

Approved by BOS (12 August, 2026)

COURSE CONTENTS & SYLLABUS

(Effective from the Academic Year 2022-2023)

MICROBIOLOGY



**Eight-Semester Undergraduate Programme
(Microbiology as one of the subjects)
as per
National Education Policy (NEP) - 2020**

**HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY
(A CENTRAL UNIVERSITY)
Srinagar, Garhwal – 246174, Uttarakhand, INDIA**

MICROBIOLOGY Syllabus: 1 to 6 semesters
DEPARTMENT OF MICROBIOLOGY
Hemvati Nandan Bahuguna Garhwal University
(A Central University)
Srinagar, Garhwal – 246174, Uttarakhand, INDIA
FOUR-YEAR BACHELOR'S DEGREE
PROGRAMME

SEMESTER - I			
1. Core paper I	INTRODUCTION TO MICROBIOLOGY	THEORY and PRACTICAL	4 + 2 CREDITS
2. Additional ID-1 (AID-I)	FUNDAMENTALS OF MICROBIOLOGY	THEORY and PRACTICAL	3 + 1 CREDITS
Skill paper I	MICROBIOLOGICAL ANALYSIS OF AIR AND WATER	THEORY	2 CREDITS
SEMESTER- II			
Core paper II	MICROBIOLOGICAL TECHNIQUES	THEORY and PRACTICAL	4 +2 CREDITS
Additional ID-2 (AID-2)	TECHNIQUES IN MICROBIOLY	THEORY and PRACTICAL	3 + 1 CREDITS
Skill paper II	MICROBIAL DIAGNOSIS IN HEALTH CLINICS	THEORY	2 CREDITS
SEMESTER- III			
Core paper III	MICROBIAL PHYSIOLOGY AND METABOLISM	THEORY and PRACTICAL	4 +2 CREDITS
Additional ID-3 (AID-3)	PHYSIOLOGY OF MICROBES)	THEORY and PRACTICAL	3 + 1 CREDITS
Skill paper I	MICROBIOLOGICAL ANALYSIS OF AIR AND WATER	THEORY	2 CREDITS
SEMESTER- IV			
Core paper IV	MICROBIAL GENETICS	THEORY and PRACTICAL	4 +2 CREDITS
Additional ID-4 (AID-4)	GENETICS OF MICROBES)	THEORY and PRACTICAL	3 + 1 CREDITS
Skill paper II	MICROBIAL DIAGNOSIS IN HEALTH CLINICS	THEORY	2 CREDITS
SEMESTER- V			
Core paper V	INDUSTRIAL MICROBIOLOGY	THEORY and PRACTICAL	4 +2 CREDITS
Vocational Course-1	FERMENTED FOODS	THEORY and PRACTICAL	3 + 1 CREDITS
SEMESTER- VI			
Core paper VI	MICROBIAL BIOTECHNOLOGY	THEORY and PRACTICAL	4 +2 CREDITS
Vocational Course (VC) -2	BIOSAFETY AND IPR	THEORY and PRACTICAL	3 + 1 CREDITS

Note:

1. ADD ID (1,2,3,4) will be opted by those students who don't have Microbiology as a core paper.
2. Skill paper will be opted for only in 2 semesters (either 1-2 or 3-4) by the students who have Microbiology as a core subject.

Core paper I:

INTRODUCTION TO MICROBIOLOGY

TOTAL HOURS: 60

CREDITS: 04

Unit I: History of Microbiology

No. of Hours: 08

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Historical accounts of modern Microbiology; from Leeuwenhoek to Craig Venter including the contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Falkow, Ross and Chakravarty; Golden era of microbiology; Scope of microbiology.

Unit II: Classification

No. of Hours: 04

Kingdom classification of microorganisms: Haeckel's three kingdom concept, Whittaker's five kingdom concept, Six kingdom classification, Eight kingdom classification, Three domain concept of Carl Woese. Definition of microorganisms, Numerical and chemical taxonomy, Introduction to Bergey's manual

Unit III: Cellular Microorganisms

No. of Hours: 20

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, cytoplasmic inclusions and endospore; Fungi: General characteristics, Ultra structure and reproduction; Protozoa: General characteristics with special reference to *Amoeba* and *Paramecium*; Algae: General characteristics. History of phycology with emphasis on contributions of Indian scientists;

Unit IV: Acellular Microorganisms

No. of Hours: 10

Characteristic features of viruses, prions and bacteriophage; Ultrastructure: Capsids, Types of envelope, Types and structure of genome; Cultivation of viruses and bacteriophage; Multiplication of viruses; Lytic and lysogeny cycle of λ phage.

Unit V: Microbes in Extreme Environment

No. of Hours: 08

Nature, special features of the thermophilic, methanogenic and halophilic Archaea; photosynthetic bacteria, Cyanobacteria some Archaea who live in extreme conditions like cold, and space.

