**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

**New Arts, Commerce and Science College, Ahmednagar**

**(Autonomous)**

**(Affiliated to Savitribai Phule Pune University, Pune)**

**Choice Based Credit System (CBCS)**

**Master of Science (M. Sc.)**

# Syllabus of

# M. Sc. Biochemistry

**Implemented from**

**Academic year 2021 -22**

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

**(Autonomous)**

## Board of Studies in Biochemistry

| Sr.No. | Name | Designation |
|---|---|---|
| 1 | Asso. Prof. P.S.Mutkule | Chairman |
| 2 | Dr. A. E. Athare | Member |
| 3 | Asst.Prof. S.P.Salve | Member |
| 4 | Asso. Prof.S.B.Dare | Member |
| 5 | Dr. S. J. Takate | Member |
| 6 | Asst. Prof. G. A. Tikone | Member |
| 7 | Dr. M. V. Padul | Academic Council Nominee |
| 8 | Dr. M. S. Panchbhai | Academic Council Nominee |
| 9 | Dr. P. S. Vaddadi | Vice ChancellorNominee |
| 10 | Mr. S.G. Pawar | Alumni |
| 11 | Mr. H. S. Joshi | Industry Expert |
| 12 | Asst. Prof .A. S. Wani | Faculty(co-opt) |

## 1. Prologue/ Introduction of the programme:

Through the present curriculum attempt has been made to generate enough interest among the students so that they can pursue education in Biochemistry to take up the career of teaching, research or to serve the needs of medicine, agriculture related industrial establishments.

The discipline of Biochemistry involves the study of the structure and function of biomolecules and the vital processes that occur in living organisms. It is regarded as "Mother of all Biological Sciences" because it unveils the chemical basis of life in all living organisms including plants, animals and microorganisms. Biochemistry has contributed enormously to the growth of modern medical and health science and agriculture. Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases, designing of drugs, and understanding their metabolism and manufacture of various biological products like amino acids, proteins, antibiotics, hormones, enzymes, nutrients, etc. Understanding the biochemical basis of vital processes of plants such as photosynthesis, respiration, hormonal regulation, nutrient assimilation have helped in developing superior varieties of crop plants with better growth attributes and yield. For the estimation of pesticide residues in soil or food grain one has to rely on biochemical tests. The functions and the roles of various nutrients are described only by biochemistry. The composition of food materials including the quality-milk and possible adulterations can be checked by biochemical tests. This discipline has played valuable role in farming, fishery, poultry, sericulture, bee keeping and environment remediation.

Keeping in pace with the developmental trends in various subareas of Biochemistry it is expected that students undertaking Biochemistry course at post graduate level become conversant with the fundamentals of Biochemistry and at the same time at the end of the programme they exhibit certain levels of learning outcomes. Such learning outcomes like understanding of discipline, critical thinking, problem solving, analytical and scientific reasoning, research/ industry related skills, etc. will empower the students to develop their future career with a much better and meaningful orientation.

## 2. Programme outcomes for M.Sc. Biochemistry:

A post graduate student shall be able to develop skill and acquire knowledge in fundamentals of chemistry, biology and will develop disciplinary theory and practical knowledge in the diversified areas of biochemistry. The students are given fundamentals in each course and they are encouraged to become unique by allowing them to perform experiments in the areas of their interest. This will enable the students to equip themselves with the basic practical training in different areas of biochemistry ranging from metabolism, enzymology, clinical biochemistry, molecular biology to genetic engineering and biotechnology etc, to take up further research in these areas or to take up assignments/jobs in Biotech/ biochemical industries. The students should enjoy the academic freedom which will bring out the best from each student. These attributes are elaborated as under:

- **Disciplinary knowledge**:
  a) Ability to understand fundamental concepts of biology, chemistry and biochemistry.
  b) Ability to apply basic principles of chemistry to biological systems and molecular biology.
  c) Ability to relate various interrelated physiological and metabolic events.
  d) A general awareness of current developments at the forefront in biochemistry and allied subjects.
  e) Ability to critically evaluate a problem and resolve to challenge blindly accepted concepts.
  f) Zeal and ability to work safely and effectively in a laboratory.
  g) Good experimental and quantitative skills encompassing preparations of lab reagents, conducting experiments, satisfactory analyses of data and interpretation of results.
  h) Awareness of resources, and their conservation.
  i) Ability to think laterally and in an integrating manner and develop interdisciplinary approach.
  j) Overall knowledge of the avenues for research and higher academic achievements in the field of biochemistry and allied subjects.
- **Communication skills**:
  a) Ability to speak and write clearly in English.

b) Ability to place scientific view points and engage with them.

- **Critical thinking**:
  a) Ability to substantial critical readings of scientific texts in order to persuade others.
  b) Ability to place scientific statements and themes in contexts and also evaluate them in terms of generic conventions.
- **Problem solving**:
  a) Ability to closely observe the situation, and apply lateral thinking and analytical skills.
- **Analytical reasoning** :
  a) Ability to evaluate the strengths and weakness in scholarly texts spotting flaws in their arguments.
  b) Ability to use critics and theorists to create a framework and to substantiate one's argument in one's reading of scientific texts.
- **Research related skills**:
  a) Ability to problematize; to formulate hypothesis and research questions, and to identify and consult relevant sources to find answers.
  b) Ability to plan and write research papers.
- **Teamwork and Time Management:**
  a) Ability to participate constructively in classroom discussions.
  b) Ability to contribute to group work.
  c) Ability to meet a deadline.
- **Scientific Reasoning:**
  a) Ability to analyze text, evaluating ideas and scientific strategies.
  b) Ability to formulate logical and convincing arguments.
- **Reflective Thinking:**
  a) Ability to locate oneself and see the influence of location – regional, national, global- on critical thinking.
- **Self- Directing Learning:**
  a) Ability to work independently in terms of organizing laboratory, and critically analyzing research literature.
  b) Ability to postulate hypothesis, questions and search for answers.

- **Digital Literacy:**
  a) Ability to use digital resources, and apply various platforms to convey and explain concepts of biochemistry.
- **Multicultural Competence:**
  a) Ability to engage with and understand cultures of various nations and respect and transcend differences.
- **Moral and Ethical Values:**
  a) Ability to interrogate one's own ethical values, and to be aware of ethical and environmental issues.
  b) Ability to read values inherited in society and criticism vis a vis, the environment, religion and spirituality, as also structures of power.
- **Leadership Readiness:**
  a) Ability to lead group discussions, to formulate questions related to scientific and social issues.
- **Life-long Learning:**
  a) Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business/life.

