VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF BIO SCIENCES AND TECHNOLOGY

M.Tech Biotechnology (MBT)

Curriculum

(2025-2026 admitted students)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

- **World class Education**: Excellence in education, grounded in ethics and critical thinking,for improvement of life.
- **Cutting edge Research**: An innovation ecosystem to extend knowledge and solve criticalproblems.
- **Impactful People**: Happy, accountable, caring and effective workforce and students. **Rewarding Co-creations**: Active collaboration with national & international industries &universities for productivity and economic development.
- **Service to Society**: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF BIO SCIENCES AND TECHNOLOGY

- To nurture high-quality bioengineers and science graduates with the potential to innovate, invent and disseminate knowledge for the benefit of society and environment

MISSION STATEMENTOF THE SCHOOL OF BIO SCIENCES AND TECHNOLOGY

- To offer academic programs to impart knowledge skills to cater to the dynamic needs of the bio sciences and the food industry
- To foster the spirit of innovation and creativity in the young minds in solving the real-time problems arising in society and industry
- To instill confidence, ethics, values, and employability skills in the future citizens to focus on the sustainable growth of the economy

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SCHOOL OF BIO SCIENCES AND TECHNOLOGY

DEPARTMENT OF BIOTECHNOLOGY

M.TECH. BIOTECHNOLOGY

MISSION OF M.TECH BIOTECHNOLOGY PROGRAMME

To equip students with advanced knowledge and technical skills in biotechnology, enabling them to develop innovative solutions through strong industry-academia collaboration.

To empower students to become competent entrepreneurs and researchers, capable of designing novel biotechnological products that address societal needs while upholding ethical and professional standards.

M.TECH BIOTECHNOLOGY - PROGRAMME OUTCOMES (POs)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students shall be able to apply advanced knowledge of molecular biology, genetic engineering, and bioinformatics to solve complex biological problems and drive innovation in biotechnological research

PO4: An ability to adhere to ethical principles and professional responsibilities in research and biotechnological practice.

PO5: An ability to collaborate effectively in individual and multidisciplinary team settings to accomplish engineering and research tasks.

PO6: An ability to engage in independent and lifelong learning to keep pace with advancements in biotechnology and related fields.

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M.TECH BIOTECHNOLOGY -PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

PEO-1: Graduates shall be capable of excelling as engineering professionals, innovators, or entrepreneurs, contributing to technological advancement and industrial growth.

PEO-2: Graduates shall be able to demonstrate ethical responsibility, collaborate across disciplines, and contribute to societal and national development.

PEO-3: Graduates shall be capable of pursuing higher education, engaging in research, and contributing to knowledge dissemination through academia or industry.

Category Credit Detail			
Sl.No.	**Description**	**Credits**	**Maximum Credit**
1	UCC - University Core Courses	39	39
2	OEC - Open Elective Courses	3	3
3	PFCC - Professional Core Courses	24	24
4	PFEC - Professional Elective Courses	14	14
Total Credits		80	

University Core Courses									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MABIT698	Internship I/ Dissertation I	Project	1.0	0	0	0	0	10.0
2	MABIT699	Internship II/ Dissertation II	Project	1.0	0	0	0	0	10.0
3	MAENG501	Technical Report Writing	Embedded Theory and Lab	1.0	1	0	4	0	3.0
4	MASET697	Project Work	Project	1.0	0	0	0	0	10.0
5	MASTS501	Qualitative and Quantitative Skills Practice I	Soft Skill	1.0	3	0	0	0	3.0
6	MASTS502	Qualitative and Quantitative Skills Practice II	Soft Skill	1.0	3	0	0	0	3.0

Open Elective Courses									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MASTS601	Competitive Coding I	Soft Skill	1.0	3	0	0	0	3.0

Professional Core Courses									
sl.no	**Course Code**	**Course Title**	**Course Type**	**Version**	**L**	**T**	**P**	**J**	**Credits**
1	MABIT501	Advanced Biochemistry	Embedded Theory and Lab	1.0	3	0	2	0	4.0
2	MABIT502	Advanced Microbiology	Embedded Theory and Lab	1.0	2	1	2	0	4.0
3	MABIT503	Computational Biology	Embedded Theory and Lab	1.0	3	0	2	0	4.0
4	MABIT504	Analytical Techniques in Biotechnology	Theory Only	1.0	3	1	0	0	4.0
5	MABIT505	Bioprocess Technology	Embedded Theory and Lab	1.0	3	0	2	0	4.0
6	MABIT506	Genetic Engineering	Embedded Theory and Lab	1.0	3	0	2	0	4.0

Professional Elective Courses									
sl.no	Course Code	Course Title	Course Type	Version	L	T	P	J	Credits
1	MABIT601	Industrial Biotechnology	Theory Only	1.0	3	1	0	0	4.0
2	MABIT602	Pharmaceutical Biotechnology	Theory Only	1.0	3	1	0	0	4.0
3	MABIT603	Medical Biotechnology	Theory Only	1.0	3	1	0	0	4.0
4	MABIT604	Plant Biotechnology	Theory Only	1.0	3	1	0	0	4.0
5	MABIT605	Animal Biotechnology	Theory Only	1.0	3	1	0	0	4.0
6	MABIT606	Genomics and Proteomics	Embedded Theory and Lab	1.0	3	0	2	0	4.0
7	MABIT607	Cancer Biology	Theory Only	1.0	3	1	0	0	4.0
8	MABIT608	Immunotechnology	Embedded Theory and Lab	1.0	3	0	2	0	4.0
9	MABIT609	Data Science and Machine Learning for Biotechnologists	Theory Only	1.0	3	1	0	0	4.0
10	MABIT610	Nanobiotechnology	Theory Only	1.0	3	0	0	0	3.0
11	MABIT611	Protein Engineering and Technology	Theory Only	1.0	2	1	0	0	3.0
12	MABIT612	Programming for Biologists	Embedded Theory and Lab	1.0	2	0	2	0	3.0
13	MABIT613	Food Process Technology	Theory Only	1.0	3	0	0	0	3.0
14	MABIT614	Natural Product Technology	Theory Only	1.0	3	0	0	0	3.0
15	MABIT615	Environmental Biotechnology	Theory Only	1.0	3	0	0	0	3.0
16	MABIT616	Aquatic Biotechnology	Theory Only	1.0	3	0	0	0	3.0
17	MABIT617	Microbial Biotechnology	Theory Only	1.0	3	0	0	0	3.0

Course Code	Course Title	L	T	P	C
MABIT501	Advanced Biochemistry	3	0	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. 1. Understanding of various biomolecules' structure, composition, and functions
2. 2. Introduction to the nature and basic properties of biomolecules involved in various metabolic pathways
3. 3. Allowing them to explore the various metabolic pathways and their regulatory mechanism

Course Outcomes

1. 1. Develop knowledge on the structure and function of macromolecules such as carbohydrates, proteins, and lipids
2. 2. Demonstrate macromolecules' organization and biological functions in different metabolic pathways
3. 3. Make use of knowledge on carbohydrate metabolism and associated thermodynamics
4. 4. Understand the structure-activity relationship of proteins and the mechanism of enzyme action
5. 5. Explain the structural organization of membranes and membrane proteins regulating the signaling pathways

Module:1	Solubility of Macromolecules	5 hours

Effect of solvent and additive; Mechanism of solvation; Buffers for biochemical reagents; buffering capacity; Numerical problems on buffer preparation, pH and the Henderson-Hasselbalch equation.

Module:2	Carbohydrates & Glycobiology	6 hours

Classification of carbohydrates, glycosaminoglycans (GAGs), proteoglycans, bacterial cell wall polysaccharides, glycoproteins, and lectins; Medical applications of glycoconjugates.

Module:3	Protein, Enzymes Structure and Function	11 hours

Classification of amino acids and titration curves; Biologically important peptides; Motifs and domains; Proteins- levels of organization; Ramachandran's plot; Structure-function relationship of Mb, Hb and collagen; Enzyme, coenzymes and cofactors; Mechanism of enzyme action in Chymotrypsin and Lysozyme; Michaelis-Menten equation; Kinetic parameters; Lineweaver-Burk plot; Eadee- Hofstee plots; Factors affecting enzyme activity; Enzyme inhibition; Multisubstrate reactions; Enzyme units; Regulation and functionality roles of proteins and enzymes

Module:4	Lipids, Membrane, Membrane Transport, and Signaling Pathways	10 hours

Classification of lipids, lipid bilayers, micelles, liposomes, membrane structure and assembly; Transport of molecules across membrane channels and pumps, such as ion channels and Na-K pump; Receptor signaling pathways involved GPCRs and RTKs; Crosstalk, amplification, desensitization.		
Module:5	**Metabolic Pathways and Bioenergetics**	**11 hours**
Thermodynamics and regulation in Glycolysis, TCA cycle, glucone ogenesis, glycogen metabolism & their regulation; Fatty acid biosynthesis and oxidation; Electron transport chain (ETC) in mitochondria, oxidative phosphorylation, shuttle systems; Inhibitors of ETC; uncouplers; Photosynthetic electron transport & regulation.		
	Total Lecture Hours:	**43 hours**
Text Book(s)		
David Lee Nelson, Michael M. Cox.,, "**Lehninger Principles of Biochemistry by David Lee Nelson, Michael M. Cox., 7th Edition, 2021, WH Freeman**", WH Freeman, 7th Edition, **2021** Donald Voet, Judith G. Voet., "**Biochemistry** ", Wiley India Pvt Ltd., 6th Edition, **2024**		
Reference Books		
Indicative Experiments		
1. Estimation of reducing sugar and total sugar by DNSA and Anthrone methods, respectively		4 hours
2. Estimation of cholesterol by Zak's method		2 hours
3. Estimation of serum creatinine by Jaffe's reaction.		2 hours
4. Determination of isoelectric point of casein.		2 hours
5. Determination of acid phosphatase activity.		2 hours
6. Amino acid purification by thin layer chromatography (TLC) and protein separation by SDS-PAGE electrophoresis.		6 hours
	Total Laboratory Hours:	**30 hours**
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT502	Advanced Microbiology	2	1	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Acquaint students with basic and advanced concepts of microbiology
2. Applying knowledge in understanding classic and modern tools in microbiology techniques
3. Appraising the role of microbes in industry

