GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Environmental Engineering
Subject Code: BE04013051
Subject Name: Environmental Microbiology and Bioremediation

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	None
Rationale:	Microorganisms plays a significant role in treatment and in the disposal of wastes but also are responsible for spreading many diseases. Hence a working knowledge of microbiology forms a base for other core subjects of Environmental Engineering

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Describe the structure, classification, and environmental significance of major groups of microorganisms.	27
CO-2	Explain the chemical composition, structural organization, and metabolic processes of microbial cells.	27
CO-3	Identify and explain various techniques to enumerate and isolate the microbes	13
CO-4	Compare the physical & chemical agents for control of microbes	13
CO-5	Discuss the role of microbes in environmental processes such as wastewater treatment and bioremediation contaminated soil and water.	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	SL	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	TW/ SL (I)	ESE (V)	
30	0	30	30	90	03	70	30	20	30	50	200

- ***Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.***

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, PA = Progressive Assessment, ESE = End-Semester Examination

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to microbiology** Scope of microbiology, Structure and classification of microbes, Role of microbes in human life and environment, Prokaryotic cell, Brief description about Bacteria and Viruses and their role and importance in Environment, Eukaryotes, Brief description about protozoa, algae and fungi and their role and importance in Environment.	**08**
2	**Cell chemistry and cell biology** Structure of proteins, nucleic acids (DNA & RNA), lipids, polysaccharides; Cell structures – cytoplasmic membrane, cell wall, glycocalyx, chromosomes, endospores, storage products, mitochondria, and chloroplasts	**04**
3	**Microbial metabolism:** Anabolism and catabolism; Phosphorylation; Glycolysis; TCA cycle; Electron transport chain; Fermentation; Anaerobic respiration; Energy balances; Enzymes and enzyme kinetics	**04**
4	**Analytical techniques in microbiology** Microscope and microscopy: Optical microscopes and electron microscopes, staining techniques, Culture methods in microbiology**:** Techniques of sterilization, Media preparation, Isolation and inoculation, direct observation, pure culture and mix cultures and its importance, Maintenance, and preservation of cultures	**04**
5	**Control of microbes** Principles of control of microbes, uses of physical agents and chemical agents. Role of microbes in human diseases and their control - Diseases caused by bacteria: typhoid, cholera, pneumonia, food poisoning, tuberculosis (TB), Diseases caused by virus: flu (influenza), chickenpox, measles, COVID-19, hepatitis	**04**
6	**Role of microorganisms in wastewater treatment** Microbes involved and their role wastewater treatment: bacteria, fungi, algae, protozoa, rotifers and crustaceans, Basics of biological treatment process in wastewater treatment: Catabolism and anabolism, Classification of organisms based on metabolic functions: aerobic, anaerobic, anoxic, and facultative	**02**
7	**Bioremediation** Introduction, Fundamental principles, In-situ bioremediation of soil and Groundwater, Ex-situ bioremediation of soil, Wastewater bioremediation, Innovative treatment technologies, Case studies.	**04**
	TOTAL	**30**

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
25	**25**	**10**	**10**	**00**	**00**

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Microbiology by Pelczar and Ried
2. Environmental Microbiology by Ralph Mitchell
3. Wastewater Engineering- Treatment and Reuse, Metcalf and Eddy, Inc., Revised by Tchobanoglous, Burton and Stensel
4. Introduction to Microbiology by A.S. Rao
5. Environmental Microbiology by Manish L. Shrivastva
6. Handbook of Bioremediation Edited by Norris et al, Robert S. Kerr; Environmental Research Laboratory.
7. Bioremediation Principles: Ewies, Ergas, Chang and Schroeder

List of Experiments:

1. To prove that microbes are ubiquities.
2. To determine MPN of given water sample.
3. To perform the Standard Plate Count (SPC) test using serial dilution technique

List of Assignments

1. Classification of microbes: Prokaryotes and Eukaryotes
2. Microbes and its Environmental Significance
3. Cellular Foundations: Chemistry and Structure
4. Microbial metabolism
5. Microscope and microscopy
6. Microbial Culture: Methods, Isolation, and Preservation
7. Control of Microbes: physical agents and chemical agents
8. Diseased caused by bacteria and virus
9. Role of microbes in wastewater treatment
10. Bioremediation

Major Equipment:

1. Microscope
2. Autoclave
3. Biological Incubator
4. Monopan Balance
5. Colony counter

List of Open-Source Software/learning website:

Virtual Lab

Bacterial Growth Curve: https://mvi-au.vlabs.ac.in/exp/bacterial-growth-curve/
Gram Stain Technique: https://vlab.amrita.edu/?sub=3&brch=73&sim=208&cnt=1
Streak Plate Method: https://mvi-au.vlabs.ac.in/exp/streak-plate-method/

NPTEL

https://nptel.ac.in/courses/102105087
https://nptel.ac.in/courses/102103015
https://nptel.ac.in/courses/105107173

List of suggested activities for Problem Based Learning:

Sr. No.	Name of Activity	No. of hours.	Evaluation Criteria
1	Laboratory Visit- State Government/ Central Government/Gujarat Pollution Control Board/ Water Supply Board	08 (Visit: 5 hrs + Report: 3 hrs)	Based on the report submitted with observations and calculations
2	Technical Video based learning related to Environmental Microbiology and Bioremediation offered during semester	10 (Video: 5 hrs + Report: 5 hrs)	Multiple choice questions-based Assessment
3	Poster presentation on topics related to the Cell chemistry and cell biology or Microbial metabolism	10	Poster presentation and explanation
4	Data aquation related to various water borne diseases for identified years for a given area and prepare a statistical analysis report	05	Report and analysis of collected data
5	Collect the data from local authorities / municipal corporations related MPN test / residual chlorin level and prepare a report	10	Based on participation certificate
6	Numerical related to subject	02	Based on submission of given assignments
7	Poster making on the topics given	08	Assessment based on poster quality and accuracy
8	Case study analysis of successful environmental bioremediation projects.	05	Report and analysis of selected case study
9	Create a concept chart for microbial interactions in soil and aquatic environments.	05	Concept chart quality and accuracy

Note:

- All the suggested activities should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective recordkeeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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