# Programme Structure and Course Titles

| Sr. No. | Class | Semester | Course Code | Course Title | Credits |
|---|---|---|---|---|---|
| **Semester I** | | | | | |
| **1** | M.Sc. I | I | **MSC-BC 111 T** | Biomolecules | 04 |
| **2** | M.Sc. I | I | **MSC-BC 112 T** | Cell Biochemistry | 04 |
| **3** | M.Sc. I | I | **MSC-BC 113 T** | Enzymology | 02 |
| **4** | M.Sc. I | I | **MSC-BC 114 P** | Analytical Biochemistry I | 02 |
| **5** | M.Sc. I | I | **MSC-BC 115 P** | Analytical Biochemistry II | 02 |
| **6** | M.Sc. I | I | **MSC-BC 116 P** | Practical Enzymology | 02 |
| **7** | M.Sc. I | I | **MSC-BC 117 T** | Elective Option-A: Genetics<br>OR<br>Elective Option-B: Biostatistics | 02 |
| **8** | M.Sc. I | I | **MSC-BC 118 P** | Elective Option-A:<br>Practical in Genetics<br>OR<br>Elective Option-B:<br>Practical Biostatistics | 02 |
| **9** | M.Sc. I | I | **MSC-BC 119 T** | Protein and Enzyme Technology | 02 |
| **Semester II** | | | | | |
| **10** | M.Sc. I. | II | **MSC-BC 211 T** | Metabolic Reactions | 04 |
| **11** | M.Sc. I. | II | **MSC-BC 212 T** | Physical Biochemistry | 04 |
| **12** | M.Sc. I. | II | **MSC-BC 213 T** | General Microbiology | 02 |

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|---|---|---|---|---|---|
| **13** | M.Sc. I. | II | **MSC-BC 214 P** | Physical Biochemistry Practical I | 02 |
| **14** | M.Sc. I. | II | **MSC-BC 215 P** | Physical Biochemistry Practical II | 02 |
| **15** | M.Sc. I. | II | **MSC-BC 216 P** | Practical in Microbiology | 02 |
| **16** | M.Sc. I. | II | **MSC-BC 217 T** | Elective Option-A: Research Methodology OR Elective Option-B: Bioinformatics | 02 |
| **17** | M.Sc. I. | II | **MSC-BC 218 P** | Elective Option-A: Practical in Research Methodology OR Elective Option-B: Practical in Bioinformatics | 02 |
| **18** | M.Sc. I. | II | **MSC-BC 219 T** | Forensic Science | 02 |
| **Semester III** | | | | | |
| **19** | M.Sc. II | III | **MSC-BC 311 T** | Molecular Biology | 04 |
| **20** | M.Sc. II | III | **MSC-BC 312 T** | Medical Biochemistry and Immunology | 04 |
| **21** | M.Sc. II | III | **MSC-BC 313 T** | Plant Biochemistry | 02 |
| **22** | M.Sc. II | III | **MSC-BC 314 P** | Practical Molecular Biology | 02 |
| **23** | M.Sc. II | III | **MSC-BC 315 P** | Practical Immunology | 02 |
| **24** | M.Sc. II | III | **MSC-BC 316 P** | Practical Plant Biochemistry | 02 |
| **25** | M.Sc. II | III | **MSC-BC 317 T** | Elective option-A: Advance Techniques in Biochemistry OR Elective option-B: | 02 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Pharmacology | |
| **26** | M.Sc. II | III | **MSC-BC 318 P** | Elective option-A:<br>Practical in Advance Techniques in Biochemistry<br>OR<br>Elective option-B:<br>Practical in Pharmacology | 02 |
| **27** | M.Sc. II | III | **MSC-BC 319 T** | Industrial Ethics and Disciplines | 02 |
| **Semester IV** | | | | | |
| **28** | M.Sc. II | IV | **MSC-BC 411 T** | Genetic Engineering | 04 |
| **29** | M.Sc. II | IV | **MSC-BC 412 T** | Endocrinology and Neurochemistry | 04 |
| **30** | M.Sc. II | IV | **MSC-BC 413 T** | Food Technology | 02 |
| **31** | M.Sc. II | IV | **MSC-BC 414 P** | Practical Genetic engineering | 02 |
| **32** | M.Sc. II | IV | **MSC-BC 415 P** | Practical Clinical Biochemistry | 02 |
| **33** | M.Sc. II | IV | **MSC-BC 416 P** | Practical in Food Technology | 02 |
| **34** | M.Sc. II | IV | **MSC-BC 417 T** | Elective option-A:<br>Fermentation Technology<br>OR<br>Elective Option-B:<br>Biology of Infectious Diseases | 02 |
| **35** | M.Sc. II | IV | **MSC-BC 418 P** | Elective option-A:<br>Practical in Fermentation Technology<br>OR<br>Elective Option-B:<br>Practical in Biology of Infectious Diseases | 02 |

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|---|---|---|---|---|---|
| **36** | M.Sc. II | IV | **MSC-BC 419** | Project / Industrial Training | 02 |
| | Total | 04 | **36** | | 88 |

**Ahmednagar Jilha Maratha Vidya Prasarak Samaj's**

# New Arts, Commerce and Science College, Ahmednagar

**(Autonomous)**

# Syllabus of M. Sc I Biochemistry

# under

# Faculty of Science

| | |
|---|---|
| **Semester –I** | **Paper – I** |
| **Course Code: MSC-BC 111 T** | **Title of the Course: Biomolecules** |
| **Credits:** 04 | **Total Lectures:** 60 |

## Course Outcomes:

- Students will be exposed to the history of Biochemistry and contribution of scientist G.N.Ramachandran, Watson and Crick.
- They will study the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoprotein and glycolipids and their importance in biological systems.
- They will understand the methods of determination of amino acid and nucleotides sequence of proteins and DNA respectively

## Detailed Syllabus:

### Section I - Amino acids and Proteins

**Unit1:** The molecular logic of life: (2 L)

-The chemical unity of diverse living organisms.

-Composition of living matter.

-Macromolecules and their monomeric subunits.

**Unit 2:** Amino acids: (5 L)

-Structure of amino acids.

- Classification based on polarity, R- group and nutrition).

-Physical Properties and chemical reactions of amino acids.

- Uncommon amino acids.

**Unit 3:** Proteins: (4 L)

- Classification based on composition, number of subunit, function.
- Reactions and Solid phase synthesis.

**Unit 4:** Structural levels of protein: (10 L)

a. Primary Structure: Peptide bond, importance of primary structure.

b. Secondary structure: α-helix, β-pleated sheets, super secondary structure.

c. Tertiary Structure: Forces stabilizing tertiary structure. Fibrous proteins(α-Keratin/Collagen/Silk Fibroin) and Globular proteins (Myoglobin).

d. Quaternary structure – Hemoglobin.

**Unit 5**: Protein denaturation and folding. (3 L)

**Unit 6:** Ramachandran plot. (3 L)

**Unit 7:** Introduction to Proteomics. (3 L)

**Section II - Carbohydrate, Lipids and Nucleic acid**

**Unit 1**: Water: (2 L)

-Weak interactions in aqueous systems.

- Ionization of water, weak acid weak bases.

-Buffering against pH changes in biological systems.

-Water as reactant.

-The fitness of the aqueous environment for living organisms.

**Unit 2:** Carbohydrates: (10 L)

-Monosaccharides: Basic chemical structure, general reactions and properties.

-Oligosaccharide:

Diasaccharids: Formation of glycosidic linkage, reducing and non-reducing sugars.

Trisaccharides and tetrasaccharides: Structure and function with example.

- Polysaccharide: Homo- and heteropolysaccharides, Structural and Storage polysaccharide (Partial structure and function with example).

-Sugar derivatives, deoxy sugars, amino sugars, and sugar acids.

- Carbohydrate as informational molecules (Sugar code).

