

<b>YEAR - I</b>	<b>MICROBIAL ECOLOGY</b> (For those students admitted in the year 2021 – 22 and onwards)	<b>21PMB14</b>
<b>SEMESTER - I</b>		<b>HRS/WK - 4</b>
<b>CORE - 4</b>		<b>CREDITS - 4</b>

**Objective:** To make the students understand the importance of microorganisms in ecology and their applications.

**Course Outcomes:**

Upon successful completion of the course, the student:

**CO1:** Gains knowledge about the basics of microbial ecology

**CO2:** Acquires knowledge about microbial interactions in various ecosystems

**CO3:** Understands the role of microorganisms in cycling of nutrients and biodegradation of pollutants

**CO4:** Gains knowledge about role of microorganisms in wastewater treatment

**CO5:** Acquires knowledge about quantitative studies and microbial applications in environment

SEMESTER: I	COURSE CODE: 21PMB14				COURSE TITLE: MICROBIAL ECOLOGY				HOURS: 4	CREDITS: 4
COURSE OUTCOMES	PROGRAMME OUTCOMES (PO)				PROGRAMME SPECIFIC OUTCOMES (PSO)				MEAN SCORE OF COs	
	PO1	PO2	PO3	PO4	PSO1	PSO2	PSO3	PSO4		
CO1	4	3	4	4	4	4	3	3	3.62	
CO2	4	4	4	3	4	4	3	4	3.75	
CO3	4	3	4	3	4	4	4	3	3.62	
CO4	4	4	4	3	3	4	4	4	3.75	
CO5	4	4	4	3	4	4	3	4	3.75	
<b>Mean Overall Score</b>									<b>3.70</b>	

**Result:** The score of this course is 3.7 (High)

Association	1%-20%	21%-40%	41%-60%	61%-80%	81%-100%
Scale	1	2	3	4	5
Interval	0<=rating<=1	1.1<=rating<=2	2.1<=rating<=3	3.1<=rating<=4	4.1<=rating<=5
Rating	Very Poor	Poor	Moderate	High	Very High

This Course is having **HIGH** association with Programme Outcomes and Programme Specific Outcomes.

**Unit – 1**

(12 Hrs)

Microbial communities – terminology, ecological hierarchy, ecological niche; Microbial colonization - energy flow in ecosystem - Environmental factors affecting microbial populations; Adaptation of microorganisms in various ecosystem – **Atmosphere - Microbiology of air, droplet nuclei, aerosols, enumeration of microorganisms in air, air sanitation, Laboratory hazards, airborne diseases.**

**Unit – 2**

(12 Hrs)

Interaction of microorganisms with their physical and chemical environments; marine ecosystem - mangroves, estuaries, deep seas and hydrothermal vents; fresh water ecosystem - lakes, rivers, ponds; terrestrial ecosystem - rock and soil, prairie, forest, tundra; extreme environments - hot springs, glaciers and acid-mine drainage; interaction of microorganisms with plants, animals and microorganisms.

**Unit – 3** (12 Hrs)

Biogeochemical cycles - carbon, nitrogen, sulfur, iron, and phosphorus cycles; adaptation of microorganisms to toxic pollutants; biodegradation of xenobiotics (pesticides, heavy metals, hydrocarbons) – mechanisms.

**Unit – 4** (12 Hrs)

Waste water treatment - primary, secondary (anaerobic and aerobic - trickling, activated sludge, oxidation pond), Sludge digestion, Disposal; Drinking water treatment – chlorination; Microbiological standards of water; Water pollution - indicators of water pollution - BOD – COD - techniques for the study of water pollution; Waterborne diseases.

**Unit – 5** (12 Hrs)

Quantitative microbial ecology - Culture based methods and molecular based methods; Composting – landfills; Biobleaching of metals; Biodeterioration of paint, textile and leather; biofouling; Biofilms; Microbial enhanced oil recovery.

