

S.S. JAIN SUBODH P.G. (AUTONOMOUS) COLLEGE, JAIPUR

(Affiliated to University of Rajasthan)



**Syllabus
For**

**Bachelor of Science (Pass Course)
Subject: Microbiology**

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

I. Course Overview & Course Objectives

B.Sc. Microbiology is a full-time undergraduate program which is of 6 semesters (**3-years**) duration. This course primarily focuses on the microorganisms and their applications in the field of Research. This course aims to provide students a detailed study of microorganisms with the help of scientific tools such as microscopes, genetics, and culture.

B. Sc. Microbiology

Semester Structure: The details of the courses with code, title assigned is as given below.

Duration: 6 Semester (3 Years)

Semester-I

- 33121: Paper - I: Cell Biology
- 33122: Paper - II: Introduction to Microbiology
- 33123: Paper - III: Microbial Diversity -I
- 33124: Practical: Based on Theory Papers**

Semester II

- 33221: Paper - I: Microbial Diversity- II
- 33222: Paper - II: Bacteriology
- 33223: Paper - III: Molecular Biology
- 33224: Practical: Based on Theory Papers**

Semester III

- 33321: Paper - I: Microbial Diversity III
- 33322: Paper - II: Microbial Genetics
- 33323: Paper - III: Microbial Physiology
- 33324: Practical: Based on Theory Papers**

Semester IV

- 33421: Paper -I: Analytical techniques
- 33422: Paper-II: Immunology
- 33423: Paper-III: Biochemistry
- 33424: Practical: Based on Theory Papers**

Semester V

- 33521: Paper- I Medical Microbiology
- 33522: Paper- II Environmental Microbiology
- 33523: Paper -III Recombinant DNA Technology
- 33524: Practical: Based on Theory Papers**

Semester VI

- 33621: Paper -I Fermentation Technology
- 33622: Paper -II Food and Dairy Microbiology
- 33623: Paper -III Soil and Agricultural Microbiology
- 33624: Practical: Based on Theory Papers**

Semester Structure: The details of the courses with code, title assign are as given below.
Duration: 6 Semesters (3 Years)

B. Sc. Semester -I

Max. Marks (Theory): 150

(Practical):75

Nomenclature			External Theory	Internal Theory	Total Max. Marks	Total Mini. Marks
	Paper I	Cell Biology	35	15	50	20
	Paper II	Introduction to Microbiology	35	15	50	20
	Paper III	Microbial Diversity I	35	15	50	20
					150	
	Lab -	Practical based on Theory Paper	45	30	75	

B. Sc. Semester -II

Max. Marks (Theory): 150

(Practical):75

Nomenclature			External Theory	Internal Theory	Total Max.Marks	Total Mini.Marks
	Paper I	Microbial Diversity II	35	15	50	20
	Paper II	Bacteriology	35	15	50	20
	Paper III	Molecular Biology	35	15	50	20
					150	
	Lab -	Practical based on Theory Paper	45	30	75	

B. Sc. Semester -III**Max. Marks (Theory): 150****(Practical):75**

Nomenclature			External Theory	Internal Theory	Total Max.Marks	Total Mini.Marks
	Paper I	Microbial Diversity III	35	15	50	20
	Paper II	Microbial Genetics	35	15	50	20
	Paper III	Microbial Physiology	35	15	50	20
					150	
	Lab -	Practical based on Theory Paper	45	30	75	

B. Sc. Semester -IV**Max. Marks (Theory): 150****(Practical):75**

Nomenclature			External Theory	Internal Theory	Total Max.Marks	Total Mini.Marks
	Paper I	Analytical Techniques	35	15	50	20
	Paper II	Immunology	35	15	50	20
	Paper III	Biochemistry	35	15	50	20
					150	
	Lab -	Practical based on Theory Paper	45	30	75	

B. Sc. Semester -V**Max. Marks (Theory): 150****(Practical):75**

Nomenclature			External Theory	Internal Theory	Total Max.Marks	Total Mini.Marks
	Paper I	Medical Microbiology	35	15	50	20
	Paper II	Environmental Microbiology	35	15	50	20
	Paper III	Recombinant DNA Technology	35	15	50	20
					150	
	Lab	Practical based on Theory Paper	45	30	75	