Unit VI: Useful and harmful aspects of Microorganisms

No. of Hours: 10

Beneficial microbes: Microbes as bio fertilizers, microbial bioremediation, role of microbes in nature, Antibiotics producing microbes and other industrially useful microbes [name of the industrially useful product and producing microbes]. *Pathogenic Microorganisms*: List of common bacterial, fungal and viral diseases of human beings [Name of the disease, causative pathogen, parts affected]

Semester I
Core Paper I: (PRACTICAL)

Title of the paper: **INTRODUCTION TO MICROBIOLOGY**

TOTAL HOURS: 60

CREDITS: 02

1. Safety rules of working in microbiology lab.
2. Study of principle and applications of important instruments (autoclave, laminar air flow, hot air oven, microscope, incubator, inoculator, colony counter and vortex) used in microbiology laboratory.
3. Demonstration of spontaneous generation vs theory of biogenesis
4. Staining of fungal cells.
5. Staining of Algal cells
6. Simple staining and negative staining of bacterial cell.
7. Diagrammatic representation of lytic and lysogenic cycle of virus replication
8. Study of characteristic features of *Aspergillus*, *Penicillium*, *Amoeba* and *Paramecium*, *Chlamydomonas*, *Euglena*, *Nostoc* and *Chlorella*.

Suggested Readings

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
4. Dimmock, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.
5. Primrose, S.B. Introduction to modern virology. John Wiley and Sons, New Jersey.
6. Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
7. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
8. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
9. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
10. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.

Semester-I
Additional ID-1 (AID-1): (THEORY)

FUNDAMENTALS OF MICROBIOLOGY

TOTAL HOURS: 45

CREDITS: 03

Unit I: History of Microbiology

No. of Hours: 12

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Historical accounts of modern Microbiology; from Leeuwenhoek to Craig Venter including the contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Falkow, Ross and Chakravarty; Golden era of microbiology; Scope of microbiology.

Unit II: Cellular Microorganisms

No. of Hours: 13

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, Fungi: General characteristics, Ultra structure and reproduction in Algae, Fungi and Protozoa (*Amoeba* and *Paramecium*).

Unit III: Acellular Microorganisms

No. of Hours: 10

Characteristic features and structure of viruses, Multiplication of viruses; Lytic and lysogeny cycle of λ phage.

Unit IV: Useful and harmful aspects of Microorganisms

No. of Hours: 10

Beneficial microbes: Microbes as bio fertilizers, microbial bioremediation, role of microbes in nature, Antibiotics producing microbes and other industrially useful microbes [name of the industrially useful product and producing microbes]. **Pathogenic Microorganisms:** List of common bacterial, fungal and viral diseases of human beings [Name of the disease, causative pathogen, parts affected]

Semester-I
Additional ID-1 (AID-1): (PRACTICAL)

Title of the paper: **FUNDAMENTALS OF MICROBIOLOGY**

TOTAL HOURS: 30

CREDITS: 01

1. Safety rules of working in microbiology lab.
2. Study of principle and applications of important instruments (autoclave, laminar air flow, hot air oven, microscope, incubator, inoculator, colony counter and vortex) used in microbiology laboratory.
3. Staining of fungal cells.
4. Staining of Algal cells
5. Diagrammatic representation of lytic and lysogenic cycle of virus replication
6. Study of characteristic features of *Aspergillus*, *Penicillium*, *Amoeba* and *Paramecium*, *Chlamydomonas*, *Euglena*, *Nostoc* and *Chlorella*.

MICROBIOLOGY Syllabus: 1 to 6 semesters

Suggested Readings

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
3. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
4. Dimmick, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.
5. Primrose, S.B. Introduction to modern virology. John Wiley and Sons, New Jersey.
6. Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
7. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
8. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
9. Kannan, K. Laboratory manual in general microbiology. Panima, New Delhi.
10. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.

Semester I
Skill Paper I: (THEORY)

MICROBIOLOGICAL ANALYSIS OF AIR AND WATER

TOTAL HOURS: 30

CREDITS: 02

Unit I: Aeromicrobiology

No. of Hours: 06

Bioaerosols; Airborne microorganisms (Bacteria, viruses and fungi) and their impact on human health and environment; Significance in food and pharma industries and operation theatres; Allergens.

Unit II: Collection and Analysis of Air Sample

No. of Hours: 08

Bioaerosol sampling; Air samplers; Methods of sampling and analysis; Culture media for bacteria and fungi; Identification characteristics.

Unit III: Water Microbiology

No. of Hours: 06

Water-borne pathogens; Water-borne diseases.

