

**M.Sc. BIOCHEMISTRY**

**CHOICE BASED CREDIT SYSTEM -  
LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)**

(Applicable to the candidates admitted from the academic year 2026- 2027 onwards)

| Sem                                                                                                 | Course                                            | Course Title                                                                                      | Ins.<br>Hrs. | Credit    | Exam<br>Hrs. | Marks    |          | Total      |
|-----------------------------------------------------------------------------------------------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------|-----------|--------------|----------|----------|------------|
|                                                                                                     |                                                   |                                                                                                   |              |           |              | Int.     | Ext.     |            |
| I                                                                                                   | Core Course - 1 (CC - 1)                          | Basics of Biochemistry                                                                            | 6            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Core Course - 2 (CC - 2)                          | Analytical and Molecular Techniques                                                               | 6            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Core Practical -1 (CP - 1)                        | Biomolecules and Techniques                                                                       | 6            | 4         | 3            | 40       | 60       | 100        |
|                                                                                                     | Discipline Centric Elective Course - 1 (DCEC - 1) | 1. Nutritional Biochemistry<br>(or)<br>2. Cell Biology                                            | 5            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Generic Elective Course - 1 (GEC - 1)             | 1. Biostatistics<br>(or)<br>2. Food Microbiology<br>(or)<br>3. Developmental Biology              | 5            | 3         | 3            | 30       | 70       | 100        |
|                                                                                                     | Skill Enhancement Course - 1 (SEC - 1)            | AI in Health Care                                                                                 | 2            | 2         | 3            | 30       | 70       | 100        |
|                                                                                                     | Value Added Course - 1 (VAC - 1) *                | Detection Methods of Food Adulteration                                                            | -            | 2*        |              | 30       | 70       | 100*       |
| <b>Total</b>                                                                                        |                                                   |                                                                                                   | <b>30</b>    | <b>21</b> | <b>-</b>     | <b>-</b> | <b>-</b> | <b>600</b> |
| II                                                                                                  | Core Course - 3 (CC - 3)                          | Advanced Enzymology                                                                               | 6            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Core Course - 4 (CC - 4)                          | Intermediary Metabolism and Regulation                                                            | 6            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Core Practical - 2 (CP - 2)                       | Enzymology (P)                                                                                    | 6            | 4         | 3            | 40       | 60       | 100        |
|                                                                                                     | Discipline Centric Elective Course - 2 (DCEC - 2) | 1. Biotechnology and Genetic Engineering<br>(or)<br>2. Human Physiology                           | 4            | 4         | 3            | 30       | 70       | 100        |
|                                                                                                     | Generic Elective Course - 2 (GEC - 2)             | 1. Bioinformatics<br>(or)<br>2. Ecology and Environmental Biology<br>(or)<br>3. Bioethics and IPR | 4            | 3         | 3            | 30       | 70       | 100        |
|                                                                                                     | Skill Enhancement Course - 2 (SEC - 2)            | Communications and Scientific Writing                                                             | 2            | 2         |              | 30       | 70       | 100        |
|                                                                                                     | Non-Major Elective Course - 1 (NMEC - 1)          | One Course from Outside department                                                                | 2            | 2         | 3            | 30       | 70       | 100        |
| <b>Total</b>                                                                                        |                                                   |                                                                                                   | <b>30</b>    | <b>23</b> | <b>-</b>     | <b>-</b> | <b>-</b> | <b>700</b> |
| <b>Summer Internship / Industrial Activity during the Summer Vacation after 1<sup>st</sup> Year</b> |                                                   |                                                                                                   |              |           |              |          |          |            |

|             |                                                   |                                                                                                   |    |    |    |    |    |      |
|-------------|---------------------------------------------------|---------------------------------------------------------------------------------------------------|----|----|----|----|----|------|
| III         | Core Course - 5 (CC - 5)                          | Molecular Biology                                                                                 | 6  | 4  | 3  | 30 | 70 | 100  |
|             | Core Course - 6 (CC - 6)                          | Clinical Biochemistry                                                                             | 6  | 4  | 3  | 30 | 70 | 100  |
|             | Core Practical -3 (CP - 3)                        | Molecular and Clinical Biochemistry (P)                                                           | 6  | 4  | 2  | 40 | 60 | 100  |
|             | Discipline Centric Elective Course - 3 (DCEC - 3) | 1. Pharmaceutical Biochemistry<br>(or)<br>2. Biochemistry of Signal Transduction                  | 5  | 4  | 2  | 30 | 70 | 100  |
|             | Generic Elective Course - 3 (GEC - 3)             | 1. Nanotechnology<br>(or)<br>2. Research Methodology<br>(or)<br>3. Genomics and Proteomics        | 5  | 3  | 3  | 30 | 70 | 100  |
|             | Non-Major Elective Course - 2 (NMEC - 2)          | One Course from Outside department                                                                | 2  | 2  | 3  | 30 | 70 | 100  |
|             | Internship / Industrial Activity @                |                                                                                                   |    | 2  |    | 20 | 80 | 100  |
| Total       |                                                   |                                                                                                   | 30 | 23 | -  | -  | -  | 700  |
| IV          | Core Course - 7 (CC - 7)                          | Endocrinology                                                                                     | 6  | 4  | 3  | 30 | 70 | 100  |
|             | Core Course - 8 (CC - 8)                          | Immunology                                                                                        | 6  | 4  | 3  | 30 | 70 | 100  |
|             | Core Course - 9 (CC - 9)                          | Microbial and Plant Biochemistry                                                                  | 6  | 4  | 3  | 30 | 70 | 100  |
|             | Discipline Centric Elective Course - 4 (DCEC - 4) | 1. Environmental chemistry and Toxicological Biochemistry<br>(or)<br>2. Chromatin and Epigenetics | 4  | 4  | 2  | 30 | 70 | 100  |
|             | Entrepreneurship / Industry Based Course @        | Bioentrepreneurship                                                                               | 3  | 3  | 3  | 30 | 70 | 100  |
|             | Project Work @                                    |                                                                                                   | 5  | 5  | -  | 20 | 80 | 100  |
|             | Value Added Course - 2 (VAC - 2)*                 | Herbal Technology                                                                                 | -  | 2* |    | 30 | 70 | 100* |
|             | Total                                             |                                                                                                   |    | 30 | 24 | -  | -  | -    |
| Grand Total |                                                   |                                                                                                   |    | 91 |    |    |    | 2600 |

### LIST OF DISCIPLINE CENTRIC ELECTIVE COURSE

| <b>Discipline Centric Elective Course - 1 (DCEC - 1)</b> |                                                        |
|----------------------------------------------------------|--------------------------------------------------------|
| 1.                                                       | Nutritional Biochemistry                               |
| 2.                                                       | Cell Biology                                           |
| <b>Discipline Centric Elective Course - 2 (DCEC - 2)</b> |                                                        |
| 1.                                                       | Biotechnology and Genetic Engineering                  |
| 2.                                                       | Human Physiology                                       |
| <b>Discipline Centric Elective Course - 3 (DCEC - 3)</b> |                                                        |
| 1.                                                       | Pharmaceutical Biochemistry                            |
| 2.                                                       | Biochemistry of Signal Transduction                    |
| <b>Discipline Centric Elective Course - 4 (DCEC - 4)</b> |                                                        |
| 1.                                                       | Environmental chemistry and Toxicological Biochemistry |
| 2.                                                       | Chromatin and Epigenetics                              |

### LIST OF NON-MAJOR ELECTIVE COURSE (NMEC) (for other Department Students only)

| <b>NON-MAJOR ELECTIVE COURSE – 1 (NME-1)</b> |                                           |
|----------------------------------------------|-------------------------------------------|
| 1.                                           | Diet and Lifestyle Modifications          |
| <b>NON-MAJOR ELECTIVE COURSE – 2 (NME-2)</b> |                                           |
| 2.                                           | Biochemical Analysis of Food Adulteration |

### LIST OF GENERIC ELECTIVE COURSE (GEC)

| <b>GENERIC ELECTIVE COURSE - 1 (GEC - 1)</b> |                                   |
|----------------------------------------------|-----------------------------------|
| 1.                                           | Biostatistics                     |
| 2.                                           | Food Microbiology                 |
| 3.                                           | Developmental Biology             |
| <b>GENERIC ELECTIVE COURSE - 2 (GEC - 2)</b> |                                   |
| 1.                                           | Bioinformatics                    |
| 2.                                           | Ecology and Environmental Biology |
| 3.                                           | Bioethics and IPR                 |
| <b>GENERIC ELECTIVE COURSE - 3 (GEC - 3)</b> |                                   |
| 1.                                           | Nanotechnology                    |
| 2.                                           | Research Methodology              |
| 3.                                           | Genomics and Proteomics           |

## SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

| Sl. No.               | Types of the Course                        | No. of Courses | Credits for each Course | Total Credits | Marks       |
|-----------------------|--------------------------------------------|----------------|-------------------------|---------------|-------------|
| 1.                    | Core Course                                | 9              | 4                       | 36            | 900         |
| 2.                    | Core Practical                             | 3              | 4                       | 12            | 300         |
| 3.                    | Discipline Centric Elective Course         | 4              | 4                       | 16            | 400         |
| 4.                    | Generic Elective Course                    | 3              | 3                       | 9             | 300         |
| 5.                    | Skill Enhancement Course                   | 2              | 2                       | 4             | 200         |
| 6.                    | Non-Major Elective Courses                 | 2              | 2                       | 4             | 200         |
| 7.                    | Internship / Industrial Activity @         | 1              | 2                       | 2             | 100         |
| 8.                    | Entrepreneurship / Industry Based Course @ | 1              | 3                       | 3             | 100         |
| 9.                    | Project @                                  | 1              | 5                       | 5             | 100         |
| <b>Total</b>          |                                            | <b>26</b>      | <b>-</b>                | <b>91</b>     | <b>2600</b> |
| Value Added Courses * |                                            | 2*             | 2                       | 4*            | 200*        |

| *           | <p><b>The value-added courses credit will not be included in the total CGPA. These courses are extra-credit courses.</b></p> <p><b>Instruction hours for these courses is 30 hours</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |             |       |        |    |      |    |       |     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-------|--------|----|------|----|-------|-----|
| @           | <p>Summer Internship will be carried out during the summer vacation after the First year. Viva Voce will be conducted by the college and Marks shall be sent to the University and the same will be included in the 3<sup>rd</sup> semester Mark Statement.</p> <p><b>Summer Internship / Industrial Activity &amp; Project Scheme of Evaluation:</b></p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left;">Description</th><th style="text-align: center;">Marks</th></tr> <tr> <td>Report</td><td style="text-align: center;">80</td></tr> <tr> <td>Viva</td><td style="text-align: center;">20</td></tr> <tr> <td>Total</td><td style="text-align: center;">100</td></tr> </table> | Description | Marks | Report | 80 | Viva | 20 | Total | 100 |
| Description | Marks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |             |       |        |    |      |    |       |     |
| Report      | 80                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |       |        |    |      |    |       |     |
| Viva        | 20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |       |        |    |      |    |       |     |
| Total       | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |             |       |        |    |      |    |       |     |

**Programme outcomes (PO):**

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PO 1</b> | Disciplinary Knowledge: Broad and in-depth knowledge of advanced scientific concepts, principles, and methodologies within the chosen domain. Ability to critically explain, integrate, and apply scientific knowledge to theoretical and practical problems. Opportunities to earn additional credits through specialized and interdisciplinary courses further enhance expertise and broaden disciplinary understanding.                   |
| <b>PO 2</b> | Critical Thinking: Field visits, academic interactions, and experiential learning activities will help students develop critical observation, interpretation, and analytical skills. Ability to evaluate and interpret scientific data, formulate hypotheses, and draw logical conclusions. Encourages independent thinking and the ability to assess scientific problems from multiple perspectives.                                        |
| <b>PO3</b>  | Analytical Reasoning: Through classroom discussions, scientific literature reviews, and interactive learning environments, students will strengthen their analytical reasoning abilities. Ability to critically evaluate scientific texts, identify gaps in existing knowledge, formulate research questions, and synthesize new ideas and concepts. Promotes evidence-based reasoning and logical interpretation of scientific information. |
| <b>PO 4</b> | Scientific Reasoning: Strong foundation in scientific methods, experimental design, and data interpretation through laboratory-based courses. Enhances practical knowledge of scientific instrumentation, calibration procedures, laboratory safety, and appropriate research techniques. Ability to conduct scientifically sound experiments and interpret results accurately.                                                              |
| <b>PO 5</b> | Self-Directed Learning: Encourages independent and self-directed learning through assignments, field reports, project work, and                                                                                                                                                                                                                                                                                                              |

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|             | literature-based studies. Ability to organize, analyze, and present scientific findings in professional formats relevant to academic and industrial settings. Fosters responsibility, time management, and continuous self-improvement in learning.                                                                                                                                                                                                        |
| <b>PO 6</b> | Reflective Thinking: Laboratory-intensive core courses will expose students to a broad range of research methodologies and experimental techniques. Ability to reflect on learning experiences, evaluate the effectiveness of scientific approaches, and understand the broader applications of scientific techniques within the discipline.                                                                                                               |
| <b>PO 7</b> | Problem-Solving Skills: Ability to develop and apply scientific principles, quantitative reasoning, and mathematical concepts to solve discipline-specific problems. Ability to analyze experimental data, interpret scientific observations, and derive meaningful conclusions. Prepares students to address real-world scientific and societal challenges effectively.                                                                                   |
| <b>PO 8</b> | Research-Related Skills: Internships, dissertation work, and research-oriented projects provide opportunities to design, develop, and execute independent research studies. Students gain hands-on experience in research methodology, experimental techniques, data analysis, scientific writing, and ethical research practices. These experiences strengthen laboratory competence and prepare students for advanced research and professional careers. |
| <b>PO 9</b> | Lifelong Learning: Cultivates a mindset of continuous learning and professional adaptability. Ability to identify gaps in knowledge and skills, adapt to emerging technologies and scientific advancements, and pursue self-directed learning throughout their careers. Encourages lifelong learning that supports academic growth, employability, and professional excellence.                                                                            |

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>PO10</b></p> | <p>Leadership Readiness: Ability to take initiative, work collaboratively, and manage academic and research responsibilities effectively. Through seminars, group projects, internships, and research activities, students develop decision-making, problem-solving, organizational, and interpersonal skills. Ability to lead scientific teams, communicate effectively in professional environments, and contribute responsibly to academic, industrial, and societal development.</p> |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

**Course Objectives**

- Introduction to the structure of biomolecules. The significance of carbohydrates in biological processes will be understood.
- The structure, properties and biological significance of lipids in the biological system will be studied.
- Students will learn about the concepts of protein structure and their significance in biological processes.
- Students will gain knowledge about the structures and functional roles of nucleic acids in the biological system.
- The significance of vitamins and minerals in biological processes will be understood.

**UNIT - I: Carbohydrates**

Carbohydrates - Classification, structure (configurations and conformations, anomeric forms), function and properties of monosaccharides, mutarotation, Disaccharides and oligosaccharides with suitable examples. Polysaccharides - Homopolysaccharides (starch, glycogen, cellulose, inulin, dextrin, agar, pectin, dextran). Heteropolysaccharides – Glycosaminoglycans – source, structure, functions of hyaluronic acid, chondroitin sulphates, heparin, keratan sulphate. Glycoproteins - proteoglycans. O- Linked and N-linked glycoproteins. Biological significance of glycan. Blood group polysaccharides. Bacterial cell wall (peptidoglycans, teichoic acid) and plant cell wall carbohydrates.

**UNIT - II: Aminoacids**

Overview of Amino acids - classification, structure and properties of amino acids, biological role. Non-Protein aminoacids and their biological significance. Proteins – classification based on composition, structure and functions. Primary, secondary, super secondary (motifs) (Helix-turn – helix, helix-loop-helix, Beta-alpha-beta motif, Rossmann fold, Greek key), tertiary and quaternary structure of proteins. Structural characteristics of collagen and hemoglobin. Determination of amino acid sequence. Chemical synthesis of a peptide, Forces involved in stabilization of protein structure. Ramachandran plot. Folding of proteins. Molecular chaperons – Hsp 70 and Hsp 90 - biological role.

**UNIT - III: Lipids**

Lipids – Classification of lipids, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, glycolipids, sphingolipids and steroids – Biological importance. Eicosanoids - classification, structure and functions of prostaglandins, thromboxanes, leukotrienes. Lipoproteins – Classification, structure, transport (endogenous and exogenous pathway) and their biological significance.

#### **UNIT - IV: Nucleic acids**

Nucleic acids – types and forms (A, B, C and Z) of DNA. Watson-Crick model - Primary, secondary and tertiary structures of DNA. Triple helix and quadruplex DNA. Mitochondrial and chloroplast DNA. DNA super coiling (calculation of Writhe, linking and twist number). Determination of nucleic acid sequences by Maxam Gilbert and Sanger's methods. Forces stabilizing nucleic acid structure. Properties of DNA and RNA. C-value, C-value paradox, Cot curve. Structure and role of nucleotides in cellular communications. Major and minor classes of RNA, their structure and biological functions.

#### **UNIT - V: Vitamins and Minerals**

Vitamins - Structure and biochemical properties of water soluble and fat-soluble vitamins and their coenzyme activity. Macro minerals (Ca, P, Mg, Na, K, Cl) and microminerals/trace elements (Co, I, Fe, Mn, Zn, and F) - their sources, daily requirements, functions and deficiency diseases and symptoms.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)**

Lipid nanoparticles in mRNA vaccines, Proteomics in cancer biomarker discovery, Gut microbiome and carbohydrate metabolism, RNA therapeutics and future medicine and Metabolomics in disease diagnosis.

#### **Recommended Texts**

1. David L. Nelson and Michael M. Cox (2012) Lehninger Principles of Biochemistry (6<sup>th</sup> ed) W.H. Freeman.
2. Voet. D & Voet.J.G (2010) Biochemistry (4<sup>th</sup> ed), John Wiley & Sons, Inc.
3. Metzler D.E (2003). The chemical reactions of living cells (2<sup>nd</sup> ed), Academic Press.
4. Zubay G.L (1999) Biochemistry (4<sup>th</sup> ed), McGraw-Hill.
5. Lubert Stryer (2010) Biochemistry (7<sup>th</sup> ed), W.H.Freeman.
6. Satyanarayan, U (2014) Biochemistry (4<sup>th</sup> ed), ArunabhaSen Books & Allied(P) Ltd, Kolkata.

#### **Course Outcomes (COs)**

**After successful completion of this course, students will be able to:**

CO1: Explain the classification, structure, properties, and biological significance of carbohydrates, including monosaccharides, polysaccharides, glycoproteins, and cell wall carbohydrates.

CO2: Analyze the structure, classification, functions, folding, and sequence determination of amino acids and proteins, including protein motifs and molecular chaperones.

CO3: Describe the classification, structure, functions, and biological importance of lipids, eicosanoids, and lipoproteins in cellular metabolism and transport.

CO4: Interpret the structural organization, properties, sequence determination methods, and biological roles of nucleic acids and nucleotides.

CO5: Explain the biochemical functions, coenzyme activities, sources, requirements, and deficiency disorders of vitamins and minerals.

**Mapping with Programme Outcomes**

| <b>COs \ POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>C01</b>       | 3          | 2          | 1          | 2          | 1          | –          | –          | –          | 1          | 1           |
| <b>C02</b>       | 3          | 3          | 2          | 2          | 1          | –          | –          | –          | 1          | 1           |
| <b>C03</b>       | 3          | 2          | 2          | 2          | 1          | –          | 1          | –          | 1          | 1           |
| <b>C04</b>       | 3          | 3          | 2          | 3          | 2          | 1          | –          | 1          | 1          | 1           |
| <b>C05</b>       | 3          | 2          | 1          | 2          | 1          | 1          | 1          | 1          | 1          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**Code: ANALYTICAL AND MOLECULAR TECHNIQUES  
(Theory)**

**Credit: 4**

**Course Objectives:**

- To understand the various basic techniques used in biochemical investigations.
- To study the live cell and organism techniques and their applications
- To emphasise the techniques for structural biology
- To comprehend the molecular biologic techniques and immunological investigations.
- To acquire knowledge of molecular interaction studies and computational aiding tools.

**UNIT – I: Basic Separation, Preparative and Analytical Techniques**

pH Meter, Differential and Density gradient Centrifugation, Ultra centrifugation, HPTLC, Affinity Chromatography, Ion exchange Chromatography, GC, GLC, HPLC, Reverse HPLC, UV-Visible Spectrophotometer, Atomic absorption Spectrophotometer, GM Counter and Scintillation Counter

**UNIT – II: Techniques for live cell and organism studies**

*In vitro* and *Ex vivo* techniques – animal cell culture, 2D and 3D cell cultures, organoids, spheroids, organ on a chip systems, Organ and Tissue slices techniques, Cell sorting and cell counting, Fluorescence and Total internal Reflection, Fluorescence Microscopic techniques (TIRF). *In vivo* Techniques – TEM and SEM, Confocal Laser Scanning Microscopy, Multiphoton microscopic, Fiber optic endo microscopic techniques, Computed Tomography imaging and Magnetic Resonance Imaging techniques (CT and MRI).

**UNIT – III: Techniques for Structural Biology Studies**

X-ray Crystallography, Circular Dichroism (CD), Cryo – Electron Microscopic technique, MS Spectrophotometer, HDX -MS, Nuclear Magnetic Resonance Spectrophotometer (NMR), ESR, Fourier Transform InfraRed FT-IR, Neutron scattering and Neutron diffraction.

**UNIT – IV: Techniques for Molecular biology and Immunology studies**

SDS- PAGE, Agarose Gel Electrophoresis, PCR, Reverse PCR, Real Time PCR (qPCR), Digital PCR, Microarray, DNA sequencing and RNA sequencing,

Whole exome sequencing, Liquid biopsy, MaldiToF – MS, CRISPR Cas 9 technique, RFLP, ELIZA, RIA, Immunofluorescence and Flow cytometry.

### **UNIT – V: Techniques for Molecular Interaction Studies**

Surface Plasmon Resonance, Isothermal Titration Calorimetry, Co-immunoprecipitation, Yeast Two Hybrid study (Y2H), Forster Resonance Energy Transfer (FRET) Microscopy, Fluorescence Recovery After Photobleaching (FRAP), Computational modelling and simulation, Molecular Dynamics, Molecular docking, Protein -Protein Interaction prediction.

### **UNIT – VI: Current contours (Self-directed learning activities for Continuous Internal Assessments Only)**

Intra vital microscopy, Photoacoustic imaging, STEM, STORM techniques.

### **Recommended Books:**

1. Keith Wilson, John Walker. Principles and Techniques of Biochemistry and Molecular Biology (7th ed) Cambridge University Press, (2010).
2. David Sheehan, Physical Biochemistry: Principles and Applications (2nd ed), Wiley-Blackwell, (2009).
3. David M. Freifelder, Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H. Freeman, (1982).
4. Rodney F. Boyer, Biochemistry Laboratory: Modern Theory and techniques, (2nd ed), Prentice Hall, (2012).
5. Kaloch Rajan, Analytical techniques in Biochemistry and Molecular Biology, Springer (2011).
6. Robyt J F, Biochemical techniques: Theory and Practice (1st ed), CBS Publishers & Distributors (2015).
7. Sambrook J.F., Russell D. W, Molecular Cloning. Vol 1, 2 and 3. Cold Spring Harbor Laboratory Press, (2001).
8. Raymond Chang, Physical Chemistry for the biosciences, 1st edition, University Science Books Publication, (2005).
9. <https://doi.org/10.1039/9781788017862-00001>, Basic Molecular biology Techniques, Ralph Rapley, (2021).
10. John M. Walker, Methods in Molecular Biology, Springer Publication, (2026).
11. <https://lifesciences.danaher.com/us/en/library/molecular-biology>,

### **Course Outcomes (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Acquire the knowledge of various basic techniques used in biochemical investigations.

CO2: Attain the live cell and organism techniques and their applications

CO3: Implement the structural findings techniques in structural biology research

CO4: Tackle the molecular biologic techniques and immunological investigations in biotechnological industries through research

CO5: Apply the technical knowledge of molecular interaction studies and computational aiding tools for improving recent biological research

**Mapping with Program Outcomes:**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO 1</b>  | 3          | 3          | 3          | 3          | -          | 3          | 3          | 3          | 2          | 3           |
| <b>CO 2</b>  | 3          | 3          | 3          | 3          | -          | 3          | 3          | 2          | 2          | 3           |
| <b>CO 3</b>  | 3          | 3          | 3          | 3          | -          | 3          | 3          | 3          | 2          | 3           |
| <b>CO 4</b>  | 3          | 2          | 2          | 3          | -          | 3          | 3          | 3          | 3          | 3           |
| <b>CO 5</b>  | 3          | 3          | 3          | 3          | -          | 3          | 3          | 1          | 3          | 3           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**Code: BIOMOLECULES AND TECHNIQUES  
(Practical)****Credit: 4****Course Objectives:**

- To instil in the students a perception of their knowledge about principles and techniques to be employed for the identification and estimation of biomolecules by qualitative and quantitative methods.
- To inculcate the knowledge of various isolation and purification techniques of macromolecules like DNA, RNA, Glycogen and Starch,
- To perform colorimetric and UV-Visible spectrophotometric estimations to quantify important molecule like Nucleic acids, vitamin C and minerals like iron from various sources.
- To achieve training in Phospholipids separation by Thin layer chromatography and to identify them using R<sub>f</sub> values.
- To demonstrate the electrophoretic and centrifugation techniques.

**Experiments:**

1. Isolate the soluble starch from potato and estimate the starch content.
2. Isolate the soluble sugars from sweet potato and qualitatively identify the sugars
3. Separation and Identification of amino acids present in egg albumin after acid hydrolysis by paper chromatography
4. Isolate and quantitatively estimate the total proteins from germinated green gram by Lowry's or Biuret method.
5. Qualitatively identify the amino acids
6. Extraction, Separation and quantitatively estimate the total lipids and phospholipids from goat brain by Folch extraction method, by silica gel G plated TLC separation method and Zaks and Fiske and Subbarow (Bartlett method) estimation methods.
7. Isolate the DNA from onion bulb (CTAB method) and estimate the DNA content using UV-Vis Spectrophotometer.
8. Isolate the RNA from Goat liver (Trizol method) and estimate the RNA content using UV-Vis Spectrophotometer.
9. Extraction of Vitamin C from amla by metaphosphoric acid method and estimation by the dichlorophenol indophenol method.
10. Extract the iron from the dry ash powder of drumstick or fenugreek leaves and estimate the iron content by the dipyrityl or Wongs method.

