M. G. Science Institute (Autonomous)
Ahmedabad 380 009, Gujarat, India.

Proposed Syllabus
B.Sc. MICROBIOLOGY SYLLABUS
Semester- 4 Effective
From June 2025

Annexure 2

Semester: IV	**Course No.: 241**	**Course Code: -- MIM-241 (T)** **Course Title: Soil and Water Microbiology**
Credits: 4		**Course Category: -Major**

Course Outcomes: On successful completion of the course the learner will be able to:

- Understand the physicochemical characteristics of soil and identify the diversity of soil flora.
- Utilize various techniques to study soil microorganisms, including microscopic methods, enrichment culture, and plate techniques.
- Explore microbial interactions in soil, focusing on plant-microbe relationships, rhizosphere significance, and mycorrhiza.
- Explain the role of microorganisms in biogeochemical cycles, including nitrogen, carbon, sulfur, phosphorus, and others.
- Assess the benefits and applications of biofertilizers and biopesticides in sustainable agriculture.
- Study microbial indicators of water quality, waterborne diseases, and nuisance organisms in water.
- Conduct bacteriological analysis and apply methods for the purification of drinking water.
- Examine wastewater characteristics and associated pollution problems.
- Develop strategies for wastewater treatment and recycling, focusing on microbial roles in these processes.

CO#	**COGNITIVE ABILITIES**	**COURSE OUTCOMES**
CO241.1	REMEMBERING	Identify the physicochemical characteristics of soil and types of soil flora. Recall key biogeochemical cycles and their significance in soil ecosystems
CO241.2	UNDERSTANDING	Describe the roles of soil microorganisms in nutrient cycling and microbial interactions. Explain microbial indicators of water quality and sources of water contamination. Summarize purification methods for drinking water and the concept of waterborne diseases.

CO241.3	APPLYING	Perform methods to study soil flora, including microscopic counts, agar plate techniques, and enrichment cultures. Conduct bacteriological analysis of water (e.g., coliform tests,
		total viable counts) and implement water purification techniques.
CO241.4	ANALYZING	Evaluate the impact of microbial interactions in soil ecosystems, such as rhizosphere effects and mycorrhizal associations. Analyze wastewater characteristics (e.g., BOD, COD) and pollution issues associated with untreated waste.
CO241.5	EVALUATING	Assess the efficacy of biofertilizers and biopesticides in agriculture. Compare wastewater treatment processes and determine suitable methods based on pollution characteristics.
CO241.6	CREATING	Can design comprehensive wastewater treatment and recycling strategies incorporating microbial processes.

Unit No.	**Unit Contents**	**Sessions Allotted**
1	**Microbiology of Soil** A. Physicochemical characteristics of soil and soil flora B. Methods to study soil flora: I. Direct microscopic count II. Agar plate technique: Total viable count, The soil plate method III. Enrichment culture technique IV. Buried slide technique V. Soil respiration technique VI. MPN for nitrifying bacteria C. Microbial Interactions in soil I. Neutral, positive and negative associations II. Interaction between plant roots and microorganisms III. Rhizosphere and its significance IV. Mycorrhiza	**15**

