

Semester	III
Course ^{*1}	Major-1
Paper Code	C2BT230312T/P
Paper Title	Microbiology
No. of Credits ^{*2}	4
Theory / Practical / Composite	Composite
Minimum No. of preparatory hours per week a student has to devote	4
Number of Modules	2
Syllabus	<p style="text-align: center;">Module A: (25 Marks; 2 classes/week)</p> <p>UNIT I: Fundamentals, History and Evolution of Microbiology: Fundamentals of Microbiology; history and evolution of Microbiology: spontaneous generation (abiogenesis) vs. biogenesis, contributions of Anton von Leeuwenhoek, Louis Pasteur and Robert Koch (including Koch's Postulates).</p> <p>UNIT II: Bacterial cell morphology and ultrastructure: Morphology of bacterial cells (size, shape and arrangement); ultrastructure of a typical bacterial cell (eubacterial and archaeobacterial cell walls; spheroplasts, protoplasts and L-forms; periplasmic space; eubacterial and archaeobacterial cell membranes; glycocalyx, capsule, slime layer & S-layer; nucleoid; plasmids and episomes; flagella, endoflagella, pili and fimbriae; ribosomes; mesosomes; inclusion bodies; gas vacuoles; endospore).</p> <p>UNIT III: Bacterial growth (reproduction): Bacterial growth (reproductive) strategies; bacterial growth curve and different phases of growth; bacterial growth kinetics - calculation of number of generations, mean growth rate constant and mean generation time; synchronous growth; diauxic growth; factors affecting bacterial growth.</p> <p>UNIT IV: Bacterial nutrition and pure culture preservation: Nutritional categories of bacteria; nutrients for bacteria (macro- and micro-nutrients); concept of pure culture; preservation of pure cultures.</p> <p>UNIT V: Water microbiology: Public health and water quality; overview of BIS regulations; basic concepts of BOD and COD; microbial (bacterial and viral) pollutants of water; indicator organisms - coliforms (fecal and non-fecal) and non-coliforms; water-borne human diseases.</p> <p>UNIT VI: Food microbiology: Food as a microbial growth medium - factors (extrinsic and intrinsic) affecting food-borne microorganisms; normal microflora and spoilage microflora of food; food spoilage; food-borne diseases (food-borne intoxications and infections); food safety and FSSAI regulations; food preservation methods; fermented foods; basic concepts of probiotics and prebiotics.</p>

UNIT VII: Dairy microbiology:

Milk as a microbial growth medium; types of microorganisms in milk (biochemical; temperature-characteristic and pathogenic); gradation of milk; sources of micro-organisms in milk; Pasteurization of milk & phosphatase test; undesirable microorganisms in milk; milk-borne diseases of human origins; fermented milk; ice cream.

UNIT VIII: Human microbiome:

Normal microbiome of the human body; gut microbiome and its regulation of human behavior; psychobiotics.

UNIT IX: Controlling microbial growth in the environment and in the body:

Antiseptics (germicides), sterilants, disinfectants and sanitizers; antimicrobial control by physical agents (heat, low temperature, filtration and radiation), chemical agents (phenol and phenolics, alcohol, and halogens) and antimicrobial agents (including drug resistance mechanisms).

Module B: (20 Marks; 1 class/week)**UNIT I: Microbial taxonomy and systematics:**

Molecular phylogeny (rRNA based), sequence alignment and phylogenetic trees; concept of species in microbiology; taxonomic methods in systematics; classification and nomenclature of bacteria and archaea, Bergey's Manual of Systematic Bacteriology.

UNIT II: Diversity in microbial world:

Phylogenetic overview; general characteristics and ecological significance of key genera of prokaryotic and eukaryotic microbes: Bacteria - Archaeobacteria; Eubacteria; Mycoplasma; Bacteroidetes; Protists; Fungi; Algae.

UNIT III: Air microbiology:

Air as a microbial growth medium; droplet nuclei and bio-aerosols; air-borne microorganisms & Stoke's Law; factors affecting air-borne microorganisms; air-borne human diseases.

UNIT IV: Soil Microbiology and biogeochemical cycles:

Soil as a microbial habitat, soil composition and formation, rhizosphere; Vegetated and dryland soils as microbial habitats; Arid soils; Phylogenetic snapshot of soil bacterial and archaeal diversity; Biogeochemical cycles: Carbon cycle, Nitrogen cycle, Phosphorus cycle, Sulphur cycle.

UNIT V: Introduction to Virology:

Viral evolution; Isolation, cultivation and identification of viruses; Structure of a virion; Baltimore Classification; Overview of the viral life cycle – One-Step Growth Curve; bacteriophages – lytic and lysogenic cycles; single-stranded DNA bacteriophages (Phage ϕ X174, M13), double-stranded DNA Bacteriophages (T7 and Mu); Viroids and Prions.

