

SYLLABUS UNDER AUTONOMY

MICROBIOLOGY

SEMESTER I

COURSE : S.MIC.1.01

MICROBIAL STRUCTURES

[45 LECTURES]

LEARNING OBJECTIVES:

1. Awareness of basic aspects of Microbiology
2. Associate the fundamental aspects with applied
3. Develop analytical skills
4. Think in a critical & creative manner
5. Develop communication & presentation skills
6. Expertise over basic lab techniques

UNIT I: PROCARYOTIC CELL STRUCTURE , FUNCTION AND STAINING [15 Lectures]

- 1. Members of the Microbial World – (3 Lecs.)**
 - i. The universal Phylogenetic tree
 - ii. Discovery of Micro-organisms
 - iii. Overview of Procaryotic Cell Structure: Size, Shape, Arrangement, Micrometry
 - iv Diagram of Procaryotic cell organization
- 2. Cell Wall Structure and Gram Stain – (3 Lecs.)**
- 3. Cell Membrane: Bacterial and Archaeal - (2 Lecs.)**
- 4. Cytoplasmic Matrix – (3 Lecs.)**
 - i. Cytoskeleton, Nucleoid, Plasmids,Ribosome
 - ii. Inclusion granules: Composition, Function and Staining
- 5. Components External to Cell Wall - (3 Lecs.)**
 - i. Capsule, Slime, S-layer, Demonstration
 - ii. Pili, Fimbriae
 - iii. Flagella: Structure, Motility, Chemotaxis, Staining
- 6. Bacterial Endospore (1 Lec.)**
 - i. Examples of spore forming organisms, habitats, function, staining
 - ii. Formation and Germination

ACTIVITY: Draw Table to include: names, morphology, arrangement, Gram nature with diagrams and kind of motility for each of 15 common microbes

UNIT II : EUKARYOTIC CELL STRUCTURE AND FUNCTION [15 lectures]

- 1. Overview of eukaryotic cell structure: General structure and types of cells. -** (1Lec.)
- 2. External Cell coverings and Cell Membrane -** (2 Lecs.)
- 3. Cytoplasmic Matrix -** (7 Lecs.)
 - i. Cytoskeleton
 - ii. Organelles of the Endocytic, Biosynthetic and Secretory pathways – Endoplasmic reticulum, Golgi complex, Lysosomes, Endocytic, Biosynthetic and Secretory pathways, Vesicles, and Ribosomes
 - iii. Double Membrane organelles – Nucleus, Mitochondrion and Chloroplast
 - iv. Peroxisomes
- 4. Organelles of motility – Structure and movement of flagella and cilia** (2 Lecs.)
- 5. Eucaryotic cell cycle and Cell division – Mitosis and Meiosis –** (2 Lecs.)
- 6. Comparison of Procaryotic and Eucaryotic cells - Structure & Function (1 Lec.)**

Self – Study: To draw typical diagrams of Algae, Fungi, Yeast and Protozoan cells

UNIT III : MICROSCOPY [15 lectures]

- 1. History of the Microscope –** (1Lec.)
- 2. Lenses and bending of Light -** (1Lec.)
- 3. Light Microscopy –** (5 Lecs.)
 - i. Bright field Microscopy: Objectives, Eyepiece, Condenser
 - ii. Microscopic Resolution, Magnification, Numerical Aperture, Focal Length, Working distance, Depth of Focus
 - iii. Specimen Preparation and Staining
- 4. Dark Field Microscopy -** (1Lec.)
- 5. Phase Contrast and Differential Interference Contrast Microscopy -** (1 Lec.)
- 6. Fluorescence Microscopy -** (1 Lec.)
- 7. Electron Microscopy: TEM & SEM and Specimen preparation –** (3 Lecs.)
- 8. Newer Techniques in Microscopy -** (1 Lec.)
 - i. Confocal Microscope
 - ii. Scanning Probe Microscope

Student activity: History of the Microscope, Different types of Light Microscopes other than those mentioned above, Draw or Google Images of microbes using all of the above Microscopes

