

Approved by BOS (12 August, 2026)

COURSE CONTENTS & SYLLABUS

UG-Microbiology

(Effective from the Academic Year 2025-2026)

UG-Microbiology

(I-IV Semester)



National Education Policy (NEP) - 2020

**DEPARTMENT OF BOTANY AND MICROBIOLOGY
HEMVATI NANDAN BAHUGUNA GARHWAL UNIVERSITY
(A CENTRAL UNIVERSITY)**

Srinagar, Garhwal – 246174, Uttarakhand, INDIA

Four-Year Undergraduate Program (FYUP) - MICROBIOLOGY

Credit Framework

B.Sc. Microbiology (Semester I)				
FYUP Semester	Course Category	Paper Name	Credits	
			T	P
I	DSC Subject-I (Major)	Introduction to Microbiology	2	2
	DSC Subject-II (Minor)	Fundamentals of Microbiology	2	2
	MD/ID (Subject-1)	Basic Microbiology	2	2
	MD/ID (Subject-2)	MD/ID-I	2	2
	SEC/ AEC	SEC I - Microbiological Analysis of Air and Water. OR Field work/SEC/Communication Skills/ OR AMSC/Field Work/SEC	2	-
	VAC	Understanding and Connecting with the Environment OR Life Skills & Personality development	2	-
		Total credits	12+8=20	
Important Note- 1. SEC I can be opted by students/offered by the dept. in either I or III semesters. 2. MD/ID Subject-2, AEC and VAC papers will be taught by other departments				
B.Sc. Microbiology (Semester II)				
II	DSC Subject-I (Major)	Microbiological Techniques	2	2
	DSC Subject-II (Minor)	Methods in Microbiology	2	2
	MD/ID (Subject-1)	Techniques in Microbiology	2	2
	MD/ID (Subject-2)	MD/ID-II	2	2
	SEC/ AEC	SEC II - Microbial Diagnosis in Health Clinics OR AMSC/Field Work/SEC OR Field work/ SEC/ Communication Skills	2	-
	VAC	Understanding and Connecting with the Environment OR Life Skills & Personality Development	2	-
		Total credits	12+8=20	
Important Note- 1. SEC II can be opted by students/offered by the dept. in either II or IV semesters. 2. MD/ID Subject-2, AEC and VAC papers will be taught by other departments				

Four-Year Undergraduate Program (FYUP) - MICROBIOLOGY

Credit Framework

B.Sc. Microbiology (Semester III)				
FYUP Semester	Course Category	Paper Name	Credit	
			T	P
III	Major-	Microbial physiology and metabolism	4	1
	Minor-	Physiology of microbes	3	1
	DSC (Major – Skill-based Course)	Biofertilizers	2	1
	MD/ID	Microbial metabolism	3	1
	AEC (Language based courses)	Indian, Modern, Regional Language-I	2	0
	VAC/AEC	Indian Knowledge System or Culture, Traditions and Moral Values	2	0
		Total credits	16+4=20	
B.Sc. Microbiology (Semester IV)				
FYUP Semester	Course Category	Paper Name	Credit	
			T	P
IV	Major	Microbial genetics	4	1
	Minor	Genetics of microbes	3	1
	DSC (Major – Skill-based Course)	Traditional Food Microbiology	2	1
	MD/ID-III	Genetics of Microorganisms	3	1
	AEC (Language based courses)	Indian, Modern, Regional Language-I	2	0
	VAC/AEC	Indian Knowledge System or Culture, Traditions and Moral Values	2	0
		Total credits	16+4=20	
NHEQF Level 5	Student on exit after successfully completing Second year (i.e., securing minimum required 80 credits + 4 Credits in one vocational course/skills-enhancement course of 4 credits) will be awarded “Undergraduate Diploma” of two year, in related field/discipline/subject.			

