

## **B.Sc. First Year Semester – I Paper I .Fundamentals of Microbiology**

### **Credit - 1 1 Scope & relevance of Microbiology**

- i) Definition & concepts
- ii) Types of microorganism
- iii) Distribution of microorganisms in nature

### **2. Development of Microbiology as a Scientific Discipline**

#### **1.1 History**

- i) Early observation of microorganisms
- ii) Spontaneous generation conflict : Contribution of scientists
- iii) Recognition of the microbial role in diseases. Koch's postulates
- iv) Recognition of microbial role in fermentations.
- v) Discovery of microbial effects on organic and inorganic matter.
- vi) Pure culture concept.
- vii) Aseptic surgery

### **Credit – 2 General characteristics of microorganisms.**

#### **2.1 General principles ( Bacteria )**

- i) Taxonomic rank
- ii) Classification system
- iii) Numerical taxonomy
- iv) Major characteristics used in taxonomy. Morphological, Physiological, Immunological, Metabolic, Etiological. Compositions of proteins, composition of nucleic acids, hybridization, nucleic acid sequencing, identification of organisms based on 16srRNA sequencing, 16S rDNA sequencing
- v) Bergey's manual of systematic Bacteriology, General characteristics enlisting all parts with major characters & examples. ( Vol I to IV)

#### **2.2 General characteristics and classification of Viruses.(LHT system)**

#### **2.3 General characters of Fungi ( including yeasts )**

#### **2.4 General characters of Actinomycetes**

**2.5 General characters of Algae**

**2.6 General characteristics of Mycoplasma and Rickettsia.**

**2.7 General characteristics of Archaeobacteria**

**2.8 Introduction to Gnotobiology/ axenic life/ space microbiology.**

**Credit – 3 : 3.1 Microscopy**

**3.1 Properties of light**

- i) Definitions : Magnification, resolving power, depth of focus, focal length, numerical aperture.
- ii) Objectives Low , high & oil immersion.
- iii) Oculars : function, Huygenian, Ramsden, Hyperplane & compensating.
- iv) Condensers ; Abbe, variable focus condenser, parabolic & their functions.
- v) Iris diaphragm.

**3.2 Principles, construction using ray diagram, application and comparative study of :**

- i) Compound Microscope
- ii) Electron Microscope – SEM, TEM

**3.3 Principles, ray diagram & applications.**

- i) Phase contrast microscope.
- ii) Dark field microscope.
- iii) Fluorescent microscope.
- iv) Advanced applications of microscopes.

## Semester – I Paper II .General Microbiology I

### Credit – I Stains and dyes.

- i) Definition : stain, dye, chromogen, chromophore, auxochrome, acidic and basic stains, simple and differential staining. (Gram's and Acid fast staining ) , natural stains, mordant, decolourizer, counter stains.
- ii) Physicochemical basis of staining.
- iii) Fixatives and fixation of smears.
- iv) Staining of Fungi.

### Cultivation of microorganisms.

- i) Properties of a good culture medium.
- ii) Definition, concept, use and types of different culture media . Synthetic, non synthetic, natural, selective, differential, enriched , enrichment, assay, minimal, maintenance, and transport media.
- iv) Role of Buffers in culture media.
- v) Media used for cultivation of bacteria , fungi, actinomycetes, yeasts, algae and photosynthetic bacteria. ( at least two )

### Credit – II Cultivation of anaerobes

- i) Principle and examples.
- ii) Methods ( at least 2 )

### Pure culture techniques

- i) Development of pure culture
- ii) Sterilization, aseptic techniques, streak, pour and spread plate methods, single cell isolation.
- iii) Significance

### Control of Microbial Growth

- i) Pattern of Microbial death – concepts.
- ii) Sterilization by physical methods
  - High temperature, canning and pasteurization.
  - Low temperature.
  - Non ionizing and ionizing radiations.
  - Bacteriological filters.
- iii) Sterilization by chemical means;  
Disinfectants and antiseptics:

Effectiveness, mode of action & application.

Phenolics, alcohols, halogens, heavy metals, quaternary ammonium compounds, aldehydes.

- iv) Sterilization using gases  
sulfur dioxide, ethylene oxide, Beta propiolactone.
- v) Control of microorganisms using sugars, nitrates, organic acids .