2	**Microorganisms as Biogeochemical Agents** A. Introduction to biogeochemical transformations in soil: Mineralization and immobilization of elements B. Rotation of elements in nature I. Nitrogen Cycle II. Sulphur Cycle III. Carbon Cycle IV. Iron Cycle V. Phosphorus Cycle VI. Potassium cycle C. Biofertilizers and biopesticides	**15**
3	**Microbiology of Drinking Water** A. Natural waters: Sources of contamination	**15**
	B. Microbial indicators of fecal pollution I. Coliforms as indicator II. Methods for differentiation: IMViC test and Elevated temperature test III. Microbial indicators other than coliforms C. Nuisance organisms in water: Slime forming bacteria, Iron and Sulphur bacteria and Algae D. Water borne diseases E. Bacteriology examination of drinking water I. Sampling II. Quantitative analysis: Total viable count, Membrane filter technique III. Qualitative analysis: Detection of coliforms (presumptive, confirm and completed test) Defined substrate test, P-A (Presence Absence test) F. Purification of drinking water: sedimentation, filtration and disinfection	
4	**Microbiology of Wastewater** A. Types of waste water, Chemical and Microbiological characteristics of waste water B. BOD, COD and TOD as indicators of untreated wastewater, Pollution problems due to disposal of untreated waste C. Methods of wastewater treatment I. Primary treatment and secondary treatment: Principles and role of microorganisms in: Septic tank, Imhoff tank, trickling filters, activated sludge process and oxidation ponds II. Advanced treatment and final treatment III. Solid waste processing: Anaerobic sludge digestion and composting D. Concept of water recycling.	**15**

Suggested Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986) Microbiology, 5th edn, McGraw-Hill Book Company, NY.

2. Alexander M, (1977), Soil Microbiology, 2nd Edition Krieger Publ. Co. Melbourne, FL

3. Atlas R M, (1977), Principles of Microbiology 2nd Edition, Wm. C. Brown Publ. Iowa USA

Semester: IV	**Course No.: 242**	**Course Code: -- MIM-242 (T)** **Course Title: Food and Dairy Microbiology**
Credits: 4		**Course Category: -Major**

Course Outcomes: On successful completion of the course the learner will be able to:

- Understand the types of microbial flora associated with various foods and the factors influencing their growth.
- Explain the causes and characteristics of foodborne infections, food poisoning, and microbial spoilage.
- Explore preservation methods for food and milk, including thermal and non-thermal techniques.
- Analyze the role of microorganisms in producing fermented foods, probiotics, and single-cell proteins.
- Conduct microbiological analyses to assess contamination levels and evaluate food and milk safety.
- Apply microbiological criteria and standards for food safety as per national and international guidelines.
- Develop strategies for safe food handling, processing, and microbial control in the food industry.

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO242.1	REMEMBERING	Recall the types of microbial flora present in various foods (e.g., fruits, vegetables, milk, and meat). List common microorganisms involved in foodborne infections and poisoning
CO242.2	UNDERSTANDING	Explain how intrinsic and extrinsic factors influence microbial growth in food. Describe the principles and methods of food preservation. Understand the role of microbes in fermented foods, probiotics, and single-cell protein production.
CO242.3	APPLYING	Perform microbiological analyses of food and milk (e.g., MPN, CFU, phosphatase test, and staining methods). Apply preservation techniques such as pasteurization, refrigeration, dehydration, and the use of preservatives.
CO242.4	ANALYZING	Examine microbial spoilage patterns in food and milk products. Analyze microbiological criteria for food safety using standards set by FSSAI and other certifications
CO242.5	EVALUATING	Assess foodborne infections and spoilage to recommend appropriate control strategies. Evaluate the effectiveness of preservation methods and microbial

CO242.6	CREATING	safety standards. Can design safe food handling and processing strategies based on microbial standards and food safety guidelines.

Unit No.	Unit Contents	Sessions Allotted
1	**Microbial Spoilage of Food** **Food as a substrate for microorganisms** [A] Contamination of food from soil, water, air and during handling & processing [B] Microbial flora of food: Meats, Eggs, Fruits & Vegetables, Milk (biochemical,temperature and pathogenic types of microorganisms) [C] Factors affecting microbial growth in food: Intrinsic and Extrinsic [D] Microbial spoilage of food: 1. Biochemical changes: Putrefaction, Fermentation, Rancidity 2. Spoilage of fresh foods, fresh milk, canned foods	15
2	**Food Infection and Poisoning** [A] Food infections: Microorganism involved, source of infection, incubation period and characteristics inbrief: *1.* Bacterial infections: *Salmonella sp., Shigella sp, Vibrio sp., Campylobacter jejuni, Listeria monocytogenes* 2. Viral infections: Rotavirus, Hepatitis A, Poliovirus 3. Protozoal infections: Entamoeba [B] Food poisoning: *1.* Bacteria as poisoning agent: *Staphylococcus aureus, Clostridium botulinum* *2.* Molds as poisoning agents: *Claviceps purpurea, Aspergillus flavus*, *Fusarium moniliformis.* [C] Microbiological examination of foods 1. Generalized scheme for microbiological examination of foods 2. Microscopic techniques 3. Culture Techniques	15
3	**Unit III Food Preservation** [A] General principles [B] Methods of food preservation 1. Aseptic handling 2. High temperature: Canning, Pasteurization of milk – confirmation by phosphatase test, Sterilization 3. Low temperature: Refrigeration and freezing	15