C.I.A Quiz

Diagram – Label the structure & give function

Model of plant or animal cell

SEMESTER I

COURSE : S.MIC.1.02

ELEMENTS OF MICROBIAL NUTRITION, GROWTH & CONTROL

[45 LECTURES]

LEARNING OBJECTIVES:

1. Awareness of basic aspects of Microbiology
2. Associate the fundamental aspects with applied
3. Develop analytical skills
4. Think in a critical & creative manner
5. Develop communication & presentation skills
6. Expertise over lab techniques

UNIT I- MICROBIAL NUTRITION, CULTIVATION, ISOLATION AND PRESERVATION [15 lectures]

Overview of Microbiology to understand the significance [2 lectures]

1. Nutritional requirements- Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulphur and Growth factors [1 lecture]
- 2 Nutritional types of microorganisms [2 lectures]
- 3 Nutrient uptake mechanisms [2 lectures]
- 4 Types of culture media with examples [3 lectures]
- 5 Isolation of microorganisms and pure culture techniques [3 lectures]
- 6 Preservation of microorganisms [2 lectures]

UNIT II- MICROBIAL GROWTH [15 lectures]

- 1 Definition of growth, Mathematical expression, Growth curve [3 lectures]
2. Measurement of Growth [5 lectures]
 - i) Direct Microscopic count- Breeds, Petroff-Hausser counting chamber, Haemocytometer

- ii) Viable count- Spread plate and Pour plate technique, Membrane filtration
- iii) Electronic Counting
- iv) Measurement of cell mass
- v) Turbidity measurements- Nephelometer and spectrophotometer techniques
- vi) Measurements of cell constituents.
- 3 Synchronous growth, Continuous growth (chemostat and turbidostat), Diauxic growth [1 lecture]
- 4 Growth Yield [1 lecture]
- 5 Influence of environmental factors on growth [1 lecture]
- 6. Microbial growth in natural environments [1 lecture]
- 7. Counting viable non-culturable organisms-Quorum sensing techniques [1 lecture]

UNIT III- CONTROL OF MICROORGANISMS

[15 lectures]

- 1 Definitions of Frequently used terms [1 lecture]
- 2 Pattern/Rate of Microbial Death [1 lecture]
- 3 Conditions influencing the effectiveness of Antimicrobial agents [1 lecture]
- 4 Physical Methods of Microbial Control [5 lectures]
 - i) Heat: Moist and Dry ii) Low temperature
 - iii) Filtration iv) High pressure
 - v) Desiccation vi) Osmotic pressure
 - vii) Radiations
- 5 Chemical methods of Microbial Control [5 lectures]
 - i) Phenolics ii) Biguanides-Chlorhexidine
 - iii) Alcohols iv) Halogens
 - v) Heavy Metals vi) Quaternary ammonium compounds
 - vii) Surface active agents viii) Aldehydes
 - ix) Sterilizing gases x) Peroxygens
 - xi) Chemotherapeutic agents
- 6 Evaluation of effectiveness of Antimicrobial agent [1 lecture]

C.I.A – QUIZ

PROBLEM SOLVING

SEMESTER II

COURSE : S.MIC.2.01

MICROBIAL DIVERSITY AND SIGNIFICANCE

[45 LECTURES]

LEARNING OBJECTIVES:

1. Awareness of basic aspects of Microbiology
2. Associate the fundamental aspects with applied
3. Develop analytical skills
4. Think in a critical & creative manner
5. Develop communication & presentation skills
6. Expertise over lab techniques

UNIT I: PROCARYOTIC CELL DIVERSITY [15 lectures]

- 1. Microbial Evolution and Origins of life –** (1 Lec.)
- 2. Classification systems in Procaryotes –** (1 Lec.)
Taxonomy based on Bergey's Manual
- 3. Procaryotic groups with unusual characteristics –** (5 Lecs.)
 - i. Photosynthetic Bacteria: Cyanobacteria, Green and Purple sulphur bacteria
 - ii. Gliding bacteria
 - iii. Rickettsia and Chlamydia
 - iv. Actinomycetes
- 4. Archaea –** (2 Lecs.)
 - i. Classification
 - ii. Significance
- 5. Viruses, Virioids & Prions –** (6 Lecs.)
 - i. Structure
 - ii. Reproduction
 - iii. Cultivation
 - iv. Classification

