RAJA NARENDRALAL KHAN WOMEN'S COLLEGE (AUTONOMOUS)

Syllabus for B.Sc. Honours in Microbiology

[Choice Based Credit System]

(Courses effective from Academic Year: 2019-2020)

SEMESTER I-VI

GOPE PALACE, PASCHIM MEDINIPUR, WEST BENGAL -721102

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY)
SEMESTER –I

Unit 1 History of Development of Microbiology No. of Hours: 15

Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton van 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 2 An overview of Scope of Microbiology No. of Hours: 05

Unit 3 Diversity of Microbial World No. of Hours: 40

A. 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.

B. 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.

• **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.

• **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.•

Protozoa

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

C-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (PRACTICALS)
SEMESTER –I
TOTAL HOURS: 60

CREDITS: 2

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*

SUGGESTED READINGS

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-2: BACTERIOLOGY (THEORY)
SEMESTER –I

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 14**

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, Archaebacterial 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 2 Bacteriological techniques **No. of Hours: 5**

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.

Unit 3 Microscopy

No. of Hours: 6

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope.

Unit 4 Growth and nutrition

No. of Hours: 8

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 5 Reproduction in Bacteria

No. of Hours: 3

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit 6 Bacterial Systematics

No. of Hours: 8

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 archaebacteria.

Unit 7 Important archaeal and eubacterial groups **No. of Hours: 16**

Archaebacteria: 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.

Gram Positive:
Low G+ C (Firmicutes): General characteristics with suitable examples
High G+C (Actinobacteria): General characteristics with suitable examples
***Cyanobacteria*:** An Introduction.

C-2: BACTERIOLOGY (PRACTICAL)
SEMESTER –I
TOTAL HOURS: 60 **CREDITS: 2**

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.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2014). Brock Biology of Micro-organisms. 14th edition. Parker J.
Prentice Hall International, Inc.

4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers,
Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition
McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson
Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition.
McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-3: BIOCHEMISTRY (THEORY)
SEMESTER –II

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Bioenergetics **No. of Hours: 8**

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 2 Carbohydrates

No. of Hours: 12

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 3 Lipids

No. of Hours: 12

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. Phoisphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins, cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers.

Unit 4 Proteins

No. of Hours: 12

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.

Unit 5. Enzymes

No. of Hours: 12

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, Km, 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.

Unit 6. Vitamins **No. Hours: 4**

Classification and characteristics with suitable examples, sources and importance:A,D,E,K,B complex and C.

C-3: BIOCHEMISTRY (PRACTICALS)
SEMESTER –II
TOTAL HOURS: 60 **CREDITS: 2**

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 , Km, Kcat values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

SUGGESTED READING

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-4: VIROLOGY (THEORY)
SEMESTER –II

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Nature and Properties of Viruses

No. of Hours: 12

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 2 Bacteriophages **No. of Hours**: **10**

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 3 Viral Transmission, Salient features of viral nucleic acids and Replication

No. of Hours: **20**

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal
Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, 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, 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 4 Viruses and Cancer **No. of Hours: 6**

Introduction to oncogenic viruses.
Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes.

Unit 5 Prevention & control of viral diseases **No. of Hours: 8**

Antiviral compounds and their mode of action
Interferon and their mode of action
General principles of viral vaccination.

Unit 6 Applications of Virology **(No. of Hours: 4)**

Use of viral vectors in cloning and expression, Gene therapy and Phage display

C-4: VIROLOGY (PRACTICAL) **SEMESTER –II**
TOTAL HOURS: 60 **CREDITS: 2**

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 (ϕX 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.

SUGGESTED READING

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,
Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. 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.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New
Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-5: MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)
SEMESTER –III

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth
No. of Hours: 12

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 2 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 3 Chemoheterotrophic Metabolism - Aerobic Respiration
No. of Hours:10

Concept of aerobic respiration, anaerobic respiration and fermentation, Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, TCA cycle, gluconeogenesis, and glycogenolysis, Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial ETC, electron transport phosphorylation, uncouplers and inhibitors.