B. Sc. Semester -VI**Max. Marks (Theory): 150****(Practical):75**

Nomenclature			External Theory	Internal Theory	Total Max.Marks	Total Mini.Marks
	Paper I	Fermentation Technology	35	15	50	20
	Paper II	Food and Dairy Microbiology	35	15	50	20
	Paper III	Soil and Agriculture Microbiology	35	15	50	20
					150	
	Lab	Practical based on Theory Paper	45	30	75	

SEMESTER –I

PAPER I - CELL BIOLOGY

Unit- I

Cell as a Basic unit of Living Systems: Discovery of cell, the cell Theory. Ultra structure of an eukaryotic cell- (Both plant and animal cells). Surface Architecture. Structural organization and functions of plasma membrane and cell wall of eukaryotes.

Unit -II

Cellular Organelles

Structure and functions of cell organelles – Endoplasmic reticulum, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nucleus (Nuclear envelope with nuclear pore complex, Nucleolus, Nucleoplasm and Chromatin).

Vacuole, Cytosol and Cytoskeleton structures (Microtubules, Microfilaments and Intermediate filaments).

Unit- III

Chromosomes: Discovery, Morphology and structural organization – Centromere, Secondary constriction, Telomere, Chromonema, Euchromatin and Heterochromatin, Chemical composition and Karyotype. Ultrastructure: Single-stranded and multi-stranded hypothesis, folded- fibre and nucleosome models. Special type of chromosomes: Salivary gland and Lampbrush chromosomes.

Unit -IV

Cell cycle: An overview of cell cycle; Components of cell cycle control system; Intracellular and Extra-cellular control of cell division. Elementary idea about Programmed cell death Apoptosis in relation with cancer.. Viral disease AIDS and Organ Transplants.

Essential Readings:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons.Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

Paper-II: INTRODUCTION TO MICROBIOLOGY

Unit -I

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Antony von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Role of microorganisms in fermentation, Germ theory of disease

Unit -II

Development of Microbial techniques- (Sterilization- Physical, chemical and radiation methods, microscopy ,staining techniques and micrometry). Golden era of microbiology. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Unit -III

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems.

Unit -IV

Morphological and differentiating characters and economic importance of microorganisms:

• Bacteria • Rickettsia • Protozoa • Algae • Fungi (Molds and Yeasts) • Viruses, viroids and prions.

Essential Readings:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company
2. General Microbiology, 7th edition, H S Schlegel, Cambridge University Press, 1995
3. Microbiology, 5th edition M J Pelezar, E C S Chan, N R Kreig, Tata Mc Graw Publication, 2006

Paper III - Microbial Diversity -I

Unit --I

Bacteria: Form and function of bacteria: Internal structure, Bacterial shapes and arrangement, cell membrane, cell wall of bacteria, Nucleoid, ribosomes, inclusion bodies, flagella, capsule, slime, fimbriae, and pilli. Bacterial endospores- structure, formation and germination. Economic importance of Bacteria.

Unit -II

Archaeobacteria: General characteristics, cell wall, phylogeny of Crenarchaeota (*Sulfolobus*, *Thermoproteus*) and Euryarchaeota [Methanogens (*Methanobacterium*, thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

Unit -III

The world of Bacteria- II: A brief outline of bacterial classification according to Bergey's manual of systematic bacteriology with salient features of the following:

Proteobacteria: alphaproteobacteria (Rickettsia), betaproteobacteria (Thiobacillus), gamma proteobacteria (Pseudomonas, E.coli), deltaproteobacteria (Myxococcus) and epsilonproteobacteria (Campylobacter); Non proteobacteria; Gram negative bacteria (cyanobacteria, purple and green photosynthetic bacteria)

Unit -IV

The world of Bacteria- II: A brief outline of bacterial classification according to Bergey's manual of systematic bacteriology second edition (2004) with salient features of the following:

Gram positive bacteria: firmicutes (*Mycoplasma*, *Staphylococcus* and *Streptococcus*), Actinobacteria (*Streptomyces*, *Mycobacterium*), *Chlamydiae*, *Spirochaetes*,

SUGGESTED READING

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw
5. Hill International.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General