Semester- I

Microbiology- DSC Subject-I (MAJOR)

Name of paper: Introduction to Microbiology

TOTAL HOURS: 30

CREDITS: 02

Unit I: History of Microbiology

No. of Hours: 08

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Ross; Golden era of microbiology.

Unit II: Classification

No. of Hours: 08

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.

Unit III: Cellular Microorganisms

No. of Hours: 07

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, and endospore; Fungi: General and unique characteristics.

Unit IV: Acellular Microorganisms

No. of Hours: 07

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.

Microbiology- DSC Subject-I (MAJOR) Practical

Name of paper: Introduction to Microbiology (Practical)

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.

Suggested Readings

- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
- Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
- Dubey, R.C. and Maheshwari, D.K. A text book of Microbiology. S Chand Publication. New Delhi.
- Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William
- Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.

Semester- I

Microbiology- DSC Subject-II (MINOR)

Name of paper: Fundamentals of Microbiology

TOTAL HOURS: 30

CREDITS: 02

Unit I: History of Microbiology

No. of Hours: 08

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Ross; Golden era of microbiology.

Unit II: Classification

No. of Hours: 08

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.

Unit III: Cellular Microorganisms

No. of Hours: 07

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, and endospore; Fungi: General and unique characteristics.

Unit IV: Acellular Microorganisms

No. of Hours: 07

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.

Microbiology- DSC Subject-II (MINOR) Practical

Name of paper: Fundamentals of Microbiology (Practical)

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.

Suggested Readings

- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
- Black, J.G. Microbiology: Principles and exploration. John Wiley and Sons, New Jersey.
- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
- Dubey, R.C. and Maheshwari, D.K. A text book of Microbiology. S Chand Publication. New Delhi.
- Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William
- Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.

Semester- I

Microbiology- MD/ ID (Subject-1)

Name of paper: Basic Microbiology

TOTAL HOURS: 30

CREDITS: 02

Unit I: History of Microbiology

No. of Hours: 08

Discovery of microorganisms; Spontaneous generation vs. biogenesis; Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Martinus W. Beijerinck, N. Winogradsky, Alexander Fleming, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Ross; Golden era of microbiology.

Unit II: Classification

No. of Hours: 08

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.

Unit III: Cellular Microorganisms

No. of Hours: 07

Bacteria: Morphology of bacteria, Structure and functions of cell wall, cell membrane, flagella, pili, ribosome, nucleoid, and endospore; Fungi: General and unique characteristics.

Unit IV: Acellular Microorganisms

No. of Hours: 07

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.

Microbiology- MD/ ID (Practical)

Name of paper: Basic Microbiology (Practical)

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. Staining of Microbial cell.

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. Dubey, R.C. and Maheshwari, D.K. A text book of Microbiology. S Chand Publication. New Delhi.
5. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. William
6. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.

SEC I: Microbiological analysis of air and water

TOTAL HOURS: 30

CREDITS: 02

Unit I: Aeromicrobiology

No. of Hours: 06

Bioaerosols; Air borne 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.
2. Microbiological examination methods of food and water: A laboratory manual. CRC Press, Boca Raton.
3. Atlas, R.M. and Bartha, R. Microbial ecology: Fundamentals and applications.
4. Benjamin/Cummings Science Publishing, USA.
5. Madigan, M.T., Martinko, J.M. and Parker, J. Brock biology of microorganisms. Prentice Hall, New Jersey.
6. Mitchell, R. and Gu, J.D. Environmental microbiology. Wiley-Blackwell, New Jersey.
7. Maier, R., Pepper, I. and Gerba, C. Environmental microbiology. Academic Press, San Diego.
8. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. John Wiley and Sons, New York.
9. 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

Microbiology- DSC Subject-I (MAJOR)

Name of paper: Microbiological Techniques

TOTAL HOURS: 30

CREDITS: 02

Unit I: Concept of Sterilization

No. of Hours: 08

Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antiseptics sterilants and fumigation.

