

Mahakaushal University, Jabalpur (M.P.)



Scheme & Syllabus

For

B.Sc. with Research/honors

Microbiology

2022-23

Duration of Course: 4 Years

Examination Mode: Semester

Examination System: CBCS

Mahakaushal University

College-Aithakheda, Mukunwara Road, Post- Tilwara Jabalpur (M.P.) **Board**

: Introduction to Microbiology and Microbial Diversity

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Unit-I

(12 Lectures)

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner).

Unit-II

(14 Lectures)

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

General characteristics of different groups: **Acellular** microorganisms (Viruses, Viroids, Prions) and **Cellular** microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit-III

(12 Lectures)

Algae: History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra-structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

Unit-IV

(14 Lectures)

Fungi: Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

Unit-V

(8 Lectures)

Protozoa: General characteristics with special reference to *Amoeba*, *Paramecium*, *Plasmodium*, *Leishmania* and *Giardia*.

Reference Books:

- Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
- Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
- Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
- Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
- Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

: Introduction to Microbiology and Microbial Diversity Lab

Practical:

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the microbiology laboratory.
3. Preparation of culture media for bacterial cultivation.
4. Sterilization of medium using Autoclave and assessment for sterility
5. Sterilization of glassware using Hot Air Oven and assessment for sterility
6. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
7. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
9. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary Mounts
10. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Reference Books:

- Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
- Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
- Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
- Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T.Brown Publishers.
- Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
- Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

: Bacteriology

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Unit-I

(14 Lectures)

Cell organization: Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.

Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaeobacterial cell wall, Gram and acid-fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

Endospore: Structure, formation, stages of sporulation.

Unit-II

(12 Lectures)

Bacteriological Techniques: Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Microscopy: Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Unit-III

(8 Lectures)

Growth and Nutrition: Nutritional requirements in bacteria and nutritional categories;

Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media

Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

Chemical methods of microbial control: disinfectants, types and mode of action.

Unit-IV

(10 Lectures)

Reproduction in Bacteria: Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

Bacterial Systematics: Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaeobacteria.

Unit-V

(16 Lectures)

Important archaeal and eubacterial groups:

Archaeobacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

Non proteobacteria: General characteristics with suitable examples

Alpha proteobacteria: General characteristics with suitable examples

Beta proteobacteria: General characteristics with suitable examples

Gamma proteobacteria: General characteristics with suitable examples.

Delta proteobacteria: General characteristics with suitable examples

Epsilon proteobacteria: General characteristics with suitable examples

Zeta proteobacteria: General characteristics with suitable examples

Gram Positive:

Low G+ C (Firmicutes): General characteristics with suitable examples

High G+C (Actinobacteria): General characteristics with suitable examples

Cyanobacteria: An Introduction

Reference Books:

- Atlas RM. (1997). Principles of Microbiology. 2nd edition. W.M.T.Brown Publishers.
- Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
- Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
- Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
- Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
- Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
- Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
- Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Bacteriology Lab

Practical:

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram' s staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour plate method.
11. Motility by hanging drop method.

Reference Books:

- Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
- Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
- Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J. Prentice Hall International, Inc.
- Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
- Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
- Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
- Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
- Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

Biochemistry

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Unit-I

(10 Lectures)

Bioenergetics: 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

(14 Lectures)

Carbohydrates: Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and 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, Sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin.

Unit-III

(12 Lectures)

Lipids: Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebroside and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

Unit-IV

(12 Lectures)

Proteins: Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. 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. Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins y.

Unit-V

(12 Lectures)

Enzymes: 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, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, K_m , and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts.

Vitamins: Classification and characteristics with suitable examples, sources and importance

Reference Books:

- Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
- Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
- Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H. Freeman and Company
- Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
- Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
- Voet D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

: Biochemistry Lab

Practical:

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/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
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
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

Reference Books:

- Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
- Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
- Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
- Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
- Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill
- Voet,D. and Voet J.G (2004) Biochemistry 3rd edition, John Wiley and Sons,

Virology

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Unit-I

(10 Lectures)

Nature and Properties of Viruses: Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses

Viral taxonomy: Classification and nomenclature of different groups of viruses.

Unit-II

(10 Lectures)

Bacteriophages: Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage.

Unit-III

(16 Lectures)

Viral Transmission, Salient features of viral nucleic acids and Replication: Modes of viral transmission: Persistent, non-persistent, vertical and horizontal Salient features of viral Nucleic acid : Unusual bases (TMV, T4 phage), overlapping genes (ϕ X174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions.

