Structure of B. Sc. Honours Microbiology under CBCS

Core Course
C-1: Introduction to Microbiology and Microbial Diversity
C-2: Bacteriology
C-3: Biochemistry
C-4: Virology
C-5: Microbial Physiology and Metabolism
C-6: Cell Biology
C-7: Molecular Biology
C-8: Microbial Genetics
C-9: Environmental Microbiology
C-10: Food and Dairy Microbiology
C-11: Industrial Microbiology
C-12: Immunology
C-13: Medical Microbiology
C-14: Recombinant DNA Technology

Discipline Specific Elective (Any Four)
DSE-1: Bioinformatics
DSE-2: Microbial Biotechnology
DSE-3: Advances in Microbiology
DSE-4: Plant Pathology
DSE-5: Biomathematics and Biostatistics
DSE-6: Inheritance Biology
DSE-7: Microbes in Sustainable Agriculture and Development
DSE-8: Biosafety and Intellectual Property Rights
DSE-9: Instrumentation and Biotechniques
DSE-10: Project Work

Generic Electives (Any Four)
GE-1: Introduction and Scope of Microbiology
GE-2: Bacteriology and Virology
GE-3: Microbial Metabolism
GE-4: Industrial and Food Microbiology
GE-5: Microbes in Environment
GE-6: Medical Microbiology and Immunology
GE-7: Genetic Engineering and Biotechnology
GE-8: Microbial Genetics and Molecular Biology

Ability Enhancement Compulsory Courses
AE-1: Environmental Sciences
AE-2: English/MIL Communication

Skill Enhancement Elective Courses (Any Two)
SE-1: Microbial Quality Control in Food and Pharmaceutical Industries
SE-2: Microbial Diagnosis in Health Clinics
SE-3: Biofertilizers and Biopesticides
SE-4: Food Fermentation Techniques
SE-5: Management of Human Microbial Diseases
SE-6: Microbiological Analysis of Air and Water
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-1: INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY
(THEORY)
SEMESTER –I

TOTAL HOURS: 60        CREDITS: 4

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

Unit 3 An overview of Scope of Microbiology
No. of Hours: 5

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, Paramaecium and Plasmodium*

**SUGGESTED READING**
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,
Archaeabacterial 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 archaeabacteria

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

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**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.
11. Motility by hanging drop method.

**SUGGESTED READINGS**

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

Unit 4 Proteins               No. of Hours: 12

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. of Hours: 4
Classification and characteristics with suitable examples, sources and importance.
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 $V_{\text{max}}$, $K_m$, $K_{\text{cat}}$ values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

SUGGESTED READING
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 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 (φX 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
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
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: 16
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 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation  No. of Hours: 6
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 5 Chemolithotrophic and Phototrophic Metabolism  No. of Hours: 10
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  No. of Hours: 6
Introduction to biological nitrogen fixation
Ammonia assimilation
Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification
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*.

**SUGGESTED READINGS**
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
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

No. of Hours: 12

Unit 2 Nucleus
Nuclear envelope, nuclear pore complex and nuclear lamina
Chromatin – Molecular organization
Nucleolus

No. of Hours: 4

Unit 3 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

No. of Hours: 12

Unit 4 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

No. of Hours: 8

Unit 5 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 pleuripotent stem cells

No. of Hours: 12

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. 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.

SUGGESTED READING
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, D-loop (mitochondrial), Θ (theta) mode of replication and other accessory protein, Mismatch and excision repair

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 Processing

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, Sporulation in Bacillus, Yeast mating type switching, 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)
4. Estimation of RNA using colorimeter (orcinol reagent) or UV spectrophotometer (A260 measurement).
5. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
6. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

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

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Genome Organization and Mutations
No. of Hours: 18
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 2 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 3 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 4 Phage Genetics
No. of Hours: 8
Features of T4 genetics , Genetic basis of lytic versus lysogenic switch of phage lambda

