EWING CHRISTIAN COLLEGE, ALLAHABAD

(An Autonomous Constituent College of Allahabad University)

CENTRE FOR MICROBIOLOGY

I SEMESTER

Paper – I (INTRODUCTION, HISTORY AND SCOPE OF MICROBIOLOGY)

UNIT I

1. Introduction, of Microbiology
2. Contribution of Following scientists in the field of Microbiology:
   I. Antony Van Leeuwenhoek
   II. Louis Pasteur
   III. Robert Koch
   IV. Edward Jenner
   V. Joseph Lister, etc.

UNIT II

1. Concept of Eukaryotic and Prokaryotic cells,
2. General characteristics of Microorganisms

UNIT III

1. Classification of Microorganisms (Bacteria, Fungi and Viruses)
2. Structure and functions of various components of bacterial, fungi and viruses.

Unit IV

1. Effect of microorganisms on Human life
2. Different Branches in Microbiology and their scope

Paper – II (FUNDAMENTALS OF MICROBIOLOGICAL TECHNIQUES)

UNIT I Microscopy :

1. Principles of Microscopy
   (i) Magnification
   (ii) Resolving Power
2. Types and application of different types of Microscopes (Light and Electron Microscope)

UNIT II Staining and Staining Techniques:

1. Concept and History of Staining Techniques
2. Simple, Differential and special types of staining

UNIT III Sterilization Techniques

1. History and significance of sterilization
2. Types of sterilization techniques
3. Methods used in sterilization
4. Fractional sterilization and its uses.

UNIT IV Pure Culture Techniques:

1. Factors affecting microbial growth
2. Media and its types

3. Principal, application, merits and demerits of following techniques:
    I. Pour Plate Technique
    II. Spread Plate technique
    III. Streak Plate technique.
4. Other methods of microbial isolation

(PRACTICALS)

1. Introduction of Microbiology Laboratory Equipment, Apparatus and Glass wares
    a. Hot Air Oven
    b. Bacterial Incubator
    c. Autoclave
    d. Laminar Air Flow
    e. Inoculation Needle
    f. Distillation Plant
    g. Petri Plates etc.
2. Preparation of Cotton Plugs and its use.
3. Washing and Cleaning of glasswares
4. Basic knowledge of precautionary measures in Microbiology laboratory
5. Types, application and functioning of Microscope
6. Preparation and sterilization of various culture media (Nutrient Agar media and Potato Dextrose Agar Media).
7. Isolation of bacteria and fungi by pour plate, spread plate and streak plate methods
8. Different types of staining techniques (bacterial and fungal)
9. Sterilization techniques: Application and Principal of Autoclave and Hot Air Oven

II SEMESTER

Paper – I (Control of Microorganisms)

UNIT I Principle of Control:

1. Need and significance of control
2. Factors affecting control of Microorganisms
3. Mechanisms of Microbial Control

UNIT II Microbial Control (Physical Agents):

1. Different physical methods used for the control of microorganisms
    a. Temperature (High Temperature and Low Temperature)
    b. pH
    c. radiation (Ionizing and Non - Ionizing)
    d. Filtration and Centrifugation
    e. Osmotic pressure (salt and sugars)
2. Principle, mechanisms and significance of:
    a. Autoclave
    b. Hot air oven
    c. Ultra violet lamp
    d. HEPA filter

UNIT III Microbial Control (Chemical Agents):

1. Different chemical agents used for the control of microorganisms
    a. Phenol and Phenolics
    b. Alcohol
    c. Halogens
    d. Quaternary Ammonium Compounds
    e. Heavy metals
    f. Antibiotics and chemotherapeutic compounds
2. Merits and Demerits of Chemical agents and Oligodynamic action
3. Mechanisms of Microbial death by chemicals agents.
4. Concept of MIC and MBC

UNIT IV Microbial Control (Gaseous Agents)

1. General gaseous compounds used for microbial control
2. Merits and demerits of antimicrobial gaseous agents

Paper – II (MICROBIAL DIVERSITY AND TAXONOMY)

UNIT I Microbial Evolution:

I. The origin of life
II. The first self replicating entity: RNA world
III. The three domains of life – Bacteria, Archaea and Eucarya
IV. The endosymbiotic origin of Mitochondria and chloroplast.
V. Evolutionary Process

UNIT II

1. Introduction to Microbial Classification and Taxonomy
2. Phenetic Classification, Phylogenetic Classification and Genetic Classification
3. Numerical Taxonomy

UNIT III

1. Taxonomic Rank
2. Techniques for determining Microbial Taxonomy and Phylogeny
    I. Classical Characteristics
    II. Molecular Characteristics
3. Phylogenetic Tree