**Text Book**

- Microbial Ecology - Fundamental and Applications. 4<sup>th</sup> Edition, 1998. Atlas & Bartha, Benjamin/ Curmmings Publishing Company, Inc., California

**Reference Books**

- Environmental Microbiology. 1981. Grant W. D. and Long P.E. Blackie and Son Ltd., Glasgow.
- Aquatic Microbiology. 2<sup>nd</sup> Edition, 1980. Rheinheimer, G. Jhon Wiley & Sons. New York.
- Environmental Aspects of Microbiology. 1996. Joseph C. Daniel. Brightsun Publications, Chennai.
- Environmental Microbiology. 2<sup>nd</sup> Edition, 2016. Mitchell, R and J.I. DongGu. John Wiley, New York.

<b>YEAR – I</b>	<b>LAB COURSE – I</b> (For those students admitted in the year 2021 – 22 and onwards)	<b>21PMBP11</b>
<b>SEMESTER - I</b>		<b>HRS / WK - 8</b>
<b>PRACTICAL</b>		<b>CREDITS - 4</b>

### **EXPERIMENTS IN BASIC MICROBIOLOGY**

1. Gram staining
2. Negative staining
3. Capsule staining
4. Spore staining
5. Hanging drop technique
6. Catalase test
7. Oxidase test
8. Indole test
9. Methyl red test
10. Voges proskauer test
11. Citrate utilization test
12. Urease test
13. Triple sugar iron agar test
14. Lysine iron agar test
15. Nitrate reduction test
16. Slide culture for fungi

### **EXPERIMENTS IN IMMUNOLOGY**

1. Separation of serum
2. Separation of plasma
3. ABO blood grouping by reverse grouping
4. ASO semi quantitative test
5. Single radial immunodiffusion
6. Double immuno diffusion
7. Rocket immuno electrophoresis
8. Serum electrophoresis
9. Isolation of lymphocytes
10. Dot ELISA

## **EXPERIMENTS IN ENVIRONMENTAL MICROBIOLOGY**

1. Enumeration of total coliform by MPN method
2. Enumeration of faecal coliform by MPN method
3. Membrane filter technique
4. Biochemical oxygen demand
5. Nitrogen cycle:
  - a. Ammonification
  - b. Nitrification
  - c. Denitrification

## **EXPERIMENTS IN BIOSTATISTICS**

1. Testing the difference between means of two samples (independent)
2. Testing the difference between means of two samples (dependent)
3. Chi square test for independence of attributes
4. F – test (or) the variance ratio test
5. One way analysis of variance (anova)
6. Randomized block design (rbo)
7. Latin square design(lsd)

## **EXPERIMENTS IN BIOINFORMATICS**

1. Pairwise alignment
2. Blast

<b>YEAR – I</b>	<b>METHODS IN BIOLOGY</b> (For those students admitted in the year 2021 – 22 and onwards)	<b>21EPM26A</b>
<b>SEMESTER - II</b>		<b>HRS / WK - 3</b>
<b>ELECTIVE – IV A</b>		<b>CREDIT - 2</b>

**Objective:**

To make the students familiar with techniques routinely used in bio sciences

**Course Outcomes:**

Upon successful completion of the course, the student:

**CO1:** acquire the knowledge about the study of advanced techniques in biology

**CO2:** gains the knowledge about the biophysical techniques used to detect functional structure of biological samples

**CO3:** gets insight knowledge about radioisotopes and its application

**CO4:** gets depth insights about the electrophysiological methods.

**CO5:** acquires the knowledge about the animal population and migration through remote sensor technique.

<b>SEMESTER: II</b>	<b>COURSE CODE: 21EPM26A</b>				<b>COURSE TITLE: METHODS IN BIOLOGY</b>				<b>HOURS: 3</b>	<b>CREDITS: 2</b>
<b>COURSE OUTCOMES</b>	<b>PROGRAMME OUTCOMES (PO)</b>				<b>PROGRAMME SPECIFIC OUTCOMES (PSO)</b>				<b>MEAN SCORE OF COs</b>	
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>		
<b>CO1</b>	4	3.5	4	3.5	4	4	4	4	<b>3.87</b>	
<b>CO2</b>	3.5	3.5	4	4	4	3.5	3.5	4	<b>3.75</b>	
<b>CO3</b>	4	3.5	4	4	3.5	4	4	4	<b>3.56</b>	
<b>CO4</b>	3	3.5	3.5	4	4	3	3	3.5	<b>3.87</b>	
<b>CO5</b>	3.5	3.5	3.5	3.5	4	3.5	3	3.5	<b>3.50</b>	
<b>Mean Overall Score</b>									<b>3.71</b>	

**Result:** The score of this course is 3.71 (High)

<b>Association</b>	<b>1%-20%</b>	<b>21%-40%</b>	<b>41%-60%</b>	<b>61%-80%</b>	<b>81%-100%</b>
<b>Scale</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Interval</b>	<b>0&lt;=rating&lt;=1</b>	<b>1.1&lt;=rating&lt;=2</b>	<b>2.1&lt;=rating&lt;=3</b>	<b>3.1&lt;=rating&lt;=4</b>	<b>4.1&lt;=rating&lt;=5</b>
<b>Rating</b>	<b>Very Poor</b>	<b>Poor</b>	<b>Moderate</b>	<b>High</b>	<b>Very High</b>

This Course is having **HIGH** association with Programme Outcomes and Programme Specific Outcomes.

**Unit 1**

**(9 Hrs)**

**Biophysical methods:** Analysis of biomolecules using UV/visible, fluorescence, atomic force microscope, circular dichroism, NMR and ESR spectroscopy

**Unit 2**

**(9 Hrs)**

**Biophysical methods:** structure determination using X-ray diffraction, X-ray photoelectron spectroscopy; analysis using light scattering, different types of mass spectrometry, Optical Tweezers

**Unit 3** (9 Hrs)

**Radiolabeling techniques:** Properties of radioisotopes, their detection and measurement; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines for removal of radioactive wastes.

**Unit 4** (9 Hrs)

**Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT

**Unit 5** (9 Hrs)

**Methods in field biology:** Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods.

**Text Book**

- Biophysical Chemistry Principles and Techniques, (4<sup>th</sup> Edition) Upadhyay, Upadhyay and Nath, 2009, Himalaya Publications, India

**Reference Book**

- A Biologists guide to Principles and Techniques of Practical Biochemistry, (8<sup>th</sup> Edition), Wilson and Walker, 2018, Cambridge University Press.
- Physical Biochemistry, (2<sup>nd</sup> Edition) David Freifelder, 1982, W. H. Freeman and Company, New York.
- Modern Experimental Biochemistry (3<sup>rd</sup> Edition) Boyer, R. 2000, Addison Wesley Longman.
- Fundamentals and Techniques of Biophysics and Molecular Biology, (1<sup>st</sup> edition), Pranavkumar, 2016, Pathfinder Publication, New Delhi.
- Biophysics Tools and Techniques, (1<sup>st</sup> edition), Mark C. Leake, 2016, CRC press. UK

<b>YEAR - II</b>	<b>SOIL AND AGRICULTURAL MICROBIOLOGY</b> (For those students admitted in the year 2021 – 22 and onwards)	<b>21PMB31</b>
<b>SEMESTER - III</b>		<b>HRS/WK - 4</b>
<b>CORE - 9</b>		<b>CREDITS - 4</b>

**Objective:** To make the students understand the importance of microbiology in the field of soil and agriculture

**Course Outcomes:**

Upon successful completion of the course, the student:

**CO1:** Understands the soil properties and the role of soilborne microbes

**CO2:** Understands the cyclical movements of important plant nutrients in the soil

**CO3:** Gains knowledge about different biofertilizers and their production

**CO4:** Understands different biopesticides and their applications

**CO5:** Knows important plant diseases of India and their control

<b>SEMESTER: III</b>	<b>COURSE CODE: 21PMB31</b>				<b>COURSE TITLE: SOIL AND AGRICULTURAL MICROBIOLOGY</b>				<b>HOURS: 4</b>	<b>CREDITS: 4</b>
<b>COURSE OUTCOMES</b>	<b>PROGRAMME OUTCOMES (PO)</b>				<b>PROGRAMME SPECIFIC OUTCOMES (PSO)</b>				<b>MEAN SCORE OF COs</b>	
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>		
<b>CO1</b>	4	3.5	4	3.5	4	4	4	4	<b>3.87</b>	
<b>CO2</b>	3.5	3.5	4	4	4	3.5	3.5	4	<b>3.75</b>	
<b>CO3</b>	3.5	3	4	3.5	3.5	4	3.5	3.5	<b>3.56</b>	
<b>CO4</b>	3	3.5	3.5	3.5	4	3.5	3	3.5	<b>3.43</b>	
<b>CO5</b>	3.5	3.5	3.5	4	4	3.5	3	4	<b>3.62</b>	
<b>Mean Overall Score</b>									<b>3.64</b>	

**Result:** The score of this course is 3.64 (High)

<b>Association</b>	<b>1%-20%</b>	<b>21%-40%</b>	<b>41%-60%</b>	<b>61%-80%</b>	<b>81%-100%</b>
<b>Scale</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Interval</b>	<b>0&lt;=rating&lt;=1</b>	<b>1.1&lt;=rating&lt;=2</b>	<b>2.1&lt;=rating&lt;=3</b>	<b>3.1&lt;=rating&lt;=4</b>	<b>4.1&lt;=rating&lt;=5</b>
<b>Rating</b>	<b>Very Poor</b>	<b>Poor</b>	<b>Moderate</b>	<b>High</b>	<b>Very High</b>

This Course is having **HIGH** association with Programme Outcomes and Programme Specific Outcomes.

**Unit –1**

**(12Hrs)**

Soil- Chemical and physical properties of soil -Types-Soil as a habitat for microbes - Microflora of various soil types-Influence of soil and environmental factors on soil microflora - Role of microorganisms in soil fertility- Interaction among soil microorganisms- Interaction between plants and microorganisms - Rhizosphere, Phyllosphere, Spherosphere; Effect of soil borne microbes on plant (Harmful and Beneficial) - Plant Growth Promoting Rhizobacteria (PGPR), Mechanisms of plant growth promotion by PGPR.

**Unit –2**

**(12Hrs)**

Microorganisms in soil process - Carbon cycle, Nitrogen cycle, Iron cycle, Phosphorus cycle - Nitrogen fixation – Types - symbiotic, free living and associative symbiotic - Mechanism of nitrogen fixation- Genetics of nitrogen fixation- Solubilization of nutrients (P, K and Zn) - Mobilization of nutrients (Mycorrhizae).

### Unit - 3

(12Hrs)

Biofertilizers - Definition, types and importance - Standards and quality control- Carrier materials- Isolation and mass multiplication of bacterial biofertilizers (*Rhizobium*, *Azospirillum*, *Azotobacter*, *Pseudomonas*) - Isolation and mass multiplication of fungal biofertilizer (VAM) - Isolation and mass multiplication of algal biofertilizers (BGA, *Azolla*)- Applications - National and regional biofertilizers production and development centers- Advantages and disadvantages of biofertilizers.

### Unit –4

(12Hrs)

Problems associated with chemical pesticides; Biocontrol agents – Definition, Types and importance, Examples and mechanisms of controlling – *Bacillus thuringiensis*, *Pseudomonas fluorescens*, *Trichoderma viridae*, NPV, Entamopathogenic protozoa and Entamopathogenic nematodes - Production and applications; Advantages and disadvantages; Microbial genes in creation of pest resistant plants.

