

GUJARAT TECHNOLOGICAL UNIVERSITY
Integrated Master of Science (Biotechnology)
Semester: 9
Subject Name: Environmental Biotechnology
Subject Code: 1390402

Prerequisite: Candidates enrolling in the Integrated MSc in Industrial Biotechnology program with a compulsory course in Environmental Biotechnology are expected to have a robust foundation in core biological and chemical sciences.

Rationale: Integrating a course on Environmental Biotechnology into the Integrated MSc in Industrial Biotechnology curriculum is critical for developing sustainable industrial practices that minimize ecological impact. This course equips students with the knowledge to harness microbial processes for bioremediation, waste conversion, and pollution control—key strategies for addressing industrial waste challenges and meeting increasingly stringent environmental regulations.

Course Scheme:

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

Course Content:

Module No:	Module Content	No. of Sessions	Weightage (%)
1	<u>Biological nitrogen fixation</u> Physiology and biochemistry of nitrogen fixing organisms, genetics and regulation of gene expression, signaling factors and molecular interaction in establishing rhizobia legume symbiosis.	7	12
2	<u>Biofertilizers</u> Phosphate Solubilizing Microorganisms, inorganic phosphate solubilization and its mechanisms, phosphate mineralizers-phytate and organic phosphate hydrolyzing bacteria, Ecto- and Endo- Mycorrhizae.	3	5
3	<u>Plant growth promoting rhizobacteria (PGPR)</u> PGPR in improving plant growth, mechanism in plant growth promotion, factors affecting rhizosphere colonization.	7	12
4	<u>Environmental problems and monitoring</u> Pollution and its classification; Effluent standards-examination of wastewater, characteristics, municipal and industrial waste water; Global environmental problems, global warming, acid rain, ozone depletion; Sampling and	7	12

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	analysis; Environmental monitoring and audit; Environmental laws and policies in India.		
5	<u>Biotreatment kinetics and reactor design</u> Principles of biological treatments; Biological treatment-composting, suspended growth systems, attached growth systems; Bioreactor design- activated sludge process, trickling filters, fluidized bed and packed bed reactor, rotating biological contactors, oxidation ponds and ditches, lagoons, anaerobic reactors.	8	13
6	<u>Bioremediation and biodegradation</u> Bioremediation principles and processes, Biosorption, bioaccumulation, bioconversion, biotransformation, bioleaching, biodegradation, detoxification, activation, accumulation and co-metabolism; Strategies and techniques of bioremediation <i>in situ</i> and <i>ex situ</i> of hydrocarbons, pesticides and dyes; GMOs in bioremediation and biodegradation, Microbial enhanced oil recovery.	8	13
7	<u>Principles of microbial diversity</u> Evolution of life, principles and concept of microbial diversity, ecological diversity, structural and functional diversity; Methods of studying microbial diversity- Morphological, biochemical/physiological and molecular techniques; Microbial classification and taxonomy; Phenetic, phylogenetic, and genotypic classification, numerical taxonomy, taxonomic ranks, phylogenetic tree, techniques for determining microbial taxonomy and phylogeny- classical and molecular characteristics.	8	13
8	<u>Fundamentals of ecology</u> Ecosystem, energy in ecological systems, energy participating in food chains and food webs; Interactions among microbial populations, interaction between microbes and plants and between microbes and animals.	12	20

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Reference Books:

1. Atlas R.M and Bertha, R, Microbial Ecology, Pearson Education., 4th Edition
2. Maier, R.M., Peppler I.L and Gertha C.P., Environmental Microbiology, Academic Press. , 2nd Edition
3. Olum E.P and Barrett G.W, Fundamental of Ecology, Cenegage learning. , 5th Edition
4. Wiley J.M., Sherwood, L.M and Woolverton C.J. Prescott, Harley and Klein, Microbiology, McGraw Hill., 7th Edition
5. Garrity, G.M, Brenner, D.J, Kreig M.R. and Staley J.T., Bergey's Manual of Systematic Bacteriology, Springer, 2nd Edition
6. Lawrence K. W, Volodymyr Ivanov, Joo-Hwa Tay, Yung-Tse Hung, Environmental Biotechnology, Vol 10, Handbook of Environmental Engineering, Springer, Latest Edition
7. Hans-Joachim Jordening, Josef Winter, Environmental Biotechnology: Concepts and Application, John Wiley & Blackwell, Latest Edition
8. Christon Hurst, Ronald L.C, Guy R. K, Miachael J.M, Linda D. S, Manual of Environmental Microbiology, ASM press , 2nd Edition

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
1	At the end of the course the students will have an understanding of the fundamentals of ecology. Students will be able to analyze the purity of portable water by different techniques like BOD and COD.	UN
2	Understand concepts of PGPR and solid waste management techniques. Describe mineral phosphate solubilization for production of fertilizers.	AN
3	Communicate concepts and ideas effectively.	EL
4	Transparency, honesty and ethical reasoning in handling cells and biomolecules.	RM

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

List of Experiments:

1. Assay for dissimilatory nitrate reductase activity
2. Estimation of nitrogenase activity of free living bacteria in soils
3. Study of biooxidation of ferrous and sulphur by chemolithotrophic bacteria.
4. Adaptation of soil bacteria to metals.
5. Biosorption of heavy metals from industrial effluents.
6. Enrichment and isolation of Azodye degrading bacteria and their application in treatment of dye containing effluents

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7. Enrichment and isolation of 2,4-D degrading bacteria
8. Study of microbial mineral phosphate solubilisation activity
9. Enrichment and isolation of naphthalene degrading bacteria
10. Analysis of biosurfactant production by hydrocarbon degrading organisms
11. Estimation of microbial activity of soil by dehydrogenase assay
12. Waste water treatment:
 - a) Biological Oxygen Demand, Chemical Oxygen Demand measurement
 - b) Running of anaerobic and aerobic fluidized bed reactors
 - c) Upflow Anaerobic Sludge Blanket reactor startup and running
 - d) Analysis of reactor operation.
