GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 9
Subject Name: Advance Genomics and Personalized medicine
Subject Code: 1390409

Prerequisite: A strong foundation in molecular biology, genetics, and bioinformatics is essential. Knowledge of next-generation sequencing (NGS), CRISPR, and omics technologies (genomics, transcriptomics, proteomics) is crucial. Proficiency in data analysis, machine learning, and biostatistics helps in interpreting genomic data. A background in biotechnology, bioinformatics, or medicine is preferred, along with an understanding of ethical, legal, and regulatory aspects of personalized medicine.

Rationale: Advancements in genomics and personalized medicine revolutionize healthcare by enabling precise, patient-specific treatments based on genetic profiles. By analyzing an individual's DNA, personalized medicine can predict disease susceptibility, optimize drug therapies, and minimize adverse reactions. This approach enhances treatment efficacy, reduces trial-and-error prescribing, and paves the way for targeted therapies in oncology, rare diseases, and chronic conditions. The integration of genomics with AI and big data further accelerates discoveries, making healthcare more efficient, proactive, and tailored to individual needs.

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	0	4	70	30	0	0	100

Course Content:

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

1	**Unit 1: Genomic Technologies and Genome Sequencing**
	• **Introduction to Genomics and Functional Genomics**
	• **Next-Generation Sequencing (NGS) & Third-Generation Sequencing**
	  ○ Whole-genome sequencing (WGS) and whole-exome sequencing (WES)
	  ○ RNA-Seq and transcriptomics
	• **Genome-Wide Association Studies (GWAS) and Multi-Omics Approaches**
	• **Epigenomics: DNA Methylation, Histone Modification, and Regulatory Genomics**
	• **Data Analysis and Bioinformatics Pipelines for Genomics**
		12	**20**

2	**Unit 2: Precision Medicine and Pharmacogenomics**
	• **Concept and Scope of Precision Medicine**
	• **Pharmacogenomics and Drug Response Variability**
	  ○ Genomic markers for drug metabolism (CYP450 enzymes)
	  ○ Case studies: Warfarin, Statins, Clopidogrel, Cancer Therapy
	• **Genetic Testing for Personalized Therapy**
	• **Cancer Genomics and Targeted Therapies**
	  ○ Companion diagnostics (e.g., HER2, EGFR, BRCA1/2)
	  ○ CAR-T cell therapy and Immunogenomics
	• **Ethical, Legal, and Social Implications (ELSI) of Personalized Medicine**
		16	**30**

3	**Unit 3: Clinical Genomics and Molecular Diagnostics**
	• **Genetic Screening and Disease Risk Assessment**
	  ○ Newborn screening, Carrier screening, Predictive testing
	• **Microbiome and Human Health in Personalized Medicine**
	• **Non-Invasive Prenatal Testing (NIPT) and Liquid Biopsy**
	• **CRISPR and Gene Therapy in Personalized Treatment**
	  ○ Case studies: Sickle Cell Disease, Cystic Fibrosis, Hemophilia
	• **Bioinformatics in Clinical Decision-Making and AI-Driven Genomic Analysis**
		12	**20**

4	**Unit 4: Immunogenomics and Disease Susceptibility** • **Host-Pathogen Genomics and Infectious Disease Susceptibility** • **HLA Typing and Organ Transplant Compatibility** • **Autoimmune Disease Genetics and Personalized Treatments** ○ Genetic basis of Type 1 Diabetes, Rheumatoid Arthritis, Multiple Sclerosis • **Single-Cell Genomics and Immune Profiling for Precision Medicine** • **Future of Personalized Vaccines and Immunotherapies**	**10**	**15**
5	**Unit 5: Applications of Genomics in Emerging Fields**	**10**	**15**

	• **Artificial Intelligence and Machine Learning in Genomic Data Analysis** • **Synthetic Biology and Personalized Therapeutics** • **Longitudinal Genomic Studies and Aging Biomarkers** • **Global Genomic Initiatives and Population-Specific Genomics** ○ 100,000 Genomes Project, Human Genome Diversity Project • **Future Trends in Personalized Healthcare and Biobanking**		

Reference Books:

1. Genomics: A Very Short Introduction – John Archibald
2. Principles of Gene Manipulation and Genomics – Sandy Primrose
3. The Personalized Medicine Revolution – Pieter Cullis
4. Pharmacogenomics: Challenges and Opportunities – Yui-Wing Francis Lam
5. Human Genome Epidemiology: Building the Evidence for Using Genetic Information to Improve Health and Prevent Disease – Muin J. Khoury

Course Outcome:

After Completion of the Course, Student will able to:

Sr. No	Course Outcomes	RBT Level
1	Describe and analyze genomic technologies and sequencing methods.	UN, RM, AP
2	Apply precision medicine and pharmacogenomics principles to healthcare.	UN, RM, AP
3	Evaluate molecular diagnostics and personalized disease risk assessment.	AP, AN, CR
4	Integrate immunogenomics with disease susceptibility studies.	AN, EL, CR
5	Demonstrate AI-based applications in genomics and personalized therapeutics.	AP, CR

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

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