THE APOLLO UNIVERSITY

Murukambattu, Chittoor (Dt) 517127, Andhra Pradesh
School of Health Sciences | Department of Biomedical Sciences

M.Sc. Medical Biotechnology

(M.Sc. MBT) – 2-Year Programme

Outcome-Based Education (OBE) Curriculum

Course Structure and Syllabi

Regulations R-26 | w.e.f. 2026-27 admitted batch

Prepared in the format required for NAAC accreditation and the UGC Credit Framework (CBCS / NEP-aligned)



PART A: PROGRAMME PROFILE

A1. Vision of the School

To be a global leader in health sciences education, research, and innovation, fostering interdisciplinary excellence to advance healthcare, improve patient outcomes, and address global health challenges through cutting-edge knowledge and technology.

A2. Mission of the School

- To excel in interdisciplinary education, pioneering research, skill development, and technology-driven healthcare solutions.
- To foster global collaboration, community engagement, and lifelong learning that advance health sciences and improve patient outcomes.

A3. Preamble

Biotechnology is an interdisciplinary field that combines the principles of biology, chemistry, and engineering to develop innovative solutions for the diagnosis, prevention, and treatment of diseases. By harnessing the power of biological systems, medical biotechnology has revolutionized healthcare delivery, enabling targeted therapies, precision medicine, advanced diagnostics, and novel therapeutic modalities. The M.Sc. Medical Biotechnology programme is designed to provide comprehensive postgraduate training in cellular and molecular biology, genetic engineering, immunology, bioprocess engineering, nanobiotechnology, and digital health analytics.

A4. Key Highlights & Healthcare Breakthroughs Supported

- Gene therapy for inherited disorders such as Severe Combined Immunodeficiency (SCID).
- Targeted therapies for cancer, such as Herceptin for breast cancer and CAR-T cell immunotherapy.
- Next-generation vaccines for infectious diseases including HPV, Hepatitis B, and mRNA vaccine platforms.
- Personalized medicine approaches tailoring treatment strategies to individual genomic profiles.
- Development of advanced medical diagnostic platforms, biosensors, and therapeutic devices.

A5. Program Profile, Eligibility, and Market Demand

Item	Provision / Details
Programme Title	M.Sc. Medical Biotechnology
Degree Level	Postgraduate (2 Years / 4 Semesters)
Regulations	R-26 (w.e.f. 2026–27 admitted batch)
Department / School	Department of Biomedical Sciences, School of Health Sciences

Eligibility	Bachelor's degree in any branch of Life Sciences/Technology (Botany, Zoology, Microbiology, Biochemistry, Biotechnology, Genetics, Agriculture or equivalent) or Health/Medical Sciences (Medicine, Dental, Nursing, Pharmacy, Allied Health Sciences, Veterinary or equivalent). Graduates in Physical/Chemical Sciences eligible if Biology was taken at +2 level.
Maximum Intake	40 seats per batch
Regional Demand Ratio	1:25 (One PG seat for every 25 UG Life Sciences graduates within 300 km radius)
Career Opportunities	Medical Laboratories, Research Centers, Biomedical/Clinical Labs, Biotech & Pharma R&D, Regulatory Affairs, Academia
Indicative Salary Range	INR 60,000 to 1,00,000 per month (INR 7.2 to 12.0 Lakhs per annum)

A6. Market Gap-Need Analysis & Global Trends

A comprehensive industry gap-need analysis reveals strong global and regional demand for medical biotechnology postgraduates equipped with modern interdisciplinary skills:

- Biopharmaceutical & Therapeutics Growth: Biologics represent over 20% of the global pharma market, projected to reach $500 billion by 2030, driving huge demand for skilled bioprocess and cell therapy experts.
- Advanced Molecular Techniques Gap: High industry demand for hands-on expertise in CRISPR gene editing, Next-Generation Sequencing (NGS), and single-cell omics.
- Regulatory & Quality Control Science: Rigorous approval processes require graduates trained in GLP, GMP, GCP, CDSCO, FDA, and ICH regulatory compliance.
- AI & Computational Integration: Growing need for professionals bridging molecular diagnostics with bioinformatics, AI in healthcare, and big data analytics.

PART B: PROGRAMME OBJECTIVES & OUTCOMES (OBE FRAMEWORK)

B1. Program Objectives (POs)

ID	Program Objective	Description
PO1	In-depth Knowledge	Develop a thorough understanding of medical biotechnology, including its applications in diagnostics, therapeutics, and drug development.
PO2	Research and Innovation	Foster research skills and innovation by engaging in cutting-edge research in biotechnology and its allied fields.
PO3	Clinical and Ethical Insight	Provide knowledge of clinical applications and emphasize ethical considerations in biotechnology and health sciences.
PO4	Industry Preparedness	Equip students with the necessary skills and knowledge to meet the demands of the biotechnology and healthcare industry.
PO5	Problem Solving & Analytics	Enhance problem-solving and critical thinking skills for addressing complex issues in biotechnology.

B2. Program Outcomes (POEs)

ID	Program Outcome	Description
POE1	Technical Expertise	Acquire expertise in key areas of biotechnology such as molecular biology, genomics, bioinformatics, and therapeutic biotechnology.
POE2	Research Skills	Ability to design, conduct, and analyze biomedical experiments, interpreting results accurately.
POE3	Industry Readiness	Preparedness for various roles in biotechnology industries, such as research and development, quality control, and regulatory affairs.
POE4	Bioethics & Regulations	Understand and apply ethical principles and regulatory guidelines in research and biotechnological applications.
POE5	Communication Skills	Ability to effectively communicate scientific findings and research outcomes to both scientific and non-scientific communities.