Unit 4 Chemoheterotrophic Metabolism-Anaerobic respiration and fermentation
No. of Hours: 6

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

Unit 5 Chemolithotrophic and Phototrophic Metabolism **No. of Hours: 10**

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 **No. of Hours: 6**

Introduction to biological nitrogen fixation. Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification, urea cycle

C-5: MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)
SEMESTER –III TOTAL HOURS: 60 CREDITS: 2

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*

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SUGGESTED READINGS

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-6: CELL BIOLOGY (THEORY)
SEMESTER –III

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structure and organization of Cell **No. of Hours: 12**

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 protoplasm.

Unit 2 Nucleus **No. of Hours: 4**

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

Unit 3 Protein Sorting and Transport **No. of Hours: 12**

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 4 Cell Signalling **No. of Hours: 8**

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 5 Cell Cycle, Cell Death and Cell Renewal **No. of Hours: 12**

Eukaryotic and prokaryotic cell cycle and its regulation, Mitosis and Meiosis, Programmed cell death, Stem cells Embryonic stem cell, induced pleuripotent stem cells

C-6: CELL BIOLOGY (PRACTICAL)
SEMESTER –III
TOTAL HOURS: 60 **CREDITS: 2**

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. Study of polyploidy in Onion root tip by colchicine treatment.
5. Identification and study of cancer cells by photomicrographs.
6. Study of different stages of Mitosis.
7. Study of different stages of Meiosis.

SUGGESTED READING

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-7: MOLECULAR BIOLOGY (THEORY)
SEMESTER –III

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Structures of DNA and RNA / Genetic Material **No. of Hours: 12**

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 2 Replication of DNA (Prokaryotes and Eukaryotes) **No. of Hours: 10**

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, C value paradox, Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair, Fidelity of replication.

Unit 3 Transcription in Prokaryotes and Eukaryotes **No. of Hours: 8**

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 4 Post- Transcriptional Prosessing **No. of Hours: 8**

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 5 Translation (Prokaryotes and Eukaryotes) **No. of Hours: 10**

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 6 Regulation of gene Expression in Prokaryotes and Eukaryotes No. of Hours: 12
Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

C-7: MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER –III
TOTAL HOURS: 60 **CREDITS: 2**

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).

SUGGESTED READINGS

1. 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
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
4. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
6. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
7. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-8: MICROBIAL GENETICS (THEORY)
SEMESTER –IV

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Mendelian Principles **No. of Hours: 12**

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity.

Unit 2 Genome Organization and Mutations **No. of Hours: 16**

Genome organization: *E. coli, Saccharomyces, Drossophila*
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; replica plating, and fluctuation test. Mutator genes.

Unit 3 Plasmids **No. of Hours: 10**

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 4 Mechanisms of Genetic Exchange **No. of Hours: 12**

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 5 Transposable elements **No. of Hours: 10**

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.

C-8: MICROBIAL GENETICS (PRACTICAL)
SEMESTER –IV
TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO_2) 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 Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

SUGGESTED READING

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-9: ENVIRONMENTAL MICROBIOLOGY (THEORY)
SEMESTER –IV

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microorganisms and their Habitats No. of Hours: 14

Structure and function of ecosystems. Terrestrial Environment: Soil profile and soil microflora. Aquatic Environment: Microflora of fresh water and marine habitats. Atmosphere: Aeromiroflora 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 2 Microbial Interactions **No. of Hours: 12**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism,predation. Microbe-plant interactions: symbiotic and non symbiotic interactions. Microbe-animal interactions: microbes in ruminants.

Unit 3 Biogeochemical Cycling **No. of Hours: 12**

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 4 Waste Management **No. of Hours: 12**

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 5 Microbial Bioremediation **No. of Hours: 5**

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, Biosurfactants.

Unit 6 Water Potability **No. of Hours: 5**

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.

C-9: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)
SEMESTER –IV
TOTAL HOURS: 60 **CREDITS: 2**

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press,Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-10: FOOD AND DAIRY MICROBIOLOGY (THEORY)
SEMESTER –IV

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Foods as a substrate for microorganisms **No. of Hours: 8**

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general.