Course Outcomes

1. Apprehend the role of advanced microscopy
2. Recognize the essentials of current methods in bacteriology
3. Gain a well-rounded perspective on virology
4. Appreciate the structure of fungi and parasites
5. The commendation of microbes in industrial applications

Module:1	Developments in Microscopy	4 hours

Advanced microscopy - Dark field microscopy, Phase contrast Electron microscopy,

Fluorescent microscopy, Electron microscopy (SEM, TEM)

Module:2	Bacteriological Techniques	6 hours

Structural and functional complexity of bacteria, role of proteins and lipids in bacterial cell architecture; Bacterial culture techniques - Aerobic, anaerobic, automated methods; Molecular methods for diagnosis and surveillance, preservation; Anti-bacterial agents; mechanisms of anti-microbial resistance

Module:3	Virological Techniques	6 hours

Structure of virus, classification of virus - Baltimore and ICTV, sample collection, transport, purification and culture methods - egg, cell lines, animal models, 3D cell cultures; Immune responses to viral infections, recent advances in identification of virus

Module:4	Eukaryotic Microbes	6 hours

Classification and morphological identification of fungi, protozoa; Current trends in detection and identification of fungi and parasites

Module:5	Microbes in Industry	6 hours

Microbial products of industrial importance - Antibiotics, Vaccines and Toxoids, Biopesticides, Biosensors, Biofuel, Fermented foods

Module:6	Contemporary Topics	2 hours
Contemporary Topics		
	Total Lecture Hours:	**30 hours**
	Tutorial Hours:	**15 hours**

Text Book(s)

1. Joanne Willey, Kathleen Sandman and Dorothy Wood, "**Prescott's Microbiology by Joanne Willey, Kathleen Sandman and Dorothy Wood** ", McGraw Hill, New York, USA, ISBN 978-1-265-12303-1, 12th Edition, **2023**
2. Tortora G J, Funke B R, Case C L, Bair W B, "**Microbiology: An Introduction** ", Pearson Education, 14th Edition, **2023**

Reference Books

Michael Madigan, Kelly Bender, Daniel Buckley, W. Sattley, David Stahl, "**Biology of Microorganisms**", Pearson Education, 1st Edition, **2018**

Jacquelyn G. Black, Laura J. Black, "**Microbiology: Principles and Explorations**", Wiley USA, 10th Edition, **2019**

Indicative Experiments

1. Staining Techniques: Gram staining, Acid fast staining (ZN stain), LPCB staining	2 hours
2. Isolation and Enumeration of bacteria from different environments	2 hours
3. Culture methods of bacteria	2 hours
4. Biochemical characterization of bacteria	2 hours
5. Isolation of fungi and yeast from different environmental samples	2 hours
6. Assay of extracellular enzymes produced by bacteria: a) Amylase, b) Protease and c) Lipase	2 hours
7. Biofuel Production- Alcohol & Hydrogen	2 hours
8. Demonstration of Electron microscope	2 hours
9. Demonstration of Bioreactor/fermenter	2 hours
10. Demonstration of Lyophilization	2 hours
Total Laboratory Hours:	**30 hours**

Text Book(s)

Cappuccino J G, and Welsh C T, "**Microbiology: A laboratory manual** ", Pearson Education , 12th Edition, **2020**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Presentation	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT503	Computational Biology	3	0	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

Understand the fundamentals of biological databases and sequence comparison and the principles of sequence alignment and database similarity search
Explore protein structure visualization, classification and computational prediction of secondary and tertiary structures
Developing skills to use machine learning and computational techniques for drug designing

Course Outcomes

Gain proficiency in using biological databases and sequence comparison for data analysis
Perform sequence alignments and similarity searches for any biological data
Construct phylogenetic trees and analyze evolutionary relationships among organisms using sequence data
Predict protein secondary and tertiary structures and analyze using visualization tools
Utilize ML algorithms and computational tools for drug design and drug repurposing

Module:1	Biological databases	8 hours

Primary Databases - Nucleotide sequence databases - GenBank, EMBL, DDBJ; Protein sequence databases - UniProtKB/Swiss-Prot, TrEMBL, PIR; Macromolecular structure databases – PDB; Secondary Databases - Protein family and domain databases - Pfam, InterPro, PROSITE; Structure classification databases -SCOP, CATH; Derived sequence databases – RefSeq; File formats (Genbank, Uniport, PDB) - Biological Sequence comparison - Dot plot.

Module:2	Sequence alignment	11 hours

Smith-Waterman and Needleman-Wunsch algorithms - sequence formats and tools; Heuristic algorithms - BLAST and its types; FASTA – Algorithms, Sensitivity, specificity, applications; Methods, algorithms, tools, applications - Profiles and Hidden Markov Models; Protein Motifs and Domain Prediction; Quantum algorithms for sequence analysis.

Module:3	Molecular Phylogenetics	10 hours

Multiple sequence alignment - Phylogram construction – Distance based method, Character Based Methods-
Maximum parsimony method, Maximum likelihood- Phylogenetic Tree Evaluation – Jackknifing and Bootstrapping – applications.

Module:4	Structural Bioinformatics	8 hours

Conceptual model of protein structure; Protein structure prediction and modelling – Homology Modeling, Threading, Ab initio- Protein Structure Visualizatio n, Comparison and Classification; Structure validation and assessment; Structure alignment and analysis.		
Module:5	**Bioinformatics in the Pharmaceutical Industry**	**6 hours**
Structure-Based Rational Drug Design and discovery - Chemoinformatic; Overview of Machine Learning Algorithms in CADD.		
Module:6	**Contemporary Topics**	**2 hours**
Industry expert lectures		
	Total Lecture Hours:	**45 hours**

Text Book(s)

S.C. Rastogi, Namita Mendiratta, and Parag Rastogi, "**Bioinformatics: Methods and Applications – Genomics, Proteomics, and Drug Discovery**", PHI Learning, 5th Edition, **2022**
Jin Xiong, "**Essential Bioinformatics**", Cambridge University , 1st Edition, **2015**

Reference Books

Vinay Sharma, Ashok Munjal, Ashish Shanker, "**A Textbook of Bioinformatics** ", Rastogi, 2nd Edition, **2018**
J Howard Parish, Richard M Twyman, Charlie Hodgman, Andrew French and David Westhead, "**Instant Notes in Bioinformatics**", Taylor & Francis, , 2nd Edition, **2015**
Andreas D. Baxevanis, B. F. Francis Ouellette, "**Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins**", Wiley, 3rd Edition, **2015**

Indicative Experiments

1. Biological Databases and Data Retrieval	3 hours
2. Pairwise Sequence Alignment	3 hours
3. Multiple Sequence Alignment and Phylogenetic Tree Construction	3 hours
4. BLAST - Basic Local Alignment Search Tool	3 hours
5. Database search using FASTA	3 hours
6. Homology Modeling of Protein Structures	3 hours
7. Protein Structure Visualization	3 hours
8. Pharmacokinetic and dynamic analysis	3 hours
9. Protein-Ligand and Protein-Protein interaction analysis	3 hours
10. Gene prediction analysis	3 hours

Total Laboratory Hours:	**30 hours**
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Presentaion	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT504	Analytical Techniques in Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Developing the skills to understand the theory and practice of analytical techniques
2. Enhancing the understanding of analytical techniques in detail to interpret results
3. Improving the learning ability to analyze and separate biomolecules based on their properties

Course Outcomes

1. Demonstrate instruments related to bio techniques
2. Build knowledge on choice of appropriate techniques for their samples
3. Prepare samples for instrumental analysis
4. Design and execute the experiments
5. Analyze the samples and interpret results

Module:1	Absorption and emission spectroscopy	8 hours

Working principle, instrumentation, sample preparation, and its applications –UV-Vis, AAS, AES, Fluorescence spectroscopy.

Module:2	Spectrometric techniques	8 hours

Working principle, instrumentation, sample preparation, and its applications– NMR, ESR / EPR, IR, Raman, MS, XRD

Module:3	Chromatographic and Electrophoretic techniques	12 hours

Theory of chromatography and types (TLC, PC, HPTLC, GC, HPLC, and 2D) – their principles and applications; Principles, instrumentation, sample preparation for electrophoresis- gel and capillary electrophoresis; 2D electrophoresis and its applications.

Module:4	Microscopic techniques	8 hours

Basics of light microscopy; Instrumentation - confocal and fluorescence microscopy; Sample preparation for fluorescence microscopy; Super resolution microscopy; Basics of SEM and TEM; Specimen preparation for SEM and TEM.

Module:5	Flow cytometry and other recent techniques	7 hours

Cell sorters and their applications; Hyphenated techniques; tracer techniques – solid, liquid scintillation; Alternative to radioactive techniques.

Module:6	**Contemporary Topics**	**2 hours**
contemporary topics		
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Keith Wilson, John Walker, "**Principles and Techniques of Biochemistry and Molecular Biology** ", Cambridge University Press., 7th Edition, **2015** Douglas A, Skoog F, Holler J, Crouch SR, "**Principles of Instrumental Analysis** ", Thomson Brooks/Cole., 6th Edition, **2015**		
Reference Books		
F.W. Fifield and D. Kealey, "**Principles and Practice of Analytical Chemistry** ", Blackwell Science. , 5th Edition, **2000** Avinash Upadhyay, Kakoli Upadhyay, Nirmalendu Nath, "**Biophysical Chemistry: (Principles and Techniques)** ", Himalaya Pub. House Mumbai., 4th Edition, **2015** Nag A, "**Analytical Techniques in Agriculture Biotechnology and Environmental Engineering** ", Prentice Hall India, New Delhi, 1st Edition, **2016**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT505	Bioprocess Technology	3	0	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understanding the principles of bioprocess engineering and its applications in biotechnology and related fields
2. Familiarity with the fundamentals of bioreactors, including mass transfer, mixing, and sterilization
3. Developing skills in designing and optimizing bioprocesses for various industrial applications

Course Outcomes

1. Ability to design and optimize media for various industrial applications
2. Design and implement effective sterilization protocols for bioprocess equipment and procedures
3. Ability to apply mass transfer principles to various bioprocess applications
4. Proficiency in applying mathematical models to analyze and simulate microbial growth and production kinetics
5. Familiarity with process intensification strategies to enhance bioreactor efficiency and productivity

Module:1	Medium Formulation and Optimization	8 hours

Media for industrial fermentation: Nutritive and non-nutritive components of fermentation medium; Medium optimization by classical method and statistical method: Plackett Burman, and Response surface method.