-Biological significance of caebohydrate.

**Unit 3:** Lipids: (10 L)

-Building blocks of lipids- Fatty acids, glycerol, ceramide.

-Classification: Structure and function of major lipid subclasses.

- Characteristics of lipids and rancidification.
- Lipoproteins- Chylomicrons, LDL, HDL and VLDL.
-Behavior of lipids in aqueous system.

**Unit 4:** Nucleic acids:

-Structure of purine and pyrimidine. (8 L)

-Nucleosides and nucleotides formation.

- Watson and Crick model of DNA, Chargaff's rule, Forms of DNA.

- Types of RNA (mRNA, rRNA, tRNA, snRNA, gRNA etc).

**Suggested Readings:**

1. Principles of Biochemistry, Lehninger C Rs. Publ. 7th edition (2017).
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco (2008).
3. Schaum's Outline Series of Theory and Problems of Biochemistry
4. Problem Approaches in Biochemistry. Wood and Hood.
5. Biochemistry by Voet and Voet, 4th edition (2010 )

| **Semester –I** | **Paper – II** |
|---|---|
| **Course Code: MSC-BC 112 T** | **Title of the Course:** Cell Biochemistry |
| **Credits:** 04 | **Total Lectures:** 60 |

**Course Outcomes:**

- This course will provide an understanding of the structure of cell and function of various sub-cellular organelles.
- Students will learn about cell theory, basic cell structure of animal and plant cell.
- Students will have an understanding of cytoskeleton and extracellular matrix.
- Students will acquire knowledge of cell cycle, cell division, etc.
- Students will understand composition and structure of biomembrane, types of transporters and transport mechanism across biological membrane.

**Detailed Syllabus:**

**Section I - Cell Biology**

**Unit 1**: Cell: (3 L)

-Structure and differences in prokaryotic cell and eukaryotic cell.

-Cell variability, size, shape and complexity, cell theory.

-Differences in plant cell and animal cell.

**Unit 2:** Animal Cell: (8 L)

-Structure and sub cellular components: Nucleus, chromosomes, plasma membrane, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus, mitochondria, cytoskeleton.

-Specific staining of organelles and marker enzymes.

**Unit 3:** Plant Cells: (4 L)

-Sub cellular components and its function: Chloroplast, xylem, phloem and epidermal cells, Cell wall.

- Interaction and communication between the cells.

**Unit 4:** Fungi: (2 L)

-Cell structure.

- Classification.

-Biological importance.

**Unit 5:** Cell Communication in animals: (5 L)

-Cell-cell adhesion and the extracellular matrix.

-Intercellular recognization.

-Cell junctions.

- Extracellular matrix and role of collagen, elastin and fibronectin.

**Unit 6:** Cell Division: (6 L)

-Cell cycle.

-Mitosis, meiosis.

-Apoptotic death in relation to cell cycle.

**Unit 7:** Stem Cells (2 L)

Introduction, types and potency of stem cell.

## Section II - Membrane Biochemistry

**Unit 1**: Biological membrane : (8 L)

-Structure (Fluid mosaic model), constituents of biomembrane.

- Membrane protein and protein lipid interactions.

-Membrane asymmetry, Lateral, transverse and rotational motion of lipids.

- Types of transporter.

- Membrane associated diseases.

**Unit 2**: Membrane transport: (12 L)

-Simple and facilitated diffusion.

-Role of proteins in the transport.

- Passive transport – Glucose transporter, anion transporter and porins.

- Primary active transport – ATPase, V type ATPase, F type ATPase.

- Secondary active transport – Lactose transport, $Na^+$ - glucose symport.

-ABC family of transporters – MDR, CFTR, Group translocation.

-Ion channels – Voltage gated ion chennels ($Na^+$ and $K^+$ voltage gated ion chennels), Ligand gated ion chennels (acetyl cholin receptor).

- Aquaporins.

**Unit 3**: Vesicular Transport and membrane fusion: (8 L)

-Types of vesicular transport and their function – Clathrin, COP I and COP II coated vesicles.

- Molecular mechanism of vesicular transport.

- Receptor mediated endocytosis of transferrin.

**Unit 4**: Ionophores.: (2 L)

-Ion translocating antibiotics eg. valinomycin, gramicidin, etc.

**Suggested Readings:**


1. Molecular Biology of the cell– Bruce Alberts – J.D. Watson et al 4th edition (2002)
2. Cell and Molecular Biology – DeRobertis and Saunders, 8th edition (2017).
3. The cell – C.P. Swanson, Prentice Hall (1989)
4. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).
5. Principles of Biochemistry, Lehninger C Rs. Publ. 7th edition (2017).
6. Biochemistry, L. Stryer, W.H. Freeman, San Francisco (2008).
7. Biochemistry by Voet and Voet, 4th edition (2010 )


| **Semester –I** | **Paper – III** |
|---|---|
| **Course Code: MSC-BC 113 T** | **Title of the Course:** Enzymology |
| **Credits:** 02 | **Total Lectures:** 30 |

**Course Outcomes:**

- The course will provide fundamental knowledge enzymes their classification and importance in biological reactions.

- Students will understand the difference between a chemical catalyst and biocatalyst and understand activation energy.
- Students will understand kinetics of the enzyme.
- They will study non- protein enzymes such as ribozymes.
- Students will be exposed to industrial and biomedical applications of enzymes.

**Detailed Syllabus:**

**Unit 1**: Basic aspects: (4 L)

-Nature of the enzymes (protein and non-protein).

-Remarkable properties of enzymes (Catalytic power and specificity of enzymes).

-Fischer's lock and key hypothesis and Koshland's induce fit hypothesis.

-Cofactors, prosthetic group, apoenzyme and holoenzyme, isoenzyme and multienzyme.

- Nomenclature and classification of enzymes.

**Unit 2**: Enzymes kinetics: (6 L)

-Relation between initial velocity and substrate concentration, steady state kinetics, equilibrium constant- Monosubstrate reactions.

-Michaelis-Menten equation and Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot.

-Effect of pH, temperature and metal ions on enzyme activity.

- Two substrate reactions: theory, order analysis, pre-steady state kinetics, stopped flow technique, relaxation methods.

**Unit 3**: Mechanism of enzymes action: (10 L)

-Theoretical background.

-Factors leading to rate enhancement of enzyme catalyzed reactions: Proximity and orientation, strain and distortion, Acid-base and covalent catalysis (Chymotrypsin and lysozyme) and change in environment.

- Experimental approaches of determination of enzymes mechanism: Kinetics studies, detection of intermediates, chemical modification of amino acid side chain and affinity labeling.

**Unit 4**: Regulation of Enzyme activity: (9 L)

-Control of activities of single enzyme: Inhibitor molecules, availability of substrate or cofactor and changes in covalent structure of enzymes.

-Zymogen activation and phosphorylation, dephosphorylation, ligand binding and induced changes, allosteric enzymes, Hill equation, Adair equation, M.W.C. and K.N.F. Models, usefulness of the models.

-Significance of allosteric and cooperative behavior in enzymes.