UNIT IV

1. The Major Divisions of Life
2. Higher Level Classification of *Eucarya*
3. The Prokaryotic Phylogeny and Diversity

PRACTICAL

1. Determination of Thermal Death Time and Thermal Death Point.
2. Effect of different pH on Microbial Growth.
3. Study on antibiotic production by dual culture method
4. Study of antibiotic production by agar well diffusion assay
5. Demonstration of oligodynamic action
6. Determination of Phenol Coefficient test

III SEMESTER

Paper – I (Microbial Metabolism)

UNIT I: Biomolecules and Bioenergetics

1. Bioenergetics: Biological system and general Laws of thermodynamics, concept of entropy, High energy bonds, biological oxidation and redox potentials
2. Structure and function of Biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids.

UNIT II: Metabolic pathways

1. Metabolism – Anabolism and Catabolism, structure and properties of ATP, Phosphorylation
2. Eukaryotic and Prokaryotic cellular components involved in microbial metabolism.
3. Metabolic pathways: Basic concept and design, Glycolysis, TCA cycle, Pentose Phosphate Pathway, Electron Transport Chain. Oxidative Phosphorylation

UNIT III: Enzymes and Enzyme Kinetics

1. Introduction to enzymes and coenzymes, units of enzyme activity, enzyme nomenclature and classification. Enzyme kinetics, Effect of substrate concentration on Michaelis Menten Equation, Determination of Km and its significance, effect of pH and temperature on rates of enzymes catalyzed reaction.
2. Enzyme inhibitors and their importance, chemical methods of active site studies, Introduction of multi substrate enzymes, allosteric enzyme and enzyme regulation, iso-enzymes, enzyme immobilization.

UNIT IV: Bacterial photosynthesis:

1. Classification of photosynthetic bacteria: anoxygenic photosynthetic bacteria, purple bacteria (purple sulphur bacteria, purple non sulphur bacteria, green bacteria, green sulphur bacteria), metabolism in photosynthetic bacteria. Photophosphorylation

Paper – II (Microbial Genetics)

UNIT I:

1. History and scope of Microbial Genetics, Law of Inheritance
2. Genome Organization - DNA – A, B, Z and Triplex DNA, RNA, organization of bacteriophage genome – PhiX174, lambda, T4.

UNIT II

1. Genome Replication, Prokaryotic and Eukaryotic Transcription, Transcript Processing,
2. Translation, Regulation of gene expression in prokaryotes and eukaryotes.

UNIT III

1. Mutations: DNA damage and Repair, Types of Mutation, Oncogenes and Tumor suppressor genes, Gene Disruption and Gene Targeting.
2. Transposable elements – classes of transposable elements, nomenclature of transposable elements, insertion sequences (IS elements), plasmids, vectors, cosmids

UNIT IV

1. Mechanism of recombination, Types of Recombination - General Recombination, Mismatch Repair, Gene Conversion, Site Specific Recombination.
2. Transduction: Generalized transduction, Abortive transduction, Specialized transduction, use of transduction in gene mapping.

3. Transformation: Competence, Mechanism of transformation, Transfection
4. Conjugation, The F- factor, High frequency recombination (Hfr) strains.

PRACTICAL

1. Screening and detection of various enzymes produced by microorganisms.
2. Sugar fermentation test
3. Catalase test
4. Starch hydrolysis test
5. Effect of pH and temperature on rates of enzymes catalyzed reaction.
6. Gelatin liquefaction test etc.
7. Gradiant plating for isolation antibiotic resistant mutant
8. Effect of UV as mutagenic agent
9. Replica plating for isolation of antibiotic resistant mutant
10. ONPG test for beta galactosidase activity
11. Estimation of proteins by Lawery's Method
12. Isolation of chromosomal and plasmid DNA
13. Transfer of resistant plasmid in bacteria

IV SEMESTER

Paper – I (General Bacteriology)

UNIT I

1. General characteristics and morphology of bacterial cell.
2. Outline of bacterial classification: Cultural, Morphological and Molecular Characteristics
3. General features of bacterial reproduction and recombination.

UNIT II

1. Nutritional requirements of bacterial cell
2. Bacterial Physiology
3. Genetics of bacterial cells

UNIT III

1. Importance of bacteria in Food, Agriculture, Medical, Environment and Industrial sectors
2. Culturable and unculturable bacteria

UNIT IV

1. Basic techniques for isolation and identification of bacteria from different samples.
2. Bacterial photosynthesis: Photosynthetic and Non Photosynthetic bacteria
3. Bacteria with unusual properties

Paper – II (General Virology)

UNIT I

1. General characteristics and morphology of viral particle.

2. Outline of virus classification: Morphological, Biochemical and Molecular Characteristics of viruses
3. General features of virus multiplication.