Unit 5 Transposable elements
No. of Hours: 12
Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon
Eukaryotic transposable elements - Yeast (Ty retrotransponso), 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 (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 Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test
SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
C-9: ENVIRONMENTAL MICROBIOLOGY (THEORY)
SEMESTER –IV

TOTAL HOURS: 60        CREDITS: 4

Unit 1 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 2 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, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 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 4 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 5 Microbial Bioremediation
Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inorganic (metals) matter, biosurfactants

Unit 6 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

C-9: ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)
SEMESTER –IV
1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
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**

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

Unit 3 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 4 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 5 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*, *Salmonellosis*, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

Unit 6 Food sanitation and control
HACCP, Indices of food sanitary quality and sanitizers

Unit 7 Cultural and rapid detection methods of food borne pathogens in foods and introduction to predictive microbiology.

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.

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

C-11: INDUSTRIAL MICROBIOLOGY (THEORY)

SEMESTER –V

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction to industrial microbiology
Brief history and developments in industrial microbiology
No. of Hours: 2

Unit 2 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, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates
No. of Hours: 10

Unit 3 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
No. of Hours: 12

Unit 4 Down-stream processing
Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying
No. of Hours: 6

Unit 5 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
No. of Hours: 18

Unit 6 Enzyme immobilization
Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase)
No. of Hours: 4

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) Amino acid: Glutamic acid
   (c) Organic acid: Citric acid
   (d) Alcohol: Ethanol
3. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
SUGGESTED READINGS
### B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
#### C-12: IMMUNOLOGY (THEORY)
#### SEMESTER –V

**TOTAL HOURS:** 60  
**CREDITS:** 4

<table>
<thead>
<tr>
<th>Unit</th>
<th>No. of Hours</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit 1 Introduction</strong></td>
<td><strong>4</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Unit 2 Immune Cells and Organs</strong></td>
<td><strong>7</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Unit 3 Antigens</strong></td>
<td><strong>4</strong></td>
<td>Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T &amp; B cell epitopes); T-dependent and T-independent antigens; Adjuvants</td>
</tr>
<tr>
<td><strong>Unit 4 Antibodies</strong></td>
<td><strong>6</strong></td>
<td>Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic, allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies</td>
</tr>
<tr>
<td><strong>Unit 5 Major Histocompatibility Complex</strong></td>
<td><strong>5</strong></td>
<td>Organization of MHC locus (Mice &amp; Human); Structure and Functions of MHC I &amp; II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)</td>
</tr>
<tr>
<td><strong>Unit 6 Complement System</strong></td>
<td><strong>4</strong></td>
<td>Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement Activation</td>
</tr>
<tr>
<td><strong>Unit 7 Generation of Immune Response</strong></td>
<td><strong>10</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Unit 8 Immunological Disorders and Tumor Immunity</strong></td>
<td><strong>10</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Unit 9 Immunological Techniques</strong></td>
<td><strong>10</strong></td>
<td>Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluorescence, Flow cytometry, Immunoelectron microscopy.</td>
</tr>
</tbody>
</table>
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. Separate serum from the blood sample (demonstration).
5. Perform immunodiffusion by Ouchterlony method.
6. Perform DOT ELISA.
7. Perform immunoelectrophoresis.

SUGGESTED READINGS
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 difficile

Unit 4 Viral diseases  
No. of Hours: 14
List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control
Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis

Unit 5 Protozoan diseases  
No. of Hours: 5
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

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
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
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
Milestones in genetic engineering and biotechnology
No. of Hours: 2

Unit 2 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
No. of Hours: 20

Unit 3 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.
No. of Hours: 16

Unit 4 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
No. of Hours: 10

Unit 5 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
No. of Hours: 6

Unit 6 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 mutagensis
No. of Hours: 6

C-14: RECOMBINANT DNA TECHNOLOGY (PRACTICAL)
SEMESTER –VI
1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-1: BIOINFORMATICS (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction to Computer Fundamentals
No. of Hours: 8
RDBMS - Definition of relational database
Mode of data transfer (FTP, SFTP, SCP), advantage of encrypted data transfer