**Self Study: Comparison between Bacteria, Archaea and Viruses
Commercial applications of Archaea.**

UNIT II : EUCARYOTIC CELL DIVERSITY [15 lectures]

- 1. Overview of eukaryotic cell diversity -** (2 Lecs.)
 - i. Three Domains of Life
 - ii. Endosymbiotic theory
- 2. Types of Eucaryotic cells -** (12 Lecs.)
 - i. Fungi: Molds and Yeasts
 - ii. Algae
 - iii. Protozoa
- 3. Morphological characteristics, Classification, Reproduction and Significance**
Student activity – (1 Lec.)
Compare and Contrast between
 - i. Bacteria, Archaea & Eucaryotes
 - ii. Molds and Yeasts
 - iii. Algae , Protozoa & Fungi
 - iv. Fungi & Bacteria
 - v. Fungi & Actinomycetes

**UNIT III : INTRODUCTION TO MICROBIAL ECOLOGY AND
MICROBIAL BIOTECHNOLOGY - [15 Lectures]**

1. Principles of Microbial Ecology (10 Lecs.)

- i. Ecological concepts (3 Lecs.)
 - a. Species diversity in habitats
 - b. Microbial ecosystems and biogeochemical cycling-microorganisms as beginning and end of every energy pyramid.
 - c. Biofilms and microbial mats
- ii. Microorganisms on land and in water & extreme environments (2 Lecs.)
- iii. Types of Microbial interactions - (2 Lecs.)
 - a. Mutualism, Cooperation, Commensalism, Predation, Amensalism, Competition
 - b. Mycorrhizae, rumen symbiosis, legume-*Rhizobium* association
- iv. Microbe-human interactions - Normal flora of humans - (3 Lecs.)
- v. Microbe-plant interactions, Microbe –animal interactions-

STUDENT ACTIVITY: Tabulate -plant diseases and their pathogens, animal diseases and their pathogens.

2. Microbial Biotechnology (5 LECTURES)

- i. Introduction to applied microbiology and biotechnology
- ii. Microorganisms in food-beneficial effects and detrimental effects
- iii. Industrial microbiology-products from microorganisms-metabolites, enzymes, pharmaceuticals, fuels, biopolymers - a list
- iv. Microorganisms and agriculture- biopesticides, biofertilizers
- v. Bioremediation- oil spills and waste water treatment
- vi. Impact of Biotechnology and ethics

SELF STUDY: List five enzymes of industrial importance, their sources and applications.

C.I.A – Quiz

Presentations

SEMESTER II

COURSE : S.MIC.2.02

INTRODUCTION TO MICROBIAL METABOLISM & MOLECULAR BIOLOGY [45 LECTURES]

LEARNING OBJECTIVES:

1. Awareness of basic aspects of Microbiology
2. Associate the fundamental aspects with applied
3. Develop analytical skills
4. Think in a critical & creative manner
5. Develop communication & presentation skills
6. Expertise over lab techniques

UNIT I : CHEMISTRY OF CELLULAR COMPONENTS – [15 lectures]

- 1. Atoms, Bonds & Molecules: -** (2 Lecs.)
Types of atoms - Elements & their properties
Bonds & Molecules
- 2. Water -** (4 Lecs.)
- 3. Non- informational macromolecules:-**
 - i) Carbohydrates – sugars & polysaccharides - (4 Lecs.)
 - ii) Lipids – Fats, Phospholipids & Waxes - (3 Lecs.)
 - iii) Amino acids & Peptide bonds - (2 Lecs.)

