle; Franklin, Beedle & Associates
2. Automate the Boring Stuff with Python by Al Sweigart; No Starch Press
3. Python for Data Analysis by W. McKinney; O'Reilly Media
4. Bioinformatics Programming Using Python by M. Model; O'Reilly Media

j. Experiment List:

Sr. No.	Experiment List
1	Installation of Python and IDE; writing and executing basic programs
2	Programs using variables, data types, and operators
3	Programs using conditional statements (if-else, nested if)
4	Programs using loops (for, while) and loop control statements

5	Programs using functions: user-defined functions, default and keyword arguments
6	Programs using lists, tuples, and dictionaries
7	Programs for string manipulation and regular expressions
8	File handling: reading, writing, and processing text and CSV files
9	Exception handling programs
10	Introduction to NumPy: array creation, operations, and basic statistics
11	Introduction to Pandas: DataFrame creation, data manipulation, and filtering
12	Data visualization using Matplotlib: line plots, bar charts, scatter plots, histograms

a. Course Name: Functional Communication Skills

b. Course Code: 03010003HM01

c. Prerequisite: Basic knowledge of English language and communication.

d. Rationale: This course develops advanced communication skills essential for professional success in biotechnology. It covers technical writing, presentation skills, group discussions, and interview techniques, equipping students for academic and industry communication demands.

e. Course Learning Objective:

CLOBJ 1 Develop advanced communication skills for professional and academic settings.

CLOBJ 2 Learn technical writing and documentation skills.

CLOBJ 3 Build confidence in public speaking and group discussions.

CLOBJ 4 Apply communication strategies in interviews and professional interactions.

f. Course Learning Outcomes:

CLO 1 Demonstrate effective oral and written communication in technical contexts.

CLO 2 Prepare technical reports, research papers, and professional correspondence.

CLO 3 Deliver presentations confidently using appropriate visual aids.

CLO 4 Participate effectively in group discussions and interviews.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
1	-	2	2	40	20	-	60	30	150

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Technical Communication:** Types of technical communication; Technical writing: reports, research papers, abstracts; Formal and informal communication; Business correspondence: emails, memos, letters; Proofreading and editing skills.	33	5
2	**Presentation and Public Speaking:** Planning and structuring presentations; Use of visual aids and technology; Body language and voice modulation; Overcoming stage fright; Group discussion techniques and strategies.	33	5
3	**Professional Communication:** Interview skills: types of interviews, preparation, body language; Resume and CV writing; Networking skills; Cross-cultural communication; Ethics in communication.	34	5
	Total	**100**	**15**

i. Text Book and Reference Book:

1. Technical Communication: Principles and Practice by M. Raman and S. Sharma; Oxford University Press
2. Business Communication by K.K. Sinha; Galgotia Publishing Company
3. Communication Skills by S. Kumar and P. Lata; Oxford University Press
4. The Quick and Easy Way to Effective Speaking by D. Carnegie; Pocket Books

j. Experiment List:

Sr. No.	Experiment List
1	Technical report writing exercises
2	Preparation and delivery of individual presentations (5-10 minutes)
3	Group discussions on current topics in biotechnology
4	Mock interviews and feedback sessions
5	Resume and CV preparation workshop
6	Business email and letter writing exercises

7	Listening comprehension and note-taking exercises

Semester 4

a. Course Name: Immunology and Immunotechnology

b. Course Code: 03014404PC01

c. Prerequisite: Basic knowledge of microbiology, biochemistry, and molecular biology.

d. Rationale: This course provides fundamental knowledge of the immune system, including innate and adaptive immunity, immunological techniques, and their applications in diagnostics, therapeutics, and biotechnology. Understanding immunology is crucial for vaccine development, monoclonal antibody production, and immunodiagnostics.

e. Course Learning Objective:

CLOBJ 1 Understand the organization and function of the immune system.

CLOBJ 2 Learn about innate and adaptive immune responses.

CLOBJ 3 Study antigen-antibody interactions and immunological techniques.

CLOBJ 4 Explore applications of immunotechnology in diagnostics and therapeutics.

f. Course Learning Outcomes:

CLO 1 Describe the components and mechanisms of innate and adaptive immunity.

CLO 2 Explain antigen-antibody interactions and their applications.

CLO 3 Apply immunological techniques such as ELISA, Western blot, and immunofluorescence.