Unit 2 Introduction to Bioinformatics and Biological Databases
No. of Hours: 14
Biological databases - nucleic acid, genome, protein sequence and structure, gene expression databases, Database of metabolic pathways, Mode of data storage - File formats - FASTA, Genbank and Uniprot, Data submission & retrieval from NCBI, EMBL, DDBJ, Uniprot, PDB

Unit 3 Sequence Alignments, Phylogeny and Phylogenetic trees
No. of Hours: 16
Local and Global Sequence alignment, pairwise and multiple sequence alignment.
Scoring an alignment, scoring matrices, PAM & BLOSUM series of matrices
Types of phylogenetic trees, Different approaches of phylogenetic tree construction - UPGMA, Neighbour joining, Maximum Parsomony, Maximum likelihood

Unit 4 Genome organization and analysis
No. of Hours: 10
Diversity of Genomes: Viral, prokaryotic & eukaryotic genomes
Genome, transcriptome, proteome, 2-D gel electrophoresis, Maldi Toff spectroscopy
Major features of completed genomes: E.coli, S.cerevisiae, Arabidopsis, Human

Unit 5 Protein Structure Predictions
No. of Hours: 12
Hierarchy of protein structure - primary, secondary and tertiary structures, modeling
Structural Classes, Motifs, Folds and Domains
Protein structure prediction in presence and absence of structure template
Energy minimizations and evaluation by Ramachandran plot
Protein structure and rational drug design

DSE-1: BIOINFORMATICS (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 2

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

SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-2: MICROBIAL BIOTECHNOLOGY (THEORY)
SEMESTER –V/VI

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
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-2: MICROBIAL BIOTECHNOLOGY (PRACTICAL)
SEMESTER –V/VI

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
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-3: ADVANCES IN MICROBIOLOGY (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Evolution of Microbial Genomes
Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics

No. of Hours: 15

Unit 2 Metagenomics
Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

No. of Hours: 15

Unit 3 Molecular Basis of Host-Microbe Interactions
Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance

No. of Hours: 15

Unit 4 Systems and Synthetic Biology
Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

No. of Hours: 15

DSE-3: ADVANCES IN MICROBIOLOGY (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 2

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

SUGGESTED READING
1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-4: PLANT PATHOLOGY (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction and History of plant pathology
No. of Hours: 5

Unit 2 Stages in development of a disease
No. of Hours: 2
Infection, invasion, colonization, dissemination of pathogens and perennation.

Unit 3 Plant disease epidemiology
No. of Hours: 5
Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 4 Host Pathogen Interaction
No. of Hours: 19
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 5 Control of Plant Diseases
No. of Hours: 10
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 6 Specific Plant diseases
No. of Hours: 19
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

DSE-4: PLANT PATHOLOGY (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60 CREDITS: 2

1. Demonstration of Koch’s postulates in fungal, bacterial and viral plant pathogens.
2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

SUGGESTED READINGS
Unit 1 Biomathematics

Sets. Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions. Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits. Intuitive idea of algebraic relationships and convergence. Infinite Geometric Series. Series formulas for \( \exp(x) \), \( \ln(1+x) \), \( \sin(x) \), \( \cos(x) \). Step function. Intuitive idea of discontinuity, continuity and limits. Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above. Differential Equations of first order, Linear Differential Equations. Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Product of matrices up to order 3.

Unit 2 Biostatistics

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions; Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample test based on t-test, Z-test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.
TOTAL HOURS: 60        CREDITS: 2

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

SUGGESTED READINGS
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-6: INHERITANCE BIOLOGY (THEORY)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction to Genetics  
No. of Hours: 5  
Historical developments  
Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae*, *Neurospora crassa*, *Caenorhabditis elegans*, *Drosophila melanogaster*, *Arabidopsis thaliana*

Unit 2 Mendelian Principles  
No. of Hours: 13  
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 3 Linkage and Crossing over  
No. of Hours: 9  
Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping

Unit 4 Extra-Chromosomal Inheritance  
No. of Hours: 9  
Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaea peregra*  
Infectious heredity - Kappa particles in *Paramecium*

Unit 5 Characteristics of Chromosomes  
No. of Hours: 15  
Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lambrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome

Unit 6 Recombination  
No. of Hours: 3  
Homologous and non-homologous recombination, including transposition, site-specific recombination.

