Study Module

Module for B.SC. (Hons) in Microbiology under choice based credit system (CBCS)

Distribution of Marks in Semester 1

Introduction to Microbiology and Microbial Diversity (Theory and Practical) credit = 6.

Internal Assessment Th + prac = (10+5) = 15
End semester Exam Th + prac = (10+5) = 15

CC1 Theory 4 credits

Introduction to Microbiology and Microbial Diversity

Unit 1: History and development of Microbiology:

Theory of Spontaneous generation, Germ theory of disease. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich Martinus, W. Beijerinck, and Sergei N. Winogradsky in the field of Microbiology. An overview of the Scope of Microbiology.

- History and development of Microbiology
  Definition of Microbe, Microbiology and miroscope
  Different parts of Microscope and it's use
  Different unit use in Microbiology
  Theory of spontaneous generation, Germ theory of disease. (3 hours)

- Early history, Starting of Microbiology, Transition period, Classical golden age, The second golden age of Microbiology, Third golden age of Microbiology, Challenges. (4 hours)

- Contribution of some renound scientist in detail: Antony Von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Edward Jenner, Paul Ehrlich, Martinus W. Beijerink, Sergei N. Winogradsky. (4 hours)

- Scope of Microbiology

  Teaching, Research, Medical, Agriculture, Food, Environment, Industry. (4 hours)

Unit 2: Diversity of Microbial world

Systems of classification: Basic idea about Haeckel's and Whittaker's kingdom concept and domain concept of Carl Woese, General characteristics and representative members of different groups:

Cellular microorganisms (Archaea, Bacteria, Algae, Fungi and Protozoa)

Acellular entity (Viruses, Viroids, Virusoids, Satellite viruses, Prions)

- Origin of life, why stable bacterial classification is yet impossible, definition of taxonomy, identification, nomenclature, classification. (2 hours)
- Two kingdom concept of Linnaeus, three kingdom concept of Hackel and Whittaker's three kingdom concept, Differences of prokaryotic and Eukaryotic microorganism, Differences of bacteria and Archaea, Domain concept Carl Worse. (2 hours)

- ***Cellular Organism***

Archaea: General character, Systematic position, how it differ from true bacteria, special feature of cell wall, cell membrane, extremophilic characters different groups and economic importance.

(2 hours)

Bacteria: Definition, General character, Differences from eukaryotic organism, Economic importance

(2 hours)

Algae: Definition, General character, How it differ from bacteria and fungi, Economic importance

(2 hours)

Fungi: Definition, General character, reproduction, Economic importance (2 hours)

Protozoa: Definition, General character, reproduction, Economic importance (1 hours)

- ***Acellular Organism***

Virus: why virus is called acellular organism

General character, types, structure, reproduction, assay, Economic importance (2 hours)

- Viroids, virusoids, satellite virus, prions
  Definition, special feature, disease caused (2 hours)

Unit 3: Microscopy

Principle and application of Bright Field Microscope, Dark Field Microscope, Phase Contrast

Microscope, Transmission Electron Microscope and Scanning Electron Microscope.

- Different parts of compound Microscope, Magnification, numerical aperture, resolution, How image is formed, common difficulties in Microscope (3 hours)
- Principle and application of
  Bright field, Dark field Microscope. (1 hours)
  Phase contrast. (1 hours)
  Electron Microscope – SEM, TEM. (2 hours)

Unit 4: phycology

General characteristics of algae including occurrence (habitat), thallus organization, cell ultra-structure, pigments, flagella, eyespot, food reserves (reserve foods) and reproduction in Chlorophyta and Xanthophyta. Economic Importance of algae.

General characteristic of algae in cooperative account of the following group

Cyanophyta, Chlorophyceae, Rhodophyceae, Phaeophyceae, Xanthophyceae, Bacillariophyceae

- Habitat and thallus organization
- Cell structure (2 hours)
- Pigments, Eye spot, Food reserve (1 hours)
- Reproduction, Life cycle pattern (1 hours)
- Economic importance (1 hours)

Chlorophyceae: Salient feature, distribution, thallus organization, cell ultrastructure, reproduction types life cycle pattern alternation of generation, Economic importance (3 hours)

Xanthophyceae: Salient features, distribution, thallus organization, cell ultrastructure, reproduction, Differences from chlorophyceae, similarity with chlorophyceae and fungi (3 hours)

Unit 5: Mycology

General characteristics of fungi including habit, habitat, nutritional requirements, thallus organization and aggregation, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic importance of fungi.