POE6	Continual Learning	Recognize the importance of lifelong learning in biotechnology and allied sciences, staying updated with emerging technologies and trends.

PART C: CREDIT FRAMEWORK AND OBE RULES

C1. Credit Norms (UGC & University Framework)

Mode of Instruction	Contact Hours / Week	Credits	Hours per Semester (15 Weeks)
Lecture (L)	1 hour	1 credit	15 hours
Tutorial (T)	1 hour	1 credit	15 hours
Practical (P)	2 hours	1 credit	30 hours
Laboratory Course (4 hrs/wk)	4 hours	2 credits	60 hours
Mini-Project (Sem III)	8 hours	4 credits	120 hours
Project / Dissertation (Sem IV)	32 hours	16 credits	480 hours

C2. Semester Credit Summary

Semester	Theory Courses	Lab / Project Courses	Total Credits	Weekly Hours
Semester I	5 Theory (20 credits)	2 Labs (4 credits)	24 Credits	36 Hours
Semester II	5 Theory (20 credits)	2 Labs (4 credits)	24 Credits	36 Hours
Semester III	5 Theory / Electives (20 credits)	1 Mini-Project (4 credits)	24 Credits	36 Hours
Semester IV	2 NPTEL/SWAYAM (4 credits)	1 Major Project (16 credits)	20 Credits	36 Hours
Total Programme	17 Theory / Elective Courses	5 Labs & 2 Research Projects	92 Credits	144 Hours

C3. Examination and Evaluation Scheme

The evaluation scheme comprises Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) to assess knowledge, technical competence, and practical expertise:

- Theory Courses (100 Marks Total): Internal Assessment = 40 Marks (Mid Exam = 20, Assignments = 10, Seminars/Quizzes = 10); External University Examination = 60 Marks.
- Practical Laboratory Courses (100 Marks Total): Internal Continuous Assessment = 80 Marks (Skills, Safety, Attendance, Lab Reports, Practical Assessment); External Practical Examination = 20 Marks.
- Semester IV Project / Dissertation (300 Marks Total): Internal Evaluation = 240 Marks; External Evaluation & Viva-Voce = 60 Marks.

PART D: SEMESTER-WISE COURSE STRUCTURE

Semester I

Code	Course Name	L	T	P	C	Hours	Category
MBTT6501	Cell and Molecular Biology	3	1	0	4	4	Core
MBTT6502	Biochemistry and Metabolism	3	1	0	4	4	Core
MBTT6503	Microbiology and Immunology	3	1	0	4	4	Core
MBTT6504	Bioanalytical Techniques	3	1	0	4	4	Core
MBTT6505	Biostatistics and Bioinformatics	3	1	0	4	4	Core
MBTL6501	Techniques in Cell Biology & Biochemistry Lab	0	0	4	2	4	Laboratory
MBTL6502	Microbiology and Immunology Lab	0	0	4	2	4	Laboratory
Non-Credit	Technical Seminar, Physical Activity, Extra-curricular, Journal Club & Publication Writing	0	0	0	0	8	Audit / Skill
	TOTAL	15	5	8	24	36	

Semester II

Code	Course Name	L	T	P	C	Hours	Category
MBTT6506	Genetic Engineering and Recombinant DNA Technology	3	1	0	4	4	Core
MBTT6507	Animal Tissue Culture & Stem Cell Biology	3	1	0	4	4	Core
MBTT6508	Bioprocess Engineering and Fermentation Technology	3	1	0	4	4	Core
MBTT6509	Environmental and Marine Biotechnology	3	1	0	4	4	Core
MBTT6510	Plant and Animal Biotechnology	3	1	0	4	4	Core
MBTL6503	Genetic Engineering Laboratory	0	0	4	2	4	Laboratory
MBTL6504	Bioprocess Engineering Laboratory	0	0	4	2	4	Laboratory
Non-Credit	Technical Seminar, Physical Activity, Extra-curricular, Journal Club & Publication Writing	0	0	0	0	8	Audit / Skill
	TOTAL	15	5	8	24	36	

Semester III

Code	Course Name	L	T	P	C	Hours	Category
MBTT7511	Nanobiotechnology	3	1	0	4	4	Core
MBTT7512	Pharmaceutical Biotechnology & Molecular Diagnostics	3	1	0	4	4	Core
MBTT7513	Biomedical Instrumentation	3	1	0	4	4	Core
MBTT7601	Program Elective I (Select from Basket 1)	3	1	0	4	4	Elective
MBTT7602	Program Elective II (Select from Basket 2)	3	1	0	4	4	Elective

MBTP7501	Mini-Project	0	0	8	4	8	Research Project
Non-Credit	Technical Seminar, Physical Activity, Extra-curricular, Journal Club & Publication Writing	0	0	0	0	8	Audit / Skill
	TOTAL	15	5	8	24	36	

Semester IV

Code	Course Name	L	T	P	C	Hours	Category
MBTT7514	Research Methodology (NPTEL / SWAYAM)	2	0	0	2	2	MOOC / Core
MBTT7515	Intellectual Property Rights (NPTEL / SWAYAM)	2	0	0	2	2	MOOC / Core
MBTP7502	Project Work / Dissertation (Major Research Project)	0	0	32	16	32	Research Project
	TOTAL	4	0	32	20	36	

Program Elective Baskets

Basket	Code	Course Name	Credits
Program Elective I	MBTT7601A	Cancer Biology	4 Credits
Program Elective I	MBTT7601B	Molecular Modelling and Drug Designing	4 Credits
Program Elective I	MBTT7601C	Quality Control & Quality Assurance in Biotechnology	4 Credits
Program Elective II	MBTT7602A	AI in Healthcare	4 Credits
Program Elective II	MBTT7602B	Systems Biology	4 Credits
Program Elective II	MBTT7602C	Protein Engineering	4 Credits