Unit II: Media and Pure Culture Techniques

No. of Hours: 08

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);

Unit III: Microscopy and Spectroscopy

No. of Hours: 07

Concept of magnification, resolution and contrast in microscopy, Introduction to Microscope, Principle, types and application of Light and Electron Microscopy, Foldscope, Beer-Lambert law and its application in Spectrophotometry.

Unit IV: Stains and staining techniques

No. of Hours: 07

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

Semester- II

Microbiology- DSC Subject-I (MAJOR) Practical

Name of paper: Microbiological Techniques (PRACTICAL)

TOTAL HOURS: 60

CREDITS: 02

1. Demonstration of autoclaving process
2. Preparation of solid and liquid media.
3. Enumeration of total viable count in water/soil sample.
4. Isolation of pure culture of bacteria.
5. Gram staining of bacterial cell.
6. Demonstration of working of UV-Visible spectrophotometer

Suggested Readings

- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
- Keith Wilson And John Walker (Editors) Principles and Techniques of Biochemistry and Molecular Biology Seventh edition. Cambridge University Press.
- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
- Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.

Semester- II

Microbiology- DSC Subject-II (MINOR)

Name of paper: Methods in Microbiology

TOTAL HOURS: 30

CREDITS: 02

Unit I: Concept of Sterilization

No. of Hours: 08

Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antiseptics sterilants and fumigation.

Unit II: Media and Pure Culture Techniques

No. of Hours: 08

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);

Unit III: Microscopy and Spectroscopy

No. of Hours: 07

Concept of magnification, resolution and contrast in microscopy, Introduction to Microscope, Principle, types and application of Light and Electron Microscopy, Foldscope, Beer-Lambert law and its application in Spectrophotometry.

Unit IV: Stains and staining techniques

No. of Hours: 07

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

Semester- II

Microbiology- DSC Subject-I (MINOR)- Practical

Name of paper: Methods in Microbiology (Practical)

TOTAL HOURS: 60

CREDITS: 02

1. Demonstration of autoclaving process
2. Preparation of solid and liquid media.
3. Enumeration of total viable count in water/soil sample.
4. Isolation of pure culture of bacteria.
5. Gram staining of bacterial cell.
6. Demonstration of working of UV-Visible spectrophotometer

Suggested Readings

- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
- Keith Wilson And John Walker (Editors) Principles and Techniques of Biochemistry and Molecular Biology Seventh edition. Cambridge University Press.
- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
- Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.

Microbiology- MD/ID (Subject-1)

Name of paper: Techniques in Microbiology

TOTAL HOURS: 30

CREDITS: 02

Unit I: Concept of Sterilization

No. of Hours: 08

Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antiseptics sterilants and fumigation.

Unit II: Media and Pure Culture Techniques

No. of Hours: 08

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);

Unit III: Microscopy and Spectroscopy

No. of Hours: 07

Concept of magnification, resolution and contrast in microscopy, Introduction to Microscope, Principle, types and application of Light and Electron Microscopy, Foldscope, Beer-Lambert law and its application in Spectrophotometry.

Unit IV: Stains and staining techniques

No. of Hours: 07

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

Semester- II

Microbiology- MD/ID

Name of paper: Techniques in Microbiology

TOTAL HOURS: 60

CREDITS: 02

1. Demonstration of autoclaving process
2. Preparation of solid and liquid media.
3. Enumeration of total viable count in water/soil sample.
4. Isolation of pure culture of bacteria.
5. Gram staining of bacterial cell.
6. Demonstration of working of UV-Visible spectrophotometer

Suggested Readings

- Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York.
- Keith Wilson And John Walker (Editors) Principles and Techniques of Biochemistry and Molecular Biology Seventh edition. Cambridge University Press.
- Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. Microbiology. McGraw-Hill, New York.
- Cappuccino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin/Cummings Publishing Company, San Francisco.

SEC II: 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

Theory (Major paper): Microbial Physiology and Metabolism

TOTAL HOURS: 60

CREDITS: 04

Unit I: 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.