Unit 7 Human genetics  
No. of Hours: 3  
Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

Unit 8 Quantitative genetics  
No. of Hours: 3  
Polygenic inheritance, heritability and its measurements, QTL mapping.
DSE-6: INHERITANCE BIOLOGY (PRACTICAL)
SEMESTER –V/VI

TOTAL HOURS: 60        CREDITS: 2

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying Rhoeo translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-7: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT
(THEORY)
SEMESTER –V/VI

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-7: MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT
(PRACTICAL)
SEMESTER –V/VI

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. *Azotobacter* as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

SUGGESTED READINGS
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-8: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (THEORY)
SEMESTER –V/VI
TOTAL HOURS: 60        CREDITS: 4

Unit 1          No of Hours: 8
Biosafety: Introduction; biosafety issues in biotechnology; Biological Safety Cabinets & their types; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms

Unit 2          No of Hours: 12
Biosafety Guidelines: Biosafety guidelines and regulations (National and International); GMOs/LMOs- Concerns and Challenges; Role of Institutional Biosafety Committees (IBSC), RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of International Agreements - Cartagena Protocol.

Unit 3          No of Hours: 4
AERB/RSD/RES guidelines for using radioisotopes in laboratories and precautions.

Unit 4          No of Hours: 12

Unit 5          No of Hours: 12

Unit 6          No of Hours: 12
Agreements and Treaties: GATT, TRIPS Agreements; Role of Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty on international recognition of the deposit of microorganisms; UPOV & Brene conventions; Patent Co-operation Treaty (PCT); Indian Patent Act 1970 & recent amendments.

DSE-8: BIOSAFETY AND INTELLECTUAL PROPERTY RIGHTS (PRACTICAL)
SEMESTER –V/VI
TOTAL HOURS: 60        CREDITS: 2

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

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
DSE-9: INSTRUMENTATION AND BIOTECHNIQUES (THEORY)
SEMESTER –V/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, ion-exchange 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


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-9: INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)
SEMESTER –V/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.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
7. Determination of $\lambda_{\text{max}}$ 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.

SUGGESTED READINGS

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
GE-1: INTRODUCTION AND SCOPE OF MICROBIOLOGY (THEORY)
SEMESTER –I

TOTAL HOURS: 60        CREDITS: 4

Unit 1 History of Development of Microbiology

Unit 2 Diversity of Microorganisms

Unit 3 Microscopy
Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluorescence Microscope, Transmission Electron Microscope, Scanning Electron Microscope.

Unit 4 Sterilization
Moist Heat, Autoclave, Dry Heat, Hot Air Oven, Tyndallization, Filtration.

Unit 5 Microbes in Human Health & Environment
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
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
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
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.
5. Sterilization of glassware using Hot Air Oven 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.
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
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
GE-2: BACTERIOLOGY AND VIROLOGY (THEORY)
SEMESTER – II

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
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
6. Study the morphological structures of viruses (DNA and RNA) and their important characters using electron micrographs
7. Study of the methods of isolation and propagation of plant viruses
8. Study of cytopathic effects of viruses using photographs

SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
GE-3: MICROBIAL 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, Batch culture, Continuous culture, generation time and specific growth rate
Temperature and temperature ranges of growth
pH and pH ranges of growth
Effect of solute and water activity on growth
Effect of oxygen concentration on growth
Nutritional categories of microorganisms

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: 16
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 4 Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation   No. of Hours: 6
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 5 Chemolithotrophic and Phototrophic Metabolism   No. of Hours: 10
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,
anoxic vs. oxygenic photosynthesis with reference to photosynthesis in green bacteria
and cyanobacteria

Unit 6 Nitrogen Metabolism - an overview   No. of Hours: 6
Introduction to biological nitrogen fixation
Ammonia assimilation
Assimilatory nitrate reduction

GE-3: MICROBIAL METABOLISM (PRACTICAL)
1. Study and plot the growth curve of *E. coli* by turbidimetric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of Nitrogen and Carbon sources on *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*.