Unit-IV

(12 Lectures)

Viruses and Cancer: Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Prevention & control of viral diseases: Antiviral compounds and their mode of action, Interferon and their mode of action, General principles of viral vaccination.

Unit-V

(12 Lectures)

Applications of Virology: Use of viral vectors in cloning and expression, Gene therapy and Phage display.

Reference Books:

- Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
- Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
- Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
- Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
- Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
- Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
- Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
- Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
- Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Virology Lab

Practical:

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕ X 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique.
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

Reference Books:

- Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
- Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
- Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
- Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
- Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
- Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
- Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
- Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
- Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

Microbial Physiology and Metabolism

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Unit-I

(14 Lectures)

Microbial Growth and Effect of Environment on Microbial Growth: Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe), barophilic. Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph..

Unit-II

(10 Lectures)

Nutrient uptake and Transport: Passive and facilitated diffusion, Primary and secondary active transport, concept of uniport, symport and antiport, Group translocation, Iron uptake.

Unit-III

(12 Lectures)

Chemoheterotrophic Metabolism - Aerobic Respiration: Concept of aerobic respiration, anaerobic respiration and fermentation Sugar degradation pathways i.e. 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.

Unit-IV

(10 Lectures)

Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation: Anaerobic respiration with special reference to dissimilatory nitrate reduction (Denitrification; nitrate/nitrite and nitrate/ammonia respiration; fermentative nitrate reduction) Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways.

Unit-V

(14 Lectures)

Chemolithotrophic and Phototrophic Metabolism: Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction) Introduction to phototrophic metabolism - groups of phototrophic microorganisms, anoxygenic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

Unit 6 Nitrogen Metabolism: an overview, Introduction to biological nitrogen fixation, Ammonia assimilation, Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification.

Reference Books:

- Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
- Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
- Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
- Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
- Stanier RY, Ingrahm JJ, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Microbial Physiology and Metabolism Lab

Practical:

1. Study and plot the growth curve of *E. coli* by turbidometric 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. Effect of carbon and nitrogen sources on growth of *E. coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

Reference Books:

- Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
- Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
- Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
- Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
- Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

Cell Biology

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Unit-I

(14 Lectures)

Structure and organization of Cell: Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules

Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell, Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects)

Mitochondria, chloroplasts and peroxisomes

Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules.

Unit-II

(8 Lectures)

Nucleus: Nuclear envelope, nuclear pore complex and nuclear lamina, Chromatin – Molecular organization, Nucleolus.

Unit-III

(14 Lectures)

Protein Sorting and Transport: Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids

Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus, Lysosomes.

Unit-IV

(12 Lectures)

Cell Signalling: Signalling molecules and their receptors, Function of cell surface receptors, Pathways of intra-cellular receptors – Cyclic AMP pathway, cyclic GMP and MAP kinase pathway.

Unit-V

(12 Lectures)

Cell Cycle, Cell Death and Cell Renewal: Eukaryotic cell cycle and its regulation, Mitosis and Meiosis Development of cancer, causes and types, Programmed cell death Stem cells, Embryonic stem cell, induced pluripotent stem cells.

Reference Books:

- Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
- Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
- De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

: Cell Biology Lab

Practical:

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

Reference Books:

- Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
- Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
- De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Molecular Biology

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Unit-I

(10 Lectures)

Structures of DNA and RNA / Genetic Material: DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology – linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA -- mitochondria and chloroplast DNA.

Unit-II

(14 Lectures)

Replication of DNA (Prokaryotes and Eukaryotes): Bidirectional and unidirectional replication, semi- conservative, semi- discontinuous replication Mechanism of DNA replication: Enzymes and proteins involved in DNA replication –DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends Various models of DNA replication including rolling circle, D- loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair.

Transcription in Prokaryotes and Eukaryotes: Transcription: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors

Unit-III

(12 Lectures)

Post-Transcriptional Processing: Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: si RNA, miRNA and its significance.

Unit-IV

(12 Lectures)

Translation (Prokaryotes and Eukaryotes): Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of

polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryote.

Unit-V

(12 Lectures)

Regulation of gene Expression in Prokaryotes and Eukaryotes: Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Sporulation in *Bacillus*, Yeast mating type switching, Changes in Chromatin Structure -DNA methylation and Histone Acetylation mechanisms.