Unit IV: Microbiological Analysis of Water

No. of Hours: 10

Sample collection, Treatment and safety of drinking (potable) water, Water purification, Methods to detect potability of water samples: (a) Standard qualitative procedure (MPN test) (b) Membrane filter technique and (c) Presence/absence tests

Suggested Readings

1. Da Silva, N., Taniwaki, M.H., Junqueira, V.C., Silveira, N., Nascimento, M.S., Gomes, R.A.R. Microbiological examination methods of food and water: A laboratory manual. CRC Press, Boca Raton.
2. Atlas, R.M. and Bartha, R. Microbial ecology: Fundamentals and applications. Benjamin/Cummings Science Publishing, USA.
3. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
4. Mitchell, R. and Gu, J.D. Environmental microbiology. Wiley-Blackwell, New Jersey.
5. Maier, R., Pepper, I. and Gerba, C. Environmental microbiology. Academic Press, San Diego.
6. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. John Wiley and Sons, New York.
7. Hurst, C.J., Crawford, R.L., Garland, J.L., Lipson, D.A., Mills, A.L. and Stetzenbach, L.D. Manual of environmental microbiology. ASM Press, Washington, D.C.

Semester-II

Core paper II: (THEORY)

MICROBIOLOGICAL TECHNIQUES

TOTAL HOURS: 60

CREDITS: 04

Unit I: Concept of Sterilization

No. of Hours: 08

Definition of sterilization, dry and moist heat, pasteurization, tyndallization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis, sterilants and fumigation. Determination of phenol coefficient of disinfectant.

Unit II: Media and Pure Culture Techniques

No. of Hours: 12

Culture media: basic composition, Solid and liquid media, Synthetic and complex media, Enriched and enrichment media, Selective and differential media; isolation and culture of microbes, inoculation and incubation and maintenance of cultures and related instruments. Pure culture techniques (Pour plate, Spreading, Streaking and serial dilution); Maintenance and preservation of pure culture; Cultivation of anaerobic bacteria.

Unit III: Microscopy, Spectroscopy and Centrifugation

No. of Hours: 14

Concept of magnification, resolution and contrast in microscopy, Introduction to Microscope, Principle, types and application of Bright Field Microscope, Dark Field microscope, Phase Contrast microscope, Fluorescence microscope, Confocal microscope, Scanning and Transmission Electron Microscope, Foldscope; Structure of simple and compound microscope, Beer-Lambert law and its application, single and double beam spectrophotometer (structure and application in microbiology), colorimeter and UV-visible spectrophotometer.

Unit IV: Stains and staining techniques

No. of Hours: 08

Theories of staining, Mechanism of gram staining; Stain vs dye, Principle and applications of staining techniques: simple stain, differential stain, negative stain, flagella stain, endospore stain, nuclear stain, acid fast stain

Unit V: Antibacterial susceptibility testing

No. of Hours: 10

Concept of susceptibility and resistance, concept of MIC, MBC and IC-50, different methods of antibacterial susceptibility testing based on solid and liquid media.

Unit VI: Pasteurization and fermentation

No. of Hours: 08

Techniques, types and industrial application of Pasteurization and Fermentation.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-II
Core paper II: (PRACTICAL)

MICROBIOLOGICAL TECHNIQUES (PRACTICAL)

TOTAL HOURS: 60

CREDITS: 02

1. Demonstration of autoclaving process
2. Comparison of different disinfectant
3. Preparation of solid and liquid media.
4. Enumeration of total viable count in water/soil sample.
5. Isolation of pure culture of bacteria.
6. Differentiation between lactose fermentor and nonfermentor on Mac Conkey agar.
7. Study of colony morphology of *E. coli* on EMB agar.
8. Gram staining of bacterial cell.
9. Demonstration of working of UV-Visible spectrophotometer
10. Demonstration of microbial culture plates showing Disc diffusion or well diffusion methods of antibacterial susceptibility
11. MIC calculation using given experimental data (experiment not to be performed, data can be hypothetical)

Suggested Readings

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Keith Wilson And John Walker (Editors) Principles and Techniques of Biochemistry and Molecular Biology Seventh edition. Cambridge University Press.
3. Chandra H, Srivastava J, Agarwal RK. Fundamental Techniques in Microbiology, Publisher John Publisher Pvt. Ltd, New Delhi; 2016.
4. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
5. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
6. Dimmick, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.
7. Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
8. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
9. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-II
Additional ID-2 (AID-2): (THEORY)

TECHNIQUES IN MICROBIOLOGY

TOTAL HOURS: 45

CREDITS: 03

Unit I: Concept of Sterilization

No. of Hours: 10

Definition of sterilization, dry and moist heat, pasteurization, tyndallization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis, sterilants and fumigation. Determination of phenol coefficient of disinfectant.

Unit II: Media and Pure Culture Techniques

No. of Hours: 15

Culture media: basic composition, Solid and liquid media, Synthetic and complex media, inoculation, incubation, cultures and related instruments. Pure culture techniques (Pour plate, Spreading, Streaking and serial dilution); Maintenance and preservation of pure culture; Cultivation of anaerobic bacteria.