**Suggested Readings:**


1. Fundamentals of Enzymology by Price and Stevens, 3rd edition (1999).
2. Enzymology by Dixon and Webb, 2nd edition (1964).
3. Principles of Biochemistry, Lehninger C Rs. Publ. 7th edition (2017)
4. Enzymes by Palmer
5. Biochemistry, L. Stryer, W.H. Freeman, San Francisco (2008).


| **Semester –I** | **Paper – IV** |
|---|---|
| **Course Code: MSC-BC 114 P** | **Title of the Course:** Analytical Biochemistry I |
| **Credits:** 02 | **Total Lectures:** 60 |

**Course Outcome:**

- The students will gain experimental training for preparation of solutions of various concentration and different buffers.
- The students will gain experimental training for isolation of biomolecules from variety sources.
- They will be able to qualitatively analyse different biomolecules such as proteins, carbohydrates, DNA, RNA, amino acids, etc.

**Detailed Syllabus:**

1. Calculation, preparation of normal, molar and percentage solutions.
2. Specific reactions for carbohydrate.
3. Specific reactions for amino acids.
4. Specific reactions for fatty acids.
5. Isolation of albumin and globulin from egg.
6. Isolation of cholesterol and lecithin from egg.
7. Isolation of casein by IpH precipitation from milk.
8. Isolation of starch from potato and its characterization.
9. Isolation of DNA from bacterial/plant/animal source.
10. Isolation of RNA from yeast/plant.

11. Determination of saponification value.
12. Determination of acid value.

**Suggested Readings:**

1. Biochemical Techniques Theory and Practice: J.R. Robyt and B.J. White
2. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker.
3. Practical Biochemistry by David Plummer
4. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh

| **Semester –I** | **Paper – V** |
|---|---|
| **Course Code: MSC-BC 115 P** | **Title of the Course:** Analytical Biochemistry II |
| **Credits:** 02 | **Total Lectures:** 60 |

**Course Outcomes:-**

- The students will gain experimental training for preparation of solutions.
- They will get ability to quantitatively estimate the amino acid.
- They will get ability to quantitatively estimate the protein
- They will get ability to quantitatively estimate the Nucleic acid
- Student will exposed to the chemical principle behind this specific reactions.

**Detailed Syllabus:**

1. Quantitative estimation of amino acid by Ninhydrin method.
2. Quantitative estimation of protein by Biuret method.
3. Quantitative estimation of protein by Lowry et.al method.
4. Quantitative estimation of protein by Bradford method.
5. Quantitative estimation of sugar by Folin-wu method.
6. Quantitative estimation of sugar by DNSA method.
7. Quantitative estimation of DNA by diphenylamine method.
8. Quantitative estimation of RNA by orcinol method.
9. Quantitative estimation of cholesterol by LB method.
10. Quantitative estimation of Vitamin C from lemon.
11. Quantitative estimation of phosphorus by Fiske-Subbarow method.
12. Quantitative estimation of α-amino nitrogen of amino acid.

**Suggested Readings:**

1. Biochemical Techniques Theory and Practice: J.R. Robyt and B.J. White.
2. Practical Biochemistry: J. Jayaraman.
3. Practical Biochemistry by David Plummer
4. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh

| **Semester –I** | **Paper – VI** |
|---|---|
| **Course Code: MSC-BC 116 P** | **Title of the Course:** Practical Enzymology |
| **Credits:** 02 | **Total Lectures:** 60 |

**Course Outcome:**

- The learning outcomes include estimation of enzyme activity.
- Student will understand the effect of pH on enzyme activity.
- They will be able to determine the optimum temperature.
- They will also know the importance of km and Vmax of enzymes and analysis of enzyme kinetics.
- Students will also learn to immobilize enzymes.

**Detailed Syllabus:**

1. Isolation and detection of enzyme invertase/amylase/peroxidase/catalase.
2. Partial purification of isolated enzyme.
3. Determination of specific activity of enzyme.
4. Influence of substrate concentration on enzyme activity.
5. Influence of enzyme concentration on enzyme activity.
6. Determination of optimum pH of enzyme.
7. Determination of optimum temperature of enzyme.
8. Influence of activator on enzyme activity.
9. Influence of inhibitor on enzyme activity.
10. Determination of type of enzyme inhibition.
11. Determination of $I_{50}$ value.
12. Enzyme immobilization.

**Suggested Readings:**

1. Biochemical Techniques Theory and Practice: J.R. Robyt and B.J. White

2. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker.
3. Practical Biochemistry by David Plummer
4. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh

| **Semester -I** | **Paper – VII** |
|---|---|
| **Course Code: MSC-BC 117 T** | **Title of the Course:**<br>Elective Option-A: Genetics<br>OR<br>Elective Option-B: Biostatistics |
| **Credits:** 02 | **Total Lectures:** 30 |

**Elective Option-A:** Genetics

**Course Outcome:**

1. Students will understand genetics of living beings.
2. Students will understand mutations in DNA.
3. Students will understand Human genetic disorders.
4. Students will learn Pedigree analysis.

**Detailed Syllabus:**

**Unit 1:** Mendelian principles: (3 L)

- Dominance, segregation, independent assortment.

**Unit 2:** Classical concept of a gene: (4 L)

-Allele, pseudoalleles, multiple alleles (blood groups)

-Gene interactions and epistasis and their types.

**Unit 3:** Extensions of Mendelian principles: (4 L)

- Codominance, incomplete dominance, gene interactions.

-Llinkage and crossing over, sex linkage, sex limited and sex influenced characters.

**Unit 4:** Mutations : (6 L)

-Types of mutation.

-Production of mutants by chemical and physical agents and their characterizations.

-Auxotroph, prototroph, conditional mutants.

**Unit 5:** Microbial genetics: (3 L)

- Methods of genetic transfers-Transformation, conjugation and transduction.

**Unit 6:**Population Genetics: (4 L)

- Interbreeding and heterosis..

-Hardy-Weinberg Equation.

**Unit 7:** Human genetics: (6 L)

-Genetic disorders: Chromosomal origin, gene origin, human teratogenesis.

- Pedigree analysis- Diagnostic tools and techniques for human genetic disorder.

- Genetic approaches to complex genetic diseases- hypertension, diabetes and Alzheimer's.

**Suggested Readings:**

1.Genetics: Principles and Analysis. Sudbury, Hartl, D. L., & Jones, E. W. (1998).
2. Genetics: a Conceptual Approach. Pierce, B. A. (2005).
3. Principles of Genetics. Tamarin, R. H., & Leavitt, R. W. (1991).
4. Evolutionary Genetics. Smith, J. M. (1998). Oxford: Oxford University Press.
5. Genetics Author B. D. Singh Edition 2, reprint Publisher Kalyani Publishers.
6. Genetic Mapping and DNA Sequencing edited by Terry Speed, Michael Waterman.

**Elective Option-B:** Biostatistics

**Course Outcomes:**

- Student will understand the principles of collection of data in biological experiments
- Student will understand proper statistical analysis of data and its presentation
- Student will understand the importance of sample size and various variables that affect data
- Student will know the importance mean.
- Student will know the importance of standard deviations

**Detailed Syllabus:**

**Unit 1:** Data collections: (8 L)

-Biological data management using statistical tools.

-Concepts of populations and sample, advantage of sampling, basic concepts in sampling and designing experiments.