- Salient feature of fungi, Similarities and Differences from algae (1 hours)
- General Characteristic of fungi in cooperative account of the following group:
  Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes
  Habitat, thallus organization, cell ultrastructure and aggregation, types of septum. (3 hours)
  Nutritional requirement, asexual reproduction. (3 hours)
  Sexual reproduction, fruit body types and development and dispersal. (3 hours)
  Heterokaryosis, heterothallism, dikaryotization, parasexual mechanism. (2 hours)
  Economic importance. (3 hours)

Unit 6: Protozoa

Life Cycle of Amoeba, Paramecium, Plasmodium. Economic importance of Protozoa.

General Characteristic of Protozoa. (3 hours)

Life cycle of *Amoeba, Paramecium , Plasmodium* (6 hours)

Economic importance of Protozoa. (3 hours)

Total = 75 hours

CC1 Practical credits = 2

Introduction to Microbiology and Microbial Diversity

1. Microbiology Laboratory Management and Bio-safety (2+2+2 hours)

To make them aware about laboratory glass ware and how to handle those (2 hours)

2. To study the principle and applications of instruments (autoclave, incubator, hot air oven, centrifugation, light microscope, pH meter) used in the microbiology laboratory. (6 hours)
3.Preparation of culture media (Nutrient Broth and Nutrient Agar) for bacterial cultivation (6 hours)

4. Sterilization of medium using Autoclave and assessment for sterility (6 hours)
5. Sterilization of glassware using Hot Air Oven. (6 hours)
6. Sterilization of heat sensitive material by filtration. (6 hours)
7. Isolation and enumeration of bacteria from air, water and soil. (18 hours)
8. Study of Rhizopus, Penicillium and Aspergillus from permanent slides. (6 hours)
9. Study of Spirogyra and Chlamydomonas from permanent slides. (4 hours)
10. Study of Paramecium and Plasmodium from permanent slides. (4 hours)

Total = 70 hours

CC2 Theory 4 credits

Unit 1: Cell organization

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, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), Spheroplast, protoplast, 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.

- Classification of bacteria on the basis of shape size and arrangement. (1 hours)
- Glycocalyx and capsule. (2 hours)
- Flagella and Endoflagella. (2 hours)
- Fimbriae Pili. (1 hours)

- Cell wall – Definition, Position detail structure and chemical composition of Gram-positive and Gram-negative cell wall. (2 hours)
- Archaeal cell wall, Sphaeroplast, Protoplast, L-form, effect of antibiotic and enzyme on cell wall, function of cell wall. (2 hours)
- Staining of cell wall Gram and acid fast. (2 hours)
- Cell membrane: Position, structure and chemical composition, function, archaeal cell wall (2 hours)
- Cytoplasm, Ribosome, mesosome, Gas Vesicle, magnetosome, chlorosome, caboxysome (2 hours)
- Reserve material, nucleoid, chromosome, plasmid. (2 hours)
- Endospore: Classification, Structure, Formation. (2 hours)

Unit2: Bacteriological Techniques

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

- Pure culture – Definition, Axenic culture, serial dilution, streaking method, spread method, pour method. (2 hours)
- Cultivation maintenance preservation – short term, long term, utility of preservation, criteria of preservation. (2 hours)
- Cultivation of anaerobic bacteria. (2hours)
- Accessing non culturable bacteria. (1 hours)

Unit 3: Nutrition

Nutritional requirements in bacteria and nutritional categories; Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, acid-base indicator, enriched media

- Nutrition types: Classification of microbes on the basis of nutritional requirement. (2 hours)
- Types of nutrient Micro and Macro, Growth factors, Auxotrophs, Prototrophs. (2 hours)
- Culture media – Definition, Components, Criteria
  Classification – I) Basis on chemical composition- Natural, Synthetic, Semi synthetic (2 hours)
  II) Basis of physical state – Solid and liquid
  III) Utility purpose – Selective, differential, acid base, enriched (3 hours)

Unit 4: Control of Microorganism

Physical methods of microbial control: heat, low temperature, filtration, desiccation, osmotic pressure, radiation Chemical methods of microbial control: types and mode of action