11. To demonstrate the separation of the subcellular organelles by differential and density gradient centrifugation.
12. To demonstrate the separation of plasma lipoproteins by cellulose acetate gel or agarose gel electrophoretic technique.

### **Recommended Books:**

1. David Plummer (2001) An Introduction to Practical Biochemistry (3rd ed) McGraw Hill Education (India) Private Ltd, (2001).
2. Jayaraman, J, laboratory Manual in Biochemistry, New age publishers, (2011).
3. Varley H, Practical Clinical Biochemistry (6th ed), CBS Publishers (2011).
4. Sarin A. Chavhan, Sushilkumar A. Shinde, A Guide to Chromatography Techniques Ist Edition, (2019).
5. Gupta R.C., Practical Biochemistry, 7<sup>th</sup> Edition, 2026.
6. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
7. Sadasivam S and Manickam A,. Biochemical Methods, 4h edition, New Age International Publishers, (2016).
8. [https://www.researchgate.net/publication/313745155\\_Practical\\_Biochemistry\\_A\\_Student\\_Companion](https://www.researchgate.net/publication/313745155_Practical_Biochemistry_A_Student_Companion)
9. <https://skyfox.co/wp-content/uploads/2020/12/Practical-Manual-of-Biochemistry.pdf>
10. Dinesh Kumar, Chandra Gurunai and Priyanka Sharma, Practical Manual Fundamentals of Plant Biochemistry and Biotechnology, Crown Publications, (2025).
11. Sawhney Randhir Singh, Introductory Practical Biochemistry, 2<sup>nd</sup> edition, Alpha Science International Ltd, (2005).
12. Bernard R, Glick and Jack J, Pasternak, Molecular Biotechnology, 3<sup>rd</sup> edition, ASM Press, Washington, (2003).
13. Serdyuk, I.N., Zaccai, N.R. and Zaccai, J. Methods in Molecular Biophysics – Structure, Dynamics and Function, Cambridge University Press, India, (2007).
14. Keith Wilson and John Walker - Principles and techniques of Biochemistry and Molecular Biology, Cambridge University Press, 6th Edition, (2006).

### **Course Outcomes (COs):**

#### **Upon successful completion of this course, the student will be able to:**

CO1: Acquire the knowledge and practical skill of various basic techniques used in biochemical investigations.

CO2: Attain the isolation and identification of sugars, amino acids and lipids using various biochemical techniques and their applications

CO3: trained on various instruments such as chromatography, centrifuge and electrophoresis.

CO4: determine vitamins and minerals content from various nutritional plant foods

CO5: Apply the practical technical knowledge to build good quality of biological research

**Mapping with Program Outcomes:**

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO7 | PO8 | PO9 | PO10 |
|-------|------|------|------|------|------|------|-----|-----|-----|------|
| CO 1  | 3    | 3    | 3    | 3    | -    | 3    | 3   | 3   | 2   | 3    |
| CO 2  | 3    | 3    | 3    | 3    | -    | 3    | 3   | 2   | 2   | 3    |
| CO 3  | 3    | 3    | 3    | 3    | -    | 3    | 3   | 3   | 2   | 3    |
| CO 4  | 3    | 2    | 2    | 3    | -    | 3    | 3   | 3   | 3   | 3    |
| CO 5  | 3    | 3    | 3    | 3    | -    | 3    | 3   | 1   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the fundamental concepts of food and nutrition and their role in maintaining health.
- To provide knowledge on different food groups, energy requirements and methods of energy measurement.
- To develop understanding of macronutrients and micronutrients, their functions, sources and deficiencies.
- To explain the principles of balanced diet planning for various age groups and physiological conditions.
- To impart knowledge on nutraceuticals, functional foods and the therapeutic role of nutrition in health and disease.

**UNIT – I: INTRODUCTION TO THE SCIENCE OF NUTRITION**

Concepts of food and nutrition - The role of nutrition in maintaining health. Basic food groups-energy yielding, body building and functional foods. Energy -units and measurements. Calorific and nutritive value of foods. Measurement of Calories by bomb calorimeter. Basal metabolic rate (BMR) - definition, determination and factors affecting BMR. Respiratory quotient (RQ) of nutrients and factors affecting the RQ. SDA-definition and determination- Anthropometric measurement and indices – Height, Weight, chest and waist circumference BMI.

**UNIT – II: FUNCTIONAL FOODS**

Carbohydrates, Fats, essential fatty acids, cholesterol and Proteins - kinds, functions, food sources. Complete and incomplete proteins. Biological value of proteins- Digestibility coefficient, Protein Energy Ratio and Net Protein Utilization. Protein energy malnutrition – Kwashiorkor and Marasmus, Obesity-Types and preventive measures. Biological importance of Vitamins, and Minerals.

**UNIT – III: DIFFERENT DIMENSIONS FOR FITNESS**

Fundamentals of human nutrition, concept of balanced diet, biochemical composition, energy and food value of various food grains (including cereals, pulses and oilseeds), fruits and vegetables. Healthy diet - definition. Planning a healthy diet. Balanced diet, Steps involved in planning a healthy diet, example of low and high cost balanced diet- for infants, children, adolescents, adults and elderly people. ICMR classification of five food groups and its significance food pyramid. Junk foods- definition and its adverse effects.

#### **UNIT – IV: PRESERVATION OF FOOD AND ADULTERATION**

Preservation of nutrients, safe food handling and toxicity. Storage of food, food preservation, food additives and its principles. Structure, chemistry, function and application of preservatives, emulsifying agents, buffering agents, stabilizing agents, natural and artificial sweeteners, bleaching, starch modifiers, antimicrobials, food emulsions, fat replacers, viscosity agents, gelling agents and maturing agents. Food colors, flavors, anti-caking agent, antioxidants. Safety assessment of food additives.

#### **UNIT – V: NUTRITIONAL THERAPY**

Nutraceuticals and Functional Foods: Definition, properties and function of Nutraceuticals, food Supplements, dietary supplements prebiotics and probiotics, and functional Foods. Food as medicine. Natural pigments from plants– carotenoids, anthocyanins and its benefits. Phytochemicals, phytosterols and other bioactive compounds. Technology integration -apps, and digital platforms for personalized nutritional guidance.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)**

Recent advancements and emerging trends in the field of nutrition. Discussion on recent Nobel Prize contributions and breakthrough research related to metabolism, microbiome and nutritional science.

#### **TEXT BOOKS:**

1. Gaile Moe, Danita Kelley, Jacqueline Berning and Carol Byrd-Bredbenner. 2021. Wardlaw's Perspectives in Nutrition: A Functional Approach. McGraw-Hill, Inc., NY, USA.
2. M.Swaminadhan (2017) Principles of Nutrition and Dietics. Bappco.
3. Tom Brody (1998). Nutritional Biochemistry (2<sup>nd</sup>ed), Academic press, USA.
4. Garrow, JS,James WPT and Ralph A (2000). Human nutrition and dietetics (11<sup>th</sup>ed) Churchill Livingstone.
5. Andreas M.Papas (1999). Antioxidant Status, Diet, Nutrition and Health (1<sup>st</sup>ed) CRC.

#### **REFERENCE BOOKS:**

1. Branen, A.L., Davidson PM & Salminen S. 2001. Food Additives.3<sup>rd</sup> Ed. Marcel Dekker.
2. George, A.B. 1996. Encyclopedia of Food and Color Additives. Vol. III. CRC Press.
3. Advances in food biochemistry, FatihYildiz (Editor), CRC Press, Boca Raton, USA, 2010
4. Food Biochemistry & Food Processing, Y.H. Hui (Editor), Blackwell Publishing, Oxford, UK, 2012.

5. Geoffrey Campbell-Platt. 2017. Food Science and Technology. Wiley-Blackwell, UK.

#### **E – SOURCES:**

1. <https://bio.libretexts.org/Bookshelves/Nutrition>
2. <https://open.umn.edu/opentextbooks/subjects/nutrition>
3. <https://www.fao.org/3/y5740e/y5740e.pdf>
4. <https://www.actionagainsthunger.org/publication/the-basics-of-nutrition/>
5. <https://www.who.int/>
6. <https://www.precisionnutrition.com>
7. <https://www.fao.org/>
8. <https://www.icmr.gov.in/>

#### **COURSE OUTCOME (COs):**

**After successful completion of this course, students will be able to:**

CO1: Explain the basic concepts of nutrition, food groups and energy metabolism including BMR, RQ, and SDA.

CO2: Classify and describe the functions, sources, and deficiencies of carbohydrates, proteins, fats, vitamins, and minerals.

CO3: Assess nutritional status using anthropometric measurements such as BMI and interpret health conditions like obesity and malnutrition.

CO4: Describe various food preservation techniques, food additives, and their safety aspects.

CO5: Analyze the role of nutraceuticals, functional foods, and bioactive compounds in disease prevention and health promotion.

#### **Mapping with Programme Outcomes**

| CO/PO | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1   | 3    | 2   | 1   | 1   | 1   | 1   | -   | -   | -   | 1    |
| CO2   | 3    | 3   | 2   | 1   | 1   | 1   | 1   | -   | -   | 1    |
| CO3   | 3    | 3   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 2    |
| CO4   | 3    | 2   | 2   | 2   | 2   | 3   | 2   | 1   | -   | 1    |
| CO5   | 3    | 3   | 2   | 3   | 3   | 2   | 1   | 2   | 1   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand cell as the basic unit of life and the differences between eukaryotic and prokaryotic cells.
- To learn the basic organization of cells, plasma membrane, cell organelles and the endomembrane system.
- To know the principles governing membrane transport, different types of transport systems, intracellular trafficking and protein sorting.
- To learn about mitochondria and energy transfer, cytoskeleton, communication between cells and cell to cell as well as cell to matrix junctions.
- To learn how cells reproduce through cell cycles, mitosis and meiosis, contribution of mitotic spindle in chromosome movement and genetic regulation of cell cycle.

**UNIT – I: Cell as a Structural and Functional Unit**

Cell Theory: historical perspective and modern tenets. General properties of cells. Prokaryotic vs. Eukaryotic cells: key differences and comparative features. Ultrastructure of prokaryotic and eukaryotic cells (plant and animal): distinguishing characteristics. Cell organelles: structure and functions of mitochondria, chloroplasts, endoplasmic reticulum, Golgi apparatus, ribosomes, lysosomes, peroxisomes, and the nucleus. Molecular organization of chromatin.

**UNIT – II: Membrane Biology and Transport**

Cell membrane: structure, functions and permeability. Molecular organization of the cell membrane. Transport mechanisms: Passive transport (diffusion, facilitated diffusion, osmosis), Active transport (primary and secondary), ATP-driven pumps: sodium-potassium pump ( $\text{Na}^+/\text{K}^+$  ATPase) and  $\text{Ca}^{2+}$  ATPase, Co-transport: symport and antiport, Bulk transport: endocytosis (phagocytosis, pinocytosis) and exocytosis.

**UNIT – III: Cytoskeleton, Cell Motility, Division and Death**

Cytoskeleton: structural components and functions (microfilaments, intermediate filaments, microtubules). Cell motility: structure and function of cilia and flagella. Cellular interactions: cell adhesion molecules (CAMs) and intercellular junctions. Cell division: mitosis and meiosis. Cell cycle: phases and regulatory mechanisms (checkpoints, cyclins, CDKs). Programmed cell death (apoptosis).

#### **UNIT – IV: Cell Signaling and Signal Transduction**

Receptors in cell signaling: types and functions. Modes of signaling: autocrine, paracrine and endocrine. Signal amplification: concept and significance. Second messengers and signaling pathways: cAMP pathway, IP3/DAG pathway, cGMP pathway. Role of G proteins in signal transduction. Calcium ions ( $\text{Ca}^{2+}$ ) influx and its role in cellular signaling.

#### **UNIT – V: Protein Secretion, Sorting**

Secretory pathway: overview of protein trafficking. Translocation of secretory proteins across the ER membrane. Protein folding in the ER: role of chaperones. Post-translational modifications and protein degradation. Protein sorting and targeting to organelles.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)**

Advanced Imaging and Single-Cell Technologies, Advances in Membrane Transport and Synthetic Biology.

#### **TEXT BOOKS:**

1. C.B. Powar (2010). Cell Biology (3rd Edition), Himalaya publisher, ISBN: 978-93-5024-669-6
2. Dr. P.S. Verma and Dr. V.K. Agarwal. (2016). Cell biology (cytology, biomolecules and molecular biology), S. Chand Publishing, ISBN:9789385676147
3. Lodish et al., (2000). Molecular Cell Biology, (Fourth Edition), W.H. Freeman & Co, ISBN 10: 0-7167-3136-3

#### **REFERENCE BOOKS:**

1. De Robertis, E.D.P. and De Robertis, E.M.F., (1980), Cell and Molecular Biology (7th Edition) Saunders College/Holt, Rinehart and Winson, Philadelphia,. ISBN-13: 978 0030567490;
2. Gerald Karp. ( 2004), Cell and Molecular Biology, 4th ed. John Wiley and sons,. ISBN: 978 1-118-88614-4
3. Bruce Alberts., Lewis. J., Johnson A.J., Raff. L.M. (2002), Molecular Biology of the Cell: Garland Publishers,. ISBN-10: 0-8153-3218-1 ISBN-10: 0-8153-4072-9
4. Cooper M.G and Hausman E.R (2018). The Cell: A Molecular approach (7th Ed.) USA: Oxford University Press, ISBN: 9781605357461.

#### **Web resources:**

1. [Khan Academy | Khan Academy](#)
2. [The Cytoskeleton – Fundamentals of Cell Biology](#)
3. [Cell Signaling: Definition, Types, and Pathways](#)

## Course Outcomes (COs):

**Upon successful completion of this course the students will be able to:**

CO1: Define the Cell Theory, identify Prokaryotic and Eukaryotic cells, list and identify the types of transport mechanisms.

CO2: Describe the general properties of cells, Explain the structure, functions, and permeability of the cell membrane.

CO3: demonstrate the relationship between organelle structure, function of the sodium-potassium pump and to apply knowledge of cytoskeletal components.

CO4: compare and contrast prokaryotic and eukaryotic cells, Analyze the molecular organization of the cell membrane and to investigate the regulatory mechanisms of the cell cycle.

CO5: Evaluate the molecular organization of chromatin, critique the classification of endocytosis, evaluate the role of calcium ions ( $\text{Ca}^{2+}$ ) as a second messenger.

## Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 1   | 1    |
| <b>CO2</b> | 3   | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 1   | 1    |
| <b>CO3</b> | 3   | 2   | 2   | 3   | 2   | 2   | 2   | 1   | 1   | 1    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 2   | 1   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 2   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand and apply appropriate statistical methods.
- To select, compute, and interpret descriptive and inferential statistical measures, diagrams, and tests.
- To analyze and interpret biological, clinical, and experimental data using statistical software and tools.
- To formulate research hypotheses and apply suitable statistical tests for data-driven decision making.
- To critically evaluate and communicate statistical findings in biomedical and life science research.

**UNIT – I: DATA COLLECTION & SURVEY: BIOSTATISTICS:**

Definition and scope. Organizing, planning and executing the survey. Source of data - Primary and secondary data. Methods of data collection: observation, interview, enquiry forms, questionnaire, schedule and checklist. Classification and tabulation of data. Diagrammatic and graphical presentation of data.

**UNIT – II: MEASURES OF CENTRAL TENDENCY:**

Measures of Central Tendency and Dispersion -individual, discrete and continuous series-mean, median, mode, range, Quartile deviation, Standard deviation, Coefficient of variation. Correlation analysis - Scatter diagram, Karl's Pearson's coefficient of correlation and Spearman's rank method. Regression analysis.

**UNIT – III: PROBABILITY:**

Definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability - Simple problems. Theoretical distributions – Binomial, Poisson and normal distribution - Simple problems (proof of the theorems not necessary).

**UNIT – IV: SAMPLING DISTRIBUTION AND TEST OF SIGNIFICANCE:**

Concepts of sampling, Testing of Hypothesis- Null and Alternate Hypotheses. Steps involved in hypothesis testing. Student's t-test, Chi square test, ANOVA (One way). SPSS in hypothesis testing. Comparison of means in one or two groups (student's t-test). Comparison of means in three or more groups (ANOVA), F- test.

## **UNIT – V: DATA REPRESENTATION & ANALYSIS**

Design of experiment- Completely randomized block design, Randomized block design. Histogram, Stem-&-Leaf Plot, Line Diagram, Frequency Polygon, Frequency Curve, Pie Diagram, Bar Diagrams, Scatter Diagram, Box-&-Whisker Plot, Bubble Plot, Growth chart, Dendrogram, Nomogram, Partogram, Pedigree Chart, Cartogram.

## **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)**

Diagnostic tests evaluation -Sensitivity, specificity, Positive predictive value (PPV), negative predictive value (NPV), ROC curve and AUC interpretation.

### **Text books:**

1. Field, A. (2018). Discovering Statistics Using IBM SPSS Statistics. 5th Edition. Sage Publications.
2. Gupta, S. P. (2020). Statistical Methods. 46<sup>th</sup> Edition. Sultan Chand & Sons.

### **Reference Books**

1. Statistical Methods, 4<sup>th</sup> Edition- Gupta, S.P, Sultan Chand & Son Publishers. 2012.
2. Biostatistical Analysis, 5<sup>th</sup> Edition- Zar, J.H, Pearson Education, 2010.
3. Biostatistics - Daniel, W.W. A Foundation for Analysis in Health Sciences, 10<sup>th</sup> Edition, John Wiley and Sons, Inc., 1999.

### **Web Resources:**

1. [Guide to Data Collection Methods and Tools - SurveyCTO](#)
2. [6: Sampling Distributions and Statistical Hypotheses | Control of Manufacturing Processes \(SMA 6303\) | Mechanical Engineering | MIT OpenCourseWare.](#)

### **Course Outcomes (COs):**

#### **Upon successful completion of this course the students will be able To:**

CO1: Recall and define the scope of biostatistics, Data Collection, Regression and Hypothesis.

CO2: State the measures of central tendency, theoretical distributions, Hypothesis.

CO3: List the theorems and calculations of probability and to apply the rules of probability and to Execute Students' t Test.

CO4: Analyze different sources of data, distinguish among Binomial, Poisson, and Normal distributions and examine and categorize various data representation tools.

CO5: Appraise the measure of central tendency, justify the calculated probability outcome and to Assess the validity of null and alternative hypotheses.

### **Mapping with Programme Outcomes**

| <b>PO/CO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 1          | 1          | 2          | 1          | 1          | 1          | 1          | 1          | 1           |
| <b>CO2</b>   | 3          | 1          | 1          | 2          | 1          | 1          | 1          | 1          | 1          | 1           |
| <b>CO3</b>   | 2          | 1          | 3          | 3          | 1          | 1          | 3          | 1          | 1          | 3           |
| <b>CO4</b>   | 2          | 2          | 3          | 3          | 1          | 1          | 2          | 1          | 1          | 1           |
| <b>CO5</b>   | 2          | 3          | 3          | 3          | 1          | 1          | 3          | 2          | 1          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

Code:

**2. FOOD MICROBIOLOGY  
(Theory)**

Credit: 3

**COURSE OBJECTIVES:**

- Explain microbial growth factors (intrinsic/extrinsic), history, classification and morphology of bacteria.
- Apply sampling, culture-dependent, molecular (PCR, metagenomics), and chemical methods to detect microbes and toxins in food.
- Use preservatives (organic acids, bacteriocins), probiotics, hurdle technology, and HACCP/ISO systems for food safety and preservation.
- Identify spoilage features of cereals, fruits, meat, milk, canned foods, and distinguish foodborne infections, intoxications, parasites and drug resistance.
- Describe food packaging, barcoding, BIS, Consumer Protection Act (1986), and international food standards.

**UNIT – I: Basics of Food Microbiology**

History and development of Microbiology-Importance and significance of microorganisms in food science. Factors affecting the growth of microorganisms in food – Intrinsic and Extrinsic parameters

**UNIT – II: Microbial Analysis in Foods**

Determination of microorganisms and their products in food: Sampling, sample collection, transport and storage, sample preparation for analysis. Microscopic and culture dependent methods- Direct microscopic observation, culture, enumeration and isolation methods; Chemical and Physical methods- immunological and nucleic acid based methods; Culture independent techniques – PCR Based, DGGE, Metagenomics. Analytical methods for microbial metabolites and toxins.

**UNIT – III: Food Preservation & Quality Control**

Food Preservation & Principles of Quality Control: Chemicals, Antibiotics, and Preservatives of microbial origin: organic acids, Bacteriocins. Applications of prebiotics and probiotics, Concept of protective cultures. Hurdle concept. The HACCP and ISO systems for food safety. Applications of HACCP in the industry.

**UNIT – IV: Food Spoilage**

Food spoilage: characteristic features, dynamics and significance of spoilage of different groups of foods - Cereal and cereal products, vegetables and fruits, meat, poultry and sea foods, milk and milk products, packed and canned foods.

## **Unit V: Food-Borne Diseases**

Food borne diseases: Bacterial food borne diseases, Food Borne Viral Pathogens, Food Borne Animal Parasites, Food borne poisoning, Non bacterial infections and intoxication.

## **UNIT – VI: Current Contours (Self-directed learning activities for Continuous Internal Assessments Only)**

Food Packaging and Food Laws and Standards – Recent developments.

### **Text Books**

1. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, New york.
2. Frazier, W.C. (1988) Food Microbiology, Mc Graw Hill Inc. 4th Edition.
3. Vijaya Ramesh, K. (2007) Food Microbiology. MJP publishers, 2007
4. Yasmine Motarjemi and Martin Adams. (2006) Emerging Food borne pathogen- Wood Head Publishing England.
5. Arun, K Bhunia. (2008) Food borne microbial pathogens: Mechanisms and pathogenesis. Springer.
6. Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). 7<sup>th</sup> edition, Modern food microbiology. (Springer eBooks.) New York: Springer.
7. Ray, B., & Bhunia, A. K. (2008). Fundamental food microbiology. 15th edition. Boca: Raton: CRC Press.

### **Reference Books:**

1. Dubey, R.C. and Maheswari, D.K. (2008) Text book of Microbiology. S Chand Publishing.
2. Adams, M. R., and M. O. Moss. Food Microbiology. 15th edition, Cambridge: Royal Society of Chemistry, 1995.

### **Web References:**

1. [Common Food Preservation Methods, Techniques & Types](#)
2. [Food Spoilage: Causes, Types, and Prevention Methods - Agriculture Notes by Agriculture.Institute](#)
3. [https://www.who.int/health-topics/foodborne-diseases/#tab=tab\\_](https://www.who.int/health-topics/foodborne-diseases/#tab=tab_)

### **Course Outcomes (COs):**

**Upon successful completion of this course the students will be able To:**

CO1: Explain fundamentals of Sampling, food Preservation, Food Spoilage and Diseases.

CO2: Understand about Factors affecting the growth of microorganisms, Food Sampling, Quality Control and Food Poisoning.

CO3: Apply Knowledge about PCR, Metagenomics and applications of probiotics.

CO4: Analyse the Causes of Food Spoilage and Food Borne Poisoning.

CO5: Evaluate the Food laws and Standards.

### **Mapping with Programme Outcomes**

| <b>PO/CO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 1          | 3          | 1          | 1          | 2          | 1          | 2          | 1           |
| <b>CO2</b>   | 3          | 2          | 2          | 3          | 1          | 1          | 2          | 1          | 2          | 1           |
| <b>CO3</b>   | 2          | 2          | 3          | 3          | 2          | 2          | 3          | 3          | 3          | 2           |
| <b>CO4</b>   | 2          | 3          | 3          | 3          | 2          | 2          | 3          | 2          | 2          | 1           |
| <b>CO5</b>   | 3          | 3          | 3          | 2          | 2          | 3          | 3          | 2          | 3          | 3           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To Explain the historical development of evolution.
- To Describe the fundamental concepts of Developmental Biology.
- To Outline the processes of gametogenesis, fertilization.
- To Compare morphogenesis and organogenesis in animals.
- To Integrate evolutionary principles with developmental mechanisms.

**UNIT – I: Evolution**

Emergence of evolutionary thoughts. Lamarck's Darwin concepts of variation, adaptation, struggle, fitness and natural selection. Mendelism spontaneity of mutations; the evolutionary synthesis- Origin of cells and unicellular evolution. Origin of basic biological molecules, abiotic synthesis of organic monomers and polymers. Concept of Oparin and Haldane experiment of Miller (1953) the first cell evolution of prokaryotes. Origin of eukaryotic cells, evolution of unicellular eukaryotes, anaerobic metabolism, photosynthesis and aerobic metabolism.

**UNIT – II: Basic concepts of development:**

Potency commitment specification induction competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting.

**UNIT – III: Gametogenesis and Fertilization**

Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

**UNIT – IV: Morphogenesis & Organogenesis in Animals**

Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, organogenesis, vulva formation in Caenorhabditis elegans; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

## **UNIT – V: Morphogenesis & Organogenesis in Plants**

Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral development in Arabidopsis and Antirrhinum.

## **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only)**

Advances in Gametogenesis & Assisted Reproduction.

### **Text Books:**

1. Developmental Biology (Looseleaf), 10th Edition, Scott F. Gilbert, Sinauer Associates, Inc., 2013, ISBN: 978-1605351926.
2. Developmental Biology, 6th edition by Scott Gillbert, 2000, Sunderland (MA): Sinauer Associates; ISBN-10: 0-87893-243-7.

### **Reference Books:**

1. Principles of Development. 3rd edition, by L. Wolpert, 2006, Oxford University press, incorporated; ISBN: 9780198709886.
2. Developmental Biology. 3rd edition, by Lewis Wolpert, 2006, Oxford University Press, USA; ISBN: 1405122161
3. Evolutionary developmental biology, 2nd edition by Brian K. Hall.1998, Springer; ISBN-10: 0412785803.