PART E: COURSE SYLLABI (OBE FORMAT)

MBTT6501: Cell and Molecular Biology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester I	Core Course

Course Description

This course provides an advanced understanding of the structural and functional organization of cells and the molecular mechanisms governing cellular processes. It explores cellular architecture, genome organization, gene regulation, intracellular signaling, stem cell biology, and emerging molecular biology techniques that support biotechnology and biomedical research.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Cellular Organization and Biomembranes: Evolution of prokaryotic and eukaryotic cells; ultrastructure and functions of cellular organelles; plasma membrane organization and transport mechanisms; cytoskeleton and extracellular matrix; intracellular trafficking, endocytosis and exocytosis.	12 Hrs
2	Genome Organization and Cell Cycle: Organization of prokaryotic and eukaryotic genomes; chromatin structure and chromosome organization; DNA replication and repair; molecular regulation of the cell cycle; mitosis, meiosis and cell cycle checkpoints.	12 Hrs
3	Gene Expression and Regulation: Transcription and RNA processing; translation and post-translational modifications; regulation of gene expression through transcription factors, operons and epigenetic mechanisms; non-coding RNAs, RNA interference and gene silencing.	12 Hrs
4	Cell Communication and Signal Transduction: Principles of cell signaling; receptor-mediated signaling and second messengers; GPCR, receptor tyrosine kinase, MAPK, PI3K-Akt, Wnt and Notch pathways; regulation of cell proliferation, differentiation, apoptosis and molecular basis of cancer.	12 Hrs
5	Stem Cell Biology and Advanced Molecular Techniques: Stem cell types and cellular differentiation; apoptosis and autophagy; CRISPR-Cas genome editing; recombinant DNA technology; transcriptomics, proteomics and single-cell technologies; applications in biotechnology and precision medicine.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the structure and function of cells, organelles and biological membranes.
- **CO2:** Analyze genome organization, DNA replication, repair mechanisms and cell cycle regulation.
- **CO3:** Interpret the molecular mechanisms controlling gene expression and its regulation.
- **CO4:** Evaluate major cell signaling pathways and their significance in normal physiology and disease.
- **CO5:** Apply modern molecular biology techniques and genome editing technologies in biotechnology research.

Recommended Text & Reference Books

- Alberts, B., et al. (2022). Molecular Biology of the Cell (7th Edition). W.W. Norton & Company.
- Lodish, H., et al. (2021). Molecular Cell Biology (9th Edition). W.H. Freeman and Company.
- Karp, G. (2019). Cell and Molecular Biology: Concepts and Experiments (9th Edition). Wiley.

MBTT6502: Biochemistry and Metabolism

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester I	Core Course

Course Description

This course provides an advanced understanding of the structure, properties, and functions of biomolecules; the principles of enzyme catalysis; metabolic pathways; and bioenergetics. It emphasizes enzyme kinetics, metabolic regulation, and the applications of enzymes in biotechnology, industrial processes, diagnostics, and synthetic biology.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Biomolecules and Protein Structure: Structure, classification and biological significance of carbohydrates, lipids, proteins and nucleic acids; amino acids and peptide bonds; primary, secondary, tertiary and quaternary structure of proteins; protein folding and stability; membrane proteins; protein-ligand interactions; protein purification and characterization.	12 Hrs
2	Enzyme Structure, Function and Kinetics: Classification and nomenclature of enzymes; active site and catalytic mechanisms; enzyme specificity; Michaelis-Menten kinetics; enzyme inhibition; allosteric enzymes; cofactors, coenzymes and prosthetic groups; regulation of enzyme activity; isoenzymes and ribozymes.	12 Hrs
3	Metabolism and Metabolic Regulation: Glycolysis; gluconeogenesis; tricarboxylic acid (TCA) cycle; pentose phosphate pathway; glycogen metabolism; lipid metabolism and β-oxidation; amino acid and nucleotide metabolism; metabolic integration; hormonal regulation of metabolism; metabolic disorders.	12 Hrs
4	Bioenergetics and Biological Oxidation: Principles of bioenergetics and thermodynamics; ATP synthesis and energy transfer; electron transport chain; oxidative phosphorylation; chemiosmotic theory; reactive oxygen species; antioxidant defense systems; mitochondrial function.	12 Hrs
5	Applied Enzymology: Enzyme immobilization techniques; enzyme engineering and directed evolution; industrial enzymes and their applications; clinical enzymology; enzyme-based biosensors and diagnostics; biocatalysis in pharmaceutical and food industries; synthetic biology.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the structure, properties and biological functions of major biomolecules.
- **CO2:** Analyze enzyme structure, catalytic mechanisms, kinetics and regulatory processes.
- **CO3:** Interpret metabolic pathways and their regulation under physiological conditions.
- **CO4:** Evaluate the principles of bioenergetics, biological oxidation and energy metabolism.
- **CO5:** Apply enzymology concepts and modern enzyme technologies in biotechnology and industry.

Recommended Text & Reference Books

- Nelson, D. L., & Cox, M. M. (2021). Lehninger Principles of Biochemistry (8th Edition). W.H. Freeman.
- Voet, D., Voet, J. G., & Pratt, C. W. (2019). Fundamentals of Biochemistry. Wiley.

