

# College of Computer, Science & Information Technology - Junagadh

AFFILIATED TO BHAKTA KAVI NARSINH MEHTA UNIVERSITY



♦ Syllabus ♦

## **Master of Science**

in

**[ MICROBIOLOGY ]**

**[ Semester – I & II ]**

Academic Year : 2024 – 25

( Effective from June – 2023 )



◀ **ADDRESS : C.C.S.I.T. - JUNAGADH** ▶

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## Credit Structure

(SEMESTER-I)					
Subject code	Subject Name	Credit	Int. Marks	Ext. Marks	Total Marks
Mic-101	Cell Biology(Core)	4	30	70	100
Mic-102	Molecular Biology, Genetics & Evolution(Core)	4	30	70	100
Mic-103	Biodiversity & Biosystematics(Core)	4	30	70	100
Mic-104	Biostatistics, Bioinformatics & Biosafety	4	30	70	100
Mic-105	Combined Practical Course	8	-	-	200
Mic-106	Seminar Course - 1	-	-	-	-
Total Credits		24	Total Marks		600

(SEMESTER-II)					
Subject code	Subject Name	Credit	Int. Marks	Ext. Marks	Total Marks
Mic-207	Biochemistry(Core)	4	30	70	100
Mic-208	Biotechnology & Immunology(Core)	4	30	70	100
Mic-209	Environmental Science(Core)	4	30	70	100
Mic-210	Analytical Techniques (Multidisciplinary/Interdisciplinary)	4	30	70	100
Mic-211	Combined Practical Course	8	-	-	200
Mic-212	Seminar Course - 2	-	-	-	-
Total Credits		24	Total Marks		600

### Structure of Theory Examination Paper – External

Question Paper contains 5 Questions (each of 14 marks). Every Question is divided in four parts like (a), (b), (c) and (d). Every Question will be asked from corresponding unit as specified in the syllabus of each course. (i.e. Question-1 is from Unit No. 1 and remaining questions from their corresponding Units).

**TOTAL MARKS : 70, TOTAL TIME : 2½ HOURS**

#### General Instructions:

1. Time duration of each theory paper will be of Two and Half hours.
2. Total marks of each theory paper will be 70 marks.
3. There will be five questions.
4. All questions are compulsory.

#### Instructions to the candidates for Practical Examination:-

1. Practical Exam. would be conducted for 1 ½ days, All the students have to remain present at the examination center 15 minutes before the scheduled time for examination.
2. Students have to carry with them certified Journal, I – card, Examination Receipt, and other necessary requirements for examination.
3. Student should not leave the laboratory without the permission of examiner.
4. Use of calculator is allowed but the use of mobile phones is strictly prohibited.
5. The candidate has to leave the laboratory only after the submission of all the answer sheets of the exercises performed.

# **M.Sc.(Microbiology) SEMESTER – I**

## **Micro -101 : CELL BIOLOGY**

### **Unit-1 : Cell Structure & Cell Cycle**

- 1.1 Cell Concept, Ultrastructure of Plasma Membrane, microbial and Plant Cell Wall
- 1.2 Ultrastructure of Nucleus and Nucleolus. Pore Complex of Nuclear envelop
- 1.3 Ultrastructure of Chromosome, Chromosomal Models, Special types of chromosomes
- 1.4 Cell Cycle, G<sub>1</sub>/S Transition, Cyclins and cyclin dependent kinases. Regulation of CDK- cycline activity

### **Unit-2 : Cellular Organization**

- 2.1 Mitochondria: Membrane Organization, Biogenesis and role in cellular energetics
- 2.2 Chloroplasts: Ultrastructure, biogenesis, Photosynthetic units and reaction centers
- 2.3 Ultrastructure and functions of Lysosome, Peroxisomes & Glyoxisomes
- 2.4 GERL System and its functions. Vacuoles and their role in cell structure and function

### **Unit-3 : Cytoskeleton, Cellular Transport & Sorting**

- 3.1 Cytoskeleton: Ultrastructure and functions of Microtubules, microfillaments and associated proteins
- 3.2 Cytoskeleton: Ultrastructure and functions of Actin, Myosin, IF and associated proteins
- 3.3 Intracellular Junctions and their functions. Ca<sup>++</sup> dependent homophillic and non-homophillic cell-cell adhesion
- 3.4 Transport across cell membrane: diffusion, active transport and pumps, uniports, symports and antiports