UNIT II : INFORMATIONAL MACROMOLECULES & INTRODUCTION TO METABOLISM [15 lectures]

- 1. The Nucleic acids –** (5 Lecs.)
RNA& types, DNA
- 2. Proteins –** (3 Lecs.)
Primary & secondary structures & higher order structures
- 3. Biocatalysts –** (4 Lecs.)
 - i) Definition of enzymes, & ribozymes
 - ii) Effect of pH, temperature, enzyme concentration, substrate concentration, and inhibitor
 - iii) Cofactors & allosteric enzymes
- 4. Introduction to metabolism –** (3 Lecs.)
 - i) Linking of catabolism & anabolism
 - ii) Role of ATP & reducing power
 - iii) Mechanism of fermentation, respiration & photosynthesis
 - iv) Substrate level, Oxidative and Photophosphorylation

UNIT III : MOLECULAR BIOLOGY & INTRODUCTION TO BIOINFORMATICS [15 lectures]

- 1) Genes & chromosomes, plasmids, DNA as genetic material & double helical structures of DNA, Flow of genetic information (Central dogma of Molecular Biology) -** (3 Lecs.)

- 2) Replication of DNA - (1 Lec.)
- 3) Gene structure & transcription - (3 Leecs.)
- 4) Genetic code & translation - (4 Leecs.)
- 5) Introduction to bioinformatics - (1 Lec.)
- i) Definitions of bioinformatics, genomics, proteomics, metabolomics
- ii) Illustrative example & exercises

C.I.A – QUIZ

MODEL/SHORT PRESENTATIONS

CHART LINKING TRANSCRIPTION & TRANSLATION WITH CHEMOTHERAPY

BIBLIOGRAPHY:

TEXT BOOKS FOR COURSES 1.01 & 2.01

1. Prescott, Harley, Klein- Microbiology 6th and 7th International edition 2006 & 2007 McGraw Hill.
2. Kathleen Park Talaro and Arthur Talaro- Foundations in Microbiology 4th International edition 2002, McGraw Hill.
3. Cruickshank, Duguid, Marmion, Swain- Medical Microbiology, 12th ed Vol II., Churchill Livingstone
4. Collee, Duguid, Fraser, Marmion –Mackie and McCartney Practical Medical Microbiology, 13th ed , Vol II, Churchill Livingstone

REFERENCE BOOKS FOR COURSES 1.01 & 2.01

1. Michael.T.Madigan, John.M.Martinto- Brock Biology of Microorganisms 11th edition international edition 2006 Pearson Prentice Hall
2. Tortora, Funke, Case Microbiology –An Introduction, 8th ed. Pearson Education.

TEXT BOOKS FOR COURSES 1.02 & 2.02

1. Prescott, Harley, Klein- Microbiology 6th and 7th International edition 2006 & 2008 McGraw Hill.
2. Kathleen Park Talaro and Arthur Talaro- Foundations in Microbiology 4th International edition 2002, McGraw Hill.
3. Stanier, Ingraham et al, General Microbiology- 4th and 5th edition 1987, Macmillan education limited.
4. Lehninger, Principles of Biochemistry, 4th edition. D. Nelson & M. Cox. W.H.Freeman & Co. New York 2005
5. E. Conn, P. Stumpf, G.Bruening & R. Doi. Outlines of Biochemistry 5th edition. John Wiley & sons. New York. 1999
6. Attwood T.K., Parry- Smith D.J., Phukan Samiron Introduction to bioinformatics by Attwood Pearson Education 2007

REFERENCE BOOKS FOR COURSES 1.02 & 2.02

1. Michael.T.Madigan, John.M.Martinto- Brock Biology of Microorganisms 11th edition international edition 2006 Pearson Prentice Hall
2. Pelczar Jr,Chan, Krieg Microbiology-Concepts and Applications, International ed, McGraw Hill

PRACTICALS

SEMESTER I

COURSE : S.MIC.1.PR

PRACTICAL 1.

1. Safety Rules to be followed in the Microbiology Laboratory
2. Assignments on –
 - i) Contributions of one Scientist of the Golden Era
 - ii) Experiments that refuted the belief in Spontaneous Generation
3. The Light Microscope –
 - i) Diagram of Path of Light through Compound Microscope
 - ii) Working Rules
4. Monochrome staining of bacteria
5. Negative staining and Micrometry
6. Gram staining of bacteria
7. Staining of Cell components – Cell wall, Capsule, Metachromatic & Lipid granules, Endospores; Demonstration-Nucleus staining.
8. Staining of Flagella and Spirocheates
9. Motility by Hanging drop technique
10. Staining of Yeasts
11. Permanent slides of Algae, Protozoa
12. Wet mount of Hay Infusion and Pond water for observing bacterial, algal and protozoan forms.

