



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

Proposed Syllabus
B.Sc. MICROBIOLOGY SYLLABUS
Semester- 3 and 4
Effective From June 2025

Annexure 2

Detailed Syllabus for Second Year BSc

Semester: III	Course No.: 231	Course Code: -- MIM-231 (T)
		Course Title: Fundamentals of Microbial Biochemistry
Credits: 4		Course Category: -Major

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

- Understand the structures, functions, and metabolic roles of carbohydrates, lipids, nucleic acid, proteins and vitamins.
- By achieving these objectives, students will develop a deep comprehension of these vital biomolecules and their significance in human health and biological processes.

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO231.1	REMEMBERING	The students will be able to recall structure and functions of biomolecules.
CO231.2	UNDERSTANDING	The students will gain foundational knowledge of the molecular structures of carbohydrates, lipids, nucleic acids, and proteins, and their physiological relevance. Students will be able to describe the structures and functions of these biomolecules, as well as their significance in maintaining life processes.
CO231.3	APPLYING	The students will be able to relate the structure of sugars, fatty acids, amino acids, nucleotides, and other components to real-life applications, such as energy production, storage, and transmission of genetic information.
CO231.4	ANALYZING	Students will analyze the mechanisms of enzyme action, enzyme kinetics (e.g., Michaelis-Menten equation), and energy flow (e.g., ATP production and utilization), understanding how these processes contribute to cellular metabolism and overall organism function.
CO231.5	EVALUATING	Students will be tasked with critically assessing the importance of vitamins, lipids, and nucleic acids in health, and understanding how deficiencies or abnormalities in these molecules can result in diseases or metabolic disorders.
CO231.6	CREATING	Students will integrate knowledge of multiple biochemical pathways, combining concepts from enzymes, energy transfer, and molecular structures, to understand the broader context of metabolic regulation, homeostasis, and cellular function.

Unit No.	Unit Contents	Sessions Allotted
1	Carbohydrates, Lipids and introduction to Vitamins A. Carbohydrates I. Sugars: Structures of monosaccharides and their stereochemistry II. Reactions of monosaccharides III. Structure and Functions of disaccharides: Sucrose, Maltose and Lactose IV. Structure and Functions of Polysaccharides: Starch, Cellulose and Peptidoglycan B. Lipids I. Types of Fatty Acids II. Classification of Lipids. III. Essential Fatty acids IV. Lipids and Biological membrane C. Vitamins Classification, characteristics and sources of vitamins.	15
2	Nucleic acids and Protein A. Nucleic acid I. Chemical Composition and structure of Nucleic acid: Sugar, Phosphoric acid, II. Nitrogenous base: Purines and Pyrimidines III. Nucleosides and Nucleotides IV. DNA: a. Formation of Phosphodiester bond and polynucleotide chain of DNA. b. Structure of ds DNA c. Functions of DNA V. RNA: Structure and Functions of rRNA mRNA and tRNA. B. Protein I. Structure and properties of amino acids II. Formation of peptide Bond and polypeptide chain III. Structure of proteins: Primary, Secondary, Tertiary and Quaternary IV. Classification of proteins V. Functions of Proteins	15
3	Enzymes A. General Introduction of Enzymes I. Physical and chemical properties II. Structure of enzymes: Prosthetic group, apoenzyme, coenzyme, cofactors. III. Localization of enzymes: Extracellular and intracellular IV. Nomenclature and classification of enzymes, IUB system of enzyme classification. B. Enzyme action I. Active site and allosteric site of an enzyme	15

	II. Mechanism of enzyme action and allosteric regulation. III. Michaelis- Menten equation IV. Lineweaver- Burk equation V. Significance of K_m and V_m value VI. Factors affecting enzyme activity VII. Inhibition of enzyme activity: Competitive and Non-competitive	
4	Bioenergetics I. Concept of energy: free energy II. Principles of thermodynamics: First law, Second law and equilibrium constant III. Differences between ΔG and ΔG^{01} IV. ATP as universal currency of free energy in biological systems V. Hydrolysis of ATP and other organophosphates. VI. Structural bases of high group transfer potential of ATP VII. Role of high energy phosphates as energy currency of the cell.	15

