

DEPARTMENT OF BOTANY AND MICROBIOLOGY

SYLLABUS

B.Sc. (MICROBIOLOGY)

Effective from academic session 2015-2016



**H.N.B. Garhwal University
(A Central University)
Srinagar-Garhwal, Uttarakhand**

DEPARTMENT OF BOTANY & MICROBIOLOGY
HEMWATI NANDAN BAHUGUNA GARHWAL UNIVERSITY,
SRINAGAR- GARHWAL-246174, UTTARAKHAND

CREDIT BASED COURSE STRUCTURE OF B.Sc. MICROBIOLOGY

SEM.	DCC (12)	AECC (2)	SEC (4)	DSE (6)
I	Microbiology: Introduction to Microbiology (4+2)	English/MIL Communication (2)		
	Zoology DCC I			
	Botany DCC I			
II	Microbiology: Biochemistry (4+2)	Environmental Science (2)		
	Zoology DCC II			
	Botany DCC II			
III	Microbiology: Microbial Physiology and Metabolism (4+2)		SEC-1 (2)	
	Zoology DCC III			
	Botany DCC III			
IV	Microbiology: Molecular Biology (4+2)		SEC-2 (2)	
	Zoology DCC IV			
	Botany DCC IV			
V			SEC-3 (2)	Microbiology DSE I (4+2)
				Zoology DSE I
				Botany DSE I
VI			SEC-4 (2)	Microbiology DSE II (4+2)
				Zoology DSE II
				Botany DSE II

Total Credits = 12(4+2) + 2 x 2 + 4x 2 + 6 x (4+2) = 72 + 4 + 8 + 36 = 120

*One Credit = 15 h of lecture per semester or 30 h of practical per semester

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Microbiology Discipline Core Courses

- C-1:** Introduction to Microbiology
- C-2:** Biochemistry
- C-3:** Microbial Physiology and Metabolism
- C-4:** Molecular Biology

Ability Enhancement Compulsory Courses

- AE-1:** Environmental Sciences
- AE-2:** English/MIL Communication

Microbiology Discipline Specific Elective Courses (Any two)

- DSE-1:** Medical Microbiology and Immunology
- DSE-2:** Plant Pathology
- DSE-3:** Bioinformatics
- DSE-4:** Microbial Biotechnology
- DSE-5:** Biostatistics and Computer Applications
- DSE-6:** Industrial and Food Microbiology
- DSE-7:** Biosafety and Intellectual Property Rights
- DSE-8:** Project Work

Microbiology Skill Enhancement Elective Courses (Any one/two)

- SE-1:** Microbial Quality Control in Food and Pharmaceutical Industries
- SE-2:** Microbial Diagnosis in Health Clinics
- SE-3:** Biofertilizers and Biopesticides
- SE-4:** Food Fermentation Techniques
- SE-5:** Management of Human Microbial Diseases
- SE-6:** Microbiological Analysis of Air and Water

C-1: INTRODUCTION TO MICROBIOLOGY (THEORY)
SEMESTER –I

TOTAL HOURS: 60

CREDITS: 04

Unit I: History of Microbiology

No. of Hours: 10

Discovery of microorganisms; Spontaneous generation vs. biogenesis; 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 and Edward Jenner; Golden era of microbiology; Scope of microbiology.

Unit II: Classification

No. of Hours: 05

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: Media and Pure Culture Techniques

No. of Hours: 12

Culture media: Solid and liquid media, Synthetic and complex media, Enriched and enrichment media, Selective and differential media; Culture techniques for isolation of pure culture: Pour plating, Spread plating, Streaking, Enrichment culture technique; Maintenance and preservation of pure culture; Cultivation of anaerobic bacteria.

Unit IV: Acellular Microorganisms

No. of Hours: 08

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 lysogenic cycle of λ phage.

Unit V: Cellular Microorganisms

No. of Hours: 25

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.

C-1: INTRODUCTION TO MICROBIOLOGY (PRACTICAL)
SEMESTER –I

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. 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 MacConkey agar.
7. Study of colony morphology of *E. coli* on EMB agar.
8. Simple staining of bacterial cell.
9. Gram staining of bacterial cell.
10. Negative staining of bacterial cell.

11. Staining of fungal cell.
12. Study of characteristic features of *Aspergillus*, *Penicillium*, *Amoeba* and *Paramecium*.

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. Dimmoc, 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. Cappucino, 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.

C-2: BIOCHEMISTRY (THEORY)
SEMESTER –II

TOTAL HOURS: 60

CREDITS: 04

Unit I: Bioenergetics

No. of Hours: 08

First and second laws of thermodynamics; Definitions of Gibb's free energy, enthalpy and entropy and mathematical relationship among them; Standard free energy change and equilibrium constant; Coupled reactions and additive nature of standard free energy change; Energy rich compounds: Phosphoenolpyruvate, 1, 3- Bisphosphoglycerate, Thioesters, ATP.