### **Web Based Resources:**

1. [Early Concepts of Evolution: Jean Baptiste Lamarck](#)
2. [Lecture - Fertilization - Embryology](#)

### **Course Outcomes (COs):**

#### **Upon successful completion of this course the students will be able To:**

CO1: Define and recall the key concepts of evolution, basic concepts of development and to Identify the stages of gametogenesis.

CO2: Explain the emergence of evolutionary thoughts, Summarize and illustrate the basic concepts of development and compare morphogenesis and organogenesis.

CO3: Apply the concepts of variation, potency, commitment, specification, apply knowledge of gametogenesis and the principles of cell aggregation.

CO4: Analyze the emergence of evolutionary thoughts, Differentiate and categorize the basic concepts of development and the process of gametogenesis.

CO5: Critique the conceptual framework of developmental biology, the processes of gametogenesis and fertilization and evaluate the mechanisms of axis and pattern formation in Drosophila.

### Mapping with Programme Outcomes

| PO/CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1   | 3   | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 1   | 1    |
| CO2   | 3   | 2   | 2   | 2   | 1   | 1   | 1   | 1   | 1   | 1    |
| CO3   | 3   | 2   | 3   | 3   | 1   | 2   | 3   | 1   | 1   | 1    |
| CO4   | 3   | 3   | 3   | 3   | 1   | 2   | 2   | 1   | 1   | 1    |
| CO5   | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 2   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVE:**

- To introduce the fundamental concepts, principles, and techniques of Artificial Intelligence and their applications in healthcare.
- To understand and apply machine learning and deep learning methods for the analysis of biomedical and healthcare data.
- To explore the use of AI in disease diagnosis, medical imaging, clinical decision support, drug discovery, and personalized medicine.
- To evaluate the ethical, legal, privacy, and regulatory challenges associated with the implementation of AI in healthcare systems.
- To develop practical skills in using AI tools and platforms for solving real-world healthcare and public health problems.

**UNIT – I: Introduction to AI in Health Care**

Definition and scope of AI, Machine Learning (ML), Deep Learning (DL)- History and evolution of AI in medicine, Key drivers: electronic health records (EHRs), medical imaging, wearables, Current landscape: AI startups, FDA-approved AI algorithms, Case examples: AI for sepsis prediction, diabetic retinopathy screening.

**UNIT – II: AI for Medical Imaging & Diagnostics**

Computer vision basics for health care, Image segmentation, classification, and detection. Applications: radiology (X-ray, CT, MRI), pathology (whole-slide imaging), dermatology, Key models: CNNs, U-Net, transfer learning, Hands-on demo (simulated): Identifying pneumonia on chest X-rays using a pre-trained model.

**UNIT – III: Natural Language Processing (NLP) in Clinical Settings**

Text mining from clinical notes, discharge summaries and research articles. Named entity recognition (NER) for diseases, drugs and symptoms. Applications: clinical decision support, adverse event detection, patient cohort identification. Tools: BERT for clinical text, MedCAT, cTAKES. Privacy considerations with free-text data.

**UNIT – IV: Predictive Analytics & Personalized Medicine**

Risk prediction models: readmission, mortality, length of stay. Genomics and AI: variant calling, drug response prediction. Reinforcement learning for treatment optimization (e.g., sepsis management). Ethical challenges: bias in

predictive models, explainability (SHAP, LIME). Case study: Predicting heart failure from EHR time-series data.

### **UNIT – V: Ethical, Regulatory & Operational Challenges**

Algorithmic fairness and bias in health care AI, Data privacy: HIPAA, GDPR, de-identification techniques, Model validation, regulatory pathways (FDA, CE marking), Human-AI interaction: clinician trust, automation bias, Health equity concerns and mitigation strategies.

### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Generative AI in medicine.

#### **Reference Books:**

1. Shamim, M. T., & Anwar, S. M. (Eds.). (2023). Artificial Intelligence in Healthcare: From Machine Learning to Clinical Integration. Springer.
2. Reddy, S. (2022). The AI Revolution in Medicine: GPT-4 and Beyond. Pearson.
3. Beam, A. L., & Kohane, I. S. (2019). Artificial Intelligence in Medicine. New England Journal of Medicine (NEJM) – Collection of review articles.

#### **Text Books:**

1. Topol, E. (2019). Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.
2. Lee, H., & Chen, Y. P. P. (2022). Deep Learning for Medical Image Analysis. (2nd ed.) Academic Press.
3. Nadkarni, P. M., Ohno-Machado, L., & Chapman, W. W. (2011). “Natural language processing: an introduction” – Journal of the American Medical Informatics Association, 18(5), 544–551.

#### **Web Resources:**

1. [Google for Health - AI Imaging & Diagnostics](#)
2. [Natural Language Processing in Healthcare Medical Records](#)

#### **Course Outcomes (COs):**

#### **Upon successful completion of this course the students will be able To:**

CO1: Describe the scope of AI, Machine Learning (ML) and Deep Learning (DL), outline the basics of computer vision for health care and to state algorithmic fairness and bias in health care.

CO2: Summarize the key drivers including electronic health records, illustrate the applications of AI in radiology and discuss the privacy considerations with free-text data.

CO3: Execute a hands-on demo (simulated) to identify pneumonia, Apply text mining techniques, risk prediction models and algorithmic fairness techniques.

CO4: Analyze case examples of AI, identify patterns in pneumonia detection and compare and contrast model validation pathways.

CO5: Appraise the current landscape of AI startups versus FDA-approved AI algorithms and evaluate the effectiveness of computer vision techniques for health care.

### **Mapping with Programme Outcomes**

| <b>PO/CO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 2          | 1          | 1          | 1          | 1          | 1          | 2          | 1           |
| <b>CO2</b>   | 3          | 2          | 2          | 1          | 1          | 2          | 1          | 1          | 2          | 1           |
| <b>CO3</b>   | 2          | 3          | 3          | 3          | 2          | 2          | 3          | 2          | 2          | 2           |
| <b>CO4</b>   | 2          | 3          | 3          | 2          | 2          | 2          | 3          | 2          | 2          | 1           |
| <b>CO5</b>   | 3          | 3          | 3          | 2          | 2          | 3          | 3          | 3          | 3          | 2           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand the fundamental principles, types and economic motivations behind food adulteration and its impact on public health.
- To Master classical and modern analytical techniques for detecting adulterants in various food matrices including dairy, oils, spices and processed foods.
- To Apply chromatographic, spectroscopic, molecular and immunological methods for food authenticity verification.
- To Interpret regulatory frameworks (FSSAI, Codex Alimentarius, FDA) governing food safety and adulteration control.
- To Design and validate rapid, cost-effective detection protocols suitable for laboratory and field applications.

**UNIT – I: Foundations of Food Adulteration & Regulatory Framework**

Definition, classification, and economic drivers of food adulteration: intentional vs. incidental, Common adulterated food commodities: milk, oils, spices, honey, cereals, meat products, Health impacts: carcinogenicity, organ toxicity, allergic responses, metabolic disorders, Global and Indian regulatory landscape: FSSAI Act 2006 and FDA guidelines.

**UNIT – II: Classical & Physicochemical Detection Methods**

Physical methods: Microscopy, density, refractive index, viscosity, sedimentation tests. Chemical tests: Spot tests, titrimetry, colorimetric assays for milk (urea, detergent), oils (Argemone, mineral oil), spices (Sudan dyes). Thermal analysis: DSC, TGA for detecting starch/flour adulteration in dairy and spices. Electrochemical sensors: Potentiometric, amperometric biosensors for rapid screening.

**UNIT – III: Advanced Chromatographic & Spectroscopic Techniques**

Chromatography: HPLC/UPLC for melamine, antibiotics, mycotoxins in milk and honey, GC-MS for fatty acid profiling, volatile adulterants in oils and beverages, LC-MS/MS for multi-residue analysis of veterinary drugs and pesticides, Spectroscopy: FTIR/NIR for rapid fingerprinting of milk powder, olive oil, coffee, Raman & SERS for detecting synthetic dyes, melamine, and adulterants at trace levels, NMR spectroscopy for metabolomic profiling and geographic origin verification.

#### **UNIT – IV: Molecular & Immunological Detection Strategies**

DNA-based methods: PCR, qPCR, ddPCR for species identification in meat, fish, and dairy products, DNA barcoding and NGS for complex processed foods and allergen detection. Immunoassays: ELISA, lateral flow assays for detecting allergens, veterinary residues, and protein adulterants, Monoclonal antibody development and validation for targeted detection, Biosensors & Nanotechnology: Aptamer-based sensors, nanoparticle-enhanced detection, lab-on-chip platforms.

#### **UNIT – V: Data Analysis, Validation & Emerging Trends**

Chemometrics & AI: PCA, PLS-DA, SIMCA for multivariate classification of authentic vs. adulterated samples, Machine learning applications in spectral data interpretation and fraud prediction, Semantic Scholar. Rapid testing kits: RAFT kits, portable NIR, smartphone-integrated sensors for on-site screening, Blockchain & traceability: Digital solutions for supply chain transparency and provenance verification.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

AI and machine learning in food analysis.

#### **Textbooks:**

1. Sharma, G. K., Xavier, J. R., & Singh, A. (2024). Food Adulterants and Contaminants. New India Publishing Agency. (Covers Omic technologies and modern detection trends).
2. Srivastava, R. P., & Kumar, S. (2023). Fruit and Vegetable Preservation: Principles and Practices. (Includes specific chapters on adulteration detection).
3. Nielsen, S. S. (2022). Food Analysis (Food Science Texts Series). 6th Edition, Springer.

#### **Reference Books**

1. Bhatnagar, S. (2024). Commentary on Food Safety Law (8th Edition). Bharat Law House.
2. Otles, S. (2021). Methods of Analysis of Food Components and Additives. CRC Press.
3. Sharma, G. K., Xavier, J. R., & Singh, A. (2024). Food Adulterants and Contaminants. New India Publishing Agency. (Covers Omic technologies and modern detection trends).
4. Srivastava, R. P., & Kumar, S. (2023). Fruit and Vegetable Preservation: Principles and Practices. (Includes specific chapters on adulteration detection).
5. Nielsen, S. S. (2022). Food Analysis (Food Science Texts Series). 6th Edition, Springer.

## Course Outcomes (COs):

**Upon successful completion of this course the students will be able to:**

CO1: Explain the biochemical basis of common food adulterants and their health implications.

CO2: Select appropriate analytical methods for detecting specific adulterants in complex food matrices.

CO3: Operate and interpret data from HPLC, GC-MS, FTIR, NIR and PCR-based detection systems.

CO4: Evaluate food authenticity using chemometric tools and multivariate data analysis.

CO5: Design a comprehensive food safety audit protocol integrating regulatory compliance and detection strategies.

## Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 1   | 2   | 2   | 2   | 1   | 2   | 1    |
| <b>CO2</b> | 3   | 1   | 1   | 1   | 2   | 2   | 2   | 1   | 2   | 1    |
| <b>CO3</b> | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1    |
| <b>CO4</b> | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 1    |
| <b>CO5</b> | 3   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 2   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand the fundamental properties and classification of enzymes and analyze enzyme kinetics and catalytic mechanisms.
- To interpret enzyme inhibition and its applications in medicine.
- To understand coenzyme function in enzymatic reactions and explain mechanisms of enzyme regulation.
- To evaluate enzyme purification and characterization techniques.
- To explore industrial and clinical applications of enzymes.

**UNIT – I: FUNDAMENTALS OF ENZYMES**

Historical development of enzymology; Enzyme nomenclature and IUBMB classification. Properties of enzymes: specificity, catalytic power, regulation. Enzyme activity: units, specific activity, turnover number. Enzyme structure and catalysis: Active site and substrate binding, Lock-and-key and induced-fit models, Transition state concept and catalytic efficiency. Factors affecting enzyme activity; pH, temperature, substrate concentration.

**UNIT – II: ENZYME KINETICS AND DATA ANALYSIS**

Michaelis–Menten kinetics and significance. Determination of  $K_m$ ,  $V_{max}$ ,  $K_{cat}$ , catalytic efficiency. Kinetic analysis: Linear plots: Lineweaver–Burk, Eadie–Hofstee, Hanes–Woelf. Overview of Advanced kinetics: Pre-steady-state kinetics, Multi-substrate reactions: Sequential and ping-pong mechanisms.

**UNIT – III: ENZYME MECHANISM AND INHIBITION**

Mechanism of enzyme action: Acid-base catalysis, Covalent catalysis, Metal ion catalysis, Proximity and orientation effects. Mechanism of Enzyme action: Chymotrypsin, Lysozyme, Carboxy peptidase, Ribonuclease. Enzyme inhibition: Reversible-competitive, non-competitive, uncompetitive, mixed. Irreversible inhibition, Determination of inhibitor constants ( $K_i$ ). Substrate inhibition and feedback inhibition. Applications: Enzyme inhibitors in drug design.

**UNIT – IV: ENZYME REGULATION AND COENZYMES**

Coenzymes: Structure and function:  $NAD^+$ , FAD, CoA, TPP, PLP, THF, Vitamin B12. Regulation of enzyme activity: Allosteric enzymes and cooperativity, Models: MWC and KNF. Other regulatory mechanisms: Covalent modification, Zymogen activation, Enzyme induction and repression, Isoenzymes and clinical significance.

## **UNIT – V: ENZYME TECHNOLOGY AND APPLICATIONS**

Multienzyme complexes – Pyruvate dehydrogenase complex, fatty acid synthase, Na-K ATPase; metalloenzymes. Enzyme purification and characterization: Methods of purification, Active site identification. Immobilized enzymes: Methods and advantages, Industrial and medical applications. Ribozymes, abzymes. Modern enzymology: basic concepts of Enzyme engineering, Biosensors and enzyme electrodes, Introduction to AI in enzyme design and applications.

## **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Artificial Intelligence in enzyme design and drug discovery. Role of enzymes in emerging diseases.

### **REFERENCES:**

1. Nelson DL, Cox MM. Lehninger Principles of Biochemistry. 8th ed. W.H. Freeman and Company; 2021.
2. Berg JM, Tymoczko JL, Gatto GJ. Biochemistry. 9th ed. W.H. Freeman and Company; 2019.
3. Segel IH. Enzyme Kinetics. John Wiley & Sons; 2007 (Reprint).
4. Copeland RA. Evaluation of Enzyme Inhibitors in Drug Discovery. 2nd ed. John Wiley & Sons; 2013. Dixon M, Webb EC. Enzymes. Academic Press; Latest Reprint.
5. Fersht A. Structure and Mechanism in Protein Science. World Scientific; 2017.
6. Voet, D. and Voet, J.G. (2010) Biochemistry. John Wiley and Sons Inc., New Jersey.
7. Nicholas, P. and Lewis, S. (1999) Fundamentals of Enzymology: Cell & Molecular Biology of Catalytic Proteins. Oxford University Press.
8. Palmer T. and Bonner P. (2007) Enzymes: Biochemistry, Biotechnology, Clinical Chemistry. Horwood Publishing Ltd., United Kingdom.

### **ONLINE REFERENCES:**

1. **IUBMB Enzyme Nomenclature Database**  
<https://www.qmul.ac.uk/sbcs/iubmb/enzyme/>
2. **BRENDA Enzyme Database**  
<https://www.brenda-enzymes.org>
3. **KEGG Enzyme Database**  
<https://www.genome.jp/kegg/>

## **COURSE OUTCOMES (COs):**

**Upon successful completion of this course the students will be able to:**

CO1: Explain the classification, structure, catalytic mechanisms, and factors influencing enzyme activity and relate enzyme properties to their biological functions.

CO2: Apply principles of enzyme kinetics to determine kinetic parameters ( $K_m$ ,  $V_{max}$ ,  $K_{cat}$ , catalytic efficiency) and interpret enzyme kinetic data using various linear transformation plots.

CO3: Analyze enzyme catalytic mechanisms, inhibition patterns, and regulatory processes and evaluate their significance in metabolic control and drug design

CO4: Examine the roles of coenzymes, allosteric regulation, covalent modification, zymogen activation and isoenzymes in controlling enzyme function and clinical applications.

CO5: Evaluate enzyme technologies including enzyme purification, immobilization, enzyme engineering, biosensors, ribozymes, abzymes and AI-assisted enzyme design for industrial, medical, and biotechnological applications.

### **Mapping with Programme Outcomes**

| <b>PO/CO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 2          | 1          | 1          | 1          | 1          | -          | 1          | -           |
| <b>CO2</b>   | 3          | 3          | 3          | 2          | 1          | 1          | 3          | 2          | 1          | -           |
| <b>CO3</b>   | 3          | 3          | 3          | 2          | 1          | 2          | 3          | 2          | 1          | 1           |
| <b>CO4</b>   | 3          | 2          | 3          | 2          | 1          | 2          | 2          | 2          | 1          | 1           |
| <b>CO5</b>   | 3          | 3          | 2          | 3          | 3          | 2          | 3          | 3          | 3          | 2           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**Code: INTERMEDIARY METABOLISM AND  
REGULATION  
(Theory)**

**Credit: 4**

**COURSE OBJECTIVES:**

- To understand the biochemical metabolic pathways of carbohydrates and their energetics.
- To enhance the knowledge about the key biochemical pathways in amino acids metabolism and their regulations.
- To attain and update the knowledge about Lipid metabolism.
- To study the importances of purine and pyrimidine metabolism.
- To acquire the concept of anabolism, catabolism and role of high energy compounds in the cell, comparative, integrative and applied metabolism.

**UNIT – I: Carbohydrate Metabolism, Kinetics and Hormonal Regulation**

Glycolysis – aerobic and anaerobic glycolysis, energetics and regulation of glycolysis, Glycolysis in various tissues and its kinetics and energetics, specific glycolysis pathway in RBC, Glucogenesis, Role of fructose 2-6 biphosphate in liver and muscle, Gluconeogenesis, Glycogenesis and Glycogenolysis, TCA cycle – pathway, kinetics and its regulation, Regulation by cAMP and hormonal regulation, Phosphorylase activation and inactivation regulation, Glyoxylate metabolism, Role of  $\text{Ca}^{++}$  and Glucose 6- Phosphate dehydrogenase, Hexose Monophosphate pathway and its biological significance. Hormonal regulation of blood sugar level, Cori cycle, uronic acid pathway, malate aspartate shuttle pathway, oxidation of Pyruvate, PDH

**UNIT – II: Amino Acid Metabolism**

Biosynthesis and degradation of essential amino acids, Alanine synthesis from pyruvate, synthesis of aspartate from oxaloacetate, Biosynthesis and degradation of non-essential amino acids, Glucogenic and ketogenic amino acids metabolism, Urea cycle and its regulation, energetics of urea cycle, Transamination, Oxidative Deamination, Decarboxylation, Ammonia formation and role of glutamate dehydrogenase in ammonia release and detoxification, Biosynthesis of neurotransmitters serotonin and dopamine, epinephrine and norepinephrine hormones, melanin pigment

**UNIT – III: Lipid Metabolism and Physiological Regulation**

Biosynthesis and degradation of saturated and unsaturated fatty acids, role of Acetyl CoA Carboxylase in lipogenesis, oxidation of fatty acids (alpha,

beta and omega), Lipid peroxidation, Biosynthesis of Tri Acyl Glycerol, Degradation of TAG, role of hormone sensitive lipase in TAG degradation, Biosynthesis of Phospholipids, Sphingolipids, Glycolipids, Prostaglandins, Biosynthesis of Cholesterol, Degradation of Cholesterol, Regulation of Cholesterol homeostasis, Ketone bodies synthesis, Metabolism of lipoproteins LDL, VLDL, HDL and Chylomicrons, Role of Reverse Cholesterol Transport, Role of epinephrine, glucagon and insulin on lipogenesis and lipolysis, Synthesis of Bile acids and steroid hormones.

#### **UNIT – IV: Metabolism of Nucleic acids**

Biosynthesis of Purines – De novo and salvage pathways for the biosynthesis of purines (Adenine and Guanine), and Pyrimidines (Cytosine, Thymine and Uracil), Role of HGPRTase in salvage pathways of purine and pyrimidine synthesis, Regulatory role of PRPP synthetase and aspartate transcarbamoylase and ribonucleotide reductase, Pathways for the Catabolism of Purines and Pyrimidines, Porphyrin metabolism, Biosynthesis and degradation of Heme

#### **UNIT – V: Bioenergetics, Comparative, Integrative and Applied Metabolism**

High-energy Phosphate Compounds, structure and mechanism of ATP synthetases, Electron Transport Chain, ATP/ADP exchange, Biological oxidation, oxidative Phosphorylation, ROS metabolism, Metabolic inter relationships – Glucose 6 Phosphate, Pyruvate and Acetyl CoA. Comparative metabolism in animals, human, plants and microorganisms, Hormonal regulation of metabolism (Insulin, glucagon, cortisol, epinephrine, AMPK and mTOR pathway), integrative metabolism of carbohydrates, lipids, proteins and nucleic acids, Stress response metabolic pathway, Autophagy, Application of machine learning and big data for metabolic pathway modeling and data analysis

#### **UNIT – VI: Current contours – (Self-directed learning activities for Continuous Internal Assessments Only):**

Metabolic interrelationships in various nutritional and hormonal states– obesity, aerobic, anaerobic endurance, exercise, pregnancy, lactation, IDDM, NIDDM and starvation, Advances in metabolomics in human health

#### **Recommended Books:**

1. Principles of Biochemistry – 7th edition, Lehninger, Nelson & Cox, Macmillan worth Publishers, (2013).
2. Stryer, “Biochemistry”, 5th edition, Freeman, (2002).
3. Murray et al., “Harper’s Biochemistry”, 30th edition, Mc. Graw Hill, (2015).
4. Primer for the Exercise and Nutrition Sciences: Thermodynamics, Bioenergetics, Metabolism, Christopher B. Scott. (2010).

5. Bioenergetics (Biochemistry Research Trends), Jeffrey W. Berkin, (2011).
6. Bioenergetics: Energy Conservation and Conversion (Results and Problems in Cell Differentiation), Günter Schäfer, (2008).
7. Donald Voet, J.G. Voet, John Wiley, "Biochemistry", 4th edition, 2006.
8. Davidson & Sittman, "Biochemistry NM., 3rd edition", Lippincott. Williams and Wilkins, (2005).
9. Champe P.C and Richard A Harvey, Lippincotts Biochemistry, Williams & Wilkins Publishers, (2004)
10. <https://www.kobo.com/us/en/ebook/metabolic-regulation>
11. <https://www.kobo.com/us/en/ebook/hepatic-de-novo-lipogenesis-and-regulation-ofmetabolism>
12. <https://www.elsevier.com/books/metabolic-regulation/vogel/978-0-12-299255-1>

### Course Outcomes (COs):

**Upon successful completion of this course the students will be able to:**

CO1: Describe the pathways, energetics, key enzymes and regulatory mechanisms involved in carbohydrate, amino acid, lipid, nucleotide and energy metabolism.

CO2: Explain the biochemical principles governing metabolic pathways, hormonal regulation, bioenergetics, redox balance and metabolic integration in different physiological states.

CO3: Apply knowledge of metabolic pathways and regulatory networks to interpret biochemical processes, energy production, nutrient utilization and metabolic adaptations in organisms.

CO4: Analyze the interrelationships among carbohydrate, lipid, protein, nucleotide and energy metabolism, including their regulation by hormones, signaling pathways and environmental conditions.

CO5: Evaluate metabolic responses in health and disease and assess emerging approaches such as systems biology, machine learning and metabolic pathway modeling for solving biological problems.

### Mapping with Program Outcomes:

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 2   | 1   | 1   | 1   | –   | 1   | –    |
| <b>CO2</b> | 3   | 2   | 2   | 2   | 1   | 1   | 2   | 1   | 1   | –    |
| <b>CO3</b> | 3   | 3   | 2   | 3   | 2   | 2   | 3   | 2   | 1   | 1    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 1   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 3   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand the principles of biochemical techniques used in protein and enzyme analysis.
- To Perform quantitative estimation of proteins using standard biochemical methods.
- To Analyze enzyme activity and evaluate the effects of physicochemical factors on enzyme kinetics.
- To apply electrophoretic techniques for separation and visualization of biomolecules.
- To Develop laboratory skills, data recording and interpretation abilities in enzymology and molecular biology experiments.

**Experiments:**

1. Estimation of protein by Lowry's/ Bradford method
2. Estimation of enzyme activity of horse radish peroxidase.
3. Effect of pH, temperature, substrate concentration, activator, inhibitor and specific activity on enzyme amylase, urease and alkaline phosphatase activity.
4. Ammonium sulphate fractionation of proteins.
5. SDS-PAGE of proteins and identification by CBB/silver staining.
6. Immobilization of an enzyme by entrapping in alginate gel.

**References:**

1. Bisswanger, H. (2011) Practical Enzymology. John Wiley & Sons, New Jersey.
2. Green, M. R. and Sambrook, J. (2012). Molecular Cloning: A Laboratory Manual Vol 1, 2 & 3, CSHL Press. New York.
3. Jayaraman J. laboratory manual in Biochemistry, 3<sup>rd</sup> ed, New Age International Pvt Ltd Publishers, New Delhi, 2011.
4. Sadasivam S, Manickam A, Biochemical Methods, 3<sup>rd</sup> ed, New Age International Pvt Ltd Publishers, New Delhi, 2009.
5. Sawhney SK, Randhir Singh. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, 2014.

## Course Outcome (COs):

**Upon successful completion of this course the students will be able to:**

CO1: Perform quantitative estimation of proteins and enzyme activities using standard biochemical methods and accurately record experimental observations.

CO2: Apply experimental procedures to investigate the effects of pH, temperature, substrate concentration, activators, inhibitors and specific activity on enzyme function.

CO3: Analyze enzyme kinetic behaviour and interpret experimental data to determine factors influencing enzyme activity and catalytic efficiency.

CO4: Demonstrate protein purification and characterization techniques, including ammonium sulphate fractionation and SDS-PAGE, and analyze protein separation patterns.

CO5: Evaluate and design enzyme immobilization techniques and their applications in biotechnology, industry, and research through experimental investigation and data interpretation.

