PROGRAM OUTCOME	
Course Code	**M.Sc. Medical Biotechnology**
PO1	**Apply Biotechnological Knowledge in Medical Sciences**: Utilize molecular, cellular, and computational techniques in medical biotechnology for disease diagnosis, treatment, and research.
PO2	**Conduct Independent and Collaborative Research**: Design and execute experiments, analyze data, and contribute to scientific advancements in medical biotechnology.
PO3	**Utilize Advanced Molecular and Analytical Techniques**: Demonstrate proficiency in PCR, flow cytometry, sequencing technologies, protein analysis, and bioinformatics tools.
PO4	**Solve Complex Biological Problems**: Address medical challenges through biotechnological approaches such as genome editing, stem cell therapy, and personalized medicine.
PO5	**Demonstrate Ethical and Professional Responsibility**: Adhere to bioethical principles, regulatory guidelines, and good laboratory practices in research and industry.
PO6	**Communicate Effectively in Scientific and Industrial Settings**: Present research findings, write scientific papers, and engage in effective interdisciplinary communication.
PO 7	**Adapt to Emerging Trends in Biotechnology**: Stay updated with advancements in precision medicine, nanobiotechnology, synthetic biology, and artificial intelligence in healthcare.
PO8	**Contribute to Public Health and Biomedical Innovation**: Develop cost-effective, innovative solutions for disease prevention, diagnostics, and therapeutics for societal impact
Course Outcomes (COs)	
Course Code	**M.Sc. Medical Biotechnology**
SEMESTER I	
MMBT 101 T	**Cell Biology**
CO1	Differentiate between prokaryotic and eukaryotic cells based on structural and functional aspects.
CO2	Describe the organization and roles of cellular organelles and the cytoskeleton in maintaining cell integrity and function.
CO3	Explain mammalian cell types, their differentiation pathways, and their significance in tissue architecture.
CO4	Analyze various cell-cell interactions, junctions, and extracellular matrix components in maintaining cellular communication.
CO5	Illustrate mechanisms of membrane transport, vesicular trafficking, and the impact of cellular signaling pathways in physiological processes.
CO6	Evaluate the regulation of the cell cycle, mechanisms of cell death, and their roles in embryogenesis, development, and disease pathology.
CO7	Apply knowledge of cellular biology to understand stem cell biology, regenerative medicine, and cancer biology.
MMBT 102 T	**IMMUNOLOGY**
CO1	Describe the key components and mechanisms of innate and adaptive immunity.
CO2	Differentiate immune system organs and cell types, explaining their roles in immune responses.
CO3	Explain antigen-antibody interactions, major histocompatibility complex (MHC) molecules, and antigen presentation mechanisms.
CO4	Analyze immune signaling pathways, the complement system, and cytokine-mediated regulation of immune responses.
CO5	Evaluate immunological disorders such as autoimmunity, hypersensitivity, and immunodeficiency diseases.
CO6	Apply immunological principles in clinical diagnostics, transplant immunology, tumor immunology, and infectious disease management.
CO7	Discuss vaccine development strategies, monoclonal antibody production, CAR-T cell therapy, and immunotherapeutic advancements.
CO8	Demonstrate knowledge of immunogenetics and antibody engineering for therapeutic and research applications.
MMBT 103 T	**Biomolecules**
CO1	Describe the structure and function of carbohydrates, proteins, lipids, and nucleic acids.
CO2	Explain the concepts of pH, buffers, and their physiological relevance in biological systems.
CO3	Analyze enzyme kinetics, inhibition mechanisms, and regulatory pathways in metabolic reactions.
CO4	Illustrate energy production through bioenergetics, the electron transport chain, and oxidative phosphorylation.
CO5	Compare key metabolic pathways, including glycolysis, gluconeogenesis, lipid metabolism, and amino acid catabolism.
CO6	Evaluate the biochemical basis of metabolic disorders such as diabetes, obesity, and dyslipidemia.
C07	Interpret liver and kidney function tests, their clinical significance, and hormonal regulation disorders.
	Apply biochemical principles to understand disease markers in cancer, cardiovascular diseases, and oxidative stress-related disorders.