Lab-Practicals Based on Theory Papers

1. Safety measures in Biotechnology laboratory
2. Cleaning and sterilization of glass wares
3. Microscopic Techniques :
 - a) Organization and working of optical microscopes: Dissecting and Compound Microscope
 - b) Principles of fixation and staining.
 - c) Micrometry
4. Study of structure of Prokaryotic and Eukaryotic cell.
5. To prepare the permanent slide using given material like plant stem, root and leaf.
6. To study the principle and applications of important instruments used in the Microbiology laboratory
 - Autoclave
 - Incubator,
 - BOD incubator,
 - Hot air oven,
 - Light microscope,
 - pH meter
 - Centrifuge
 - Spectrophotometer
7. Cell division: Mitotic and meiotic studies in onion root tips, grasshopper testes or flower Buds.
8. Preparation of polytene chromosomes from *Drosophila* salivary gland.
9. Study of Mitochondria in Buccal Epithelium

Semester II

Paper I- Microbial Diversity- II

Unit -I

Viruses: Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and prions. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses .Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit -II

Bacteriophages: General characteristics life cycles, lytic and lysogenic phages (lambda phage) regulation of transcription in lambda phage

Unit -III

Cyanobacteria: Introduction, general characteristics features and importance with special reference to genera *Nostoc* and *Oscillatoria*.

Unit -IV

Protozoa: General characteristics features with special reference to *Amoeba*, *Paramecium*, and *Plasmodium*

ESSENTIAL READINGS:

1. Biology of Microorganisms, 10th edition, T D Brock, M T Madigan, Pearson Education, Inc., 2003
2. General Microbiology, R Y Stanier, J L Ingharam, M L Wheelies, P R Painter, Mac Millan Education Ltd, 1999
3. Laboratory fundamentals of microbiology, I E Alcamo, Jones and Barlett Publishers, 2001
4. Microbiology, 6th edition, Prescott, Harley, Klein, Mc Graw Hill Companies, 2005
5. Microbiology, Fundamentals and Applications, 2nd edition, R M Atlas, Maxwell Macmillan International Edition, 1989

Paper II- Bacteriology

Unit –I

Growth of bacteria : Definition of growth, rate of growth, generation time, growth curve, measurement of population growth, batch culture, continuous culture and synchronous growth, Factors affecting growth. – Temperature, pH, oxygen, water availability.

Unit –II

Control of Microorganisms: Physical agents- Moist heat, dry heat, filtration, radiation. Chemicals as antimicrobial agents major groups of disinfectants, antiseptics and chemical sterilants.

Unit –III

Cultivation of microorganisms: Microbiological media, Physical states and chemical content of media, general purpose and special purpose media. Nutritional classification of Microorganisms. Isolation techniques (Streak plate, pour plate and spread plate method).

Unit –IV

Identification and preservation of microorganisms: Preparation of microorganisms for light microscopy- wet mount and hanging drop technique. Staining techniques- simple staining, differential staining (Gram's staining, acid fast staining, endospore staining). Special staining (capsule staining and flagella staining). Preservation of microorganisms by sub culturing, overlaying cultures with mineral oil, lyophilization, use of liquid nitrogen.

ESSENTIAL READINGS:

1. General Microbiology, 7th edition, H S Schlegel, Cambridge University Press, 1995
2. Microbiology, 5th edition M J Pelczar, E C S Chan, N R Kreig, Tata Mc Graw Publication, 2006
3. Microbiology-a Laboratory Manual, 6th edition, J G Cappuccino and N Sherman, Addison Wesley, Pearson Education, Inc., 2006
4. Microbiology-an introduction, 9th edition G J. Tortora, B.R. Funke, C.L. Case Pearson Education, Inc. 2007
5. Biology of Microorganisms, 10th edition, T D Brock, M T Madigan, Pearson Education, Inc., 2003
6. General Microbiology, R Y Stanier, J L Ingharam, M L Wheelies, P R Painter, Mac Millan Education Ltd, 1999
7. Laboratory fundamentals of microbiology, I E Alcamo, Jones and Barlett Publishers, 2001
8. Microbiology, 6th edition, Prescott, Harley, Klein, Mc Graw Hill Companies, 2005

Paper -III Molecular Biology

Unit –I

DNA Structure and Replication: DNA as a genetic material, structure of DNA and RNA, Types of DNA (A,B,Z), DNA replication in prokaryotes and eukaryotes.

Unit –II

Transcription : Mechanism of Transcription in prokaryotes and eukaryotes, Enzymes and transcription factors, Posttranscriptional modifications of eukaryotic mRNA.