- Definition – Bacteriostatic, cidal and lytic agent, sterilization, disfection, sanitization, antiseptics, tindallization. (1 hours)
- Condition influencing the efficiency of antimicrobial agents, death rate of microbes, mode of action of antimicrobial agent (1 hours)
- Physical sterilizing agent-
  Heat (low and high) – function of each type, limitation. (2 hours)
  Filtration, desiccation, osmotic pressure – types, mode of action, limitation. (2 hours)
  Radiation – types, mode of action, limitation. (1 hours)
- Chemical agent- (4 hours)
  History of use, criteria of an ideal chemical antimicrobial agent, selection of a chemical agent for particular application. Evaluation of effectiveness of disinfectants.
  Mode of action, types, use and limitation of following chemical agents – alcohol, phenolics, ethylene oxide, formaldehyde, halogen.

Unit 5: Growth and Reproduction in Bacteria

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate

- Asexual reproduction. (2 hours)
- Steps of binary fission. (1 hours)
- Mechanism of binary fission. (2 hours)
- Phages of growth. (2 hours)
- Logarithmic representation of bacterial population, generation time, specific growth rate. (3 hours)

Unit 6: Bacterial systematics

Aim and principles of classification, taxonomy, concept of species, taxa, strain; Characters used in bacterial systematic.

- Aims and Principle. (2 hours)
- Concept of taxonomy, species, taxa, strain. (1 hours)
- Bergey's manual and Bacterial classification. (4 hours)
- Characters used in Bacterial classification. (2 hours)

Unit 7: Important Archaeal & Bacterial Groups

Archaea: Different physiological groups, suitable example and economic importance.

Bacteria: General characteristics & economic importance with suitable example of the following groups:

Gram Negative: Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Delta proteobacteria, Epsilon proteobacteria, Zeta proteobacteria.

Gram Positive: Low G+ C (Firmicutes), High G+C (Actinobacteria).

Cyanobacteria

- Cyanobacteria – Salient features, distribution, organization of thallus cell structure, reproduction, Economic importance. (3 hours)
- Gram positive low GC + High GC – Salient features, morphology, Reproduction, pathogenicity, economic importance. (3 hours)
- Gram negative – Salient features of proteobacteria (alpha, beta, delta, epsilon, zeta) and nonproteobacteria. Economic importance, representative genera, pathogenic aspect (3hours)
- Archaea – General character, major physiological groups,economic importance, How it differ from bacteria, extremophilic characters. (3 hours)

Total= 78 hours

CC2 Practical 2 Credit

1. Preparation of different media: synthetic media (BG-11), Complex media Tryptic soy agar, Differential and Selective media (Mac-Conkey agar, EMB agar). (20 hours)

- Microscope setting. (11 hours)

2. Simple staining. (4 hours)

3. Negative staining. (4 hours)

4. Gram's staining. (4 hours)

5. Acid fast staining-permanent slide only. (2 hours)

6. Endospore staining. (4 hours)

7. Isolation of pure cultures of bacteria by streaking method. (8 hours)

8. Preservation of bacterial cultures (slant / stab). (4 hours)

9. Estimation of CFU count by spread plate method/pour plate method. (10 hours)

10. Motility by hanging drop method. (4 hours)

Total = 75 hours

STUDY MODULE

B.Sc. Honours Course in Microbiology under CBCS pattern

Semester	Course Code	Course Title	Units	No. of Hours	Assigned Teacher
II	CC-3 (Th)	**Biochemistry**	1. Bioenergetics • First and second laws of Thermodynamics. • Definitions of Gibb's Free Energy, enthalpy and Entropy; mathematical relationship among them, • Standard free energy change and equilibrium constant Coupled reactions • additive nature of standard free energy change, • Energy rich compounds: Phosphoenolpyruvate and ATP 2. Carbohydrates • General properties and classification of carbohydrates, • families of monosaccharides: structural concept of aldoses and ketoses, trioses, tetroses, pentoses, and hexoses (glucose and fructose). • Stereo isomerism of monosaccharides, epimers and anomers of glucose, Mutarotation, optical isomerism. • Furanose and pyranose forms of glucose and fructose, • sugar derivatives, glucosamine, galactosamine, muramic acid, N- acetyl neuraminic acid, • Disaccharides: concept of reducing and non-reducing sugars, occurrence; • Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose and peptidoglycan. 3. Lipids • Fatty acids: definition, types, structures and functions, essential fatty acids. • Lipid: definition, nomenclature and classification • triacyl glycerols, phosphoglycerides,	2 4 1 1 2 1 1 4 2 1 1 2 2 1 1	SC SC SC_2