Unit II: Carbohydrates

No. of Hours: 12

Families of monosaccharides: Aldoses and ketoses, Trioses, Tetroses, Pentoses, Hexoses; Stereo-isomerism of monosaccharides; Epimers; Mutarotation and anomers of glucose; Furanose and pyranose forms of glucose and fructose; Haworth projection formulae for glucose; Chair and boat forms of glucose; Disaccharides; Concept of reducing and non-reducing sugars; Storage polysaccharides: Starch, Glycogen; Structural polysaccharides: Cellulose, Peptidoglycan, Chitin.

Unit III: Lipids

No. of Hours: 12

Definition and major classes of storage and structural lipids; Storage lipids; Fatty acids: Structure and functions, Essential fatty acids; Triacylglycerols: Structure, functions and properties; Saponification; Structural lipids; Phosphoglycerides: Building blocks, General structure, functions and properties; Introduction of lipid micelles, monolayers and bilayers.

Unit IV: Proteins

No. of Hours: 15

Structures of proteins: Amino acids, General formula of amino acid and concept of zwitterion, Titration curve of amino acid and its significance, Classification, biochemical structure and notation of standard protein amino acids, Ninhydrin reaction, Introduction to secondary, tertiary and quaternary structures of proteins; Functions of proteins.

Unit V: Enzymes

No. of Hours: 13

Structure of enzyme: Apoenzyme and cofactors, Prosthetic group-TPP, coenzyme NAD, metal cofactors; Classification of enzymes; Mechanism of action of enzymes: Active site, transition state complex and activation energy, Lock and key hypothesis, Induced fit hypothesis; Enzyme kinetics: Significance of hyperbolic, double reciprocal plots of enzyme activity, K_m , and allosteric mechanism; Definitions of terms: Enzyme unit, Specific activity, Turnover number.

C-2: BIOCHEMISTRY (PRACTICAL)

TOTAL HOURS: 60

CREDITS: 02

1. Properties of water, concept of pH and buffers, preparation of buffers and numerical problems to explain the concepts.
2. Numerical problems on calculations of standard free energy change and equilibrium constant.
3. Standard free energy change of coupled reactions.
4. Qualitative tests for carbohydrates, reducing sugars and non-reducing sugars.
5. Qualitative tests for lipids and proteins.

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6. Study of protein secondary and tertiary structures with the help of models.
7. Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values.

Suggested Readings

1. Campbell, M.K. (2012). Biochemistry. Cengage Learning Publishers, 7th ed.
2. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated. Churchill Livingstone, London, 4th ed.
3. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, W.H. Freeman and Company, 2nd ed.
4. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011). Biochemistry. W.H. Freeman and Company, New York.
5. Nelson, D.L. and Cox, M.M. (2008). Lehninger principles of biochemistry. W.H. Freeman and Company, New York, 5th ed.
6. Wiley, J.M., Sherwood, L.M. and Woolverton, C.J. Prescott, Harley and Klein's microbiology. McGraw-Hill, New York, 9th ed.
7. Voet, D. and Voet J.G. (2004). Biochemistry. John Wiley and Sons, New York, 3rd ed.

C-3: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)
SEMESTER –III

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: Chemoheterotrophic Metabolism

No. of Hours: 18

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

Unit IV: Chemolithotrophic and Phototrophic Metabolism

No. of Hours: 10

Chemolithotrophic metabolism: Introduction to aerobic and anaerobic chemolithotrophy with an example each, Hydrogen oxidation (Definition and reaction), Methanogenesis (Definition and reaction); Phototrophic metabolism: Introduction, Groups of phototrophic microorganisms, Anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria and cyanobacteria.

Unit V: Nitrogen Metabolism

No. of Hours: 10

An overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, Dissimilatory nitrate reduction (Denitrification, nitrate/nitrite and nitrate/ammonia respiration, fermentative nitrate reduction).

C-3: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)
SEMESTER –III

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. Effect of temperature on growth of *E. coli*.
4. Effect of pH on growth of *E. coli*.
5. Demonstration of alcoholic fermentation.
6. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

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.

C-4: MOLECULAR BIOLOGY (THEORY)
SEMESTER –IV

TOTAL HOURS: 60

CREDITS: 04

Unit I: Nucleic acid and Chromosome Structure

No. of Hours: 10

Experimental evidences for nucleic acid as carrier of genetic information; Chemical properties of genetic material; Structure and types of DNA; Packaging of DNA into chromosome; Structure and functions of mRNA, tRNA and rRNA.

Unit II: Replication and Transcription

No. of Hours: 20

DNA replication: Meselson and Stahl's experiment, Enzymes involved in DNA replication, Mechanism of replication in prokaryotes and eukaryotes, Rolling circle model of replication; Transcription: Promoter, RNA polymerases, Mechanism of transcription in prokaryotes and eukaryotes, Post transcriptional modifications.

Unit III: Translation

No. of Hours: 10

Basic features of genetic code; Translation: Structure of ribosomes, Mechanism of translation in prokaryotes and eukaryotes.

Unit IV: Mutation and Repair Mechanism

No. of Hours: 12

Mutations: Types of mutations, Mutagens; DNA repair: Photoreactivation, Methyl directed mismatch repair, Nucleotide excision repair, Base excision repair, SOS system.