MBTT6503: Microbiology and Immunology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester I	Core Course

Course Description

This course provides a comprehensive understanding of microbial diversity, microbial physiology and genetics, host–pathogen interactions, immune mechanisms, immunopathology, and modern immunological techniques. It emphasizes the applications of microbiology and immunology in biotechnology, diagnostics, vaccine development, and therapeutic interventions.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Microbial Diversity: Classification and taxonomy of microorganisms; morphology and ultrastructure of bacteria, archaea, fungi, viruses, algae and protozoa; microbial nutrition and growth requirements; microbial growth kinetics; cultivation and preservation techniques; extremophiles.	12 Hrs
2	Microbial Genetics and Pathogenesis: Microbial genome organization; mutation, recombination and DNA repair; plasmids, transposons and bacteriophages; horizontal gene transfer; pathogenic microorganisms and virulence factors; host–pathogen interactions; antimicrobial agents and drug resistance.	12 Hrs
3	Fundamentals of Immunology: Organization of the immune system; cells and organs of innate and adaptive immunity; antigens and antibodies; major histocompatibility complex (MHC); cytokines and chemokines; complement system; inflammation and immune regulation.	12 Hrs
4	Immune Responses and Immunopathology: Antigen-antibody interactions; humoral and cell-mediated immune responses; hypersensitivity reactions; autoimmune diseases; transplantation immunology; immunodeficiency disorders; tumor immunology; immune evasion by pathogens.	12 Hrs
5	Immunotechnology and Therapeutics: Monoclonal antibody production; ELISA, Western blotting, immunofluorescence and flow cytometry; vaccine development and recombinant vaccines; therapeutic antibodies; CAR-T cell therapy; immunodiagnostics and precision medicine.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the diversity, classification and physiology of microorganisms.
- **CO2:** Analyze microbial genetics, pathogenic mechanisms and antimicrobial resistance.
- **CO3:** Describe the organization and functioning of innate and adaptive immune systems.
- **CO4:** Evaluate immune responses, immunopathological disorders and host-pathogen interactions.
- **CO5:** Apply immunological techniques and therapeutic approaches in diagnostics and biomedical research.

Recommended Text & Reference Books

- Madigan, M. T., et al. (2021). Brock Biology of Microorganisms (16th Edition). Pearson.
- Murphy, K., & Weaver, C. (2022). Janeway's Immunobiology (10th Edition). W.W. Norton.
- Abbas, A. K., et al. (2024). Cellular and Molecular Immunology (11th Edition). Elsevier.

MBTT6504: Bioanalytical Techniques

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester I	Core Course

Course Description

This course provides comprehensive knowledge of modern analytical techniques and instrumentation used in biotechnology, molecular biology, pharmaceutical sciences, proteomics, metabolomics, and biomedical research. It emphasizes the principles, instrumentation, applications, and interpretation of analytical data for biological systems.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Spectroscopic Techniques: Principles and instrumentation of UV-Visible spectroscopy, fluorescence spectroscopy, infrared (IR) spectroscopy, Raman spectroscopy, circular dichroism (CD), atomic absorption spectroscopy (AAS), FRET, sample preparation and biological applications.	12 Hrs
2	Separation Techniques: Principles of chromatography; paper, TLC, ion-exchange, affinity, gel filtration, gas chromatography (GC), high-performance liquid chromatography (HPLC), liquid chromatography-mass spectrometry (LC-MS), method optimization.	12 Hrs
3	Electrophoretic and Molecular Separation Techniques: Principles of electrophoresis; agarose gel electrophoresis, PAGE and SDS-PAGE, 2D-PAGE, isoelectric focusing, capillary electrophoresis, pulsed-field gel electrophoresis, blotting techniques.	12 Hrs
4	Microscopy and Imaging Techniques: Principles of light microscopy; fluorescence and confocal microscopy; transmission electron microscopy (TEM); scanning electron microscopy (SEM); atomic force microscopy (AFM); live-cell imaging, digital image analysis.	12 Hrs
5	Structural and Advanced Analytical Techniques: Principles and applications of mass spectrometry, MALDI-TOF, NMR spectroscopy, X-ray crystallography, cryo-EM, biosensors, surface plasmon resonance (SPR), applications in genomics and drug discovery.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles and applications of major spectroscopic techniques used in biological research.
- **CO2:** Apply chromatographic and electrophoretic methods for the separation and analysis of biomolecules.
- **CO3:** Interpret data obtained from microscopy and imaging techniques for biological investigations.
- **CO4:** Evaluate advanced structural and analytical techniques for biomolecular characterization.
- **CO5:** Select appropriate bioanalytical techniques for research, diagnostics and biopharma.

Recommended Text & Reference Books

- Wilson, K., & Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology (8th Edition). Cambridge Univ Press.
- Skoog, D. A., et al. (2017). Principles of Instrumental Analysis (7th Edition). Cengage.

MBTT6505: Biostatistics and Bioinformatics

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester I	Core Course

Course Description

This course introduces statistical methods and computational tools for the analysis of biological data. It covers biostatistics, biological databases, sequence analysis, genomics, structural bioinformatics, computational drug discovery, and systems biology with applications in biotechnology, biomedical research, and precision medicine.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Biostatistics: Types of biological data; measures of central tendency and dispersion; probability distributions; hypothesis testing; correlation and regression; chi-square test, t-test and ANOVA; experimental design; sampling methods; statistical software.	12 Hrs
2	Biological Databases and Sequence Analysis: Primary, secondary and specialized biological databases; NCBI, EMBL, DDBJ, UniProt, PDB, KEGG and Gene Ontology; sequence retrieval and searching; pairwise and multiple sequence alignment; BLAST; sequence annotation.	12 Hrs
3	Computational Genomics and Phylogenetics: Genome assembly and annotation; transcriptomics and RNA-Seq analysis; genome browsers; phylogenetic tree construction; molecular evolution; comparative genomics; metagenomics; GWAS.	12 Hrs
4	Structural Bioinformatics and Drug Discovery: Protein structure prediction; homology modeling; molecular docking; virtual screening; molecular dynamics simulations; pharmacophore modeling; ADMET prediction; computer-aided drug design (CADD).	12 Hrs
5	Systems Biology and Multi-omics: Proteomics and metabolomics; interactomics and network biology; pathway enrichment analysis; systems biology approaches; multi-omics data integration; machine learning in bioinformatics; precision medicine.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Apply statistical methods for the analysis and interpretation of biological data.
- **CO2:** Utilize biological databases and sequence analysis tools for genomic and proteomic studies.
- **CO3:** Analyze genomic, transcriptomic and phylogenetic data using computational approaches.