Module:2	Sterilization for Fermentation Processes	9 hours

Thermal death kinetics of microbial cells and spores; Design of Batch and Continuous heat sterilization of Medium; Filter sterilization of Medium; Sterilization of
Air.

Module:3	Mass Transfer	10 hours

Principles of molecular diffusion and role of molecular diffusion in bioprocessing; Film theory; Convective mass transfer and oxygen uptake in cells; Concepts of mass transfer coefficients and its measurements; Power requirement in stirred tank reactors.

Module:4	Kinetics of Microbial Growth and Product Formation	8 hours

Stoichiometry of cell growth and product formation; Cell growth kinetics; Determination of cell kinetics parameters; Growth associated and non-growth associated product formation kinetics; Structured and unstructured models for growth and product formation.

Module:5	**Reactor Engineering**	**8 hours**
Bioreactor configurations; Batch, Continuous and Fed-batch systems; Scale up criteria -procedure and scale-down.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

Michael L Shuler, Kargi F, Matthew DeLisa, "**Bioprocess Engineering**", Prentice Hall International Series USA, 3rd Edition, **2017**
Stanbury P, Whitaker A. & amp; Hall, SJ., "**Principles of Fermentation Technology**", Butterworth Heinemann India , 3rd Edition, **2016**

Reference Books

Shijie Liu, "**Bioprocess Engineering, Kinetics, Sustainability, and Reactor Design**", Elsevier NY USA, 3rd Edition, **2017**
Pauline M Doran, "**Bioprocess Engineering Principles** ", Academic press Australia , 2nd Edition, **2015**

Indicative Experiments

1. Estimation of enzyme activity	3 hours
2. Determination of growth kinetics parameters	3 hours
3. Classical method of medium optimization by OFAT	3 hours
4. Statistical media optimization: Plackett–Burman design	3 hours
5. Statistical media optimization: Response surface methodology (RSM)	3 hours
6. Determination of enzyme kinetics parameters	3 hours
7. Enzyme immobilization and characterization	3 hours
8. Determination of thermal death kinetics	3 hours
9. Demonstration of fermenter and submerged fermentation	3 hours
10. Estimation of volumetric oxygen transfer coefficient	3 hours
Total Laboratory Hours:	**30 hours**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Group Discussion, Presentation

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT506	Genetic Engineering	3	0	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand the components required for gene manipulation
2. Understand the transformation of genetic material at molecular and cellular levels
3. Understand the methods of change of genetic material and construction of transgene organisms with the given properties

Course Outcomes

1. Outline the pros and cons of GMOs
2. Utilize tool enzymes for commercialization
3. Construct the recombinant vector and develop genetically modified organisms
4. Make use of gene cloning principles
5. Demonstrate the methods to transfer foreign genes

Module:1	DNA modifying Enzymes	8 hours

Polymerases, ligases, endo and exo nucleases; restriction enzymes and its types; adapters and linkers; homopolymer tailing; reverse transcriptase; phosphatase; polynucleotide kinase; RecA; zinc finger nucleases.

Module:2	Vectors	8 hours

Plasmid and phage vectors, YAC, BAC, M13 vector; Expression of foreign proteins in *E. coli*, Bacillus, yeast, insect cells, viral and mammalian cells.

Module:3	Transformation and Labelling Techniques	10 hours

Methodologies of gene transfer in plants, animals and microbes; Advanced cloning methods: multi-gene cloning, assembly cloning; Gene silencing techniques; Nick translation, Random priming, Radioactive and non-radioactive probes; Southern hybridization, Northern hybridization, Western blotting. cDNA and genomic DNA library construction and screening; Sequencing (NGS, RNA Seq).

Module:4	Reporter genes and PCR	9 hours

Role and mechanism of GFP, CAT, luciferases and β-galactosidases; PCR – Principle and applications (gene isolation, clinical diagnostics and detection, forensics, environmental and industrial applications); Different types of PCR; Real-time PCR (SYBR Green assay, Taqman Probes, Molecular beacons).

Module:5	Importance of Genetic Engineering	8 hours

In agriculture, human medicine, environment, forensic, industrial production of recombinant proteins, food, and pharmaceutical industry; Biosafety guidelines for GMOs.

Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

Brown T A, "**Gene Cloning and DNA Analysis: An Introduction**", Wiley Blackwell UK, 8th Edition, **2020**

Reference Books

Christopher Howe, "**Gene Cloning and Manipulation**", Cambridge University Press UK, 2nd Edition, **2017**

Indicative Experiments

1. Isolation of a gene from different source, cloning, screening, and expression of the recombinant protein	4 hours
2. RNA extraction / DNA extraction	3 hours
3. cDNA synthesis and preparation of vector	3 hours
4. PCR amplification of the gene of interest	2 hours
5. Cloning and preparation of competent cell	2 hours
6. Transformation of the cloned product	2 hours
7. Screening to identify recombinant clones - PCR	2 hours
8. Isolation of the plasmid DNA from the recombinant clone	3 hours
9. Confirmation of positive clones by restriction digestion	3 hours
10. Recombinant Protein Expression	2 hours
11. Real-time PCR	4 hours
Total Laboratory Hours:	**30 hours**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Group Discussion, Presentation

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT601	Industrial Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Apprehend the methods of screening significant microbes and strain improvement for the overproduction of bioproducts
2. Comprehend the industrial method of fermentation for various primary and secondary metabolites and biocatalysts
3. Apply Industrial Biotechnology principles to drive innovation and sustainability in various industries

Course Outcomes

1. Ability to design and implement screening and strain improvement strategies for microorganisms
2. Familiarity with the biosynthetic pathways and regulatory mechanisms involved in metabolite production
3. Knowledge of the industrial processes and technologies used for the mass production of enzymes used in different industries
4. Understanding of the types, production and applications of various biospeciality products
5. Ability to analyze and compare different approaches to enzyme immobilization and its possible applications

Module:1	Fermentation and Production Strain for Industrial Fermentations	9 hours

Fermentation process and its development, case study of Penicillin as a milestone in bioprocess development, Case-study involving an engineered organism. Techniques for isolation and screening of modelling, microorganisms for industrial scale production; strain improvement and selection.

Module:2	Production of primary and secondary metabolites	8 hours

Production of commercially important metabolites like organic acids, amino acids, antibiotics and pigments

Module:3	Mass production of enzymes	9 hours

Production of commercially important used in leather, textile, baking, brewing, detergent and food industry

Module:4	Biospeciality products and Biotransformation	9 hours

Production of biopolymers, biopesticides, biofertilizers, biopreservatives and biotransformation of steroids

Module:5	Immobilization	8 hours

Techniques of immobilization of enzymes; Kinetics of immobilized enzymes; Application of immobilized enzymes in bioremediation and biofuel production.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Peter Stanbury, "**Principles of Fermentation technology**", Butterworth Heinemann, 3rd Edition, **2016** Biotechnology, "**Satyanarayana U**", Books Allied Pvt Ltd, 1st Edition, **2020**		
Reference Books		
Cruger Wulf and Anneliese Crueger, "**A Textbook of Industrial Microbiology**", Medtech India, 3rd Edition, **2017** Nduka Okafor and Benedict C , "**Modern Industrial Microbiology and Biotechnology**", Taylor and Francis, 2nd Edition, **2017**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT602	Pharmaceutical Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Outline the basic and fundamental concepts in Pharmacology
2. Discuss, dissect, interpret and build knowledge and skill-sets in pharmacology and Biotechnology based pharmaceutical products
3. Evaluate and apply the fundamental knowledge in biotechnology-based applications in the pharmaceutical and sectors related to drug development and use

Course Outcomes

1. Recall fundamental concepts in Pharmacology including ADME and solve numerical problems in PK/PD.
2. Understand and explain the mechanism of action of the different classes of drugs
3. Demonstrate the concepts and outline the critical determinants and nuances in conventional manufacturing of drug formulations including Good Manufacturing Practices
4. Analyse and draw inferences with respect to the methodological and manufacturing challenges in Biologics and Nanocarriers
5. Elaborate upon and assess the regulatory approval and clinical trial criteria for bulk drugs and biologics as well as the inherent challenges

Module:1	Basics of Pharmacology	8 hours

Sources of drugs; different dosage forms and routes of drug administration; Mechanism of action of drugs; Combined effect of drugs; Factors modifying drug action; Tolerance and dependence; Pharmacogenetics; Kinetics - Absorption, Distribution, Metabolism, Excretion and toxicity of drugs; Numerical problems in Pharmacokinetics and Pharmacodynamics.

Module:2	General Pharmacology	9 hours

General anaesthetics; Opioids; NSAIDs; Anti-histamines; Anti-Hypertensives; Diuretics; Ulcer.

Module:3	Formulative Pharmacy	8 hours

Manufacturing, quality control, stability testing and storage of tablets, capsules, parenterals, solutions, aerosols and ointments; Good Manufacturing Practices; Scale-up-related determinants.

Module:4	Biologics & Nanocarriers	9 hours

Biologics: Advancements in rDNA technology -key examples -hormones, cytokines, vaccines, monoclonal antibodies, biosimilars; Nanocarriers: rate-controlled and site-specific delivery; Synthesis and characterization of organic and inorganic

nanoparticles and blends; Fate and disposition of nanoparticles in *in vivo* and *in vitro* model systems.		
Module:5	**Regulatory Affairs**	**9 hours**
Pre-clinical trials, design of clinical trials, phases of clinical trials and testing of drugs in human; ICH, FDA, EMEA and Indian drug regulations Regulatory Affairs: Globalization of drug industry; present status and scope of pharmaceutical industry in India; WHO and NABL certification; Regulatory aspects of pharmaceutical and bulk drug manufacture; Regulatory drug analysis.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**

Text Book(s)

Satoskar RS, Bhandarkar SD, Nirmala N Rege, Satoskar RR, "**Pharmacology and Pharmacotherapeutics**", Elsevier India, 25th Edition, **2017**

Loyd V Allen, Howard C, Ansel, , "**Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems**", Wolters Kluwer (India) Pvt. Ltd., 12th Edition, **2021**

Daan J. A. Crommelin, Robert D. Sindelar and Bernd Meibohm, , "**Pharmaceutical Biotechnology: Fundamentals and Applications,** ", Springer International Publishing AG., 6th Edition, **2024**

Reference Books

Laurence Brunton, Bruce A Chabner, Bjorn Knollman, "**Goodman and Gilman's the Pharmacological Basis of Therapeutics**", McGraw Hill Education/Medical, 15th Edition, **2022**

Roop K Khar, SP Vyas, Farhan J Ahmad and Gaurav K Jain, , "**Liebermans: The Theory and Practice of Industrial Pharmacy**", CBS., 4th Edition, **2020**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT603	Medical Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Enhance students' understanding of modern cell culture methods and computational biology
2. Stimulate students with the translational aspects of medical biotechnology
3. Transform the field with advanced biotechnology tools and techniques

Course Outcomes

1. Familiarize students with the fundamentals of medical biotechnology
2. Facilitate knowledge on computational biology for drug discovery
3. Introduce students to advanced scientific techniques related to medical biotechnology.
4. Explore modern drug delivery strategies.
5. Appraise the translational aspects of advanced technologies.