Unit III: Microscopy

No. of Hours: 10

Concept of magnification, resolution and contrast in microscopy, Introduction to Microscope, Principle, types and application of Bright Field Microscope, Dark Field microscope.

Unit IV: Stains and staining techniques

No. of Hours: 10

Theories of staining, Mechanism of gram staining; Stain vs dye.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-II
Additional ID-2 (AID-2) (PRACTICAL)

TECHNIQUES IN MICROBIOLOGY

TOTAL HOURS: 30

CREDITS: 01

1. Demonstration of autoclaving process
2. Comparison of different disinfectant
3. Preparation of solid and liquid media.
4. Enumeration of total viable count in water/soil sample.
5. Isolation of pure culture of bacteria.
6. Gram staining of bacterial cell.
7. Demonstration of microbial culture plates showing Disc diffusion or well diffusion methods of antibacterial susceptibility
8. MIC calculation using given experimental data (experiment not to be performed, data can be hypothetical)

Suggested Readings

1. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
2. Keith Wilson And John Walker (Editors) Principles and Techniques of Biochemistry and Molecular Biology Seventh edition. Cambridge University Press.
3. Chandra H, Srivastava J, Agarwal RK. Fundamental Techniques in Microbiology Publisher John Publisher Pvt. Ltd, New Delhi; 2016.
4. Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
5. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
6. Dimmick, N.J., Easton, A.J. and Leppard, K.N. Introduction to modern virology. Wiley-Blackwell, New Jersey.
7. Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.
8. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William C. Brown, Dubuque.
9. Atlas, R.M., Brown, A.E. and Parks, L.C. Laboratory manual of experimental microbiology. Mosby College Publishing Company, St. Louis.

Semester II
Skill paper II (THEORY)

MICROBIAL DIAGNOSIS IN HEALTH CLINICS

TOTAL HOURS: 30

CREDITS: 02

Unit I: Importance of Diagnosis of Diseases

No of Hours: 04

Bacterial, viral, fungal and protozoan diseases of various human body systems; disease-associated clinical samples for diagnosis.

Unit II: Collection of Clinical Samples

No of Hours: 10

Procedure of collection of clinical samples (Oral cavity, throat, skin, blood, CSF, urine and faeces) and precautions required; Method of transport of clinical samples to laboratory and storage.

Unit III: Direct Microscopic Examination and Culture

No of Hours: 06

Examination of sample by staining: Gram staining, Ziehl-Neelson staining for tuberculosis, Giemsa stained thin blood film for malaria; Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar; Distinct colony properties of various bacterial pathogens.

Unit IV: Serological and Molecular Methods

No of Hours: 10

Serological methods: Agglutination, ELISA, Immunofluorescence; Nucleic acid based methods: PCR, Nucleic acid probes; Kits for rapid detection of typhoid, dengue and HIV, Swine flu.

Suggested Readings

1. Ananthanarayan, R. and Paniker, C.K.J. (2009). Textbook of microbiology. University Press Pvt.Ltd., 8th ed.
2. Brooks, G.F., Carroll, K.C., Butel, J.S., Morse, S.A. and Mietzner, T.A. (2013). Jawetz, Melnick and Adelberg's Medical microbiology. McGraw Hill Publication, 26th ed.
3. Randhawa, V.S., Mehta, G. and Sharma, K.B. (2009). Practicals and viva in medical microbiology. Elsevier India Pvt. Ltd., 2nd ed.
4. Tille, P. (2013). Bailey's and Scott's Diagnostic microbiology. Mosby, St. Louis, 13th ed.
5. Collee, J.G., Fraser, A.G., Marmion, B.P. and Simmons, A. (2007). Mackie and McCartney Practical medical microbiology. Elsevier Publishers, 14th ed.

Semester-III
Core paper III: (THEORY)

MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 60

CREDITS: 04

Unit I: Microbial Growth and Effect of Environment on Microbial Growth

No. of Hours: 12

Definitions of growth; Batch culture; Continuous culture; Generation time and specific growth rate; Temperature and pH ranges of growth; Effect of solute and water activity on growth; Effect of oxygen concentration on growth; Nutritional categories of microorganisms.

Unit II: Nutrient Uptake and Transport

No. of Hours: 10

Passive and facilitated diffusion; Primary and secondary active transport; Concept of uniport, symport and antiport; Group translocation; Iron uptake.

