GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Biotechnology
Subject Code: BE03004041
Subject Name: Microbiology

w. e. f. Academic Year:	**2025-26**
Semester:	**3**
Category of the Course:	**Professional Core Course**

Prerequisite:	Basic Chemistry and Biology
Rationale:	The rationale lies in understanding microbial roles in fermentation, biodegradation, and bioconversion. In future contexts, microbiology is vital for sustainable bio-manufacturing, waste valorization, and biotech innovation, aligning with green technologies and circular economy goals.

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Understand cellular ultrastructure of prokaryotes and eukaryotes	15
CO-2	Select the optimum environmental factors for microbial growth	15
CO-3	Analyze the outcome of genetic variations in microbes	25
CO-4	Evaluate the impact of viruses on the physiology of animals, plants and microbes	25
CO-5	Understand the biology of fungi and protists and their importance	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	45	120	4	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to the World of Microbes:** Overview of microbial life; debate between spontaneous generation and biogenesis. Development of the germ theory of disease and Koch's postulates. Comparative study of prokaryotic and eukaryotic microorganisms; structural organization of microbial cells—internal structures (nucleoid, ribosomes, inclusions) and external structures (cell wall, membranes, pili, flagella) with their functions. Basic principles and applications of light microscopy and introduction to advanced microscopy techniques (fluorescence,	**10**

	electron microscopy).	
2	**Microbial Nutrition and Growth:** Nutritional requirements of microbes—macronutrients and micronutrients, essential growth factors, and mechanisms of nutrient uptake. Preparation and types of culture media—selective, differential, enriched, and minimal media. Methods for isolation of pure cultures—streak plate, pour plate, spread plate, and enrichment techniques. Microbial growth curve: phases of growth and the impact of environmental factors (temperature, pH, osmolarity, oxygen levels). Control of microbial growth using physical methods (heat, filtration, radiation) and chemical agents (disinfectants, antiseptics). Introduction to antibiotics, mechanisms of action, and antibiotic resistance.	**10**
3	**Microbial Genetics and Virology:** Microbial genetics: DNA as the hereditary material, nature and significance of spontaneous mutations. Horizontal gene transfer mechanisms—conjugation, transformation, and transduction. General features of viruses; cultivation and quantification methods for bacteriophages, animal, and plant viruses. Baltimore classification of viruses based on genome structure and replication strategies. Introduction to viroids and prions.	**10**
4	**Diverse Types of Microorganisms and Their Applications:** Study of fungi (yeasts and molds)—morphology, physiology, reproduction, and their industrial and medical significance. Overview of algae—classification, characteristics, biological roles, and commercial applications. Lichens as symbiotic organisms—morphology and ecological importance. Protozoa—morphology, physiology, reproduction, and pathogenic potential. Introduction to microbial ecology and microbial interactions (symbiosis, commensalism, competition). Applications of microorganisms in environmental microbiology: roles in biogeochemical cycles (nitrogen, sulfur, carbon cycles), wastewater treatment processes (primary, secondary, tertiary treatment). Introduction to biofilms and their significance. Extremophiles—microbes in extreme environments and their biotechnological potential. Introduction to microbial biotechnology: production of enzymes, biofuels, bioplastics, and antibiotics.	**15**
	TOTAL	**45**

Suggested Specification table with Marks (Theory): (For B.E. only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**20**	**20**	**10**	**10**

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

1. Willey, J. M., Sandman, K. M. and Wood, D. H, Prescott's Microbiology, McGraw Hill Education, 2020, 11th Edition
2. Michael T. Madigan, Kelly S. Bender, Daniel H. Buckley, W. Matthew Sattley and David A. Stahl,Brock Biology of Microorganisms, Pearson, 2017, 15th Edition
3. Ananthanarayan, R and Paniker, C. K. J, Ananthanarayan and Paniker's Textbook of Microbiology, Orient Longman Pvt. Ltd., 2020, 11th Edition
4. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. (2002) Microbiology. 5th Edition, Tata McGraw-Hill

List of Experiments:

1. Media preparation—solid and liquid.
2. Pure culture techniques—inoculating, streaking and spreading.
3. Microbial growth characteristics—growth curve.
4. Gram's staining.
5. Isolation of pure culture from environmental samples—serial dilution and membrane filter technique.
6. Effects of physical and chemical agents on microbial growth.
7. Delbruck's fluctuation test.
8. Determination of bacteriophage titer value by plaque assay.

Major Equipment:

- Microscope
- Incubator (Temperature-controlled for microbial growth)
- Laminar Air Flow Hood (aseptic work environment)
- Spectrophotometer (measuring cell density)
- Autoclave

List of Open Source Software/learning website:

- MEGA: Phylogenetic analysis
- QIIME 2: Microbiome bioinformatics
- Mothur: 16S rRNA sequence analysis
- Artemis: Genome visualization
- BacDive: Bacterial strain database
- OpenCFU: Colony counting software
- PhyloPhlAn: Microbial phylogenetics

Free Learning Websites for Microbiology

- Microbiology Society Learning Hub: Educational resources
- HHMI Biointeractive: Interactive lessons
- OpenStax Microbiology: Free textbook
- Coursera: Free microbiology courses (audit)
- edX: Microbiome courses (audit)

- MIT OpenCourseWare: University lectures
- NCBI Bookshelf: Reference books

*** List of suggested activities for Problem Based Learning:**

- **Microscopic Observation:** Study bacterial morphology using stained slides.
- **Culture Techniques:** Practice aseptic techniques and culture bacteria on agar plates.
- **Gram Staining:** Perform and interpret Gram staining of bacterial samples.
- **Biochemical Tests:** Conduct tests like catalase, oxidase, and sugar fermentation.
- **Microbial Growth Curve:** Measure and plot bacterial growth phases.
- **Antibiotic Sensitivity Test:** Perform Kirby-Bauer disk diffusion assay.
- **Isolation of Microorganisms:** Isolate bacteria from soil, water, or food samples.
- **Enzyme Activity Assays:** Study microbial enzymes such as amylase or protease.
- **Microbial Identification:** Use Bergey's Manual for identifying unknown microbes.
- **Online Simulations:** Engage with virtual labs and microbiology simulations.
- **Microbiome Exploration:** Research human or environmental microbiomes through literature.
- **Presentation:** Prepare and present a topic on a microbial disease or biotechnology application.

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