Suggested Text Books:

1. Rastogi S. C., Biochemistry (2003) 2nd Edition, ISBN: 978-0070527959, Tata McGraw - Hill Education
2. Atlas R M, (1977), Principles of Microbiology, 2nd Edition, Wm. C. Brown Publ. Iowa USA
3. Fundamentals Of Biochemistry (2000) by J L Jain, Sunjay Jain and Nitin Jain, ISBN-10: 9352838300 S. Chand Publication, New Delhi

Suggested Reference Books:

1. Principles of Biochemistry, Cox, M. M. and Nelson, D. L. Leininger 5thedn (2008), W. H. Freeman and Company, USA.
2. Prescott L.M., Harley J.P., and Klein D.A. (2005). Microbiology, 7th Edition. McGraw Hill Companies Inc.

URLs/Weblinks for E-content:

<https://www.youtube.com/watch?v=Q8kPQQfdtgY&list=PL0o42GecDaMe4h7oZ22kHC45Cpg>
<https://www.youtube.com/watch?v=YWEiQIEUFak&list=PLRdQ4XybtNjRjIIIVcoCMcwN36BI>
https://www.youtube.com/watch?v=kDmOM_sggtc&list=PLRdQ4XybtNjRjIIIVcoCMcwN36BI
<https://www.youtube.com/watch?v=Fp1wKo72b2A&list=PLRdQ4XybtNjRjIIIVcoCMcwN36BI>
<https://www.youtube.com/watch?v=KCG5fDKr9HQ&list=PLRdQ4XybtNjRjIIIVcoCMcwN36BI>
<https://www.youtube.com/watch?v=IG4uMKtftLI>
<https://www.youtube.com/watch?v=s1MoBTEcVYY>
<https://www.youtube.com/watch?v=ZqoX2W1N6l0>
<https://www.youtube.com/watch?v=dtCvYfhzPQ0>
<https://www.youtube.com/watch?v=fnkjrUZLFi0>

Semester: III	Course No.: 232	Course Code: -- MIM-232 (T)
Credits: 4		Course Title: Microbial growth and physiology Course Category: -Major

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

- Explain mechanisms of nutrient uptake and transport in microbial cells.
- Analyze bacterial growth dynamics, reproduction, and population kinetics.
- Apply methods to measure and interpret microbial growth under varying culture conditions.
- Differentiate microbial growth patterns in various culture systems and explain their relevance.

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO232.1	REMEMBERING	Students shall be able to recall the principles of methods to enumerate cells and remember the equations to calculate growth rate and generation time
CO232.2	UNDERSTANDING	Students will describe how microorganisms acquire nutrients, grow, and reproduce, while recognizing the environmental factors affecting these processes.
CO232.3	APPLYING	Students will use their understanding of microbial growth and nutrient transport mechanisms to analyze the behavior of microorganisms in various growth conditions (e.g., batch culture, continuous culture).
CO232.4	ANALYZING	Students will examine how various environmental factors (e.g., temperature, pH, oxygen availability) influence microbial growth and categorize microorganisms based on their environmental preferences (e.g., psychrophiles, thermophiles, acidophiles).
CO232.5	EVALUATING	Students will critically assess different microbial control strategies, including the effectiveness of physical and chemical agents such as heat, antibiotics, disinfectants, and radiation.
CO232.6	CREATING	Students will combine concepts of microbial metabolism, growth curves, and control methods to create solutions for managing microbial contamination or optimizing microbial processes in industrial or clinical settings.

