

UNIVERSITY OF MUMBAI



REVISED SYLLABUS

FOR

FIRST YEAR B.Sc.

(MICROBIOLOGY)

(with effect from the Academic Year 2002 – 2003)

MICROBIOLOGY

PAPER I

	<u>No of lectures</u>
<u>FUNDAMENTALS OF MICROBIOLOGY</u>	(85)
I. INTRODUCTION TO MICROBIOLOGY	(3)
(a) The scope and relevance of Microbiology.	
(b) fields of Microbiology.	
(c) Discovery of Micro-organisms. Spontaneous generation versus Biogenesis (self study).	
(d) Position of Micro-organisms in the living world.	
2. PROCARYOTIC CELL STRUCTURE AND FUNCTION	(15)
(a) Size, shape and arrangement of bacterial cells.	
(b) Micrometry.	
(c) Structures external to the cell wall.	
(d) Cell wall.	
(e) Structures internal to the cell wall.	
(f) Spores and cysts.	
(g) Comparison of pro and eucaryotic cells (Tabular and diagrammatic).	
3. MICROBIAL NUTRITION AND CULTIVATION OF MICRO-ORGANISMS	(8)
(a) Nutritional requirements.	
(b) Major nutritional types of micro-organisms and their cultivation.	
(c) Common ingredients, culture media and types of media.	
(d) Physical conditions required for growth	
4. ISOLATION AND PURE CULTURE	(6)
(a) Natural Microbial populations (Mixed cultures).	
(b) Selection methods.	
(c) Concepts of pure culture Techniques.	
(d) Study of cultural characteristics.	

5. GROWTH CURVE AND MEASUREMENT OF MICROBIAL GROWTH (8)

- (a) Normal growth curve with respect to bacteria, growth phases, and their significance (no calculations)
- (b) Quantitative measurement of growth

6. SAFETY IN LABORATORIES (4)

- (a) General safety measures
- (b) Chemical, Physical, Biological hazards.
- (c) Spillage and waste disposal.
- (d) First aid.

7. MICROBIAL ECOLOGY (5)

- (a) Micro-organisms and components of the environment
- (b) Microbial associations with relevant examples.

8. STUDY OF VARIOUS GROUP OF MICRO-ORGANISMS (36)

Classification (Tabular), Morphology, Cultivation, Reproduction (No cycles) and Significance of,

- (a) Yeast and Molds.
- (b) Algae
- (c) Protozoa
- (d) Rickettsia
- (e) Chlamydia
- (f) Actinomycetes
- (g) Archaeobacteria
- (h) Viruses

For details see next page:

(a) Yeast and Molds:

Diagrams of *S.cerevisiae*, *Penicillium*, *Aspergillus*, *Rhizopus* and *Mucor*
For self study and journal: Life cycle of *Saccharomyces* and *Rhizopus*)

(b) Algae:

Morphology -diagram Prescott (4th) -542
Cynobacteria - Brock Pg. 654 -658
Self study & Journal- Diagram Asexual reproduction of *chlamydomonas* -Pelczar 5th

(c) Protozoa:

Morphology with respect to *Amoeba* & *Paramaceium*
Self study & Journal diagram -Life cycle of *E.histolytica* -Chattetjee.

(d) Rickettsia:

(Self-study & Journal- Tabulation of
Rickettsial diseases with vectors etc.

(e) Chlamydia:

Only General characters.

(f) Actinomycetes:

Prescott -(4th) -507 -510
Self-study & Journal: Commercial importance of *Arctinomycetes*.

(g) Archaeobacteria:

Characteristics of major groups of *Archaeobacteria* -(Prescott (4th) Page 427) .
Self-study & Journal: A short note on *Methanogenic Archaeobacteria*.