## Mapping with Programme Outcomes

| PO/CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1   | 3   | 2   | 2   | 3   | 1   | 1   | 2   | 2   | 1   | -    |
| CO2   | 3   | 3   | 2   | 3   | 1   | 2   | 3   | 2   | 1   | -    |
| CO3   | 3   | 3   | 3   | 2   | 1   | 2   | 3   | 3   | 1   | 1    |
| CO4   | 3   | 2   | 3   | 3   | 2   | 2   | 2   | 3   | 1   | 1    |
| CO5   | 3   | 3   | 2   | 3   | 2   | 2   | 3   | 3   | 2   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**Code:                      1. BIOTECHNOLOGY AND GENETIC                      Credit: 4**  
**ENGINEERING**  
**(Theory)**

**COURSE OBJECTIVES:**

- This course enables students to understand the fundamental mechanisms involved in the functioning and transmission of genetic material at both molecular and cellular levels.
- The methods of change of a genetic material and construction of transgenic organisms with the given properties.
- Students can understand the natural function of restriction endonucleases and how a normal bacterial cell protects its DNA from their activity.
- Understand the value and the processes involved with the polymerase chain reaction (PCR).
- To understand the function of creative use of modern tools and techniques for manipulation and analysis of genomic sequences.

**UNIT – I: Genetic Engineering Tools and Vectors**

Principles of genetic engineering and rDNA technology. Cutting and joining of DNA molecules. Restriction enzymes and their types. DNA ligases. Alkaline phosphatase. Double linkers. Adaptors. Homopolymeric tailing. Essential features of cloning vectors. Plasmids - pBR322 and pUC, Phage vectors -  $\lambda$  and M13, Cosmids and High-capacity cloning vectors -YAC, PAC and BAC. Shuttle vectors. Expression vectors. Gene cloning in bacteria and yeast. Selection and screening of recombinants.

**UNIT – II: Gene Cloning and DNA Analysis Techniques**

Genomic DNA library, cDNA synthesis and cloning, Chromosome walking, Gene transfer methods - Calcium phosphate precipitation, PEG stimulated, liposome mediated, electroporation, microinjection, viral vectors and particle bombardment gun (biolistic) method. PCR technology. Blotting techniques - southern, northern and western blotting.

**UNIT – III: Plant Genetic Engineering and Biotechnology**

Agrobacterium mediated transformation. Ti plasmids - cointegrative and binary vectors, Production of transgenic plants - viral, pest and herbicide resistant plants. Plant as bioreactors. Plant tissue culture - callus culture, micropropagation and protoplast culture. Anti-sense RNA technology and its applications.

#### **UNIT – IV: Animal Biotechnology and Gene Therapy**

Transgenic animals - Production and applications. Animal cell culture – methods and applications. Gene therapy - Ex-vivo, In vivo and in situ gene therapy. Principles and applications of stem cell technology - Embryonic and adult Stem Cells, Totipotent, Pluripotent and Multipotent Cells. Production of insulin, vaccines, antibodies, interferons and somatostatin.

#### **UNIT – V: Genomics, DNA Profiling and Bioethics**

Human genome projects. DNA Fingerprinting - RAPD, RACE (Rapid Amplification of cDNA Ends), RFLP and AFLP analysis and its application in forensic science. DNA foot printing. Bioethics: Laws and regulations in biotechnology, patent laws and Intellectual property rights (IPR). Biosafety, types of biosafety, advantages and disadvantages. Ethics in cloning and stem cell research. Ethical issues in production of genetically engineered foods, transgenic plants and animals.

#### **UNIT – VI: Current Contours (Self-directed learning activities for Continuous Internal Assessments Only):**

Organoid Technology in Disease Modeling and Drug Discovery.

#### **References**

1. Molecular Cloning: A Laboratory manual, J. Sambrook, E. Frisch and T. Maniatis, Old Spring Harbor Laboratory Press New York, 2000.
2. Glover, D. M. and Hames, B. D. DNA Cloning: A Practical Approach, IRL Press, Oxford University Press, Oxford, Latest Reprint Edition available.
3. Kaufman, P. B., Wu, W., Kim, D., and Cseke, L. J. Molecular and Cellular Methods in Biology and Medicine, CRC Press, Boca Raton, 1995.
4. Micklos, D. A. and Freyer, G. A. DNA Science: A First Course in Recombinant DNA Technology, 2nd Edition, Cold Spring Harbor Laboratory Press, New York, 2003.
5. Molecular Biotechnology (2nd Edn.) SB Primrose, Blackwell Scientific Pub. Oxford, 1994
6. Milestones in Biotechnology. Classic papers on Genetic Engineering. JA Davies and WS Reznikoff, Butterworth-Heinemann, Boston, 1992
7. Route Maps in Gene Technology, MR Walker and R Rapley, Blackwell Science Ltd, Oxford 1997
8. Old, R. W. and Primrose, S. B. Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell Publishing, Oxford, 2006.
9. Benjamin Lewin, 2011, Genes X, Pearson Educational international.
10. Brown T.A, 2003, Gene Cloning- An introduction, 3<sup>rd</sup> edition, Chapman Hall.
11. Watson, 2001, Recombinant DNA, 2<sup>nd</sup> edition, Scientific American Books. Adrian Slater, 2003, Plant Biotechnology, Oxford University Press.

## Course Outcomes (COs):

**After successful completion of this course, students will be able to:**

CO1: Explain the principles of genetic engineering, recombinant DNA technology, cloning vectors, and the methods used for gene cloning and recombinant selection.

CO2: Apply gene cloning, DNA amplification, gene transfer, and molecular analysis techniques such as PCR and blotting methods for genetic studies.

CO3: Analyze plant genetic engineering approaches, transgenic plant production, plant tissue culture techniques, and their biotechnological applications.

CO4: Evaluate animal biotechnology applications including transgenic animals, animal cell culture, gene therapy, stem cell technology, and biopharmaceutical production.

CO5: Assess genomic technologies, DNA profiling methods, biosafety regulations, intellectual property rights, and ethical issues in modern biotechnology.

## Mapping with Programme Outcomes

| PO/CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1   | 3   | 2   | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 1    |
| CO2   | 3   | 3   | 2   | 3   | 2   | 1   | 1   | 1   | 1   | 1    |
| CO3   | 3   | 3   | 3   | 2   | 2   | 2   | 1   | 1   | 1   | 1    |
| CO4   | 3   | 3   | 2   | 3   | 2   | 2   | 1   | 2   | 1   | 1    |
| CO5   | 2   | 3   | 1   | 2   | 2   | 3   | 2   | 3   | 1   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand cellular and molecular basis of physiological processes.
- To analyze cardiovascular and respiratory functions.
- To understand renal regulation and homeostasis.
- To correlate physiological mechanisms with disease conditions.
- To develop analytical and integrative understanding of physiology.

**UNIT – I: HUMAN HOMEOSTASIS AND APPLIED PHYSIOLOGY**

Concept of homeostasis and integration of physiological systems. Physiological adaptations to internal and external environments. Body fluid compartments and regulation of fluid balance; electrolyte distribution and imbalance. Thermoregulation: mechanisms of heat production and loss; regulation of body temperature; fever and hyperthermia. Stress physiology: general adaptation syndrome; physiological responses to acute and chronic stress; role of neuroendocrine integration.

**UNIT – II: CARDIOVASCULAR AND BLOOD PHYSIOLOGY**

Blood composition and functions; Hemoglobin and oxygen transport; Overview of hematological disorders. Cardiac physiology: Structure and conduction system of heart; Cardiac cycle and cardiac output; Basic ECG interpretation. Vascular physiology: Blood flow and blood pressure regulation, Capillary gaseous exchange. Clinical aspects: Basic mechanism of Hypertension and overview of atherosclerosis.

**UNIT – III: RESPIRATORY AND RENAL PHYSIOLOGY:**

Respiratory system: Mechanics of breathing, Gas exchange and transport, Regulation of respiration. Renal system: Structure of nephron, Urine formation, Water and electrolyte balance. Acid–base balance: Buffer systems, Role of lungs and kidneys. Clinical aspects: Asthma, COPD and Renal dysfunction.

**UNIT – IV: DIGESTIVE SYSTEM AND METABOLIC INTEGRATION**

Structural organization of the gastrointestinal tract and organs (salivary glands, liver, pancreas, gallbladder). Functional aspects: ingestion, motility, secretion, digestion, absorption and excretion. Gastrointestinal motility: peristalsis, segmentation and regulation by neural and hormonal mechanisms. Secretory functions: salivary, gastric, pancreatic and intestinal secretions; role of bile in lipid digestion. Digestion and absorption of

carbohydrates, proteins and lipids; absorption of vitamins and minerals. Regulation of digestive processes: enteric nervous system, autonomic control and gastrointestinal hormones (gastrin, secretin, cholecystokinin). Clinical correlations: peptic ulcer, gastroesophageal reflux disease (GERD), malabsorption syndromes.

### **UNIT – V: NEUROPHYSIOLOGY AND MUSCLE FUNCTION**

Neurophysiology: Neuron structure and function: Synaptic transmission, Neurotransmitters. Basic concepts of Learning and Memory. Muscle physiology: Types of muscle, Mechanism of contraction and relaxation. Neuromuscular disorders: Parkinson's disease, Myasthenia gravis.

### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Recent researches in physiological sciences.

#### **Text books**

1. Pal, G.K. (2022). Comprehensive Textbook of Medical Physiology. Jaypee Brothers.
2. Jain, A.K. (2021). Textbook of Physiology. Avichal Publishing.
3. Sembulingam, K. (2022). Essentials of Medical Physiology. Jaypee Brothers.
4. Best & Taylor (2021). Physiological Basis of Medical Practice. Wolters Kluwer.

#### **Reference Books**

1. Hall, J.E. (2025). Guyton and Hall Textbook of Medical Physiology, 15th Edition. Elsevier.
2. Koepfen, B.M., Stanton, B.A. (2024). Berne and Levy Physiology, 8th Edition. Elsevier.
3. Barrett, K.E. (2023). Ganong's Review of Medical Physiology, 26th Edition. McGraw Hill.
4. Khurana, I. (2024). Textbook of Medical Physiology, 4th Edition. Elsevier India.
5. Fox, S.I. (2025). Human Physiology, McGraw Hill.

### **COURSE OUTCOMES(COs):**

**Upon successful completion of this course the students will be able to:**

CO1: Describe the principles of human homeostasis and explain the structure and functions of major physiological systems including cardiovascular, respiratory, renal, digestive, nervous and muscular systems.

CO2: Explain the physiological mechanisms involved in fluid and electrolyte balance, thermoregulation, circulation, respiration, excretion, digestion, neural communication and muscle contraction.

CO3: Apply physiological principles to interpret normal body functions, physiological adaptations and the maintenance of internal homeostasis under different environmental and physiological conditions.

CO4: Analyze the integration of organ systems and evaluate physiological data related to cardiovascular, respiratory, renal, digestive, neuromuscular and metabolic functions in health and disease.

CO5: Evaluate physiological disturbances associated with common disorders such as hypertension, atherosclerosis, asthma, COPD, renal dysfunction, GERD, Parkinson's disease and myasthenia gravis and propose scientifically justified interpretations of their underlying mechanisms.

### Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 2   | 1   | 1   | 1   | –   | 1   | –    |
| <b>CO2</b> | 3   | 2   | 2   | 2   | 1   | 1   | 2   | 1   | 1   | –    |
| <b>CO3</b> | 3   | 3   | 2   | 2   | 1   | 2   | 3   | 1   | 1   | 1    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 2   | 1   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 2   | 2   | 2   | 3   | 2   | 2   | 1    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To provide students with fundamental and comprehensive knowledge of bioinformatics, including biological databases, data retrieval systems, and computational tools used in modern biological and biochemical research.
- To develop the ability to analyse nucleotide and protein sequences using sequence alignment algorithms, scoring matrices, phylogenetic methods, and bioinformatics software tools.
- To train students in structural bioinformatics techniques, including protein structure prediction, molecular modelling, molecular visualization, and biomolecular interaction analysis.
- To enable students to apply bioinformatics and functional genomics approaches in genome analysis, disease pathway studies, systems biology, and computational drug discovery research.
- To familiarize students with emerging applications of bioinformatics in genomics, proteomics, precision medicine, artificial intelligence, and interdisciplinary biomedical sciences.

**UNIT – I: BIOINFORMATICS**

An overview, Definition & History; Bioinformatics databases & tools on the Internet- NCBI, EBI, PIR, Swiss-Prot, GenBank; pattern & motif searches- BLOCKS, PRINTS, PFAM.

**UNIT II: PROTEIN STRUCTURE PREDICTION**

Levels of protein structure – Ramachandran Map. Protein Secondary structure prediction - Chou Fasman rules, Gamier-Osguthorpe-Robson (GOR) methods; Predicting 3D structure – homology modeling, threading - fold recognition and ab initio methods - Rosetta – CASP.

**UNIT – III: BIOLOGICAL SEQUENCE ANALYSIS**

Pairwise sequence comparison – Sequence queries against biological databases – BLAST and FASTA - Multiple sequence alignments – Phylogenetic alignment.

Algorithms and Matrices: Scoring matrices- PAM and BLOSUM; dynamic programming, Algorithms, Needleman and Wunsch, Smith-Waterman.

#### **UNIT – IV: PROTEIN STRUCTURE TOOLS**

RasMol, HEX, Argus Lab Swiss PDB Viewer - Structure –Classification, alignment and analysis – SCOP, CATH, FSSP, UNIX.

#### **UNIT – V: FUNCTIONAL GENOMICS (METABOLISM AND REGULATION) IN BIOCHEMISTRY**

Sequencing genomes– Genome databases on the web, Prokaryotic Genome Database with comparison with Human genome, HGP, GENECLUSTER, DNA Microarray, SWISS-2DPAGE Database, TIGR, WIT, CYTOSCAPE and DRUG DISCOVERY.

#### **UNIT – VI: CURRENT CONTOUR (Self-directed learning activities for Continuous Internal Assessments Only):**

Using a Bioinformatics tool to predict protein models in disease-related pathways.

#### **Recommended References:**

1. Bioinformatics: A Practical Guide to Next Generation Sequencing Data Analysis -J by Hamid D. Ismail, 1st edition, 2023. Publisher - Boca Raton: CRC Press
2. Methods and Applications: Genomics, Proteomics and Drug Discovery – by Namita Mendiratta, Parag Rastogi, S.C.Rastogi, 5th edition, 2022
3. Bioinformatics-Sequence and Genome Analysis- David W.Mount, Cold Spring Harbor Laboratory Press (2004).
4. Introduction to Bioinformatics, Attwood, T.K. and D.J. Parry-Smith, Pearson Education Ltd., New Delhi (2004).
5. Bioinformatics – Westhead, D.R., Paris J.H. And R.M. Twyman, Instant Notes: Viva Books Private Ltd, New Delhi (2003).
6. Introduction to Bioinformatics, Arthur M. Lesk, Oxford University Press, New Delhi (2003).
7. Bioinformatics- Sequence, structure and databanks, Higgins D. and W. Taylor (Eds), Oxford University Press, New Delhi (2000).
8. Introduction to computational Biology, Michael, S. Waterman, Chapman & Hall.

#### **COURSE OUTCOMES(COs):**

**Upon successful completion of this course the students will be able to:**

CO1: Explain the fundamental concepts of bioinformatics, biological databases, sequence analysis, protein structure prediction, and functional genomics used in biochemical research.

CO2: Interpret and analyse biological sequence and structural data using bioinformatics algorithms, scoring matrices, phylogenetic tools, and database resources.

CO3: Evaluate protein modelling methods, genome analysis tools, and computational approaches for studying biomolecular interactions, disease pathways, and drug discovery applications.

CO4: Apply bioinformatics software and computational tools such as BLAST, FASTA, RasMol, Swiss PDB Viewer, and molecular docking platforms to solve biological and biochemical problems.

CO5: Develop computational and research skills required for advanced studies, interdisciplinary research, and emerging applications of bioinformatics in biotechnology, genomics, and precision medicine.

### Mapping with Programme Outcomes

| COs\POs    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 2   | 1   | 2   | 1   | –   | –   | –   | 1   | 1    |
| <b>CO2</b> | 3   | 3   | 2   | 2   | 1   | –   | –   | –   | 1   | 1    |
| <b>CO3</b> | 3   | 2   | 2   | 2   | 1   | –   | 1   | –   | 1   | 1    |
| <b>CO4</b> | 3   | 3   | 2   | 3   | 2   | 1   | –   | 1   | 1   | 1    |
| <b>CO5</b> | 3   | 2   | 1   | 2   | 1   | 1   | 1   | 1   | 1   | 1    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**Code: 2. ECOLOGY AND ENVIRONMENTAL BIOLOGY  
(Theory)****Credit: 3****COURSE OBJECTIVES:**

- Understand the fundamental concepts of ecology including abiotic and biotic factors and relate them to biochemical processes in living organisms.
- Analyse population dynamics, growth models, and intra- and inter-specific interactions such as predation, competition, mutualism, and parasitism.
- Describe the structure, functioning, and succession of ecological communities, and evaluate the role of biodiversity in ecosystem stability.
- Explain energy flow through ecosystems, productivity, trophic levels, and the major biogeochemical cycles of carbon, nitrogen, phosphorus, sulphur, and water.
- Critically evaluate current environmental issues such as pollution, climate change, ozone depletion, biodiversity loss, and solid waste management, and propose evidence-based remediation strategies.

**UNIT – I: Introduction to Ecology and Abiotic Factors**

Definition, scope, and branches of ecology. History and development of ecology as a science. Levels of ecological organization: organism, population, community, ecosystem, biome, and biosphere. Abiotic (physical) factors: light — light as an energy source, photoperiodism, shadow and sun plants; temperature — effects on metabolic rates, ecotypes, Bergmann's rule; water and humidity — water availability and organisms; soil (edaphic factors) — soil profile, texture, pH and mineral content, soil organisms; atmospheric gases — role of CO<sub>2</sub> and O<sub>2</sub>. Concept of ecological tolerance — Shelford's Law of Tolerance, limiting factors, Liebig's Law of the Minimum. Liebig's Law vs Shelford's Law — comparative analysis.

**UNIT – II: Population Ecology**

Definition and attributes of population: natality, mortality, age distribution, sex ratio, and population density. Population growth: exponential growth model (J-curve), logistic growth model (S-curve / Verhulst-Pearl logistic equation), carrying capacity (K). Life tables, survivorship curves (Type I, II, III). r-selected and K-selected species strategies. Population regulation: density-dependent and density-independent factors. Intraspecific interactions: competition, territoriality, allee effect. Metapopulation concept — source-sink dynamics. Human population growth: demographic transition model, implications for natural resources.

**UNIT – III: Community Ecology and Succession**

Definition and characteristics of ecological community: species richness, evenness, diversity indices (Shannon-Wiener, Simpson's). Interspecific interactions: predation, competition (Gause's competitive exclusion

principle, Lotka-Volterra equations), mutualism, commensalism, amensalism, parasitism. Ecological niche concept — fundamental vs realised niche. Food chains, food webs, trophic levels, trophic cascade. Ecological succession: primary and secondary succession, seral communities, climax community, allogenic vs autogenic succession. Theories of community structure — Clements vs Gleason. Keystone species and indicator species. Edge effect and ecotone. Island biogeography and species-area relationship.

#### **UNIT – IV: Ecosystem Ecology: Energy Flow and Biogeochemical Cycles**

Concept of ecosystem: structure and function. Producers, consumers, decomposers. Energy flow: laws of thermodynamics applied to ecosystems. Gross Primary Productivity (GPP) and Net Primary Productivity (NPP); secondary productivity. Ecological pyramids — pyramid of numbers, biomass, and energy; Lindemann's 10% law. Decomposition: factors, stages, and significance. Major biogeochemical cycles: Carbon cycle — atmospheric CO<sub>2</sub>, photosynthesis, respiration, fossil fuels; Nitrogen cycle — nitrogen fixation, nitrification, denitrification, ammonification; Phosphorus cycle — terrestrial and aquatic; Sulphur cycle — vulcanism, microbial transformations; Hydrological (water) cycle — evapotranspiration, precipitation, runoff. Human impacts on biogeochemical cycles. Eutrophication — causes and consequences.

#### **UNIT – V: Biodiversity, Environmental Issues and Conservation**

Biodiversity: definition, levels (genetic, species, ecosystem), measurement. Hotspots of biodiversity — global and Indian perspective. Threats to biodiversity: habitat loss, fragmentation, invasive species, over-exploitation, pollution, climate change. IUCN categories of threatened species. Strategies for biodiversity conservation: in situ (national parks, biosphere reserves, wildlife sanctuaries) and ex situ (seed banks, cryopreservation, captive breeding). Environmental pollution: air pollution — causes, effects, acid rain, photochemical smog, ozone layer depletion, Montreal Protocol; water pollution — industrial effluents, eutrophication, heavy metals, remediation; soil pollution — pesticides, heavy metals, bioremediation; noise and radioactive pollution. Global warming and climate change — greenhouse effect, global temperature rise, IPCC reports, Paris Agreement. Solid waste management — 3R principle, bioremediation, vermicomposting. Environmental legislation in India: Environment Protection Act, Wildlife Protection Act, Biological Diversity Act.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Ecological and Ecosystem modelling.

#### **Textbooks**

1. Odum, E. P., & Barrett, G. W. (2005). Fundamentals of Ecology (5th ed.). Thomson Brooks/Cole, Belmont, CA, USA.
2. Mackenzie, A., Ball, A. S., & Virdee, S. R. (2001). Instant Notes in Ecology (2nd ed.). BIOS Scientific Publishers / Taylor & Francis.
3. Ricklefs, R. E., & Miller, G. L. (2000). Ecology (4th ed.). W. H. Freeman and Company, New York.

4. Dash, M. C. (2001). Fundamentals of Ecology. Tata McGraw-Hill, New Delhi.
5. Misra, R. (1968 (Repr.)). Ecology Workbook. Oxford and IBH Publishing, New Delhi.

### **Reference Books**

1. Krebs, C. J. (2009). Ecology: The Experimental Analysis of Distribution and Abundance (6th ed.). Pearson Benjamin Cummings, San Francisco.
2. Smith, R. L., & Smith, T. M. (2001). Ecology and Field Biology (6th ed.). Benjamin Cummings, San Francisco.
3. Putman, R. J., & Wratten, S. D. (1984). Principles of Ecology. University of California Press, Berkeley.
4. Begon, M., Townsend, C. R., & Harper, J. L. (2006). Ecology: From Individuals to Ecosystems (4th ed.). Blackwell Publishing, Oxford.
5. Sharma, P. D. (2014). Ecology and Environment (11th ed.). Rastogi Publications, Meerut.
6. Trivedy, R. K., & Goel, P. K. (1986). Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad.
7. Singh, J. S., Gupta, S. R., & Singh, S. P. (2006). Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
8. De, A. K. (2010). Environmental Chemistry (8th ed.). New Age International, New Delhi.

### **Web Resources:**

1. [Biotic vs. Abiotic Factors in an Ecosystem](#)
2. [Community ecology - Succession, Species Interactions, Ecosystems | Britannica](#)
3. [Conservation of Biodiversity – Environmental Geography](#)

### **Course Outcomes (COs):**

#### **Upon successful completion of this course the students will be able To:**

CO1: Recall the history and development of ecology, state the exponential growth model, describe primary and secondary succession.

CO2: classify the Biotic, abiotic factors, explain intraspecific interactions, compare and contrast the theories of Clements and Gleason.

CO3: Apply the concepts of ecological organization, to calculate and predict population changes over time, to calculate species-area relationships, apply the concepts of global warming and climate change.

CO4: examine how limiting factors interact to determine species, analyze intraspecific interactions, investigate island biogeography theory.

CO5: critique the demographic transition model and evaluate its predictions, Evaluate the effectiveness of diversity indices and assess solid waste management approaches.

### Mapping with Programme Outcomes

| COs\POs    | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>C01</b> | 3   | 1   | 2   | 2   | 1   | 1   | 1   | 1   | 2   | 1    |
| <b>C02</b> | 3   | 3   | 2   | 2   | 1   | 2   | 1   | 1   | 2   | 1    |
| <b>C03</b> | 2   | 2   | 3   | 3   | 2   | 2   | 3   | 2   | 3   | 2    |
| <b>C04</b> | 2   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 2   | 2    |
| <b>C05</b> | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To provide fundamental knowledge of Bioethics and Intellectual Property Rights (IPR), including patents, copyrights, trademarks, geographical indications, plant variety protection, industrial designs, and related international agreements relevant to science, technology, and innovation.
- To develop an understanding of patentability criteria, filing procedures, registration processes, and legal protection mechanisms for inventions, research outcomes, and innovations in biological, biochemical, and allied sciences.
- To familiarize students with the management and commercialization of intellectual property through copyrights, trademarks, industrial designs, and other IPR tools in academia, research organizations, industry, and entrepreneurship.
- To create awareness about national and international IPR policies, recent developments, government initiatives, ethical practices, and regulatory frameworks that strengthen the intellectual property ecosystem.
- To enable students to apply IPR principles for protecting innovative projects, scientific discoveries, and technological advancements responsibly while exploring career and entrepreneurial opportunities in the field of intellectual property management.

**UNIT – I: Introduction to Bioethics and Intellectual Property**

Introduction to Bioethics – Principles of Bioethics: Autonomy, Beneficence, Non-maleficence and Justice – Ethical Issues in Biotechnology, Genetic Engineering, Stem Cell Research, Cloning and Genomics – Ethical Issues in Patenting Biological Materials, Traditional Knowledge and Indigenous Resources – Biosafety and Biosecurity – Ethical Guidelines for Human and Animal Research – Informed Consent and Confidentiality – Introduction and Need for Intellectual Property Rights (IPR) – Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret – IPR in India and abroad.

**UNIT – II: Patents**

Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non- Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board.

### **UNIT – III: Copyrights**

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights.

### **UNIT – IV: Trademarks**

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well-known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board.

### **UNIT – V: Other Forms of IP**

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection. Geographical Indication (GI): meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection. Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection. Layout Design Protection: meaning – Procedure for registration, effect of registration and term of protection.