Practical (Major paper): Microbial Physiology and Metabolism

TOTAL HOURS: 30

CREDITS: 01

1. Calculations of the generation time and specific growth rate of bacteria from the graph plotted with the given data.
2. Biochemical identification of bacteria: catalase and oxidase.

Suggested Readings

1. Madigan, M. T., & Martinko, J. M. (2025). Brock biology of microorganisms. Prentice Hall International Inc., New Jersey.
2. Moat, A. G., & Foster, J. W. (2024). Microbial physiology (4th ed.). John Wiley & Sons, New York.
3. Reddy, S. R., & Reddy, S. M. (2005). Microbial physiology. Scientific Publishers, India.
4. Gottschalk, G. (1986). Bacterial metabolism (2nd ed.). Springer-Verlag, New York.
5. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1999). General microbiology (5th ed.). Macmillan Press, London.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2013). Prescott's microbiology (9th ed.). McGraw-Hill, New York.
7. Duby R.C. and Maheshwari DK (2024) Text book of Microbiology, S.Chand, New Delhi

Theory (Minor paper): Physiology of Microbes

Total Hours: 45

Credits: 03

Unit I: Microbial Growth

No. of Hours: 10

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: 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. 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.

Practical (Minor paper): Physiology of Microbes

Total Hours: 30

Credits: 01

1. Calculations of the generation time and specific growth rate of bacteria from the graph plotted with the given data.
2. Biochemical identification of bacteria: catalase and oxidase.

Suggested Readings

1. Madigan, M. T., & Martinko, J. M. (2025). Brock biology of microorganisms. Prentice Hall International Inc., New Jersey.
2. Moat, A. G., & Foster, J. W. (2024). Microbial physiology (4th ed.). John Wiley & Sons, New York.
3. Reddy, S. R., & Reddy, S. M. (2005). Microbial physiology. Scientific Publishers, India.
4. Gottschalk, G. (1986). Bacterial metabolism (2nd ed.). Springer-Verlag, New York.
5. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1999). General microbiology (5th ed.). Macmillan Press, London.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2013). Prescott's microbiology (9th ed.). McGraw-Hill, New York.
7. Duby R.C. and Maheshwari DK (2024) Text book of Microbiology, S.Chand, New Delhi

Theory (DSC (Major – Skill-based Course): Biofertilizers

Total Hours: 30

Credits: 02

Unit I: Fundamentals of Biofertilizers

No. of Hours: 8

Concept, definition and importance of biofertilizers; Classification and types of biofertilizers; Microbial inoculants used as biofertilizers; Bacterial biofertilizers: *Rhizobium*, Fungal biofertilizers: (Arbuscular mycorrhizal fungi (AMF); Advantages and limitations of biofertilizers over chemical fertilizers

Unit II: Functional Role and Mechanisms of Biofertilizers

No. of Hours: 7

Biological nitrogen fixation; Role of nitrogen-fixing microorganisms in crop production; Phosphate solubilization; Plant growth-promoting microorganisms and mechanisms of plant growth promotion.

Unit III: Biofertilizers, Biopesticides and Sustainable Agriculture

No. of Hours: 7

Concept and significance of biopesticides; Microbial biopesticides: bacterial, fungal and viral agents; Mechanisms of biological control: Integrated pest and disease management; Role of biofertilizers and biopesticides in sustainable agriculture

Unit IV: Production, Formulation and Application of Bioinoculants

No. of Hours: 8

Selection and screening of efficient microbial strains; Maintenance and mass multiplication of microbial inoculants; Carrier materials: characteristics, selection and preparation; Formulation and quality control of microbial inoculants; Storage, shelf life and factors affecting microbial viability.

Practical (DSC (Major – Skill-based Course): Biofertilizers

Total Hours: 30

Credit: 01

1. Isolation of *Rhizobium* from root nodules of leguminous plants.
2. Isolation of phosphate-solubilizing microorganisms from soil.