Module:1	Fundamentals of Medical Biotechnology	8 hours

Mammalian cell culture techniques; Primary cell isolation and maintenance; Gene expression and regulations; rDNA technology; Cell-based assays.

Module:2	Computational Biology	9 hours

Multilevel computational modelling for humane diseases; Bioinformatics for drug discovery; Proteomics; Clinical data analysis.

Module:3	Advanced Techniques	9 hours

CRISPR-CAS9 gene editing; Synthetic biology applications; Transplantation and tissue engineering; RNA therapeutics; 3D bioprinting; Microfluidics; Biosensors; organs-on-chips.

Module:4	Drug Delivery Systems	9 hours

Nanoparticle-based delivery system; Targeted drug delivery; Viral vector; Microelectromechanical system (MEMS).

Module:5	Translational Biotechnology	8 hours

Disease-relevant model development; Clinical trial design and methodology; Regulatory affairs.

Module:6	Contemporary Topics	2 hours

Lectures delivered by field experts.

Total Lecture Hours:	45 hours

Tutorial Hours:	**15 hours**
Text Book(s)	
Bernard R. Glick, Cheryl L. Patten, Terry L. Delovitch, "**Medical Biotechnology**", American Society for Microbiology, 1st Edition, **2013** Mumtaz Anwar, Riyaz Ahmad Rather, Zeenat Farooq, "**Fundamentals and Advances in Medical Biotechnology**", Springer Charm, 1st Edition, **2023** Dev Bukhsh Singh, Santosh Kumar Upadhyay, "**Medicinal Biotechnology; Methods and Applications**", Academic Press, 1st Edition, **2024**	
Reference Books	
Brenda A. Wilson, Malcolm Winkler, Brian T. Ho, "**Bacterial Pathogenesis: A Molecular Approach**", ASM Press, 4th Edition, **2019** Alok Das Mohapatra, Priyadarshi S. Sahu, "**Advances in Immunology and Immuno-techniques, Updated Concepts and Recent Applications**", Springer Singapore, 1st Edition, **2024**	
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT604	Plant Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand the fundamental concepts of totipotency, explant selection, and various culture techniques used in plant tissue culture.
2. Develop transgenic plants for improved traits and bio-product expression using gene transfer techniques.
3. Understand the global status, biosafety, and legal frameworks related to transgenic plants.

Course Outcomes

1. Learn totipotency and apply suitable culture methods for plant regeneration
2. Identify major components of plant transformation vectors and distinguish between Agrobacterium-mediated and direct gene transfer techniques
3. Explain strategies for developing stress-tolerant and high-yielding crops through genetic improvement
4. Explain how transgenic plants produce bio-products and express functional proteins
5. Summarize biosafety concerns and key legal acts governing transgenic plant development and use.

Module:1	Tissue Culture	8 hours

Totipotency, equipotency, pluripotency and plasticity; Explants; Media and culture conditions; Cultures: single cell, callus, cell- suspension, protoplast, leaf, root, shoot tip and meristems, embryo, anther, microspore and ovary; Somatic embryogenesis, organogenesis, synthetic seeds and hardening; Applications of tissue culture.

Module:2	Vector components and Transformation	12 hours

Features of a plant transformation vector; Constitutive, inducible and tissue specific promoters, terminators and regulatory elements; Selectable markers and reporter genes; binary and RNAi vectors; Nuclear and plastid transformation; Agrobacterium mediated and direct gene transfer methods; Terminator and Traitor technologies; Clean gene technologies.

Module:3	Transgenic Plants	8 hours

Herbicide tolerance; pest tolerance; disease resistant; abiotic, biotic and secondary stress tolerance; improvement of crop yield and quality.

Module:4	Molecular Pharming	8 hours

Transgenic systems to derive carbohydrates, plantibodies, edible vaccines, enzymes, biopharmaceuticals, bioplastics, biofuel, silk and elastin; Gene to functional protein processing steps in plants.

Module:5	**Biosafety and IPR**	**7 hours**
Global status and bio-safety concerns for production and release of transgenic plants; Plant breeder's rights; Protection of plant varieties and Farmers right act, Biodiversity bill, Geographical indications act, patents.		
Module:6	**Contemporary Topics**	**2 hours**
Contemporary Topics		
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Adrian Slater, N. W. Scott and M. Fowler., "**Plant Biotechnology: The Genetic Manipulation of Plants** ", Oxford University Press UK, 2nd Edition, **2015**		
Reference Books		
Suresh Kumar, Gahlawat, Raj Kumar Salar, Priyanka Siwach, Joginder Singh Duhan, Suresh Kumar and Pawan Kaur,, "**Plant Biotechnology: Recent Advancements and Developments** ", Springer Nature Singapore, 1st Edition, **2017**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT605	Animal Biotechnology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Explore advances in animal cell culture including various genetic modification techniques in animal cells and embryos
2. Explain and recall advances and challenges of animal reproductive technology
3. Appreciate the conservation of farm/wildlife animals and to understand the utility of genetically modified animal models for understanding human health and disease

Course Outcomes

1. Learn fundamentals and advances of animal cell culture and their applications
2. Comparatively appreciate the strengths and limitations of different genetic modification techniques in animals
3. Explain and recall advanced animal reproductive technology
4. Apply fundamental knowledge of breeding and gene modification technologies in conservation of farm/wild animals and selective breeding
5. Use different animal models for understanding animal diseases and conceive a holistic perspective of their ethical, legal and social implications

Module:1	Animal cell culture and gene modification techniques	9 hours

Culture media; Primary and secondary cell culture; Contamination issues; Animal Cell characterization; Stem Cells and Tissue Engineering; Immortalization of Cells; Methods to introduce transgene into cell; Expression vectors; Transient and stable transgene expression in cells; Cellular gene silencing - siRNA and shRNA technique; Gene editing - TALEN, ZFN, and CRISPR-Cas9; Industrial applications of animal cell culture.

Module:2	Genetically engineered mice	9 hours

Gene manipulation in embryo: Production and breeding of various genetically modified mice such as transgenic/knockout/Cre-LoxP animals; Transgenic mice: constitutive, inducible, and cell-type specific expression of transgene; Drawbacks of transgenic mice and knock out mice; Cre-LoxP: cell type specific and inducible deletion of target gene; Applications of transgenic animals - Production of pharmaceuticals and donor organs

Module:3	Advanced Animal reproductive technology	8 hours

Animal propagation; Artificial Insemination; Estrous synchronization; superovulation; embryo transfer; pregnancy and parturition control; Immunological methods to control reproduction; monitoring reproductive status; Surrogate mother; ICSCI; In-vitro fertilization in farm animals and humans

Module:4	**Innovation for Sustainability and Conservation of Wildlife Species**	**8 hours**
Animal genome projects; Next generation sequencing technique; genetic conservation and marker assisted breeding of farm animals; Somatic Cell Nuclear Transfer and gene manipulation in conservation of farm animals and endangered/extinct wild animals (E.g. Dire wolf).		
Module:5	**Animal models in biomedical research**	**9 hours**
Genetically modified animal models used in biomedical research: Cancer, diabetes; Immunocompromised mice – Nude mice, SCID mice, NSG mice, NBSGW mice, humanised mice; Ethical, social and legal issues related to animal models; Alternatives to animal models		
Module:6	**Contemporary topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**

Text Book(s)

Ashish Verma, Anchal Singh, "**Animal Biotechnology: Models in Discovery and Translation**", Academic Press USA, 2nd Edition, **2020**
Sandy B. Primrose and Richard Twyman, "**Principles of Gene Manipulation and Genomics**", Wiley Blackwell Publishing Oxford UK, 8th Edition, **2016**

Reference Books

Ian Gordon, "**Reproductive Technologies in Farm Animals**", CABI Publishing Ireland, 2nd Edition, **2017**
R. Ian Freshney, Amanda Capes-Davis, Carl Gregory, Stefan Przyborski, "**Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications**", Wiley Blackwell New Jersey USA, 7th Edition, **2016**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT606	Genomics and Proteomics	3	0	2	4
Pre-requisite	NIL	**Syllabus Version**			
		1			

Course Objectives

1. Provide a broad overview of genomics and proteomics technologies
2. Evaluate the role of omics approaches in the functional understanding of biological systems
3. Develop foundational skills in the analysis of omics data

Course Outcomes

1. Demonstrate mastery of current DNA sequencing methods for the study and analysis of genomic data
2. Apply high-throughput expression studies to understand their role in biological processes and disease mechanisms
3. Characterize proteomes using separation and identification-based analytical techniques
4. Measure protein dynamics and functions and accurately characterize protein properties
5. Integrate multi-omics data to enhance understanding and application in personalized diagnostics and therapeutics

Module:1	**Genomics and Sequencing Techniques**	**9 hours**

Genome organization in prokaryotes and eukaryotes, Organelle genome; Genome sequencing technologies, Next Generation sequencers, Short read sequencers: Illumina and Ion torrent; Long read Sequencers: Nanopore sequencing and PACBIO; Single-
molecule sequencing, Sequencing by Expansion (SBX); NGS workflow: Library preparation. Whole Genome Sequencing, Exome sequencing, Targeted sequencing, Methyl Sequencing.