C.I.A – Assignment/Microscopic/Staining technique

PRACTICAL 2.

1. Preparation of culture medium:
 - a) Liquid medium (Nutrient broth)

- b) Solid media (Nutrient agar, Sabouraud agar)
 - c) Preparation of slants, butts and plates
2. Inoculation Techniques:
- a) Liquid medium
 - b) Solid media (slants, butts and plates)
 - c) Study of Colony Characteristics
 - d) Study of Motility (Hanging drop preparation)
 - e) Use of differential, selective and enriched media
 - (i) MacConkey's agar
 - (ii) Superimposed blood agar
3. Determination of optimum growth conditions (Temperature, pH)
4. Cultivation of yeasts and molds:
- a) Cultivation on Sabouraud agar
 - b) Static and Shaker cultures
 - c) Slide-Culture Technique
5. Measurement of Microbial growth
- a) Microscopic cell count (Haemocytometer, Breed's Count)
 - b) Preparation of opacity tubes and determination of cell count.
 - c) Viable count (Pour plate and surface spread)
 - d) Growth curve of *E. coli* and determination of generation type (Grp.Expt)
 - e) Diauxic Growth - Demonstration
6. Physical methods of control of microorganisms:
- a) Heat: Autoclaving, Fractional sterilization, Dry heat.
 - b) Bacteria proof filtration (Demonstration of Membrane filtration)
 - c) Effect of U-V rays
 - d) Effect of desiccation.
 - e) Effect of high osmotic pressure
3. Chemical Methods of Control of microorganisms:
- a) Effect of phenolics (Disc Method)
 - b) Oligodynamic action
 - c) Tween 80
 - d) Dyes (Disc Method)
 - e) Chemotherapeutic agents

CIA- Viable count/Tube dilution technique

SEMESTER II

COURSE : S.MIC.2.PR

PRACTICAL 1

1. Gram stain of Actinomycetes – *Nocardia*
2. Permanent slides of Cyanobacteria
3. Wet Mount of *Aspergillus*, *Penicillium*, *Mucor* & *Rhizopus*

4. Permanent slides of *Spirogyra*, *Spirulina*, *Euglena*, *Diatoms*
5. Observations of Plaques on a lawn of host cells
6. Setting up Winogradsky's column- study of different types of microorganisms
7. Study of microorganisms in soil and water
8. Study of extremophiles- isolation of halophiles from sea water/ dried fish
9. Study of *Rhizobium* –legume symbiosis, isolation of *Rhizobium* (production of biofertilizer)
10. Study of normal flora
11. Study of microorganisms in food- curd and idli batter
12. Production of amylase and its immobilization
13. Wine production
14. Bread making
15. Mushroom cultivation – demonstration

Assignment on Diversity of Micro-organisms

Students will record in the pages of the journal a list of all microbes studied in Theory and Practicals. These organisms will be grouped according to classification studied in theory. The record will include a representative well labelled colour diagram and the function of the organism in ecology.

Assignment on PROBIOTICS.

TABLE ACTIVITY: Small exhibition on FERMENTED FOODS.

CIA- Assignments / Isolation techniques

PRACTICAL 2.

1. Qualitative tests for Proteins, Carbohydrates, Nucleic Acids & Lipids
2. Study of Enzymes
Isolation of Amylase, Casease, Urease, Catalase & Lipase Producers
3. Effect of Temperature and pH on Amylase Activity

Assignment: Metabolism/ Genetics

CIA- Assignment / Isolation technique

REFERENCES :

1. Practical Microbiology, R.Vasanthakumari, BI Publications 2009.
2. Microbiology, A Laboratory Manual, 7th ed, Cappucino and Sherman, Pearson Education
3. An Introduction to Practical Biochemistry, 3rd ed, David Plummer, Tata McGraw Hill
4. Microbiological Applications, A Laboratory Manual in General Microbiology, 5th ed, Harold Benson.