- **CO4:** Evaluate structural bioinformatics methods and computer-aided drug discovery techniques.
- **CO5:** Integrate multi-omics data and bioinformatics tools for systems biology and precision medicine.

Recommended Text & Reference Books

- Pagano, M., & Gauvreau, K. (2018). Principles of Biostatistics (2nd Edition). CRC Press.
- Pevsner, J. (2015). Bioinformatics and Functional Genomics (3rd Edition). Wiley.

MBTL6501: Techniques in Cell Biology and Biochemistry Lab

L	T	P	C	Contact Hours	Semester	Category
0	0	4	2	60 Hours	Semester I	Core Course

Course Description

This laboratory course provides hands-on training in essential techniques used in cell biology and biochemistry. Students gain practical experience in microscopy, cell counting, biomolecule estimation, enzyme assays, chromatographic and electrophoretic techniques, enabling them to develop competence in experimental design and data analysis.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Demonstrate proficiency in laboratory safety, solution preparation, and calibration of basic biochemical instruments.
- **CO2:** Perform qualitative and quantitative estimation of biomolecules using standard biochemical techniques.
- **CO3:** Conduct enzyme assays and evaluate factors affecting enzyme activity.
- **CO4:** Apply chromatographic and electrophoretic techniques for biomolecular separation and analysis.
- **CO5:** Interpret experimental data and prepare scientific laboratory reports.

Recommended Text & Reference Books

- Wilson, K. & Walker, J. Principles and Techniques of Biochemistry and Molecular Biology.
- Plummer, D. T. An Introduction to Practical Biochemistry.

MBTL6502: Microbiology and Immunology Lab

L	T	P	C	Contact Hours	Semester	Category
0	0	4	2	60 Hours	Semester I	Core Course

Course Description

This laboratory course introduces students to fundamental microbiological and immunological techniques including microbial cultivation, staining, sterilization, microbial identification, antimicrobial susceptibility testing, and immunological assays.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Perform microbiological experiments using aseptic techniques and standard laboratory practices.
- **CO2:** Isolate, culture, identify, and characterize microorganisms using microbiological and biochemical methods.
- **CO3:** Evaluate microbial growth characteristics and antimicrobial susceptibility using standard assays.
- **CO4:** Perform basic immunological assays (ELISA, blood grouping) and interpret antigen-antibody interactions.
- **CO5:** Analyze experimental observations, maintain laboratory records, and prepare scientific reports.

Recommended Text & Reference Books

- Cappuccino, J. G. & Welsh, C. T. Microbiology: A Laboratory Manual.
- Harley, J. P. Laboratory Exercises in Microbiology.

MBTT6506: Genetic Engineering and Recombinant DNA Technology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester II	Core Course

Course Description

This course provides an in-depth understanding of the principles and techniques of genetic engineering and recombinant DNA technology. It covers molecular cloning, gene expression, genome editing, transgenic technologies, and advanced nucleic acid manipulation techniques.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Genetic Engineering: Restriction endonucleases and DNA modifying enzymes; cloning and expression vectors; plasmids, bacteriophages, cosmids, BACs and YACs; host-vector systems; transformation methods; screening recombinant clones.	12 Hrs
2	Recombinant DNA Technology: Construction of recombinant DNA molecules; genomic and cDNA library preparation; PCR and its variants; nucleic acid hybridization; DNA sequencing; recombinant protein expression systems.	12 Hrs
3	Genome Editing and Functional Genomics: CRISPR-Cas genome editing; TALENs and zinc finger nucleases; RNA interference; site-directed mutagenesis; gene knockout and knock-in approaches; transcriptome analysis.	12 Hrs
4	Advanced Molecular Biology Techniques: Next-generation sequencing; DNA fingerprinting; quantitative PCR; digital PCR; gene delivery systems; viral and non-viral vectors; recombinant vaccine technology; synthetic biology.	12 Hrs
5	Applications of Genetic Engineering: Production of recombinant therapeutics; molecular diagnostics; gene therapy; agricultural and industrial biotechnology; biosafety guidelines, bioethics, and regulatory framework.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles and tools of genetic engineering and recombinant DNA technology.
- **CO2:** Apply molecular cloning and nucleic acid manipulation techniques for gene analysis and expression.
- **CO3:** Analyze genome editing technologies and functional genomics approaches for genetic modification.

- **CO4:** Evaluate advanced molecular techniques used in genome engineering and biotechnology research.
- **CO5:** Assess the applications, biosafety, bioethics, and regulatory aspects of recombinant DNA technology.

Recommended Text & Reference Books

- Brown, T. A. Gene Cloning and DNA Analysis: An Introduction (9th Edition). Wiley-Blackwell.
- Glick, B. R., et al. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.