### **UNIT – VI: Current Contours (Self-directed learning activities for Continuous Internal Assessments Only):**

India's New National IP Policy, 2016 – Govt. of India steps towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in the current scenario

### **References:**

1. Beauchamp, T. L. and Childress, J. F. Principles of Biomedical Ethics, 8th Edition, Oxford University Press, New York, 2019.
2. Vaughn, Lewis. Bioethics: Principles, Issues, and Cases, 4th Edition, Oxford University Press, New York, 2020.
3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
4. Neeraj, P., & Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
5. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
6. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from <http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf>
7. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from [https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\\_pub\\_489.pdf](https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf)
8. A Handbook of Copyright law  
([copyright.gov.in/Documents/handbook.html](http://copyright.gov.in/Documents/handbook.html))

9. WIPO Intellectual Property Handbook, WIPO publication 489(E) ([http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo\\_pub\\_489.pdf](http://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf))
10. Journal of Intellectual Property Rights (JIPR): NISCAIR
11. Cell for IPR Promotion and Management (<http://cipam.gov.in/>)
12. World Intellectual Property Organisation (<https://www.wipo.int/about-ip/en/>)
13. Office of the Controller General of Patents, Designs & Trademarks (<http://www.ipindia.nic.in/>)

### **Course Outcomes (COs):**

#### **Upon successful completion of this course the students will be able To:**

CO1: Understand the basic concepts of Bioethics and IPR, different forms of Intellectual Property Rights, including patents, copyrights, trademarks, geographical indications, plant variety protection, and international IPR agreements.

CO2: Explain the procedures and legal aspects of patent filing, copyright protection, trademark registration, and licensing in scientific and research communication.

CO3: Differentiate various types of intellectual property rights and evaluate issues related to patentability, infringement, ownership, and legal protection.

CO4: Apply IPR principles and regulatory procedures to protect research innovations, scientific discoveries, and technological developments in biotechnology and biochemistry.

CO5: Analyse national and international IPR policies, ethical concerns, and real-life case studies to arrive at appropriate legal and professional decisions in intellectual property management.

### **Mapping with Programme Outcomes:**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1   | 3   | 1   | 1   | 2   | -   | -   | -   | 1   | 1   | -    |
| CO2   | 2   | 2   | 2   | 3   | 1   | 1   | 1   | 2   | 1   | -    |
| CO3   | 2   | 3   | 3   | 2   | 1   | 2   | 2   | 2   | 1   | -    |
| CO4   | 2   | 2   | 2   | 2   | 2   | 1   | 2   | 2   | 1   | 1    |
| CO5   | 3   | 2   | 2   | 2   | 1   | 1   | 3   | 3   | 2   | 1    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To develop scientific communication skills for academic and research settings
- To train students in writing research papers, theses, and reports
- To familiarize students with publication ethics and plagiarism issues
- To enhance skills in oral, poster, and digital scientific presentations
- To introduce referencing styles and literature management tools

**UNIT – I: Fundamentals of Scientific Communication**

Nature and importance of scientific communication, Types: oral, written, visual communication, Barriers to effective communication, Scientific vs general writing, Audience analysis and purpose of writing.

**UNIT – II: Structure of Scientific Documents**

Components of research papers: Title, Abstract, Introduction, Methods, Results, Discussion (IMRAD format), Writing review articles and short communications, Thesis and dissertation writing format, Preparation of tables, graphs, and figures, Writing laboratory reports.

**UNIT – III: Scientific Writing Skills**

Literature survey and review writing, Paraphrasing, summarizing, and note-making, technical writing style and clarity, Avoiding plagiarism and proper citation, Use of reference management tools (e.g., Mendeley, Zotero).

**UNIT – IV: Publication Ethics and Research Integrity**

Ethics in scientific research and writing, Plagiarism, fabrication, falsification, Authorship criteria and conflicts of interest, Peer review process, Impact factor, indexing, and journal selection.

**UNIT – V: Presentation and Communication Skills**

Oral presentations and seminar techniques, Poster preparation and presentation, PowerPoint and digital communication tools, Scientific communication for grants and proposals, Science communication for public understanding.

**UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Open-access publishing, Preprints and non-blind review, AI tools in scientific writing Science communication via blogs and media.

**Reference Books**

1. Hofmann, A., & Clokie, S. (2022). Introduction to Bioanalytical Methods and Instrumentation. (Includes sections on reporting biochemical data).

2. Peat, J., et al. (2020). Scientific Writing: Easy When You Know How (2nd Ed.). BMJ Books.
3. Gastel, B., & Day, R. A. (2022). How to Write and Publish a Scientific Paper (9th Ed.). Cambridge University Press.
4. Cargill, M., & O'Connor, P. (2021). Writing Scientific Research Articles: Strategy and Steps. Wiley-Blackwell.
5. Council of Science Editors (2020). Scientific Style and Format: The CSE Manual for Authors, Editors, and Publishers.
6. Macrina, F. L. (2014). Scientific Integrity: Text and Cases in Responsible Conduct of Research. ASM Press.

### **E-Sources**

1. **Nature Masterclasses:** Online Course on Scientific Writing
2. **PubMed/NCBI Tutorials:** Effective Literature Searching
3. **BioRender Learning Hub:** Best Practices in Biological Illustrations
4. **Purdue OWL:** Scientific Writing Resources

### **COURSE OUTCOMES (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Demonstrate advanced proficiency in scientific communication, including clear, concise, and structured writing for academic and research purposes.

CO2: Analyze and critically evaluate scientific literature to identify key findings, research gaps, and methodological approaches.

CO3: Apply principles of scientific writing to prepare research documents such as manuscripts, review articles, theses, and technical reports

CO4: Develop effective oral and visual communication skills, including presentations, posters, and seminar delivery using appropriate scientific tools.

CO5: Adhere to ethical standards in scientific communication, including proper citation practices, avoidance of plagiarism, and responsible authorship

### **Mapping with Programme Outcomes**

| <b>PO/CO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 2          | 2          | 2          | 2          | 2          | 3          | 3          | 3           |
| <b>CO2</b>   | 3          | 2          | 2          | 2          | 2          | 2          | 2          | 3          | 3          | 3           |
| <b>CO3</b>   | 3          | 2          | 2          | 2          | 2          | 2          | 2          | 3          | 3          | 3           |
| <b>CO4</b>   | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3           |
| <b>CO5</b>   | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

|                |                                                      |                     |
|----------------|------------------------------------------------------|---------------------|
| <b>Year: I</b> | <b>NON-MAJOR ELECTIVE COURSE 1</b>                   | <b>Semester: II</b> |
| <b>Code:</b>   | <b>DIET AND LIFESTYLE MODIFICATIONS<br/>(Theory)</b> | <b>Credit: 2</b>    |

### **COURSE OBJECTIVES:**

- To understand the scientific principles of balanced nutrition, healthy lifestyle practices, and preventive healthcare.
- To analyse the relationship between diet, physical activity, stress, sleep, environmental factors, and chronic non-communicable diseases.
- To develop evidence-based dietary planning and lifestyle modification strategies for individuals across different age groups and physiological conditions.
- To evaluate the role of nutrition, exercise, behavioural changes, and mental well-being in the management and prevention of lifestyle disorders.
- To promote healthy living through nutrition education, sustainable dietary practices, public health awareness, and community-based lifestyle interventions.

### **UNIT – I: Fundamentals of Nutrition and Healthy Living**

Concept of health, wellness, fitness, and quality of life. Nutrition and its role in human health. Macronutrients: carbohydrates, proteins, fats. Micronutrients: vitamins and minerals. Water balance and hydration. Balanced diet and food pyramid/MyPlate concepts. Indian dietary guidelines (ICMR-NIN). Nutritional requirements across life stages. Dietary diversity and sustainable eating.

### **UNIT – II: Lifestyle Disorders and Nutritional Management**

Lifestyle diseases: overview and epidemiology. Obesity and metabolic syndrome Type 2 diabetes mellitus, Hypertension and cardiovascular diseases, Fatty liver disease and dyslipidemia. Nutritional approaches for prevention and management, Role of fibre, probiotics, antioxidants, and functional foods, Glycemic index and glycemic load, Dietary myths and fad diets.

### **UNIT – III: Physical Activity, Mental Health, and Behavioural Modification**

Physical fitness and exercise physiology. WHO recommendations for physical activity. Sedentary behaviour and screen-time associated health risks. Yoga, meditation, and mindfulness practices. Stress physiology and stress management. Sleep hygiene and circadian rhythm: behavioural modification and habit formation. Addiction: tobacco, alcohol, substance abuse, digital addiction.

### **UNIT – IV: Modern Dietary Trends and Public Health Nutrition**

Vegetarian, vegan, ketogenic, intermittent fasting, and Mediterranean diets. Personalised nutrition and nutrigenomics: basic concepts. Gut microbiome and health. Food safety, food adulteration, and hygiene. Processed foods,

ultra-processed foods, and health implications. Public health nutrition programs in India. FSSAI Eat Right initiatives. Sustainable nutrition and environmental health.

### **UNIT – V: Lifestyle Modification Strategies and therapies**

Principles of lifestyle counselling. Nutrition education and communication strategies. Planning individualized lifestyle modification programs. Workplace wellness and occupational health. Lifestyle management for adolescents and elderly populations. Community-based health promotion. Digital health applications and wearable health technologies. Preventive healthcare and holistic wellness. Precision nutrition and personalized lifestyle medicine. Nutraceuticals, dietary supplements, and evidence-based complementary therapies. Integrative health approaches: Ayurveda, naturopathy, and functional wellness practices.

### **UNIT – VI: Current Contours (Self-directed learning activities for Continuous Internal Assessments Only):**

Artificial intelligence and digital health tools in nutrition and lifestyle monitoring.

### **Recommended References:**

1. Nutrition and Dietetics – by Shubhangini A. Joshi, 5th edition, 2022. Publisher – McGraw Hill Education, New Delhi.
2. Textbook of Human Nutrition – by Mahtab S. Bamji, N. Pralhad Rao and Vinodini Reddy, 4th edition, 2017. Publisher – Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Krause's Food and the Nutrition Care Process – by Janice L. Raymond and Kelly Morrow, 16th edition, 2023. Publisher – Elsevier, St. Louis.
4. Advanced Nutrition and Human Metabolism – by Sareen S. Gropper and Jack L. Smith, 8th edition, 2021. Publisher – Cengage Learning.
5. Nutrition Science – by Michelle McGuire and Kathy A. Beerman, 5th edition, 2021. Publisher – Cengage Learning.
6. Lifestyle Medicine – by James M. Rippe, 4th edition, 2023. Publisher – CRC Press, Boca Raton.
7. Preventive and Social Medicine – by K. Park, 27th edition, 2023. Publisher – Banarsidas Bhanot Publishers, Jabalpur.
8. Exercise Physiology: Nutrition, Energy, and Human Performance – by William D. McArdle, Frank I. Katch and Victor L. Katch, 10th edition, 2022. Publisher – Wolters Kluwer.
9. Sports Nutrition – by Asker Jeukendrup and Michael Gleeson, 3rd edition, 2019. Publisher – Human Kinetics Publishers.
10. Nutrition and Lifestyle in Neurological Autoimmune Diseases – by Ronald Ross Watson and Colin R. Martin, 1st edition, 2017. Publisher – Academic Press, Elsevier.
11. Public Health Nutrition – by Sari Edelstein, 4th edition, 2022. Publisher – Jones & Bartlett Learning.
12. Community Nutrition in Action: An Entrepreneurial Approach – by Marie A. Boyle, 8th edition, 2021. Publisher – Cengage Learning.
13. The Complete Guide to Fasting – by Jason Fung and Jimmy Moore, 1st edition, 2016. Publisher – Victory Belt Publishing.

14. The Circadian Code – by Satchin Panda, 1st edition, 2018. Publisher – Rodale Books, New York.
15. Nutrition Through the Life Cycle – by Judith E. Brown, 7th edition, 2023. Publisher – Cengage Learning.
16. ICMR-NIN Dietary Guidelines for Indians – by National Institute of Nutrition (NIN), 2nd revised edition, 2024. Publisher – Indian Council of Medical Research, Hyderabad.
17. WHO Guidelines on Physical Activity and Sedentary Behaviour – World Health Organisation, 2020. Publisher – WHO Press, Geneva.
18. Eat Right India: Handbook for Healthy and Sustainable Diets – by Food Safety and Standards Authority of India (FSSAI), 2023. Publisher – FSSAI, New Delhi.
19. Gut: The Inside Story of Our Body's Most Underrated Organ – by Giulia Enders, revised edition, 2022. Publisher – Greystone Books.
20. Principles of Nutrigenetics and Nutrigenomics: Fundamentals of Individualized Nutrition – by Raffaele De Caterina and J. Alfredo Martinez, 1st edition, 2019. Publisher – Academic Press, Elsevier.

### **Course Outcomes (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Identify major nutrients, food groups, and healthy dietary patterns recommended for Indian populations.

CO2: Understand the role of exercise, mental health, circadian rhythm, and lifestyle behaviour in overall wellness.

CO3: Evaluate the impact of modern lifestyle factors such as processed foods, screen time, substance abuse, and sedentary behaviour.

CO4: Interpret nutritional labels, dietary guidelines, and evidence-based wellness recommendations.

CO5: Develop critical thinking and practical skills for adopting and advocating healthy lifestyle modifications.

### **Mapping with Programme Outcomes:**

| <b>COs/POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|----------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>     | 3          | 1          | 1          | 2          | -          | -          | -          | 1          | 1          | -           |
| <b>CO2</b>     | 2          | 2          | 2          | 3          | 1          | 1          | 1          | 2          | 1          | -           |
| <b>CO3</b>     | 2          | 3          | 3          | 2          | 1          | 2          | 2          | 2          | 1          | -           |
| <b>CO4</b>     | 2          | 2          | 3          | 3          | 2          | 2          | 3          | 3          | 1          | 1           |
| <b>CO5</b>     | 3          | 2          | 2          | 2          | 1          | 1          | 2          | 3          | 2          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand the physical and chemical properties of genetic material (DNA/RNA) and how it is packaged within cells.
- To master the "Central Dogma," detailing the precise mechanisms of replication, transcription, and translation.
- To explore regulatory systems, learning how cells turn genes "on" or "off" in response to the environment.
- To gain technical proficiency in Recombinant DNA Technology, understanding the tools used to edit life.
- To evaluate the ethical and practical applications of molecular biology in medicine, forensics, and agriculture.

**UNIT – I: Gene Structure & Genome Organization**

Organization of prokaryotic and eukaryotic genomes, DNA structure and properties, Chromatin organization and nucleosome structure, DNA replication: mechanisms and regulation, DNA damage and repair mechanisms, Mutations and their molecular basis.

**UNIT – II: Transcription & RNA Processing**

Transcription in prokaryotes and eukaryotes, RNA polymerases and transcription factors, Promoters, enhancers, and regulatory elements, RNA processing: capping, splicing, polyadenylation, RNA editing and RNA stability, Types and functions of non-coding RNAs.

**UNIT – III: Translation & Gene Regulation**

Genetic code and protein synthesis, Translation mechanism in prokaryotes and eukaryotes, Post-translational modifications, Regulation of gene expression (operon concept, epigenetics basics), Role of transcription factors and regulatory networks.

**UNIT – IV: Recombinant DNA Technology**

Tools of recombinant DNA technology, Cloning vectors: plasmids, phages, cosmids, Gene cloning and expression systems, PCR and its variants, Blotting techniques: Southern, Northern, Western, DNA sequencing methods (basic overview).

**UNIT – V: Applications of Molecular Biology**

Genetic engineering and biotechnology applications, Molecular diagnostics, Gene therapy basics, DNA fingerprinting and forensic applications, Introduction to bioinformatics, Applications in medicine, agriculture, and industry.

**UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Latest research in the areas of gene expression and genome organization.

### **Recommended Books**

1. Molecular Biology of the Cell (Alberts et al.): Often called "The Bible" of the field. The 7th Edition (2022) is the current standard, with advanced digital resources released in 2024-2025 (Alberts et al., 2022).
2. Molecular Cell Biology (Lodish et al.): The 9th Edition (2021) and its associated Achieve digital platform provide 3D structural animations based on the Protein Data Bank (Lodish et al., 2021).
3. Molecular Biology of the Gene (Watson et al.): Covers foundational principles with deep historical and mechanistic context. The 7th Edition (Watson, 2017) remains a core requirement for university courses.
4. Advances in Microbial Physiology (Vol. 89, 2026): A specialized resource for the latest developments in gene regulation and metabolism in microbes.
5. Alberts, B., Heald, R., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2022). Molecular biology of the cell (7th ed.). W. W. Norton & Company.
6. Khan Academy. (2024). Molecular biology. <https://www.khanacademy.org/science/biology/molecular-biology>
7. Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Martin, K. C., Yaffe, M., & Amon, A. (2021). Molecular cell biology (9th ed.). Macmillan Learning.
8. Watson, J. D. (2017). Molecular biology of the gene (7th ed.). Pearson Education India.

### **Recommended Online Sources**

1. NCBI Bookshelf: Free access to several classic textbooks like Molecular Biology of the Cell (NIH, 2024).
2. Khan Academy: Excellent for mastering the basics of the Central Dogma and Biotechnology (Khan Academy, 2024).
3. Nature Reviews Molecular Cell Biology: The highest-impact journal for summaries of cutting-edge research in gene editing and cell signaling.
4. edX & Coursera: University-level certifications from Harvard, MIT, and Wageningen for specific modules like "Gene Regulation" or "Genomics" (edX, 2026).

### **Course Outcomes (COs):**

**Upon successful completion of the course the students would be able to:**

CO1: Analyze the molecular basis of heredity, variation, gene structure, and the complex mechanisms of gene regulation and microbial genetics.

CO2: Demonstrate comprehensive knowledge and execution of modern experimental protocols, including PCR, sequencing methodologies, and biotechnological laboratory workflows.

CO3: Critically evaluate the historical progression of molecular biology discoveries alongside the bioethical and socio-economic impacts of genetic engineering on society.

CO4: Apply molecular biology concepts to diagnose, analyze, and solve complex problems in clinical diagnostics, cancer genetics, and environmental science.

CO5: Explain the fundamental molecular mechanisms governing mutations, DNA repair pathways, and the dynamics of molecular evolution.

### Mapping with Programme Outcomes

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>C01</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>C02</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>C03</b> | 3   | 3   | 3   | 3   | 2   | 3   | 2   | 3   | 2   | 3    |
| <b>C04</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |
| <b>C05</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVE:**

- To develop advanced knowledge of clinical biochemistry laboratory organization, safety practices, automation and quality assurance systems in diagnostic settings.
- To understand and interpret metabolic pathways underlying carbohydrate, protein and lipid metabolism in health and disease conditions.
- To evaluate biochemical and molecular mechanisms involved in major metabolic disorders such as diabetes mellitus, dyslipidemia and inborn errors of metabolism.
- To assess emerging technologies including biosensors, point-of-care testing (POCT), artificial intelligence and personalized medicine in clinical diagnostics.
- To interpret the clinical data and exposure to recent advances in laboratory medicine.

**UNIT – I: Clinical Biochemistry Laboratory and Hematological Diagnostics**

Clinical biochemistry laboratory – organization, roles, and safety practices (GLP). Automation and instrumentation – auto analyzers, semi-automated systems, POCT. Specimen analysis – blood and urine (routine and advanced). Plasma proteins –acute phase proteins, paraproteinemia, Hematological Disorders Anemia, hemoglobinopathies (thalassemia, sickle cell anemia). Hemostasis – PT, aPTT, INR, hemophilia. Blood gas analysis and interpretation using Arterial Blood Gas Analysis. Acid–base disorders – metabolic and respiratory acidosis and alkalosis.

**UNIT – II: Disorders of Carbohydrate Metabolism**

Glucose homeostasis – role of insulin, glucagon, incretins. Normal blood glucose, renal threshold, glycosuria. Hyperglycemia and hypoglycemia – biochemical basis. Diabetes mellitus – classification, etiology, pathogenesis. Laboratory diagnosis – fasting glucose, HbA1c, glucose tolerance tests, CGM. Diabetic complications – ketoacidosis, hyperosmolar coma, vascular complications. Inherited disorders – glycogen storage diseases, galactosemia, fructosuria, pentosuria. Metabolic syndrome and insulin resistance.

**UNIT – III: Disorders of Protein and Lipid Metabolism**

Amino acid and Plasma protein disorders – phenylketonuria, alkaptonuria, tyrosinemia, maple syrup urine disease; agammaglobulinemia, amyloidosis, cryoglobulinemia. Nitrogen metabolism – uremia and nitrogen balance. Porphyrrias and porphyrin metabolism. Lipid metabolism – lipoproteins, cholesterol, triglycerides. Dyslipidemia – hyperlipidemia, fatty liver, ketone bodies. Atherosclerosis – risk factors and pathogenesis. Lipid storage diseases – Gaucher's, Tay–Sachs, Niemann–Pick disease. Laboratory

diagnosis of myocardial infarction – cardiac biomarkers (troponins, CK-MB). Clinical biomarkers – alpha-fetoprotein, CRP.

#### **UNIT – IV: Nucleic acid disorders and prenatal diagnosis**

Purine metabolism disorders – gout, Lesch–Nyhan syndrome, ADA deficiency; Pyrimidine metabolism disorders – Orotic aciduria. Prenatal diagnosis of diseases, Amniocentesis and chorionic villus sampling (CVS). amniotic fluid and fetal blood examination. Molecular basis of metabolic disorders and diagnostic approaches.

#### **UNIT – V: Hepatic and Renal Disorders**

Liver Disorders- Bilirubin metabolism and jaundice classification. Hepatitis (including viral markers), cirrhosis, fatty liver (NAFLD). Liver function tests (LFTs) and diagnostic enzymes. Renal Disorders Renal function tests (RFTs) – urea, creatinine, eGFR, clearance tests. Acute and chronic renal failure. Urinalysis and renal complications (calculi, hypertension). Dialysis – hemodialysis and peritoneal dialysis.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Advanced biomarkers and personalized medicine. Artificial intelligence and automation in laboratory medicine.

#### **References:**

1. Chatterjea MN, Shinde R. Textbook of Medical Biochemistry. 9th ed. New Delhi: Jaypee Brothers Medical Publishers; 2022.
2. Vasudevan DM, Sreekumari S, Vaidyanathan K. Textbook of Biochemistry for Medical Students. 10th ed. New Delhi: Jaypee Brothers Medical Publishers; 2023.
3. Bishop ML, Fody EP, Schoeff LE. Clinical Chemistry: Principles, Techniques and Correlations. 9th ed. Philadelphia: Wolters Kluwer; 2023.
4. Murphy M, Srivastava R, Deans K. Clinical Biochemistry: An Illustrated Colour Text. 7th ed. London: Elsevier; 2023–2024.
5. Marshall WJ, Lapsley M, Day AP, Ayling RM. Clinical Biochemistry: Metabolic and Clinical Aspects. 3rd ed. London: Churchill Livingstone Elsevier; 2014.
7. Sood R. Textbook of Clinical Biochemistry. 1st ed. New Delhi: CBS Publishers & Distributors; 2019.
8. Saini AS. Clinical Biochemistry in Diagnosis and Management. 1st ed. New Delhi: CBS Publishers & Distributors; 2020.
9. Devlin TM. Textbook of Biochemistry with Clinical Correlations. 7th ed. New Delhi: Wiley India; 2022.
10. Acharya VP, Acharya YP. A Complete Workbook on Clinical Biochemistry. New Delhi: Jaypee Brothers Medical Publishers; 2010.
11. Silvia CRWD, et al. Competency-Based Textbook of Medical Biochemistry. 1st ed. Bangalore: Emmess Medical Publishers; 2023.
12. Berg JM, Tymoczko JL, Gatto GJ, Stryer L. Biochemistry. 9th ed. New York: W.H. Freeman and Company; 2019.
13. Rodwell VW, Bender DA, Botham KM, Kennelly PJ, Weil PA. Harper's Illustrated Biochemistry. 32nd ed. New York: McGraw Hill; 2023.

14. Nelson DL, Cox MM. Lehninger Principles of Biochemistry. 8th ed. New York: W.H. Freeman and Company; 2021.
15. Abali EE, Cline SD, Franklin DS, Viselli SM. Lippincott Illustrated Reviews: Biochemistry. 8th ed. Philadelphia: Wolters Kluwer; 2021.

### **Course Outcomes (COs):**

**After successful completion of the course, students will be able to:**

CO1: Recall and describe the organization of clinical biochemistry laboratories, specimen analysis procedures and the biochemical basis of hematological disorders and acid–base balance.

CO2: Explain the biochemical mechanisms underlying disorders of carbohydrate, protein, lipid, nucleic acid, hepatic and renal metabolism and their clinical manifestations.

CO3: Apply biochemical principles and laboratory investigations, including hematological tests, glucose monitoring, cardiac biomarkers, LFTs, RFTs and prenatal diagnostic techniques for the assessment of metabolic and systemic disorders.

CO4: Analyze clinical and laboratory data to interpret disease conditions such as diabetes mellitus, dyslipidemia, inherited metabolic disorders, liver diseases, renal dysfunction and acid–base abnormalities.

CO5: Evaluate diagnostic approaches, biomarker-based investigations, and emerging laboratory technologies to formulate evidence-based interpretations for clinical decision-making and disease management.

### **Mapping with Programme Outcomes**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 1          | 1          | 2          | 1          | 1          | 1          | –          | 1          | –           |
| <b>CO2</b>   | 3          | 2          | 2          | 2          | 1          | 1          | 2          | 1          | 1          | –           |
| <b>CO3</b>   | 3          | 3          | 2          | 3          | 2          | 2          | 3          | 2          | 1          | 1           |
| <b>CO4</b>   | 3          | 3          | 3          | 3          | 2          | 2          | 3          | 3          | 1          | 1           |
| <b>CO5</b>   | 3          | 3          | 3          | 3          | 2          | 2          | 3          | 3          | 2          | 2           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVE:**

- To Understand principles of clinical sample collection, preservation, and handling.
- To Perform hematological investigations and interpret results.
- To Analyze biochemical parameters of blood and urine using standard methods.
- To Estimate enzyme activities and evaluate their clinical significance.
- To Apply analytical techniques for diagnosis of metabolic and physiological disorders.