Unit –III

Translation of Regulation of Gene Expression: The genetic code, Translational machinery in eukaryotes and prokaryotes, inhibitors of protein synthesis
Regulation of Gene expression in prokaryotes (lac and trp operon)

Unit –IV

Mutations and DNA repair: Molecular mechanism of mutation, forward and reverse mutation, Transition, transversion, Spontaneous and induced mutations
Methods for mutant selection-direct selection, antibiotic selection, replica plating
Mechanism of DNA repair-photo reactivation, Nucleotide excision repair, mismatch repair

Essential Readings:

1. Biochemistry and Molecular Biology, 3rd edition, Elliott W H and Elliot D C, Oxford University press, 2005.
5. Essentials of Molecular Biology, 3rd edition, Malacinski G M and Freifelder D Jones and Bartlett Publishers, 1998.
6. Instant Notes, Molecular Biology. Turner P.G., Mc Lennan, Bates A D, and White M R H, 2nd edition. Bios Scientific Publishers. 2002.
7. Cell and Molecular Biology, 3rd edition, Philip Scheeler and Donald E Bianchi, John Wiley and Sons. 1987.
8. Microbial Genetics, 2nd edition, Stanley R Maloy, John E Cronnan, David Freifelder. Jones and Bartlett Publisher. 1994.

MB 204: Lab- Practical based on Theory

1. Isolation of genomic DNA
2. Media preparation
- 3 Demonstration of serial dilution technique.
4. Pure culture techniques-isolation of microorganisms by streak plate. Spread plate and pour plate method.
5. Study of growth of bacteria.
6. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
7. Count the WBC / RBC using Haemocytometer
8. Study of Cyanobacteria- Nostoc and Oscillatoria.
9. Study of Protozoa – Amoeba, Paramecium, and Plasmodium.
10. Microscopic study of phytoplankton & zooplankton.
11. Differential staining (Grams staining), Negative staining and endospore staining.

Semester III

Paper – I: Microbial Diversity III

Unit -1

Algae-I:General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, food reserves and vegetative, asexual and sexual reproduction.

Unit-II

Algae II- Different types of life cycles in algae with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic lifecycles. Applications of algae in agriculture, industry, environment and food.

Unit -III

Fungi I

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure, asexual and, sexual reproduction.

Unit-IV

Fungi II

Heterokaryosis, heterothallism and parasexual mechanism.

Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

Essential Readings

1. Biology of Microorganisms, 10th edition, T D Brock, M T Madigan, Pearson Education, Inc.,
2. General Microbiology, R Y Stainer, J L Ingharam, M L Wheelies, P R Painter, Mac Millan Education Ltd, 1999
3. Laboratory fundamentals if microbiology I E Alcamo, Jones and Barlett Publishers, 2001
4. Micorbiology, 6th edition, Prescott, Harley, Klein, Mc Graw Hill Companies, 2005
5. Microbiology fundamentals and Application, 2nd edition, R M Atlas, Maxwell Macmillan International Edition, 1989

Paper II- Microbial Genetics

Unit-I

Plasmids: Types of plasmids - F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmid. yeast-2 μ plasmid, Plasmid- replication, incompatibility, plasmid amplification, copy number.

Unit -II

Gene transfer in Bacteria : Recombination in bacteria- Site specific recombination, Holliday model, Transformation Discovery, mechanism of natural competence

Conjugation - Discovery, mechanism, F+, F-, Hfr and F' strains,

Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates.

Unit-III

Phage Genetics : Features of T4 genetics, Genetic basis of lytic *versus* lysogenic switch of phage lambda. **Transposable elements-I:** Prokaryotic transposable elements –Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition

Unit-IV

Transposable elements-II: Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of Transposition

SUGGESTED READINGS

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. 4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin
5. Cummings
6. 5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
7. 6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings

Paper III- Microbial Physiology

Unit-I

Biochemical properties of membrane, Nerst equation. Osmosis, Plasmolysis, passive & facilitated diffusion, active transport, role of ionophores.

Unit-II

Photosynthesis

Photosynthesis micorbes, oxygenic & anoxygenic photosynthesis, photophosphory lation, Calvin cycle

Unit-III

Respiratory Pathways: Glycolysis, Oxidative pentose phosphate pathway, Entner-Doudoroff pathway, fermentative pathways, Yeast fermentation, Lactic acid fermentation, Acetic acid fermentation, Krebs cycle, ETC, oxidative and substrate level phosphorylation.