Suggested Readings

1. Subba Rao, N.S. (1977) *Soil microorganisms and plant growth*. Oxford and IBH Publishing Company, New Delhi.
2. Alexander, M. (1977) *Introduction to soil microbiology*. John Wiley and Sons, New York.
3. Dubey, R. C., & Maheshwari, D. K. (1999) *A Textbook of Microbiology (Library Hardback Edition)*. S. Chand Publishing.
4. Aneja, K. R. (2018). *Experiments in microbiology, plant pathology, tissue culture and microbial biotechnology*. New Age International Publishers.
5. Giri, B., Prasad, R., Wu, Q. S., & Varma, A. (Eds.). (2019). *Biofertilizers for sustainable agriculture and environment*. Springer Nature Switzerland AG.
6. Popkova, E. G. (2022). *Sustainable Development of Agriculture: Modeling and Management to Ensure Food Security*. In Sustainable Agriculture and Food Security. Springer.

Theory (MD/ID): Microbial Metabolism

Total Hours: 45

Credits: 03

Unit I: Microbial Growth

No. of Hours: 10

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: 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. 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.

Practical (MD/ID): Microbial Metabolism

Total Hours: 30

Credits: 01

3. Calculations of the generation time and specific growth rate of bacteria from the graph plotted with the given data.
4. Biochemical identification of bacteria: catalase and oxidase.

Suggested Readings

1. Madigan, M. T., & Martinko, J. M. (2025). Brock biology of microorganisms. Prentice Hall International Inc., New Jersey.
2. Moat, A. G., & Foster, J. W. (2024). Microbial physiology (4th ed.). John Wiley & Sons, New York.
3. Reddy, S. R., & Reddy, S. M. (2005). Microbial physiology. Scientific Publishers, India.
4. Gottschalk, G. (1986). Bacterial metabolism (2nd ed.). Springer-Verlag, New York.
5. Stanier, R. Y., Ingraham, J. L., Wheelis, M. L., & Painter, P. R. (1999). General microbiology (5th ed.). Macmillan Press, London.
6. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2013). Prescott's microbiology (9th ed.). McGraw-Hill, New York.
7. Duby R.C. and Maheshwari DK (2024) Text book of Microbiology, S.Chand, New Delhi

Semester-IV

Major: MICROBIAL GENETICS (THEORY)

TOTAL HOURS: 60

CREDITS: 04

Unit I: Genome Organization

No. of Hours: 10

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

Unit II: Plasmids

No. of Hours: 15

Types of plasmids: F plasmid, R plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, and 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: 15

Transformation: Discovery and mechanism of natural competence; Artificial methods including chemical method, electroporation, microinjection, biolistic method (gene gun), liposome-mediated, virus-mediated, and *Agrobacterium*-mediated delivery; Conjugation: Discovery and mechanism; Hfr and F' strains; Interrupted mating technique and time-of-entry mapping.

Unit IV: Phage Genetics

No. of Hours: 10

Features of T4 genetics; Genetic basis of lytic versus lysogenic switch in bacteriophage lambda; Transduction: Generalized and specialized transduction; LFT and 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; Applications of transposons and transposition.

Practical (Major paper): Microbial Genetics

TOTAL HOURS: 30

CREDITS: 01

1. Isolation of genomic and plasmid DNA from *E. coli*.
2. Study of different conformations of plasmid DNA through agarose gel electrophoresis.

Suggested Readings

1. Snustad, D. P., & Simmons, M. J. *Principles of Genetics*. John Wiley & Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., & Matsudaira, P. *Molecular Cell Biology*. W. H. Freeman and Company, New York.
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. *Lewin's Genes*. Jones and Bartlett Learning Publishers, Sudbury.
4. Snyder, L., Peters, J. E., Henkin, T. M., & Champness, W. *Molecular Genetics of Bacteria*. ASM Press, Washington, D.C.