**SUGGESTED READINGS**
GE-4: INDUSTRIAL AND FOOD MICROBIOLOGY (THEORY)
SEMESTER – IV

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction to Industrial microbiology
No. of Hours: 10
Brief history and developments in industrial microbiology
Types of fermentation processes - solid state, liquid state, batch, fed-batch and continuous
Types of fermenters – laboratory, pilot-scale and production fermenters
Components of a typical continuously stirred tank bioreactor

Unit 2 Isolation of Industrial Strains and Fermentation Medium
No. of Hours: 8
Primary and secondary screening
Preservation and maintenance of industrial strains
Ingredients used in fermentation medium - molasses, corn steep liquor, whey & Yeast extract

Unit 3 Microbial fermentation processes
No. of Hours: 12
Downstream processing - filtration, centrifugation, cell disruption, solvent extraction.
Microbial production of industrial products - citric acid, ethanol and penicillin.
Industrial production and uses of the enzymes - amylases, proteases, lipases and cellulases

Unit 4 Food as a substrate for microbial growth
No. of Hours: 9
Intrinsic and extrinsic parameters that affect microbial growth in food
Microbial spoilage of food - milk, egg, bread and canned foods

Unit 5 Principles and methods of food preservation and food sanitation
No. of Hours: 9
Physical methods - high temperature, low temperature, irradiation, aseptic packaging
Chemical methods - salt, sugar, benzoates, citric acid, ethylene oxide, nitrate and nitrite
Food sanitation and control – HACCP

Unit 6 Dairy products, probiotics and Food-borne Diseases
No. of Hours: 12
Fermented dairy products - yogurt, acidophilus milk, kefir, dahi and cheese
Probiotics definition, examples and benefits
Food intoxication by Clostridium botulinum and Staphylococcus aureus
Food infection by Salmonella and E.coli

GE-4: INDUSTRIAL AND FOOD MICROBIOLOGY (PRACTICAL)
SEMESTER – IV

TOTAL HOURS: 60        CREDITS: 2

1. Microbial fermentation for the production and estimation of amylase
2. Microbial fermentation for the production and estimation of citric acid
3. Microbial fermentation for the production and estimation of ethanol
4. Determination of the microbiological quality of milk sample by MBRT
5. Isolation of fungi from spoilt bread/fruits/vegetables
6. Preparation of Yogurt/Dahi
SUGGESTED READING
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)

GE-5: MICROBES IN ENVIRONMENT (THEORY)
SEMESTER – IV

TOTAL HOURS: 60        CREDITS: 4

Unit 1 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.

Unit 2 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, nematophagus fungi and symbiotic luminescent bacteria

Unit 3 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 4 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 5 Microbial Bioremediation
Principles and degradation of common pesticides, hydrocarbons (oil spills).

Unit 6 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

GE-5: MICROBES IN ENVIRONMENT (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 (28°C & 45°C).
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**
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
GE-6: MEDICAL MICROBIOLOGY AND IMMUNOLOGY (THEORY)
SEMESTER – IV

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,

Unit 2 Sample collection, transport and diagnosis
No. of Hours: 5
Collection, transport and culturing of clinical samples and their identification characteristics.

Unit 3 Bacterial diseases
No. of Hours: 3
List of diseases of various organ systems and their causative agents.

Unit 4 Viral diseases
No. of Hours: 3
List of diseases of various organ systems and their causative agents.