Module:2	**Transcriptomics and Functional Genomics**	**8 hours**

Gene expression: Quantitative real-time PCR; Transcriptomics: RNA seq, Small RNA seq, Single-cell Sequencing, Spatial transcriptomics, Data analysis; Gene function studies using sequence comparison, genome editing, systematic gene knockout; Genome-wide knockout/knockdown

Module:3	**Proteomic Methods in the Post-Genomic Era**	**10 hours**

Protein Separation: Chromatography - Multidimensional chromatography, NanoL C, Combined fractional diagonal chromatography (COFRADIC), GCxGC-two-dimensional gas chromatography, Hydrophilic interaction liquid chromatography (HILIC); Electrophoretic Techniques - One-dimensional and two-dimensional 2-D gel electrophoresis, Difference gel electrophoresis (DIGE); Protein Identification -

Mass spectrometry MALDI, SELDI, Peptide mass fingerprinting, and analysis of data .		
Module:4	**Quantitative and Functional Proteomics**	**8 hours**
Qualitative and quantitative proteome analysis: Isotope label-free and labelling approaches (SILAC, TMT, iTRAQ); Sequencing-based proteomics – OLINK; Proteomic analysis of protein-protein and protein-DNA interactions; Protein microarray; Identification of ligand-receptor pairing and transcriptional regulators, interaction of proteins with small molecules and biomacromolecules; Analysis of posttranslational modifications.		
Module:5	**Systems Biology and Integrative Clinical Omics**	**8 hours**
Systems biology approaches - model complex biological processes, Enhancement of omics data interpretation by network modelling; Integrative omics approach in disease biomarker discovery, diseases pathology, drug discovery, Personalized Medicine. AI and Big Data in Clinical Omics.		
Module:6	**Contemporary topics**	**2 hours**
Guest lectures on contemporary topics		
	Total Lecture Hours:	**45 hours**

Text Book(s)

1. Arthur M. Lesk, "**Introduction to genomics**", Oxford University Press, 3rd Edition, **2025**
2. Brown, T. A., & Brown, T. A, "**Genomes 5**", CRC Press, 5th Edition, **2022**
3. Peter Wyatt, "**Proteomics: Principles, Techniques and Analysis**", Syrawood Publishing House, 2nd Edition, **2018**

Reference Books

1. Czaplewska, P., Macur, K., & Ciborowski, P, "**Primer of proteomics**", World Scientific, 1st Edition, **2024**
2. Liu, Y., "**Omics in clinical practice: Genomics, Pharmacogenomics, Proteomics, and Transcriptomics in Clinical Research,**", Apple Academic Press, 1st Edition, **2021**
3. Sobti, R. C., Mukesh, M., & Sobti, A., "**Genomics, Proteomics and Biotechnology**", CRC Press, 1st Edition, **2022**

Indicative Experiments

1. Understanding File formats for NGS data analysis	3 hours
2. Genome Assembly- Variant Calling	3 hours
3. Transcriptomics- RNA-Seq Data analysis pipeline	3 hours
4. Differential gene expression analysis	3 hours
5. Functional annotation: Gene set enrichment analysis: Molecular Function	3 hours

(MF), Biological Process (BP), Cellular Component (CC), KEGG path ways.	
6. Data extraction from Proteome 2D-PAGE Database	3 hours
7. Peptide mass fingerprinting search using Expasy tool	3 hours
8. From protein sequence to structure prediction	3 hours
9. Structure-Based Functional Annotation of Hypothetical Proteins	3 hours
10. Protein-protein interaction network analysis	3 hours
Total Laboratory Hours:	**30 hours**
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Group Discussion, Presentation	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT607	Cancer Biology	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Demonstrate the main cellular processes altered during cancer onset and progression.
2. Analyze novel therapeutics designed to target an individual tumor based upon its genetic and epigenetic signature.
3. Include recent advances in molecular diagnostics and the modern methods in cancer research

Course Outcomes

1. Identify and describe the characteristics of cancer cells that explain high mortality rate
2. Define the role of cancer genes mutations as well as the deregulated signaling pathways in tumor cells
3. Apply the major approaches involved in cancer screening and evaluate the prognostic and predictive value of current and emerging cancer biomarkers
4. Expound on the role of traditional and novel cancer therapies in clinical practice
5. Comprehend and interpret main conclusions drawn from publications and experimental studies in cancer research.

Module:1	Cellular and Molecular Basis of Cancer	9 hours

Introduction to Cancer and carcinogenesis; Hallmarks of cancer; Extracellular signal mechanism and Oncogenes, Tumor Suppression Genes; Control of Cell Cycle; Control of Apoptosis in Normal and Malignant Cells.

Module:2	Tumor Metabolism	7 hours

Changes in Energy Metabolism and Warburg Effect; Tumor microenvironment; Glutamine and amino acid, lipid and fatty acid metabolism; Inflammation, infection and microbe.

Module:3	Genetic Instability and Epigenetic Modifications in Cancer	9 hours

Role of Mutations and Genetic Instability in Neoplastic Growth; chromatin remodelling and Epigenetic regulation; DNA damage response and Repair mechanism; Cellular Senescence, Telomerase and Cancer.

Module:4	Invasion and Metastasis	9 hours

Role of Angiogenesis in Tumor Progression; Metastasis; EMT; Evading immune system; Multi drug resistance in cancer; Role of Stem / Precursor Cells in Cancer Initiation and Progression; Origin and Markers of Cancer Stem Cells.

Module:5	Cancer Diagnosis	9 hours

Experimental Models for Studies of Malignant Growth and Progression *in vivo* and *in vitro*. Modern Methods and Probes for Differential Cellular and Molecular Diagnostics of Cancer-Cancer Genomics and Proteomics; Biomarkers; Cellular and Molecular Targets of Traditional and Novel Therapies for Cancer.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Robert Weinberg, "**The Biology of Cancer**", W W Norton and Company USA, 3rd Edition, **2023** Lauren Pecorino , "**Molecular Biology of Cancer-Mechanisms, Targets, and Therapeutics**", Oxford Press England, 5th Edition, **2021**		
Reference Books		
David Tarin , "**Understanding cancer: the molecular mechanisms, biology, pathology and clinical implications of malignant neoplasia,** ", Springer Nature, 2nd Edition, **2023** Carlberg, Carsten, and Eunike Velleuer, , "**Cancer biology: how science works**", Springer Switzerland, 3rd Edition, **2021**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Final Assessment Test, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT608	Immunotechnology	3	0	2	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Acquire knowledge in immunology and immunotechnology
2. Understand the basic principles and recent advancements in the field of Immunotechnology
3. Interpret the role of immunodiagnostics and immune therapeutics

Course Outcomes

1. Relate the role of the immune cells and organs in immune response
2. Interpret the basis of immunopathogenic mechanism
3. Demonstrate the versatility of monoclonal and polyclonal antibodies
4. Summarize the utility of various Immunodiagnostics
5. Interpret the recent trends and strategies in immunodiagnostics and Immunotherapeutics

Module:1	Immune system	9 hours

Cells of Immune system: Hematopoiesis- growth factors and regulation; Organs of the immune system: Primary and secondary lymphoid organs; Types of immunity; Innate immunity: Pattern recognition receptor, Signaling, Inflammation; Complement system; Acquired immunity: humoral immune response and cell mediated immune response; Major Histocompatibility Complex, antigen processing & presentation.

Module:2	Immunopathology	7 hours

Hypersensitivity and autoimmunity: overview of immunopathogenic mechanism; Cancer immunology: tumor antigens, immune response to tumor antigens; Transplantation: immunological mechanisms of graft rejection.

Module:3	Antigens and antibodies	9 hours

Antigens: structure, properties and types; Antibodies: structure, properties; Principles of Antigen and antibody interactions; Monoclonal and polyclonal antibodies; Production of Polyclonal antibodies; Antigen preparation, adjuvants and modification; Antigen administration, collection of sera, purification of antibodies; Hybridoma technology: Reactor system for large scale production and purification of monoclonal antibodies; Antibody genes and antibody engineering: chimeric and hybrid monoclonal antibodies; Humanized and bispecific antibodies; (scFv) antibodies; Antibody microarray; Antibody drug conjugates (ADC); Applications of monoclonal antibodies.

Module:4	Vaccines	9 hours

Principles & development of vaccines; Active and Passive Immunization; Recombinant vaccines; DNA vaccines; Protein-based vaccines; Sub-unit vaccines; Peptide & conjugate vaccines; Vector vaccines; Plant-based vaccines; RNA vaccines; Cancer vaccines; Reverse vaccinology; Current vaccine development strategies against COVID-19, AIDS, malaria, dengue and other emerging diseases.		
Module:5	**Immunodiagnostics and Immunotherapeutics**	**9 hours**
ELISA; ELISPOT; Immunoblotting; Immunohistochemistry; Radioimmune assay; Immunofluorescence; Flow Cytometry; Current trends in Immunotherapeutics; Clinical applications, challenges and future perspectives; development of immune drug targets; dendritic cells-based immunotherapy; Stem cells and their therapeutic potentials; CAR T-cell therapy, inhibitors of immune check points; recombinant cytokines.		
Module:6	**Contemporary Topics**	**2 hours**
Contemporary Topics		
	Total Lecture Hours:	**45 hours**

Text Book(s)

Abbas K A, Litchman A. H., "**Cellular and Molecular Immunology**", Elsevier., 10th Edition, **2021**

David male, R. Stokes Peebles, Victoria Male, "**Immunology**", Elsevier, 9th Edition, **2020**

Reference Books

C. A. Janeway Jr, P. Travers, "**Immunobiology**", Taylor & Francis, 10th Edition, **2022**

Judy Owen, Jenni Punt, Sharon Stranford, Patricia Jones Kuby, "**Immunology**", W.H. Freeman and Co, 8th Edition, **2018**

Indicative Experiments

1. Ethics, selection and handling of animals for immunological experiments (Eg. Mice, Guinea pigs, Rabbits), Routes of immunization (Eg. Intraperitoneal, Sub-cutaneous, Intra-muscular) [Demo only]	2 hours
2. Preparation of antigens for immunization	2 hours
3. Collection of serum, storage and purification of antibodies	4 hours
4. Immunodiffusion/Immunoelectrophoresis/ Agglutination test	4 hours
5. Evaluation of Antigens by Sandwich ELISA	4 hours
6. Separation of antigens by native/SDS-PAGE	3 hours
7. Characterization of antigens by Immunoblotting	4 hours

