GUJARAT TECHNOLOGICAL UNIVERSITY

Syllabus for M.Sc. in Industrial Biotechnology, Semester - 3

Subject Name: Environmental Biotechnology

Subject Code: 1330102 **W.E.F 2021-22**

1. Learning Outcomes

Learning Outcome Component	Learning Outcome (Learner will be able to)
Theoretical and practical understanding of Environmental Biotechnology	● At the end of the course the students will have an understanding of the fundamentals of ecology. ● Students will be able to analyse the purity of portable water by different techniques like BOD and COD.
Value applications of Environmental Biotechnology in biological research as well as in biotech-industries	● Understand concepts of PGPR and solid waste management techniques. ● Describe mineral phosphate solubilization for production of fertilizers.
Effective Communication	● Communicate concepts and ideas effectively.
Professional & Ethical Behaviour	● Transparency, honesty and ethical reasoning in handling cells and biomolecules.

LO – PO Mapping: Correlation Levels:
1 = Slight (Low); 2 = Moderate (Medium); 3 = Substantial (High), "-"= no correlation

Sub Code: 1330102	PO1	PO2	PO3	PO4	PO5	PO6	PO7
LO1: Theoretical and practical understanding of Environmental Biotechnology	2	3	2	2	2	3	2
LO2: Value applications of Environmental Biotechnology in biological research as well as in biotech-industries	2	2	3	3	2	3	2
LO3: Effective communication	3	2	2	2	3	3	2
LO4: Professional & Ethical Behaviour	2	2	2	2	3	2	3

2. Course Duration: The course duration is 45 sessions of 60 minutes each.

3. Course Contents:

Module No:	Module Content	No. of Sessions	70 Marks (External Evaluation)
1	**Biological nitrogen fixation** Physiology and biochemistry of nitrogen fixing organisms, genetics and regulation of gene expression, signaling factors and molecular	5	9

	interaction in establishing rhizobia legume symbiosis.		
2	**Biofertilizers** Phosphate Solubilizing Microorganisms, inorganic phosphate solubilization and its mechanisms, phosphate mineralizers-phytate and organic phosphate hydrolyzing bacteria, Ecto- and Endo-Mycorrhizae.	3	9
3	**Plant growth promoting rhizobacteria (PGPR)** PGPR in improving plant growth, mechanism in plant growth promotion, factors affecting rhizosphere colonization.	5	7
4	**Environmental problems and monitoring** 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 analysis; Environmental monitoring and audit; Environmental laws and policies in India.	5	10
5	**Biotreatment kinetics and reactor design** 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.	6	9
6	**Bioremediation and biodegradation** Bioremediation principles and processes, Biosorption, bioaccumulation, bioconversion, biotransformation, bioleaching, biodegradation, detoxification, activation, accumulation and co-metabolism; Strategies and techniques of	6	10

	bioremediation *in situ* and *ex situ* of hydrocarbons, pesticides and dyes; GMOs in bioremediation and biodegradation, Microbial enhanced oil recovery.		
7	**Principles of microbial diversity** 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.	6	7
8	**Fundamentals of ecology** 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.	9	9
9	**Practicals** 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 7. Enrichment and isolation of 2,4-D degrading bacteria	-	(30 marks)

	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.		

4. Pedagogy:

- ICT enabled Classroom teaching
- Practical / live assignment
- Interactive classroom discussions

5. Evaluation:
Students shall be evaluated on the following components:

	Internal Evaluation	**(Internal Assessment – 20 Marks)**
A	● Assignments	10 marks
	● Class Presence	5 marks
	● Record maintenance	5 marks
B	**Mid-Semester Examination**	**(Internal assessment-30 Marks)**
C	**End-Semester Examination**	**(External assessment-70 Marks)**

6. Reference Books:

No	Author	Name of the Book	Publisher	Year of Publication / Edition
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 Statey 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

Note: Wherever the standard books are not available for the topic appropriate print and online resources, journals and books published by different authors may be prescribed.

7. List of Journals/Periodicals/Magazines/Newspapers / Web resources, etc

- https://www.researchgate.net/publication/43451458_Environmental_microbiology_A_laboratory_manual
- https://www.sciencepublishinggroup.com/journal/index?journalid=384

Course Outcomes:

On completion of this course, students should be able to:

- Gain understanding of the basic microbiological, molecular and analytical methods extensively used in environmental biotechnology.