	4. Dehydration 5. Osmotic pressure 6. Chemicals 7. Radiations 8. Microbial product-based inhibition	
4	**Unit IV Fermented Food and Food Standards** [A] Fermented dairy products 1. Starter culture 2. Fermented milks: Cultured buttermilk, Acidophilus milk, Yogurt, Kefir 3. Cheese: Types, curdling, processing, ripening [B] Other fermented foods: Bread, Sauerkraut, Pickles [C] Traditional Indian fermented foods: Dahi, Idli, Dosa, Dhokla [D] Fermented beverage: Wine [E] Microbes as food: Yeast & Spirulina (SCP), Mushroom, Probiotics (including Prebioticsand Synbiotics) [G] Microbiological criteria of food safety: 1. Introduction to Food Safety and Standards Act, 2006, India 2. Microbiological standards (criteria) for foods Food certification marks in India: ISI, BIS, Agmark, FPO, India Organic, FSSAI and HACCP	**15**

Suggested Text Books:

1. Pelczar Jr, M J, Chan E C S, Krieg N R, (1986), Microbiology: An Application Based Approach, 5th edn. McGraw-Hill Book Company, NY
2. Frazier W C and Westhoff D C (1988), Food Microbiology, 4th edn. McGraw-Hill Book Company, NY
3. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA.
4. Indian Standards: Food Hygiene-Microbiological Criteria-Principles for Establishment and Application
5. FSSAI: Manual of methods of analysis of foods- food safety and standards authority of India, Ministry of health and family welfare, Government of India, New Delhi, 2015

MIM-243(P): MICROBIOLOGY PRACTICALS
Paper Name: Microbiology Practicals

Credits: 04 (08 hours/week)

- On completion of this course the student will be able to:

- Understand and apply techniques for enumerating microorganisms from soil and analyzing microbial diversity.
- Isolate and cultivate specific soil microorganisms, including nitrogen-fixing bacteria, actinomycetes, fungi, and phosphate solubilizers.
- Perform microbiological analyses of drinking water, including standard plate counts, tests for fecal pollution, and determination of coliform levels using MPN methods.
- Conduct microbiological evaluations of milk, including standard plate counts, microbial load determination (MBRT and RRT), detection of fecal coliforms and acid-fast bacteria, and tests for adulteration.
- Analyze microbial contamination in food using standard plate counts, MPN techniques, and detection of microbial enzymes like amylase, protease, and lipase.
- Isolate and cultivate yeast from various sources.
- Study the morphology and characteristics of microorganisms such as Amoeba, Euglena, Paramecium, Diatoms, and Spirogyra through permanent slides**.**