Unit-IV

Nitrogen Metabolism: Biological nitrogen fixation: process, components of nitrogenase system. Nitrogen fixation in symbiotic and free living systems.

Essential Readings:

1. Biology of Microorganisms, 10th edition, T D Brock, M T Madigan, Pearsong Education, Inc.,2003
2. Microbial Physiology and Metabolism, D R Caldwell, Brown Publisher, 1995
3. Microbial Physiology, 4th edition, A G Moat and J W Foster, John Wiley and Sons, Inc.,2002
4. Microbiology-a Laboratory Manual, th edition, J G Cappuccino and N Sherman, Addison Wesley, Pearson Education, Inc., 2006

Lab- Practical based on Theory

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO₂) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Demonstration of AMES test.
5. Production of alcohol.
6. Estimation of lactic acid in curd.
7. Estimation of ascorbic acid.
8. Demonstration for utilization of sugars by oxidation and fermentation by microbes.
9. Reduction of nitrate by Microorganisms.
10. Mushroom cultivation
11. Isolation of Rhizobium from root nodules
12. Plasmid Isolation from bacterial Culture.
13. Identification and characterization of different types of Algae from your surroundings.

Semester IV

Paper I - Analytical techniques

Unit-I

Chromatography

Working principle, instrumentation and application of: Paper Chromatography, Thin Layer Chromatography, Column Chromatography (Affinity Chromatography), Ion-exchange Chromatography, Gel filtration Chromatography or Exclusion Chromatography)

Unit-II

Centrifugation: principle, differential and density gradient centrifugation, ultracentrifugation (preparative and analytical centrifuges).

Unit-III

Electrophoretic Techniques: Principle, factors affecting electrophoresis- pH, voltage, supporting medium (agar, polyacrylamide, dextran), Agarose gel electrophoresis, PAGE, SDS-PAGE, isoelectric focusing

Unit-IV

Optical methods of Analysis: Introduction to basic principles and applications: Beer Lambert's Law, Spectrophotometry (UV-visible, infrared, AAS), Mass spectroscopy
Autoradiography, Radioactive labeling & counting,

ESSENTIAL READINGS:

1. Methods in Modern Biophysics, B Notting, Springer Verlag Berlin Heidelberg New York, 2003
2. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition, K Wilson and J Walker (ed.) Cambridge University Press, 2007
3. Bioinstrumentation, J G Webster, John Wiley & Sons Inc. 2004
4. Essentials of Biophysics, P Narayanan, New Age Int. Pub. New Delhi. 2000
5. Spectroscopy for the Biological Sciences, G.G Hames, John Wiley & Sons Inc. 2005

Paper II- Immunology

Unit –I

Basic Immunology: Introduction to immune system- Innate and acquired immunity
Cells of the Immune system: Hematopoiesis and differentiation, B-lymphocytes, T- lymphocytes, Macrophages, Dendritic cells, NK cells, Eosinophils, Neutrophils and Mast Cells. Structure and function of lymphoid organs

Unit –II

Cellular and molecular aspects: Nature and biology of antigens and super antigens
Immunoglobulin: structure, types and their function MHC, B and T-Cell Receptor Complement system

Unit –III

Immune re response and its regulation: Generation of Humoral and Cell mediated immune responses. B-and T-cell maturation, activation and differentiation. Cytokines and their role in immune regulation .T-cell regulation, MHC restriction. Immunological tolerance

Antigen- antibody interactions:Antigen processing and presentation Precipitation, Immunodiffusion, Immunoelectrophoresis, Agglutination, RIA, ELISA, Immunofluorescence.
Selected concepts in Immunology: Hypersensitivity, Autoimmunity, AIDS

ESSENTIAL READINGS:

1. Kubby Immunology, 4th edition- R.A. Goldsby and others, Freeman & Co., New York, 2001
2. Roitt's, Essential Immunology, 10th edition, Ivan M Roitt and Peter J Delves, Blackwell Science, 2001
3. Instant Notes on Immunology, 2nd edition, Lydyard, Wheran and Fanger, Viva Books Pvt. Ltd., 2003

Paper III- Biochemistry

Unit –I

Nature of Biomolecules and Thermodynamics: Cell: Chemical components, Molecular Hierarchy. Types of interactions in molecular and supramolecular complexes
Laws of thermodynamics, Nature of biochemical reactions and DG values, Reversible and Irreversible reactions. Water and the aqueous environment .Buffers: Concept of pH, pK, acids, bases.