Unit III: Phototrophy and Autotrophy

No. of Hours: 18

Phototrophic metabolism: Introduction, Groups of phototrophic microorganisms, Photosynthetic and accessory pigments, Anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria. Carbon fixation pathways

Unit IV: Carbon catabolism

No. of Hours: 10

Concept of aerobic and anaerobic respiration; Sugar degradation pathways: EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: Components of respiratory chain, Comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation, Uncouplers and inhibitors. Fermentation: Alcohol and Lactate fermentation,

Unit V: Nitrogen Metabolism

No. of Hours: 10

An overview of Nitrogen cycle, Biological nitrogen fixation, Nitrification, Nitrate reduction, Denitrification, and Anammox.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-III
Core paper III: (PRACTICAL)

MICROBIAL PHYSIOLOGY AND METABOLISM

TOTAL HOURS: 60

CREDITS: 02

1. Study and plot the growth curve of E. coli by turbidimetric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data.
3. Biochemical identification of bacteria; catalase, oxidase,

Suggested Readings

1. Madigan, M.T., and Martinko, J.M. (2014). Brock biology of microorganisms. PrenticeHall International Inc., New Jersey, 14th ed.
2. Moat, A.G. and Foster, J.W. (2002). Microbial physiology. John Wiley and Sons, NewYork, 4th ed.
3. Reddy, S.R. and Reddy, S.M. (2005). Microbial physiology. Scientific Publishers, India.
4. Gottschalk, G. (1986). Bacterial metabolism. Springer Verlag, New York, 2nd ed.
5. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. (1987). General microbiology. McMillan Press, London, 5th ed.
6. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's microbiology. McGraw Hill, New York, 9th ed.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-III
Additional ID-3 (AID-3): (THEORY)

PHYSIOLOGY OF MICROBES

TOTAL HOURS: 45

CREDITS: 03

Unit I: Microbial Growth and Growth-Affecting Factors No. of Hours: 12

Definitions of growth; Batch culture; Continuous culture; Temperature and pH ranges of growth; Effect of pH, temperature, oxygen and Salt concentration on growth; Nutritional categories of microorganisms.

Unit II: Nutrient Uptake and Transport No. of Hours: 08

Passive and facilitated diffusion; Primary and secondary active transport; Concept of uniport, symport and antiport.

Unit III: Phototrophy and Autotrophy No. of Hours: 15

Phototrophic metabolism: Introduction, Groups of phototrophic microorganisms, Photosynthetic and accessory pigments, Anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

Unit IV: Carbon catabolism No. of Hours: 10

Concept of aerobic and anaerobic respiration; Sugar degradation pathways: EMP, ED, Pentose phosphate pathway, TCA cycle, Electron transport chain: Components of respiratory chain, Comparison of mitochondrial and bacterial ETC, Electron transport phosphorylation, Uncouplers and inhibitors. Fermentation: Alcohol and Lactate fermentation,

Semester-III
Additional ID-3 (AID-3): (PRACTICAL)

PHYSIOLOGY OF MICROBES

TOTAL HOURS: 30

CREDITS: 01

1. Study and plot the growth curve of *E. coli* by turbidimetric and standard plate count methods.
2. Biochemical identification of bacteria: catalase, oxidase,

Suggested Readings

1. Madigan, M.T., and Martinko, J.M. (2014). Brock biology of microorganisms. Prentice Hall International Inc., New Jersey, 14th ed.
2. Moat, A.G. and Foster, J.W. (2002). Microbial physiology. John Wiley and Sons, New York, 4th ed.
3. Reddy, S.R. and Reddy, S.M. (2005). Microbial physiology. Scientific Publishers, India.
4. Gottschalk, G. (1986). Bacterial metabolism. Springer Verlag, New York, 2nd ed.
5. Stanier, R.Y., Ingrahm, J.I., Wheelis, M.L. and Painter, P.R. (1987). General microbiology. McMillan Press, London, 5th ed.
6. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's microbiology. McGraw Hill, New York, 9th ed.

Semester-IV
Core paper IV: (THEORY)

MICROBIAL GENETICS

TOTAL HOURS: 60

CREDITS: 04

Unit I Genome Organization

No. of Hours: 10 Experimental

evidences for nucleic acid as genetic material, Structure and types of DNA; Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*

Unit II Plasmids

No. of Hours: 15

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit III Mechanisms of Genetic Exchange

No. of Hours: 10

Transformation - Discovery, mechanism of natural competence, Artificial methods: chemical method, electroporation, microinjection, biolistic method (gene gun), liposome and virus mediated and Agrobacterium - mediated delivery

Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping

Unit IV Phage Genetics

No. of Hours: 15

Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda, Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit V Transposable Elements

No. of Hours: 10

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon, Uses of transposons and transposition

Semester-IV, Core paper IV: (PRACTICAL)

Title of the paper: **MICROBIAL GENETICS**

TOTAL HOURS: 60

CREDITS: 02

1. Isolation of genomic and plasmid DNA from *E. coli*
2. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
3. Demonstration of Bacterial Conjugation
4. Demonstration of bacterial transformation and transduction

Suggested Readings

1. Snustad, D.P. and Simmons, M.J. Principles of genetics. John Wiley and Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Lewin's genes. Jones and Bartlett Learning Publishers, Sudbury.
4. Synder, L.J., Peters, E., Henkins, T.M. and Champness, W. Molecular genetics of bacteria. ASM Press, Washington, D.C.
5. Maloy, S.R., Cronan, J.E. and Freifelder, D.M. Microbial genetics. Jones and Bartlett Learning, Sudbury.
6. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
7. Miller, J.H. Experiments in molecular genetics. Cold Spring Harbor Lab Press, New York.
8. Karp, G. Cell and molecular biology: Concepts and experiments. John Wiley and Sons, New York.
9. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.