5. Maloy, S. R., Cronan, J. E., & Freifelder, D. *Microbial Genetics*. Jones and Bartlett Learning, Sudbury.
6. Sambrook, J., & Russell, D. W. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor Laboratory Press, New York.
7. Miller, J. H. *Experiments in Molecular Genetics*. Cold Spring Harbor Laboratory Press, New York.
8. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, New York.
9. Chaitanya, K. V. *Cell and Molecular Biology: A Lab Manual*. PHI Learning, New Delhi.

Theory (Minor paper): Genetics of Microbes

TOTAL HOURS: 45

CREDITS: 03

Unit I: Genome Organization

No. of Hours: 8

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

Unit II: Plasmids

No. of Hours: 15

Types of plasmids: F plasmid, R plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, and 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: 15

Transformation: Discovery and mechanism of natural competence; Artificial methods including chemical method, electroporation, microinjection, biolistic method (gene gun), liposome-mediated, virus-mediated, and *Agrobacterium*-mediated delivery; Conjugation: Discovery and mechanism; Hfr and F' strains; Interrupted mating technique and time-of-entry mapping.

Unit IV: Phage Genetics

No. of Hours: 7

Features of T4 genetics; Genetic basis of lytic versus lysogenic switch in bacteriophage lambda; Transduction: Generalized and specialized transduction; LFT and HFT lysates; Mapping by recombination and co-transduction of markers.

Practical (Minor paper): Genetics of Microbes

TOTAL HOURS: 30

CREDITS: 01

1. Isolation of genomic and plasmid DNA from *E. coli*.
2. Study of different conformations of plasmid DNA through agarose gel electrophoresis.

Suggested Readings

1. Snustad, D. P., & Simmons, M. J. *Principles of Genetics*. John Wiley & Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., & Matsudaira, P. *Molecular Cell Biology*. W. H. Freeman and Company, New York.
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. *Lewin's Genes*. Jones and Bartlett Learning Publishers, Sudbury.
4. Snyder, L., Peters, J. E., Henkin, T. M., & Champness, W. *Molecular Genetics of Bacteria*. ASM Press, Washington, D.C.
5. Maloy, S. R., Cronan, J. E., & Freifelder, D. *Microbial Genetics*. Jones and Bartlett Learning, Sudbury.
6. Sambrook, J., & Russell, D. W. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor Laboratory Press, New York.
7. Miller, J. H. *Experiments in Molecular Genetics*. Cold Spring Harbor Laboratory Press, New York.
8. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, New York.
9. Chaitanya, K. V. *Cell and Molecular Biology: A Lab Manual*. PHI Learning, New Delhi.

DSC (Major – Skill-based Course): Traditional Food Microbiology

Total hours: 30

Credits: 02

Unit I: Introduction to Traditional Food Microbiology

No. of Hours: 8

Concept and scope of traditional food microbiology; Traditional Knowledge Systems (TKS) and indigenous knowledge; Role of microorganisms in traditional food processing and preservation; Indigenous knowledge in the identification and utilization of beneficial microorganisms

Unit II: Traditional Fermented Foods and Beverages

No. of Hours: 7

Microbiology and fermentation processes of Idli, and Dosa; Role of lactic acid bacteria, yeasts and other microorganisms; Biochemical changes during fermentation; Nutritional and health benefits of traditional fermentation; Traditional fermentation practices and their scientific basis

Unit III: Ethnomicrobiology, and Probiotics

No. of Hours: 8

Concept and scope of ethnomicrobiology; Traditional knowledge of mushrooms and fungi; Ethnomycological uses of edible and medicinal mushrooms; Probiotics: definition, characteristics and significance, Common probiotic microorganisms: *Lactobacillus*, *Bifidobacterium*; Health benefits of probiotics; Postbiotics.