MBTT6507: Animal Tissue Culture & Stem Cell Biology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester II	Core Course

Course Description

This course provides comprehensive knowledge of animal cell culture techniques, stem cell biology, tissue engineering, and regenerative medicine. It focuses on the establishment and maintenance of animal cell cultures, stem cell differentiation, tissue engineering approaches, and cell-based therapeutics.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Animal Cell Culture: History and scope; laboratory design and aseptic techniques; culture media and supplements; primary and continuous cell lines; cryopreservation and cell banking; authentication of cell lines.	12 Hrs
2	Animal Cell Culture Techniques: Cell proliferation and viability assays; cell separation and sorting; organoid and spheroid cultures; 3D cell culture; serum-free culture; large-scale bioreactors for mammalian cells.	12 Hrs
3	Stem Cell Biology: Stem cell classification and potency; embryonic, adult and induced pluripotent stem cells (iPSCs); stem cell niche; molecular regulation of self-renewal; cellular reprogramming; genome editing in stem cells.	12 Hrs
4	Tissue Engineering and Regenerative Medicine: Biomaterials and scaffolds; tissue engineering principles; organ-on-chip technologies; cell and gene therapy; stem cell transplantation; disease modeling; personalized medicine.	12 Hrs
5	Applications and Ethical Considerations: Monoclonal antibody production; vaccine production; toxicological screening; clinical applications of stem cells; biosafety, bioethics, regulatory guidelines and Good Cell Culture Practices (GCCP).	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles and laboratory practices of animal cell culture.
- **CO2:** Apply cell culture techniques for research and biotechnology applications.
- **CO3:** Evaluate stem cell biology and differentiation mechanisms.
- **CO4:** Analyze tissue engineering and regenerative medicine approaches.

- **CO5:** Assess the biomedical applications and ethical aspects of stem cell technologies.

Recommended Text & Reference Books

- Freshney, R. I. (2021). Culture of Animal Cells: A Manual of Basic Technique (8th Edition). Wiley.
- Lanza, R., et al. (2014). Principles of Tissue Engineering (4th Edition). Academic Press.

MBTT6508: Bioprocess Engineering and Fermentation Technology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester II	Core Course

Course Description

This course introduces the principles of bioprocess engineering and fermentation technology for the industrial production of biological products. It covers microbial growth kinetics, fermentation systems, bioreactor design, downstream processing, process optimization, and quality control.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals and Microbial Kinetics: Bioprocess Engineering scope; batch growth phases, Monod kinetics, yield coefficients; mass and heat transfer (kLa determination); energy metabolism and kinetic models.	12 Hrs
2	Bioreactor Design and Operation: Stirred-tank, airlift, bubble column, fluidized bed bioreactors; batch, fed-batch, continuous modes; aeration, agitation, sparger design; PAT instrumentation; sterilization and scale-up.	12 Hrs
3	Upstream Processing: Media formulation and statistical optimization (RSM); inoculum development; raw material preparation; feeding strategies; solid-state fermentation.	12 Hrs
4	Downstream Processing: Cell disruption; filtration, centrifugation; ultrafiltration, diafiltration; chromatography (ion-exchange, gel filtration, HIC, affinity); drying and formulation.	12 Hrs
5	Industrial Fermentation and Applications: Production of primary and secondary metabolites (ethanol, citric acid, penicillin); industrial enzymes; biopharmaceuticals (recombinant insulin, mAbs); environmental bioprocessing.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles of bioprocess engineering and fermentation technology.
- **CO2:** Apply fermentation techniques and bioreactor operations for industrial bioprocesses.
- **CO3:** Analyze downstream processing methods for the recovery and purification of bioproducts.
- **CO4:** Evaluate bioprocess parameters for process optimization and scale-up.
- **CO5:** Assess industrial applications and quality management practices in bioprocess industries.

Recommended Text & Reference Books

- Shuler, M. L., & Kargi, F. Bioprocess Engineering: Basic Concepts (3rd Edition). Pearson.
- Stanbury, P. F., et al. Principles of Fermentation Technology (3rd Edition). Elsevier.

MBTT6509: Environmental and Marine Biotechnology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester II	Core Course

Course Description

This course provides a comprehensive understanding of environmental and marine biotechnology with emphasis on the sustainable utilization of biological resources, environmental protection, and marine biodiversity.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Environmental Biotechnology: Fundamentals of environmental microbiology; biogeochemical cycles; environmental pollutants; waste management strategies; biodegradation; biofertilizers and biopesticides.	12 Hrs
2	Bioremediation and Pollution Control: Principles of bioremediation; degradation of hydrocarbons, pesticides and dyes; phytoremediation, mycoremediation; wastewater treatment; activated sludge; biogas production.	12 Hrs
3	Marine Biotechnology: Marine ecosystems and microbial diversity; extremophiles; aquaculture biotechnology; marine enzymes; natural products and bioactive metabolites; blue biotechnology.	12 Hrs
4	Marine Bioresources and Industrial Applications: Marine-derived pharmaceuticals, nutraceuticals, cosmeceuticals; microalgal cultivation; marine polysaccharides; microalgal biofuels; climate change resilience.	12 Hrs
5	Environmental Sustainability and Emerging Technologies: Biotechnology for sustainable development; carbon capture and sequestration; circular bioeconomy; environmental biosafety regulations; green technologies.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles of environmental and marine biotechnology.
- **CO2:** Analyze biotechnological approaches for pollution control and bioremediation.
- **CO3:** Evaluate marine bioresources for pharmaceutical, industrial, and environmental applications.
- **CO4:** Assess sustainable biotechnological strategies for environmental conservation.
- **CO5:** Apply environmental and marine biotechnology concepts to address climate resilience.