CLO 4 Evaluate the applications of immunotechnology in vaccine and antibody production.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Introduction to Immunology:** Overview of the immune system; Innate immunity: physical, chemical, and cellular barriers; Complement system; Inflammation; Cells of the immune system: macrophages, dendritic cells, NK cells, mast cells.	15	7
2	**Adaptive Immunity:** Humoral immunity: B cells, antibody structure and classes, antibody diversity; Cell-mediated immunity: T cells, TCR, MHC molecules, antigen processing and presentation; Clonal selection theory; Immunological memory.	25	11
3	**Antigens and Antibodies:** Properties of antigens: immunogenicity and antigenicity; Haptens; Epitopes; Antibody structure: domains, classes, subclasses; Antibody-antigen interactions: affinity, avidity; Isotype switching; Hybridoma technology and monoclonal antibodies.	20	9
4	**Immunological Techniques:** ELISA: direct, indirect, sandwich, competitive; Western blotting; Immunofluorescence; Immunoprecipitation; Flow cytometry; RIA; Immunodiffusion and immunoelectrophoresis.	20	9
5	**Applied Immunology:** Vaccines: types, adjuvants, delivery systems; Hypersensitivity reactions (Types I-IV); Autoimmunity; Immunodeficiency diseases; Transplantation immunology; Tumor immunology; Immunotherapy.	20	9
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Kuby Immunology by J. Owen, J. Punt, S. Stranford; W.H. Freeman
2. Janeway's Immunobiology by K. Murphy and C. Weaver; Garland Science
3. Roitt's Essential Immunology by P.J. Delves, S.J. Martin, D.R. Burton, I.M. Roitt; Wiley-Blackwell
4. Immunology by R.A. Goldsby, T.J. Kindt, B.A. Osborne, J. Kuby; W.H. Freeman

j. Experiment List:

Sr. No.	Experiment List
1	Blood grouping and Rh typing
2	Total and differential leukocyte count (TLC and DLC)
3	Ouchterlony double diffusion test
4	Radial immunodiffusion (Mancini method)
5	Immunoelectrophoresis
6	Agglutination reactions: slide and tube agglutination
7	ELISA: indirect ELISA for antibody detection
8	Western blotting technique (demonstration)
9	Immunofluorescence staining (demonstration)
10	Widal test for typhoid diagnosis
11	Preparation of antigens from bacterial cultures
12	Study of hypersensitivity reactions (case studies)

a. Course Name: Techniques in Biotechnology

b. Course Code: 03014404PC03

c. Prerequisite: Basic knowledge of biochemistry, microbiology, and molecular biology.

d. Rationale: This course introduces students to essential analytical and preparative techniques used in biotechnology research and industry. Mastery of these techniques is critical for laboratory work in molecular biology, protein engineering, and bioprocess development.

e. Course Learning Objective:

CLOBJ 1 Learn principles and applications of chromatographic techniques.

CLOBJ 2 Understand electrophoretic separation methods for biomolecules.

CLOBJ 3 Study spectroscopic and microscopic techniques used in biotechnology.

CLOBJ 4 Develop hands-on skills in centrifugation, blotting, and PCR techniques.

f. Course Learning Outcomes:

CLO 1 Perform chromatographic separations of biomolecules.

CLO 2 Apply electrophoretic techniques for protein and nucleic acid analysis.

CLO 3 Use spectroscopic methods for quantitative analysis of biomolecules.

CLO 4 Integrate multiple techniques for comprehensive biomolecule characterization.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Chromatographic Techniques:** Principles of chromatography; Paper and thin-layer chromatography; Column chromatography; Ion-exchange chromatography; Gel filtration chromatography; Affinity chromatography; HPLC; Gas chromatography.	25	11
2	**Electrophoretic Techniques:** Principles of electrophoresis; Agarose gel electrophoresis; SDS-PAGE; Native PAGE; Isoelectric focusing; 2D gel electrophoresis; Capillary electrophoresis.	20	9
3	**Spectroscopic Techniques:** UV-Visible spectrophotometry; Fluorescence spectroscopy; Infrared spectroscopy; Circular dichroism; Mass spectrometry; NMR spectroscopy basics.	20	9
4	**Centrifugation and Microscopy:** Principles of centrifugation; Differential and density gradient centrifugation; Ultracentrifugation; Light microscopy; Phase contrast and fluorescence microscopy; Electron microscopy: SEM and TEM.	15	7
5	**Blotting and PCR Techniques:** Southern blotting; Northern blotting; Western blotting; Dot blot; PCR: principle, types (RT-PCR, real-time PCR, nested PCR); DNA sequencing: Sanger method; Next-generation sequencing overview.	20	9
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Principles and Techniques of Biochemistry and Molecular Biology by K. Wilson and J. Walker; Cambridge University Press

2. Biophysical Chemistry by C.R. Cantor and P.R. Schimmel; W.H. Freeman

3. Molecular Cloning: A Laboratory Manual by J. Sambrook and D.W. Russell; Cold Spring Harbor Laboratory Press

4. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean; CBS Publishers

j. Experiment List:

Sr. No.	Experiment List

1	Separation of amino acids by paper chromatography
2	Thin layer chromatography of plant pigments
3	Column chromatography: separation of a mixture
4	Ion-exchange chromatography for protein purification
5	Gel filtration chromatography for molecular weight determination
6	SDS-PAGE for protein separation and molecular weight estimation
7	Native PAGE for protein separation
8	UV-Vis spectrophotometry: absorption spectrum and concentration determination
9	Fluorescence spectroscopy of proteins
10	Differential centrifugation of cell homogenate
11	DNA amplification by PCR and product analysis
12	Southern/Western blotting (demonstration)

a. Course Name: Enzymology and Enzyme Technology

b. Course Code: 03014404PC05

c. Prerequisite: Basic knowledge of biochemistry and enzyme kinetics.

d. Rationale: This course provides in-depth knowledge of enzyme structure, function, kinetics, and their industrial applications. Enzyme technology is a cornerstone of modern biotechnology, finding applications in pharmaceuticals, food industry, biofuels, and environmental management.

e. Course Learning Objective:

CLOBJ 1 Understand enzyme structure-function relationships and catalytic mechanisms.

CLOBJ 2 Master advanced enzyme kinetics and inhibition analysis.

CLOBJ 3 Learn enzyme immobilization techniques and their applications.

CLOBJ 4 Explore industrial applications of enzymes and enzyme engineering.

f. Course Learning Outcomes:

CLO 1 Analyze enzyme mechanisms and catalytic strategies.

CLO 2 Solve complex enzyme kinetics problems including multi-substrate reactions.

CLO 3 Design enzyme immobilization strategies for industrial applications.

CLO 4 Evaluate enzyme applications in various biotechnological processes.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Enzyme Structure and Classification:** Enzyme nomenclature and classification (EC numbers); Active site and substrate specificity; Lock and key vs induced fit models; Cofactors, coenzymes, and prosthetic groups; Isoenzymes; Ribozymes and abzymes.	15	7
2	**Enzyme Catalysis and Mechanisms:** Theories of enzyme catalysis; Proximity and orientation effects; Acid-base catalysis; Covalent catalysis; Metal ion catalysis; Transition state theory; Examples: serine proteases, lysozyme.	20	9
3	**Advanced Enzyme Kinetics:** Michaelis-Menten derivation; Multi-substrate reactions: sequential and ping-pong mechanisms; Allosteric enzymes: sigmoidal kinetics, Hill equation; Cooperative binding; pH and temperature effects; Enzyme inhibition: reversible and irreversible.	25	11
4	**Enzyme Immobilization:** Methods of immobilization: adsorption, covalent binding, entrapment, encapsulation, cross-linking; Properties of immobilized enzymes; Kinetics of immobilized enzymes; Applications in biosensors, bioreactors, and diagnostics.	20	9
5	**Industrial Applications of Enzymes:** Enzymes in food industry: amylases, proteases, lipases, pectinases; Enzymes in pharmaceutical industry; Enzymes in textile and detergent industry; Enzymes in biofuel production; Enzyme engineering: directed evolution and rational design; Extremozymes.	20	9
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by T. Palmer and P.L. Bonner; Woodhead Publishing

2. Fundamentals of Enzymology by N.C. Price and L. Stevens; Oxford University Press

3. Industrial Enzymology by T. Godfrey and S. West; Nature Press

4. Enzyme Technology by M.F. Chaplin and C. Bucke; Cambridge University Press

j. Experiment List:

Sr. No.	Experiment List
1	Extraction and assay of amylase from germinated seeds
2	Extraction and assay of protease from papaya/pineapple
3	Effect of pH on enzyme activity
4	Effect of temperature on enzyme activity
5	Determination of Km and Vmax of an enzyme
6	Study of enzyme inhibition: competitive and non-competitive
7	Immobilization of enzyme by entrapment in calcium alginate beads
8	Immobilization of enzyme by covalent binding
9	Activity assay and reusability study of immobilized enzyme
10	Application of immobilized enzyme in continuous reactor
11	Estimation of invertase activity
12	Study of lipase activity using olive oil emulsion

a. Course Name: Biostatistics

b. Course Code: 03014404PC07

c. Prerequisite: Basic knowledge of mathematics and data handling.

d. Rationale: Biostatistics provides essential quantitative tools for designing experiments, analyzing biological data, and drawing valid conclusions. It is indispensable for research in biotechnology, bioinformatics, and pharmaceutical development.

e. Course Learning Objective:

CLOBJ 1 Understand fundamental concepts of probability and statistics.

CLOBJ 2 Learn techniques for data presentation and descriptive statistics.

CLOBJ 3 Apply hypothesis testing and statistical inference methods.

CLOBJ 4 Use statistical software for biological data analysis.

f. Course Learning Outcomes:

CLO 1 Summarize and present biological data using appropriate statistical measures.