-Estimation of sample size for biological experiments, sources of errors. Sample scheme-Simple random sampling, Systemic sapling, Stratified sampling, Cluster sampling, Non-Probability sampling.

-Estimation of mean proportion and standard error in cluster sampling, multistage and multiphase sampling, Types of numerical data- Nominal data, ordinal data, ranked data, discrete data, continuous data;

-Modes of presenting data: Frequency distributions, relative frequency.

**Unit 2:** Analysis of variance (4 L)

Mean, median, mode; Coefficient of variation and standard deviation, range and interquartile range; Grouped mean and grouped variance;Frequency distributions.

**Unit 3:** Probability (4 L)

-Operations on events.

-Conditional probability, Probability distributions.

- Venn diagrams.

**Unit 4:** Hypothesis testing: (6 L)

-General concept- Null hypothesis, alternative hypothesis; Rejection of hypothesis.

- Type I and Type II errors.

-P value and sample size estimation.

**Unit 5:** Regression and correlation: (6 L)

Chi square test- Observed and expected frequencies, Calculating P values, Assumption of chi square goodness of fit; Correlation- Two way scatter plot, Pearson's correlation coefficient; Regression- regression concepts, simple linear regression; Calculation of $R^2$ and $\rho$.

**Unit 6:** Introduction to ANOVA, AMOVA and SPSS. (2 L)

**Suggested Readings:**

1. Principles of biostatistics, M. Pagano and K.Gauvreau (2000)Duxbury Thomas Learnings
2. Analysis of biological data, M. Whitlock and D. Schluter (2009) Roberts and company publisher

| **Semester –I** | **Paper – VIII** |
|---|---|
| **Course Code: MSC-BC 118 P** | **Title of the Course:**<br>Elective Option-A: Practical Genetics |

| | |
|---|---|
| | OR<br>Elective Option-B: Practical Biostatistics |
| **Credits:** 02 | **Total Lectures:** 60 |

**Elective Option-A:** Practical Genetics

## Course Outcomes:

1. Students will learn genetics problem solving in genetics.
2. Students will understand variation in population.
3. Students will understand Human genetic by karyotype analysis.
4. Students will learn Pedigree analysis.

## Detailed Syllabus:

1. Problem set in Mendelian inheritance (Monohybrid cross and Dihybrid cross).
2. Deviation from in Mendelian inheritance (Incomplete dominance and Codominance).
3. Problem set in epistasis (Dominant, Recessive, Duplicate gene).
4. Problem set in Chi-Square test.
5. Problem set based on sex linked inheritance.
6. Pedigree analysis.
7. Problem set based on Hardy-Wenberg principle.
8. Problems based on inbreeding coefficient.
9. Study of *Drosophila melanogaster* (wild type).
10. Study of *Drosophila melanogaster* (mutant type).
11. Studies on Karyotype analysis.

## Suggested Readings:

1.Genetics: Principles and Analysis. Sudbury, Hartl, D. L., & Jones, E. W. (1998).
2. Genetics: a Conceptual Approach. Pierce, B. A. (2005).
3. Principles of Genetics. Tamarin, R. H., & Leavitt, R. W. (1991).
4. Evolutionary Genetics. Smith, J. M. (1998). Oxford: Oxford University Press.
5. Genetics Author B. D. Singh Edition 2, reprint Publisher Kalyani Publishers.

6. Genetic Mapping and DNA Sequencing edited by Terry Speed, Michael Waterman.

**Elective Option-B:** Practical Biostatistics

**Course Outcomes:**

- Student will acquire hands on practical training to plan biological experiments with requisite sample size
- Student will understand proper statistical analysis of data.
- Student will be able to apply the principles of biological data management in real life situations
- Statistical training will improve computational, mathematical skills
- Student will be able to formulate the hypothesis, relevance to type of sample collected and sample size

**Detailed Syllabus:**

1. Estimation of population means and variance in simple random sampling.
2. Collection of data- random sampling method
3. Collection of data- cluster sampling method
4. Collection of data- stratified sampling method
5. Cluster sampling – equal and unequal cluster sizes. Double sampling using regression and ratio estimates and double sampling for stratification.
6. Data representation- frequency and relative frequency distribution table. Plotting of biological data in graphical format.
7. Data analysis- calculating mean, median, mode, variance, standard deviation and standard error for given data set.
8. Data analysis – Standard T- test for group analysis. Analysis of two way variance.
9. Chi square goodness of fit test. Regression analysis and calculating regression coefficient.
10. Learning to analyze data using SPSS software.

**Suggested Readings:**

1. Principles of biostatistics, M. Pagano and K.Gauvreau (2000)Duxbury Thomas Learnings
2. Analysis of biological data, M. Whitlock and D. Schluter (2009) Roberts and company publisher

| **Semester -I** | **Paper – IX** |
|---|---|
| **Course Code: MSC-BC 119 T** | **Title of the Course:** Protein and Enzyme Technology |
| **Credits:** 02 | **Total Lectures:** 30 |

## Course Outcomes:

- This course will provide fundamental knowledge of proteins.
- This course will provide fundamental knowledge of Enzymes.
- They will study the importance of enzymes in industrial and biomedical applications.
- They will be exposed to various techniques of isolation and purification of proteins

## Detailed Syllabus:

**Unit 1:** Introduction to proteins: (6 L)

-Polypeptides and proteins.

-Subunit structure, conjugated proteins, diversity of function.

**Unit 2:** Isolation and analysis of proteins: (6 L)

-Techniques to analyze proteins – salt fractionation, ion exchange chromatography, gel permeation, HPLC, SDS-PAGE, IEF.

**Unit 3:** Introduction to enzyme catalysis: (6L)

-Features of enzyme catalysis, superior catalytic power.

-General mechanism of catalysis.

**Unit 4:** Mechanism of enzyme action and regulation (6L)

-Mechanism of action of trypsin.

-Inhibitors of enzyme – antibiotics.

-Regulation of enzyme activity and its importance – aspartate transcarbamoylase.

**Unit 5:** Enzymes in medicine and industry: (6L)

-Enzymes used in clinical biochemistry as reagents, diagnostics and therapy.

-Role of enzymes in industry.

**Suggested Readings:**

1. Principles of Biochemistry, Lehninger C Rs. Publ. 7th edition (2017).
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco (2008).
3. T.M. Devlin , textbook of biochemistry with clinical correlations, (1982) John Wiley and Sons inc. USA.
4. Harpers Biochemistry – murray Granner, mayes and rodwell – prentice hall international inc.

| **Semester –II** | **Paper - I** |
|---|---|
| **Course Code: MSC-BC 211 T** | **Title of the Course:** Metabolism |
| **Credits:** 04 | **Total Lectures:** 60 |

**Course Outcomes:**

- Students acquire the concept of anabolism, catabolism and role of high energy compounds in the cell.
- They will acquire knowledge related to regulation of various Pathways.
- The importance of lipids as storage molecules and structural components of bio membrane will be a curtained.
- The importance of high energy compounds, electron transport chain, synthesis of ATP under aerobic and aerobic conditions will be understood.
- The role of of TCA cycle in Central carbon metabolism,

**Detailed Syllabus:**

**Section –I Carbohydrate and Lipid Metabolism**

**Unit 1:** Introduction of metabolism and Bioenergetics. (4L)

-Basic law of thermodynamic.