Unit 2 Microbial spoilage of various foods **No. of Hours: 10**

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods

Unit 3 Principles and methods of food preservation **No. of Hours: 12**

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 4 Fermented foods **No. of Hours: 10**

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 5 Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **No. of Hours: 10**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins;
Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control **No. of Hours: 5**

HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introductionto predictive microbiology. **No. of Hours: 5**

C-10: FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)
SEMESTER –IV
TOTAL HOURS: 60 **CREDITS: 2**

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

SUGGESTED READINGS

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-11: INDUSTRIAL MICROBIOLOGY (THEORY)
SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to industrial microbiology **No. of Hours: 2**

Brief history and developments in industrial microbiology

Unit 2 Isolation of industrially important microbial strains and fermentation media
No. of Hours: 10

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 3 Types of fermentation processes, bio-reactors and measurement of fermentation parameter **No. of Hours: 12**

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 4 Down-stream processing **No. of Hours: 6**

Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray Drying

Unit 5 Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) **No. of Hours: 18**

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12. Enzymes (amylase, protease, lipase). Wine, beer

Unit 6 Enzyme immobilization **No. of Hours: 4**

Methods of immobilization, advantages and applications of immobilization, large scale applications ofimmobilized enzymes (glucose isomerase and penicillin acylase) whole cell immobilization for production.

C-11: INDUSTRIAL MICROBIOLOGY (PRACTICAL)
SEMESTER –V
TOTAL HOURS: 60 **CREDITS: 2**

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
 (a) Enzymes: Amylase and Protease
 (b) Alcohol: Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-12: IMMUNOLOGY (THEORY)
SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction **No. of Hours: 4**

Concept of Innate and Adaptive immunity.

Unit 2 Immune Cells and Organs **No. of Hours: 7**

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

Unit 3 Antigens **No. of Hours: 4**

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

Unit 4 Antibodies **No. of Hours: 6**

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

Unit 5 Major Histocompatibility Complex **No. of Hours: 5**

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

Unit 6 Complement System **No. of Hours: 4**

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

Unit 7 Immune Response and Immunological Disorders

Primary and Secondary Immune Response; Generation of Humoral Immune Response; Generation of Cell Mediated Immune Response; Killing Mechanisms by CTL and NK cells, Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD.

Unit 8 Immunological Techniques **No. of Hours: 10**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy.

C-12: IMMUNOLOGY (PRACTICAL)
SEMESTER –V
TOTAL HOURS: 60 **CREDITS: 2**

1. Identification of human blood groups.
2. Perform Total Leukocyte Count of the given blood sample.
3. Perform Differential Leukocyte Count of the given blood sample.
4. Determination of Hb, ESR.
5. Separate serum from the blood sample (demonstration).
6. Perform immunodiffusion by Ouchterlony method.
7. Perform DOT ELISA.
8. Perform immunoelectrophoresis.

SUGGESTED READINGS

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-13: MEDICAL MICROBIOLOGY (THEORY)
SEMESTER –VI

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Normal microflora of the human body and host pathogen interaction
No. of Hours: 8

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

Unit 2 Sample collection, transport and diagnosis **No. of Hours: 5**

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

Unit 3 Bacterial diseases **No. of Hours: 15**

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 difficie*

Unit 4 Viral diseases **No. of Hours: 14**

Polio , Hepatitis, , Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephelatis.

Unit 5 Protozoan diseases **No. of Hours: 5**

Causative agents, symptoms, mode of transmission, prophylaxix and prevention and control of the following diseases: Malaria, Kala-azar.

Unit 6 Fungal diseases **No. of Hours: 5**

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 7 Antimicrobial agents: General characteristics and mode of action
No. of Hours: 8

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, Nystatin Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine Antibiotic resistance, MDR, XDR, MRSA, NDM-1.

C-13: MEDICAL MICROBIOLOGY (PRACTICAL)
SEMESTER –VI
TOTAL HOURS: 60 **CREDITS: 2**

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

SUGGESTED READING

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
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. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology.9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-14: RECOMBINANT DNA TECHNOLOGY (THEORY)
SEMESTER –VI

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Introduction to Genetic Engineering **No. of Hours: 2**
Milestones in genetic engineering and biotechnology

Unit 2 Molecular Cloning- Tools and Strategies **No. of Hours: 20**
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 3 Methods in Molecular Cloning **No. of Hours: 16**
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.

Unit4 DNA Amplification and DNA sequencing **No. of Hours: 10**
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 5 Construction and Screening of Genomic and cDNA libraries **No. of Hours: 6**
Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping.

Unit 6 Applications of Recombinant DNA Technology **No. of Hours: 6**
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.