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO243.1	REMEMBERING	Recall laboratory procedures for various microbiological tests (e.g., SPC, MPN, enzyme detection). Recall characteristics of microorganisms like yeasts, Actinomycetes, and coliforms.
CO243.2	UNDERSTANDING	Explain the significance and ecological role of different microorganisms (e.g., nitrogen-fixing bacteria, Actinomycetes). Understand the importance of microbiological tests in assessing food, water, and milk quality.
CO 243.3	APPLYING	Perform microbiological tests (e.g., SPC, MPN, acid-fast staining) on soil, water, milk, and food samples. Cultivate and isolate various microorganisms for laboratory analysis
CO243.4	ANALYZING	Analyze test results (e.g., microbial load, presence of coliforms) to evaluate sample quality. Differentiate between types of microorganisms (e.g., yeast, bacteria, fungi)
CO 243.5	EVALUATING	Assess the effectiveness of various detection methods (e.g., MBRT, RRT) for determining microbial contamination.
CO 243.6	CREATING	Design microbiological experiments to detect contamination or evaluate microbial quality in various samples

[A] Microbiological analysis of soil
1. Enumeration of organisms from soil (Standard plate count)
2. Isolation and cultivation of symbiotic and non-symbiotic nitrogen fixing bacteria,
3. Isolation and cultivation of Actinomycetes
4. Isolation and cultivation of Fungi (*Mucor*, *Rhizopus*, *Aspergillus*, *Fusarium*, *Curvularia*, *Helminthosporium*, *Alternaria* and *Penicillium*) from soil
5. Isolation and cultivation of phosphate solubilizers.

[B] Microbiological analysis of drinking water
6. Standard plate count of drinking and tap water
7. Detection of fecal pollution of water by performing presumptive, confirmed and completed test
8. Determination of MPN of coliforms in water

[C] Microbiological analysis of milk
9. Standard plate count of milk
10. Determination of microbial load by use of MBRT of raw, boiled and pasteurized milk
11. Determination of microbial load by use of RRT
12. Detection of fecal coliforms
13. Detection of Acid-fast bacteria in milk
14. Adulteration of milk: Starch and Urea

[D] Microbiological analysis of food
15. Standard plate count of food
16. Detection of microbial enzymes: Amylase, Protease and Lipase

[E] 17 Isolation and cultivation of yeast

[F] 18 Study of permanent slides: Amoeba, Euglena, Paramecium, Diatoms and Spirogyra.

References:

1. Dubey R C and Maheshwari D K Practical Microbiology (2012) 3rd Edition S Chand and Co pvt ltd, Ramnagar, New Delhi.
2. Experimental Microbiology, Volume-I, Rakesh Patel, Aditya Publication – Ahmedabad
3. Experimental Microbiology, Volume-II, Rakesh Patel, Aditya Publication – Ahmedabad
4. J G Cappuccino and Natalie Sherman Microbiology: A laboratory Manual (1999) 4th Edition Addison Wesley Longman.inc

Semester: IV	Course No.: 246A	Course Code: MI-SEC-246A Course Title: Commercial Microbial Products
Credits: 02		Course Category: -SEC

Upon successful completion of this course, students will:

- Understand the fundamentals of commercial microbial products, their importance, and applications across various sectors.
- Gain insights into the microorganisms involved in the production of microbial products and their commercial significance.
- Evaluate the market trends, challenges, and future prospects of microbial technologies in different industries

CO#	Course Outcome	Bloom's cognitive level
CO1	Recall definitions, microorganisms involved in product production, and different types of commercial microbial products. Identify microbial products used in various industries (e.g., biofertilizers, enzymes, antibiotics). .	1
CO2	Explain the commercial importance of microbial products and their role in food, healthcare, agriculture, and the environment. Explain the processes involved in producing microbial products such as antibiotics, biofuels, and enzymes	2
CO3	Demonstrate the techniques for isolating and cultivating microorganisms that produce value-added products. Discuss the commercial applications of microbial products in various industries and their global market trends	3
CO4	Compare microbial products with plant and animal-derived products in terms of sustainability and market demand. Analyze market trends and future challenges in microbial product commercialization.	4
CO5	Evaluate the future trends and challenges in microbial product commercialization. Assess the impact of microbial technologies in solving environmental issues (e.g., bioremediation, biofuels).	5