CLO 2 Apply probability distributions to model biological phenomena.

CLO 3 Perform hypothesis testing, ANOVA, and regression analysis.

CLO 4 Design experiments using appropriate statistical methods.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
4	-	0	4	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Descriptive Statistics:** Types of data; Measures of central tendency: mean, median, mode; Measures of dispersion: range, variance, standard deviation, coefficient of variation; Data presentation: frequency distributions, histograms, box plots; Skewness and kurtosis.	15	9
2	**Probability Theory:** Basic probability concepts; Conditional probability; Bayes' theorem; Probability distributions: binomial, Poisson, normal; Standard normal distribution; Central limit theorem.	20	12
3	**Statistical Inference:** Sampling techniques; Standard error; Confidence intervals; Hypothesis testing: null and alternative hypotheses; Type I and Type II errors; Z-test; Student's t-test: one-sample, two-sample, paired; Chi-square test.	25	15
4	**Analysis of Variance and Regression:** One-way ANOVA; Two-way ANOVA; Post-hoc tests: Tukey, Duncan; Simple linear regression; Multiple regression; Correlation: Pearson and Spearman.	25	15
5	**Experimental Design:** Principles of experimental design: randomization, replication, blocking; Completely randomized design (CRD); Randomized complete block design (RCBD); Latin square design; Factorial experiments; Introduction to non-parametric tests.	15	9
	Total	**100**	**60**

i. Text Book and Reference Book:

1. Biostatistics: A Foundation for Analysis in the Health Sciences by W.W. Daniel and C.L. Cross; John Wiley & Sons

2. Fundamentals of Biostatistics by B. Rosner; Cengage Learning

3. Introduction to Biostatistics by R.R. Sokal and F.J. Rohlf; W.H. Freeman

4. Probability and Statistics for Engineers and Scientists by R.E. Walpole, R.H. Myers, S.L. Myers; Pearson

a. Course Name: Transport Phenomena

b. Course Code: 03014404ES01

c. Prerequisite: Basic knowledge of mathematics, physics, and fluid mechanics.

d. Rationale: This course covers the principles of momentum, heat, and mass transfer essential for understanding bioprocess engineering. Knowledge of transport phenomena is critical for bioreactor design, downstream processing, and scale-up of biotechnological processes.

e. Course Learning Objective:

CLOBJ 1 Understand the fundamentals of fluid mechanics and momentum transfer.

CLOBJ 2 Learn principles of heat transfer in biological and engineering systems.

CLOBJ 3 Study mass transfer phenomena relevant to bioprocesses.

CLOBJ 4 Apply transport principles to biotechnological process design.

f. Course Learning Outcomes:

CLO 1 Analyze fluid flow problems using principles of momentum transfer.

CLO 2 Calculate heat transfer rates in conduction, convection, and radiation.

CLO 3 Apply mass transfer principles to diffusion and convection problems.

CLO 4 Design and evaluate transport operations in bioprocess engineering.

g. Teaching & Examination Scheme:

Teaching Scheme				Evaluation Scheme					Total Marks
L	T	P	C	Int T	Int P	CE	Ext T	Ext P	
3	-	0	3	20	-	20	60	-	100

h. Course Content:

Sr. No.	Content	Weightage (%)	Teaching Hours
1	**Fluid Mechanics:** Properties of fluids; Newton's law of viscosity; Newtonian and non-Newtonian fluids; Viscosity of biological fluids; Fluid statics; Bernoulli's equation; Reynolds number; Laminar and turbulent flow; Flow in pipes and channels.	25	12
2	**Heat Transfer:** Modes of heat transfer: conduction, convection, radiation; Fourier's law; Thermal conductivity; Steady-state conduction; Convective heat transfer coefficients; Heat exchangers: types and design; Heat sterilization of media.	25	11
3	**Mass Transfer:** Fick's law of diffusion; Diffusivity in gases and liquids; Mass transfer coefficients; Film theory and penetration theory; Interphase mass transfer; Gas absorption; Oxygen transfer in bioreactors; kLa determination.	25	11
4	**Applications in Biotechnology:** Rheology of fermentation broths; Mixing and agitation; Aeration systems; Scale-up of bioreactors based on transport criteria; Membrane transport; Sterilization kinetics.	25	11
	Total	**100**	**45**

i. Text Book and Reference Book:

1. Transport Phenomena by R.B. Bird, W.E. Stewart, and E.N. Lightfoot; John Wiley & Sons
2. Bioprocess Engineering Principles by P.M. Doran; Academic Press
3. Unit Operations of Chemical Engineering by W.L. McCabe, J.C. Smith, and P. Harriott; McGraw-Hill
4. Heat Transfer by J.P. Holman; McGraw-Hill