GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 9
Subject Name: Microbiome science and Personalized Nutrition
Subject Code: 1390407

Prerequisite: A prerequisite for Microbiome Science and Personalized Nutrition includes foundational knowledge in microbiology, biochemistry, molecular biology, and human physiology. Understanding the gut microbiome's role in metabolism, immunity, and overall health is essential. Familiarity with next-generation sequencing (NGS), bioinformatics, and statistical analysis is beneficial for microbiome data interpretation. Additionally, knowledge of nutritional science, nutrigenomics, and metabolomics helps in applying microbiome insights to personalized dietary recommendations. Basic skills in laboratory techniques, data analysis, and clinical research methodologies are also advantageous.

Rationale: The rationale for microbiome science and personalized nutrition lies in the understanding that the human gut microbiome plays a crucial role in metabolism, immunity, and overall health. Individual differences in microbiome composition influence nutrient absorption, metabolism, and disease susceptibility. Personalized nutrition leverages microbiome data to tailor dietary recommendations, optimizing health outcomes by addressing specific deficiencies, gut health, and metabolic needs. This approach moves beyond one-size-fits-all dietary guidelines, enabling targeted interventions for improved digestion, immunity, and chronic disease prevention.

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: Gut Microbiome and Human Health**
	• **Introduction to the Human Microbiome**
	  ○ Composition and Function of Gut Microbiota
	  ○ Symbiosis, Dysbiosis, and Disease Associations
	• **Microbiome-Host Interactions and Health Implications**
	  ○ Gut-Brain Axis and Neurological Disorders
	  ○ Role of Microbiota in Immunity and Metabolism
	  ○ Microbiome's Impact on Autoimmune and Inflammatory Diseases
	• **Techniques for Studying the Gut Microbiome**
	  ○ 16S rRNA Sequencing and Metagenomics
	  ○ Microbiome Data Analysis Using AI
		15	**25**

2	**Unit 2: Microbiome Engineering & Synthetic Ecology**
	• **Probiotics, Prebiotics, and Postbiotics in Human Health**
	  ○ Mechanisms of Action of Beneficial Bacteria
	  ○ Role of Prebiotics in Modulating Gut Microbiota
	• **Synthetic Microbiome and Engineered Probiotics**
	  ○ Engineering Gut Microbes for Health Benefits
	  ○ CRISPR-Based Microbiome Editing
	• **Microbiome-Based Biotherapeutics**
	  ○ Microbial Metabolites as Therapeutic Agents
	  ○ AI and Machine Learning in Microbiome Engineering
		15	**25**

3	**Unit 3: Fecal Microbiota Transplantation (FMT) and Disease Management**
	• **Fecal Microbiota Transplantation (FMT) – Concept and Applications**
	  ○ History and Clinical Use of FMT
	  ○ Role in Treating Clostridium difficile Infections
	• **Microbiome Therapy in Chronic Diseases**
	  ○ FMT in Metabolic Disorders, IBD, and Autism Spectrum Disorders
	  ○ Risks, Ethical Concerns, and Regulatory Guidelines
	• **Future of Microbiome Transplantation and Personalized Therapies**
	  ○ Next-Generation Probiotics and Personalized FMT
		15	**25**

4	**Unit 4: Nutrigenomics and Personalized Diets**
	• **Gut Microbiota and Nutrient Absorption**
	  ○ Role of Microbiome in Digestion and Metabolism
	  ○ Microbiome-Driven Personalized Dietary Interventions
	• **Nutrigenomics and Nutrigenetics in Personalized Medicine**
	  ○ Genetic and Epigenetic Regulation of Nutrient Metabolism
	  ○ AI-Driven Personalized Nutrition and Diet Planning
	• **Microbiome-Guided Functional Foods and Supplements**
	  ○ Precision Probiotics and Functional Foods
	  ○ Designing Microbiome-Based Nutrition Programs
		15	**25**

Reference Books:

1. The Human Microbiota and Microbiome – Julian R. Marchesi
2. Gut Microbiota: Methods, Applications, and Research – Debabrata Biswas
3. The Personalized Diet – Eran Segal and Eran Elinav
4. The Good Gut: Taking Control of Your Weight, Your Mood, and Your Long-Term Health – Justin Sonnenburg
5. Artificial Intelligence in Nutrigenomics – Paul Wilmes

List of Experiments (Minimum 6 to be performed):

1. Isolation and Culturing of Probiotic Bacteria from Dairy Products
2. Fecal DNA Extraction and 16S rRNA Analysis of Microbiome
3. Metagenome analysis of Gut Microbiota
4. Prebiotic and Probiotic Growth Assays
5. Metabolomics Analysis of Gut Microbial Metabolites
6. Bioinformatics Pipeline for Microbiome Data Analysis
7. Functional Food Formulation Based on Microbiome Data
8. Study of Oral Microbiota in health and disease conditions

Assessment Methods:

- **Basic Experiments & Reports** (50%)
- **Mid-Semester Exam** (30%)
- **Final Theory Exam** (20%)

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