Unit No.	Unit Contents	Sessions Allotted
1	Microbial Nutrition and Growth A. Modes of Nutrient uptake and Transport: Entry of nutrients in cell, Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation B. Bacterial Growth I. Reproduction of bacterial cells: Binary Fission, cell Elongation, DNA Replication, Septum Formation. II. Normal Growth Curve of Bacteria (phases of growth), Calculation of Generation time and Growth Rate C. Measurement of Microbial growth, Cell mass and Cell numbers D. Batch culture, Continuous culture, Synchronous Growth, Diauxic Growth Curve	15
2	Effect of Environment on Microbial Growth and Cell Communications A. Microbial growth in response to environment – I. Temperature (Psychrophiles, Mesophiles, Thermophiles, Thermotolerants, Psychrotrophs), II. pH (Neutrophiles, Acidophiles, Alkaliphiles), III. Oxygen (Aerobic, Anaerobic, Microaerophilic, Facultative anaerobe), IV. Salt/Sugar/Solute and Water activity (Halophiles, Xerophiles, Osmophilic), V. Hydrostatic Pressure: Barophiles VI. Radiation: Types and effects VII. Surface tension B. Biofilms, Cell-Cell communication, Inter domain Communication	15
3	Principles of Microbial control A. General Principles: Control by killing, inhibition, and removal B. Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation C. Chemical methods of microbial control: Ideal antimicrobial agent D. Major groups, types and mode of action: Disinfectants and antiseptics, surfactants (phenols), Halogens, Alcohols, Heavy metals, Gaseous agents, Dyes.	15
4	Antibiotics as chemotherapeutic agents A. Principles of chemotherapy B. Chemical structure and mode of action of antibiotics I. Inhibition of cell wall synthesis (Penicillin G) II. Inhibition of membrane functions (Polymyxin b) III. Inhibition of DNA synthesis (Ciprofloxacin) IV. Inhibition of RNA synthesis (Rifamycin B) V. Inhibition of protein synthesis and Enzymes (Streptomycin and Sulphonamides) C. Introduction to antifungal and antiviral agents.	15

Suggested Text Books:

1. Microbiology, Pelczar JR., Chan ECS, Krieg NR, 5th Edition (1993), McGraw-Hill Book Company, NY.
2. Principles of Microbiology, R. M. Atlas, 2nd Edition (Indian Edition) (2015) McGraw Hill Education (India) Private Limited, New Delhi, India.
3. Microbiology, Prescott, Joanne Willey, Kathleen Sandman and Dorothy Wood, 5th Edition (1993), McGraw-Hill Book Company, NY.

URLs/Weblinks for E-content:

<https://youtu.be/XlCA-cdvSvU?si=cMyUvzwaZocXDNl9>
https://youtu.be/JpnH_6kqvvdw?si=D26WwgdinyE_xwg5
<https://youtu.be/2fbwCsCxmt4?si=tCUwQRc0QBJNltP6>
<https://youtu.be/mE9PRcBJWdo?si=-F0J0GkWw2qQ-eCJ>
https://youtu.be/cmHZWaxndsU?si=JdG_qtrUmRqDwckK
<https://youtu.be/N1DaPuO5gRY?si=Izgf9oOK4LZ93vH1>
<https://youtu.be/2AQ6iLmo0h0?si=iVt6HhTLyCoIoJ6I>
<https://youtu.be/eVafcIVWzdM?si=zumV1xwFn8nS2P9u>
<https://youtu.be/mu6JFX3WkmA?si=TXRFiLl78Jpcgwed>
<https://youtu.be/eoHWobPU6C4>
<https://youtu.be/3otG8ic14kk?si=ErPZQGzoqv08gnhL>
<https://youtu.be/IENaBxJBW78?si=OPqy6zt9xlC8JPu9>
<https://youtu.be/1i5h1OCA6i4?si=-uiIDUDPK9hXF6Ge>
<https://youtu.be/FfSqugAKF7I?si=dFBSM7SaPJTehjmN>

