

**DISCIPLINE SPECIFIC CORE COURSE – 9:
ENVIRONMENTAL MICROBIOLOGY**

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		
MICROB-DSC303: ENVIRONMENTAL MICROBIOLOGY	4	3	0	1	Class XII pass with Biology/ Biotechnology/ Biochemistry	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this paper is to provide students with in-depth knowledge of diverse microbial populations/ communities present in different habitats in the ecosystem.
- Students will become aware of the inter-microbial, microbe-plant and microbe-animal interactions and their benefits. The students will also learn about the management of solid and liquid waste and different strategies for microbial remediation of environment pollutants.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to discuss natural habitats of diverse microbial populations and give an overview of the concept of metagenomics.
- Student will be able to analyse various positive and negative interactions amongst microbes and also between microbes and plants / animals.
- Student will be able to explain the importance of microorganisms in mineral cycling within an ecosystem, and their effects on the environment.
- Student will be able to discuss various methods involved in sewage treatment, how we can make water safe for drinking, and various methods for testing water potability.
- Student will be able to evaluate different waste management strategies using microorganisms.
- Student will be able to describe various methods of microbial remediation for treating pollutants present in our environment. Student will be able to determine the importance of quality control in the food industry and describe various indices being used to measure quality and safety in the food industry.

SYLLABUS OF DSC-9

UNIT – I (11 hours)

Natural habitats and their microbial communities: Concepts of habitat, niche. Autochthonous, allochthonous, zymogenous microorganisms. Colonization and succession. Lithosphere: Soil profile, soil characteristics: physical and chemical, soil microbial community. Hydrosphere: Freshwater habitat: stratification and microbial composition of lake. Marine habitat: stratification and microbial composition of ocean. Atmosphere: atmosphere as microbial habitat, dispersal of microorganisms/spores, bioaerosols, methods of air sampling (filtration and deposition). Extreme habitats with reference to temperature, hydrostatic pressure, salinity and low nutrient levels. Concept of metagenomics, use of metagenomics to profile microbial communities in natural habitats.

UNIT – II (9 hours)

Interactions of microbial populations: Microbe-microbe interactions. Positive interactions: mutualism, proto cooperation, commensalism. Negative interactions: antagonism, competition, predation, parasitism. Microbe-plant interactions. Symbiotic association: microbes associated with roots and aerial plant surfaces, leguminous roots-rhizobium symbiosis, Anabaena-Azolla symbiosis, mycorrhizal and actinorhizal associations. Microbe- animal interactions. Microflora in ruminant gut, nematophagous fungi and symbiotic luminescent bacteria.

UNIT – III (9 hours)

Mineral cycling by microbes and their effects on the environment : Importance of biogeochemical cycles. Carbon cycle: microbial degradation of cellulose, lignin and chitin, Nitrogen cycle: nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction. Phosphorus cycle: solubilisation and immobilization. Sulphur cycle: oxidative and reductive sulphur transformation, metal corrosion, acid mining drainage, nitrate pollution

UNIT – IV (9 hours)

Wastewater treatment and water potability: Sources and composition of liquid waste. Sewage strength: BOD and COD. Primary, secondary (aerobic: trickling filter, activated sludge process; anaerobic: septic tank, anaerobic sludge digester) and tertiary sewage treatment. Treatment and safety of drinking (potable) water, Methods to detect potability of water samples: standard qualitative procedure - presumptive test/MPN test, confirmed and completed tests for fecal coliforms; membrane filter technique and Presence/Absence tests for coliforms, Indicator microorganisms.

UNIT – V (7 hours)

Disposal of solid waste by microbes and microbial remediation of environment: Sources and types of solid waste. Methods of solid waste disposal: sanitary landfills, composting (static piles, aerated piles and continuous feed reactors). Concepts of xenobiotics, recalcitrant compounds and bioremediation. Biodegradation of pesticides (DDT and Propanil), oil spills, e-waste and plastics.

Practical component

30 Hours

UNIT 1: (15 hours)

Soil microflora:

Study of the presence of microbial activity in soil by qualitative detection of enzyme activity: dehydrogenase, amylase, urease. Microbial interactions: Isolation and quantitation of bacteria from rhizosphere and root-free soil to determine the rhizosphere effect. Isolation of symbiotic and non-symbiotic nitrogen fixers: *Rhizobium* and *Azotobacter* or *Azospirillum*.

Unit 2: (15 hours)

Mineral cycling and waste management by microbial remediation: Demonstration of phosphate solubilization by plate isolation method. Student group project: Preparation of Winogradsky column mini aquatic ecosystem. Assessment of the microbiological quality of water by standard qualitative procedures. Determination of BOD of wastewater sample by Dissolved Oxygen Electrode method/ Winkler's method. **Student group project:** Sewage surveillance in the fight against COVID19.

Essential/recommended readings

Theory:

1. Brock Biology of Microorganisms by M.T. Madigan, J. Aiyer, D. Buckley, W. Sattley and D. Stahl. 16th edition. Pearson, USA. 2021.
2. Microbial bioremediation by P. Rajendran and P. Gunasekaran. 1st edition, MJP Publishers, India. 2019.
3. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
4. Environmental microbiology by K.V. Ramesh. MJP Publisher. 2019.
5. Soil Microbiology by N.S. Subba Rao. 5th edition. Medtech, India. 2017.
6. Wastewater Microbiology by D.H. Bergey. Medtech, India. 2014.
7. Environmental Biotechnology by M. Jain. 1st Edition. Alpha Science International Ltd. 2014.
8. Environmental Microbiology edited by I.L. Pepper, C.P. Gerba, T.J. Gentry. 3rd edition. Academic Press, USA. 2014.
9. Microbial ecology by L.L. Barton and D.E. Northrup. 1st Edition. John Wiley & Sons. 2011.
10. Environmental Microbiology of Aquatic and Waste Systems by N. Okafor. Springer, USA. 2011.
11. Environmental Biotechnology: Basic Concepts and Applications by I.S. Thakur. 2nd Edition. I K International Publishing House Pvt. Ltd. 2011.
12. Advances in Applied Bioremediation edited by A. Singh, R.C. Kuhad and O. P. Ward. Springer-Verlag, Germany. 2009.
13. Microbial Ecology: Fundamentals and Applications by R.M. Atlas, R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.
14. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA. 1997.

Practicals:

1. Benson's Microbiological Applications, Laboratory Manual in General Microbiology by A. Brown and H. Smith. 15th edition. McGraw-Hill Education, USA. 2022.
2. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
3. Experiments in Microbiology, Plant Pathology and Biotechnology by K. R. Aneja. 5th edition. New Age International Publishers, India. 2017.
4. Manual of Environmental Microbiology by C. J., Hurst, R. L., Crawford, J. L., Garland and D. A. Lipson. American Society for Microbiology Press. USA. 2007.
5. Microbial Ecology: Fundamentals and Applications by R.M. Atlas and R. Bartha. 4th edition. Benjamin Cummings, USA. 2000.
6. Methods in Applied Soil Microbiology and Biochemistry by K. Alef and P. Nannipieri. 1st edition. Academic Press, USA. 1995.

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