Unit IV: Microbial Bioprospecting, Biosafety and IPR

No. of Hours: 7

Concept, scope and significance of microbial bioprospecting; Exploration of microorganisms for food and agriculture; Introduction to biosafety and responsible handling of microorganisms; Intellectual Property Rights (IPR); Traditional Knowledge Digital Library (TKDL)

Practical -DSC (Major – Skill-based Course): Traditional Food Microbiology

Total hours: 30

Credits: 01

1. Isolation of *Lactobacillus* from curd.
2. Demonstration of alcohol fermentation by yeast.

Suggested Readings

1. Frazier, W.C. and Westhoff, D.C. (1958) *Food microbiology*. Tata McGraw Hill, New Delhi.
2. Davis, M. H., & Miller, A. R. (2000). *Intellectual property: patents, trademarks, and copyright in a nutshell*. St. Paul, Minn.: West Group.
3. Mohanta, B. K., & Singh, V. K. (2012). *Traditional Knowledge System and Technology in India*. Pratibha Prakashan.
4. Bamforth, C. W., & Cook, D. J. (2019). *Food, fermentation, and micro-organisms*. John Wiley & Sons.
5. Reddy, S. R., Charya, M. S., & Girisham, S. (2012). *Microbial Diversity: Exploration & Bioprospecting*. Scientific Publishers.
6. Ojha, K. S., & Tiwari, B. K. (2016). *Novel food fermentation technologies*. Springer International Publishing.

Theory (MD/ID paper): Genetics of Microorganisms

TOTAL HOURS: 45

CREDITS: 03

Unit I: Genome Organization

No. of Hours: 8

Experimental evidences for nucleic acids as genetic material; Structure and types of DNA; Genome organization in *E. coli* and *Saccharomyces*.

Unit II: Plasmids

No. of Hours: 15

Types of plasmids: F plasmid, R plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, and 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: 15

Transformation: Discovery and mechanism of natural competence; Artificial methods including chemical method, electroporation, microinjection, biolistic method (gene gun), liposome-mediated, virus-mediated, and *Agrobacterium*-mediated delivery; Conjugation: Discovery and mechanism; Hfr and F' strains; Interrupted mating technique and time-of-entry mapping.

Unit IV: Phage Genetics

No. of Hours: 7

Features of T4 genetics; Genetic basis of lytic versus lysogenic switch in bacteriophage lambda; Transduction: Generalized and specialized transduction; LFT and HFT lysates; Mapping by recombination and co-transduction of markers.

Practical Theory (MD/ID paper): Genetics of Microorganisms

TOTAL HOURS: 30

CREDITS: 01

3. Isolation of genomic and plasmid DNA from *E. coli*.
4. Study of different conformations of plasmid DNA through agarose gel electrophoresis.

Suggested Readings

1. Snustad, D. P., & Simmons, M. J. *Principles of Genetics*. John Wiley & Sons, New York.
2. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Scott, M. P., Bretscher, A., Ploegh, H., & Matsudaira, P. *Molecular Cell Biology*. W. H. Freeman and Company, New York.
3. Krebs, J. E., Goldstein, E. S., & Kilpatrick, S. T. *Lewin's Genes*. Jones and Bartlett Learning Publishers, Sudbury.
4. Snyder, L., Peters, J. E., Henkin, T. M., & Champness, W. *Molecular Genetics of Bacteria*. ASM Press, Washington, D.C.
5. Maloy, S. R., Cronan, J. E., & Freifelder, D. *Microbial Genetics*. Jones and Bartlett Learning, Sudbury.
6. Sambrook, J., & Russell, D. W. *Molecular Cloning: A Laboratory Manual*. Cold Spring Harbor Laboratory Press, New York.
7. Miller, J. H. *Experiments in Molecular Genetics*. Cold Spring Harbor Laboratory Press, New York.
8. Karp, G. *Cell and Molecular Biology: Concepts and Experiments*. John Wiley & Sons, New York.