MIM-233(P): MICROBIOLOGY PRACTICALS**Paper Name: Microbiology Practicals****Credits: 04 (08 hours/week)****Course Outcome: On success completion of course, the learner will be able to:**

- Demonstrate proficiency in using various types of microbiological media for the cultivation, isolation, and identification of microorganisms.
- Conduct qualitative biochemical tests to detect the presence of key biomolecules such as carbohydrates, proteins, and lipids in microbial samples.
- Perform experiments to assess the effect of various environmental factors and antimicrobial agents on microbial growth.
- Analyze microbial growth patterns, including the effects of temperature, pH, and salt concentration on bacteria, as well as the determination of microbial motility and spore size.
- Conduct biochemical tests for the identification of microbial metabolic activities, including fermentation, utilization of carbon and nitrogen sources, and enzymatic activity.

CO#	COGNITIVE ABILITIES	COURSE OUTCOMES
CO233.1	REMEMBERING	Recall tests, reagents, and procedures for microbial media preparation and biochemical analysis. Identify key features of microbial growth and environmental effects on microorganisms.
CO233.2	UNDERSTANDING	Explain the principles behind various microbial techniques, such as selective and differential media, biochemical tests, and antimicrobial susceptibility testing. Understand the significance of environmental factors and microbial metabolism in growth and identification.
CO233.3	APPLYING	Conduct laboratory experiments applying the appropriate methods to study microbial growth, identify biomolecules, and test antimicrobial susceptibility
CO233.4	ANALYZING	Analyze experimental results, identify patterns of microbial behavior under various conditions, and draw conclusions based on observed data
CO233.5	EVALUATING	Evaluate the effectiveness of antimicrobial agents, media types, and environmental conditions for microbial growth in research and practical applications.

CO233.6	CREATING	Shall be able to design their own experiments to identify bacteria, check efficacy of antimicrobial agent and measure size of microorganisms
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1. Study of different types of media
 - A. Selective media: Rose Bengal agar medium
 - B. Differential medium: MacConkey's agar, EMB agar, Triple sugar iron agar
 - C. Enrichment media: Selenite broth
 - D. Enriched media: Blood agar medium
 - E. Natural media: Soil extract agar medium,
2. Qualitative analysis of biomolecules:
 - A. Carbohydrates: Iodine test, Molisch's test, Benedict's test, Barfoed's test, Bial's test and Seliwanoff's test
 - B. Protein: Biuret test, Ehrlich's test, Glyoxylic acid test, Ninhydrin test, Nitroprusside test and Xanthoproteic test
 - C. Qualitative analysis of lipids –Sudan IV dye test, Solubility test, Saponification test, Potassium permanganate test for unsaturated fatty acids
3. Study of effect of antimicrobial compounds on growth of bacteria
 - A. Study of effect of heavy metal on growth of bacteria
 - B. Study of effect of chemicals (5% phenol, 1% crystal violet and 0.001% HgCl₂) on growth of bacteria (Agar cup method)
 - C. Study of effect of antibiotics on growth of bacteria using paper disc method
 - D. Study of effect of antibiotic on growth of bacteria using agar ditch method
4. Study of normal growth curve of *E. coli* (Demonstration only)
5. Study of effects of environmental factors on growth on microorganism (Tube method)
 - A. Study of effect of Temperature on growth of *E. coli*
 - B. Study of effect of pH on growth of *E. coli*
 - C. Study of effect of NaCl concentration on growth of *E. coli*
6. Study of biochemical reactions
 - A. Based on utilization of carbon source
 - I. Fermentation of sugars:
 - (a) Broth media: Glucose, Xylose, Mannitol and lactose
 - (b) Agar media: TSI agar slant
 - II. Detection of glucose break-down products: Methyl red test and Voges Proskauer's test
 - III. Citrate utilization test
 - IV. Starch utilization test
 - V. Lipid utilization test