(h) Viruses:

General characteristics, structure of T4 phage, Viral classification, Cultivation of viruses,
Viral inclusion bodies and their significance
Life cycle of coliphage -lytic & lysogenic

LIST OF BOOKS FOR PAPER I

1. J.R..Norris & D. W .Robbills Methods in Microbiology (1971) Vol.II. Academic Press.
2. A.H. Patel-Industrial Microbiolgy -1985 -Macmillan India Ltd.
3. A.D. Chatterjee -Parasitology -1981 -Chatterjee Medical Publishers.
4. Pelezar. JR. Microbiology -Tata McGraw-Hill
5. Cruickshank. R..Duguid J.P. -Medical Microbiology Vol-II 1973. ELBS/Churchill Livingstone
6. S. N.Jogdand -Advances in Biotechnology -Himalaya Publication.
7. A.J .Salle -Fundamental Principles of Bacteriology
8. Presott. Harley, Klein -Microbiology 4th Edn. International Edn.1999 McGraw Hill.
9. Talaro K.P. and Talaro A. -Foundations in Microbiology III International Edn 1999 McGraw Hill.
10. Brock -Biology of Microorganisms 8th Edn. Prentice Hall International.
11. Dubey -Text book of Biotechnology 1999- S.Chand & Company
12. Plummer -Introduction of Practical Biochemistry 2nd Edn. 1979 -Tata McGraw Hill.

MICROBIOLOGY

PAPER II

ESSENTIALS OF MICROBIOLOGY (85)

1. **MICROSCOPY** (20)

- a) Principles of optics
- b) Historical aspects of development of a microscope.
- c) Compound optical microscope -
Construction and functions of parts, Ray diagram of path of light,
Objectives, Oculars, Condensers, Sources of illumination.
- d) Modifications of compound optical Microscope -
Dark field, Phase contrast, Fluorescent, Confocal Microscope -Principle,
Construction, ray diagram, applications.
- e) Electron Microscopy:
TEM and SEM- Principle, construction, ray diagram and applications.

2. **PREPARATION OF MICRO-ORGANISMS FOR MICROSCOPIC OBSERVATION** (10)

a) For Light Microscope:

Fixation, Dyes and simple staining,
Differential staining (Gram's staining, Acid fast staining, Polychrome)
Staining specific structures (Capsule, cell wall, endospores, reserve material,
Nuclear material, flagella, spirochactes).

b) For Electron Microscopy:

Principle and Techniques

3. CONTROL OF MICRO-ORGANISMS

(10)

- a) Definitions of frequently used term and dynamics of disinfection.
- b) Difference between sterilization and disinfection.
- c) Properties of an ideal disinfectant.
- d) Types of disinfectants: Listing, mechanism, advantages and disadvantages and applications
- e) Evaluation of a disinfectant:
Inhibition coefficient, phenol coefficient RWC
Tissue Toxicity Index
- f) Sterilization:
Physical methods:
 - i) Dry and moist heat, mechanism, instruments used and their operations.
 - ii) Electromagnetic radiations: Ionizing radiations, mechanisms of sterilization, Advantages and disadvantages.
 - iii) Bacteria proof filtration: Types of filters and their operations, advantages and disadvantages.

4. A REVIEW OF CHEMISTRY OF BIOMOLECULES

(34)

A) Introduction

(2)

- a) Major and minor bioelements and their function in microbes-
tabular presentation
- b) Types of compounds, the bonds present and their importance:
 - i) Inorganic compounds -Electrovalence
 - ii) Organic compounds -Covalence, condensation reaction bonds
(i.e. ester bonds, phosphate ester bonds, thio ester bonds,
peptide bonds, glycosidic bonds), hydrogen bond..

B) General considerations:

(2)

- a) Configuration and conformation (Definitions)
- b) Water - structure and its interaction with solute-
hydrogen bonding, ionic interaction, hydrophobic interaction,
van der waai interaction (in general)

C) Elementary knowledge of biomolecules

a) Carbohydrates:

(5)

Definition, biological importance and classification based on number of sugar units.

- i) Monosaccharides:
Triose (aldo triose-glyceraldehyde), tetrose (eryturose), yribose), hexose (aldo hexose -glucose, Ketonexose -fructose: their pyranose and furanose forms, alpha and beta forms)

Student must know the structure (D-configuration) of sugars given in parenthesis.

- ii) Oligosaccharides:
Nature of glycosidic bond and constituent monosaccharide
Lactose, maltose, sucrose.