-Internal energy, enthalpy, entropy, concept of free energy, redox potentials, structure and significance of ATP.

**Unit 2:** Carbohydrate metabolism: (8L)

-Reactions, energetics and regulation of glycolysis.

-Fates of pyruvate.

- Gluconeogenesis, Glyoxylate cycle and Glucuronic acid pathway, Pentose phosphate pathway.

- Synthesis and breakdown of glyogen and starch.

**Unit 3:** Citric acid cycle: (4L)

-Production of Acetyl-CoA.

-Reactions, Energetics and Regulation.

**Unit 4:** Electron transport system: (4 L)

Oxidative phosphorylation, ATP synthase and its mechanism.

**Unit 5:** Lipid metabolism: (10 L)

-Types of fatty acid oxidation(α, β and γ)

- β-oxidation of fatty acid energetic with example.

-Formation of ketone bodies.

-Fatty acid synthase complex.

-Biosynthesis of triglycerides, cholesterol, phospholipids, spingolipid and its regulation.

**Section –II Amino acid and Nucleotide metabolism**

**Unit 1:** Oxidative degradation of amino acids: (8 L)

-Proteolysis, transamination, oxidative deamination, decarboxylation.

-Fates of carbon skeleton of amino acids.

- Urea cycle, ammonia excretion.

**Unit 2:** Biosynthesis of amino acids: (8 L)

-Precursor functions of amino acids.

-One carbon atom transfer by folic acid.

-Amino acid biosynthesis (glycine, serine, cysteine, methionine, threonine, histidine)

**Unit 3:** Protein Metabolism: (6 L)

- Polyamines, porphyrins, gamma glutamyl cycle, glutathione biosynthesis, nonribosomal protein biosynthesis.

**Unit 5:**. Nucleotide metabolism: (8 L)

Biosynthesis, degradation and regulation of purine and pyrimidine nucleotides.

**Suggested Readings:**

1. Principles of Biochemistry, Lehninger C Rs. Publ. 7th edition (2017).
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco (2008).
3. Biochemistry, G. L. Zuby,4th edition (1998).W.C.Brown Publishers,USA.
4. Biochemistry (2016) 6th edition, Garret R.H., Grisham C.M. Cengage Learning (Boston).
5. Biochemistry by Voet and Voet, 4th edition (2010 )

| **Semester –II** | **Paper – II** |
|---|---|
| **Course Code: MSC-BC 212 T** | **Title of the Course:** Physical Biochemistry |
| **Credits: 4** | **Total Lectures:** 60 |

**Course Outcomes:**

- Students will be exposed to various chromatography technique
- Student will learn to apply techniques in isolation of different Biological molecules
- They will gain insight into purification of proteins by various techniques
- Student will learn the separation of nucleic acid and proteins using electrophoresis

**Detailed Syllabus:**

**Section-I Biophysical Techniques**

**Unit 1:** Sedimentation (8 L)

Theory, Preparatory and Analytical ultracentrifuges, factors affecting sedimentation velocity, measurement of Sedimentation Coefficient, Zonal centrifugation, Specific example of application

**Unit 2:** Membrane filtration (4 L)

Nitrocellulose, Fibre glass, Polycarbonate filters, Dialysis and Reverse dialysis

**Unit 3:** Chromatography (8 L)

Partition and Adsorption Chromatography- paper, TLC,GLC,GSC, gel filtration, ion exchange chromatography, affinity chromatography, hydrophobic interaction chromatography, metal chelate chromatography, covalent chromatography.DNA cellulose chromatography, MAK hydroxyl-apatite chromatography

**Unit 4:** Electrophoresis (5 L)

Types of electrophoresis: moving boundary electrophoresis and zone electrophoresis. Paper Electrophoresis, Cellulose-acetate electrophoresis, Gel Electrophoresis,2D gel electrophoresis, Isoelectric focusing

**Unit 5:** Viscosity (5 L)

Theory, effect of macromolecules on the viscosity of a solution, Measurement of viscosity , molecular weight determination.

**Section II- Techniques for Characterization of Biomolecules**

**Unit 1:** Spectroscopy

Principle, instrumentation, methodology and biological applications of

- Atomic Absorption Spectroscopy (AAS), (3 L)
- UV-Visible spectroscopy, Infra red (IR) spectroscopy, (5 L)
- Nuclear Magnetic Resonance (NMR) spectroscopy, (2 L)
- Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD), (5 L)
- Spectrofluorimeter and polarization of fluorescence (5 L)

**Unit 2:** Mass Spectrometry (10 L)

Principle, component's, working and applications of mass spectrometer,

- Ionization methods used in mass spectrometer (CI,EI,ESI),
- Mass analysers used in mass spectrometer (magnetic sector, quadrapole),
- MALDI-MS, MALDI-TOF-MS

**Suggested Readings:**

1. Physical Biochemistry by D. Freifelder IInd Edition
2. Biochemical techniques by Wilson and Walker,
3. Biophysical techniques by Upadhye and Upadhye,
4. Molecular cell biology 4th ed. Lodish B. Ball, 4th edition

| **Semester -II** | **Paper - BC III** |
|---|---|
| **Course Code: MSC-BC 213 T** | **Title of the Course: General Microbiology** |
| **Credits: 2** | **Total Lectures: 30** |

**Course Outcomes:**

- Students will understand cell structure and components of prokaryotes.
- They will understand the importance of microorganisms as a model system in genetics and biochemistry will be explained.
- Students will be exposed to basic concept of handling microorganism.
- Student will learn host microbe interaction.
- Students will acquire knowledge of sterilization, media preparation etc.

**Detailed Syllabus:**

**Unit 1:** 1. Introduction : (2 L)

Cell structure and components, characterization and classification of microorganisms.

**Unit 2**: Microscopy: (4 L)

-Principle and Application of phase contrast microscopy, fluorescence microscopy and electron microscopy.

-Specimen preparation, freeze etching, freeze fracture, shadow casting, electron microscopy of nucleic acids.

**Unit 3:** Cultivation of Bacteria: (6 L)

-Nutrition, physiology and growth of microbial cells, reproduction and growth, synchronous growth, continuous culture of microorganisms.

- Pure cultures and their characteristics.

**Unit 4:** Fundamentals of control of microbial growth: (6 L)

-Use of physical agents for sterilization.

-Chemical and biochemical agents to control growth of microorganism.

**Unit 5:** Host microbe interactions: (5 L)

-Endotoxins, exotoxins, capsular material.

- Tissue affinity, resistance and immunity.

**Unit 6:** Viruses: (5 L)

Viruses of bacteria, plant and animal cells, (Structure, classification and life cycle), mycoplasma and viriods, diseases.

**Unit 7**: Nitrogen fixation: (2 L)

Historical background, nitrogen cycle in nature, symbiotic nitrogen fixation, nitrogenase system, nitrate reductase.

