DEPARTMENT OF ENVIRONMENTAL SCIENCE

Category-I

BSC (H) ENVIRONMENTAL SCIENCE

DISCIPLINE SPECIFIC CORE COURSE – 7 (DSC-EVS-7): ENVIRONMENTAL BIOTECHNOLOGY

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSC-EVS-7: ENVIRONMENTAL BIOTECHNOLOGY	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Provide theoretical and practical biotechnological skills for environmental goals
- Evolve ecological foundations of using microorganisms in biodiversity assessment, ecosystems restoration, and environmental remediation
- Relate the microbial ecophysiology with biogeochemical cycles that govern the terrestrial ecosphere
- Emphasize the relevance of biotechnological processes in environmental applications and sustainable development

Learning outcomes

After this course, students will be able to learn the following skills.

- Apply the biotechnological methods to improve environmental management
- Perform comparative protein and DNA sequence analyses to elucidate the phylogenetic relationship
- Analyze non-culturable microbial diversity in the environment and classify microbes based on energy and carbon metabolism
- Plan methods for combined biological nutrient removal (BNR), treat wastewater, and remedify soils and water contaminated with organic and inorganic pollutants

SYLLABUS OF DSC-EVS-7

UNIT – I The Structure and Function of DNA, RNA and Protein (7 Hours)

DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation, and renaturation kinetics; biological significance of different forms; Synthesis.

RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.

Protein: hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; post-translational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).

Central dogma of biology; genetic material prokaryotes, viruses, eukaryotes and organelles; mobile DNA; chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin).

UNIT – II Recombinant DNA Technology (7 Hours)

Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA: restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase); genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays

UNIT – III Ecological restoration and bioremediation (10 Hours)

Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; treatment schemes for wastewater: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment); specific bioremediation technologies: land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat method, constructed wetlands, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; advantages and disadvantages; degradation of xenobiotics in the environment, decay behavior and degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

UNIT – IV Ecologically safe products and processes (6 Hours)

PGPR bacteria: biofertilizers, microbial insecticides, and pesticides; bio-control of the plant pathogen, Integrated pest management; development of stress-tolerant plants, biofuel; mining and metal biotechnology: microbial transformation, accumulation, and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uranium extraction.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Undertake comparative analyses of the ultrastructure of cells and cellular organelles of prokaryotes and eukaryotes.

2. Analyze UV absorption spectra of DNA, RNA and protein
3. Determine denaturation and renaturation of dsDNA
4-5. Estimate contents of DNA and protein in the given samples
6. Visit contaminated or degraded habitats and analyze their vegetation characteristics and compare them with pristine habitat
7. Characterize and analyze plants documented in practical 6 to identify species having the potential for phytoremediation
8-10. Isolate phosphate-solubilizing bacteria from different soils and assess morphological and functional variations in phosphate-solubilizing bacteria
11. Determine bacterial density in soils sampled from contaminated and pristine habitat
12. Visit and analyze various steps of Sewage/Wastewater treatment processes (STP/WTP).
13-15. Explore and use different molecular databases for application in environmental science

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Essential/recommended readings

- Furlong, J. and Evans, G.G., 2011. Environmental Biotechnology: Theory and Application. John Wiley & Sons.
- Jordening, H.J. & Winter J. 2005. Environmental Biotechnology: Concepts and Applications. John Wiley& Sons.
- Nelson, D.L. & Cox, M.M. 2013. Lehninger's Principles of Biochemistry. W.H. Freeman.
- Rittman, B.E. & McCarty, P.L. 2020. Environmental Biotechnology. Principles and Applications. McGraw-Hill, New York.
- Snustad, D.P. & Simmons, M.J. 2011. Principles of Genetics (6th edition). John Wiley& Sons.
- Vallero, D., 2015. Environmental Biotechnology: A Biosystems Approach. Academic Press.
- Wainwright, M., 2012. An introduction to Environmental Biotechnology. Springer Science & Business Media.

Suggestive readings

- Lodish, H., Berk, A., Kaiser, C.A., Kaiser, C., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P., 2008. Molecular Cell Biology. Macmillan.
- Moo-Young, M., Anderson, W.A. and Chakrabarty, A.M. eds., 2013. Environmental Biotechnology: Principles and Applications. Springer Science & Business Media.
- Petre, M. ed., 2013. Environmental Biotechnology: New Approaches and Prospective Applications. InTech, Crotia.
- Scagg, A.H. 2005. Environmental Biotechnology. Oxford University Press.
- Souvorov, A.V. 1999. *Marine Ecologonomics: The Ecology and Economics of Marine Natural Resource Management*. Elsevier Publications.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.