CC 001 T	**Research Methodology & Biostatistics (Core Course)**
CO1	Student will be able to understand develop statistical models, research designs with the understating of background theory of various commonly used statistical techniques as well as analysis, interpretation & reporting of results and use of statistical software.
MMBT 104 P	**Practical Lab I – (MMBT 101 & MMBT 102)**
CO1	Operate a microscope efficiently and analyze different cell types and structures along with viability and counting.
CO2	Conduct blood group typing using haemagglutination tests.
CO3	Understand and demonstrate the principles of immunodiagnostic tests such as VDRL/Widal (demonstration-based).
CO4	Analyze the histological organization of lymphoid organs.
CO5	Perform antigen-antibody interaction studies using ELISA.
CO6	Interpret Western blotting results for protein analysis (demonstration-based).
CO7	Apply immunological techniques for disease diagnosis using commercial kits
CO8	Correlate theoretical knowledge with practical applications in immunology and cellular biology.
MMBT 105 CP	**MBT Directed Clinical Education-I**
CO1	Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories.
CO2	Effectively communicate and collaborate with healthcare professionals and patients.
CO3	Apply QA and QC protocols in a regulated laboratory environment.
CO4	Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches.
CO5	Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL).
CO6	Develop decision-making skills for effective healthcare management and administration.
CO7	Gain practical insights into biotechnology-based clinical applications and patient care.
CO8	Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.
SEMESTER II	
MMBT 106 T	**MOLECULAR BIOLOGY**
CO1	Explain the central dogma of molecular biology and its significance in gene expression.
CO2	Describe the structure and function of DNA and RNA, including their types, modifications, and regulatory elements.
CO3	Compare prokaryotic and eukaryotic DNA replication mechanisms, including DNA damage and repair processes.
CO4	Illustrate transcription and translation mechanisms, their regulation, and RNA processing events such as splicing and RNA interference.
CO5	Analyze operon models (lac, trp, and ara operons) and their regulation mechanisms in prokaryotes.
CO6	Discuss epigenetic modifications, chromatin remodeling, and the role of non-coding RNAs in gene expression regulation.
CO7	Evaluate the impact of post-translational modifications (phosphorylation, glycosylation, ubiquitination) on protein function.
CO8	Apply molecular biology concepts to understand genetic regulation, gene expression control, and its implications in disease and biotechnology.
MMBT 107 T	**ANALYTICAL BIOTECHNOLOGY**
CO1	Explain the significance of analytical techniques in biotechnology and biomedical research.
CO2	Describe the principles and applications of various spectroscopic techniques (UV-Vis, fluorescence, IR, Raman, NMR, MS) in biomolecular analysis.
CO3	Demonstrate proficiency in chromatography and electrophoresis techniques for separation and purification of biomolecules.
CO4	Apply immunoassays (ELISA, RIA) and biosensors for disease diagnostics and biomarker detection.
CO5	Utilize advanced analytical tools such as flow cytometry, microarrays, PCR, and NGS for genetic and proteomic analysis.
CO6	Analyze data obtained from analytical techniques and interpret results for biomedical and biotechnological applications.
CO7	Evaluate the role of analytical methodologies in pharmaceutical biotechnology, clinical diagnostics, and therapeutic development.

MMBT 108 T	**GENETIC ENGINEERING**
CO1	Explain the history, principles, and applications of genetic engineering.
CO2	Demonstrate proficiency in DNA and RNA extraction, PCR techniques, and molecular cloning strategies.
CO3	Analyze the role of restriction enzymes, ligases, and vectors in gene cloning and expression.
CO4	Apply genome editing tools like CRISPR-Cas, RNA interference, and gene silencing for genetic modifications.
CO5	Evaluate the applications of gene therapy in the treatment of inherited and acquired diseases.
CO6	Assess the role of recombinant DNA technology in vaccine development and regenerative medicine.
CO7	Discuss biosafety concerns, ethical issues, and regulatory frameworks in genetic engineering research.
MMBT 109 T	**BIOINFORMATICS**
CO1	Explain the principles and applications of bioinformatics in medical and biological research.