### **Unit-4 : Cellular Communication, Apoptosis and Cancer**

- 4.1 Cell surface receptors and their mode of action. Phenomenon of exocytosis and endocytosis
- 4.2 Second messenger system, MDP kinase pathways
- 4.3 Apoptosis: Mechanism and significance
- 4.4 Cell biological approach of cancer, AIDS

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## **Micro -102: MOLECULAR BIOLOGY, GENETICS & EVOLUTION**

### **Unit-1 : Population Genetics**

- 1.1 Principles of Mendalian genetics : Dominance, segregation, independent assortment
- 1.2 Hardy-Weinberg genetic equilibrium, Natural selection
- 1.3 Genetics of Speciation
- 1.4 Origin of life: Coacervates, Miller's experiment, theories of organic evolution

### **Unit-2 : DNA as a hereditary material**

- 2.1 Structure of Nucleic acids, Structural differences in prokaryotic and eukaryotic DNA
- 2.2 DNA constancy and C-value paradox,
- 2.3 DNA replication and DNA methylation
- 2.4 Linkage and genetic mapping

### **Unit-3 : Gene structure and Expression**

- 3.1 The Concept of Gene
- 3.2 Genetic code, Transcription and RNA processing
- 3.3 Translation and post translational modifications
- 3.4 Regulation of gene expression and Operon model

### **Unit-4 : Structural Changes in DNA material and Extra Chromosomal inheritance**

- 4.1 Molecular basis of spontaneous and induced mutations,
- 4.2 Chromosomal aberration
- 4.3 DNA damages and repair
- 4.4 Extra-chromosomal inheritance : of Mitochondrial and chloroplast genes, maternal inheritance.

## **Micro -103 : BIODIVERSITY & BIOSYSTEMATICS**

### **Unit – 1 : Biodiversity**

- 1.1 Basic Concepts of Biodiversity: Genetic, species and ecological diversity.
- 1.2 Terrestrial, Marine Biodiversity, Eco-tourism and Biodiversity. Conservation and Sustainable use of Biodiversity. Ecosystem monitoring and Rehabilitation.
- 1.3 Threats to Biological Diversity: Habitat Destruction, Invasive species, Disease, Over-exploitation, Pollution, Climate change and Biodiversity.
- 1.4 Structure and functions of the Convention on Biological Diversity (CBD), CBD mechanisms and working bodies.

### **Unit – 2: Microbial Taxonomy**

- 2.1 Principles of systematics and classification of microbes
- 2.2 Introduction to akaryotes, Virus, Archea & bacteria, cyanobacteria prokaryotes
- 2.3 Fungus like protists: Cellular slime moulds, plasmodial slime moulds. General features of Fungus
- 2.4 Organisms of health importance: Common parasites and pathogens of humans and domestic animals

### **Unit – 3 : Plant Taxonomy**

- 3.1 Principles of systematics and classification of plants.
- 3.2 General features and classification of green protists like diatom, dinoflagellates, lichens and algae
- 3.3 Non-tracheophytes (Mosses) and Non-Seed Tracheophytes(Ferns and Fern allies)
- 3.4 Seed plants : Gymnosperm and Angiosperms

### **Unit – 4: Animal Taxonomy**

- 4.1 Principles of systematics and classification of Animals. Organisms of conservation concern: Rare, endangered species. Conservation strategies.
- 4.2 Classification of Protista (Flagellates, Amoebas, Ciliates and Apicomplexans).
- 4.3 Major invertebrate phyla, Lower chordates
- 4.4 Vertebrates: Fish, Amphibia, Reptiles, Birds and Mammal

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## **Micro -104 : BIOSTATISTICS, BIOINFORMATICS & BIOSAFETY**

### **Unit – 1 : Basics and Concepts of Biostatistics**

- 1.1 Data classification, Frequency distribution and Graphs
- 1.2 Measure of Central Tendency: Meaning, Objectives, Merits, Demerits & Uses
- 1.3 Measure of Dispersion – Range, Variance, Standard deviation, Coefficient of Variation; Confidence limit and confidence interval
- 1.4 Probability distributions (Binomial, Poisson and normal), Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance;