Unit V: Microbial Genetics

No. of Hours: 08

Transposition: Insertion sequences and transposable elements in prokaryotes and eukaryotes, Mechanism of transposition; Plasmids: Types; Gene transfer mechanisms: Basic idea of transformation, conjugation and transduction.

C-4: MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER –IV

TOTAL HOURS: 60

CREDITS: 02

1. Study of different types of DNA and RNA using micrographs and model / schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Determination of quality of DNA.
4. Quantitative estimation of DNA.
5. Quantitative estimation of RNA.
6. Isolation of genomic DNA from bacterial culture.
7. Visualization of DNA by agarose gel electrophoresis.
8. Study of effect of temperature on denaturation of DNA.
9. Study of effect of pH on denaturation of DNA.

Suggested Readings

1. Snustad, D.P. and Simmons, M.J. Principles of genetics. John Wiley and Sons, New York.

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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.

DSE-1: MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)
SEMESTER –V/ VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Host Pathogen Interaction

No. of Hours: 10

Normal microflora; Host-parasite relationships; Definitions: Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity; Infection and its type; Opportunistic and nosocomial infections; Pathogenicity and virulence in relation with bacteria, virus fungi and parasites; Transmission of pathogen and its routes.

Unit II: Microbial Diseases

No. of Hours: 18

Symptoms, pathogenesis, transmission, prophylaxis and control of infectious diseases: Tuberculosis, Typhoid, AIDS, Dengue fever, Malaria, Amoebiasis, Dermatomyces, Opportunistic mycoses.

Unit III: Introduction of Immunology and Immune Responses

No. of Hours: 10

History of immunology; Composition and functions of cells and organs involved in immune system; Immune response and its type: Innate (Nonspecific) and acquired (Cell mediated and humoral) immunity.

Unit IV: Antigens and Antibodies

No. of Hours: 10

Antigens: Structure and properties; Immunoglobulin: Structures, properties and functions; Complements: Structure and functions; Major Histocompatibility Complex (MHC): Structure and functions.

Unit V: Diagnosis and Chemotherapy

No. of Hours: 12

Principles of different diagnostic tests: ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes; Chemotherapy: Types and action mechanisms of antimicrobials, Antimicrobial assay and drug resistance, Vaccines and its types.

DSE-1: MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)
SEMESTER –V/ VI

TOTAL HOURS: 60

CREDITS: 02

1. Cultural characteristics of different bacteria on nutrient agar and in nutrient broth.
2. Gram characteristic and Motility tests.
3. Biochemical characteristics like IMViC, TSI, sugar fermentation, nitrate reduction, urease production, oxidase and catalase tests.
4. To perform antibacterial testing by Kirby-Bauer and Well diffusion method.
5. Identification of human blood groups.
6. To perform Total Leukocyte Count of the given blood sample.
7. To perform Differential Leukocyte Count of the given blood sample.
8. To separate serum from the blood sample.
9. To perform immunodiffusion by Ouchterlony method.
10. To perform DOT ELISA.

Suggested Readings

1. Ananthanarayan, R. and Paniker, C.K.J. (2005). Textbook of Microbiology. University Press Publication, 7th ed.
2. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott's microbiology. McGraw Hill, New York, 9th ed.
3. Brooks GF, Carroll KC, Butel JS and Morse SA. (2013). Jawetz, Melnick and Adelberg's medical microbiology. McGraw Hill Publication, 26th ed.
4. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007). Mims' medical microbiology. Elsevier, London, 4th ed.
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. (2014). Brock biology of microorganisms. Pearson International Edition, 14th ed.

DSE-2: PLANT PATHOLOGY (THEORY)
SEMESTER –V/ VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Introduction and History of Plant Pathology

No. of Hours: 11

Concept of plant disease: Definitions of disease, disease cycle and pathogenicity, Types of plant pathogens, Basic idea of monocyclic, polycyclic and polyetic diseases, Disease triangle and disease pyramid; Significant landmarks in the field of plant pathology: Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor and Van Der Plank.

Unit II: Stages in the Development of Disease

No. of Hours: 04

Stages: Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit III: Host-Pathogen Interaction

No. of Hours: 18

Microbial pathogenicity: Virulence factors of pathogens in disease development; Effects of pathogens on host physiological processes (Photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction); Genetics of plant diseases: Concept of resistance (R) gene and avirulence (avr) gene, Types of plant resistance (True and apparent resistance); Defense mechanisms in plants: Inducible structural defenses (Histological cork layer, abscission layer, tyloses, gums), Inducible biochemical defenses (Hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, phenolics, quinones and oxidative bursts).

Unit IV: Plant Diseases

No. of Hours: 18

Symptoms, causative organisms, disease cycle and control measures of plant diseases: Fungal diseases (Late and early blight of potato, white rust of crucifers, wilt of tomato, powdery mildew, black rust and loose smut of wheat, red rot of sugarcane), Bacterial diseases (Blight of rice, citrus canker and crown gall), Viral diseases (Papaya ring spot and tomato yellow leaf curl).