Unit 5 Protozoan diseases
No. of Hours: 2
List of diseases of various organ systems and their causative agents.

Unit 6 Fungal diseases
No. of Hours: 2
Brief description of various types of mycoses.

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

Unit 8 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

Unit 9 Antigens and Antibodies
No. of Hours: 7
Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes), Adjuvants, Structure, Types and Functions of antibodies.

Unit 10 Generation of Immune Response
No. of Hours: 6
Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response

Unit 11 Immunological Disorders and Tumor Immunity
No. of Hours: 5
Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice).

Unit 12 Immunological Techniques  
No. of Hours: 5
Principles of Precipitation, Agglutination, Immunodiffusion, Immunelectrophoresis, ELISA, ELISPOT.

GE-6: MEDICAL MICROBIOLOGY AND IMMUNOLOGY (PRACTICAL)  
SEMESTER –V
TOTAL HOURS: 60  CREDITS: 2

1. Identify bacteria 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. Identification of human blood groups.
6. To perform Total Leukocyte Count of the given blood sample.
7. To perform Differential Leukocyte Count of the given blood sample.
8. To separate serum from the blood sample (demonstration).
9. To perform immunodiffusion by Ouchterlony method.

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

GE-7: GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

SEMESTER –VI

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Introduction to genetic engineering
Milestones in genetic engineering and biotechnology
Restriction modification systems: Mode of action, 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: Use of linkers and adaptors
Transformation of DNA: Chemical method, Electroporation
Methods of DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting.

Unit 2 Vectors
Cloning Vectors: Definition and Properties
Plasmid vectors: pBR and pUC series
Bacteriophage lambda and M13 based vectors
Cosmids, BACs, YACs
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 DNA Amplification and DNA sequencing
PCR: Basics of PCR, RT-PCR, Real-Time PCR
Genomic and cDNA libraries: Preparation and uses, Genome sequencing
Sanger’s method of DNA Sequencing: traditional and automated sequencing

Unit 4 Application of Genetic Engineering and Biotechnology
Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium - mediated delivery
Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, flavo savo tomato, Gene therapy, recombinant vaccine, protein engineering

Unit 5 Intellectual Property Rights
Patents, Copyrights, Trademarks

GE-7: GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICAL)

SEMESTER –VI

TOTAL HOURS: 60        CREDITS: 2

1. Isolation of Plasmid DNA from E.coli
2. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
3. Ligation of DNA fragments
4. Interpretation of sequencing gel electropherograms
5. Designing of primers for DNA amplification
6. Amplification of DNA by PCR
7. Demonstration of Southern blotting

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

GE-8: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (THEORY)
SEMESTER – IV

TOTAL HOURS: 60        CREDITS: 4

Unit 1 Structures of DNA and RNA / Genetic Material
DNA structure, Salient features of double helix, Types of DNA, denaturation and renaturation, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure

No. of Hours: 10

Unit 2 Replication of DNA
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

No. of Hours: 6

Unit 3 Transcription
Transcription: Definition, promoter - concept and strength of promoter. Transcriptional Machinery and Mechanism of transcription.

No. of Hours: 6

Unit 4 Translation
Genetic code, Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides.

No. of Hours: 6

Unit 5 Regulation of gene Expression
Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons

No. of Hours: 5

Unit 6 Mutations
Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Uses of mutations, DNA repair mechanisms

No. of Hours: 9

Unit 7 Mechanisms of Genetic Exchange
Transformation - Discovery, mechanism of natural competence
Conjugation - Discovery, mechanism, Hfr and F’ strains
Transduction - Generalized transduction, specialized transduction

No. of Hours: 10

Unit 8 Plasmids and Transposable Elements
Property and function of plasmids, Types of plasmids. Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Uses of transposons and transposition.

No. of Hours: 8

GE-8: MICROBIAL GENETICS AND MOLECULAR BIOLOGY (PRACTICAL)
SEMESTER – IV

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. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A_260 measurement)
4. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
5. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).
6. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells
7. Study survival curve of bacteria after exposure to ultraviolet (UV) light
8. Demonstration of Bacterial Transformation and calculation of transformation efficiency.