Unit –II

Carbohydrates : Structure of monosaccharide (trioses, pentoses & hexoses), disaccharides (sucrose, maltose, lactose), polysaccharides (starch, glycogen, cellulose, peptidoglycan)
Fundamental Properties: Stereoisomerism and mutarotation.

Unit –III

Amino acids and Proteins: Structure of essential and non-essential amino acids. Peptide bond. Protein classification on the basis of structure and function. Biological functions of proteins.

Enzymes: Classification and nomenclature of enzymes. Mechanism of enzyme action, Michaelis- Menton kinetics. Coenzymes, Enzyme inhibition, Allosteric enzymes

Unit –IV

Lipids: Structure and nomenclature of fatty acids. Classification of lipids (triacylglycerols, phospholipids, sphingolipids, sterols). Membrane lipids. Biological functions of lipids

ESSENTIAL READINGS:

1. Biochemistry, 2nd edition, D Voet and J G Voet, John Wiley & Sons, 1995.
2. Lehninger, 3rd edition, Principles of Biochemistry, Nelson and Cox, 1999.
3. Principles and Techniques in Biochemistry and Molecular Biology, 6th edition, Edited by Keith Wilson and John Walker, CMBLridge University Press, 2007.
4. Biochemistry and Molecular Biology, 3rd Edition, W H Elliot and Daphne C Elliot, Oxford University Press, 2005.
5. Biochemistry, J David Rawn, Panima Publishing Corporation, 1st Indian Reprint, 2004
6. Biochemistry, 5th edition L Stryer, W H Freeman and Co., New York.

Laboratory : Practical based on theory papers

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts.
2. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
3. Qualitative/Quantitative tests for lipids and proteins
4. Study of protein secondary and tertiary structures with the help of models
5. Study of enzyme kinetics – calculation of V_{max} , K_m , K_{cat} values
6. Study effect of temperature, pH and Heavy metals on enzyme activity
7. Blood Grouping and Rh typing
8. Blood film preparation and identification of cells
9. Counting of RBC and WBC by Hemocytometry
10. Double diffusion
11. Radial Immuno diffusion
12. DOT- ELISA
13. Latex Agglutination
14. Widal test
15. Antibiotic sensitivity test by disc diffusion method
16. Dental carries susceptibility
17. Radio immunoassay (RI)

Semester V

Paper I- Medical Microbiology

Unit- I

Beneficial and Harmful Microbial Interactions with Human

Normal microbial population of healthy human body - Skin, mouth, upper respiratory tract, intestinal tract, urino-genital tract.

Mechanism of bacterial pathogenicity, Entry of pathogens into the host, colonization and growth, Virulence, Virulence factors –exotoxins, enterotoxins, endotoxins.

Unit- II

Epidemiology: the study of disease in population

Principles of epidemiology, reservoirs of pathogens, acquisition and transmission of infectious agents, Nosocomial infections, Measures for prevention of epidemics. Immunization program in India. Fungal diseases: Mycoses, mycotoxicoses

Unit- III

Bacterial diseases

General idea of infections: symptoms, treatment and preventive measure of diseases caused by Gram positive bacteria: *Mycobacterium* (Tuberculosis and leprosy), *Corynebacterium* (Diphtheria) and Gram negative bacteria: *Salmonella* (Typhoid), *Vibrio* (*cholera*), *Shigella* (*Dysentery*), *Niseeria* (Gonorrhoea).

Unit- IV

Viral diseases

Animal viruses life cycle, pathogenicity, diagnosis, prevention and treatment of RNA viruses- Picorna virus- Poliomyelitis; Orthomyxoviruses- influenza viruses.

Paramyxoviruses- Mumps, Measles; retroviruses- HIV, Rabies virus.

DNA viruses- Herpes virus- Varicella zoster virus; Hepatitis viruses-HBV.

ESSENTIAL READINGS:

1. Instant Notes Medical Microbiology, Irving W, Boswell T, Ala Aldeen D, Taylor and Francis group, 2005
2. Medical virology- Morag C and Timbury M.C. X Edition. Churchill Livingstone, London. 1994
3. Microbiology A Human Perspective, Nester E.W., Roberts CE, Nester MT, Wm. C. Brown Publishers, 1995.
4. Text book of Microbiology, R Ananthnarayanan and C K J Paniker, Orient Longman, 1997

Paper II- Environmental Microbiology

Unit- I

Microbiology of Air, Water and Soil: Microbial population of air, water (drinking and potable) and soil. Population interaction: Neutralism, Commensalism, Synergism, Mutualism, Competition, Ammensalism, Parasitism, and Predation.