### **Credit - III Structural Organization of microorganisms.**

#### **A] Fundamental categories of microorganisms.**

- i) Prokaryotic & Eucaryotic cell concepts and differential account

#### **B] Role of microorganisms:**

- 1.1 In agriculture : As biofertilizers, bioinsecticides, in soil improvement (texture , water holding capacity ) as geochemical agents, microbe plant interactions (phyllosphere, rhizosphere, mycorrhizal and nodule formation). Plant diseases : list of common plant diseases with their causative agents.
- 1.2 In human and animal health : list of common bacterial, rickettsial , fungal and viral diseases.( with causative agents ) in human beings, role of normal flora of human body, antibiotics, vaccines and antisera.
- 1.3 In industries : list of microbial products ( and producers ) produced on industrial scale, role of contaminants.
- 1.4 In food processing : list of common fermented food & milk products with their representative organisms. Food spoilage, list of organisms causing changes in texture, colour, aroma, taste & nutritional value of the food products. List of food poisoning & food infection causing microorganisms.

## B.Sc. First Year

### Semester II

#### Paper V Cytology and general Microbiology

##### Credit – 1 : 1. Bacterial morphology and ultra structure.

- 1.1 Cytology of a typical bacterial cell.
  - i) Morphology – size and arrangement of bacterial cells.
  - ii) Structure ,chemical compositions and functions of :
    1. Capsule and slime layer
    2. Cell wall : Gram positive and Gram negative bacteria
    3. Unit membrane
    4. Flagella : Arrangement, mechanism of flagellar movement, Chemotaxis, phototaxis, Magnetotaxis.
    5. Pili
    6. Ribosomes.
    7. Nuclear material, Mesosome
    8. Endospore – types, sporulating bacteria ,architecture of endospore, sporulation process , germination process.
    9. Reserved food material: Poly beta hydroxy butyric acid granules, glycogen and polyphosphate granules.
- 1.2 Bacterial cell division
  - i) Binary fission

##### Credit – 2 Nutritional Requirements

- i) Concept.
- ii) Common nutritional requirements – Energy sources, C, N, P, O,S, micronutrients, growth factors, water etc.
- iii) Classification on the basis of carbon and energy

##### Bacterial growth

- i) Concept of Growth
- ii) Definition
- iii) Bacterial growth curve
- iv) Phases of growth
- v) Mathematics of growth
- vi) Diauxy
- vii) Factors influencing bacterial growth ( temp, pH, oxygen and nutrients).
- viii) Synchronous growth

- ix) Continuous culture
- x) Measurement of bacterial growth

### **Credit – 3 Water purification**

- Sources of contamination.
- Disinfection of potable water supplies.
- Standards for potable water.
- Brief survey of water borne diseases & preventive measures.

### **Types of wastes**

- i) Characteristics of solid & liquid wastes
- ii) Solid waste treatment & useful byproducts
- iii) Solid waste disposal – composting & land filled technology
- v) Xenobiotics and biodegradation

### **Introduction to :**

- a) Bio-deterioration of paint , paper and textiles.
- b) Biosensors.
- c) Bioaugmentation
- d) Nano biotechnology
- e) Biohydrometallurgy
- f) Genetic engineering
- g) Enzymes and cell immobilization
- h) Bioinformatics
- i) Biostatistics

### **Introduction to metal – microbe interactions**

- a) Bioremediation
- b) Bioaccumulation
- c) Biosorption
- d) Bioprecipitation

**Semester II Paper VI. Basic Biochemistry and Microbial physiology**

**Credit – 1 Carbohydrates**

- i) Definition and classification.
- ii) Properties –optical and chemical.
- iii) Structure of glucose: ring structure, Haworth & fisher's projection, pyranoses , furanoses, isomers, mutarotation.
- iv) Triose, pentose, hexose, heptoses - examples & structures.
- v) Derived monosaccharides: glycosides, furano acids, sugar phosphates, uronic acids, sugar alcohol.
- vi) Disaccharides , glycoside linkage, lactose, maltose, sucrose.
- vii) Oligosaccharides – Trisaccharides, structure of raffinose.
- viii) Polysaccharides – Homo and heteropoly saccharides ,structures starch, cellulose, mucopolysacchrides.
- ix) Biological significance

**Lipids**

- i) Classification simple compounds.
- ii) Chemistry of fatty acids, unsaturated and saturated fatty acids, triglycerides, saponification alkyl ether phospho glycerides , sterols, cholesterol , prostaglandins, glycol lipids.
- iii) Function of lipids.