Reference Books:

- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
- Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
- De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
- Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
- Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
- Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-

India

Molecular Biology Lab

Practical:

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. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement)
5. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

Reference Books:

- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
- Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
- De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
- Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
- Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
- Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-



Microbial Genetics

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Unit-I

(14 Lectures)

Genome Organization and Mutations: Genome organization: *E. coli*, *Saccharomyces*, *Tetrahymena*

Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations

Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes.

Unit-II

(12 Lectures)

Plasmids: 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

(16 Lectures)

Mechanisms of Genetic Exchange: Transformation - Discovery, mechanism of natural competence

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

(8 Lectures)

Phage Genetics: Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda.

Unit-V

(10 Lectures)

Transposable elements: Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non-replicative transposition, Mu transposon
Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds)

Uses of transposons and transposition.

Reference Books:

- Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
- Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
- Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
- Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
- Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
- Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
- Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Microbial Genetics Lab

Practical:

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agarose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

Reference Books:

- Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
- Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
- Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
- Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
- Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
- Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
- Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
- Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers

Department Specific Elective

Environmental Microbiology

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Unit-I

(14 Lectures)

Microorganisms and their Habitats: Structure and function of ecosystems, Terrestrial Environment: Soil profile and soil microflora, Aquatic Environment: Microflora of fresh water and marine habitats, Atmosphere: Aeromicroflora and dispersal of microbes, Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. Microbial succession in decomposition of plant organic matter.

Unit-II

(10 Lectures)

Microbial Interactions: Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation. Microbe-Plant interaction: Symbiotic and non-symbiotic interactions, Microbe-animal interaction: Microbes in ruminants, nematophagous fungi and symbiotic luminescent bacteria.

Unit-III

(12 Lectures)

Biogeochemical Cycling: Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin, Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction, Phosphorus cycle: Phosphate immobilization and solubilisation, Sulphur cycle: Microbes involved in sulphur cycle, Other elemental cycles: Iron and manganese.

Unit-IV

(12 Lectures)

Waste Management: Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill), Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment.

Unit-V

(12 Lectures)

Microbial Bioremediation: Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

Water Potability: Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

Reference Books:

- Atlas RM and Bartha R. (2000). *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA
- Madigan MT, Martinko JM and Parker J. (2014). *Brock Biology of Microorganisms*. 14th edition. Pearson/ Benjamin Cummings
- Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology*. 2nd edition, Academic Press
- Okafor, N (2011). *Environmental Microbiology of Aquatic & Waste systems*. 1st edition, Springer, New York
- Singh A, Kuhad, RC & Ward OP (2009). *Advances in Applied Bioremediation*. Volume 17, Springer-Verlag, Berlin Hedeilberg
- Barton LL & Northup DE (2011). *Microbial Ecology*. 1st edition, Wiley Blackwell, USA
Campbell RE. (1983). *Microbial Ecology*. Blackwell Scientific Publication, Oxford, England.
- Coyne MS. (2001). *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning.
- Lynch JM & Hobbie JE. (1988). *Microorganisms in Action: Concepts & Application in Microbial Ecology*. Blackwell Scientific Publication, U.K.
- Subba Rao NS. (1999). *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi.
- Willey JM, Sherwood LM, and Woolverton CJ. (2013). *Prescott's Microbiology*. 9th edition. McGraw Hill Higher Education.

: Industrial Microbiology

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Unit-I

(12 Lectures)

Introduction to industrial microbiology: Brief history and developments in industrial microbiology

Isolation of industrially important microbial strains and fermentation media: Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates.

Unit-II

(16 Lectures)

Types of fermentation processes, bio-reactors and measurement of fermentation Parameters: Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations, Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation, parameters - pH, temperature, dissolved oxygen, foaming and aeration..

Unit-III

(10 Lectures)

Down-stream processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying.

Unit-IV

(10 Lectures)

Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses): Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12, Enzymes (amylase, protease, lipase) Wine, beer).

Unit-V

(12 Lectures)

Enzyme immobilization: Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

Reference Books:

- Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
- Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
- Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
- Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

Food and Dairy Microbiology

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Unit-I

(10 Lectures)

Foods as a substrate for microorganisms: Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit-II

(10 Lectures)

Microbial spoilage of various foods: Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods.