Unit- II

Biogeochemical Cycles: Carbon Cycle, Nitrogen Cycle, Sulphur Cycle, Phosphorus Cycle, Iron, heavy metals cycles. Hydrogen and Oxygen cycle.

Unit - III

Solid and Liquid Waste Disposal: Different types of liquid waste treatment: Primary, Secondary and tertiary treatment. Aerobic process – activated sludge, oxidation ditches, and trickling filters, Anaerobic Process – anaerobic digestion, anaerobic filters, up flow anaerobic sludge. Solid Wastes: Sources and management (Sanitary landfills, incineration, composting, vermiculture, methane production).

Unit - IV

Biodegradation and Bioremediation: Biodegradation of natural compounds (cellulose, hemicelluloses, lignin, starch, chitin), Biodegradation of environmental pollutants, Bioremediation of Xenobiotics, bioaccumulation and biomagnification.

ESSENTIAL READINGS:

1. Plant, Gene and Crop Biotechnology, M J Chrispeel and D E Sadava ASPB 2003.
2. Textbook of Environmental Biotechnology, P K Mohapatra, I K International Publications, Mumbai, 2006.
3. Environmental Chemistry, A K De, Willey Eastern Ltd., New Delhi.
4. Advances in Industrial Waste water treatment, First Edition, Technosound Publications. 1999.
5. Microbial Ecology- Fundamentals & Applications, 4th Edition, Ronald . M. Atlas, Richard Bartha, Pearsrson Publication. 2005

Paper III- Recombinant DNA Technology

Unit -I

Milestones in genetic engineering and biotechnology

Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, Use of linkers and adaptors

DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases

Unit -II

Cloning Vectors: Definition and Properties. Plasmid vectors: pBR and pUC series. Bacteriophage lambda based vectors, Cosmids, BACs and YACs.

Unit -III

Methods in Molecular Biology

Transformation of DNA: Electroporation,. Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and, *Agrobacterium* - mediated delivery.

Southern, Northern blotting, Western blotting and dot blot techniques

Unit-IV

DNA Amplification and DNA libraries

PCR: Basics of PCR, RT-PCR, Real-Time PCR

Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization

Applications and products of recombinant DNA technology.

SUGGESTED READING

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

Lab- Practical based on Theory Papers

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
2. Ligation of DNA fragments
3. Designing of primers for DNA amplification
4. Amplification of DNA by PCR
5. Demonstration of Southern blotting.
6. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
7. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
8. Assessment of microbiological quality of water.
9. Determination of BOD of waste water sample.
10. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
11. Isolation of *Rhizobium* from root nodules.

Semester VI

Paper I- Fermentation Technology

Unit –I

Bioreactors: The fermentation industry, screening of industrially important microorganisms. Factors involved in Bioreactor design, design of a bioreactor, Types of Bioreactors.

Unit –II

Fermentation Process: Types of fermentation- batch, continuous, fed batch, surface, and submerged and solid state fermentation. Inoculum development, media formulation, scale-up. Process control.

Unit- III

Down Stream Processing and Product Recovery

Filtration, centrifugation, cell disruption, solvent extraction, precipitation, chromatography (gel filtration, ion exchange, affinity) membrane process (ultra filtration) and spray drying.

Unit –IV

Industrial Products Derived from Microorganisms

Antibiotic- Penicillin. Steroids, Vaccines. Production of organic acid- Acetic acid, Citric acid, Production of amino acids- Glutamic acid, Industrial alcohol and SCP and Mushroom cultivation.