Recommended Text & Reference Books

- Maier, R. M., et al. Environmental Microbiology (3rd Edition). Academic Press.
- Kim, S. K. (Ed.). Handbook of Marine Biotechnology. Springer.

MBTT6510: Plant and Animal Biotechnology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester II	Core Course

Course Description

This course provides comprehensive knowledge of plant and animal biotechnology with emphasis on tissue culture, genetic transformation, genome editing, molecular breeding, reproductive biotechnology, and transgenic technologies.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Plant Tissue Culture and Micropropagation: Fundamentals of plant cell culture; media composition; plant growth regulators; organogenesis; somatic embryogenesis; synthetic seeds; cryopreservation and germplasm storage.	12 Hrs
2	Plant Genetic Engineering: Agrobacterium-mediated and direct gene transfer; transgenic crop development; CRISPR-Cas genome editing; molecular markers; marker-assisted selection; molecular farming.	12 Hrs
3	Animal Biotechnology: Animal cell culture; artificial insemination, embryo transfer, IVF; somatic cell nuclear transfer; transgenic animals; genome editing; molecular diagnostics in livestock.	12 Hrs
4	Advanced Applications: Recombinant vaccines and therapeutic proteins; biopharming; nutritionally enhanced crops; animal disease models; precision breeding for food security.	12 Hrs
5	Biosafety, Bioethics and Commercialization: National and international biosafety guidelines; IPR and patenting; regulatory frameworks for GMOs; risk assessment and public acceptance.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles of plant tissue culture and genetic transformation.
- **CO2:** Apply molecular breeding and genome editing techniques for crop improvement.
- **CO3:** Analyze reproductive biotechnology and genetic engineering approaches in animals.
- **CO4:** Evaluate the applications of plant and animal biotechnology in agriculture and medicine.
- **CO5:** Assess biosafety, bioethics, and regulatory aspects of plant and animal biotechnology.

Recommended Text & Reference Books

- Slater, A., et al. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford Univ Press.
- Freshney, R. I. Culture of Animal Cells: A Manual of Basic Technique. Wiley-Blackwell.

MBTT7511: Nanobiotechnology

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester III	Core Course

Course Description

This course provides comprehensive knowledge of nanotechnology and its applications in biological systems. It covers the synthesis, characterization, functionalization, and biomedical applications of nanomaterials in nanomedicine, drug delivery, diagnostics, biosensing, and tissue engineering.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Nanotechnology: Nanoscale concepts; top-down and bottom-up nanofabrication; biological building blocks (DNA, proteins, lipids); nanotoxicology, safety and ethics.	12 Hrs
2	Self-Assembly and Nanostructures: Principles of molecular self-assembly; synthesis of metallic nanoparticles, quantum dots, liposomes, dendrimers; 0D, 1D, 2D, and 3D nanostructures; nanozymes.	12 Hrs
3	DNA Nanotechnology: Structural DNA nanotechnology; DNA origami, nanomachines; functional nucleic acids (aptamers, DNAzymes); biosensing and logic gates.	12 Hrs
4	Nanomaterial Characterization: UV-Vis, DLS, SEM, TEM, AFM, XRD, Raman/SERS, and surface analysis of nanomaterials.	12 Hrs
5	Nanomedicine and Diagnostics: Targeted drug delivery systems; theranostics; point-of-care biosensors; non-viral vectors for gene therapy; clinical translation and FDA approval pathways.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles, synthesis, and properties of nanomaterials used in biotechnology.
- **CO2:** Analyze techniques for the characterization of nanomaterials.
- **CO3:** Evaluate the applications of nanotechnology in medicine, drug delivery, and diagnostics.
- **CO4:** Assess nanotoxicology, biosafety, and regulatory aspects of nanobiotechnology.
- **CO5:** Apply nanobiotechnology principles to solve clinical and industrial problems.

Recommended Text & Reference Books

- Niemeyer, C. M., & Mirkin, C. A. Nanobiotechnology: Concepts, Applications and Perspectives. Wiley-VCH.
- Vo-Dinh, T. Nanotechnology in Biology and Medicine. CRC Press.

MBTT7512: Pharmaceutical Biotechnology and Molecular Diagnostics

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester III	Core Course

Course Description

This course introduces the principles of pharmaceutical biotechnology and molecular diagnostics with emphasis on the development of biopharmaceuticals, recombinant therapeutics, vaccines, molecular diagnostic technologies, and personalized medicine.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Pharmaceutical Biotechnology: Recombinant therapeutic proteins, monoclonal antibodies, biosimilars, vaccines; drug discovery pipeline; preclinical/clinical trials; GMP/GLP guidelines.	12 Hrs
2	Drug Discovery & Biopharmaceutical Production: Target validation; expression systems; upstream/downstream bioprocessing; purification, formulation, process validation, and IPR.	12 Hrs
3	Molecular Diagnostics: PCR, RT-PCR, qPCR, digital PCR; nucleic acid hybridization, DNA microarrays, NGS; biomarker discovery, liquid biopsy, companion diagnostics.	12 Hrs
4	Advanced Diagnostic Technologies: Biosensors, microfluidics, lab-on-a-chip; molecular imaging; AI in diagnostics and point-of-care testing.	12 Hrs
5	Precision Medicine & Emerging Trends: Gene therapy, cell therapy, precision oncology, molecular pathology, biomarker-driven therapeutics, and quality management.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles of pharmaceutical biotechnology and biopharmaceutical production.
- **CO2:** Analyze recombinant therapeutics and modern drug discovery strategies.
- **CO3:** Apply molecular diagnostic techniques for disease detection and monitoring.
- **CO4:** Evaluate advanced diagnostic technologies and precision medicine approaches.
- **CO5:** Assess the regulatory, ethical, and commercialization aspects of pharmaceutical biotechnology.