Student must know the structure of above disaccharides

- iii) Polysaccharides:
Nature of bonds involved in polymerisation and constituent sugars involved: glycogen, starch, cellulose.

Self study: General structure and biological role of carbohydrates such as galactose, mannose, cellobiose..

b) Proteins:

(10)

- i) Definition and biological importance
ii) General properties of proteins
iii) Chemistry of proteins -amino acids as building block, structure of alpha -amino acids, list of important properties and different types of amino acids (with one example from each type).
IV) Structure of proteins -primary, secondary, tertiary and quaternary (only outline) with one example of each-principle bonds involved in polymerisation of basic buiding blocks and in determination of final molecular structure.

v) Catalytic protein,-Biocatalyst -

A special reference -

Definition of enzyme, substrate, cofactor, prosthetic group, apoenzyme, holoenzyme, specificity general properties of enzymes, factors affecting enzymic activity (enzyme and substrate concentration, pH, temperature. activator, inhibitor -General. no kinetics). classification of enzymes- six groups with one example only.

c) Lipids: (4)

i) Definition and biological importance

ii) Classification in tabular form (as per 'Biochemistry' 2nd Ed. 1984 By Lehninger Page 278 -280).

iii) Fatty acids -general properties, general tonnulae of saturated (palmitic and stear~c acid) and unsaturated (oleic, cis-vaccinic), fatty acids.

iv) PHB (Polyhydroxy-butyrate)

d) Nucleic acids: (6)

i) Definition and biological importance

ii) Structure of nucleic acids -nucleosides, nucleotides, phosphodiester bond, major groove, minor groove ,

iii) List of important properties

iv) Salient structural features of single stranded and double stranded DNA

v) RNA -significance of messenger, transfer and ribosomal RNA.

e) Essentials of Genetics: DNA -A Genetic Code (5)

5. MICROBE -HUMAN INTERACTIONS (6)

a) The Human Host:

Human as a habitat: Resident and indigenous flora of new borns and specific regions of the human body-

b) Germ free animals

c) Anatomy of an infection:

Detinition of Pathogenicity, virulence and infection

Types of pathogens, Portal of entry

Mechanism of invasion and establishment of the pathogen, Types of infections.

6. BIOTECHNOLOGY

(5)

Introduction -
Exploitation of micro-organisms by humans in (at least two examples each)
Waste water treatment
Agriculture
Bioenergy production
Medicine, Industry, Environment

List of Books for Paper II:

Gottschalk, G. (1985), Bacterial Metabolism, 2nd Ed. Springer -verlag

Frobisher, Hinsdill, Crabtree, Goodheart, Fundamentals of Microbiology, 9th Ed.
Sannners College Pub.

Lehninger, Nelson, Cox (1993), Principlcs of Biochem 2nd Ed. CBS Publishers &
Distributors

Conn, Stumpf, Nriemomg, Doi (1995) Outline of Biochem 4th & 5th Ed., John Wiley &
Sons

Hartl & Jones, Essential Genetics

PRACTICALS BASED ON PAPER I

PRACTICAL I

1. **Safety in Laboratory**
2. **Assignment:**
Contributions of a scientist to the field of Microbiology (Two hand-written pages of the journal)
3. **Nutrition and Physiological parameters for growth of Micro-Organisms.**
 - (a) Minimal growth requirements of bacteria
 - (b) Effect of pH, temperature, osmotic conditions, desiccation and surface tension on growth of bacteria..
 - (c) Effect of buffers on growth of bacteria.
4. **Preparation of culture media:**
 - (a) Liquid media -Peptone water, Nutrient broth.
 - (b) Solid media -Nutrient agar, Sabouraud agar, Super Imposed Blood Agar(Demonstration)
 - (c) Preparation of butts, slants, plates
 - (d) Aseptic transfer of liquid media
 - (e) Construction and working of an autoclave
5. **Inoculation techniques and study of growth:**
 - (a) Inoculation of liquid media
 - (b) Inoculation of solid media
 - (i) Butts (ii) Motility test agar
 - (iii) Slant (iv) Plate (spot inoculation, streak inoculation, streak isolation; surface spreading -spreader and swab, Bulk seeding)
 - (c) Study of colony characteristics
6. **Cultivation of Micro-Organisms:**
 - (a) Cultivation of yeast -Sabouraud agar
 - (b) Fungi -Liquid media (Static and shake flask)
Solid media -Sabouraud agar
Slide culture technique
Study of morphological characteristics of Penicillium, Aspergillus, Rhizopus and Mucor-coverslip preparation.
 - (c) Enrichment of BGA, observation of wet mounts and permanent. slides of BGA.
 - (d) Observation of permanent slides of Protozoa -Amoeba and Paramoecium