Unit V: Control of Plant Diseases

No. of Hours: 09

Principles and practices involved in the management of plant diseases by different methods: Regulatory (Quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material), Cultural (Host eradication, crop rotation, sanitation, polyethylene traps and mulches), Chemical (Fungicides and antibiotics), Biological (Biopesticides, viral proteins, antisense RNA and RNAi).

DSE-2: PLANT PATHOLOGY (PRACTICAL)
SEMESTER –V/ VI

TOTAL HOURS: 60

CREDITS: 02

1. Study of symptoms of bacterial diseases of plants.
2. Study of symptoms of fungal diseases of plants.
3. Study of symptoms of viral diseases of plants.
4. Isolation and identification of pathogenic microorganisms from diseased plant sample.

Suggested Readings

1. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.
2. Rangasami G. and Bagyarai, D.J. Agricultural microbiology. Prentice-Hall, New Delhi.
3. Agrios, G.N. Plant pathology. Academic Press, San Diego.
4. Mathews, R.E. Functionals of plant virology. Academic Press, San Diego.
5. Adrian, G. and Harrison, B. Plant virology: The principles. Edward Arnold, London.
6. Lucas, J.A. Plant pathology and plant pathogens. Blackwell Science, Oxford.
7. Mehrotra, R.S. Plant pathology. Tata McGraw-Hill Limited, New Delhi.
8. Singh, R.S. Plant diseases management. Oxford & IBH, New Delhi.

DSE-3: BIOINFORMATICS (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Introduction to Computer Fundamentals **No. of Hours: 08**

RDBMS (Relational Data Base Management System): Definition of relational database, Mode of data transfer (FTP, SFTP, SCP), Advantage of encrypted data transfer.

Unit II: Introduction to Bioinformatics and Biological Databases **No. of Hours: 14**

Biological databases: Nucleic acid, Genome, Protein sequence and structure, Gene expression databases, Database of metabolic pathways; Mode of data storage - File formats - FASTA, Genbank, and Uniprot; Data submission and retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB.

Unit III: Sequence Alignments, Phylogeny and Phylogenetic Trees **No. of Hours: 16**

Sequence alignments: Local and global sequence alignment, Pairwise and multiple sequence alignment, Scoring an alignment, Scoring matrices, PAM and BLOSUM series of matrices; Phylogenetic trees: Types of phylogenetic trees, Different approaches of phylogenetic tree construction (UPGMA, Neighbour joining, Maximum Parsimony, Maximum likelihood).

Unit IV: Genome Organization and Analysis **No. of Hours: 10**

Diversity of genomes: Viral, prokaryotic and eukaryotic genomes; Transcriptome; Proteome; Techniques used to study proteome (2-D gel electrophoresis and MALDI-TOF spectroscopy); Major features of completed genomes: *E. coli*, *S. cerevisiae*, *Arabidopsis*, Human.

Unit V: Protein Structure Predictions **No. of Hours: 12**

Hierarchy of protein structure: Primary, secondary and tertiary structures; Modeling structural classes, Motifs, folds and domains; Protein structure prediction in presence and absence of structure template; Energy minimizations and evaluation by Ramachandran plot; Protein structure and rational drug design.

DSE-3: BIOINFORMATICS (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 02

1. Introduction to different operating systems - UNIX, LINUX and Windows.
2. Introduction to bioinformatics databases (any three): NCBI/PDB/DDBJ, Uniprot, PDB.
3. Sequence retrieval using BLAST.
4. Sequence alignment and phylogenetic analysis using clustalW and phylip.
5. Picking out a given gene from genomes using Genscan or other softwares (Promoter region identification, repeat in genome, ORF prediction), gene finding tools (Glimmer, GENSCAN), primer designing, Genscan/Gene tool.
6. Protein structure prediction: Primary structure analysis, Secondary structure prediction using psipred, Homology modeling using Swiss model, Molecular visualization using jmol, Protein structure model evaluation (PROCHECK).
7. Prediction of different features of a functional gene.

Suggested Readings

1. Saxena, S. (2003). A first course in computers. Vikas Publishing House.
2. Pradeep and Sinha, P. (2007). Foundations of computing. BPB Publications, 4th ed.
3. Lesk, M.A. (2008). Introduction to bioinformatics. Oxford Publication, 3rd International Student Edition.
4. Rastogi, S.C., Mendiratta, N. and Rastogi, P. (2007). Bioinformatics: Methods and applications, genomics, proteomics and drug discovery. Prentice Hall India Publication, 4th ed.
5. Primrose, S.B. and Twyman, R. (2003). Principles of genome analysis and genomics. Blackwell Publishers, New Jersey.

DSE-4: MICROBIAL BIOTECHNOLOGY (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Scope and Applications of Microbial Biotechnology **No. of Hours: 10**

Scope and applications of microbial biotechnology in human therapeutics, agriculture, environment and food technology; Genetically engineered microbes for industrial application: Bacteria and yeast.