### **Unit – 2 : Statistical Tests in Biology**

- 2.1 Regression and Correlation analysis
- 2.2 Student's t-test: Paired and Unpaired
- 2.3 Level of Significance & Degree of Freedom: Chi-square test (X<sup>2</sup>); Analysis of Variance (ANOVA)
- 2.4 Basics of Multivariate statistics

### **Unit – 3 : Bioinformatics**

- 3.1 Introduction of Bioinformatics, Basic terminology, Application of bioinformatics in various fields: Medicine, Agriculture, Industries etc.
- 3.2 Types and structures of biological databases
- 3.3 Sequence alignment: Nucleotide and Protein sequences, Pairwise and multiple sequence alignment, BLAST and Phylogenetic analysis
- 3.4 Gene prediction: Gene structure in prokaryotic and eukaryotic systems, Prediction tools for the gene

### **Unit – 4 : Biosafety & Bioethics**

- 4.1 Biosafety fundamentals: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels.

- 4.2 Biosafety regulation: Biosafety Guidelines-Government of India; Roles of Institutional Biosafety Committee, RCGM, GEAC etc.
  - 4.3 Environmental release and application of GMO
  - 4.4 Risk Analysis; Risk Assessment; Risk management and communication.
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## **Micro. 105 : COMBINED PRACTICAL COURSE**

### **101. Cell Biology : Suggested practical work**

1. Preparation of paraffin blocks of animal tissue – Understanding the cytological and histological techniques
2. Section cutting, spreading and staining methods, Microscopy
3. Supra – vital Cytological staining of cellular organelles
4. Cellular metabolites: Permanent Cytological Staining
5. Nucleic Acids: Permanent Cytological Staining
6. Cytogenetics: Onion root tip squash preparation for mitosis
7. Dipteran salivary gland squash preparation for giant chromosome
8. Cytological Staining of Barr body
9. Cytogenetics: Stages of meiosis
10. Histological and Cytological Staining of Drumstick
11. Enzyme histochemistry & Cytochemistry
12. Observations on permanent cytological slides

### **102. Molecular Biology, Genetics & Evolution: Suggested Practical Work**

1. To confirm thalassemia by NESTROFT (Necked Eye Single Tube RBCs Osmotic Fragility Test)
2. To induce polyploidy in root of Allium cepa and observe cytological changes in cell
3. To study karyotype of human chromosome
4. Identification of normal male and female karyotype
5. Identification of Turner syndrome using Karyotype
6. Identification of Klinefelter syndrome using the karyotype
7. Identification of Down syndrome using the karyotype
8. Identification of Edwards syndrome using the karyotype
9. To perform linkage analysis and Map construction with example
10. To perform Pedigree analysis and Probabilities with example
11. Staining of Microbial Cells: Monochrome, Negative & Gram Staining
12. Bacterial Motility (Hanging Drop Method)
13. Bacteriological Media Composition & Preparation and Bacterial Cultivation Methods

### **103. Biodiversity & Biosystematics : Suggested Practical work**

1. General features & classification of Invertebrates up to class or order
2. General features & classification of vertebrates up to class or order
3. General features and classification of diatoms, dinoflagellates, lichens and algae
4. General features and classification of non-tracheophytes and non-seed tracheophytes
5. General features and classification of Gymnosperms
6. General features and classification of angiosperms
7. Negative staining, Differential staining (Gram's staining)
8. Specialized staining: Capsule staining, Spirocheck staining, Metachromatic granule staining, Cell wall staining
9. Hanging drop techniques for motility

### **104. Biostatistics, Bioinformatics & Biosafety**

1. Frequency Distribution
2. Standard Deviation and Coefficient of Variation
3. Confidence limits for the population mean
4. Students 't' test
5. Analysis of Variance
6. Regression and Correlation
7. Chi Square Test
8. Multivariate analysis
9. Basic Terminologies in Bioinformatics
10. Biological databases
11. NCBI Search for Gene Sequences
12. UniProt Knowledgebase (UniProt KB) Search for Protein Sequences

