Programme	BS Biotechnology	Course Code	BT. 407	Credit Hours	2+1
Course Title	Environmental Biotechnology				

Course Introduction

The course is designed to acquaint students with conservation and reclamation of environment through biotechnology This course offers a comprehensive introduction to environmental biotechnology, covering the fundamentals of biological intervention and genetic manipulation strategies.

Learning Outcomes

On the completion of the course, the students will:

- Describe biotechnological approaches for environmental remediation.
- Explain the role of microbes and plants in waste treatment and pollution control.
- Evaluate the use of biotechnology in sustainable environmental management.

Course Content

Theory Unit

- Introduction to Environmental biotechnology & Fundamentals of Biological Intervention, Bioremediation and Phytoremediation, Endocrine disruptors, Pollution and Sewage treatment, How are GMOs generated, Bioreactors, Genetic manipulation strategies, Future prospects for gene transfer methodologies
- Extremophiles: Thermophiles, Cryophiles and Halophiles, Barophiles, Acidophiles, Alkaliphiles, Radioresistors and Tradigrades
- Metagenomics and bioremediation (culture independent insight)
- Proteomics insights in bioremediation,
- Role of LC-MS in identification of proteins, Preparation of microbial protein sample for LC-MS analysis, Mascot software (interpretation of LC-MS spectra)
- Environment biotechnology and sustainability, Contextualizing biotechnology and sustainable development
- Biotechnology R and D, Microbial enhanced oil recovery (MEOR)
- Environmental toxicology: Adverse effects, branches of toxicology, Toxicological process, Toxicokinetics, Toxicodynamics, Persistent organic pollutants (POPs)
- Pollution indicators / bioindicators: Use, classification, microbial, plant and animal systems,
- selection of bioindicator, bioindicators vs traditional methods
- Introduction to pollution, types and control strategies
- Biology of waste water and its treatment: Classification of bioreactors
- Sludge treatment, types, composition, process design, anaerobic and aerobic digestion processes
- Phytotechnology: Terrestrial Phyto-systems
- Hyperaccumulation, photovolatilization, treatment systems, metal Phytoremediation
- Production of bioenergy from energy crops used in remediation of soils contaminated with heavy metals, Phytostabilization, Solid Waste treatments
- Integrated Environmental biotechnology, Biodegradation: Introduction, history, types, factors, Acclimation, sorption and advantages

- Biotransformation: Consequences, phases of metabolism, drug metabolizing enzymes
- Phytoremediation: Mechanism, types of plants used and advantages and disadvantages
- Rhizofiltration: Sources of pollution in ground water, steps of rhizofiltration, plants to be selected and factors affecting rhizofiltration
- Biochemistry techniques and bioremediation, Application of biochemistry in bioremediation , Techniques of biochemistry (GC-MS, LC-MS, FTIR)
- Molecular techniques in bioremediation, PCR and gel electrophoresis, oligos for hydrocarbon degraders, detection by PCR, DNA hybridization, DNA sequencing, TRFLP (Real time TRFLP), DGGE, Microarrays, RT-PCR, Stable isotope probing (SIP) and Fluorescent in-situ hybridization (FISH)
- Metabolic or pathway engineering: Goals, methods, approaches, applications, Biofuels: Applications, classification and advantages
- Bioplastics: History, examples, types, mechanism of production, disadvantages and advantages.
- Biopesticides: Introduction, advantages and types

Practical Unit-

- Bacteriology of Drinking water
- Microscopic studies of water specimens collected from various locations
- Isolation of plastic degrading bacteria from plastic contaminated soil through serial dilution method
- Extraction, preparation and identification of bioremediation associated bacterial enzymes through LC-MS
- Isolation of BTEX degrading bacteria from tannery industry effluent through enrichment culture technique
- Confirmation of bioremediation associated enzymes of bacteria via zymography.
- Extraction of metabolites and proteins of bacteria
- Identification of metabolites produced through bacterial bioremediation via GC-MS and LC-MS
- Confirmation of organic pollutant degradation by bacteria via FTIR analysis
- Isolation of nicotine degrading bacteria from tobacco field soil through serial dilution methods
- Assessment of nicotine degrading efficiency of bacteria through standard curve method
- Assessment of toluene degradation potential of bacteria through solvent extraction and spectrophotometric methods
- Estimate the plastic degradation efficiency of bacteria through weight reduction assay
- Estimate the petrol degradation efficiency of petrol metabolizing bacteria by using Dichlorophenolindophenol (DCPIP)
- Field survey of polluted areas
- Study for pollution indicators (Plants and Microorganisms)

Textbooks and Reading Material

Textbooks.

- Arvind, D. Hemen, S. and Sanket, J. (2022). Biotechnology for sustainable environment. Springer Nature Singapore. ISBN: 9789811619571, 9811619573.
- Gothandam, K. M., Srinivasan, R., Ranjan, S., Dasgupta, N., and Lichtfouse, E. (2021). *Environmental Biotechnology* Volume 4 (Vol. 68). Springer International Publishing.
- Rafael Luque, Carol Sze Ki Lin, Karen Wilson, and James Clark (2016) *Handbook of Biofuels Production: Processes and Technologies. 2nd Edition.* Woodhead Publishing.
- Hurst, C. J., Crawford, R. L., Garland, J. L., & Lipson, D. A. (2007). *Manual of Environmental Microbiology* (3rd ed.). American Society for Microbiology Press.
- Bhattacharyya, B. C., & Banerjee, R. (2007). *Environmental biotechnology.* Oxford Higher Education.
- Spencer, J. F. T. and De Spencer, A. L. R. (2004). E*nvironmental Microbiology: Methods and Protocols.* Humana Press.

Articles (For Practicals).

- Muccee, F., Ejaz, S., & Riaz, N. (2019). *Toluene degradation via a unique metabolic route in indigenous bacterial species*. Archives of Microbiology.
- Mohammadpour, H., Shahriarinour, M., & Yousefi, R. (2020). *Benzene Degradation by Free and Immobilized Bacillus glycinifermantans Strain GO-13T Using GO Sheets.* Polish Journal of Environmental Studies.
- Hussain, N., Muccee, F., Hammad, M., Mohiuddin, F., Bunny, S. M., & Shahab, A. (2024). *Molecular and metabolic characterization of petroleum hydrocarbons degrading Bacillus cereus.* Polish Journal of Microbiology.
- Jardine, J., Stoychev, S., Mavumengwana, V., & Ubomba-Jaswa, E. (2018). *Screening of potential bioremediation enzymes from hot spring bacteria using conventional plate assays and liquid chromatography - Tandem mass spectrometry (Lc-Ms/Ms).* Journal of Environmental Management.

Teaching Learning Strategies

- Lecturing
- Written Assignments
- Class activities
- Class discussion

Assignments: Types and Number with Calendar

- 1st Quiz in 4th Week of 5 marks
- 2nd Quiz in 10th Week of 5 marks
- 3rd Quiz in 14th Week of 5 marks
- 1st Assignment in 8th Week of 10 marks

Assessment

Sr. No.	Elements	Weightage	Details
1	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.

2	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.