CO6	Design experiments to isolate microorganisms from agro-waste that produce bioactive compounds or organic acids. Propose new applications for microbial technologies in emerging markets	**6**

Unit No	**Title of Unit and Contents**	**No of Lectures**
I	**A. Introduction to Commercial microbial products** 1. Definition, Importance of commercial microbial products, 4. Comparison with plant and animal derived commercial products 5. Market value and demand at national and international market 6. Future trends and challenges in microbial technology **B. Commercial microbial products used in various sectors with respect to: microorganisms involved and its importance** 1. **Food and Healthcare:** Nutraceuticals, yoghurt, acidified milk 2. **Agriculture:** biofertilizers, biopesticides and bio stimulants **3. Environment:** Bioremediation (oil spills)**,** Biofuels 4. **Pharmaceutical:** Antibiotics and Vaccines 5. **Other Industries:** Enzymes, metabolites, Alcoholic beverages and dyes	**15**
II	1. Mushroom cultivation 2.Spirulina cultivation 3.Screening and isolation of microbes producing value added products (enzymes/ biopolymers /bioactive compounds/Organic acids) using agro waste	**30**

References:

1. Madigan, M. T., & Brock, T. D. (2012). Brock biology of microorganisms (13th ed.). Pearson Education
2. Casida LE. (1984) Industrial Microbiology. Wiley Easterbs, New Delhi
3. Patel A.H. (1985) Industrial Microbiology, Macmillan India Ltd
4. R M. Atlas, (1988), Microbiology fundamentals and applications 2nd Edition, Macmillan Publishing Co, New York, Collier Macmillan publishers, London

Semester: IV	Course No.: 246B	Course Code: MI-SEC-246B Course Title: Plant Pathology
Credits: 02		Course Category: -SEC

Upon successful completion of this course, students will:

- Understand the history, classification, and epidemiology of plant diseases, as well as the methods for their control.
- Identify various plant pathogens and their symptoms, gaining practical knowledge in isolation and observation of pathogens.
- Explore modern techniques in plant disease control, including chemical, biological, and integrated approaches

CO#	Course Outcome	Bloom's cognitive level
CO1	Recall the key symptoms, pathogens, and methods used in plant disease control. Identify specific plant pathogens from specimens.	1
CO2	Explain the underlying causes of plant diseases and the mechanisms of different control methods. Describe the role of pathogens in plant disease development	2
CO3	Apply practical techniques for isolating and observing plant pathogens. Implement disease control methods in laboratory and field settings.	3
CO4	Analyze the symptoms of plant diseases and link them to specific pathogens. Evaluate the effectiveness of different plant disease control strategies	4
CO5	Assess the potential for managing plant diseases using various control methods (chemical, biological, IPM). Critically evaluate the impact of plant diseases on crop production and food security.	5
CO6	Develop integrated plant disease management plans based on the knowledge of symptoms, pathogens, and control methods. Propose new strategies for managing emerging plant diseases in agriculture	6

Unit No	Title of Unit and Contents	No of Lectures
I	a. History of Plant pathology: Global and Indian b. General symptoms c. Canker, powdery mildew, downy mildew, rust, smut, wilt, spots, mosaic, galls and rots c. Epidemiology of plant diseases d. Methods of plant disease control i. Eradication ii. Chemical control iii. Biological control iv. Integrated Pest Management (IPM)	**15**
II	1. Study of oozing of Citrus canker 2. Isolation and observation of bacterial pathogen from diseased plant 3. Isolation and observation of fungal pathogen from diseased plant 4. Study of specimen of plant pathogens 5. Visit to Botanical Garden	**30**

References:

1. R. M. Atlas, Principles of Microbiology, 2nd Edition (Indian Edition) (2015) McGraw Hill Education (India) Private Limited, New Delhi, India.
2. B.P. Pandey, Plant pathology Pathogens and plant diseases,2nd Edition, (2018) S Chand and Co. Ltd. Ramnagar, New Delhi.