SUGGESTED READINGS
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SE-1: Microbial Quality Control in Food and Pharmaceutical Industries
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 BSL-
1, 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, 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)

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 READING

   International Publishing House Pvt. Ltd.
   Pharmaceutical and Medical Devices, Taylor and Francis Inc.
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SE-2: MICROBIAL DIAGNOSIS IN HEALTH CLINICS
SEMESTER – IV

TOTAL HOURS: 30        CREDITS: 2

Unit 1 Importance of Diagnosis of Diseases
No of Hours: 5
Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis.

Unit 2 Collection of Clinical Samples
No of Hours: 5
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.

Unit 3 Direct Microscopic Examination and Culture.
No of Hours: 5
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.

Unit 4: Serological and Molecular Methods
No of Hours: 5
Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes

Unit 5: Kits for Rapid Detection of Pathogens
No of Hours: 5
Typhoid, Dengue and HIV, Swine flu

Unit 6: Testing for Antibiotic Sensitivity in Bacteria
No of Hours: 5
Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method,
Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

SUGGESTED READING

B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SE-3: BIOFERTILIZERS AND BIOPESTICIDES
SEMESTER – IV

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 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.

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 inoculum 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

# B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
## SE-4: FOOD FERMENTATION TECHNIQUES
### SEMESTER – IV

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<td>Definition, types, advantages and health benefits</td>
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<td><strong>Unit 2 Milk Based Fermented Foods</strong></td>
<td>Dahi, Yogurt, Buttermilk (Chach) and cheese: Preparation of inoculums, types of microorganisms and production process</td>
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<td><strong>Unit 3 Grain Based Fermented Foods</strong></td>
<td>Soy sauce, Bread, Idli and Dosa: Microorganisms and production process</td>
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<tr>
<td><strong>Unit 4 Vegetable Based Fermented Foods</strong></td>
<td>Pickels, Saeurkraut: Microorganisms and production process</td>
<td>4</td>
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<tr>
<td><strong>Unit 5 Fermented Meat and Fish</strong></td>
<td>Types, microorganisms involved, fermentation process</td>
<td>4</td>
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<tr>
<td><strong>Unit 6 Probiotic Foods</strong></td>
<td>Definition, types, microorganisms and health benefits</td>
<td>4</td>
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**Suggested Readings**
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SE-5: MANAGEMENT OF HUMAN MICROBIAL DISEASES
SEMESTER – IV

TOTAL HOURS: 30        CREDITS: 2

Unit 1 Human Diseases
Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections

Unit 2 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.

Unit 3 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.

Unit 4 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.

Suggested Readings
B.Sc (HONOURS) MICROBIOLOGY (CBCS STRUCTURE)
SE-6: MICROBIOLOGICAL ANALYSIS OF AIR AND WATER
SEMESTER – III/IV

TOTAL HOURS: 30        CREDITS: 2

Unit 1 Aeromicrobiology        No of Hours: 4
Bioaerosols, Air borne microorganisms (bacteria, Viruses, fungi) and their impact on human health and environment, significance in food and pharma industries and operation theatres, allergens

Unit 2 Air Sample Collection and Analysis        No of Hours: 7
Bioaerosol sampling, air samplers, methods of analysis, CFU, culture media for bacteria and fungi, Identification characteristics

Unit 3 Control Measures        No of Hours: 4
Fate of bioaerosols, inactivation mechanisms – UV light, HEPA filters, desiccation, Incineration

Unit 4 Water Microbiology        No of Hours: 4
Water borne pathogens, water borne diseases

Unit 5 Microbiological Analysis of Water        No of Hours: 7
Sample Collection, Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests

Unit 6 Control Measures        No of Hours: 4
Precipitation, chemical disinfection, filtration, high temperature, UV light

Suggested Reading