**Experiments:**

1. Collection and preservation of blood and urine samples.
2. Haematology: Blood grouping, RBC Count, WBC Count – total and differential count, clotting time, ESR, PCV, MCV.
3. Estimation of haemoglobin by cyanmethaemoglobin method.
4. Biochemical analysis of blood and urine
  - Estimation of bilirubin – direct and indirect.
  - Estimation of plasma protein and A/G ratio
  - Estimation of cholesterol by Zak's method
  - Estimation of blood glucose by orthotoluidine method.
  - Estimation of Copper and iron by colorimetric method.
  - Determination of sodium and potassium by flame photometer.
  - Determination of glycosylated Hb.
  - Estimation of urea in blood and urine
  - Estimation of creatinine in blood and urine
  - Estimation of creatine in blood and urine
  - Estimation of uric acid in blood and urine.
5. Assay of serum glutamate oxaloacetate transaminase
6. Assay of lactate dehydrogenase.
7. Assay of SOD and Catalase
8. Estimation of ascorbic acid
9. Qualitative analysis of normal and pathological component of urine.
10. Glucose Tolerance Test.
11. Isolation and Estimation of DNA and RNA
12. Isolation of plasmids
13. Separation of DNA by agarose gel electrophoresis.

**REFERENCES:****Textbooks**

1. Jayaraman J. laboratory manual in Biochemistry, 3<sup>rd</sup> ed, New Age International Pvt Ltd Publishers, New Delhi, 2011.
2. Godkar PB, Godkar DP. *Textbook of medical laboratory technology*. 3<sup>rd</sup> ed. Bhalani Publishing House; 2020.

3. Sadasivam S, Manickam A, Biochemical Methods, 3<sup>rd</sup> ed, New Age International Pvt Ltd Publishers, New Delhi, 2009.
4. Sawhney SK, Randhir Singh. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, 2014.
5. Maneemegalai S. Biochemistry – A Practical Handbook, Ryan Publishers, Tamil Nadu, 2024.
6. Murphy MJ, Srivastava R, Deans KA. Clinical biochemistry: An illustrated colour text. 7th ed. Elsevier; 2024.
7. Marshall WJ, Lapsley M, Day AP, Shipman K. Clinical chemistry. 10th ed. Elsevier; 2025.
8. Shawn O Farrell, Ryan T Ranallo. Experiments in Biochemistry – A Hands on Approach, Thomson Learning Inc., USA, 2000.
9. Nayak SB. Manipal manual of clinical biochemistry. 5th ed. Jaypee Brothers; 2024.

### **Reference Books**

1. Gowenlock AH. *Varley's practical clinical biochemistry*. 6th ed. CBS Publishers; 2022.
2. Burtis CA, Ashwood ER, Bruns DE. *Tietz fundamentals of clinical chemistry*. 6th ed. Saunders/Elsevier; 2008.
3. Varley H. *Practical clinical biochemistry*. 6th ed. Heinemann Medical Books; 1988.
4. Rodney Boyer, Modern Experimental Biochemistry third edition, Published by Pearson Education Inc, Singapore, 2001.
5. Marshall WJ, Lapsley M, Day AP, Ayling RM. *Clinical biochemistry: Metabolic and clinical aspects*. 3rd ed. Churchill Livingstone Elsevier; 2014.

### **Course outcomes (COs):**

#### **Upon successful completion of the course, students will be able to:**

CO1: Recall laboratory safety practices, specimen collection, preservation procedures and the principles underlying hematological, biochemical and molecular diagnostic techniques.

CO2: Explain the principles, methodology and clinical significance of hematological investigations, biochemical estimations, enzyme assays and molecular biology techniques.

CO3: Perform hematological tests, biochemical analyses of blood and urine, enzyme assays, electrolyte determination, glucose tolerance tests and nucleic acid isolation using standard laboratory procedures.

CO4: Analyze experimental results obtained from clinical, biochemical, enzymological and molecular investigations and interpret their significance in normal physiology and disease conditions.

CO5: Evaluate laboratory findings and integrate hematological, biochemical, enzymatic and molecular data to support diagnosis, monitoring and research applications in clinical biochemistry.

### Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 2   | 1   | 1   | 1   | –   | 1   | –    |
| <b>CO2</b> | 3   | 2   | 2   | 2   | 1   | 1   | 2   | 1   | 1   | –    |
| <b>CO3</b> | 3   | 2   | 2   | 3   | 2   | 2   | 3   | 3   | 1   | 1    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 1   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 2   | 2    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To provide fundamental knowledge of pharmacokinetics, drug action, drug metabolism, and factors influencing drug toxicity.
- To impart understanding of pharmacodynamics, drug receptors, drug-receptor interactions, and mechanisms underlying therapeutic and adverse drug effects.
- To familiarize students with regulatory affairs, pharmacovigilance, adverse drug reactions, and epidemiological approaches in pharmaceutical sciences.
- To introduce intellectual property rights, patent filing procedures, pharmaceutical documentation, and data management in drug research.
- To develop understanding of xenobiotic metabolism, detoxification mechanisms, and pharmaceutical-associated toxicity affecting major organs.

**UNIT - I: PHARMACOKINETICS**

Source and nature of drugs, classification, nomenclature. principles of drug action, absorption, distribution and elimination of drugs, routes of drug administration. Drug-protein interactions. dose response curve - ED50 and LD50, Origin of drug from plants and animals, Uses of Pharmacokinetics In Drug Development Process, Concept of Prodrug and Soft Drug. Synergism and Antagonism, Acute and chronic exposures, factors influencing toxicity.

**UNIT – II: PHARMACODYNAMICS AND DRUG TARGET**

Introduction, Concept of Receptor Agonists and Antagonists, Drug Receptors, Enzymes, carrier proteins Interactions, Theories of Drug Activity Relationship, Forces involved in drug - receptor interaction, Receptor theories. Cholinergic and anticholinergic drugs, adrenergic blockers, General anesthetics, Local anesthetics. Adverse reactions to drugs and common drug receptor interactions, Treatment of Diseases by Enzyme Stimulation, Elementary treatment of drug Receptor Interaction, Mic and Mec, Membrane Active Drugs. Drug delivery Systems, Liposomes.

**UNIT – III: REGULATORY AFFAIRS AND PHARMACOVIGILANCE**

Pharmaceutical Products-their Manufacturing, Analytical Aspect, Product Registration and their Requirement looking to WHO-GMP, European DMF, US-FDA Regulations, ICH Guidelines, pharmacopaeal and extra pharmacopaeal Entry. Definition and aims of pharmacovigilance, Adverse drug reactions, Classification, mechanism, predisposing factors and causality assessment. Role of clinical pharmacist in reporting, evaluation, monitoring, prevention and management of ADR, drug induced diseases. Pharmaco epidemiology, Epidemiological approach, measurements epidemiology, (rates, ratios, and proportions), measurement of mortality, morbidity. Descriptive, analytical and experimental epidemiology.

#### **UNIT - IV: INTELLECTUAL PROPERTY RIGHTS**

Documentation Required for Filing Patent, Chemical, Physical and Biological (Clinical) Data Documentation, Patent Writing Art and Introduction of Concept of Non-infringing Patent Ability, Looking to GATT-WTO Scenario, Computer Based Data Mining in Drug Research, Pharmaceutical Product Management Aspect.

#### **UNIT – V: PHARMACEUTICAL ASSOCIATED TOXICITY**

Xenobiotics metabolism, Phase-I reactions, Oxidation, reduction, hydrolysis & hydration. Phase-II reactions\conjugation, Methylation, glutathione & amino acid conjugations, detoxifications. Metabolism of CCl<sub>4</sub>& Paracetamol & their effect in liver & kidney.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Discussion on recent advances in pharmaceutical biochemistry.

#### **Recommended References:**

##### **Textbooks**

1. Tripathi, K. D. Essentials of Medical Pharmacology, 8th Edition, Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi, 2018.
2. Mohanta, Guru Prasad. A Textbook of Pharmacovigilance: Concept and Practice, PharmaMed Press, Hyderabad, 2016.
3. Park, K. Park's Textbook of Preventive and Social Medicine, 27th Edition, Banarsidas Bhanot Publishers, Jabalpur, 2023.
4. Subba Rao, Bayya. Intellectual Property Rights in Pharmaceutical Industry, PharmaMed Press, Hyderabad, Latest Edition available.
5. Stine, Karen E. and Brown, Thomas M. Principles of Toxicology, 3rd Edition, CRC Press, Boca Raton, 2015.

##### **Reference Books**

1. Brunton, Laurence L., Knollmann, Björn C., and Hilal-Dandan, Randa (Eds.). Goodman & Gilman's: The Pharmacological Basis of Therapeutics, 14th Edition, McGraw Hill Education, New York, 2023.
2. Whalen, Karen. Lippincott Illustrated Reviews: Pharmacology, 8th Edition, Wolters Kluwer, Philadelphia, 2023.
3. Klaassen, Curtis D. Casarett& Doull's Toxicology: The Basic Science of Poisons, 9th Edition, McGraw Hill Education, New York, 2019.

#### **COURSE OUTCOMES (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Describe the principles of pharmacokinetics, pharmacodynamics, drug metabolism, regulatory affairs, and pharmaceutical toxicity.

CO2: Apply concepts of drug action, drug-receptor interactions, pharmacovigilance, and toxicity studies in pharmaceutical sciences.

CO3: Analyze drug responses, adverse drug reactions, regulatory requirements, and mechanisms of xenobiotic metabolism and toxicity.

CO4: Design and develop strategies for drug evaluation, safety assessment, pharmaceutical documentation, and drug delivery systems.

CO5: Integrate concepts of pharmacokinetics, pharmacodynamics, regulatory affairs, and pharmaceutical toxicity for drug development and therapeutic applications.

**Mapping with Programme Outcomes:**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| CO1          | 3          | 1          | 1          | 2          | -          | -          | -          | 1          | 1          | -           |
| CO2          | 2          | 2          | 2          | 3          | 1          | 1          | 1          | 2          | 1          | -           |
| CO3          | 2          | 3          | 3          | 2          | 1          | 2          | 2          | 2          | 1          | -           |
| CO4          | 2          | 2          | 2          | 2          | 2          | 1          | 2          | 2          | 1          | 1           |
| CO5          | 3          | 2          | 2          | 2          | 1          | 1          | 3          | 3          | 2          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the molecular mechanisms involved in transcriptional regulation and translational control in prokaryotic and eukaryotic systems.
- To provide knowledge on cell surface receptors, signaling molecules, and intracellular signal transduction pathways.
- To develop understanding of sensory transduction, nerve impulse transmission, visual signaling, and muscle contraction mechanisms.
- To familiarize students with nuclear receptor signaling, cytokine signaling pathways, and regulation of the cell cycle.
- To impart knowledge on the molecular basis of cancer, tumor suppressor mechanisms, and recent advances in signaling pathway research.

**UNIT - I: REGULATION OF TRANSCRIPTION**

Regulation of transcription in prokaryotes - positive and negative control, repressor and inducer, concept of operon, lac and trp operons, regulons. Regulation in eukaryotes- gene families, regulatory strategies in eukaryotes, gene alteration, regulation of synthesis of primary transcripts, hormonal control, transcription factors: targets of signaling pathways. DNA binding motifs in pro and eukaryotes - helix turn helix, zinc fingers, leucine zippers/ b zip, helix loop helix motifs. Regulation at the level of translation in prokaryotes and eukaryotes.

**UNIT - II: CELL SURFACE RECEPTORS AND SIGNALLING**

Signal transduction – definition, signals, ligands and receptors. Endocrine, paracrine and autocrine signaling. Receptors and signaling pathways- cell signaling, cell surface receptors. G Protein coupled receptors- structure, mechanism of signal transmission, regulatory GTPases, heterotrimeric G proteins and effector molecules of G Proteins. Receptor tyrosine kinases - Role of phosphotyrosine in SH2 domain binding, Signal transmission via Ras proteins and MAP kinase pathways. Signaling molecules- cAMP, cGMP, metabolic pathways for the formation of inositol triphosphate from phosphatidyl inositol diphosphate, Ca<sup>2+</sup>, DAG and NO as signaling molecules, ryanodine and other Ca<sup>2+</sup> receptors, phosphor-regulation of inositol and the calcium channel activation. Ser/Thr-specific protein kinases and phosphatases.

**UNIT - III: SIGNALLING IN NERVE IMPULSE TRANSMISSION, VISION AND MUSCLE CONTRACTION**

Sensory Transduction: Nerve impulse transmission – Nerve cells, synapses, reflex arc structure, Resting membrane potential, Nernst equation, action potential, voltage gated ion-channels, impulse transmission, neurotransmitters, neurotransmitter receptors. Rod and cone cells in the retina, biochemical changes in the visual cycle, photochemical reaction and

regulation of rhodopsin. Chemistry of muscle contraction – actin and myosin filaments, theories involved in muscle contraction, Calcium signalling in muscle contraction, energy sources for muscle contraction.

#### **UNIT - IV: NUCLEAR RECEPTOR AND SIGNALING**

Signaling by nuclear receptors- ligands, structure and functions of nuclear receptors, nuclear functions for hormones/metabolites - orphan receptors; cytoplasmic functions and crosstalk with signaling molecules, signaling pathway of the steroid hormone receptors. Cytokine receptors- structure and activation of cytokine receptors, Jak-Stat pathway, Janus kinases, Stat proteins.

#### **UNIT - V: CELL CYCLE AND ITS REGULATION**

Regulation of the cell cycle- Overview of the cell cycle, cell cycle control mechanisms, Cyclin-dependent protein kinases (CDKs), regulation of cell cycle by proteolysis, G1/S Phase transition, G2/M Phase transition, cell cycle control of DNA replication, DNA damage checkpoints. Cancer, types of cancer, factors causing cancer-physical, chemical and biological agents. Errors in function of signal proteins and tumorigenesis. Oncogenes, proto-oncogenes and tumour suppressor genes. Tumour suppressor protein p53 and its role in tumour suppression. Tumour suppressor APC and Wnt/ $\beta$ -Catenin signaling.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Discuss the latest advances on identification of signaling pathways in pre-clinical and clinical research. Ex: In-silico approach.

#### **Recommended References:**

1. Molecular Cell Biology, 9th edition, Harvey Lodish. New York: W. H. Freeman; 2021.
2. Molecular Biology of the Cell, 7th edition, Bruce Alberts. New York: Garland Science; 2021
3. Biochemistry of Signal Transduction and Regulation. 5th Edition. Gerhard Krauss, 2014 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim
4. Molecular biology- David Freifelder, 2nd edition, Narosa Publishing House Pvt. (Ltd), 2012
5. Principles of cell and molecular biology- Lewis Kleinsmith, Pearson, 2nd edition, illustrated, HarperCollins, 1997.
6. <https://pmc.ncbi.nlm.nih.gov/articles/PMC7520847/>
7. <https://www.nature.com/articles/s41392-023-01442-3> (2023)
8. <https://www.sciencedirect.com/science/article/pii/S1936523322001693>
9. <https://academic.oup.com/narcancer/article/2/3/zcaa025/5911781> (2020)

## **COURSE OUTCOMES (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Describe the molecular mechanisms of transcriptional regulation, receptor signaling, and intracellular signal transduction.

CO2: Apply principles of receptor-mediated signaling, sensory transduction, and cell cycle regulation to understand cellular communication.

CO3: Analyze signaling pathways and molecular defects associated with diseases such as cancer and other cellular disorders.

CO4: Design and develop experimental and computational approaches for investigating signal transduction pathways.

CO5: Integrate concepts of signal transduction and cellular signaling to understand molecular mechanisms underlying physiology and disease conditions.

## **Mapping with Programme Outcomes:**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 2          | 2          | -          | -          | -          | 1          | 1          | -           |
| <b>CO2</b>   | 2          | 2          | 2          | 3          | 1          | 1          | 1          | 2          | 1          | -           |
| <b>CO3</b>   | 2          | 3          | 3          | 2          | 1          | 2          | 2          | 2          | 1          | -           |
| <b>CO4</b>   | 2          | 2          | 3          | 3          | 2          | 2          | 3          | 3          | 1          | 1           |
| <b>CO5</b>   | 3          | 3          | 2          | 2          | 1          | 1          | 2          | 3          | 2          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- Understand the principles of drug delivery systems and control of varied parameters for effective drug delivery.
- Understand why materials change behavior (e.g., gold appearing red or becoming a catalyst) due to increased surface-area-to-volume ratios and quantum confinement.
- Learn the "Top-Down" (breaking bulk material) and "Bottom-Up" (building from atoms) methods, with a specific focus on eco-friendly Green Synthesis.
- Gain theoretical knowledge of advanced imaging tools (SEM, TEM, XRD) used to "see" and measure atoms.
- Develop a framework for assessing Nanotoxicology—the study of how nanoparticles interact with human health and the environment.

**UNIT - I: Fundamentals of Nanotechnology**

Introduction to nanotechnology: definition, scope, and importance, Nanoscale dimensions and properties of nanomaterials, Types of nanomaterials: nanoparticles, nanorods, nanotubes, nanocomposites, Physical and chemical properties at nanoscale, Surface area, quantum effects, and size-dependent properties, Classification: organic, inorganic, and hybrid nanomaterials.

**UNIT - II: Synthesis and Characterization of Nanomaterials**

Methods of synthesis: top-down and bottom-up approaches, Chemical methods: sol-gel, co-precipitation, hydrothermal synthesis, Biological synthesis: green synthesis using plants and microbes, Characterization techniques: UV-Vis spectroscopy, X-ray diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Particle size and surface analysis.

**UNIT - III: Nanobiotechnology**

Interaction of nanomaterials with biological systems, Nanoparticles in drug delivery systems, Targeted drug delivery and controlled release, Nanocarriers: liposomes, dendrimers, polymeric nanoparticles, Toxicity and biocompatibility of nanomaterials, Nanotechnology in gene delivery.

**UNIT - IV: Biomedical and Diagnostic Applications**

Nanotechnology in diagnostics and imaging, Biosensors and nanosensors, Nanoparticles in cancer therapy, Nanomedicine and personalized medicine, Role of nanotechnology in vaccine development, Lab-on-chip and microfluidics.

**UNIT - V: Industrial and Environmental Applications**

Nano-Agri-Tech (Agriculture & Food): Precision Agriculture - Nano-fertilizers, Nano-pesticides & Herbicides, Nano-Biosensors in Soil, Food

Nanotechnology, Nano-nutraceuticals: Improving the bioavailability of vitamins and minerals in food products, Smart Packaging. Environmental Nanotechnology: Nanoremediation, Water Purification, Nanofiltration, Photocatalysis, Pollution Control. Nanotechnology in Energy Systems: Advanced Biofuels - Nano-catalysts, Immobilized Enzymes, Energy Storage & Conversion, Next-Gen Batteries, Solar Harvest. Nano-Safety & Governance: Nanotoxicology, Environmental Fate, Regulatory Frameworks, Ethical & Social Implications (ELSI). Future Horizons & Challenges: Molecular Manufacturing, Nanorobotics, Scalability, Standardization, Public Perception.

## **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Advanced Research in Nanomaterials and its applications.

### **Recommended Books**

1. Introduction to Nanotechnology, by Poole & Owens (2026 Edition): A standard textbook for fundamental concepts (Harvin, 2026).
2. Introduction to Nanoscience and Nanotechnology by Chris Binns (2026 Edition): Comprehensive coverage of nanomaterials and their applications.
3. Bhushan, Bharat (Ed.). *Springer Handbook of Nanotechnology*, 4th Edition, Springer-Verlag, Berlin Heidelberg, 2017.
4. Nanotechnology Advances and Applications (Routledge & CRC Press): Includes 2025 titles like Advancements in Nanobiology and Green Nanobiotechnology (Routledge, n.d.).
5. AZoNano. (2007). Top down and bottom up construction nanofabrication techniques defined. <https://www.azonano.com/article.aspx?ArticleID=1835>
6. Frontiers. (2025). 25 years of research and regulation: Is nanotechnology safe to commercialize? Frontiers in Toxicology. <https://www.frontiersin.org/journals/toxicology/articles/10.3389/ftox.2025.1629813/full>
7. Harvin, H. (2026). 16 Best nanotechnology books to read in 2026. Henry Harvin Blog. <https://www.henryharvin.com/blog/16-best-nanotechnology-books-to-read-in-2026/>
8. John, J. (2026). Advancements in nano-based drug delivery systems for therapeutics: A comprehensive review. RSC Pharmaceutics, 3, 43–59. <https://doi.org/10.1039/D5PM00179J>
9. Lallawmkimi, et al. (2025). Agro-nanotechnology: Advancements and challenges in nanofertilizers for sustainable agriculture. Frontiers in Nanotechnology. <https://doi.org/10.3389/fnano.2025.1668484>
10. PMC. (2025). Nanotoxicology: Developments and new insights. <https://pmc.ncbi.nlm.nih.gov/articles/PMC11731054/>
11. Research and Markets. (2026). Nanotechnology in energy applications market report 2026. <https://www.researchandmarkets.com/reports/5954667/nanotechnology-in-energy-applications-market>
12. Routledge. (n.d.). Nanotechnology advances and applications - Book series. <https://www.routledge.com/Nanotechnology-Advances-and-Applications/book-series/NAA>

13. Slideshare. (n.d.). Top-down and bottom\_upapproches.  
<https://www.slideshare.net/slideshow/topdown-and-bottomup-approches/176835852>
14. Thakur, A., Thakur, P., & Suhag, D. (Eds.). (2025). Advancements in nanobiology: Characterization techniques and cutting-edge applications. Routledge.

### Course Outcomes (COs):

**Upon successful completion of the course the students would be able to:**

CO1: Select and evaluate appropriate chemical versus biological (green) synthesis routes for nanoparticles based on specific industrial and pharmaceutical requirements.

CO2: Interpret characterization data, including UV-Vis spectra and XRD patterns, to determine nanoparticle size, optical properties, and crystalline structures.

CO3: Propose and design targeted nanocarrier systems for gene or drug delivery, integrating recent developments in cancer therapy while minimizing systemic toxicity.

CO4: Apply nanotechnology-based solutions to address critical environmental challenges, including water scarcity, water purification, and soil degradation.

CO5: Explain the mode of action of nanoparticles through *in vitro* toxicity assays, and evaluate the bioethical, legal, and regulatory requirements for commercializing nano-products.

### Mapping with Programme Outcomes

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 3   | 2   | 3   | 2   | 3   | 2   | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the fundamental concepts, approaches, and significance of research methodology and experimental design in scientific investigations.
- To develop competency in data collection methods, sampling techniques, scientific documentation, and preparation of research reports and manuscripts.
- To provide knowledge of descriptive statistics, probability distributions, and hypothesis testing for interpretation and analysis of research data.
- To familiarize students with bioinformatics resources, biological databases, sequence alignment methods, and computational tools used in biological research.
- To impart understanding of genomics, proteomics, and current statistical and computational approaches applied in modern life science research.

**UNIT - I: RESEARCH METHODOLOGY**

Introduction: Definition of research; objectives of research; types of research; research approaches; significances of research; Components of a research, research methods; importance of research; Computer application in scientific research: Finding scientific articles. Research design; Need for research Design; different types of research designs; basic principles of experimental designs, Sources of research materials - year books, & monographs, journals, conference proceedings, abstracting & indexing journals, index & References cards, internet, magazines.

**UNIT - II: DATA COLLECTION AND REPORT WRITING**

Primary and secondary Data collection. Sampling: Sampling and Population, Techniques of sampling selection, Characteristics of a good sample, Sampling errors. Techniques of Data Collection: Data schedule, Observation, Opinionnaire, Questionnaire, Interview schedules, Bibliometrics, Webometrics. Report writing; Preparation of manuscript and thesis- plan of the report, review of literature, designing of methodology, interpretation of data & thesis layout, writing of results & discussions, conclusions, Bibliography. Precautions for writing research reports.

**UNIT - III: DESCRIPTIVE STATISTICS**

Tabulation, organization and graphical representation of quantitative data. Measures of central tendencies: Mean Median and Mode. Measures of variability: Range. QD; SD; AD; and Coefficient of Variation Measures of Relative Position: Percentiles, Percentile Ranks, Standards Scores, Stanine Scores, T- Scores Normal Probability Distribution, properties of normal curve, applications of normal curve, Basic concepts concerning testing of hypothesis; procedure for hypothesis testing; Probability; Markov models

and Hidden Markov Models; Probability distribution; Binomial; Poisson; Normal distribution and Multiple testing Methods ANOVA; Test of significance-t-test; F-test.

#### **UNIT - IV: BIOINFORMATICS**

Origin and overview of bioinformatics. Applications of bioinformatics. Research in bioinformatics, Biological Databases: Literature databases, Sequence databases, Structure databases, Structural classification databases, Metabolic pathways database, Pattern and Motif searches: PROSITE, BLOCKS, PRINTS, PFAM. Sequence alignment: Pairwise sequence alignment - Local and Global alignments. Dotplot -Dynamic programming methods. Scoring or Substitution matrices - Database searching -FASTA and BLAST searches - Multiple sequence alignment. ClustalW. T-Coffee. Tools for Drug discovery / drug design.

#### **UNIT - V: GENOMICS AND PROTEOMICS**

Genome features of Prokaryote and Eukaryote. - Genome projects: HGP, E.coli, A.thaliana and Human-Genomic variations (SNP). Genome expression (Microarray). Comparative Genomics: MUMMER.

Proteomics: Protein sequence and structure characterization - Proteomics tools in ExPasy server. Primary Structure Prediction by Computing pi, Secondary structure prediction: GOR and Chou Fasman – Tertiary structure prediction: Homology modeling. Ab initio Modelling, Protein Structure and Function Determination, Protein structure visualization tools: RasMol and Swiss PDB Viewer, online Analyzing Tools.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Describing Data, The Normal Distribution, Sampling Distributions, Confidence Intervals, Hypothesis Testing, Proportions, Linear Regression, Survival Analysis.