B. Based on utilization of nitrogen source

- I. Indole production test
- II. H₂S production test
- III. Urea utilization test
- IV. Gelatine Hydrolysis test
- V. Casein hydrolysis test
- VI. Deamination test
- VII. Ammonia production test
- VIII. Nitrate reduction test

C. Based on enzymes: I. Dehydrogenase test II. Catalase test and III. Oxidase test

7. Study of bacterial motility by hanging drop and agar stab method.

8. Determination of the size of fungal spore/hyphae and yeast using micrometer

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: III	Course No.: 236	Course Code: MI-SEC-236A Course Title: Preparations of Standard Solutions in Laboratory
Credits: 02		Course Category: -SEC

Course outcomes:

- Understand the basic concepts related to the structure of atoms, molecules, and the properties of water in solution preparation.
- Accurately define key terms such as solute, solvent, solution, molarity, normality, molality, and pH.
- Identify and utilize appropriate glassware/plasticware for preparing solutions.
- Prepare various types of solutions, including molar, normal, percent, and buffer solutions, and perform serial dilutions.
- Demonstrate practical skills in preparing solutions of specific concentrations and performing dilutions with precision.

CO#	Course Outcome	Bloom's cognitive level
CO1	Recall basic terms such as solute, solvent, molarity, normality, and pH. Recognize the different types of glassware and their appropriate use in solution preparation.	1
CO2	Grasp the concepts of noncovalent interactions, how water's properties affect solution preparation, and the relationship between molarity and normality. Understand the significance of accurate solution preparation for experimental results and applications	2
CO3	Apply knowledge to prepare solutions with specific concentrations, perform dilutions, and create buffer solutions. Use appropriate lab equipment and follow procedures for preparing various types of solutions.	3
CO4	Analyze the effects of different dilution methods and solution concentrations on experimental outcomes. Perform accurate calculations to determine volumes and concentrations for solution preparation.	4
CO5	Design and create buffer solutions for experiments with specific pH requirements.	5

CO6	Modify dilution schemes for custom solutions in various lab experiments.	6
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Unit No	Title of Unit and Contents	No of Lectures
I	Introduction to basics of solution preparation A. Structure of atom: Atom, Isotope, Molecule, Molecular weight, Equivalent weight B. Water as molecule: General properties of water C. Noncovalent Interactions in aqueous systems: Hydrogen bond, Hydrophilic and Hydrophobic interactions, Vander Waals interactions and Electrostatic interactions D. Definitions of basic terms: Solute, Solvent, Solution, Molarity, Normality, Molality, pH E. Glass-wares/plastic-wares used to prepare solutions: Volumetric flasks, Measuring Cylinder, Pipettes, Graduated Beaker, Conical flasks, Test tubes etc. F. General guidelines for preparation of solutions G. Types of solution and dilution: Normal Solution, Molar Solution, Percent Solution (W/V and V/V), Part dilution, Serial dilution (single and double), Buffer solution	15
II	1. Preparation of 100 ml of 0.1 N HCl solution 2. Preparation of 100 ml of 2.5 M NaOH solution 3. Preparation of 100 ml of 0.1 % Starch solution 4. Preparation of 100 ml of 0.9 % NaCl solution (Normal Saline) 5. Preparation of 100 ml of 60% ethanol from 95% pure ethanol 6. Preparation of part dilutions such as 1:2, 1:5, 1:10 of 0.5 % (or 1.0%) Methylene blue 7. Preparation of serial dilutions 10^{-1} , 10^{-2} , 10^{-3} 10^{-10} of soil 8. Dilution of antibiotic solutions of ampicillin vial 9. Preparation of 100 ml of phosphate buffer (pH: 7.0)	30

References:

1. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA
2. Experimental Microbiology, Volume-I, Rakesh Patel, Aditya Publication – Ahmedabad
3. A handbook of Laboratory Solutions, M. H. Gabb, W. E. Latchem, Print (2020) Scientific Publishers (INDIA)
4. Chemistry Part- I, NCERT Textbook for Class XII, Edition (2022).