Recommended Text & Reference Books

- Crommelin, D. J. A., et al. (Eds.). Pharmaceutical Biotechnology (5th Edition). Springer.

- Buckingham, L. Molecular Diagnostics: Fundamentals, Methods and Clinical Applications. F.A. Davis.

MBTT7513: Biomedical Instrumentation

L	T	P	C	Contact Hours	Semester	Category
3	1	0	4	60 Hours	Semester III	Core Course

Course Description

This course provides comprehensive knowledge of biomedical instrumentation used in clinical diagnostics, biomedical research, and healthcare technology, covering physiological monitoring, imaging, biosignals, and lab analyzers.

Unit-Wise Syllabus

Unit	Title & Detailed Syllabus Contents	Hours
1	Fundamentals of Biomedical Instrumentation: Physiological measurements; sensors and transducers; signal conditioning and amplifiers; data acquisition; electrical safety.	12 Hrs
2	Biosignal Measurement and Monitoring: ECG, EEG, EMG, blood pressure, pulse oximetry; telemetry; wearable medical devices; biomedical signal processing.	12 Hrs
3	Diagnostic and Imaging Instruments: X-ray, CT, MRI, ultrasound, PET, SPECT, endoscopy; image processing.	12 Hrs
4	Laboratory and Therapeutic Instrumentation: Blood cell analyzers, biochemical analyzers, flow cytometry, dialyzers, ventilators, defibrillators.	12 Hrs
5	Advanced Biomedical Technologies: Medical robotics, implantable devices, IoMT, telemedicine, AI in healthcare, equipment maintenance, and regulatory standards.	12 Hrs

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

- **CO1:** Explain the principles and operation of biomedical instruments used in healthcare.
- **CO2:** Analyze biosignal acquisition and physiological monitoring systems.
- **CO3:** Evaluate diagnostic imaging and laboratory instrumentation.
- **CO4:** Assess therapeutic equipment and advanced biomedical technologies.
- **CO5:** Apply biomedical instrumentation principles in clinical diagnostics and research.

Recommended Text & Reference Books

- Khandpur, R. S. (2020). Handbook of Biomedical Instrumentation (4th Edition). McGraw-Hill.
- Enderle, J. D., et al. (2012). Introduction to Biomedical Engineering (3rd Edition). Academic Press.

Program Elective Detailed Syllabi Summary

Students choose one course from Program Elective Basket I (Semester III) and one course from Program Elective Basket II (Semester III):

- MBTT7601A: Cancer Biology — Molecular basis of cancer, oncogenes, tumor suppressors, metastasis, cancer genomics, precision oncology, and targeted therapeutics.
- MBTT7601B: Molecular Modelling and Drug Designing — Computational chemistry, CADD, structure/ligand-based design, molecular docking, QSAR, and virtual screening.
- MBTT7601C: Quality Control & Quality Assurance in Biotechnology — TQM, GLP, GMP, GCP, ISO 9001/13485, validation protocols, regulatory audits, and CAPA.
- MBTT7602A: AI in Healthcare — Machine learning, deep learning, CNNs in medical imaging, predictive risk analytics, IoMT, NLP, and clinical decision support systems.
- MBTT7602B: Systems Biology — Omics data integration, biological network modeling, flux balance analysis, pathway enrichment, and digital twins.
- MBTT7602C: Protein Engineering — Rational design, directed evolution, site-directed mutagenesis, computational protein design, and therapeutic antibody engineering.

MBTP7502: Major Project / Dissertation (Semester IV)

L	T	P	C	Duration	Semester	Evaluation
0	0	32	16	15 Weeks (480 Hours)	Semester IV	300 Marks (240 Internal, 60 External)

Project Guidelines & Work Breakdown

The Major Project provides an intensive 15-week research experience enabling students to formulate a original research problem in medical biotechnology, execute laboratory or data-driven investigations, and present a thesis.

Task Phase	Activity & Focus Area	Timeline	Allocated Hours
Phase 1	Problem Selection: Select a focused healthcare problem in diagnostics, genomics, biopharmaceuticals, or AI in healthcare.	Weeks 1–2	30 Hours
Phase 2	Literature Review & Hypothesis Formulation: Critical survey of research databases and hypothesis formulation.	Weeks 3–4	50 Hours
Phase 3	Experimental Design / Data Acquisition: Design lab experiments or acquire clinical/genomic datasets with ethical compliance.	Weeks 5–6	90 Hours
Phase 4	Data Preprocessing & Execution: Conduct lab assays or execute computational pipelines and statistical analysis.	Weeks 7–10	110 Hours
Phase 5	Model Validation / Results Analysis: Validate experimental/predictive results against current scientific benchmarks.	Weeks 11–12	80 Hours
Phase 6	Report Writing & Thesis Preparation: Structure project report, methodology, and manuscript preparation.	Weeks 13–14	60 Hours
Phase 7	Final Presentation & Defense: Oral presentation before departmental faculty and external expert panel.	Week 15	60 Hours

Project Course Outcomes

- **CO1:** Formulate an original, ethically sound research proposal in medical biotechnology after a critical literature review.
- **CO2:** Design and execute laboratory experiments or data-driven studies with complete biosafety and data security compliance.

- **CO3:** Acquire, preprocess, and analyze biological or clinical data using advanced bioinformatics, statistical, or ML tools.
- **CO4:** Develop, validate, and interpret experimental or model results against published peer-reviewed research.
- **CO5:** Prepare a comprehensive thesis and manuscript for publication, defending findings before an expert panel.