UNIT II

1. **Animal Virus:**
    i. General characteristics and structure of HIV
    ii. AIDS: Transmission, infection, multiplication, symptoms, pathogenesis, diagnosis and treatment of AIDS.

UNIT III

1. **Plant Virus:**
    i. General characteristics and structure of TMV
    ii. TMV: Transmission, infection, multiplication, symptoms, pathogenesis and control of Tobacco Mosaic Virus.

UNIT IV

1. **Bacterial Virus:**
    i. General characteristics and structure of Bacteriophage.
    ii. Multiplication of bacterial virus: Lytic and Lysogenic cycle

PRACTICAL

1. Isolation and identification of bacteria from various samples i.e. water, food and soil.
2. Study of various morphological types and arrangements of bacterial cells.
3. Study of various cultural characteristics of bacterial genera
4. Study of plant virus diseases (symptoms and control)
5. Isolation of coli phage by plaque forming technique
6. Yolk Sack Inoculation Technique
7. Study of animal virus diseases.

V SEMESTER

Paper – I (General Mycology and Phycology)

UNIT I

1. General characteristics and morphology of Algae and Fungi.
2. Outline of fungal classification: Cultural, Morphological and Molecular Characteristics
3. Outline of algal classification: Cultural, Morphological and Molecular Characteristics

UNIT II

1. Reproduction in fungi: Sexual, Asexual and Vegetative mode of reproduction in fungi.
2. Physiology of fungal and algal cells

UNIT III

1. Importance of fungi and algae in Food, Agriculture, Medical, Environment and Industrial sectors
2. Lichens and Mycorrhizal association

UNIT IV

1. Basic techniques for isolation and identification of fungi and algae from different samples.
2. Single Cell Proteins: its importance and application

Paper – II (Fundamentals of Food and Dairy Microbiology)

UNIT I:

1. Introduction and History of Food and Dairy Microbiology at global and national level.
2. Factors affecting growth of microorganisms in Food products.
3. Detection and enumeration of Microorganisms in food products.

UNIT II

1. Food spoilage and its types. Factors affecting spoilage of different types of foods.
2. Food Preservation by different (Physical, Chemical and Gaseous) methods.

UNIT III

1. Starter Cultures: Production of different dairy products.
2. Production of fermented food products.

UNIT IV

1. Food borne diseases.
2. Quality assurance of food products. National and International agencies for quality assurance of food products

Paper – III (Basics of Industrial Microbiology)

UNIT I:

1. History, Introduction and scope of Industrial Microbiology.
2. Fermentation: Types and application of different types of fermenters and fermentation process. SNS

UNIT II

1. Down Stream Processing: Extraction and purification of microbial metabolites.
2. Bio leaching: Microbial Extraction of Gold, Copper and other heavy metals.

UNIT III

1. Alcohol production: Preparation of medium, fermentation and recovery, Malt beverages: Production of Beer (Malting, Mashing and Finishing).
2. Industrial Production of vinegar, citric acid, lactic acid and Vitamins.

UNIT IV

1. Production of antibiotics (Penicillin, Tetracyclines, Chloramphenicol and streptomycin): Strain improvement for secondary metabolite production.
2. Production of amino acids and enzymes: L- Lysin, L- Glutamic acid, Pectolytic Enzymes, pectinases, Invertase, Lipases, Cellulases.

PRACTICAL

1. Isolation and identification of fungi (yeasts and molds) from various samples.
2. Study of selected animal and plant fungal disease
3. Microscopic examination of various fungal spores
4. Isolation and identification of algae from different samples

5. Study of normal microflora of various food products.
6. Isolation and identification of various spoilage causing bacteria and fungi.
7. Isolation and identification of various food borne pathogenic microorganisms.
8. Evaluation of Microbiological quality of food products by SPC, Yeast and Molds count and Coliform count.
9. Evaluation of microbiological quality of milk by DMC, MBR test and Rapid Platform Test.
10. Fractional sterilization of dairy products.
11. Screening and production of various bacterial enzymes.
12. Screening and production of antibiotics from bacteria and fungi.
13. Demonstration of Alcohol production in laboratory condition.

VI SEMESTER

Paper – 1 (Essentials of Agriculture Microbiology)

UNIT I:

1. Types and chemical composition of soil. Factors affecting fertility of soil.
2. Soil Microflora: factors affecting growth of microorganisms in soil.
3. Isolation and enumeration of Microorganisms from soil samples.