MICROBIOLOGY Syllabus: 1 to 6 semesters
Semester-IV
Additional ID-4 (AID-4): (THEORY)

GENETICS OF MICROBES

TOTAL HOURS: 45

CREDITS: 03

Unit I: Genome Organization

No. of Hours: 10

Experimental evidences for nucleic acid as genetic material, Structure and types of DNA; Genome organization of *E. coli*,

Unit II: Plasmids

No. of Hours: 15

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

Unit III: Mechanisms of Genetic Exchange

No. of Hours: 10

Transformation - Discovery, mechanism of natural competence, Artificial methods: chemical method, electroporation, microinjection, biolistic method (gene gun); Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

Unit IV: Transposable elements

No. of Hours: 10

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon, Uses of transposons and transposition

Semester-IV, Additional ID-4 (AID-4): (PRACTICAL)

GENETICS OF MICROBES

TOTAL HOURS: 30

CREDITS: 01

1. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
2. Demonstration of Bacterial Conjugation.
3. Demonstration of bacterial transformation.
4. Demonstration of transduction.

Suggested Readings

1. Snustad, D.P. and Simmons, M.J. Principles of genetics. John Wiley and Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Scott, M.P., Bretscher, A., Ploegh, H. and Matsudaira, P. Molecular cell biology. W.H. Freeman and Company, New York.
3. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. Lewin's genes. Jones and Bartlett Learning Publishers, Sudbury.
4. Synder, L.J., Peters, E., Henkins, T.M. and Champness, W. Molecular genetics of bacteria. ASM Press, Washington, D.C.

MICROBIOLOGY Syllabus: 1 to 6 semesters

5. Maloy, S.R., Cronan, J.E. and Freifelder, D.M. Microbial genetics. Jones and Bartlett Learning, Sudbury.
6. Sambrook, J. and Russell, D.W. Molecular cloning: A laboratory manual. Cold Spring Harbor Lab Press, New York.
7. Miller, J.H. Experiments in molecular genetics. Cold Spring Harbor Lab Press, New York.
8. Karp, G. Cell and molecular biology: Concepts and experiments. John Wiley and Sons, New York.
9. Chaitanya, K.V. Cell and molecular biology: A lab manual. PHI Learning, New Delhi.

SEMESTER – V
Core Paper V - INDUSTRIAL MICROBIOLOGY
(THEORY)

TOTAL HOURS: 60

CREDITS: 04

Unit 1: Introduction to Industrial Microbiology Microbial growth (12 hours)

Traditional fermentation processes (e.g., bread, beer, wine); Discovery of penicillin and antibiotics; Contribution of key scientists (Louis Pasteur: Fermentation and pasteurization; Alexander Fleming: Discovery of antibiotics; Carl Neuberg: Enzyme fermentation); Overview and significance of various industries (Pharmaceuticals: Antibiotics, vaccines, and bio-therapeutics; Food and Beverages: Fermented foods, additives, and enzymes; Agriculture: Bio-fertilizers, bio-pesticides; Environment: Bioremediation and waste treatment; Energy: Biofuels and biogas production).

Unit 2: Fermentation Technology (12 hours)

Principles of fermentation; Types of fermentations: Submerged and solid-state; types of cultures: batch, fed-batch and continuous; Inoculum development; basic design and functions of different part of fermenter/bioreactor; Types of bioreactors; Scale-up and scale-down processes; Downstream processing and product recovery.

Unit 3: Microbiology for Industrial Production (15 hours)

Overview of microorganisms (Bacteria: *Bacillus*, *Escherichia coli*, *Streptomyces*; Fungi: *Aspergillus*, *Penicillium*; Yeasts: *Saccharomyces cerevisiae*; Algae: *Chlorella*, *Spirulina*; Viruses: Bacteriophages in biotechnology) and cell-lines used in industry; Characteristics of industrially important microorganisms; Sources and isolation of industrial microorganisms; Preservation and maintenance of industrial strains; Primary and secondary screening techniques; use of recombinant DNA technology for strain improvement and industrial production.

Unit 4: Production of Industrial Products (15 hours)

Production of antibiotics (Penicillin & Streptomycin), alcohols (Ethanol & Butanol), enzymes (Amylase & Lipase), organic acids (Citric acid & lactic acid) and vitamins (B-12 & C); Introduction and industrial production of Biopolymers and bioplastics.