Unit II: Therapeutic and Industrial Biotechnology **No. of Hours: 12**

Recombinant microbial production processes in pharmaceutical industries: Streptokinase and recombinant vaccines (Hepatitis B vaccine), Microbial polysaccharides and polyesters, Microbial production of bio-pesticides and bioplastics; Microbial biosensors.

Unit III: Applications of Microbes in Biotransformations **No. of Hours: 13**

Microbial based transformation of steroids and sterols; Bio-catalytic processes and their industrial applications: Production of high fructose syrup and production of cocoa butter substitute.

Unit IV: Microbes for Bio-energy and Environment **No. of Hours: 15**

Bio-ethanol and bio-diesel production: Commercial production from lignocellulosic waste and algal biomass; Biogas production: Methane and hydrogen production using microbial culture; Microorganisms in bioremediation: Degradation of xenobiotics, Removal of heavy metals.

Unit V: Applications of Antisense RNA and RNAi **No. of Hours: 10**

Antisense RNA: Mechanism of action, Applications in therapeutics and agriculture; RNAi: Mechanism of action, Applications in therapeutics and agriculture.

DSE-4: MICROBIAL BIOTECHNOLOGY (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 02

1. Isolation and screening of microbial cultures for enzyme production.
2. Qualitative estimation of enzyme production by microbial culture.
3. Estimation of enzyme production by microbial culture *via* liquid state fermentation.
4. Isolation of *Rhizobium* sp. from root nodules of leguminous plants.
5. Isolation of rhizobacteria from plant rhizosphere.
6. Estimation of plant growth promotion potential of rhizobacteria.

Suggested Readings

1. Crueger, W. and Crueger, A. Biotechnology: A textbook of industrial microbiology. Sinauer Associates, Sunderland.
2. Reed, G. Prescott and Dunn's industrial microbiology. Globe Bookservices, London.
3. Demain, A.L and Davies, J.E. Manual of industrial microbiology and biotechnology. ASM Press, Washington, D.C.
4. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi.

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5. Richard, H., George, B., Hagemann, D. and Paul, L. Industrial microorganisms: Basic and applied molecular genetics. ASM Press, Washington, D.C.
6. Sharma, A.K. Biofertilizers for sustainable agriculture. ABD Publishers, Jaipur.
7. Goel, P.K. and Pathade, G.R. Biotechnological applications in environment and agriculture. ABD Publishers, Jaipur.
8. Evans, G.M. and John, J.C.F. Environmental biotechnology: Theory and applications. John Wiley and Sons, New York.
9. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin Cummings Publishing Company, San Francisco.
10. Prescott, L.M. and Harley, J.P. Laboratory exercises in microbiology. McGraw-Hill, New York.
11. Aneja, K.R. Experiments in microbiology, plant pathology and biotechnology. New Age International (P) Limited, New Delhi.

DSE-5: BIOSTATISTICS AND COMPUTER APPLICATIONS (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Introduction to Statistical Methods

No. of Hours: 07

Scope of statistics, Utility and misuse; Principles of statistical analysis of biological data; Difference between sample and population; Sampling parameters and types; Difference between parametric and non-parametric statistics; Types of data; Methods of data representation.

Unit II: Central Tendencies

No. of Hours: 15

Measures of central tendency: Mean, median, mode and their relationship; Measures of dispersion: Mean deviation, Standard deviation and standard error; Normal distribution curve: Properties, Skewness and kurtosis.

Unit III: Probability and Correlations

No. of Hours: 12

Probability: Random experiment, Random variables (Discrete and continuous), Events, Sample space, Mutually exclusive events, Independent and dependent events, Various definitions of probability, Addition and multiplication theorems of probability (only statement), Basic idea of Poisson and binomial distributions and their applications; Correlation and regression analysis with emphasis on examples from biological sciences.

Unit IV: Statistical Tests

No. of Hours: 20

Testing of hypothesis; Level of significance and degree of freedom; Large sample test based on normal distribution; Small sample test based on t-test, Z- test and F-test; Confidence interval; Distribution-free test - Chi-square test; Analysis of variance (ANOVA): Introduction, Procedure and problems based on one way ANOVA.

Unit V: Computer and its Applications

No. of Hours: 06

Component of computer system; Memory (Primary and secondary); CPU; Operating system: Definition, Importance, Disc Operating System; Network: Types of network, Local Area Network (LAN), Wide Area Network (WAN), Metropolitan Air Network (MAN); Internet: Basic idea.

DSE-5: BIOSTATISTICS AND COMPUTER APPLICATIONS (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 02

1. Mean, median and mode from grouped and ungrouped data set.
2. Standard deviation and Coefficient of variation.
3. Skewness and Kurtosis.
4. Curve fitting.
5. Correlation and Regression.
6. Finding area under the curve using normal probability.
7. Testing of hypothesis- Normal distribution, t-test and Chi-Square-test.
8. Confidence interval.

