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

Proposed Syllabus
B.Sc. MICROBIOLOGY SYLLABUS
Semester- 3 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=YWEiQlEUFak&list=PLRdQ4XybtNjRjlIIVcoCMcwN36BI
https://www.youtube.com/watch?v=kDmOM_sggtc&list=PLRdQ4XybtNjRjlIIVcoCMcwN36BI
https://www.youtube.com/watch?v=Fp1wKo72b2A&list=PLRdQ4XybtNjRjlIIVcoCMcwN36BI
https://www.youtube.com/watch?v=KCG5fDKr9HQ&list=PLRdQ4XybtNjRjlIIVcoCMcwN36B
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)** **Course Title: Microbial growth and physiology**
Credits: 4		**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, Thermodurics, 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_6kqvdw?si=D26WwgdinyE_xwg5
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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

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% $HgCl_2$) 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. H_2S 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**

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.