Unit 5: Regulatory and Quality Control (06 hours)

Overview of regulatory bodies; Regulatory frameworks and Guidelines; Compliance with Environmental and Safety Standards; Principles of Quality Control; Quality Assurance Systems; Testing and Validation Procedures; Fundamentals of GMP; Implementation of GMP in Bioprocessing; Documentation and Record-Keeping.

SEMESTER – V

**Core Paper V - INDUSTRIAL MICROBIOLOGY
(PRACTICAL)**

TOTAL HOURS: 60

CREDITS: 02

1. Isolation of microorganisms from natural sources.
2. Screening of bacterial cultures for Amylase production.
3. Quantitative estimation of amylase production by bacterial culture.
4. Screening of bacterial cultures for lipase production.
5. Quantitative estimation of lipase production by bacterial culture.
6. Glucose fermentation and Ethanol production using yeast
7. Penicillium culture and microscopic identification
8. Demonstration of antibiotic production and activity on agar plate
9. Demonstration of centrifugation, filtration and precipitation as part of downstream processes.
10. Display of fermenter/bioreactor design
11. Demonstration of Recombinant DNA technology using chart/models.
12. Documents and record keeping in GMP

Suggested Readings

1. Industrial Microbiology by L.E. Casida
2. Industrial Microbiology by Reed, G. Prescott and Dunn.
3. Industrial Microbiology: An Introduction by Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higon
4. Principles of Fermentation Technology by Peter F. Stanbury, Allan Whitaker, Stephen J. Hall
5. Microbial Biotechnology: Fundamentals of Applied Microbiology by Alexander N. Glazer, Hiroshi Nikaido
6. Fermentation Microbiology and Biotechnology by E. M. T. El-Mansi, C. F. A. Bryce, Arnold L. Demain, A. R. Allman
7. Bioprocess Engineering: Basic Concepts by Michael L. Shuler, Fikret Kargi
8. Biotechnology: A Textbook of Industrial Microbiology by Wulf Crueger, Anneliese Crueger, Kazuo A. Nonomura
9. Industrial Biotechnology: Sustainable Growth and Economic Success edited by Wim Soetaert, Erick J. Vandamme
10. Biotechnology for Beginners by Reinhard Renneberg
11. Modern Industrial Microbiology and Biotechnology by Nduka Okafor
12. Practical Fermentation Technology Edited by Brain McNeil and Linda M. Harvey

SEMESTER –V

VC 1 - FERMENTED FOODS (THEORY)

TOTAL HOURS: 45

CREDITS: 03

Unit I: Fermented foods

No. of Hours: 9

Concept of fermented foods, history, advantage and disadvantage of fermented foods, nutritive value of fermented foods, microbial changes in fermented foods (proteolytic, lipolytic and fermentative bacteria)

Unit II: Importance of fermented foods:

No. of Hours: 9

Traditional fermented foods, Organisms used for production of fermented food products, Environmental parameters for fermentation process; Classification of fermentation processes for fermented foods; safety criteria of fermented foods.

Unit III: Fermented food products

No. of Hours: 9

Production of bread, fermented dairy products: acidophilus milk, cheese (Mozzarella and Cheddar) and yoghurt; Fermented meat and fishery products.

Unit IV: Fermented vegetables

No. of Hours: 9

Production methods and benefits of Sauerkraut, Kimchi, olives, cucumber, Coffee, Sufu, Poi.

Unit V: Oriental foods

No. of Hours: 9

Mycoprotein, miso, soya sauce, idli, natto; beverages: vinegar, cider and sake; Alcoholic beverages of Himalayan region (Jann, Kacchi, Sez).

VC 1 - FERMENTED FOODS (PRACTICAL)

TOTAL HOURS: 30

CREDITS: 01

- 1) Microbial production of yoghurt.
- 2) Isolation and identification of *Lactobacillus* from fermented dairy products.
- 3) Production of sauerkraut,
- 4) Determination of Lactic acid in sauerkraut

Suggested readings

1. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
2. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw Hill, New Delhi.
3. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.
4. R.C. Dubey and D. K. Maheshwari (2018) A Text book of Microbiology, S.Chand, New Delhi, ISBN: 978-8121926201.
5. R.C. Dubey and D. K. Maheshwari (2018) Practical Microbiology, S.Chand, New Delhi.

SEMESTER –VI

DSE 3 - MICROBIAL BIOTECHNOLOGY (THEORY)

TOTAL HOURS: 60

CREDITS: 04

Unit 1: Microbial Biotechnology

No. of Hours: 12

Scopes and challenges; Industrial microorganisms: Growth metabolism regulation, Isolation and preservation of industrially important microorganisms. Production of metabolites: Microbial production and applications of primary metabolites: Citric acid, Ethanol, L Glutamic acid, L Lysine, Vitamins B; Industrially important microbial enzymes: Types, mode of action and industrial applications of microbial amylases and proteases.