C-14: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)
SEMESTER –VI
TOTAL HOURS: 60 **CREDITS: 2**

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophores
2. Cloning of DNA insert and Blue white screening of recombinants.
3. Amplification of DNA by PCR

4. Demonstration of Southern/western blotting
5. Cloning of DNA insert and Blue White screening of recombinants.

SUGGESTED READING

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

SE-1: BIOFERTILIZERS AND BIOPESTICIDES (THEORY)

SEMESTER – III

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Biofertilizers **No of Hours: 10**

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N_2 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.

Unit 2 Non - Symbiotic Nitrogen Fixers **No of Hours: 4**

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Unit 3 Phosphate Solubilizers **No of Hours: 4**

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

Unit 4 Mycorrhizal Biofertilizers **No of Hours: 5**

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculums production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 5 Bioinsecticides **No of Hours: 7**

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

SUGGESTED READINGS

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (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. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG.
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

SE-2: MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES (THEORY)

SEMESTER – IV

TOTAL HOURS: 30 **CREDITS: 2**

Unit 1 Microbiological Laboratory and Safe Practices No. of Hours: 8

Good laboratory practices - Good laboratory practices, Good microbiological practices. Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL1, BSL-2, BSL 3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration.

Unit 2 Determining Microbes in Food / Pharmaceutical Samples No. of Hours: 10

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.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water No. of Hours: 8

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, MacConkey Agar, Sabouraud 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).

Unit 4 HACCP for Food Safety and Microbial Standards **No. of Hours: 4**

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.

SUGGESTED READINGS

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press

2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.

3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer

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

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-1: MICROBIAL BIOTECHNOLOGY (THEORY)

SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microbial Biotechnology and its Applications **No. of Hours: 10**

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 2 Therapeutic and Industrial Biotechnology **No. of Hours: 10**

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 3 Applications of Microbes in Biotransformations **No. of Hours: 8**

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 4 Microbial Products and their Recovery **No. of Hours: 10**

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

Unit 5 Microbes for Bio-energy and Environment **No. of Hours: 12**

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 6 RNAi **No. of Hours: 6**

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

Unit 7 Intellectual Property Rights **No. of Hours: 4**

Patents, Copyrights, Trademarks.

DSE-1: MICROBIAL BIOTECHNOLOGY (PRACTICAL)

SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 2**

1. Study yeast cell immobilization in calcium alginate gels.

2. Study enzyme immobilization by sodium alginate method.

3. Pigment production from fungi (Trichoderma / Aspergillus / Penicillium).

4. Isolation of xylanase or lipase producing bacteria.

5. Study of algal Single Cell Proteins.

SUGGESTED READING

1. Ratledge, C and Kristiansen, B. (2001). Basic Biotechnology, 2nd Edition, Cambridge University Press.

2. Demain, A. L and Davies, J. E. (1999). Manual of Industrial Microbiology and Biotechnology, 2nd Edition, ASM Press.

3. Swartz, J. R. (2001). Advances in Escherichia coli production of therapeutic proteins. Current Opinion in Biotechnology, 12, 195–201.

4. Prescott, Harley and Klein's Microbiology by Willey JM, Sherwood LM, Woolverton CJ (2014), 9th edition, Mc Graw Hill Publishers.

5. Gupta PK (2009) Elements of Biotechnology 2nd edition, Rastogi Publications,

6. Glazer AN and Nikaido H (2007) Microbial Biotechnology, 2nd edition, Cambridge University Press

7. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,

8. Stanbury PF, Whitaker A, Hall SJ (1995) Principles of Fermentation Technology 2nd edition., Elsevier Science.

9. Crueger W, Crueger A (1990) Biotechnology: A text Book of Industrial Microbiology 2nd edition Sinauer associates, Inc.

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-2: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY) SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Soil Microbiology **No of Hours: 8**

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Unit 2 Mineralization of Organic & Inorganic Matter in Soil **No of Hours: 8**

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit 3 Microbial Activity in Soil and Green House Gases **No of Hours: 5**

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control

Unit 4 Microbial Control of Soil Borne Plant Pathogens **No of Hours: 8**

Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds.