#### **Recommended References:**

1. Statistical Methods, by - Gupta, S.P, 49th edition, 2023, Sultan Chand & Son Publishers.
2. Research Methodology and Applied Statistics - by D N SANSANWAL, paperback2020.
3. Tests, Measurements and Research Methods in Behavioural Sciences. Singh, A.K. Bharati bhawan, 2015
4. Biostatistical Analysis, 5thEdition- Zar, J.H, Pearson Education, 2010.
5. Aggarwal, Y. P. Statistical Methods: Concepts, Application and Computation, Sterling Publishers Pvt. Ltd., New Delhi, 2012.
6. Kothari. C.R. Research Methodology – Methods and Techniques, New Age International(P)Ltd, 2004
7. Research Methodology. Methods &Techniques: Kothari, C.R. 2nd edition, 2004
8. Methods of Statistical Analysis. P.S. Grewal -14th edition, 2007

## **COURSE OUTCOMES (COs):**

Upon successful completion of this course, the student will be able to:

CO1: Describe the fundamental concepts of research methodology, biostatistics, bioinformatics, genomics, and proteomics used in scientific research.

CO2: Apply research methodologies, statistical tools, and bioinformatics techniques for scientific data collection, analysis, and interpretation.

CO3: Analyze experimental data using statistical and computational approaches and interpret findings to derive meaningful scientific conclusions.

CO4: Design and develop research methodologies and computational approaches for addressing problems in biological research.

CO5: Integrate concepts of research methodology, statistics, bioinformatics, genomics, and proteomics to solve scientific research problems effectively.

### **Mapping with Programme outcomes:**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 2          | 2          | 1          | 1          | -          | 2          | 1          | -           |
| <b>CO2</b>   | 2          | 3          | 2          | 3          | 2          | 1          | 2          | 3          | 1          | -           |
| <b>CO3</b>   | 2          | 3          | 3          | 2          | 1          | 2          | 3          | 2          | 1          | -           |
| <b>CO4</b>   | 2          | 2          | 3          | 3          | 2          | 2          | 3          | 3          | 1          | 1           |
| <b>CO5</b>   | 3          | 3          | 2          | 2          | 2          | 2          | 3          | 3          | 2          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand how DNA is organized and packaged across different domains of life.
- To master the tools of the "Omics" revolution, from Next-Generation Sequencing (NGS) to Tandem Mass Spectrometry.
- To move beyond listing genes to understanding how they are expressed (Transcriptomics) and translated into functional machines (Proteomics).
- To apply molecular data to drug discovery, precision medicine, and agricultural improvement
- To integrate and interpret multi-omics data to elucidate complex biological processes, molecular interactions, and disease mechanisms.

**UNIT - I: Structural & Functional Genomics**

Architecture of the Genome: Comparative Organization-Structural differences between prokaryotic and eukaryotic genomes, Organellar Genomes and Packaging Dynamics. Structural Genomics & Sequencing Tech: Genome Mapping, Sequencing Evolution and Assembly Strategies. Functional Genomics (From Sequence to Sense): Gene Identification, Genome Annotation, Transcriptomics & Proteomics. Genome Variation & Precision Medicine: Types of Variation, Genomics of Disease, Evolutionary Genomics. Digital Biology & Resources: Primary Databases, Specialized Resources, Data Mining.

**UNIT - II: Transcriptomics**

The Dynamic Transcriptome: Concepts of the Transcriptome, The RNA World, Coding RNA, Housekeeping RNA, Non-coding RNA (ncRNA). Mechanisms of Gene Regulation: Transcriptional Control – Prokaryotes and Eukaryotes, Epigenetic Regulation, RNA Processing & Maturation: Co-transcriptional Modifications 5' Capping & 3' Polyadenylation, Splicing Machinery, Alternative Splicing, RNA Transport. Expression Profiling & Technologies: Quantitative PCR (RT-qPCR, Microarrays, RNA-Sequencing (RNA-Seq, Single-cell RNA-seq (scRNA-seq. Transcriptomics in Health & Disease: Disease Biomarkers, Pharmacogenomics, Infectious Disease, Therapeutic RNA.

**UNIT - III: Proteomics – Fundamentals**

The Proteome - Structure & Dynamics: The Proteomic Paradigm, Protein Architecture, The Folding Problem, Proteome Dynamics. Post-Translational Modifications (PTMs): Common PTMs, Functional Impact, Analysis of PTMs. Protein-Protein Interactions (PPIs) & Networks: Interaction Types, Mapping the Interactome - Yeast Two-Hybrid (Y2H, Co-Immunoprecipitation (Co-IP), FRET & BRET, Network Biology. Analytical Proteomics (Separation & Prep): Principles of Extraction, Electrophoretic Techniques, SDS-PAGE, 2D-Gel Electrophoresis, Chromatography (HPLC/FPLC, Sample Prep for Mass

Spectrometry. Clinical Proteomics & Biomarkers: Targeted Proteomics, Biomarker Discovery, Structural Proteomics

#### **UNIT - IV: Proteomics Techniques & Bioinformatics**

Gel-Based Proteomics: Principles of Electrophoresis, SDS-PAGE, Two-Dimensional (2D) Electrophoresis, Visualization & Staining. Mass Spectrometry (MS) Principles: MS Hardware, Ionization Sources, Mass Analyzers, Tandem MS (MS/MS), Peptide Mass Fingerprinting (PMF). Quantitative Proteomics: Label-Free Quantification (LFQ), Metabolic Labeling, Chemical Tagging, Targeted Proteomics. Bioinformatics & Data Interpretation, Search Engines & Algorithms, Protein Databases, PDB (Protein Data Bank), Functional Annotation, Data Validation. Integrative "Omics" & Systems Biology: Multi-omics Integration, Pathway Analysis.

#### **UNIT - V: Applications of Genomics & Proteomics**

Precision Medicine & Clinical Genomics: Biomarker Discovery, Pharmacogenomics (PGx), Genomic Diagnostics. Genomic-Driven Drug Discovery: Target Identification & Validation, Structure-Based Drug Design, Toxicogenomics. Agricultural & Microbial Genomics: Agricultural Genomics, Genetically Modified Organisms (GMOs), Microbial Genomics, Pathogen Surveillance. Multi-Omics Integration (Systems Biology): Data Integration Strategies, Interactomics, Network Medicine. Ethical, Legal, and Social Implications (ELSI): Genetic Privacy, Bioethics, and Access & Equity.

#### **UNIT – VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Recent advances in genomics and proteomics.

#### **Recommended Books**

1. The 2025 Report on the Human Proteome (HUPO): While a report, this is the definitive reference for the current "blueprint" of the human proteome (93.6% complete as of early 2026).
2. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006).
3. Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
4. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology.
5. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
6. NCBI / Ensembl: The primary hubs for genome sequences and annotations.
7. UniProt: The world's most used protein knowledge base, providing comprehensive data on protein sequence and function.
8. PDB (Protein Data Bank): The 3D structural repository for all proteins and nucleic acids.
9. Coursera (Johns Hopkins / UC San Diego): Features professional specializations in "Genomic Data Science" and "Bioinformatics" which are frequently updated with the latest algorithmic shifts.

10. Nucleic Acids Research (NAR) Database Issue: Published annually (2025/2026), this is the "bible" for discovering new specialized databases in the omics field.

### **Course Outcomes (COs):**

**Upon successful completion of the course the students would be able to:**

CO1: Differentiate between coding and non-coding genomic regions and analyze how genomic variations contribute to human disease states.

CO2: Evaluate and select appropriate transcriptomic techniques (qPCR, Microarrays, or single-cell RNA sequencing) to investigate specific biological and clinical research questions.

CO3: Explain the biophysical principles of protein separation by charge and size (2D-Gel Electrophoresis) and analyze complex proteomic data generated via tandem mass spectrometry (MS/MS).

CO4: Apply computational skills to navigate, retrieve, and analyze structural and molecular data from global bioinformatics repositories like NCBI and the Protein Data Bank (PDB).

CO5: Critically evaluate the societal implications, biosafety regulations, and bioethical concerns surrounding Genetically Modified Organisms (GMOs) and genomic privacy.

### **Mapping with Programme Outcomes**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 3          | 3          | 3          | 2          | 3          | 1          | 3          | 2          | 3           |
| <b>CO2</b>   | 3          | 3          | 3          | 3          | 2          | 3          | 1          | 3          | 2          | 3           |
| <b>CO3</b>   | 3          | 3          | 3          | 3          | 2          | 3          | 2          | 3          | 2          | 3           |
| <b>CO4</b>   | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3           |
| <b>CO5</b>   | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3          | 3           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To understand the biochemical nature of common food adulterants and their physiological impact on human health.
- To master analytical techniques (spectroscopic, chromatographic, and enzymatic) used in the identification of food fraud.
- To develop proficiency in standard operating procedures (SOPs) as per international and national food safety guidelines (e.g., FSSAI, FDA).
- To evaluate the legal and ethical frameworks governing food authenticity and consumer protection.
- To gain hands-on expertise in detecting contaminants in high-risk food groups like dairy, spices, and oils.

**UNIT - I: Introduction to Food Adulteration & Risk Assessment**

Definitions and Classification: Intentional vs. incidental adulteration; economic motivated fraud (EMF). Biochemical Impact: Metabolic pathways of common toxins (e.g., Aflatoxins, Methanol); toxicity and chronic health effects. Sampling Protocols: Principles of representative sampling; preparation of samples for biochemical analysis; preservation techniques.

**UNIT - II: Analysis of Dairy and Animal-Derived Foods**

Milk & Dairy: Detection of urea, starch, detergents, and melamine using enzymatic and chemical methods. Meat & Fish: Biochemical markers for species identification (DNA-based vs. protein-based); detection of formaldehyde and ammonia in seafood. Egg & Honey: Analysis of C3/C4 sugars in honey; detection of synthetic colors in egg yolks.

**UNIT - III: Lipids, Spices, and Condiments**

Oils and Fats: Determination of Saponification value, Iodine value, and Reichert-Meissl (RM) value. Detection of Argemone oil, Mineral oil, and Rancidity (Kries Test). Spices: Detection of Metanil Yellow in turmeric, Lead Chromate in chilli powder, and papaya seeds in black pepper. Beverages: Analysis of chicory in coffee; detection of iron filings and artificial coloring in tea.

**UNIT - IV: Advanced Instrumental Techniques**

Chromatography: Principles of HPLC and GC-MS in detecting pesticide residues and veterinary drug residues. Spectroscopy: Use of Atomic Absorption Spectroscopy (AAS) for heavy metals (Lead, Mercury, Arsenic). Molecular Biology: Application of PCR and ELISA for detecting allergens and GMOs in processed foods.

**UNIT - V: Regulatory Framework & Quality Management**

Standards & Acts: Food Safety and Standards Act (FSSAI); Codex Alimentarius; ISO 22000. Validation of Methods: Sensitivity, specificity, and

LOD (Limit of Detection) in biochemical assays. Quality Assurance: GLP (Good Laboratory Practices) and HACCP (Hazard Analysis Critical Control Point) in preventing adulteration.

## **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Portable biosensors and smartphone-based detection in food quality analysis.

### **Textbooks**

1. Deshpande, A. (2025). Food Adulteration: Identifying the Risks. Educohack Press. (1st Edition).
2. Siva Kiran, R.R. (2023). Manual for Detection of Common Food Adulterants. IAPEN.
3. Nielsen, S. S. (2022). Food Analysis. Springer. (5th Edition).
4. Otles, S. (2024). Methods of Analysis of Food Components and Additives. CRC Press.

### **Reference Books**

1. FSSAI (2024). Manual of Methods of Analysis of Foods (Revised Editions for Oils, Dairy, and Spices).
2. Wrolstad, R. E. (2021). Handbook of Food Analytical Chemistry. Wiley-Interscience.
3. Tittlemier, S. (2023). Chemical Contaminants and Residues in Food. Woodhead Publishing.

### **E-Sources**

1. **FSSAI E-Library:** [fssai.gov.in](https://fssai.gov.in) (Official manuals for laboratory methods).
2. **Codex Alimentarius:** [fao.org/fao-who-codexalimentarius](https://fao.org/fao-who-codexalimentarius) (International food standards).
3. **ACS Food Science & Technology:** [pubs.acs.org/journal/afsthl](https://pubs.acs.org/journal/afsthl) (Latest research on detection techniques).
4. **AOAC International:** Official Methods of Analysis (OMA) online database.

## **COURSE OUTCOMES (COs):**

Upon successful completion of this course, the student will be able to:

CO1: Identify specific biochemical markers used to distinguish between authentic and adulterated food products.

CO2: Execute qualitative and quantitative biochemical assays for common adulterants like melamine, argemone oil, and synthetic dyes.

CO3: Operate advanced analytical instruments (HPLC, GC-MS, AAS) for residue analysis of pesticides and heavy metals.

CO4: Interpret analytical data to determine if a food sample meets regulatory compliance.

CO5: Design a food safety audit plan for a food processing unit based on adulteration risk assessment.

### Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>C01</b> | 3   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 1    |
| <b>C02</b> | 3   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 1    |
| <b>C03</b> | 3   | 2   | 2   | 2   | 2   | 2   | 1   | 1   | 1   | 1    |
| <b>C04</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |
| <b>C05</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the structure, organization, and regulation of the mammalian endocrine system and hormone signaling mechanisms.
- To provide knowledge on the chemistry, biosynthesis, and functions of hormones associated with hypothalamic, pituitary, thyroid, adrenal, pancreatic, and reproductive systems.
- To develop understanding of molecular mechanisms involved in endocrine regulation and reproductive physiology.
- To familiarize students with the biochemical and physiological basis of endocrine disorders and their clinical significance.
- To impart knowledge on recent advances and research trends in endocrinology and endocrine-related disorders.

**UNIT - I: BASICS OF ENDOCRINE SYSTEM**

Definition and scope of Endocrinology- Historical and anatomical aspects of mammalian endocrine system. Definition of a hormone- chemical nature of mammalian hormones- types of hormone receptors- secondary messenger system, general mechanism of peptide and non- peptide hormones action. Feed-back regulation of Endocrine System.

**UNIT - II: ENDOCRINES OF HYPOTHALAMUS AND THYROID GLAND**

The Endocrines of Hypothalamus - Hypo-Physiotropic hormones- Neurovascular hypothesis. Pituitary gland hormones- chemistry and biochemical functions. Pineal gland hormones- chemistry- biochemical functions- mechanism of action. Thyroid gland hormones- chemistry- biochemical functions- mechanism of action. Parathyroid glands- biochemical functions.

**UNIT - III: HORMONES OF ADRENAL AND PANCREAS**

Adrenal gland: Hormones of adrenal gland- chemistry- mechanism of action, biochemical functions. Pancreas- Insulin/glucagon: chemistry- biochemical functions- mechanism of action. Somatostatin. Hormones involved in calcium metabolism- chemistry- mechanism of action. Neuro-hormones- the brain- Renin-Angiotensin System, Urotensin- neuropeptides.

**UNIT - IV: HORMONES OF FEMALE AND MALE REPRODUCTIVE SYSTEM**

Hormones of female and male reproductive system: Ovarian steroid hormones chemistry- biosynthesis and transport; Synthesis, chemistry and metabolism of androgens- dynamics of steroid hormone production and metabolism, mechanisms of action of sex steroid hormones. Testicular and ovarian determining genes – Mullerian-inhibiting substance genes- molecular basis of male and female contraception.

## **UNIT - V: ENDOCRINOPATHIES**

Endocrinopathies: Hypo-physal, Thyroid, parathyroid, adrenal and pancreas. Disorders of pituitary hormone axis- thyrotoxicosis- hypothyroidism- Hashimoto's thyroiditis- metabolic bone diseases- Cushing's syndrome- Addison's diseases. Diabetes mellitus- androgen deficiency syndromes- Testicular neoplasm: Klinefelter's syndrome and Turner's syndrome. Clinical evaluation of endocrine functions-overview.

## **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Discussion on recent research in key human endocrine disorders.

### **Recommended References:**

1. A. L. Lehninger, Nelson & Cox. 2021. Principles of Biochemistry, 8th edition, CBS, India
2. Endocrinology: Mac E. Hadely. 5th edition, Pearson Education, 2000.
3. Henry M. Kronenberg, Shlomo Melmed, Kenneth S. Polonsky, P. Reed Larsen. William Textbook of Endocrinology, 13th edition. Saunders Elsevier 2016
4. Bolander, Franklyn F. *Molecular Endocrinology*, 3rd Edition, Academic Press, San Diego, 2004.
5. van Holde, Kensal E. Chromatin, Springer Science & Business Media, Reprint Edition, 2012.
6. Chromatin (Springer Series in Molecular and Cell Biology) Paperback – 2011

### **COURSE OUTCOMES (COs):**

**Upon successful completion of this course, the student will be able to:**

- CO1: Describe the structure, functions, and mechanisms of action of hormones involved in the endocrine system.
- CO2: Apply concepts of molecular endocrinology to understand hormonal signaling, endocrine regulation, and reproductive physiology.
- CO3: Analyze the molecular and biochemical basis of endocrine disorders and their physiological implications.
- CO4: Design and develop experimental approaches for studying endocrine functions and endocrine-related disorders.
- CO5: Integrate principles of molecular endocrinology to understand endocrine regulation, hormonal mechanisms, and endocrine disorders in biological and clinical research.

**Mapping with Programme Outcomes:**

| <b>COs/POs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|----------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>     | 3          | 1          | 1          | 2          | -          | -          | -          | 1          | 1          | -           |
| <b>CO2</b>     | 2          | 2          | 2          | 3          | 1          | 1          | 1          | 2          | 1          | -           |
| <b>CO3</b>     | 2          | 3          | 3          | 2          | 1          | 2          | 2          | 2          | 1          | -           |
| <b>CO4</b>     | 2          | 2          | 3          | 3          | 2          | 2          | 3          | 3          | 1          | 1           |
| <b>CO5</b>     | 3          | 2          | 2          | 2          | 1          | 1          | 2          | 3          | 2          | 1           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the fundamental concepts of the immune system and its components.
- To understand antigen–antibody reactions and immune system functioning.
- To provide basic knowledge about immune-related diseases and immunization.
- To familiarize students with basic immunological techniques used in diagnostics and research.
- To demonstrate the molecular basis of complex, cellular processes involved in inflammation and immunity, in states of health and disease.

**UNIT - I: OVERVIEW OF THE IMMUNE SYSTEM:**

Historical development of immunology: Contributions of Élie Metchnikoff, Edward Jenner, Louis Pasteur, and Wu Ting-Chao & Elvin A. Kabat. Haematopoiesis, Organs of the immune system – anatomy and functions of lymphoid tissues – Bone marrow, thymus, lymph node and lymphatic system, spleen and other peripheral lymphoid tissues – MALT, GALT and CALT. Cells of the immune system- lymphocytes, mononuclear phagocytes – dendritic cells, granulocytes, NK cells and mast cells. Immunoglobulins – structure, classification and functions. Idiotypic network hypothesis. Antigen, types of antigen, antigen Vs immunogens, Haptens. Factors influencing immunogenicity. Isotypes, allotypes and idiotypes.

**UNIT - II: COMPLEMENT SYSTEM:**

Complement System: characteristic features, activation - MAC, Classical pathway and Alternative pathway- biological functions. Theories of Antibody formation - Instructive, selective, clonal selection theories and evidence; Immunological memory. Factors influencing antibody production –Genetic basis of antibody diversity. T-cell, B-cell receptors, Antigen recognition-processing and presentation to T-cells. Interaction of T and B cells. Effector mechanisms- macrophage activation. Cell mediated cytotoxicity.

**UNIT - III: MAJOR HISTOCOMPATIBILITY COMPLEX AND IMMUNOPATHOLOGY:**

Major Histocompatibility complex (MHC): MHC genes organization and expression, MHC polymorphism and diversity, Role of MHC in antigen presentation and immune responses. Transplantation immunology: Types of transplantation (autograft, allograft, and xenograft) Mechanisms of graft rejection. Immunological tolerance and immunosuppression. Immune responses to infectious diseases: Viral, Bacterial and Protozoan infections. Immunodeficiency disorders: Primary and secondary immunodeficiency, Immune mechanisms involved in AIDS. Autoimmunity: Mechanisms of induction, Organ-specific and systemic autoimmune diseases.

Hypersensitivity reactions (Type I-IV). Tumor immunology and immune surveillance. Principles of immunotherapy.

#### **UNIT - IV: VACCINES AND ANTIBODY ENGINEERING:**

Immunization practices: Active and passive immunization. Conventional vaccines: Killed vaccines, Attenuated vaccines, Toxoid vaccines, and Modern vaccines: Recombinant vector vaccines - DNA and mRNA vaccines and Synthetic peptide vaccines, Anti-idiotypic vaccines. Antibody engineering: Humanized antibodies, Plant-derived antibodies (plantibodies). Production of antibodies: Polyclonal and Monoclonal antibodies using Hybridoma technology. Genetically engineered antibodies and antibody fragments. Catalytic antibodies (Abzymes). Therapeutic antibodies in disease treatment.

#### **UNIT - V: ADVANCED IMMUNOLOGICAL TECHNIQUES:**

Antigen-antibody interaction techniques: Agglutination and precipitation assays. Electrophoretic and molecular techniques: Immunoelectrophoresis Radioimmunoassay (RIA) Immunoblotting (Western blot). Advanced immunoassays: Avidin-biotin mediated immunoassay, Fluorescent immunoassays. Immunohistological techniques: Immunohistochemistry Immunofluorescence, Immunoferritin techniques. Cell-based immunological techniques: Flow cytometry and fluorescence activated cell sorting (FACS). Cytokine detection assays: ELISA ELISPOT. Cellular assays: Lymphocyte transformation test (LTT) Lymphoblastoid cell lines. Experimental animal models in immunology: Inbred strains, SCID mice, Nude mice, Knockout and transgenic models, Cloned animals.

#### **UNIT VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Host immune responses against emerging infections.

#### **TEXT BOOKS:**

1. Anil K. Sharma. 2019. Immunology: An Introductory Textbook, 1st Edition, Jenny Stanford Publishers, California.
2. Gupta SK. 2017. Essentials of Immunology, 2nd Edition, ARYA Publishers, New Delhi.
3. Kenneth Murphy. 2017. Janeway's Immunobiology, 9th Edition, W.W. Norton & Company Publishers, New York.
4. Mohanty SK. 2019. Essentials of Microbiology & Immunology, 1st Edition, Paras Medical Publishers, New Delhi.
5. Robert R. Rich. 2020. Clinical Immunology- Principles and Practice, 5th Edition, Elsevier Publishers, India.
6. Shyamasree Ghosh. 2020. Computational Immunology Basics, 1st Edition, CRC Press Publishers, England.

#### **REFERENCE BOOKS:**

1. Abul K. Abbas, Andrew H. Lichtman, and Shiv Pillai. 2020. Cellular and Molecular Immunology, 10th Edition, Elsevier Publishers, India.
2. Ashim K. Chakravarty. 2016. Immunology and Immunotechnology, 1st Edition, Oxford Publishers, England.

3. Jenni Punt, Sharon A Stranford, Patricia P Jones and Judith A Owen. 2019. Kuby Immunology, 8th Edition, Macmillan Education Publishers, London.
4. Peter J. Delves, Seamus J. Martin, Dennis R. Burton and Ivan M. Roitt. 2016. Roitt's Essential Immunology, 13th Edition, Wiley-Blackwell Publishers, New Jersey.
5. Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby. 2002. Immunology, 5th Edition, W.H. Freeman Publishers, New York.

#### **E- RESOURCES:**

1. <https://www.nature.com/ni/video>
2. <https://www.cell.com/immunity/home>
3. [https://www.wpunj.edu/sec/vsec/science\\_courses/bio/BIOimmuANIM.html](https://www.wpunj.edu/sec/vsec/science_courses/bio/BIOimmuANIM.html)
4. <https://www.youtube.com/watch?v=K09xzIQ8zsG>

#### **COURSE OUTCOMES (COs):**

**After completion of this course, students will be able to:**

CO1: Understand the molecular and cellular basis of innate and adaptive immunity.

CO2: Analyse the mechanisms of antigen recognition, immune signalling, and immune regulation.

CO3: Interpret immune responses in infection, autoimmunity, cancer, and transplantation.

CO4: Integrate immunology with genomics, proteomics, and computational biology.

CO5: Design research proposals addressing immunological problems in health and disease.

#### **Mapping with Programme Outcomes**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 3          | 2          | 1          | 1          | 1          | -          | 1          | -          | -          | 1           |
| <b>CO2</b>   | 3          | 3          | 2          | 2          | 1          | -          | 1          | -          | -          | 1           |
| <b>CO3</b>   | 3          | 3          | 3          | 3          | 2          | -          | 2          | 1          | 1          | 1           |
| <b>CO4</b>   | 3          | 3          | 2          | 2          | 3          | 2          | 1          | 1          | -          | 1           |
| <b>CO5</b>   | 3          | 2          | 3          | 3          | 3          | -          | 1          | 2          | 1          | 2           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To explore how plants convert light energy into chemical energy (Photosynthesis) and how both plants and microbes break down fuel molecules (Respiration).
- To detail the biosynthesis of primary and secondary metabolites and understand their roles in plant defense and human industry.
- To examine how plants manage water, nutrients, and stress through complex signaling and molecular responses.
- To categorize microbial diversity (Bacteria, Archaea, Fungi, Viruses) and understand their unique metabolic capabilities like fermentation and anaerobic respiration.
- To introduce the principles of industrial fermentation, bioremediation, and genetic engineering for sustainable agriculture and bio-product development.

**UNIT - I: Plant Biochemistry**

Photosynthesis: The Energy Conversion - Light-Dependent Reactions, Calvin Cycle and Regeneration. Carbon Fixation Variants & Photorespiration: Photorespiration, C<sub>3</sub>, C<sub>4</sub> and CAM Pathway. Respiration and Energy Metabolism: Glycolysis and TCA Cycle, Alternative Oxidase (AOX) Pathway and Pentose Phosphate Pathway. Biosynthesis of Primary Metabolites: Carbohydrates, Lipids and Amino Acids. Secondary Metabolites: Alkaloids, Flavonoids & Phenolics, Terpenoids. Plant Growth Regulators (Phytohormones).