**Suggested Readings:**

1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, Mc Graw Hill, New York, 5th edition (2001).
2. General Microbiology (Vth Edition), R.Y. Stanier, Prentice Hall (1986)
3. Biology of Microorganisms by Brocks, 12th edition (2009)
4. Introductory Microbiology, F.C. Ross, Charles Merril Publication (1983).

| **Semester -II** | **Paper - IV** |
|---|---|

| **Course Code: MSC-BC 214 P** | **Title of the Course:** Physical Biochemistry I |
|---|---|
| **Credits: 2** | **Total Lectures:** 60 |

## Course Outcomes:

- Student will learn the preparation of buffer and measurement of pH.
- Student will obtain hands on training in handling the electrophoresis unit.
- Student will obtain hands on training in handling the paper chromatography and TLC.
- Student will obtain hands on training in handling column chromatography.
- Student will learn the difference between various separation techniques.

## Detailed Syllabus:

1. Preparation of acidic and basic buffer of desired molarity.
2. Determination of pH using pH meter and pH indicators.
3. Determination of pI and pKa of amino acid using pH meter.
4. Determination of nature and capacity of ion exchange column.
5. Separation of amino acids by ion exchange chromatography.
6. Separation and detection of amino acids by using paper chromatography/TLC.
7. Separation plant pigments by using paper chromatography.
8. Separation plant pigments by using column chromatography using silica gel-G.
9. Separation of lipids by TLC.
10. Separation of proteins by gel filtration chromatography.
11. Separation of proteins by polyacrylamide gel electrophoresis (Native-PAGE).
12. Separation of DNA by agarose gel electrophoresis.

## Suggested Readings:

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. (2015) 3rd Edition.
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry by Sadasivam and Manickam.
4. Practical Biochemistry, Principles and Techniques (1995). Ed. Keith Wilson and John Walker. . (2006) 5th Edition.
5. Practical Biochemistry by J. Jayaraman.
6. Practical Biochemistry by Shinde and Rao.

| Semester –II | Paper - V |
|---|---|
| **Course Code: MSC-BC 215 P** | **Title of the Course:** Physical Biochemistry II |
| **Credits: 2** | **Total Lectures:** 60 |

**Course Outcomes:**

- Student will obtain hands on training in handling the spectrophotometer.
- Student will get expertise in separating subcellular components by centrifugation.
- Student will learn determining viscosity of biomolecules.
- Student will get expertise in isolation of various cellular organelles.
- Student will learn to concentrate biomolecules by dialysis and reverse dialysis.

**Detailed Syllabus:**

1. Verification of Lamberts-Beer's Law using Colorimeter/Spectrophotometer.
2. Absorption spectrum of proteins and determination of it's λmax.
3. Absorption spectrum of nucleic acids and determination of it's λmax.
4. Determination of relative viscosity of hydrolyzed and unhydrolyzed starch.
5. Determination of specific viscosity of hydrolyzed and unhydrolyzed starch.
6. Sub- cellular fractionation by sedimentation.
7. Isolation of mitochondria from liver and assay of marker enzyme.
8. Isolation of chloroplast pigments from spinach leaves.
9. Separation/ Purification of biomolecules by using dialysis.
10. Concentrate the sample using Reverse dialysis.

**Suggested Readings:**

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay. (2015) 3rd Edition
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry by Sadasivam and Manickam.
4. Practical Biochemistry, Principles and Techniques (1995). Ed. Keith Wilson and John Walker. (2006) 5th Edition
5. Practical Biochemistry by J. Jayaraman
6. Practical Biochemistry by Shinde and Rao

| Semester -II | Paper - VI |
|---|---|
| **Course Code: MSC-BC 216 P** | **Title of the Course:** Practical Microbiology |
| **Credits: 2** | **Total Lectures:** 60 |

**Course Outcomes:**

- Student will gain to identify different microbes
- Student will learn culturing bacteria in different media
- Student will learn media preparations, sterilization , maintenance of bacterial culture
- Student will learn routine microbiological practices.
- Student will learn staining techniques
- They will acquire expertise in to culture and screen microbes for antibiotic resistance

**Detailed Syllabus:**

1. Culture media preparation and sterilization.
2. Isolation of bacteria from soil or sewage water.
3. Culture transfer techniques:
    a) Solid to solid (streaking).
    b) Liquid to solid (spreading)
    c) Solid to liquid
    d) Liquid to liquid
4. Microscopic examination:
    a) Monochrome staining.
    b) Gram's staining.
    c) Negative staining.
    d) Motility testing by hanging drop technique.
    e) Capsular staining
5. Colony characterization and biochemical test in organism identification.
6. Cell counting by haemocytometer and determination of CFU/ml.
7. Methylene blue reduction test (MBRT) for quality of milk.
8. Growth curve of *E. coli*.
9. Total viable count determination (pour plate).
10. Microbial assay of antibiotic.
11. Plaque assay for phage.

12. UV survival curve.

**Suggested Readings:**


1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, Mc Graw Hill, New York, 5th edition (2001).
2. General Microbiology (Vth Edition), R.Y. Stanier, Prentice Hall (1986)
3. Biology of Microorganisms by Brocks, 12th edition (2009)
4. Introductory Microbiology, F.C. Ross, Charles Merril Publication (1983).


| **Semester –II** | **Paper - VII** |
|---|---|
| **Course Code: MSC-BC 217 T** | **Title of the Course:**<br>Elective Option-A: Research Methodology<br>OR<br>Elective Option-B: Bioinformatics |
| **Credits: 2** | **Total Lectures:** 30 |

**Elective Option-A:** Research Methodology

**Course Outcomes:**

- Student will understand the objectives of doing scientific research
- They will learn how to identify area of research to be conducted
- How to proceed for literature survey using variety of sources
- Students will learn how to write research proposal with well laid hypothesis and objectives
- They will learn the skills of research design, nature of sample size as well as collection and analysis of data

**Detailed Syllabus:**

**Unit 1:** Research Methods: (6 L)

-Scientific research: Scientific methods and problem solving, Various phases of research.

- Major steps in the research process: Literature review, research proposal and aspects, Review of literature using appropriate sources – reviews, patents, research papers, books.

**Unit 2:** Research Design: (8 L)

-Types of research design – exploratory, descriptive, experimental, survey and case study.

-Sampling techniques and sample size determination.

Sample – Types, criteria, characteristics and steps.

**Unit 3:** Research reports: (10 L)

-Data preparation and preliminary analysis, Statistical analysis, Model building and decision making.

-Types of research documents, writing and formatting of reports, presentation, interpretation, art of oral presentation, format of publication in research journals.

-Journal Impact factor, citation index, h-index and i-10 index.

**Unit 4:** Bio-Ethics: (6 L)

-Bio-ethical concerns, Plagiarism, Citation and acknowledgement.

**Suggested Readings:**

1. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers ( 2011) ISBN 978-81-224-1522-3
2. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (2013), ISBN-10: 8191064278, ISBN-13: 978-8191064278
3. Writing Science: How to Write Papers That Get Cited and Proposals That Get FundedJoshua Schimel, Oxford University Press, (2011), ISBN: 9780199760

**Elective Option-B:** Bioinformatics

**Course Outcomes:**

- Studying this course students will have an understanding of tools of bioinformatics and computational biology and will be we are in position to access biological databases and

software which will be helpful in understanding sequential regiments and predicting the structure of biomolecules such as protein.