Unit-III

(12 Lectures)

Principles and methods of food preservation: Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO₂, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

Unit-IV

(12 Lectures)

Fermented foods: Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit-V

(16 Lectures)

Food borne diseases (causative agents, foods involved, symptoms and preventive measures): Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonella*, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Empylobacterium*

Food sanitation and control: HACCP, Indices of food sanitary quality and sanitizers, Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

Reference Books:

- Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
- Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
- Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
- Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
- Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
- Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
- Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
- Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
- Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

: Medical Microbiology

L T P
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Unit-I

(10 Lectures)

Normal microflora of the human body and host pathogen interaction: Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract, Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS

Sample collection, transport and diagnosis: Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

Unit-II

(14 Lectures)

Bacterial diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control

Respiratory Diseases: *Streptococcus pyogenes*, *Haemophilus influenzae*, *Mycobacterium tuberculosis*

Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori*

Others: *Staphylococcus aureus*, *Bacillus anthracis*, *Clostridium tetani*, *Treponema pallidum*, *Clostridium difficile*.

Unit-III

(10 Lectures)

Viral diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control,

Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis.



Unit-IV

(14 Lectures)

Protozoan diseases: List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control, Malaria, Kala-azar

Fungal diseases: Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention

Cutaneous mycoses: Tinea pedis (Athlete's foot)

Systemic mycoses: Histoplasmosis

Opportunistic mycoses: Candidiasis.

Unit-V

(12 Lectures)

Antimicrobial agents: General characteristics and mode of action: Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin; Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine; Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

Reference Books:

- Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
- Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
- Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
- Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

Immunology

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Unit-I

(12 Lectures)

Introduction: Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

Unit-II

(12 Lectures)

Immune Cells and Organs: Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Antigens: Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants.

Unit-III

(12 Lectures)

Antibodies: Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

Major Histocompatibility Complex: Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways).

Unit-IV

(12 Lectures)

Complement System: Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation



Generation of Immune Response: Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Co- stimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

Unit-V

(12 Lectures)

Immunological Disorders and Tumor Immunity: Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Types of tumors, tumor Antigens, causes and therapy for cancers.

Immunological Techniques: Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.

Reference Books:

- Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
- Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
- Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
- Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
- Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
- Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication.

Recombinant DNA Technology

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Unit-I

(16 Lectures)

Introduction to Genetic Engineering: Milestones in genetic engineering and biotechnology
Molecular Cloning- Tools and Strategies: Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering; DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases; Cloning Vectors: Definition and Properties; Plasmid vectors: pBR and pUC series; Bacteriophage lambda and M13 based vectors; Cosmids, BACs, YACs; Use of linkers and adaptors; Expression vectors: *E. coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors.

Unit-II

(12 Lectures)

Methods in Molecular Cloning: Transformation of DNA: Chemical method, Electroporation, Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral mediated delivery, *Agrobacterium* - mediated delivery, DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern – blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit-III

(10 Lectures)

DNA Amplification and DNA sequencing: PCR: Basics of PCR, RT-PCR, Real-Time PCR, Sanger's method of DNA Sequencing: traditional and automated sequencing, Primer walking and shotgun sequencing.

Unit-IV

(10 Lectures)

Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

Unit-V

(12 Lectures)

Applications of Recombinant DNA Technology: Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagenesis.

Reference Books:

- Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
- Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
- Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
- Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
- Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
- Brown TA. (2007). Genomes-3. Garland Science Publishers
- Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

: Microbial Biotechnology

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Unit-I

(12 Lectures)

Microbial Biotechnology and its Applications: Microbial biotechnology: Scope and its applications in human therapeutics, agriculture (Biofertilizers, PGPR, Mycorrhizae), environmental, and food technology Use of prokaryotic and eukaryotic microorganisms in biotechnological applications Genetically engineered microbes for industrial application: Bacteria and yeast.

Unit-II

(10 Lectures)

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

Unit-III

(10 Lectures)

Applications of Microbes in Biotransformations: 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

(16 Lectures)

Microbial Products and their Recovery: Microbial product purification: filtration, ion exchange & affinity chromatography techniques, Immobilization methods and their application: Whole cell immobilization

Microbes for Bio-energy and Environment: 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, mineral recovery, removal of heavy metals from aqueous effluents.



Unit-V

(12 Lectures)

RNAi: RNAi and its applications in silencing genes, drug resistance, therapeutics and host pathogen, interactions

Intellectual Property Rights: Patents, Copyrights, Trademarks.