CO2	Navigate major biological databases such as GenBank, UniProt, PDB, and KEGG for data retrieval and analysis.
CO3	Perform sequence alignment using tools like BLAST and understand primer design strategies.
CO4	Analyze protein structures using homology modeling, ab initio methods, and structure visualization tools.
CO5	Apply network pharmacology concepts to study multi-target drugs and systems biology approaches.
CO6	Demonstrate the fundamentals of molecular docking and drug-target interaction analysis.
CO7	Utilize molecular dynamics simulation and QSAR modeling in drug discovery and optimization
MMBT 110 P	**Practical Lab II (MMBT 106 & MMBT 107)**
CO1	Perform centrifugation for biomolecule separation and Extract DNA and RNA from biological samples with high purity.
CO2	Analyze nucleic acids and proteins using UV-Visible spectroscopy.
CO3	Conduct Agarose gel electrophoresis for DNA visualization and integrity assessment.
CO4	Execute PCR and real-time PCR (qPCR) for molecular diagnostics and gene amplification.
CO5	Separate and analyze proteins using SDS-PAGE and Western blotting.
CO6	Apply HPLC techniques for the purification and separation of biomolecules.
CO7	Document and interpret results using gel documentation systems. Understand and apply analytical techniques in clinical and research settings.
CO8	Develop problem-solving skills for biomolecular analysis in medical biotechnology.
MMBT 111 P	**Practical Lab III (MMBT 108 & MMBT109)**
CO1	Isolate plasmid DNA from bacteria and perform restriction digestion and ligation for genetic manipulation.
CO2	Conduct bacterial transformation and confirm the presence of recombinant DNA.
CO3	Perform RFLP analysis for genetic variation studies.
CO4	Demonstrate bacterial conjugation and understand horizontal gene transfer.
CO5	Retrieve and analyze nucleotide and protein sequences using NCBI and BLAST and Perform multiple sequence alignment and construct phylogenetic trees for evolutionary studies.
CO6	Utilize molecular docking tools to analyze protein-ligand interactions in drug discovery.
CO7	Apply homology modeling techniques to predict protein structures using Swiss-Model.
CO8	Integrate genetic engineering and bioinformatics approaches for biomedical and biotechnological research applications.

MBT 112 CP	MBT Directed Clinical Education-II
CO1	Demonstrate proficiency in diagnostic and therapeutic techniques used in hospital laboratories.
CO2	Effectively communicate and collaborate with healthcare professionals and patients.
CO3	Apply QA and QC protocols in a regulated laboratory environment.
CO4	Analyze and troubleshoot clinical and diagnostic challenges using biotechnological approaches.
CO5	Understand and adhere to hospital regulatory standards and accreditation requirements (NABH/NABL).
CO6	Develop decision-making skills for effective healthcare management and administration.
CO7	Gain practical insights into biotechnology-based clinical applications and patient care.
CO8	Prepare for professional roles in clinical research, diagnostics, and hospital-based biotechnology settings.
Skill Ehancement Courses	
SEC 001 T	**Molecular Diagnostics**
CO1	Explain the principles of molecular diagnostics and its role in modern healthcare.
CO2	Describe the significance of biomarkers in disease detection and prognosis.
CO3	Demonstrate proper methods for sample collection, storage, and processing in a diagnostic lab.
CO4	Perform molecular diagnostic techniques such as PCR, ELISA, and immunohistochemistry.
CO5	Analyze the applications of molecular diagnostics in infectious diseases and cancer.
CO6	Evaluate the role of emerging diagnostic technologies like NGS and CRISPR-based methods.
CO7	Apply biosafety and biomedical waste disposal protocols in a molecular diagnostics lab.
SEC 002 T	**Data Analysis for Biologists**
CO1	Understand the basic principles of probability and statistical analysis in biological research.
CO2	Use R programming for data manipulation, visualization, and statistical computations.
CO3	Perform correlation and regression analysis for biological datasets.
CO4	Apply clustering and classification techniques to categorize biological data.
CO5	Analyze high-dimensional biological data using advanced statistical approaches.