### Unit –5

(12Hrs)

Microbial Diseases of plants - disease symptoms, - mode of entry of pathogens – factors affecting disease incidence - control measures - Examples -Bacterial Diseases: Bacterial Blight of Paddy, Citrus Canker - *Mycoplasma* Diseases: Rice Yellow Dwarf, Grassy shoot of sugarcane, Fungal Diseases: Late Blight of Potato, Downy Mildew of Maize, Rust of Wheat, Wilt of Cotton, Leaf Spot of Turmeric, Blast disease of Rice, Mango Anthracnose - Viral Diseases: Leaf Curl of Tomato, Yellow Vein Mosaic of Bhendi – Nematode Diseases: Ear Cockle of Wheat, root knot of vegetables.

### Text Books

- Soil Microbiology - Soil microorganisms and Plant growth. 4<sup>th</sup> Edition, 2017. Subba Rao, N.S. Oxford & IBH publishing Co. Pvt. Ltd.
- Agricultural microbiology. 2<sup>nd</sup> Edition, 2004. Rangaswami, G., and Bhagyaraj, D.J. Prentice Hall of India, New Delhi.

### Reference Books

- Plant diseases. 10<sup>th</sup> Edition. Singh, R.S. 2017. Medtech, New Delhi
- Diseases of crop plants in India. 1998. 4<sup>th</sup> Edition. G. Rangaswami, A. Mahadevan. Prentice - Hall of India Private Ltd., New Delhi.
- A Text book of Microbiology. 2013. Dubey, R.C., and Maheshwari, D.K. S Chand Publishing, New Delhi.
- Biofertilizers: Commercial production Technology and quality control. Hyma, P. 2017. Random publishers. New Delhi.
- Biofertilizer Technology. 2019. Ramanathan, N. Kalyani Publishers, New Delhi.



YEAR – II	<b>LAB COURSE – III</b> (For those students admitted in the year 2021 – 22 and onwards)	21PMP33
SEMESTER - III		HRS / WK - 8
PRACTICAL		CREDITS - 4

### **EXPERIMENTS IN AGRICULTURAL MICROBIOLOGY**

1. Enumeration of bacteria from soil
2. Enumeration of fungi from soil
3. *Rhizobium* Isolation
4. Rhizosphere effect
5. Isolation and Enumeration of Phosphate utilizing bacteria

### **EXPERIMENTS IN MICROBIAL BIOTECHNOLOGY**

1. Isolation of Actinomycetes
2. Isolation and enumeration of *Azospirillum* from soil
3. Isolation and enumeration of *Azotobacter* from soil
4. Carrier based inoculum preparation for biofertilizer
5. Immobilization of Amylase enzyme
6. Sterility test

### **EXPERIMENTS IN FOOD MICROBIOLOGY**

1. MBRT
2. Resazurin Test
3. Isolation of *Vibrio* from marine food

### **EXPERIMENTS IN MOLECULAR BIOLOGY**

1. Agarose gel electrophoresis
2. Isolation of Bacterial Genomic DNA
3. Isolation of Plasmid DNA
4. Preparation of acetate buffer
5. Lowry's method for protein estimation

<b>YEAR - II</b>	<b>MICROBIAL BIOTECHNOLOGY</b> (For those students admitted in the year 2021 – 22 and onwards)	<b>21PMB41</b>
<b>SEMESTER - IV</b>		<b>HRS/WK - 4</b>
<b>CORE - 13</b>		<b>CREDITS - 4</b>

**Objective:** To make the students familiar with applications of microbiology

**Course Outcomes:**

Upon successful completion of the course, the student:

**CO1:** learns about Microbial enzyme technology and Biotransformation

**CO2:** becomes familiar with the microbial products of industrial fermentations

**CO3:** acquires knowledge about the use of microorganisms in the production of biopolymers

**CO4:** gains knowledge about biotechnological applications available for environmental issues

**CO5:** understands the possibilities of entrepreneurship in microbiology

<b>SEMESTER: IV</b>	<b>COURSE CODE: 21PMB41</b>				<b>COURSE TITLE: MICROBIAL BIOTECHNOLOGY</b>				<b>HOURS: 4</b>	<b>CREDITS: 4</b>
<b>COURSE OUTCOMES</b>	<b>PROGRAMME OUTCOMES (PO)</b>				<b>PROGRAMME SPECIFIC OUTCOMES (PSO)</b>				<b>MEAN SCORE OF COs</b>	
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>		
<b>CO1</b>	3.5	3.5	4	3.5	4	3	4	3	3.56	
<b>CO2</b>	4	4	3.5	4	3	3.5	3.5	4	3.69	
<b>CO3</b>	3.5	3.5	4	3	4	3.5	4	3.5	3.63	
<b>CO4</b>	4	4	3.5	3	3.5	4	3	3	3.50	
<b>CO5</b>	4	3.5	4	3	4	3.5	4	3	3.63	
<b>Mean Overall Score</b>									<b>3.60</b>	

**Result:** The score of this course is 3.60 (High)

<b>Association</b>	<b>1%-20%</b>	<b>21%-40%</b>	<b>41%-60%</b>	<b>61%-80%</b>	<b>81%-100%</b>
<b>Scale</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>Interval</b>	<b>0&lt;=rating&lt;=1</b>	<b>1.1&lt;=rating&lt;=2</b>	<b>2.1&lt;=rating&lt;=3</b>	<b>3.1&lt;=rating&lt;=4</b>	<b>4.1&lt;=rating&lt;=5</b>
<b>Rating</b>	<b>Very Poor</b>	<b>Poor</b>	<b>Moderate</b>	<b>High</b>	<b>Very High</b>

This Course is having **HIGH** association with Programme Outcomes and Programme Specific Outcomes.

**Unit - 1**

**(12 Hrs)**

**Introduction and Basics:** History and Scope of Microbial Biotechnology – Enzyme technology - production of microbial enzymes (amylase, pectinases, cellulase) - Enzyme immobilization, Products, Applications; Biotransformation.

**Unit - 2**

**(12 Hrs)**

**Important industrial fermentations** - Amino acid production (glutamic acid and lysine) - Production of antibiotics (penicillin, tetracycline) - Production of Vitamins (riboflavin, cyanocobalamin) - Production of alcohol (Ethanol) and beverages (beer and wine) - Organic

acids - lactic acid, citric acid.

### Unit - 3

(12 Hrs)

**Biopolymers and Biomass:** Microbial production of carbohydrates, Xanthan gum and polyester (PHAs, higher alkanes and methanol); Single cell proteins; Microbial whole-cell bioreporters; Biosensors - Types and Applications; Role of microorganisms in Nanotechnology.

### Unit - 4

(12 Hrs)

**Environmental Biotechnology:** Biotechnological methods for environmental monitoring – Recalcitrant xenobiotics - Biodegradation (hydrocarbons, pesticides, herbicides); Bioremediation – contaminated soils and water; marine oil pollutants; Microbes in mining, Ore leaching.

### Unit - 5

(12 Hrs)

**Entrepreneurial Aspects:** Qualities of an entrepreneur, Factors influencing entrepreneurship; Biogas production; Biofuels; Mushroom cultivation; *Spirulina* cultivation; *Azolla* cultivation; Microbial pigments; bacterial and algal carotenoids.

### Text Book

- Elements of Biotechnology. 1996. Gupta, P.K. Rastogi and Company, Meerut.

### Reference Books

- Concepts in Biotechnology. 1996. Balasubramanian, D., C.F.A. Bryce., K. Dharmalingam, J. Green and K. Jayaraman. Universities Press (India) Limited, Hyderabad.
- Molecular Biotechnology. Indian Edition, 2002. Glick, B.R. and J.J. Pasternack. Panima Publishing Corporation, New Delhi.
- Microbial Biotechnology. 1995. Alexander N. Glazer and Hiroshi Nikaido. W. H Freeman and Company.
- Biotechnology Expanding Horizons. 2021. Singh B.D. Kalyani Publishers, Ludhiana.
- Biotechnology. 2005. Satyanarayana U. Books and Allied (P) Ltd., Kolkata.