13. RCSB PDB search for Protein 3D Structures
14. Pair wise Sequence Alignment using NCBI BLAST
15. Pair wise Sequence Alignment using Bio edit
16. Multiple Sequence alignment using CLC Protein Workbench
17. Multiple Sequence alignment using Clustal X
18. Analysis of 3 D structure of protein by Rasmol

#### **SUGGESTED BOOKS FOR PAPER: MIC 101- CELL BIOLOGY**

1. Biology by Peter Raven, George Johnson, Kenneth Mason, Jonathan Losos, Susan Singer, McGraw Hill Education
2. Cell and Molecular Biology by S.C. Rastogi, New Age international
3. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by Verma P.S. & Agarwal V.K.
4. Cell Biology by Gerald Karp, Wiley
5. The Cell – A molecular Approach, Cooper and Hausman
6. Molecular cell biology, Lodish, WH freeman
7. Cells, Benjamin Lewin, Jones and Bartlett Publishers, Inc
8. Cell Biology, Devasena, Oxford
9. Cell and Molecular Biology by Eduardo D.P.De Robertis and E.M.P.De Robertis

#### **SUGGESTED BOOKS FOR PAPER: MIC 102 - MOLECULAR BIOLOGY, GENETICS & EVOLUTION**

1. Biology, Raven and Johnson, 2013, McGraw Hill India publication
2. Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings
3. Cell and Molecular Biology by S.C. Rastogi, New Age international
4. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma and Agarwa,
5. Evolution third edition, Mark Ridley, Blackwell Publishing
6. Evolution, Strickberger, Monroe W, Jones & Bartlett Publishers, Inc.
7. Life: The Science of Biology, William, W. H. Freeman
8. Genetic Engineering – Smita Rastogi and Neelam Pathak
9. Genetic Engineering, Verma P.S., S Chand & Company

#### **SUGGESTED BOOKS FOR PAPER: MIC 103 - BIODIVERSITY & BIOSYSTEMATICS**

1. Biodiversity: Perception, Peril and Preservation Prabodh K. Maiti, PHI Learning Private Limited
2. The Bio-Diversity of India, Erach Bharucha, Grantha Corporation
3. Biogeography and Biodiversity, R. B. Singh, Rawat Pubns
4. An Introduction to Biodiversity, Prithipalsingh, Ane books
5. An Advanced Textbook on Biodiversity, K. V. Krishnamurthy
6. Biodiversity Measurement and estimation, Hawksworth, Chapman
7. Fundamentals of Ecology, Eugene Odum, Cengage
8. Concepts of Ecology, Kormondy Edward, Pearson Education
9. Elements of Ecology, Smith, Pearson Education
10. Fundamentals of Ecology and Environmental Biology, S. C. Santra
11. Ecology and Environment, PD Sharma, Rastogi Publications
12. Modern Textbook of Zoology by R.L. Kotpal

#### **SUGGESTED BOOKS FOR PAPER: MIC 104 - Biostatistics, Bioinformatics & Biosafety**

1. Introduction to Bio-Statistics, Banerjee Pranab Kumar, S Chand & Company
2. Biostatistics, Veer Bala Rastogi, Medtech
3. Biostatistics Analysis, Zar, Pearson
4. Biostatistics for health and life sciences, Rao K Surya, Himalaya Publishing house
5. Research methodology, C R Kothari, New Age Publishers
6. Principles of Biostatistics by Marcello Pagano, Duxbury Thomson Learning
7. A Text Book of Biotechnology, R. C. Dubey, S. Chand Publication
8. Bioinformatics-A beginners Guide-Claverie J & Notredame C
9. Developing Bioinformatics Computer Skills-Gibas C & Jambeck P
10. The single Genetic Algorithm-Vose M D
11. Bioinformatics-Sequence, structure and Databases –Higgins D & Taylor W
12. Bioinformatics: Methods And Applications - Genomics, Proteomics And Drug Discovery by Rastogi SC, Rastogi P & Mendiratta N, PHI
13. IPR, Biosafety and Bioethics, Goel And Parashar, Person
14. Bioethics and Biosafety M.K. Sateesh, I K International Publishing House
15. Biosafety and Regulation for Genetically Modified Organisms, Xue, lpha Science International Ltd