**Proteins**

- i) Classification based on properties of solubility & heat. coagulability. Fibrous, globular proteins and functions.
- ii) Protein structures ; conformation & configuration ,primary structure determination, secondary structure  $\pi$  - helix &  $\beta$  - pleated sheet, tertiary & quaternary structure.
- iii) Classification of amino acids : based on acid – base properties.
- iv) Properties of amino acids – solubility, ampholyte, Zwitterions isoelectric pH .
- v) Peptide bonds – Concepts of biological peptide bond formation, types.
- vi) Enzymes – Concepts, definition, nature , active site, properties, physico-chemical factors contributing to catalytic efficiency of enzymes

### **Nucleic acids**

- i) Structure of nitrogen bases & base pairing.
- ii) Structure of nucleosides & nucleotides, ribose, deoxyribose sugars.
- iii) DNA : properties, forms , structure, function as genetic material.  
Types of DNA
- iv) RNA : Structure, function, types (r-RNA, m-RNA, t-RNA )
- v) Comparative account of DNA & RNA.

**pH & buffers.** pH titration curve,  $P_K$  value.

### **Credit – 2**

#### **Anaerobic respiration :**

$NO_3$  ,  $SO_4$  and  $CO_2$  as electron acceptors.

#### **Bacterial photosynthesis :**

- i) Photosynthetic bacteria,
- ii) Photopigments and associated carriers,
- iii) Photosynthetic apparatus and its mechanism
- iv) Cyclic and non cyclic photophosphorylation ,
- v) Calvin cycle, and reductive carboxylic acid cycle for  $CO_2$  fixation.
- vi) Differences between bacterial and plant photosynthesis.

### **Credit – 3**

#### **Uptake of nutrients**

- i) Passive diffusion
- ii) Facilitated diffusion
- iii) Active transport mechanism.
- iv) Group translocation
- v) Uptake of amino acids and metals



**B.Sc. First Year**  
**Paper III .Practical [ Credit 1.5 ]**

- 1) Microscopy :
  - i) Different parts of a compound microscope.
  - ii) Use and care of compound microscope .
  - iii) Visit to see an electron microscope .
- 2) Construction , operation and utility of laboratory equipments
  - i) Autoclave
  - ii) Hot air oven
  - iii) Incubator
  - iv) pH meter
  - v) High speed centrifuge
  - vi) Colorimeter/ spectrophotometer
  - vii) Anaerobic jar
  - viii) Bacterial Filters
  - ix) Laminar air flow.
- 3) Demonstration of presence of bacteria from – soil/ water/ air/ milk
- 4) Demonstration of yeast, fungi, actinomycetes, algae, protozoa
- 5) Microscopic examination of bacteria:
  - i) Monochrome staining
  - ii) Negative Staining
  - iii) Gram's Staining
- 6) Hanging drop technique to demonstrate bacterial motility
- 7) Micrometry
- 8) Qualitative tests for:
  - i) Carbohydrates – Benedict's test.
  - ii) Protein – Biuret test.
  - iii) Nucleic acid – Diphenylamine(DNA) and orcinol (RNA)tests

## **Paper IV .Practical [Credit 1.5 ]**

Project work

## **Paper VII Practical [Credit 1.5 ]**

- 1) Structural staining –
  - ◆ Bacterial flagella by Patel, Kulkarni and Gaikwad method
  - ◆ Capsule staining – Maneval’s method.
  - ◆ Cell-Wall staining- Chance’s method.
  - ◆ Spore staining – Schaefer &Fulton’s method.
  - ◆ Lipid (PHB) granule staining- Burdon’s method.
  - ◆ Metachromatic granule staining- Albert and Neusser’s method.
  - ◆ Preparation of culture media.
    - i) Nutrient broth and agar
    - ii) MacConkeys broth and agar..
    - iii) Sugar media
    - iv) Potato dextrose agar
    - v) Blood agar
    - vi) Photosynthetic bacterial growth medium
- 2) Sterility checks for Autoclaving
- 3) Isolation of microorganisms from :
  - i) Air
  - ii) Water
  - iii) Soil
  - iv) Milk
- 4) Isolation of bacteria from mixed cultures ( streak plate method)
- 5) Cultivation of Anaerobes
- 6) Effect of physical and chemical agents on growth of bacteria.
  - i) pH
  - ii) Temperature.
  - iii) Heavy metal ions (oligodynamic action)
  - iv) UV rays.
  - v) Antibiotics.

**Paper VIII .Practical [ Credit 1.5 ]**

**Desk assignment**