ESSENTIAL READINGS:

1. Industrial Microbiology, E Casida, New Age International (P) Ltd. Publishers. 2005
2. Manual of Industrial Microbiology and Biotechnology, A L Demain and J E Davies, ASM Press, 1999
3. Principles of Fermentation Technology, 2nd edition, P F Stanbory, Whitaker and Hall, Elsevier India, 2005
4. A Textbook of Industrial Microbiology, 2nd edition, W Crueger and A Crueger, Panima Publication Corporation, 2000
5. Fermentation Microbiology and Biotechnology, Mansi and Bryce, Taylor & Francis group, 2002
6. Industrial Microbiology, 4th edition, S C Prescott and D C Dunn, CBS Publishers and Distributors, 1987
7. Nanobiotechnology: Concepts, Applications & Perspectives, C N Niemeyer and C A Mirkin, Wiley-VCH Verlag GmbH & Co., 2004.
8. Process Biotechnology Fundamentals, 2nd edition, S N Mukhopadhyay, Viva books Pvt. Ltd., 2004

Paper II-Food And Dairy Microbiology

Unit – I

Industrial Food fermentations: Introduction, food fermentation, the science and technology. Fermented foods (Soya sauce, bread, Sauerkraut, idly), fermented beverages (wine, Beer)

Unit – II

Microbiology of Milk : Sources of Milk contamination and their control. Microbiology of raw and pasteurized milk, Biochemical changes in fermented milk. (Fermentation of lactose to lactic acid, hydrolysis of proteins and lipid). Study of spoilage organisms in dairy industry. Introduction to Probiotics

Unit – III

Industrial Dairy fermentations: Classification of various groups of microorganisms associated with dairy industry. Acid fermented milks (Yoghurt, Cultured butter milk). Starter cultures for fermented dairy products (*Streptococcus thermophilus*, *Lactobacillus bulgaricus*,). Cheese- (Milk, microorganisms, enzymes and other additives). Cheese production: steps involved in manufacture of cheese, preservation, classification and nutritional aspects.

Unit – IV

Food spoilage and Preservation : General Principle underlying spoilage: Chemical changes caused by micro organisms. Spoilage of different kinds of foods (Cereals, sugar products, caused by micro organisms. Spoilage of different kinds of foods (Cereals, sugar products, vegetables, fruits, meat, eggs, canned foods). Food preservation by Radiations (UV, Gamma and microwave), Food preservation by low and high Temperature, Chemical preservation and naturally occurring antimicrobials.

ESSENTIAL READINGS:

1. Food Microbiology, 2nd edition by Adams
2. Dairy Microbiology by Robinson. Volume II and I.
3. Applied dairy microbiology edited by Elmer Marth and James Steele.
4. Food Microbiology by Frazier.
5. Industrial Biotechnology by L.E. Cassida Jr. New Age International Pvt. Ltd. Publishers, 2005
6. Food Microbiology by W.C Frazier and D.C. Westhoff. Tata McGraw Hill Publishing Company Ltd, New Delhi 1998

Paper III - Soil and Agricultural Microbiology

Unit -I

Soil as habitat for microorganisms- Soil Quality, Physico-chemical Properties of Soil (Organic matter , soil water and Air). Soil Microbes. Rhizosphere and Rhizoplane microorganisms. Factors affecting microbial community in soil.

Unit- II

Organic matter decomposition: Composition of litter(cellulose, hemicelluloses, lignin and proteins). Carbon assimilation and immobilization , microorganisms associated with organic matter decomposition, factors affecting decomposition.

Unit- III

Microbial inoculants, production of bacterial biofertiliser. Green manuring; algae and other biofertilisers; mass cultivation of cyanobacteria biofertiliser. Biofertilisers aiding phosphorus nutrients: production of mycorrhizal biofertilisers.

Unit -IV

Crop protection: Microbial herbicides; Bacterial insecticides; *Pseudomonas* , *Bacillus* sp. As bacterial insecticides; Virus insecticides; Entomopathogenic fungi- *Verticillium*, *Hirsutella*.

Lab- Practical based on Theory Paper

1. Isolation of industrially important microorganisms
 - a. amylase producing microorganism
 - b. protease producing microorganism
 - c. lipase producing microorganism
2. Isolation of antibiotic producing microorganism from soil
3. Production of alcohol.
4. Estimation of lactic acid in curd.
5. Estimation of ascorbic acid.
6. Demonstration for utilization of sugars by oxidation and fermentation by microbes.
7. Isolation and identification of fungi from spoiled food samples.
8. Methylene blue reductase time test for checking microbial quality of milk.
9. Isolation of milk fermenting organisms from milk.
10. Production of fermented food using microbial culture
11. Study of Soil Microbes
12. Isolation of Rhizosphere and rhizoplane microflora and their Identification.
13. Study of Mycorrhizal biofertilizer.
14. Study of Microbes that can be used as Biopesticides.