- Students will be exposed to available bioinformatics tools and databases.
- They will be in a position to complete the fundamental aspects of *in silico* protein structure prediction.
- They will understand application of theoretical approaches to biological systems.
- Students will get trained in applications of program use for database searching protein and DNA sequence analysis and prediction of protein structures.

## Detailed Syllabus:

**Unit 1: Introduction to Bioinformatics**: (1 L)

-Definition, History and Applications of Bioinformatics

**Unit 2: Biological Databases**: (8 L)

-Concept of database and types of Biological databases, various databases (NCBI, SwissProt, PDB) and bioinformatics tools, Nucleic acid sequence databases (GenBank), Protein sequence databases (UniProt), Genome Databases, 3D Structure Database (PDB), Literature Database (PubMed).

**Unit 3: Sequence Analysis**: (10 L)

-File formats, Basic concepts of sequence analysis.

- Scoring matrices.

- Pair wise sequence alignments, Multiple sequence alignment, Database Searches (BLAST, FASTA)

**Unit 4: Structural bioinformatics:** (6 L)

-Overview and Introduction to Protein Structure.

- Visualization of structures using Rasmol or SPDBV.

- Structure prediction by Homology Modeling.

**Unit 5: Phylogenetic analysis:** (5 L)

-Introduction to Molecular Phylogeny.

- Choice of Molecular Marker.

- Overview of methods of Phylogeny.

## Suggested Readings:

1. Essential Bioinformatics – Jin Xiong Cambridge University Press; 1st edition, Cambridge.
2. A text book of bioinformatics (2008) Sharma, Munjal and Shankar. Rastogi Publications, Meerut.
3. Introduction to Bioinformatics (2008) Arthur M. Lesk OUP, Oxford

| **Semester –II** | **Paper - VIII** |
|---|---|
| **Course Code: MSC-BC 218 P** | **Title of the Course:**<br>Elective Option-A: Research Methodology Practical<br>OR<br>Elective Option-B : Practical Bioinformatics |
| **Credits: 2** | **Total Lectures:** 60 |

**Elective Option-A:** Research Methodology

## Course Outcomes:

- Student will acquire the knowledge of using excel for data analysis and interpretation
- They will gain the knowledge of making power point presentations.
- They will gain the knowledge of how to review a research paper.
- They will know how to use media tools for research purpose.
- Student will learn the skill of research designing.
- They will learn writing a research proposal.
- They will be exposed to policies of different funding agencies.
- They will be able to perform skilled presentations of their proposal.

## Detailed Syllabus:

1. Use of Google Scholar, Scopus, Science Direct, PubMed, LibGen, Sci-Hub, etc. for research.
2. Use of Mendeley for citation and bibliography.
3. Introduction to MS-word for research writing.
4. Use of MS-Word for reference writing.
5. Use of Excel for measurement of Central Tendency (Mean, Median, Mode).

6. Use of Excel for Measurement of Dispersion/variability (Mean Deviation, Standard Deviation, Co efficient of variation).
7. Use of Excel for data representation by Line Graph, Bar graph, Pie chart, etc.
8. Introduction to MS- power point.
9. Use of MS- power point for preparing PPT.
10. Use of ChemDraw for chemical and biological structure drawing.
11. Writing of review article.
12. Preparation of research proposal for submitted to the funding agencies. (Submit it as report).
13. Presentation of prepared proposal.
14. Tools for plagiarism detection.

**Suggested Readings:**

1. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers ( 2011) ISBN 978-81-224-1522-3
2. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (2013), ISBN-10: 8191064278, ISBN-13: 978-8191064278
3. Writing Science: How to Write Papers That Get Cited and Proposals That Get FundedJoshua Schimel, Oxford University Press, (2011), ISBN: 9780199760

**Elective Option-B:** Practical Bioinformatics

**Course Outcomes:**

1. The student will acquire training in different areas of bioinformatics related to various biological databases such as protein databases, nucleic acid databases, metabolic pathway databases, etc.
2. With training in multiple sequence alignment they will be in a position to perform *in silico* experiments and will predict structures of proteins.

**Detailed Syllabus:**

1. Referencing in Scientific literature and their practical usage- PubMed.
2. Study of biological databases GenBank, DDBJ.
3. Study of biological databases- EMBL, UniProt, PDB.
4. Sequence retrieval from biological databases.
5. Pair wise sequence alignment - Local and Global alignment
6. Multiple Sequence Alignment – Clustal Omega, Clustal X, T-Coffee, Muscle.

7. Databases search for homologous sequence using BLAST.
8. Databases search for homologous sequence using FASTA.
9. Protein structure visualization and prediction tools- RASMOL, SwissPDB Viewer, Swiss Model.
10. Phylogenetic tree construction using MEGA.

**Suggested Readings:**


1. Bioinformatics: Sequence, Structure and Databanks: A Practical Approach (The Practical Approach Series, 236), Des Higgins (Editor), Willie Taylor. 1st edition, October 2000, Oxford University Press. ISBN: 978-0199637904.
2. Bioinformatics: Sequence and Genome Analysis, David W. Mount. 2nd edition, June 2004, Cold spring harbor laboratory press. ISBN: 978-0879697129
3. Introduction to Bioinformatics, Teresa Attwood, David Parry-Smith, 1st edition, May 2001, Pearson Education. ISBN: 978-8178085074
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition, Andreas D. Baxevanis, B. F. Francis Ouellette. 3nd edition, October 2004, A John Wiley & Sons, Inc., Publication. ISBN: 978-0471478782.


| **Semester –II** | **Paper - IX** |
|---|---|
| **Course Code: MSC-BC 219 T** | **Title of the Course:** Forensic Science |
| **Credits: 2** | **Total Lectures:** 30 |

**Course Outcomes:**

After studying this paper the students will know –

- The significance of forensic science to human society.
- The fundamental principles and functions of forensic science.
- The work nature in a forensic science laboratory.
- Encourage academic students towards the noble career

**Detailed Syllabus:**

**Unit 1:** General forensic science (10 L)

Introduction, Development, principle, role and prospective of forensic science, Divisions of forensic science laboratory, stages in crime scene investigation, chemical evidences in forensic science.

**Unit 2:** Forensic Chemistry and drugs of abuse (10 L)

Introduction, theory of forensic analysis, introduction to drug abuse, psychoactive drugs, opium, depressants, stimulants, hallucinogens, alkaloids, drug abuse-case studies

**Unit 3:** Forensic Biology and serology (10 L)

Introduction, general definitions and concept, nature and role of forensic biologists in crime scene investigation, introduction to biological fluids and their types, nature, location, collection and laboratory handling of biological evidences.

**Suggested Readings:**

1. R. Saferstein, *Criminalistics*, 8th Edition, Prentice Hall, New Jersey (2004).
2. S.B. Karch, *The Pathology of Drug Abuse*, CRC Press, Boca Raton (1996).
3. Poklis, Forensic toxicology in, *Introduction to Forensic Sciences*, 2nd Edition, W.G. Eckert (Ed.), CRC Press, Boca Raton (1997).
4. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's, *Techniques of Crime Scene Investigation*, CRC Press, Boca Raton (2013).
5. Forensic Analytical Techniques, Barbara Stuart University of Technology, Sydney, Australia, first edition 2013, John Wiley & Sons, Ltd. 143-166.

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