# **M.Sc.(Microbiology) SEMESTER – II**

## **MIC-207 : BIOCHEMISTRY**

### **Unit – 1 : Carbohydrates, Lipids and Fatty Acid metabolism**

- 1.1 Monosaccharides and disaccharides: Types and properties
- 1.2 Polysaccharides: Homopolysaccharides and heteropolysaccharides
- 1.3 Classification and properties of simple and compound lipids
- 1.4 Function of lipids, Metabolism of fatty acids: Beta oxidation

### **Unit – 2 : Protein Structure and Function**

- 2.1 Physical and chemical properties of amino acid, Classification of amino acids
- 2.2 Primary and Secondary structure of protein
- 2.3 Tertiary and Quaternary structure of protein, Ramchandran Plots
- 2.4 Titration curves and function of proteins

### **Unit – 3 : Enzymes: Basic Concepts and Kinetics**

- 3.1 An introduction to enzymes: Nomenclature and classification
- 3.2 Principles and mechanism of enzymes catalysis: single and multisubstrate, Coenzymes and cofactors
- 3.3 Kinetic properties of enzymes, Michaelis-Menten Model, Double reciprocal plot
- 3.4 Enzyme Inhibition: Competitive, Non- competitive, Uncompetitive and Mixed type

### **Unit – 4 : Metabolism: Basic Concepts and Regulation**

- 4.1 Concept of Bioenergetics: laws of thermodynamic, Entropy and Enthalpy, Energy rich compounds and electron carriers
- 4.2 Glycolysis and Citric Acid Cycle
- 4.3 Other pathways of carbohydrate metabolism ED, Pentose Phosphate, Glyoxylate,
- 4.4 Gluconeogenesis Allosteric proteins, Feedback inhibition

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## **MIC-208 : BIOTECHNOLOGY & IMMUNOLOGY**

### **Unit – 1 : Biotechnology**

- 1.1 Biotechnology : Definition, History and Career scopes, Techniques of immobilization of enzymes & cells, Applications of Immobilized Enzymes & Cells
- 1.2 Bioremediation, Basics of genetic engineering, DNA isolation techniques
- 1.3 Restriction enzymes, Gene targeting
- 1.4 Vectors : plasmids, cosmids and phages, Host vector system

### **Unit – 2 : Animal and Plant Tissue culture**

- 2.1 Principles and Techniques of Plant Tissue Culture
- 2.2 Basic Steps of Plant Tissue Culture
- 2.3 Types of Plant Tissue Culture
- 2.4 Principles and techniques of animal tissue culture

### **Unit – 3 : Immunology**

- 3.1 Antigen Antibody: Factors Influencing Immunogenicity, Structure of Ig, Ig Classes & Biological Activities, Monoclonal Antibodies
- 3.2 Innate and Adaptive Immune System
- 3.3 Antigen-Antibody Interactions: ELISA Test, Agglutination, Precipitation, Immunofluorescence
- 3.4 Hypersensitivity and Autoimmunity

### **Unit – 4 : Intellectual Property Right**

- 4.1 IP: Fundamentals of patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP.
- 4.2 IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.
- 4.3 Patent Application: Types of patents, Patent application- forms and guidelines, fee structure, time frames;
- 4.4 Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs

## **MIC 209 : ENVIRONMENTAL SCIENCES**

### **Unit – 1 : Ecological Principles**

- 1.1 Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
- 1.2 Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection)
- 1.3 Concept of metapopulation – demes and dispersal, interdemec extinctions, age structured populations.
- 1.4 Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

### **Unit – 2 : Community Ecology**

- 2.1 Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
- 2.2 Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.
- 2.3 Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition;
- 2.4 Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

### **Unit – 3 : Environment Science**

- 3.1 Definition and Scope of Environmental science. The Environment: Physical environment; biotic environment; biotic and abiotic interactions.
- 3.2 Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere.
- 3.3 Biomes of the world, Parasitism, prey-predator relationships
- 3.4 Overview of Sanctuaries, National park and Botanical garden

### **Unit – 4 : Pollution and Environmental Impact Assessment**

- 4.1 Air: Natural and anthropogenic sources of pollution, primary and secondary pollutants, Methods of monitoring and control of air pollution, Effects of pollutants on human beings, plants, animals, materials and on climate, Acid rain, Air Quality Standards
- 4.2 Water: Types and Sources of water pollution, Standards, sewage and waste water treatment. Water quality standard, Soil pollution and Soil pollution control
- 4.3 Global Environmental problems: Ozone depletion, global warming and climatic change, clean development mechanism.
- 4.4 Introduction to environment impact analysis, Environmental Impact Assessment methodologies, Procedure for reviewing environmental impact analysis, Principles of Remote sensing and its applications of environmental sciences, Application of GIS in Environmental management.

