GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 7
Subject Name: Advanced Techniques in Medical Biotechnology
Subject Code: 1370407

Prerequisite: Students should have a basic understanding of molecular biology, genetics, microbiology, and analytical techniques. Familiarity with laboratory instrumentation, bioinformatics, and clinical diagnostics is beneficial.

Rationale: This course provides students with cutting-edge technologies and methodologies used in biomedical research, molecular diagnostics, and therapeutic applications. It covers high-throughput screening, next-generation sequencing, genome editing, proteomics, and nanobiotechnology, equipping students with industry-relevant analytical and biotechnological skills.

Course Scheme:

Teaching Scheme			Total Credits	Assessment Pattern and Marks				Total Marks
				Theory		Practical		
L	T	PR	C	ESE (E)	PA(M)	ESE (V)	PA (I)	
4	0	8	8	70	30	30	20	150

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage

1	**Unit 1: Advanced Molecular Biology and Genomics Techniques**
	• Next-Generation Sequencing (NGS) & Third-Generation Sequencing
	  ○ Whole-genome sequencing, RNA-Seq, Metagenomics
	• Polymerase Chain Reaction (PCR) and its Variants
	  ○ qPCR, RT-PCR, Digital PCR, Isothermal Amplification
	• Microarrays and Gene Expression Profiling
	  ○ DNA Microarrays, RNA Microarrays, CRISPR Screens
	• Chromatin Immunoprecipitation (ChIP) and Epigenomics
	• CRISPR-Cas9 and Gene Editing Applications in Medicine
		12	**20**

2	**Unit 2: Proteomics and Structural Biology Techniques** • Proteomic Technologies ○ 2D-Gel Electrophoresis, Mass Spectrometry (MALDI-TOF, LC-MS/MS) • Protein-Protein Interaction Studies	**12**	**30**

	○ Yeast Two-Hybrid, Co-Immunoprecipitation, SPR, Biacore • High-Resolution Structural Biology ○ X-Ray Crystallography, NMR Spectroscopy, Cryo-Electron Microscopy • Post-Translational Modifications & Functional Proteomics • Phosphoproteomics, Glycoproteomics, Lipidomics		
3	**Unit 3: Advanced Imaging and Single-Cell Technologies** • Fluorescence and Super-Resolution Microscopy ○ Confocal, Two-Photon, STORM, PALM, SIM • Flow Cytometry and Fluorescence-Activated Cell Sorting (FACS) • Live Cell Imaging and Single-Cell RNA Sequencing (scRNA-Seq) • Nanoparticle-Based Imaging and Biosensing • MRI, PET-CT, and Optical Coherence Tomography (OCT) in Medical Diagnosis	**12**	**20**
4	**Unit 4: Nanobiotechnology and Biosensors** • Nanoparticle-Based Drug Delivery Systems ○ Liposomes, Polymeric Nanoparticles, Dendrimers • Quantum Dots and Nanomaterials in Biomedical Imaging • Lab-on-a-Chip and Microfluidics for Diagnostics • Biosensors for Disease Detection ○ Electrochemical, Optical, Graphene-Based, CRISPR-based biosensors • Point-of-Care Diagnostics and AI in Medical Biotechnology	**12**	**20**
5	**Unit 5: High-Throughput Screening and Automation in Biotechnology** • Automated Cell Culture and Bioreactor Systems • High-Throughput Screening (HTS) in Drug Discovery • AI and Machine Learning in Bioinformatics and Drug Design	**12**	**20**

	• Organoids and 3D Bioprinting in Tissue Engineering • Wearable Biosensors and Personalized Medicine Technologies		

Reference Books:

1. Principles and Techniques of Biochemistry and Molecular Biology – Wilson & Walker
2. Molecular Biology of the Cell – Alberts et al.
3. Genomes 4 – Brown, T.A.
4. Medical Biotechnology – Bernard R. Glick, Terry L. Delovitch
5. Nanobiotechnology in Molecular Diagnostics – Christof M. Niemeyer

Course Outcome:

After Completion of the Course, Student will able to:

Sr. No	Course Outcomes	RBT Level
1	Describe and analyze modern molecular biology and genomic techniques.	UN, RM, AP
2	Apply proteomics and structural biology tools for biomedical research.	UN, RM, AP
3	Evaluate and implement imaging techniques for diagnostics and research.	AP, AN, CR
4	Integrate nanobiotechnology and biosensor technology into diagnostics.	AN, EL, CR
5	Demonstrate high-throughput screening and automation in medical biotechnology.	AP, CR

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

List of Experiments:

1. Quantitative PCR (qPCR) for Gene Expression Analysis
2. Protein Separation using 2D Gel Electrophoresis
3. Western Blotting for Protein Detection
4. FACS Analysis for Cell Sorting and Characterization
5. Mass Spectrometry-Based Proteomics
6. Biosensor-Based Detection of Biomolecules
7. Nanoparticle Synthesis for Drug Delivery Applications

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