UNIT II

1. Bio- Geo Chemical Cycles (N, P, S and C cycle).
2. Symbiotic association in Soil microorganisms: Lichens, Mycorrhiza and symbiotic biological Nitrogen fixers
3. Asymbiotic and Associative biological Nitrogen fixation

UNIT III

1. Biofertilizers: Types and production of different types of biofertilizers.
2. Biopesticides: Types and production of different types of biopesticides.

UNIT IV

1. Soil borne microbial diseases (fungal, bacterial and viral).
2. Chemical and biological control of microbial diseases in soil.

Paper – II (Fundamentals of Medical Microbiology)

UNIT I:

1. History, introduction and scope of Medical Microbiology.
2. Koch's Postulates and Neo Koch's Postulates.
3. Origin and development of Normal human Microflora.

UNIT II

1. Cell injury and cellular adaptation, inflammation, haemodynamic disorders, neoplasia and healing.
2. Hematological disorders.
3. Basic hematological techniques, coagulation and bleeding disorders.

UNIT III

1. Immunology: Immunity, immunity response, antigen, antibody/immunoglobulin, antigen – antibody reaction, hyper sensitive reactions.
2. Concepts and process of vaccination and immunization

UNIT IV

1. Human diseases: Mode of transmission, diagnosis, symptoms, pathogenesis, treatment of:
    a. Tuberculosis
    b. Small Pox
    c. Candidiosis
2. Types and application of different types of antibiotics and other chemotherapeutic compounds.
3. Diagnostic techniques: Biochemical, Serological and molecular methods of diagnosis.

Paper III. (Basics of Environmental Microbiology)

UNIT I:

1. Organic Composting (definition, Process of Composting, Factors affecting the composting- microorganisms, soil and organic matter, role of compost), vermicomposting.
2. Biogas (benefits from Biogas plants, Feed Stock Material, Biogas Production: Solubilization, acetogenesis and methanogenesis), mechanism of methane formation, factors affecting methane formation.

UNIT II

1. Sewage (Waste Water Treatment): Sewage Microorganisms, BOD and COD estimation.
2. Small scale sewage treatment (Cesspool, Septic Tank), Large Scale Sewage Treatment (Primary, Secondary and tertiary treatment)

UNIT III

1. Biodegradation: biodegradation of petroleum, Microbial degradation of xenobiotics
2. Characteristics of microbial metabolism (enzymatic process, non enzymatic process)

UNIT IV

3. Microorganism in abatement of heavy metal pollution, heavy metal tolerance in microorganisms (algae, bacteria, actinomycetes, fungi and cyanobacteria.), bio filtration and bio deterioration.

PRACTICAL

1. Isolation and identification of various soil microflora
2. Isolation and identification of Rhizobium from root nodule.
3. Isolation and identification of Azotobacter from soil.
4. Isolation and identification of cellulose degrading bacteria
5. Isolation and identification of *Bacillus thuringiensis* from soil
6. Isolation of rhizospheric and phyllospheric microorganisms
7. Study of various soil borne microbial diseases.
8. Isolation and identification of pathogenic bacteria from sputum, mucus and urine.
9. Preparation of blood smear
10. Isolation and identification of haemolytic microorganisms
11. Determination of MIC and MBC of given chemical compound.
12. Detection of Coagulase enzyme
13. Determination of BOD and COD of given water body.
14. Air sampling for microbial isolation
15. Study of various air and water borne diseases.

16. Isolation and identification of heavy metal tolerant bacteria.

Skill Enhancement Course (Optional)
Title: Biofertilizer and Mushroom Cultivation

Unit A (10 lecture)

General Account of Microbes used as biofertiliser

Mechanism and factors of Microbial Nitrogen Fixation

Isolation and Cultivation of Nitrogen fixing microbes (Rhizobium, Azospirrilium, Azotobacter, Anabena, Mycorrhiza).

Concept of organizing farming, Biocomposting and vermicomposting

Unit B (10 lectures)

Introduction, history, nutritional and medicinal value of edible Mushroom, types of edible mushroom available in India (Volvariella, Pleurotus, Agaricus etc.)

Mushroom Cultivation technology (Preparation of Spawn, Multiplication, Mushroom bed preparation etc.)

Marketing of Biofertilizer and Mushroom

Practicals:

1. Isolation of Nitrogen fixing bacteria i.e. Rhizobium and Azotobacter.

2. Cultural and morphological identification of Nitrogen fixing bacteria.

3. Isolation of *Agaricus bisporus* under laboratory conditions

4. Spawn production using wheat as a substrate.