Semester: III	Course No.: 236B	Course Code: MI-SEC-236B Course Title: Aero microbiology and Biodeterioration
Credits: 02		Course Category: -SEC

Upon completion of this course, students will be able to:

- Understand the occurrence and distribution of microorganisms in the air and the factors contributing to microbial pollution.
- Evaluate the methods for controlling airborne microorganisms and understand the significance of airborne infections.
- Understand the concept of biodeterioration and its impact on materials such as paper, wood, textiles, paints, and metals.
- Apply various techniques to study air flora, assess air sterilization methods, and observe microbial deterioration in materials.

CO#	Course Outcome	Bloom's cognitive level
CO1	Recall key concepts such as types of airborne microorganisms, factors affecting microbial distribution in the air, and causes of biodeterioration.	1
CO2	Understand how microbial pollution occurs in the air and how environmental factors influence the distribution and growth of microorganisms.	2
CO3	Use appropriate techniques like the settling plate and liquid impingement to collect air samples. Demonstrate the application of UV light for air sterilization and perform practical experiments to observe microbial activity in deteriorated materials.	3
CO4	Interpret results from air microbial studies and assess the effectiveness of sterilization methods. Analyze the relationship between microbial activity and the degradation of materials like paper, wood, and textiles.	4

CO5	Critically assess the efficacy of different methods of air sterilization and evaluate the impact of airborne microorganisms on human health and material preservation	5
CO6	Design experiments to further study microbial control techniques or biodeterioration in various environmental conditions.	6

Unit No	Title of Unit and Contents	No of Lectures
I	A. Air Microbiology I. Occurrence and distribution of microorganisms in air II. Microbial pollution of air: Dust, aerosols and droplet nuclei III. Control of air flora: sterilization and sanitation IV. Air borne infections B. Biodeterioration: Biodeterioration of Paper, Wood, Textiles, Paints and Metals	15
II	1. Study of Air Flora: a. Settling Plate technique b. Liquid impingement technique 2. Efficacy check of UV light as air sterilizing agent by swab method 3. Microscopic observation of deteriorated paper/leather/textile/wood	30

References:

1. Prescott L, Harley J P, and Klein D A, (2008), Microbiology, 7th edn. Wm C. Brown - McGraw Hill, Dubuque, IA
2. R. M. Atlas, Principles of Microbiology, 2nd Edition (Indian Edition) (2015) McGraw Hill Education (India) Private Limited, New Delhi, India.
3. R M. Atlas, Microbiology fundamentals and applications, (1988) 2nd Edition, Macmillan Publishing Co, New York, Collier Macmillan publishers, London
4. Experimental Microbiology, Volume-I, Rakesh Patel, Aditya Publication – Ahmedabad
5. Martin Frobisher, Fundamentals of Microbiology: An introduction to the microorganisms with special reference to the prokaryote (1968) 8th Edition, Toppan Printing Co, Ltd, Tokyo, Japan.

Semester: IV	Course No.: 241	Course Code: -- MIM-241 (T)
Credits: 4		Course Title: Soil and Water Microbiology 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)
Credits: 4		Course Title: Food and Dairy Microbiology 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.
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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 in brief: 1. Bacterial infections: <i>Salmonella sp.</i> , <i>Shigella sp.</i> , <i>Vibrio sp.</i> , <i>Campylobacter jejuni</i> , <i>Listeria monocytogenes</i> 2. Viral infections: Rotavirus, Hepatitis A, Poliovirus 3. Protozoal infections: Entamoeba [B] Food poisoning: 1. Bacteria as poisoning agent: <i>Staphylococcus aureus</i> , <i>Clostridium botulinum</i> 2. Molds as poisoning agents: <i>Claviceps purpurea</i> , <i>Aspergillus flavus</i> , <i>Fusarium moniliformis</i> . [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 Prebiotics and 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
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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.