8. Conjugation of Immunoglobulins [Antibody labelling]	3 hours
9. Monoclonal antibody production (Demo only)	2 hours
10. Screening of lymphocytes by FACS [Demo only]	2 hours
Total Laboratory Hours:	**30 hours**

Reference Books

Christine D. Stevens and Linda E. Miller, "**Clinical Immunology and Serology: A Laboratory Perspective**", F. A. Davis Co., USA. , 4th Edition, **2017**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Lab Continuous Assessment, Lab Final Assessment, Oral Examination, Seminar, Group Discussion, Presentaion

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT609	Data Science and Machine Learning for Biotechnologists	3	1	0	4
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand foundational statistical concepts and sampling techniques for biological data analysis
2. Develop proficiency in Python libraries to manipulate, analyze, and visualize data for scientific applications
3. Apply core machine learning algorithms and evaluate model performance using regression and classification metrics

Course Outcomes

1. Apply statistical concepts to biological data and determine appropriate sampling and data collection methods
2. Interpret biological datasets using measures of central tendency, dispersion, and probability distributions
3. Use Python and essential libraries to clean, manipulate, and visualize biological data effectively
4. Prepare biological data for machine learning through transformation, feature selection, and handling missing values
5. Implement and evaluate classification and regression models for biological data using appropriate metric

Module:1	Data Science Foundation	8 hours

Data Types: Numerical Data, Categorical data; Harnessing Data; Data sampling- Probability sampling methods, non-probability sampling methods, Sampling error, Data collection methods; Application of statistical concepts, Types of statistics: Descriptive statistics, Inferential statistics; Cochran's minimum sample size formula

Module:2	Exploratory Analysis	10 hours

Measures of Data: Measures of Central tendencies, Measures of dispersion; Shape of distribution: Probability distributions, Bernoulli distribution, Binomial distribution, Normal Distribution, Poisson distribution, Exponential distribution; Histogram; Z- score, Standard error; Empirical rule, Normality testing, Central limit Theorem; Outlier; Distance measurement.

Module:3	Python Libraries	8 hours

Overview of Python libraries: NumPy, Pandas, Matplotlib; Data preparation: NumPy: Installation instructions, Numpy array, Built-in methods; Data preparation: Pandas: Importing data and creating Data Frame, selecting data, Methods for data analysis, Grouping and sorting, Handling Missing Data.

Module:4	**Machine Learning**	**7 hours**
Machine learning introduction: Types of Machine Learning, Steps in Machine Learning modelling; Feature Engineering: Feature Selection, Feature Transformation, Feature extraction, Feature Creation		
Module:5	**Machine Learning Algorithms**	**10 hours**
Supervised Learning Algorithms: Linear Regression, Logistic Regression, Support Vector Machine, Decision Tree, Random Forest; Model evaluation: Cross validation, Regression Metrics, Classification Metrics; Unsupervised Machine Learning: K-Means Clustering, Principal Component Analysis (PCA).		
Module:6	**Contemporary Topics**	**2 hours**
Industry expert lectures		
	Total Lecture Hours:	**45 hours**
	Tutorial Hours:	**15 hours**
Text Book(s)		
Peter Bruce, Andrew Bruce, and Peter Gedeck, , "**Practical Statistics for Data Scientists**", O'Reilly Media, 2nd Edition, **2020** Aurélien Géron, "**Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow** ", O'Reilly Media, 3rd Edition, **2022** Wes McKinney, "**Python for Data Analysis**", O'Reilly Media, **2019**		
Reference Books		
Andreas C. Müller and Sarah Guido, "**Introduction to Machine Learning with Python** ", O'Reilly Media, **2016** Oliver Theobald, "**Machine Learning for Absolute Beginners**", Scatterplot Press, 3rd Edition, **2021** Wayne W. Daniel & Chad L. Cross, "**Biostatistics: A Foundation for Analysis in the Health Sciences** ", Wiley, 11th Edition, **2018**		
Mode of Evaluation :		
Recommended by Board of Studies :		26-05-2025
Approved by Academic Council : No. 78		12-06-2025

Course Code	Course Title	L	T	P	C
MABIT610	Nanobiotechnology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Develop a basic understanding of various types of nanomaterials and their synthesis and characterization
2. Design functional nanomaterials for biomedical applications
3. Evaluate the impact of nanomaterials on the environment and human health

Course Outcomes

1. Understand the concepts related to nanotechnology and various types of nanomaterials
2. Compare different techniques of synthesis of nanomaterials
3. Perceive the use of different characterization techniques to understand the properties of nanomaterials
4. Formulate biomedical applications of nanomaterials and assess the impact of nanomaterials on the environment and human health

Module:1	Overview of Nanobiotechnology	8 hours

Evolution of nanotechnology; Surface & quantum effects; Unique properties of nanomaterials; Types of nanomaterials: Inorganic nanoparticles, quantum dots, carbon particles/nanotubes, polymeric nanoparticles, nano-emulsion; nucleic acid nanostructures and protein nanostructures.

Module:2	Nanomaterials Synthesis Routes and Properties	9 hours

Synthesis of nanomaterials: physical, chemical and biological methods, advantages and disadvantages; Top-down approaches: Mechanical milling, Dry and wet etching, Laser ablation; Bottom-up approaches: Electrospinning, Sol-gel process, Chemical reduction, Dispersion and Emulsion polymerization; Structure property relationships with respect to mechanical, electrical, optical, and magnetic properties.

Module:3	Characterization of Nanomaterials	9 hours

Significance of nanomaterial characterization; Principle, working and applications: dynamic light scattering, zeta potential, vibrational spectroscopy, contact angle and wettability, atomic force microscopy, electron microscopy, energy dispersive X-ray analysis, X-ray photoelectron spectroscopy and X-ray diffraction.

Module:4	Functionalization and Biomedical Applications of Nanomaterials	9 hours

Importance of functionalization; Non-covalent methods: adsorption, electrostatic interaction; covalent methods: carbodiimide chemistry, Schiff's base, crosslinking chemistry; Applications of nanomaterials for bioactive delivery; Anti-microbial

therapy, Anti-tumor therapy; Sensors and Diagnostics; Tissue engineering and regenerative medicine.		
Module:5	**Nanotoxicology**	**8 hours**
Introduction, mechanism and types of nanomaterial toxicity; Routes of exposure and limits of nanomaterials; Nanotoxicology of selected nanomaterials; Implications for human health Effects in ecosystems; Systemic effects; Biological models of toxicity assessment.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
Text Book(s)		
Thomas Varghese, K.M. Balakrishna, "**Nanotechnology: An Introduction to Synthesis Properties and Applications of Nanomaterials**", Atlantic , **2024** Upendranath Nandi, Debnarayan Jana, "**Nanomaterials: Theory Problems and Solutions**", Techno World , 2nd Edition, **2020**		
Reference Books		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT611	Protein Engineering and Technology	2	1	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Familiarize with the structure-stability-function relationship of proteins
2. Learn the different strategies for engineering proteins
3. Understand the application of engineered proteins

Course Outcomes

1. Understand the factors contributing to structure, folding and stability of proteins
2. Formulate strategies and workflows to create mutant proteins and device appropriate methods to screen, select and characterize the mutant proteins
3. Identify required properties of proteins for matching technological applications
4. Analyse case studies related to the application of engineering proteins

Module:1	Factors Affecting Stability and Folding of Proteins	6 hours

Protein structure and factors contributing to stability of proteins, solute and solvent effects on protein structure; Protein folding: problem and models, helpers (*in vitro* and *in vivo*); Consequences of protein misfolding, denaturation and aggregation; Three functional states of proteins: Structured, Intrinsically disordered and Phase-
Separated; Proteoforms, Protein turnover and protein half-life.

Module:2	Strategies to Create Protein Mutants	7 hours

Overview of expression hosts, expression plasmids and gene cloning (including cell free expression); Use of degenerate codons, incorporation of non-natural / non- proteogenic amino acids; Irrational approaches: Directed evolution of proteins, Random and focused mutagenesis, Saturation mutagenesis, homologous and heterologous gene recombination methods; Knowledge-based approaches: Sequence-based and structure-based strategies; Denovo design strategies – positive and negative design methods; Design-Build-Test-Learn (DBTL) iterative procedures.

Module:3	Production, Screening and Characterization of Protein Mutants	5 hours

Phage display and cell surface display methods (direct and indirect methods); cell free display systems (microarray based) – biopanning, antibody assays, aptamers, small molecules; Strategies to produce functional proteins and their purification; Protein characterization: MS based approaches, application of nuclear magnetic resonance spectroscopy, X-ray diffraction and Cryo-electron microscopy.

Module:4	Protein Technology	5 hours
Biosensors; Protein scaffolds; Drug carriers; 3D printed proteins for tissue engineering; Proteolysis targeting chimeras (PROTACs); Proteins for gene editing (CRISPR-Cas9); Bioremediation; Pharmaceutical proteins; Nanoparticles through protein self-assembly, Protein nanowires, Gels and emulsions.		
Module:5	**Application of Engineered Proteins**	**5 hours**
Insulin and its analogs; Antibody drug conjugates; Cancer imaging and therapy,;Dye degrading enzymes; Collagen-like peptides; protein nanomaterial for functional foods, flavors and packaging; Green synthesis of fine chemicals, detergent in leather industries.		
Module:6	**Contemporary Topics**	**2 hours**
Lecture by industry experts		
	Total Lecture Hours:	**30 hours**
	Tutorial Hours:	**15 hours**

Text Book(s)

Huimin Zhao, "**Protein Engineering – Tools and Applications**", Wiley VCH GmbH, 1st Edition, **2021**

KM Poluri and K Gulati, "**Protein Engineering Techniques – Gateways to Synthetic Protein Universe**", Springer Nature, 1st Edition, **2017**

Reference Books

TS Wong and KL Tee, "**A Practical Guide to Protein Engineering**", Springer Nature, 1st Edition, **2020**

N Bandara and A Ullah, "**Functional Materials from Lipids and Proteins (Smart Materials Series)**", Royal Society of Chemistry USA, 1st Edition, **2024**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Group Discussion, Presentaion

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT612	Programming For Biologists	2	0	2	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand basic programming concepts such as variables, data types, operators, control flow, and functions
2. Apply programming principles to solve biological problems
3. Perform basic data analysis and statistical calculations using programming libraries

Course Outcomes

1. Ability to write and execute basic Python scripts relevant to biology
2. Capability to effectively use of data structures and control flow for analyzing biological data
3. Capability to create reusable functions and utilize built-in functions
4. Proficiency in applying regular expressions for data extraction and string manipulation

Module:1	Fundamentals of Unix and Python	6 hours

Basic structure of the Unix file system, Essential navigation commands and File permissions; Python: installation, interpreters, and basic syntax; Variables, data types: integers, floats, strings; Booleans, Basic input and output operations; Integrated Development Environments (IDEs) or text editors.