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## **MIC-210 : ANALYTICAL TECHNIQUES**

### **Unit – 1 : Microscopy and Autoradiography**

- 1.1 Theories of Tissue fixation and staining techniques
- 1.2 Principles of Transmission and Scanning Electron microscopy
- 1.3 Principles of Phase Contrast and Fluorescence Microscopy
- 1.4 Principle and applications of Autoradiography

### **Unit – 2 : Spectroscopy**

- 2.1 Basic principles of Spectroscopy, UV, IR, Raman, ESR, ORD
- 2.2 CD and structure of proteins using NMR and ESR
- 2.3 Neutron and X-Ray diffraction for elucidation of 3D structure
- 2.4 Molecular modelling, Mass Spectrometry

### **Unit – 3 : Chromatographic techniques**

- 3.1 Basic Principle and types of Chromatography
- 3.2 Gas Chromatography & GC-MS
- 3.3 Ion Exchange Chromatography, gel permeation, Affinity chromatography
- 3.4 High Performance Liquid Chromatography and FPLC



## **Unit – 4 : Centrifugation and Electrophoretic Techniques**

- 4.1 Principle and applications of Centrifugation techniques
- 4.2 Basic principles of Electrophoresis, Agarose gel, native and SDS-PAGE
- 4.3 Isoelectric focusing, 2D-PAGE and their uses in protein research
- 4.4 Fractionation and Blotting Technique

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## **MICRO – 211 : COMBINED PRACTICAL COURSE**

### **MIC : COMBINED PRACTICAL COURSE SUGGESTED LABORATORY WORK**

1. To prepare a titration curve of a weak acid with a strong base
2. To prepare a titration curve and determine the pK and pI value of an amino acid
3. To prepare a calibration curve of reducing sugars by DNSA
4. To prepare a calibration curve of protein by Folin-Lowry method
5. Extraction and estimation of protein by Folin-Lowry method
6. To prepare a calibration curve of amino acid using Ninhydrin reaction method
7. Extraction and estimation of free amino acid content in germinating seeds by ninhydrin reaction method
8. To determine saponification value of fats and oils
9. Isolation & Identification of Bacteria, Yeasts & Fungi
10. Biochemical Tests: Metabolic Activities of Enteric Bacteria: Sugar Fermentation, IMViC, H<sub>2</sub>S production, Phenylalanine Deaminase, Urea Hydrolysis, Nitrate Reduction, Amylase, Protease
11. Direct ELISA Technique
12. Indirect ELISA Technique
13. Preparation of plant tissue culture media
14. To perform the Ouchterlony double diffusion.
15. To learn the technique of radial immunodiffusion.
16. To learn the technique of agglutination.
17. To determine colour of soil by physical observation and to determine water holding capacity
18. To determine field capacity of soil
19. To determine temperature of soil by thermometer.
20. To determine soil-moisture by oven drying
21. To determine soil texture
22. To estimate the amount of organic carbon by Walkley and Black titration method
23. To estimate the amount of Ca from given soil sample
24. To estimate the amount of Mg from given soil sample
25. To determine the amount of carbonate in the soil by rapid test
26. To determine Calcium Carbonate in the Soil.
27. To determine phosphate content in the soil
28. To determine the alkalinity of given water sample.
29. To determine acidity of given water sample.
30. Dissolved oxygen (DO)
31. Biological oxygen demand (BOD)
32. Bacteriological analysis by MPN
33. Colour, turbidity, odour and pH, TS, TDS and TSS
34. Chloride estimation
35. Sulfate estimation
36. Ca-Mg Hardness/ Estimation of total hardness of water by EDTA method.
37. Demonstration of a state-of-the-art compound microscope with Brightfield, Phase-Contrast, Fluorescence and Darkfield operational details.
38. Demonstration of computer controlled brightfield microscopy
39. Demonstration of Image capturing and Image analysis by Image Analysis software
40. Determination of molecular mass of Protein by size exclusion chromatography (Theoretical)
41. PCR amplification of gene
42. DNA sequencing of the amplified gene
43. To perform sandwich DOT ELISA test for antigen.
44. To perform Western Blot Technique
45. To isolate genomic DNA from bacterial isolate
46. To separate amino acids by ascending paper chromatography
47. To separation of amino acids by TLC method
48. Demonstrate the colorimetric method using Beer's & Lambert's law
49. To perform the separation technique by using centrifugation method