Suggested Readings

1. Edmondson, A. and Druce, D. (1996). Advanced biology statistics. Oxford University Press, New York.
2. Danial, W. (2004). Biostatistics: A foundation for analysis in health sciences. John Wiley and Sons, New York.
3. Ron, W. (2000). How computer work? Techmedia Publishers.
4. Preston, G. (2000). How internet work? Techmedia Publishers.
5. Bliss, C.I.K. (1977). Statistics in biology. Mc Graw Hill, New York, vol. I.
6. Campbell, R.C. (1974). Statistics for biologists. Cambridge University Press, Cambridge.
7. Wardlaw, A.C. (1985). Practical statistics for experimental biologists. John Wiley and Sons, New York.
8. Glover, T. and Mitchell, K. An introduction to biostatistics. Waveland Publishers.
9. Mishra and Mishra. An Introduction to biostatistics. Kalyani Publication.

DSE-6: INDUSTRIAL AND FOOD MICROBIOLOGY (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Introduction to Industrial Microbiology

No. of Hours: 10

History; Basic idea about design of fermenter/bioreactor; Types of fermentor/ bioreactors; Types of fermentation processes (Solid state, liquid state, batch, fed-batch and continuous fermentation).

Unit II: Basic Aspects of Fermentation

No. of Hours: 13

Media formulation; Inoculum development; Criterion used for selection of microorganisms for fermentation; Strategies for strain improvement: Natural selection followed by primary and secondary screening, Mutation, Protoplast fusion, Recombinant DNA technology; Preservation of industrial strains.

Unit III: Microbial Fermentation Processes

No. of Hours: 14

Downstream processing; Microbial production of industrial products: Citric acid, Ethanol, Penicillin, Vitamin B12, Amylase, Single cell protein, Fermented food (Vinegar, yogurt and cheese).

Unit IV: Food Spoilage and Preservation

No. of Hours: 14

Factors affecting microbial growth in food; Microbial spoilage of milk, vegetables, meat and canned food products; Physical and chemical methods of food preservation.

Unit V: Foodborne Infections and Intoxications

No. of Hours: 09

Infections and intoxications of *Clostridium*, *Escherichia*, *Salmonella* and *Staphylococcus*; Laboratory testing procedures.

DSE-6: INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 02

1. Assay of quality of milk sample using MBRT test.
2. Isolation of *Lactobacillus* from curd.
3. Isolation of microorganisms from contaminated food samples.
4. Screening of bacterial cultures for enzyme production.
5. Quantitative estimation of enzyme production by bacterial culture.

Suggested Readings

1. Crueger, W. and Crueger, A. Biotechnology: A textbook of industrial microbiology. Sinauer Associates, Sunderland.
2. McLandsborough, L. Food microbiology laboratory. CRC Press, Boca Raton.
3. Harrigan, W.F. Laboratory methods in food microbiology. Gulf Professional Publishing, Houston.
4. Cappucino, J. and Sherman, N. Microbiology: A laboratory manual. Benjamin Cummings Publishing Company, San Francisco.
5. Reed, G. Prescott and Dunn's industrial microbiology. Globe Bookservices, London.

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6. Casida, J.E. Industrial microbiology. Wiley Eastern, New Delhi.
7. Adams, M.R., and Moss, M.O. Food microbiology. Royal Society of Chemistry Publication, Cambridge.
8. Frazier, W.C. and Westhoff, D.C. Food microbiology. Tata McGraw Hill, New Delhi.
9. Stanbuty, P.F. and Hall, S.J. Principles of fermentation technology. Pergamon Press, Oxford.

DSE-7: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 04

Unit I: Introduction to Biosafety

No. of Hours: 08

Introduction; Biosafety issues in biotechnology; Biological safety cabinets and their types; Primary containment for biohazards; Biosafety levels of specific microorganisms.

Unit II: Biosafety Guidelines

No. of Hours: 16

Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of institutional biosafety committees, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk analysis; Risk assessment; Risk management and communication; Overview of international agreements - Cartagena protocol; AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Unit III: Intellectual Property Rights

No. of Hours: 12

Introduction to IPR; Intellectual property; Types of Intellectual Property Rights: Copyright and Related rights, Trademarks, Industrial designs, Geographical indications, Patents, Plant breeder's rights, Traditional knowledge; Importance of IPR; Patentable and non-patentables; Legal protection of biotechnological inventions; World Intellectual Property Organization (WIPO).

Unit IV: Patents

No. of Hours: 12

Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of addition; Introduction to patent filing procedures; Patent licensing and agreement; Patent infringement: Meaning, Scope, Litigation, Case studies, Rights and duties of patent owner.

Unit V: Patent Laws

No. of Hours: 12

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.

DSE-7: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60

CREDITS: 02

1. Study of components and design of a BSL-III laboratory.
2. Filing applications for approval from biosafety committee.
3. Filing primary applications for patents.
4. Study of steps of a patenting process.
5. Case studies.

Suggested Readings

1. Bare Act, 2007. Indian Patent Act 1970 Acts and Rules. Universal Law Publishing Co. Pvt. Ltd., New Delhi.

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2. Kankanala, C. (2007). Genetic patent law and strategy. Manupatra Information Solution Pvt. Ltd., New Delhi, 1st ed.
3. Mittal, D.P. (1999). Indian patents law, Taxmann. Allied Services (p) Ltd.
4. Singh, K.K. (2015). Biotechnology and intellectual property rights: Legal and social implications. Springer India.
5. Goel, D. and Prashar, S. (2013). IPR, biosafety and bioethics. Pearson Publishers.
6. Sadhasivam, S.K. and Mohammed Jaabir, M.S. (2008). IPR, biosafety and biotechnology management. Jasen publications, Tiruchirappalli, India.