			• phosphatidylethanolamine, phosphatidylcholine, sphingosine with functions	1	
			4. Proteins		
			• Functions of proteins,	1	SC
			• Primary structures of proteins: Amino acids- the building blocks of proteins.	1	
			• General formula of amino acid and concept of zwitterion.	1	
			• Titration curve of amino acid and its significance,	1	
			• Classification, biochemical structure and notation of standard protein amino acids. Ninhydrin reaction.	2	
			• Secondary structure of proteins: Peptide unit and its salient features.	1	
			• The alpha helix, the beta pleated sheet and their occurrence in proteins,	1	
			• Tertiary and quaternary structures of proteins	2	
			5. Enzymes		DN
			• Structure of enzyme: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme NAD, metal cofactors,	2	
			• Classification of enzymes,	1	
			• Mechanism of action of enzymes: active site, specificity,	1	
			• Enzyme kinetics, Michaelis-Menten equation and their transformations, Km and allosteric mechanism,	2	
			• Lock and key hypothesis, and Induced Fit hypothesis.	1	
			• Definitions – enzyme unit, specific activity and turnover number,	1	
			• Multienzyme complex : pyruvate dehydrogenase;	1	
			• isozyme: lactate dehydrogenase,	1	
			• Effect of pH and temperature, substrate concentration, enzyme concentration, time on enzyme activity.	1	
			• Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts, uncompetitive	2	
			6. Vitamins		
			• Classification and importance	2	SC_2

			7. Nucleic Acids • Purine, pyrimidine bases, • nucleoside, nucleotide-structure, properties. • Types of DNA and RNA	1 1 4	DN
II	CC3 (Pr)	**Biochemistry (Practical)**	1. Concept of pH and buffers, preparation of buffers – phosphate and acetate buffer. 2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars (DNS method) 3. Qualitative/Quantitative tests for proteins (Lowry method), amino acids (Ninhydrine), DNA(DPA) and RNA(Orcinol). 4. Qualitative/Quantitative assay of amylase. 5. Study the effect of temperature and pH on enzyme activity (amylase). 6. Estimation of Ascorbic acid.	2 2 6 3 2 2	SC & SC_2 or SC & SN
II	CC4 (th)	**Virology**	1. **Nature & Properties of Viruses** • Introduction: Discovery of viruses, • nature and general properties. • Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses • Isolation, purification and cultivation of viruses • Viral taxonomy: Baltimore Classification 2. **Bacteriophages** • Diversity, classification, • lytic and lysogenic cycle of lambda phage 3. **Viral Transmissions, salient features of Viral Nucleic acids & Reproduction** • Mode of viral transmission • Structure, Nucleic acid, Replication and Symptoms of : Adenovirus, Retrovirus, Hepatitis B virus, Influenza virus • Assembly, budding and maturation of HIV 4. **Viruses & Cancer** • Introduction to oncogenic viruses • Types of oncogenic DNA and RNA	1 1 2 2 2 2 4 1 8 2 1 1	SN DN DN SC

			viruses • Concepts of oncogenes and proto-oncogenes 5. **Prevention & Control of Viral Diseases** • Antiviral compounds and their mode of action • Interferon and their mode of action • General principles of viral vaccination 6. **Applications of Virology** • Use of viral vectors in cloning and expression and Gene therapy	2 1 1 1 3	 SN DN
II	CC4 (Practical)	**Virology (Practical)**	1. Study of TMV infection on Tomato plant induced by TMV infected tobacco extract. 2. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique 3. Study of one step phage growth curve using isolated bacteriophages. 4. Isolation of Bacteriophage DNA and study of its HindIII digestion pattern. 5. Report writing: Educational tour to Institute/ Industry.	2 3 4 1	AR & DN

SC - Subhendu Chakrabarty

AR - Anindita Roy

DN - Dipta Nag

SC_2 - Sukanya Chaki

SN - Sreyashi Nandi