	<p>Practical [40 marks; End-Sem (8 marks) + CA (30 marks) + Attendance (2 marks)]</p> <ol style="list-style-type: none"> 1. Maintenance of sterility and growing microbes in the laboratory 2. Preparation of culture media 3. Cultivation of microorganisms in pure culture in broth and agar (slant, stab). 4. Staining methods: Simple staining, Gram staining, Endospore staining, Negative staining and Acid-fast staining (demonstration) 5. Isolation of pure culture of bacteria by Streak-plate (four-way & continuous) and Serial-Dilution-Spread plate methods 6. Enumeration of microorganisms - total count (by Petroff-Hausser Counting chamber) & viable count (by Pour-plate method) 7. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
<p>Learning Outcomes *³</p>	<p>Learning Outcomes (Theory)</p> <ol style="list-style-type: none"> 1. To impart an understanding of the fundamentals, history and evolution of Microbiology as a subject. 2. To provide a comprehensive idea on cell morphology, ultrastructure, growth (reproduction) and nutrition of bacteria. 3. To introduce basic ideas on pure culture preservation, water-, food- and dairy microbiology, and human microbiome. 4. To present a fundamental concept on controlling microbial growth in the environment, and in the body. 5. To provide a basic understanding of the concepts and applications of molecular taxonomy of microorganisms, and a brief overview of microbial diversity. 6. To provide a fundamental knowledge on the various aspects of air- and soil microbiology, with special emphasis on the biogeochemical cycles in nature. 7. To introduce a basic understanding of virology and methods of viral classification. <p>Learning Outcomes (Practical)</p> <ol style="list-style-type: none"> 1. To introduce the basic concepts of maintaining aseptic conditions in the Microbiology lab. 2. To provide hands-on experience on culturing microorganisms, media preparation, and different types of staining procedures. 3. To introduce different techniques of bacterial pure culture isolation. 4. To provide fundamental concepts on bacterial cell counting, and enumeration of bacteriophages from water/sewage samples.

Theory text/references

1. Bauman RW. (2019). Microbiology: With Diseases by Taxonomy. 6th edition. Pearson / Benjamin Cummings.
2. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
3. William C. Frazier, Dennis C. Westhoff, N.M. Vanitha. (2017). Food Microbiology, 5th Edition. McGraw Hill Education.
4. R G Buckley. (2019). Environmental Microbiology. CBS Publishers and Distributors, Delhi, India.
5. Michael Madigan, Jennifer Aiyer, Daniel Buckley, W. Sattley, David Stahl (2021). Brock Biology of Microorganisms. 16th edition. Pearson / Benjamin Cummings.
6. Pelczar MJ, Chan ECS and Krieg NR. (2022). Microbiology. 5th Edition. Affiliated East West Press Private Limited New Delhi.
7. Salle, A.J. (1974). Fundamental Principles of Bacteriology. TMH / 7th Edition. Tata McGraw Hill.
8. Roger Y Stanier, John L Ingraham, Mark L Wheelis, Page R Painter (2005). General Microbiology. 5th Edition. Palgrave Macmillan.
9. Gerard Tortora, Berdell Funke, Christine Case, Derek Weber, Warner Bair III. (2020). Microbiology: An Introduction. 13th edition. Pearson Education.
10. Joanne Willey, Kathleen Sandman, Dorothy Wood. (2022). ISE Prescott's Microbiology. 12th Edition. McGraw Hill Higher Education.
11. Jacquelyn G. Black, Laura J. Black (2018). Microbiology: Principles and Explorations. 10th Edition. Wiley Publications.
12. Ronald M. Atlas. (2020). Principles Of Microbiology. Second Edition (India Ed). McGraw-Hill.
13. N.S. Subbarao. (2017). Soil Microbiology. MedTech Publishers.
14. Edward K. Wagner, Martinez J. Hewlett. (2003). Basic Virology. 2nd Edition. John Wiley & Sons.
15. Dimmock, Easton and Leppard. (2016). Introduction to Modern Virology. 7th Edition. Wiley-Blackwell
16. Vincent R. Racaniello, Glenn F. Rall, Anna Marie Skalka, S. Jane Flint, Lynn W. Enquist. (2015). Principles of Virology: Vol I-II. 4th Edition. ASM Press.
17. David M. Knipe, Peter M. Howley. (2006). Fields Virology. 5th Edition. Lippincott Williams and Wilkins.

Practical text/references

1. Experiments in Microbiology, Plant Pathology, Tissue culture and Microbial Biotechnology – K. R. Aneja. 6th Edition (2022). New Age International Private Limited.
2. Laboratory Manual of Microbiology and Biotechnology – K. R. Aneja. 2nd Edition. (2017). MedTech Publishers.
3. Microbiology: A Laboratory Manual – Cappuccino and Sherman. 10th Edition. (2013). Pearson Benjamin Cummings Publishers.
4. Practical Microbiology – Dr. R.C. Dubey, D K Maheshwari (2023 Ed). S Chand and Company Publishing.

Evaluation	Theory (60) CIA- 10 Assignment – 02 Attendance - 03 Semester Exam- 45	Practical (40) CA- 30 Attendance - 02 Semester Exam- 08
Paper Structure for Theory Semester Exam	<p>Module A (25 Marks)</p> <ul style="list-style-type: none"> •1 Compulsory Question – objective-type (any 5 out of 7 questions; each of 1 mark): 1×5 marks = 5 marks •Any 2 out of 3 questions; each of 10 marks, with subparts (no sub-part will be more than 5 marks, and less than 1 mark): 2×10 marks = 20 marks <p>Module B (20 Marks)</p> <ul style="list-style-type: none"> •1 Compulsory Question – any 5 out of 7 questions; each of 2 marks, with subparts (no sub-part will be less than 1 mark): 5×2 marks = 10 marks •Any 1 out of 2 questions; each of 10 marks, with subparts (no sub-part will be more than 5 marks, and less than 1 mark): 1×10 marks = 10 marks 	