DSE-8: PROJECT WORK
SEMESTER –V/VI

TOPICS FOR PROJECT WORK

CREDITS: 06

1. Microbial Biotechnology
2. Drug Resistance
3. Plant- Microbes Interaction
4. Microbial Diversity
5. Bioremediation
6. Prevalence and Characterization of Pathogenic Microorganisms
7. Food Adulteration and Food borne Pathogens
8. Fermented Foods
9. Enzyme Production

Any other topic suggested by departmental committee may also be considered for the project work.

**SE-1: MICROBIAL QUALITY CONTROL IN FOOD AND
PHARMACEUTICAL INDUSTRIES
SEMESTER – III/IV/V/VI**

TOTAL HOURS: 30

CREDITS: 02

Unit I: Microbiological Laboratory and Safe Practices **No. of Hours: 05**

Laboratory practices: Good laboratory practices, Good microbiological practices; Biosafety cabinets: Working of biosafety cabinets, Specification for BSL-1, BSL-2, BSL-3; Discarding biohazardous waste: Methodology of disinfection, autoclaving and incineration

Unit II: Determining Microbes in Food / Pharmaceutical Samples **No. of Hours: 10**

Culture and microscopic methods: Standard plate count, Most probable numbers, Direct microscopic counts; Biochemical, immunological and molecular methods of detection; Limulus lysate test for endotoxin; Biosensors; Ascertaining microbial quality of milk by MBRT; Rapid detection methods of microbiological quality of milk at milk collection centers (COB, 10 min Resazurin assay).

Unit III: Pathogenic Microorganisms of Importance in Food & Water **No. of Hours: 05**

Enrichment culture technique; Detection of specific microorganisms on XLD agar, Salmonella Shigella agar, Manitol salt agar, EMB agar, Mac Conkey agar and Saboraud agar.

Unit IV: HACCP for Food Safety and Microbial Standards **No. of Hours: 04**

Hazard analysis of critical control point (HACCP): Principle, Flow diagrams, Limitations; Microbial standards for different foods and water: BIS standards for common foods and drinking water.

Unit V: Quality Assurance and Validation **No. of Hours: 06**

Basic principles of quality control (QC) and quality assurance (QA); Sterilization control and sterility testing: Heat sterilization, D value, Z value, Survival curve, Radiation, gaseous and filter sterilization, Chemical and biological indicators, Sterility testing.

Suggested Readings

1. Harrigan, W.F. (1998). Laboratory methods in food microbiology. Academic Press, 3rd ed.
2. Garg, N., Garg, K.L. and Mukerji, K.G. (2010). Laboratory manual of food microbiology I.K. International Publishing House Pvt. Ltd., New Delhi.
3. Jay, J.M., Loessner, M.J. and Golden, D.A. (2005). Modern food microbiology. Springer Publishers, New York, 7th ed.
4. Baird, R.M., Hodges, N.A. and Denyer, S.P. (2005). Handbook of microbiological quality control in pharmaceutical and medical devices. Taylor and Francis Inc.

SE-2: MICROBIAL DIAGNOSIS IN HEALTH CLINICS
SEMESTER – III/IV/V/VI

TOTAL HOURS: 30

CREDITS: 02

Unit I: Importance of Diagnosis of Diseases

No of Hours: 06

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: 06

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: 06

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

Unit V: Testing for Antibiotic Sensitivity in Bacteria

No of Hours: 06

Importance; Determination of resistance/sensitivity of bacteria using disc diffusion method; Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method.

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.

SE-3: BIOFERTILIZERS AND BIOPESTICIDES
SEMESTER – III/IV/V/VI

TOTAL HOURS: 30

CREDITS: 02

Unit I: Biofertilizers

No. of Hours: 10

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers; Symbiotic N₂ fixers: *Rhizobium* (Isolation, characteristics, inoculum production, mass multiplication and field application), *Frankia* (Isolation, characteristics, inoculum production, mass multiplication and field application), Cyanobacteria (Isolation, characteristics, inoculum production, mass multiplication, field application and role in rice cultivation).

Unit II: Non - Symbiotic Nitrogen Fixers

No. of Hours: 04

Isolation, characteristics, inoculum production, mass multiplication and field application of *Azospirillum* and *Azotobacter*.

Unit III: Phosphate Solubilizers

No. of Hours: 04

Isolation, characteristics, inoculum production, mass multiplication and field application of phosphate solubilizing microbes.

Unit IV: Mycorrhizal Biofertilizers

No. of Hours: 05

Characteristics and types of mycorrhizae; Isolation, inoculum production, mass multiplication and field application of AM fungi.