Module:2	Data structures and Control Flow	6 hours

Data structures: lists, tuples, dictionaries, sets; Conditional statements - if, elif, else, Loops - for and while loops, Controlling loop execution – break and continue.

Module:3	Functions	4 hours

Defining and calling functions; Passing arguments and returning values; Scope of variables; Introduction to built-in functions.

Module:4	Regular Expressions	6 hours

The importance of patterns in biology; Python's re module; Raw strings and special sequences; Finding multiple matches; Extracting and grouping matches; Splitting and substituting strings with Regex

Module:5	Modules and Libraries for Biology	6 hours

Introduction to Python modules; Using standard library modules; Introduction to key biological libraries; Sequence manipulation with Biopython - reading sequences and extracting features.

Module:6	Contemporary Topics	2 hours

Industry Expert Lectures	
Total Lecture Hours:	**30 hours**
Text Book(s)	
Hasija, Yasha, and Rajkumar Chakraborty, "**Hands on Data Science for Biologists Using Python**", CRC Press, 1st Edition, **2021**	
Reference Books	
Tiago Antao, "**Bioinformatics with Python Cookbook: use modern Python libraries and applications to solve real-world computational biology problems,**", Packt Publishing Ltd, 2nd Edition, **2022**	
Indicative Experiments	
1. **Calculating AT content** Write a program that will print out the AT content of this DNA sequence. "ACTGATCGATTACGTATAGTATTTGCTATCATACATATATATCGATGCGTTCAT"	3 hours
2. **Complementing DNA** Write a program that will print the complement of this sequence. "ACTGATCGATTACGTATAGTATTTGCTATCATACATATATATCGATGCGTTCAT"	3 hours
3. **Restriction fragment lengths** Write a program which will calculate the size of the two fragments that will be produced when the DNA sequence is digested with EcoRI. "ACTGATCGATTACGTATAGTAGAATTCTATCATACATATATATCGATGCGTTCAT " The sequence contains a recognition site for the EcoRI restriction enzyme, which cuts at the motif G*AATTC (the position of the cut is indicated by an asterisk).	3 hours
4. **Splicing out introns**	3 hours

Here's a short section of genomic DNA:
“ATCGATCGATCGATCGACTGACTAGTCATAGCTATGCATGTAGCTACTC
GATCG
ATCGATCGATCGATCGATCGATCGATCGATCATGCTATCATCGATCGAT
ATCGA TGCATCGACT ACTAT”

It comprises two exons and an intron. The first exon runs from the start of the sequence to the sixty-third character, and the second exon runs from the ninety- first character to the end of the sequence. Write a program that will print just the coding regions of the DNA sequence.

5.

Writing a FASTA file

Write a program that will create a FASTA file for the following three sequences – make sure that all sequences are in upper case and only contain the bases A, T, G and C.

Sequence header	**DNA sequence**
ABC123	ATCGTACGATCGATCGATCGCTAGACGTATCG
DEF456	actgatcgacgatcgatcgatcacgact
HIJ789	ACTGAC-ACTGT--ACTGTA----CATGTG

3 hours

6.

Splitting genomic DNA

Write a program that will split the genomic DNA into coding and non-coding parts, and write these sequences to two separate files.

3 hours

7.

Processing DNA in a file

The file *input.txt* contains a number of DNA sequences, one per line. Each sequence starts with the same 14 base pair fragment – a sequencing adapter that should have been removed. Write a program that will (a) trim this adapter and write the cleaned sequences to a new file and (b) print the length of each sequence to the screen.

3 hours

8.

Percentage of amino acid residues

3 hours

Write a function that takes two arguments – a protein sequence and an amino acid residue code – and returns the percentage of the protein that the amino acid makes up. Use the following assertions to test your function: assert my_function("MSRSLLLRFLLFLLLLPPLP", "M") == 5 assert my_function("MSRSLLLRFLLFLLLLPPLP", "r") == 10 assert my_function("MSRSLLLRFLLFLLLLPPLP", "L") == 50 assert my_function("MSRSLLLRFLLFLLLLPPLP", "Y") == 0	
9. **Identifying and Extracting Sequence Motifs** - Using Python's re module, write a regular expression that can identify all occurrences of the motif "GATC" (case- insensitive) within the DNA sequence "AGCTAGATCGAATCGATC".	3 hours
10. **Biopython module** - Reading sequence files using Bio.SeqIO.parse(), Nucleotide sequences and (reverse) complements, Transcription and Translation	3 hours
Total Laboratory Hours:	**30 hours**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Presentaion	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT613	Food Process Technology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand the conventional and non-conventional methods of food processing. Gain knowledge of basic and advanced food packaging techniques
2. Comprehend the steps and considerations in food product development. Explore emerging and innovative technologies in food processing
3. Introduce concepts of food quality control and safety standards at national and international levels

Course Outcomes

1. Apply concepts of biotechnology to understand and improve food processing techniques
2. Analyze the scope and potential of various food processing operations across the industry
3. Explain the scientific principles underlying conventional and emerging food processing methods
4. Evaluate food preservation techniques for maintaining quality, safety, and shelf life, Design innovative food products using modern processing and packaging technologies

Module:1	Methods of Food Processing	10 hours

Overview of the food processing industry: potential, scope, and relevance; Principles and salient features of food processing methods; Thermal processing: blanching, pasteurization, sterilization (canning and bottling), evaporation, extrusion, dehydration, spray drying, dielectric and infrared heating; Non-thermal processing: chilling, refrigeration, freezing, freeze drying, minimal processing, vacuum cooling, and fermentation.

Module:2	Advanced and Emerging Technologies in Food Processing	8 hours

High Pressure Processing (HPP) of foods; Enzyme-assisted food processing; Pulsed Electric Field (PEF) technology; Food irradiation: principles and processes; Introduction to nanotechnology in food processing.

Module:3	Packaging Science for Processed Foods	8 hours

Scope and role of the packaging industry in food processing; Traditional and modern packaging materials and technologies; Case study: Nano-packaging applications in food; Interaction of packaging with food quality and shelf life**.**

Module:4	Food Product Development and Commercialization	8 hours

Overview and stages of food product development : concept, formulation, and design; Sensory evaluation and consumer testing' Shelf-life assessment methods' Strategies for commercialization of new food products; Regulatory and market considerations.		
Module:5	**Food Quality Assurance and Safety Management**	**9 hours**
Principles and practices of quality control in food processing; National and international food safety regulations: FSSAI, HACCP, ISO 22000; Safety evaluation of food-related nanomaterials (Case Study).		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

Kapoor, S., by Kaur, G., Dar, B. N., & Sharma, S.,, "**Emerging Techniques for Food Processing and Preservation,**", CRC Press, Boca Raton, Florida, USA., 1st Edition, **2024**

Goyal, M. R., Mishra, S. K., & Birwal, P., "**Food Processing and Preservation Technology: Advances, Methods, and Applications,**", Apple Academic Press, Oakville, Ontario, Canada., 1st Edition, **2022**

Reference Books

1. Birwal, P., Goyal, M. R., & Sharma M, "**Handbook of Research on Food Processing and Preservation Technologies: Volume 2 – Nonthermal Food Preservation and Novel Processing Strategies,**", Apple Academic Press, Oakville, Ontario, Canada., 1st Edition, **2021**
2. Shafiur R. M.,, "**Handbook of Food Preservation**", CRC Press, Boca Raton, Florida, USA., 3rd Edition, **2020**

Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar

Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT614	Natural Product Technology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Explain the importance of natural products
2. Learn the chemical and biological synthesis of metabolites
3. Demonstrate drug discovery and development

Course Outcomes

1. Demonstrate key concepts related to the classification, collection and processing of natural products from different organisms
2. Develop detailed knowledge about the chemistry of medicinal compounds of natural origin
3. Relate the processing, extraction and purification of different kinds of natural products
4. Relate the sustainable usage of bio resources and their natural products for the welfare of mankind

Module:1	Bioprospecting of Natural Products	7 hours

Bioprospecting of natural products: Definition; approaches for bioprospecting: Indigenous knowledge, Phylogenetic approach, Ecological knowledge and Evolutionary rationale-based searches-case study.

Module:2	Classification and Processing Methods	8 hours

Classification of natural products; Collection methods; processing methods; extraction methods; purification methods and concentration.

Module:3	Secondary Metabolites	12 hours

Chemistry, biosynthesis and types of various secondary metabolites, alkaloids, essential oils; Natural products from marine and microbial sources; Poisonous plants sources and toxic manifestations of poisonous plants.

Module:4	Pigments and Natural Dyes	8 hours

History, Importance; Chemistry and types; Dye extraction and fabric dye process; Application of Technology for producing natural dyes and colourants.

Module:5	Herbal Products and Indigenous Medicine	8 hours

Herbal Products and Indigenous Medicine; Siddha, Ayurveda, Unani; Study of different traditional medicine: Conservation, sustainable utilization.