### **SUGGESTED BOOKS :**

1. Biology by Peter Raven, George Johnson, Kenneth Mason, Jonathan Losos, Susan Singer, McGraw Hill Education
2. Cell and Molecular Biology by S.C. Rastogi, New Age international
3. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology by Verma P.S. & Agarwal V.K.
4. Cell Biology by Gerald Karp, Wiley
5. The Cell – A molecular Approach, Cooper and Hausman
6. Molecular cell biology, Lodish, WH freeman
7. Cells, Benjamin Lewin, Jones and Bartlett Publishers, Inc
8. Cell Biology, Devasena, Oxford
9. Cell and Molecular Biology by Eduardo D.P.De Robertis and E.M.P.De Robertis
10. Biology, Raven and Johnson, 2013, McGraw Hill India publication
11. Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings
12. Cell and Molecular Biology by S.C. Rastogi, New Age international
13. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma and Agarwa,
14. Evolution third edition, Mark Ridley, Blackwell Publishing
15. Evolution, Strickberger, Monroe W, Jones & Bartlett Publishers, Inc.
16. Life: The Science of Biology, William, W. H. Freeman
17. Genetic Engineering – Smita Rastogi and Neelam Pathak
18. Genetic Engineering, Verma P.S., S Chand & Company
19. Biodiversity: Perception, Peril and Preservation Prabodh K. Maiti, PHI Learning Private Limited
20. The Bio-Diversity of India, Erach Bharucha, Grantha Corporation
21. Biogeography and Biodiversity, R. B. Singh, Rawat Pubns
22. An Introduction to Biodiversity, Prithipalsingh, Ane books
23. An Advanced Textbook on Biodiversity, K. V. Krishnamurthy
24. Biodiversity Measurement and estimation, Hawksworth, Chapman
25. Fundamentals of Ecology, Eugene Odum, Cengage
26. Concepts of Ecology, Kormondy Edward, Pearson Education
27. Elements of Ecology, Smith, Pearson Education
28. Fundamentals of Ecology and Environmental Biology, S. C. Santra
29. Ecology and Environment, PD Sharma, Rastogi Publications
30. Modern Textbook of Zoology by R.L. Kotpal
31. Introduction to Bio-Statistics, Banerjee Pranab Kumar, S Chand & Company
32. Biostatistics, Veer Bala Rastogi, Medtech
33. Biostatistics Analysis, Zar, Pearson
34. Biostatistics for health and life sciences, Rao K Surya, Himalaya Publishing house
35. Research methodology, C R Kothari, New Age Publishers
36. Principles of Biostatistics by Marcello Pagano, Duxbury Thomson Learning
37. A Text Book of Biotechnology, R. C. Dubey, S. Chand Publication
38. Bioinformatics-A beginners Guide-Claverie J & Notredame C
39. Developing Bioinformatics Computer Skills-Gibas C & Jambeck P
40. The single Genetic Algorithm-Vose M D
41. Bioinformatics-Sequence, structure and Databases –Higgins D & Taylor W
42. Bioinformatics: Methods And Applications-Genomics, Proteomics And Drug Discovery by Rastogi SC, Rastogi P & Mendiratta N, PHI
43. IPR, Biosafety and Bioethics, Goel And Parashar, Person
44. Bioethics and Biosafety M.K. Sateesh, I K International Publishing House
45. Biosafety and Regulation for Genetically Modified Organisms, Xue, lpha Science International Ltd