Unit V: Biopesticides

No. of Hours: 07

General account of microbes used as biopesticides and their advantages over synthetic pesticides; *Bacillus thuringiensis*: Mechanism of biocontrol, Production of bioinsecticide, Field applications, Viruses: Cultivation, Mechanism of biocontrol, Field applications.

Suggested Readings

1. Kannaiyan, S. (2003). Bioethnology of biofertilizers, CHIPS, Texas.
2. Rai, M.K. (2005). Hand book of microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et al. (2002). Bioinoculants for sustainable agriculture and forestry. Scientific Publishers.
4. Subba Rao, N.S (1995). Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd., New Delhi.
5. Saleem, F. and Shakoori, A.R. (2012). Development of bioinsecticide. Lap Lambert Academic Publishing GmbH and Company.
6. Aggarwal, S.K. (2005). Advanced environmental biotechnology. APH publication.

SE-4: FOOD FERMENTATION TECHNIQUES
SEMESTER – III/IV/V/VI

TOTAL HOURS: 30

CREDITS: 02

Unit I: Fermented Foods

No. of Hours: 05

Definition, types, advantages and health benefits of fermented foods; Probiotics.

Unit II: Milk Based Fermented Foods

No. of Hours: 09

Preparation of inoculums, microorganisms and production process: Dahi, Yogurt, Buttermilk, Cheese.

Unit III: Grain Based Fermented Foods

No. of Hours: 06

Microorganisms and production process: Soy sauce, Bread, Idli, Dosa.

Unit IV: Vegetable Based Fermented Foods

No. of Hours: 05

Microorganisms and production process: Pickle, Sauerkraut.

Unit V: Fermented Meat and Fish Products

No. of Hours: 05

Microorganisms and production process: Sausages and sauces.

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. Robinson, R.K. Dairy microbiology. Elsevier Applied Sciences, London.
5. James M.J. Modern food microbiology. CBS Publishers and Distributors, New Delhi.
6. Wood, B.J. Microbiology of fermented foods. Elsevier Applied Sciences, London.
7. Ayres, J.C., Mundt, O. and Sandinee, W.E. Microbiology of foods. W.H. Freeman and Company, New York.
8. Jay, M.J., Loessner, M.J. and Golden, D.A. Modern food microbiology. Springer Science and Business Media, New York.
9. Hui, Y.H., Meunier-Goddik, L., Josephsen, J., Nip, W.K. and Stanfield, P.S. Handbook of food and fermentation technology. CRC Press, Boca Raton.

SE-5: MANAGEMENT OF HUMAN MICROBIAL DISEASES
SEMESTER – III/IV/V/VI

TOTAL HOURS: 30

CREDITS: 02

Unit I: Human Diseases

No. of Hours: 04

Infectious and non-infectious diseases; Microbial and non-microbial diseases; Deficiency diseases; Occupational diseases; Incubation period; Mortality rate; Nosocomial infections.

Unit II: Microbial Diseases

No. of Hours: 12

Respiratory microbial diseases; Gastrointestinal microbial diseases; Nervous system diseases; Skin diseases; Eye diseases; Urinary tract diseases; Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods; Mosquito borne disease: Types and prevention.

Unit III: Disease Outbreaks and Cancer

No. of Hours: 05

Study of recent outbreaks of human diseases (SARS, Swine flu, Ebola): Causes, spread and control; Cancers: Types, Causes, Prevention, Detection, Treatment.

Unit IV: Microbial Diseases and Societal Issues

No. of Hours: 04

Importance of personal hygiene (Typhoid Mary); Judicious use of antibiotics; Importance of completing antibiotic regimen; Emergence of antibiotic resistance; Current issues of MDR/XDR microbial strains.

Unit V: Vaccines

No. of Hours: 05

Importance; Types of vaccines; Vaccines available against microbial diseases; Vaccination schedule (Compulsory and preventive) in Indian context.

Suggested Readings

1. Ananthanarayan, R. and Paniker, C.K.J. (2009). Textbook of microbiology. University Press Publication, 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. Goering, R., Dockrell, H., Zuckerman, M. and Wakelin, D. (2007). Mims' Medical microbiology. Elsevier, London, 4th ed.
4. Willey, J.M., Sherwood, L.M. and Woolverton, C.J. (2013). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education, 9th ed.
5. Madigan, M.T., Martinko, J.M., Dunlap, P.V. and Clark, D.P. (2014). Brock biology of microorganisms. Pearson International Edition, 14th ed.

SE-6: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER
SEMESTER – III/IV/V/VI

TOTAL HOURS: 30

CREDITS: 02

Unit I: Aeromicrobiology

No. of Hours: 05

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: 07

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

Unit III: Water Microbiology

No. of Hours: 04

Water-borne pathogens; Water-borne diseases.

Unit IV: Microbiological Analysis of Water

No. of Hours: 08

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

Unit V: Control Measures

No. of Hours: 06

Air: Fate of bioaerosols; Inactivation mechanisms (U.V. light, H.E.P.A filters, desiccation and incineration); Water: Precipitation, Chemical disinfection, Filtration, High temperature and U.V. light treatment.

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.