- (e) Cultivation of Actinomycetes
- (f) Demonstration of viral cultivation: coliphage -Plaque formation,
- (g) Use of differential, selective and enriched media for cultivation of bacteria: MacConkey's agar, Centrimide agar, Salt mannitol agar, Super imposed blood agar.
- (h) Construction and working of an incubator.

7. **Preservation of cultures:**
 Serial subculture, oil overlay, soil stock, use of low temperature, lyophilization (Demonstration).

8. **Measurement of Microbial growth:**

- (a) Growth curve (Group Experiment)
- (b) Construction and working of a colorimeter
- (c) Cell count (Haemocytometer)
- (d) Packed cell volume (Yeast)
- (e) Construction and working of a centrifuge
- (f) Preparation of opacity tubes, comparison of bacterial culture to determine the approximate cell count
- (g) Measurement of cell activity -(Acidity in glucose broth using pH paper)
- (h) Serial dilution technique and viable count
- (i) Surface spreading method (ii) Pour plate method

9. **Micrometry:**
 Measurement of dimensions of a yeast cell

10. **Microbial Ecology:**

- (a) Crowded plate (Soil)
- (b) Synergistic association between bacteria
- (c) Symbiotic association between,
- (j) Plant and bacteria -Root nodule bacteria: Microscopic observation of crushed nodule
- (k) Fungi and algae: Lichen -Microscopic observation.

PRATICALS BASED ON PAPER II

PRACTICAL II

1. **Morphology and cytology of Micro-organisms:**
 - (a) Monochrome staining
 - (b) Negative staining
 - (c) Differential staining: Gram's staining
 - (d) Staining of specific structures of bacteria: cell wall, capsule, metachromatic granules, lipid granules, endospores, nuclear material, flagella, spirochaetes

2. **Construction and working of the hot air oven and bacteria proof filters**
 - (a) Determination of efficacy of the above by culture techniques
 - (b) Use of U- V lamp for sterilization
 - (c) Effect of gaseous sterilant on airflora of an enclosed cabinet
 - (d) Effect of chemical sterilant (alcohol) on bacteria
 - (e) Effect of dyes on bacterial growth
 - (f) Effect of heavy metal (copper) on bacterial growth
 - (g) Evaluation of a disinfectant -Phenol coefficient (Demonstration)

3. **Qualitative tests for Biomolecules:**
 - (a) Carbohydrates: Reducing sugars (Benedict's), Carbohydrates (Molisch)
 - (b) Proteins: Biuret
 - (c) Amino acids: Ninhydrin
 - (d) Enzymes: Dehydrogenase, catalase, alpha-amylase, urease, tryptophan-indole lyase, phenylalanine pyruvate amino transferase
 - (c) Nucleic acids: RNA (Orcinol), DNA (DPA)

4. **Study of normal flora of human body:**
 - (3) Skin
 - (b) Upper Respiratory tract
 - (c) Gastro intestinal tract

5. **Biotechnology:**
 - (a) Preparation of a biofertilizer
 - (b) Preparation of yogurt
 - (c) Agar strip and agar streak methods
 - (d) Production of fungal SCP or Production of mushrooms
 - (e) Leavening of bread or Wine making
 - (f) Detection of amino acid producers (soil)
 - (g) Immobilization of amylase producing fungi (*Aspergillus* spp) on sponge and demonstration of activity
 - (h) Degradation of phenol in wastewater by micro-organisms (Qualitative -amino antipyrine)