Module:6	Contemporary Topics	2 hours

Guest lectures

Total Lecture Hours:	**45 hours**
Text Book(s)	
Juliana M. Prado, Mauricio A. Rostagno, "**Natural Product Extraction: Principles and Applications**", Royal Society of Chemistry, 2nd Edition, **2022** Iris F.G. Benzie, Sissi Wachtel-Galor, "**Herbal Medicine: Biomolecular and Clinical Aspects**", CRC Press, 3rd Edition, **2022**	
Reference Books	
Ahmed Al-Harrasi, Shakeel Ahmed, Salim Al-Rejaibi, "**Recent Advances in Natural Products Science**", Elsevier, 1st Edition, **2023** Ajay Sharma and Anil Kumar Sharma, "**Plant Secondary Metabolites: Physico-Chemical Properties and Therapeutic Applications**", Springer, 1st Edition, **2022**	
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025

Course Code	Course Title	L	T	P	C
MABIT615	Environmental Biotechnology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Understand the basis of microbial metabolism of environmental contaminants
2. Analyze environmental pollution and develop suitable technologies to address these problems
3. Apply scientific concepts to environmental problems and their correlation with technological concepts

Course Outcomes

1. Examine the sources and impacts of environmental pollutants
2. Apply interdisciplinary approaches including chemistry, biochemistry, molecular biology, and microbiology to understand and address environmental issues, exploring resources for new technologies
3. Outline biological treatment processes and develop suitable technologies for environmental applications
4. Explain microbial processes and growth requirements underlying activated sludge, nitrification, denitrification, enhanced phosphorus removal, Demonstrate the role of microorganisms in biofilm formation, mineral leaching, and biodegradation, examining their potential in environmental remediaand anaerobic digestion, and evaluate alternative process schemes for combined biological nutrient removal

Module:1	Sources and Treatments of Various Pollutants	8 hours

Classification and sources of pollutants: organic, inorganic, emerging contaminants; Functional role of microorganisms in pollutant degradation; Environmental degradation: Loss of biodiversity, population explosion and energy demands; Microbial redox reaction in pollutant degradation.

Module:2	Conventional Methods Used in Waste Water Management	9 hours

Introduction to waste water management; Stages of waste water treatment; Bioreactors: Types, design and operation; Bioscrubbers; Biofilters; Case studies for odor removal from municipal waste waters and sulphurous emissions; Eutrophication; Role of microorganisms in wastewater treatment, bioremediation and biogeochemical cycling; In-situ and ex-situ remediation, Phytoremediation and Rhizoremediation.

Module:3	Bioreactors Based Degradation and Remediation by Micro and Macro-organism	9 hours

Bioreactor types: Solid-state bioreactors, Aerated/mixed/anaerobic - Types, operation and optimization; Landfill and composting; Mineral and metal extraction

biotechnology; Culture media used in environmental biotechnology; Batch and continuous culture; Effects of environmental factors on growth; Aquaculture treatment: Water hyacinth & wetland system, evapo-transpiration system; Bioremediation of metal pollutants; Biogas production.		
Module:4	**Biofilm based Remediation Technologies**	**9 hours**
Aerobic and anoxic suspended growth biotechnologies: Conventional/high rate activated sludge system, Powder activated and Carrier activated sludge process; Nitrification/ PHOSTRIP process; Vertical and attached growth technologies; Trickling/denitrification RBC/FBR/PBR and hybrid systems; Control of microbes using physical and chemical methods; Biofilm modelling and mass transfer.		
Module:5	**Recent Molecular Tools involved in Remediation**	**8 hours**
Biotechnological tools in environment; Living organisms as indicators of pollution; Molecular analysis of microbial community; Sequence and function-based screening of metagenomics libraries; Community Transcriptomics and Metaproteomics; Catalytic evolutionary engineering; Environmental biosensors: real time pollutant detection and bioreactor optimization; CRISPR-Cas and synthetic biology for pollutant degradation; Molecular techniques for monitoring pollutants.		
Module:6	**Contemporary Topics**	**2 hours**
	Total Lecture Hours:	**45 hours**
Text Book(s)		
Mondal, S., Singh, S. P., & Lahir, Y. K., "**Emerging Trends in Environmental Biotechnology**", CRC Press, 1st Edition, **2022** Sibi, G., "**Environmental Biotechnology: Fundamentals to Modern Techniques**", CRC Press, 1st Edition, **2022**		
Reference Books		
Rittmann, B.E. and McCarty, P.L., "**Environmental biotechnology: principles and applications**", Tata McGraw-Hill Education, 2nd Edition, **2020** Evans, G.M. and Furlong, J.C., "**Environmental biotechnology: theory and application**", IK International Pvt Ltd., 1st Edition, **2003**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT616	Aquatic Biotechnology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Enhance understanding of aquatic ecosystems, biodiversity, taxonomy and tools/techniques to study them.
2. Realize the biotechnological significance of aquatic organisms and investigate their potential for human benefit.
3. Cultivate students' skills to enable them to secure employment, engage in research, and launch businesses in the field of aquatic biotechnology.

Course Outcomes

1. Recognize the significance, potential, and limitations within the field of aquatic biotechnology.
2. Differentiate between diverse aquatic ecosystems based on their unique characteristics and biodiversity.
3. Apply essential technical skills in aquatic sampling, isolation, and classification (taxonomy).
4. Explain the nature of aquatic pathogenic microbes and various strategies for disease diagnosis and prevention.

Module:1	Scope and Challenges in Blue Biotechnology	6 hours

Origin and scope; Genetic, species and molecular diversity; Regulating Marine Bioresources and Sample collection; Global and Indian scenario; Policy Frameworks for International and Indian Marine Biotechnology; Demand and valuation of marine bioproducts; Bioeconomy and socio-economics; Entrepreneurship; Marine biotechnology parks in India; R&D institutions, centers, and consultation services.

Module:2	Aquatic Ecosystems	8 hours

Biogeographic zones; Sediments and Surfaces; Benthic and Pelagic Zone; Photic, dysphotic and aphotic zones; Coastal, open ocean and sea floor habitats; Intertidal; Sandy shores; Rocky shores; Mudflats; Mangrove; salt marshes.

Module:3	Sampling, Biological Resources and Taxonomy	9 hours

Sampling devices; Conventional and advanced devices; Sample processors; Sensors; Microbial isolation; Cultivation and optimization; Taxonomy by traditional methods; Techniques in metagenomics.

Module:4	Aquatic microbial pathogens	8 hours

Microbial pathogens in the aquatic environment – Microbial pathogens of captured and cultured edible aquatic organisms; Risk assessment process; Strategies for

disease prevention and control; Pathogens of recreational sites - diversity, sources, and detection; Indicator organisms; WHO guidelines.		
Module:5	**Aquatic microbes for bioprospecting**	**12 hours**
Drugs and pharmaceuticals; Aquaculture and fisheries biotechnology; Biofuels and bioenergy, Bioremediation, Biofouling; Cosmetics-cosmeceuticals; algotherapy; Thalassotherapy; Enzymes; Food and Supplements; Nutrition and energy drinks; Fish feed, manure, and fertilizers.		
Module:6	**Contemporary Topics**	**2 hours**
Guest lecture on Contemporary Topics		
	Total Lecture Hours:	**45 hours**
Text Book(s)		
Joël Fleurence, "**Aquatic Biotechnologies: From Genetic Engineering to Enzymatic or Fermentation Engineering**", Wiley Publishers USA, 1st Edition, **2024** Se-Kwon Kim, "**Essentials of marine biotechnology**", Springer Publications Switzerland, 1st Edition, **2020**		
Reference Books		
Colin Munn, "**Marine Microbiology Ecology & Applications**", CRC Press USA, 3rd Edition, **2020** Se-Kwon Kim, "**Hand book of marine biotechnology**", Springer Publications USA, 1st Edition, **2015**		
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation		
Recommended by Board of Studies :	26-05-2025	
Approved by Academic Council : No. 78	12-06-2025	

Course Code	Course Title	L	T	P	C
MABIT617	Microbial Biotechnology	3	0	0	3
Pre-requisite	NIL	Syllabus Version			
		1			

Course Objectives

1. Impart the knowledge of industrially important microbes and microbial products
2. Explore bioprocesses, industrial production of various metabolites using microbial cells
3. Impart the knowledge of the mechanistic features of the cells and microbes to use them as a tool for various applications related to human health and environment

Course Outcomes

1. Understand the importance of microbes and contemporary issues
2. Demonstrate the microbial metabolites having industrial applications
3. Solve the current problems related to antibiotics, vaccines and anticancer drugs
4. Analyze the techniques, modern engineering tools for large-scale production of enzymes, recombinant products, food additives and biofuels

Module:1	Microbes of industrial interest and their medical products	10 hours

Industrially important microbes: Yeast (Saccharomyces cerevisiae, Yarrowia lipolytica), Bacteria (Bacillus spp., Lactobacillus spp., Xanthomonas campestris), Algae (Spirulina); Single cell protein (SCP); Primary and secondary metabolites: Antibiotics (Penicillin, Cephalosporin, Tetracyclines and antimicrobial peptides); Vaccine (TT, DPT, BCG and anticancer compounds).

Module:2	Microbial enzymes and recombinant products	10 hours

General aspects of enzyme production and strain improvement; Industrial scale production of Protease, Lipase, Cellulase, Pectinase, Amylase; Production of Insulin and Growth hormones; Recombinant enzymes and vaccine production.

Module:3	Food additives	9 hours

Organic acid Production: Acetic acid, Gluconic acid, Lactic acid; Amino acid production: Lysine and Glutamic acid; Vitamin Production: Pantothenic acid, Riboflavin, Vitamin B12, Ascorbic acid.

Module:4	Biofuels	6 hours

Production of Bioethanol, Biobutanol, Biodiesel, Biohydrogen, Methane production.

Module:5	Other Microbial products	8 hours

Biofertilizers; Bioinsecticides; Biofungicides; Biopolymers; Biosurfactants; Microbial pigments.

Module:6	Contemporary Topics	2 hours

Contemporary Topics	
Total Lecture Hours:	**45 hours**
Text Book(s)	
Yuan Kun Lee (Edited), "**Microbial Biotechnology: Principles and Applications**", World Scientific Publishing Company, 3rd Edition, **2015** Ashish Vyas, Joginder Singh, Ram Prasad, Shanquan Wang, "**Microbial Biotechnology: Basic Research and Applications (Environmental and Microbial Biotechnology)**", Springer, 1st Edition, **2020**	
Reference Books	
Frans J. de Bruijn, Hauke Smidt, Luca S. Cocolin, Michael Sauer, David N. Dowling, Linda Thomashow (Edited), "**Good Microbes in Medicine, Food Production, Biotechnology, Bioremediation, and Agriculture**", John Wiley and Sons, 1st Edition, **2022** Mumtaz Anwar, Riyaz Ahmad Rather, Zeenat Farooq (Edited), "**Fundamentals and Advances in Medical Biotechnology**", Springer Nature, 1st Edition, **2022**	
Mode of Evaluation : Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test, Seminar, Group Discussion, Presentation	
Recommended by Board of Studies :	26-05-2025
Approved by Academic Council : No. 78	12-06-2025