Reference Books:

- Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.
- Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.
- Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.
- Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.
- Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,
- Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press
- Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
- Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science
- Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

Plant Pathology

L T P
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Unit-I

(12 Lectures)

Introduction and History of plant pathology: Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton DeBary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

Unit-II

(12 Lectures)

Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation.

Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit-III

(12 Lectures)

Host Pathogen Interaction: A. *Microbial Pathogenicity:* Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction).

B. *Genetics of Plant Diseases:* Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

C. *Defense Mechanisms in Plants:* Concepts of constitutive 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, plantibodies, phenolics, quinones, oxidative bursts].

Unit-IV

(12 Lectures)

Control of Plant Diseases: Principles & practices involved in the management of plant diseases by different methods, *viz.* regulatory - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material; cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches; chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals.; biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants, genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes.

Unit-V

(12 Lectures)

Specific Plant diseases: *Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control*

A. Important diseases caused by fungi

White rust of crucifers - *Albugo candida*

Downy mildew of onion - *Peronospora destructor*

Late blight of potato - *Phytophthora infestans*

Powdery mildew of wheat - *Erysiphe graminis*

Ergot of rye - *Claviceps purpurea*

Black stem rust of wheat - *Puccinia graminis tritici*

Loose smut of wheat - *Ustilago nuda*

Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici*

Red rot of sugarcane - *Colletotrichum falcatum*

Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

Reference Books:

- Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
- Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.
- Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.
- Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.
- Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi..

**Skill Based: Skill
Enhancement Courses**

Microbial Quality Control in Food and Pharmaceutical Industries

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Microbiological Laboratory and Safe Practices: Good laboratory practices - Good laboratory practices, Good microbiological practices; Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL-1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration


Determining Microbes in Food / Pharmaceutical Samples: Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Pathogenic Microorganisms of Importance in Food & Water: Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella, Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar, Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

HACCP for Food Safety and Microbial Standards: Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water.

Reference Books:

- Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
- Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
- Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

 Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality Control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

UNIT 1 : Microbial Diagnosis in Health Clinics

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Importance of Diagnosis of Diseases: Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Collection of Clinical Samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Direct Microscopic Examination and Culture: Examination of sample by staining - Gram stain, 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.

Serological and Molecular Methods: Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Kits for Rapid Detection of Pathogens: Typhoid, Dengue and HIV, Swine flu

Testing for Antibiotic Sensitivity in Bacteria: 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.

Reference Books:

- Ananthanarayan R and Paniker CKJ (2009) Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
- Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology, 26th edition. McGraw Hill Publication
- Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
- Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
- Murray PR, Tenover JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and McCartney Practical Medical Microbiology, 14th edition, Elsevier.

Biofertilizers and Biopesticides

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Biofertilizers: General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N₂ fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field, application, legume/pulses plants; *Frankia* - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Non - Symbiotic Nitrogen Fixers: Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Phosphate Solubilizers: Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application

Mycorrhizal Biofertilizers: Importance of mycorrhizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Bioinsecticides: General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

Reference Books:

- Kannaiyan, S. (2003). Bioethnology of Biofertilizers, CHIPS, Texas.
- Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
- Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
- Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
- Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
- Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

: Food Fermentation Techniques

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Fermented Foods: Definition, types, advantages and health benefits

Milk Based Fermented Foods: Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process

Grain Based Fermented Foods: Soy sauce, Bread, Idli and Dosa: Microorganisms and production process

Vegetable Based Fermented Foods: Pickels, Saeurkraut: Microorganisms and production process

Fermented Meat and Fish: Types, microorganisms involved, fermentation process

Probiotic Foods: Definition, types, microorganisms and health benefits.

Reference Books:

- Hui YH, Meunier-Goddik L, Josephsen J, Nip WK, Stanfield PS (2004) Handbook of food and fermentation technology, CRC Press
- Holzapfel W (2014) Advances in Fermented Foods and Beverages, Woodhead Publishing.
- Yadav JS, Grover, S and Batish VK (1993) A comprehensive dairy microbiology, Metropolitan
- Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

: Management of Human Microbial Diseases

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Human Diseases: Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Microbial diseases: 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, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Therapeutics of Microbial diseases: Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides. Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Prevention of Microbial Diseases: General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors.

Vaccines: Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Reference Books:

- Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
- Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
- Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
- Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 11th edition. Pearson International Edition