Unit II: Production of important microbial products

No. of Hours: 12

Antibiotics (Penicillin and Streptomycin), Ergot alkaloids; Biotransformations of steroids: Hydroxylations and dehydrogenation, Sterol biotransformations; Probiotics, prebiotics and synbiotics: Fundamental aspects and health benefits, Vaccines production by bacteria.

Unit III: Microbes and society:

No. of Hours: 12

Microbes in agrobiotechnology; microbial pesticides; integrated pest management, nanofertilizers, environmental biotechnology; food production involving microorganisms and their products, microbes in medical biotechnology, microbes in alternative energy, microbes in detergent, textile industries.

Unit IV: Bioplastics and Bioweapons

No. of Hours: 12

Plastics vs. Bioplastics; History, chemical nature and production of bioplastics, health benefits of bioplastics; Microplastics: Microbial degradation of microplastics; Bioterrorism/bioweapons – History, microbes used in bioterrorism, threats and policy to control bioterrorism.

Unit V: Biosurfactants and Biosensors

No. of Hours: 12

Biosurfactants: History, Characteristics, Sources, types and production, application in Agriculture, food, medical and paper industries; Biosensors: History, types, characteristics and Application in food quality monitoring, soil quality monitoring, water quality monitoring, environmental monitoring and environmental monitoring.

SEMESTER –VI

DSE 3 - MICROBIAL BIOTECHNOLOGY (PRACTICAL)

TOTAL HOURS: 60

CREDITS: 02

1. Isolation of amylase producing bacteria from soil.
2. Isolation of plastic degrading microbes
3. Isolation and screening of bioplastic producing microorganisms.
4. Demonstration of isolation and production of microbial pesticides
5. Demonstration of vaccine production by bacteria.

Suggested readings

1. R.C. Dubey (2014), Advanced Biotechnology, S. Chand, New Delhi, ISBN: 9788121942904
2. Alexander N. Glazer (2012), Microbial Biotechnology: Fundamentals of Applied Microbiology, Cambridge University Press, ISBN: 9780511811227
3. Relevant research/review articles

VC 2 - Biosafety and IPR

Total Hours: 45

Credits: 03

Unit I: Introduction to Biosafety

(09 Hours)

Understanding biosafety and its significance in research and industry. Biosafety levels and associated requirements of BSL-1, BS-2, BSL-3, and BSL-4. Identifying hazards and risk assessments protocols.

Unit II: Laboratory Biosafety

(09 Hours)

Standard operating procedures (SOPs), containment practices, personal protective equipment (PPE). Safe handling, transportation, and disposal of biohazardous materials. Emergency procedures -Response plans for spills, exposures, and other emergencies.

Unit III: Regulatory Framework for Biosafety

(09 Hours)

GMO's and associated Biosafety concerns & Regulations. GEAC (Genetic Engineering Approval Committee), RCGM (Regional Committee on Genetic Manipulation), and IBC (Institutional Biosafety Committee). International treaties regulating Biosafety from potential biological hazards – Cartagena Protocol, Nagoya-Kuala Lumpur Supplementary Protocol, IPPC – International Plant Protection Convention, and the EU regulation (No. 1829/2003).

Unit IV: IPR and its different types

(09 Hours)

Types of Intellectual property and their significance. Patents, Trademarks, Copyrights, Trade secrets, Industrial designs, Geographical Indicators, Plant breeder's rights, Traditional knowledge; Importance of IPR; Patentable and non-patentable IPs; Legal protection of biotechnological inventions; World Intellectual Property Organization (WIPO).

Unit V: Patents and Patent Laws

(09 Hours)

Types of patent applications: Ordinary, PCT, Conventional, Divisional. Agreements and Treaties: GATT, TRIPS agreement, Role of Madrid agreement, Hague agreement, WIPO treaties, Budapest treaty on international recognition of the deposit of microorganisms, UPOV, Berne convention, Patent Co- operation Treaty (PCT), Indian Patent Act 1970 and recent amendments.

SEMESTER - VI

VC 2 - Biosafety and IPR (Practical)

Total Hours: 30

Credit: 01

1. Analyse real-life biosafety incidents from recent history and their causes.
2. Emergency response drill under simulated conditions.
3. International treaty reviews and presentation by students.
4. Drafting a typical patent application.
5. Patent search exercise.

Suggested Readings

1. Biosafety in Microbiological and Biomedical Laboratories" (BMBL) by Centers for
2. Disease Control and Prevention (CDC) and National Institutes of Health (NIH).
3. Intellectual Property: Patents, Trademarks, and Copyright in a Nutshell" by Arthur R. Miller and Michael H. Davis
4. Patent Law and Policy: Cases and Materials" by Robert P. Merges and John F. Duffy.