Unit 5 Biofertilization, Phytostimulation, Bioinsecticides **No of Hours: 15**

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), Non Symbiotic (*Azospirillum*, *Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit 6 Secondary Agriculture Biotechnology **No of Hours: 10**

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters

Unit 7 GM crops **No of Hours: 6**

Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

DSE-2: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)

SEMESTER –V

TOTAL HOURS: 60 **CREDITS: 2**

1. Study soil profile.

2. Study microflora of different types of soils.

3. *Rhizobium* as soil inoculants characteristics and field application.

4. *Azotobacte*r as soil inoculants characteristics and field application.

5. Design and functioning of a biogas plant.

6. Isolation of cellulose degrading organisms.

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego.

2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press.

4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.

5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.

6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA.

7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.

8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, Ist edition, Marcel decker Inc.

10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.

11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.

12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-3: INSTRUMENTATION AND BIOTECHNIQUES (THEORY)

SEMESTER –VI

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Microscopy **No. of Hours: 10**

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy, Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography **No. of Hours: 14**

Principles and applications of paper chromatography (including Descending and 2-D), Thin layer chromatography. Column packing and fraction collection. Gel filtration chromatography, ionexchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis **No. of Hours: 14**

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gel electrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gel electrophoresis.

Unit 4 Spectrophotometry **No. of Hours: 10**

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Unit 5 Centrifugation **No. of Hours: 12**

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF and sedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

DSE-3: INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

SEMESTER –VI

TOTAL HOURS: 60 **CREDITS: 2**

1. Study of fluorescent micrographs to visualize bacterial cells.

2. Ray diagrams of phase contrast microscopy and Electron microscopy.

3. Separation of mixtures by paper / thin layer chromatography.

4. Demonstration of column packing in any form of column chromatography.

5. Separation of protein mixtures by any form of chromatography.

6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).

7. Determination of λmax for an unknown sample and calculation of extinction coefficient.

8. Separation of components of a given mixture using a laboratory scale centrifuge.

9. Understanding density gradient centrifugation with the help of pictures.

10. A visit to any educational institute/industry to see different advanced instruments and Techniques: Report preparation and presentation.

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SUGGESTED READINGS

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9th Ed., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.

5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill.

B.Sc. (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

DSE-4: PROJECT WORK

SEMESTER –VI

TOTAL HOURS: 60 **CREDITS: 6**

The Topic for Dissertation will be assigned to the students by the concerned guide at the beginning of the 6^{th} Semester:

Project Work pertaining to any Pure Microbiology/ Applied microbiology / Advanced Microbiology / Plant Pathology/ Animal pathology/ Immunology/ Biochemistry/ Molecular Biology/ Biophysics/ Bioinformatics/ Biostatistics/ Inter-disciplinary biological science.

GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)
SEMESTER –I/III

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 History of Development of Microbiology **No. of Hours: 12**

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 2 Diversity of Microorganisms **No. of Hours: 10**

Systems of classification : Binomial nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Prokarya: Archaea and Bacteria, Eukarya : Algae, Fungi and Protozoa) giving definitions and citing examples. Protozoa : Methods of nutrition, locomotion & reproduction - Amoeba, *Paramecium* and *Plasmodium*

Unit 3 Microscopy **No. of Hours: 7**

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope,Transmission Electron Microscope, Scanning Electron Microscope

Unit 4 Sterilization **No. of Hours: 5**

Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filteration.

Unit 5 Microbes in Human Health & Environment **No. of Hours: 10**

Medical microbiology and immunology: List of important human diseases and their causative agents of various human systems. Definitions of immunity (active/passive), primary and secondary immune response, antigen, antibody and their types

Environmental microbiology: Definitions and examples of important microbial interactions – mutualism, commensalism, parasitism, Definitions and microorganisms used as biopesticides, biofertilizers, in biodegradation, biodeterioration and bioremediation (*e.g.* hydrocarbons in oil spills)

Unit 6 Industrial Microbiology **No. of Hours: 8**

Definition of fermentation, primary and secondary metabolites, types of fermentations and fermenters and microbes producing important industrial products through fermentation.

Unit 7 Food and Dairy Microbiology **No. of Hours: 8**

Microorganisms as food (SCP), microorganisms in food fermentations (dairy and non dairy based fermented food products) and probiotics. Microorganisms in food spoilage and food borne infections.

GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY (PRACTICALS)
SEMESTER –I/III

TOTAL HOURS: 60 **CREDITS: 2**

1. Microbiology Laboratory Management 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 filtration and assessment for sterility
7. Demonstration of presence of microflora in the environment by exposing nutrient agar plates to air.
8. Study of different shapes of bacteria using permanent slides
9. Study of *Rhizopus* and *Penicillium* using permanent mounts
10. Study of *Spirogyra* and *Chlamydomonas* using permanent Mounts
11. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

SUGGESTED READING

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
GE-2: BACTERIOLOGY AND VIROLOGY (THEORY)
SEMESTER – II/IV

TOTAL HOURS: 60 **CREDITS: 4**

Unit 1 Cell organization **No. of Hours: 10**

Cell size, shape and arrangements, capsule, flagella and pili, Composition and detailed structure of gram- positive and gram- negative cell wall and archaeal cell wall, Structure, chemical composition and functions of bacterial and archaeal cell membranes, Ribosomes, inclusions, nucleoid, plasmids, structure, formation and stages of sporulation

Unit 2 Bacterial growth and control **No. of Hours: 8**

Culture media: Components of media, Synthetic or defined media, Complex media, enriched media, selective media, differential media, enrichment culture media. Pure culture isolation: Streaking, serial dilution and plating methods, cultivation, maintenance and stocking of pure cultures, cultivation of anaerobic bacteria. Growth: Binary fission, phases of growth.

Unit 3 Bacterial Systematics and Taxonomy **No. of Hours: 12**

Taxonomy, nomenclature, systematics, types of classifications
Morphology, ecological significance and economic importance of the following groups:
Archaea: methanogens, thermophiles and halophiles
Eubacteria: Gram negative and Gram positive
Gram negative:
Non-proteobacteria– *Deinococcus, Chlamydiae,* Spirochetes
Alpha proteobacteria- *Rickettsia, Rhizobium, Agrobacterium*
Gamma proteobacteria –*Escherichia,Shigella,Pseudomonas*
Gram positive: Low G+C: *Mycoplasma*, *Bacillus, Clostridium, Staphylococcus* High G+C: *Streptomyces, Frankia*

Unit 4 Introduction to Viruses **No. of Hours: 8**

Properties of viruses; general nature and important features. Subviral particles; viroids, prions and their importance. Isolation and cultivation of viruses

Unit 5 Structure, and multiplication of viruses **No. of Hours: 12**

Morphological characters: Capsid symmetry and different shapes of viruses with examples
Viral multiplication in the Cell: Lytic and lysogenic cycle. Description of important viruses: salient features of the viruses infecting different hosts - Bacteriophages (T4 & Lambda); Plant (TMV & Cauliflower Mosaic Virus), Human (HIV & Hepatitis viruses)

Unit 6 Role of Viruses in Disease and its prevention **No. of Hours: 10**

Viruses as pathogens: Role of viruses in causing diseases.
Prevention and control of viruses: Viral vaccines, interferons and antiviral compounds.

GE-2: BACTERIOLOGY AND VIROLOGY (PRACTICAL)
SEMESTER – II/IV
TOTAL HOURS: 60 **CREDITS: 2**

1. Preparation of different media: Nutrient agar, Nutrient broth
2. To perform simple staining and Gram's staining of the bacterial smear
3. To perform spore staining
4. Isolation of pure cultures of bacteria by streaking method
5. Enumeration of colony forming units (CFU) count by spread plate method/pour plate
7. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs
8. Study of the methods of isolation and propagation of plant viruses
9. Study of cytopathic effects of viruses using photographs

SUGGESTED READING

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP (2014). Brock Biology of Micro-organisms.
14th edition. Pearson Education, Inc.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology.
5th edition. McMillan
4. Carter J and Saunders V(2007). Virology; principles and Applications. John Wiley and Sons
5. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR Skalka, AM (2004) Principles of Virology, Molecular Biology, Pathogenesis and Contro*l*.2nd edition.ASM Press
6. Shors Teri (2013) Understanding Viruses 2nd edition Jones and Bartlett Learning Burlington USA
7. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson
Education.
9. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
10. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition,
Blackwell Publishing Ltd.
11. Cann AJ (2012) Principles of Molecular Virology, Academic Press Oxford UK