**UNIT - II: Plant Physiology & Molecular Aspects**

Water Relations and Mineral Nutrition: Water Potential, Mineral Acquisition and Essential Nutrients. Transport Systems: Xylem Transport and Phloem Translocation. Hormones and Signal Transduction: Receptor Perception, Second Messengers and Signal Cascades. Plant Stress Physiology: Abiotic Stress, Drought & Salinity, Osmolytes & Temperature and Biotic Stress, Hypersensitive Response, Systemic Acquired Resistance. Basics of Plant Molecular Biology: Genome Organization, Gene Expression, Genetic Engineering. Plant-Microbe Interactions: Symbiosis - Nitrogen Fixation and Mycorrhizae, Pathogenesis - PAMP-Triggered Immunity and Effector-Triggered Immunity.

**UNIT - III: Microbial Biochemistry**

Microbial Diversity: Bacteria (Prokaryotes) - Diversity in shape (cocci, bacilli, spirilla) and cell wall composition (Gram-positive vs. Gram-negative). Introduction to Archaea (extremophiles), Fungi (Eukaryotes) - Distinctions between unicellular yeasts and multicellular molds/mushrooms; saprophytic vs. parasitic lifestyles. Viruses (Acellular - Structural components (capsid, envelope, nucleic acid core); the debate on living vs. non-living. Microbial Cell Structure and Ultrastructure: The Cell Envelope,

External Structures, Internal Ultrastructure, Endospores. Microbial Metabolism: Glycolysis & Alternatives, Fermentation, Anaerobic Respiration. Enzyme Production and Regulation: Extracellular vs. Intracellular Enzymes, Constitutive vs. Inducible Enzymes, Allosteric Regulation. Microbial Growth Curve and Kinetics: Four Phases of Growth and Growth Kinetics. Nutritional Requirements: Chemical Requirements, Energy Sources, Growth Factors, Environmental Factors.

#### **UNIT - IV: Industrial & Environmental Microbiology**

Fermentation Technology: Batch Culture, Fed-Batch Culture, Continuous Culture (Chemostats). Industrial Production of Bio-products: Antibiotics, Enzymes, Organic Acids. Food Microbiology: Probiotics, Fermented Foods. Environmental Microbiology: Nutrient Cycles - Carbon Cycle, Nitrogen Cycle, Sulfur Cycle. Bioremediation and Waste Management: Bioremediation (Phytoremediation), Waste Management - Sewage Treatment and Anaerobic Digestion

#### **UNIT - V: Applications of Plants & Microbes**

Biofertilizers and Biopesticides: Biofertilizers - Nitrogen Fixers, Phosphate Solubilizers, Mycorrhizae, Biopesticides – Bacterial, Fungal, Viral. Microbes in Agriculture and Soil Fertility: Decomposition and Humification, Rhizosphere Effect, Mineralization vs. Immobilization, Plant Growth Promoting Rhizobacteria. Plant Tissue Culture and Micropropagation: Totipotency Techniques, Micropropagation, Haploid Production. Genetic Improvement of Plants: Recombinant DNA Technology, Direct Gene Transfer, Trait Engineering-Herbicide Resistance, Abiotic Stress Tolerance, Nutritional Enhancement. Industrial Applications of Microbes: Bio-fuels, Single Cell Protein. Bioplastics, Biosensors. Sustainable Agriculture and Environmental Applications: Integrated Pest Management (IPM, Phytoremediation, Carbon Sequestration, Organic Farming.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Recent advances in Microbial and Plant Biochemistry.

#### **Recommended Books**

1. Taiz, Lincoln and Zeiger, Eduardo. Plant Physiology and Development, 7th Edition, Sinauer Associates/Oxford University Press, New York, 2018.
2. Buchanan, Bob B., Gruissem, Wilhelm, and Jones, Russell L. Biochemistry and Molecular Biology of Plants, 2nd Edition, Wiley Blackwell Publishers, 2015.
3. Madigan, Michael T., Bender, Kelly S., Buckley, Daniel H., Sattley, W. Matthew, and Stahl, David A. Brock Biology of Microorganisms, 16th Edition, Pearson Education, 2021.
4. Willey, Joanne M., Sherwood, Linda M., and Woolverton, Christopher J. Prescott's Microbiology, 12th Edition, McGraw Hill Education, New York, 2022.
5. Nelson, David L. and Cox, Michael M. Lehninger Principles of Biochemistry, 8th Edition, W. H. Freeman and Company, New York, 2021.

6. Molecular Plant-Microbe Interactions, American Phytopathological Society (APS) Journals, APS Press, Latest Volume/Issue available, 2026.
7. Phytopathological Society. <https://apsjournals.apsnet.org/journal/mpmi>
8. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry and Molecular Biology of Plants (2nd ed.). Wiley-Blackwell. <https://atlanticbooks.com/products/biochemistry-and-molecular-biology-of-plants-9780470714218>
9. Madigan, M. T., Bender, K. S., Buckley, D. H., Sattley, W. M., & Stahl, D. A. (2021). Brock Biology of Microorganisms (16th ed.). Pearson. <https://www.pearson.com/en-us/subject-catalog/p/brock-biology-of-microorganisms/P200000006867/9780135860717> Cited by: 2020
10. NCBI. (n.d.). All Resources - Site Guide. National Center for Biotechnology Information. <https://www.ncbi.nlm.nih.gov/guide/all/>
11. Nelson, D. L., & Cox, M. M. (n.d.). Lehninger Principles of Biochemistry(7th ed.). <https://sites.usp.br/lbbp/wp-content/uploads/sites/464/2019/09/Ch12-Lehninger-7th-Edition.pdf>
12. Plantae. (2025, January 24). Unraveling plant-microbe interaction dynamics: Insights from the Tripartite Symbiosis Model. <https://plantae.org/review-unraveling-plant-microbe-interaction-dynamics-insights-from-the-tripartite-symbiosis-model/>
13. Taiz, L., & Zeiger, E. (n.d.). Plant Physiology and Development. Goodreads. <https://www.goodreads.com/en/book/show/24538677-plant-physiology-and-development>
14. Willey, J. M., Sandman, K. M., & Wood, D. H. (2022). Prescott's Microbiology (12th ed.). McGraw Hill. [https://books.google.com/books/about/Prescott\\_s\\_Microbiology.html?id=uHLKzgEACAAJ](https://books.google.com/books/about/Prescott_s_Microbiology.html?id=uHLKzgEACAAJ)

## Course Outcomes (COs)

**Upon successful completion of the course the students would be able to:**

CO1: Differentiate between the metabolic mechanisms of the Calvin Cycle, C3/C4/CAM pathways, and evaluate the physiological role of the Alternative Oxidase (AOX) pathway in plants.

CO2: Compare the structural composition of Gram-positive and Gram-negative cell walls, and analyze the replication cycles and structural variations of major viruses and fungi.

CO3: Calculate microbial growth kinetics and select optimal bioprocess culture strategies (Batch vs. Continuous) for the commercial scale-up of antibiotics and industrial enzymes.

CO4: Analyze the molecular and physiological mechanisms behind plant defense responses to abiotic (drought, salinity) and biotic stresses via osmolyte accumulation and Systemic Acquired Resistance (SAR).

CO5: Propose and design sustainable agro-environmental solutions utilizing biofertilizers, biopesticides, and phytoremediation strategies to combat soil degradation and environmental pollution.

### Mapping with Programme Outcomes

| CO/PO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>CO2</b> | 3   | 3   | 3   | 3   | 2   | 3   | 1   | 3   | 2   | 3    |
| <b>CO3</b> | 3   | 3   | 3   | 3   | 2   | 3   | 2   | 3   | 2   | 3    |
| <b>CO4</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To Explain the fundamental concepts of environmental chemistry.
- To Describe the chemical composition, reactions, and pollutants of the Atmosphere.
- To Analyze soil chemistry, soil contaminants and principles of waste Management.
- To Outline the principles of toxicology including dose-response.
- To Explain the mechanisms of toxicity.

**UNIT - I: Fundamentals of Environmental Chemistry & Green Principles**

Introduction: Scope and importance of environmental chemistry; interactions between the anthroposphere and natural spheres (atmosphere, hydrosphere, lithosphere, biosphere). Green Chemistry: The 12 principles of green chemistry; sustainable development goals (SDGs); pollution prevention vs. control. Basic Analytical Tools: Sampling techniques (water, air, soil); introduction to pH, conductivity, turbidity, and spectroscopic methods (UV-Vis, AAS).

**UNIT - II: Atmospheric & Hydrospheric Chemistry**

Atmospheric Chemistry: Layers of the atmosphere; major chemical reactions (photochemical smog, acid rain formation); greenhouse gases and global warming; ozone layer depletion (CFCs and alternatives). Air Pollutants: Sources and effects of SO<sub>x</sub>, NO<sub>x</sub>, CO, CO<sub>2</sub>, particulate matter (PM<sub>2.5</sub>, PM<sub>10</sub>), VOCs. Hydrosphere: Hydrological cycle; chemical composition of natural waters; water quality parameters (dissolved oxygen, BOD, COD, hardness, alkalinity); eutrophication; basic water and wastewater treatment processes.

**UNIT - III: Geosphere, Waste Management & Industrial Ecology**

Soil Chemistry: Soil formation, composition, cation exchange capacity (CEC); pH and nutrient availability. Soil Contaminants: Heavy metals (Pb, Cd, Hg, As), pesticides, and industrial chemicals; bioaccumulation and biomagnification. Waste Management: Classification of waste (municipal, hazardous, e-waste); principles of landfill, incineration, and recycling; life cycle assessment (LCA); industrial ecology and circular economy.

**UNIT - IV: General & Biochemical Toxicology**

Principles of Toxicology: History, dose-response relationships (LD<sub>50</sub>, ED<sub>50</sub>); selective toxicity; routes of exposure (oral, dermal, inhalation). Toxicokinetics (ADME): Absorption: Mechanisms across biological membranes. Distribution: Role of plasma proteins, blood-brain barrier, storage depots. Metabolism (Biotransformation): Phase I reactions (Cytochrome P450 oxidation, reduction, hydrolysis); Phase II conjugation (glucuronidation, glutathione, sulfation). Excretion: Renal, biliary, and

pulmonary routes. Factors affecting toxicity: Age, sex, genetics, nutritional status.

### **UNIT - V: Toxicodynamics, Organ Toxicity & Case Studies**

Mechanisms of Toxicity (Toxicodynamics): Molecular targets (enzymes, receptors, ion channels, DNA); oxidative stress and lipid peroxidation; mitochondrial dysfunction; disruption of calcium homeostasis. Specific Organ Toxicity: Hepatotoxicity (liver – CCl<sub>4</sub>, acetaminophen); nephrotoxicity (kidney – heavy metals); neurotoxicity (organophosphates, lead); teratogenesis and carcinogenesis (initiation, promotion, progression).

### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Emerging Contaminants and Their Interactions, High-Throughput and Non-Targeted Analytical Methods.

### **TEXT BOOKS:**

1. Manahan, Stanley E. Environmental Chemistry, 10th Edition, CRC Press/Taylor & Francis Group, Boca Raton, 2017.
2. Introduction to Green Chemistry by John Andraos & Albert S. Matlack (3rd Edition, CRC Press, 2022).
3. A Textbook of Modern Toxicology by Ernest Hodgson (4th Edition, Wiley, 2010)

### **REFERENCE BOOKS:**

1. Environmental Chemistry: Advanced Concepts and Applications (Ed. Zhen-Yu Tian, Springer, 2025).
2. Chemistry of the Environment by Bailey, Clark, Ferris, Krause & Strong (2nd Edition, Elsevier, 2002)
3. Environmental Chemistry: Principles and Practices by Rihana-Abdallah et al. (De Gruyter).
4. Green Toxicology: Making Chemicals Benign by Design by Alexandra Maertens (RSC, 2022)

### **Web Resources:**

1. [Fundamental Environmental Chemistry](#)
2. [Microsoft Word - CHE\\_P4\\_M4\\_e-Text.docx](#)
3. [Waste Management](#)
4. [9781845936761.pdf](#)

### **Course Outcomes (COs):**

**Upon successful completion of this course the students will be able to:**

CO1: Recall the scope and importance of environmental chemistry, layers of the atmosphere, and the process of soil formation.

CO2: Explain the principles of sampling techniques, the role of CFCs and their alternatives, Bioaccumulation and Biomagnification.

CO3: Apply the 12 principles of green chemistry, Calculate water quality parameters, circular economy principles.

CO4: compare and contrast various sampling techniques, Analyze the chemical reactions involved.

CO5: Critique the 12 principles of green chemistry, assess the efficiency of water treatment.

### Mapping with Programme Outcomes

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 1   | 1   | 2   | 1   | 1   | 1   | 1   | 2   | 1    |
| <b>CO2</b> | 3   | 2   | 2   | 2   | 1   | 1   | 1   | 1   | 2   | 1    |
| <b>CO3</b> | 2   | 2   | 3   | 3   | 2   | 2   | 3   | 2   | 3   | 2    |
| <b>CO4</b> | 2   | 3   | 3   | 3   | 2   | 2   | 2   | 2   | 2   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 3   | 2   | 3   | 3   | 3   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- This course is designed to familiarize the students with basic and more advanced concepts of an emerging and rapidly evolving field of epigenetics.
- To address fundamental questions in Epigenetics and Genetics Regulation.

**UNIT - I: CHROMATIN STRUCTURE**

DNA and Histones, Structure of Histones, Histone-DNA Interactions, Nucleosomes, organization of Nucleosomes, Chromatin, Chromosomal architecture. Histone variants, Nonhistone proteins.

**UNIT - II: EPIGENETICS**

Genetics Vs Epigenetics, Regulation of gene expression and cell fate, Regulation from zygote to multipotent cells. Epigenetics of Tissue development, Homeostasis and regeneration. Epigenetic process of chromatin modification by transcriptional regulation, Hetero chromatin and Euchromatin.

**UNIT - III: EPIGENETIC MODIFICATIONS**

Chromatin remodeling by DNA binding proteins, SWI/SNF family repositioning nucleosomes. Chromatin modifications by spontaneous conformational change, covalent modifications, Epigenetic modifications: DNA methylation and Post translational modification of Histones

**UNIT - IV: EPIGENETIC CONTROL OF CHROMATIN**

Locus specific control: NURD, SIN3A, methyl transferase and kinase complexes. Coordination among Chromatin modifying complexes. Epigenetic control of Cell specific gene expression, Mitotic cell cycle, Gene imprinting, Cellular differentiation. Reversibility of Epigenetic modifications: Reprogramming epigenome by somatic cell nuclear transfer, cell fusion and by cell extracts.

**UNIT - V: EPIGENETICS AND DISEASES**

Predisposition to disease, Imprinting based disorders, Epigenetics of Memory, neurodegeneration and mental health, Kidney, Diabetes and cardiovascular disorders.

**UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Recent advances in chromatin and Epigenetics in AI.

**Text Books**

1. Fundamentals of Epigenetics by Gurbachan S. Miglani, 2023, Publisher, Krishan Makhijani
2. Epigenetics. Lyle Armstrong. 1<sup>st</sup> edition, 2014, Publication, New York,
3. Epigenetic Advancements in Cancer by Manoj K, Mishra, 1<sup>st</sup> edition 2016
4. Epigenetic Biomarkers and Diagnostics by Jose luis garcia -Mica Haley, 1<sup>st</sup> edition, 2016,
5. Chromatin Structure and Function by Alan P. Wolffe. Academic Press. 3<sup>rd</sup> Edition 2012.
6. Chromatin Kensal E. van Holde · 2012,
7. Chromatin (Springer Series in Molecular and Cell Biology) Paperback – 2011

**Course Outcomes (COs):**

Upon successful completion of this course the students will be able to:

CO1: On Successful Completion of this course the students will have a sound knowledge about the Epigenetic contribution in cellular functions.

CO2: Students can understand the function of DNA packaging within the cell and use examples to illustrate how packaging is achieved in various organisms.

CO3: Students can describe in detail the protein components of the nucleosome and key modifications to nucleosome components, and understand the interactions between the DNA double helix and the nucleosome

CO4: Students can understand the various chromatin states within the interphase nucleus – their degrees of compaction and the hierarchy of chromatin assembly

CO5: The students would also learn the critical analysis, thinking of research papers and problem solving skills

**Mapping with Programme Outcomes**

| PO/CO      | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| <b>CO1</b> | 3   | 2   | 1   | 3   | 1   | 1   | 2   | 1   | 2   | 1    |
| <b>CO2</b> | 3   | 2   | 2   | 3   | 1   | 1   | 2   | 1   | 2   | 1    |
| <b>CO3</b> | 2   | 2   | 3   | 3   | 2   | 2   | 3   | 3   | 3   | 2    |
| <b>CO4</b> | 2   | 3   | 3   | 3   | 2   | 2   | 3   | 2   | 2   | 1    |
| <b>CO5</b> | 3   | 3   | 3   | 2   | 2   | 3   | 3   | 2   | 3   | 3    |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- To introduce the concepts and scope of bio-business, biotechnology entrepreneurship, and wealth creation in life science industries.
- To provide knowledge on biotechnology-based industries, healthcare business, environmental management, and agricultural bio-enterprises.
- To develop understanding of marketing strategies, commercialization processes, negotiation skills, and business management in bio-industries.
- To familiarize students with intellectual property rights, patent systems, patent filing procedures, and regulatory frameworks related to biotechnology.
- To impart skills in business plan preparation, financial management, collaborations, and innovation-driven entrepreneurship in biotechnology.

**UNIT - I: INTRODUCTION TO BIO BUSINESS**

Introduction to Bio-business, Fundamentals of Biotech for bio-Business, Contemporary Vs antique Bio-business, Wealth Creation in Bio-business. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India), strategic dimensions of patenting & commercialization strategies.

**UNIT - II: BIOSCIENCES IN BUSINESS**

Healthcare, Biomedical sciences, Industrial Life Sciences, Biotechnology, Agriculture based business, Food Industry; Where Things Stand: A Quick Survey of Regional and Global Strengths and Capabilities. Business related to Environment Management, Bioremediation, Bioleaching and waste management.

**UNIT - III: BIO MARKETS - BUSINESS STRATEGY AND MARKETING**

Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio-business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.

**UNIT - IV: PROTECTING THE INTELLECTUAL PROPERTY**

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework

for the protection of IP; 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; plant variety protection and farmers rights act; concept of 'prior art': invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

#### **UNIT - V: PATENTING: BASICS OF PATENTS**

Types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and noncommercial incentives.

#### **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

Business plan preparation including statutory and legal requirements, Business feasibility study, and financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.

#### **Recommended References:**

1. James F. Jordan, Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press, 2021
2. Ganguli, P. Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: McGraw Hill Education; 1st edition, 2017
3. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, Government of India, 2016
4. David J. Adams, John C. Sparrow. Enterprise for Life Scientists: Developing Innovation and Entrepreneurship in the Biosciences., Scion Publishing Ltd, Bloxham, 2008.

#### **COURSE OUTCOMES (COs):**

**Upon successful completion of this course, the student will be able to:**

CO1: Describe the fundamentals of bio-business, entrepreneurship, intellectual property rights, and patenting processes in biotechnology industries.

CO2: Apply business strategies, marketing principles, and regulatory frameworks in biotechnology and life science enterprises.

CO3: Analyze bio-business opportunities, market challenges, patent-related issues, and commercialization strategies in biotechnology sectors.

CO4: Design and develop business plans, patent strategies, and entrepreneurial solutions for biotechnology-based industries.

CO5: Integrate concepts of bio-entrepreneurship, intellectual property management, and business strategies for successful biotechnology ventures and innovations.

#### **Mapping with Programme Outcomes:**

| <b>CO/PO</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|--------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b>   | 2          | 1          | 1          | -          | 1          | -          | 3          | -          | 2          | 2           |
| <b>CO2</b>   | 3          | 2          | 1          | 1          | 1          | -          | 3          | -          | 1          | 2           |
| <b>CO3</b>   | 2          | 3          | 2          | -          | 2          | 1          | 3          | 1          | 1          | 3           |
| <b>CO4</b>   | 2          | 2          | 2          | -          | 2          | 1          | 3          | 1          | 1          | 2           |
| <b>CO5</b>   | 2          | 2          | 2          | 1          | 3          | 2          | 3          | 2          | 2          | 3           |

**Correlation level: 1 – Low 2 – Moderate 3 – High**

**COURSE OBJECTIVES:**

- Understand raw material as source of herbal drugs from cultivation to herbal drug product.
- Know the WHO and ICH guidelines for evaluation of herbal drugs.
- Know the herbal cosmetics, natural sweeteners, and nutraceuticals.
- Appreciate patenting of herbal drugs and Good Manufacturing Practices (GMP).
- To understand the principles and techniques involved in the standardization, quality control, and safety assessment of herbal drugs and herbal formulations

**UNIT - I: Herbs as raw materials**

Definition of Herb, Herbal medicine, Herbal drug preparation Source of Herbs Selection, Identification and authentication of herbal materials, processing of herbal raw material. Biodynamic, Agriculture, Good agricultural practices in cultivation of medicinal plants including Organic farming. Pest and Pest management in medicinal plants: Biopesticides/Bioinsecticides. Indian Systems of Medicine -Basic principles involved in Ayurveda, Siddha, Unani and Homeopathy.

**UNIT - II: Nutraceuticals**

General aspects, Market, growth, scope and types of products available in the market. Health benefits and role of Nutraceuticals in ailments like Diabetes, CVS diseases, Cancer, Irritable bowel syndrome and various Gastro intestinal diseases. Study of following herbs as health food: Alfaalfa, Chicory, Ginger, Fenugreek, Garlic, Honey, Amla, Ginseng, Ashwagandha, Spirulina. Herbal-Drug and Herb-Food Interactions: General introduction to interaction and classification. Study of following drugs and their possible side effects and interactions: Hypercium, kava-kava, Ginkobiloba, Ginseng, Garlic, Pepper & Ephedra.

**UNIT - III: Herbal Cosmetics**

Sources and description of raw materials of herbal origin used via, fixed oils, waxes, gums colours, perfumes, protective agents, bleaching agents, antioxidants in products such as skin care, hair care and oral hygiene products. Herbal excipients: Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors & perfumes.

**UNIT - IV: Evaluation of Drugs**

WHO & ICH guidelines for the assessment of herbal drugs Stability testing of herbal drugs. Patenting and Regulatory requirements of natural products: a) Definition of the terms: Patent, IPR, Farmers right, Breeder's right, Bioprospecting and Biopiracy b) Patenting aspects of Traditional Knowledge and Natural Products. Case study of Curcuma & Neem.

## **UNIT - V: Herbal drugs industry**

Present scope and future prospects. A brief account of plant-based industries and institutions involved in work on medicinal and aromatic plants in India. Schedule T – Good Manufacturing Practice of Indian systems of medicine. Components of GMP (Schedule – T) and its objectives Infrastructural requirements, working space, storage area, machinery and equipment, standard operating procedures, health and hygiene, documentation and records.

## **UNIT - VI: CURRENT CONTOURS (Self-directed learning activities for Continuous Internal Assessments Only):**

AI in Ethnobotany, Regulatory Evolution & Global Markets, Sustainability & Circular Economy.

### **Recommended Books**

1. Herbal Drug Technology- A Comprehensive Textbook by Dr. Sonia Narwal et al. (2026 Edition): (Innovative Publication, 2026).
2. Textbook of Herbal Drug Technology by Shobha Rani R. Hiremath (2024 Edition): A standard reference for formulation and standardization.
3. ICH Official Website: For the latest "Efficacy" (E) and "Quality" (Q) guidelines on herbal implementation (ICH, 2026).
4. Traditional Knowledge Digital Library (TKDL): A vital Indian resource for checking the patentability of herbal products and preventing biopiracy.
5. Formula Botanica / Pepagora Blogs: Excellent for real-time trends in natural cosmetic ingredients and "Green Biotech" (Formula Botanica, 2026; Pepagora, 2026).
6. Ramamurthy and Durgadevi. Ethanomedicine, Mahi publication, gujarat, 2021
7. Formula Botanica. (2026, January 27). Top 7 cosmetic ingredients predictions for 2026 - Your expert guide. <https://formulabotanica.com/2026-cosmetic-ingredients/>
8. Grand View Research. (2026). Nutraceuticals market size & share | Industry report, 2033. <https://www.grandviewresearch.com/industry-analysis/nutraceuticals-market>
9. ICH. (2026). ICH Guideline implementation. <https://www.ich.org/page/ich-guideline-implementation>
10. Innovative Publication. (2026, April 23). Herbal Drug Technology- A Comprehensive Textbook for the Students of B. Pharm. 6th Semester. <https://books.ipinnovative.com/books/423/herbal-drug-technology-a-comprehensive-textbook-for-the-students-of-bpharm-6th-semester>
11. Pepagora. (2026, March 14). Advanced cosmetic raw materials trends for 2026. <https://blog.pepagora.com/advanced-cosmetic-raw-materials-trends/>
12. Scribd. (2026). Schedule T: GMP for ASU Medicines. <https://www.scribd.com/document/791607938/GMP-Sche-T>

### Course Outcomes (COs):

**Upon successful completion of the course the students would be able to:**

CO1: Identify, authenticate, and scientifically process herbal raw materials by applying Good Agricultural and Collection Practices (GACP).

CO2: Evaluate and justify the physiological mechanisms, nutritional benefits, and therapeutic applications of specific functional foods and nutraceuticals.

CO3: Select and utilize appropriate natural excipients—including botanical binders, diluents, and colorants—for the formulation of herbal cosmetics and oral hygiene products.

CO4: Design, execute, and interpret Stability Testing protocols for herbal drugs in strict accordance with WHO and ICH regulatory guidelines.

CO5: Apply Good Manufacturing Practices (GMP) under Schedule T requirements to ensure quality control, industrial compliance, and public safety in professional plant-based manufacturing.

### Mapping with Programme Outcomes

| CO/PO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 |
|-------|------|------|------|------|------|------|------|------|------|-------|
| CO-1  | 2    | 2    | 3    | 1    | 2    | 3    | 1    | 1    | 2    | 2     |
| CO-2  | 1    | 3    | 2    | 2    | 1    | 3    | 1    | 3    | 2    | 3     |
| CO-3  | 3    | 2    | 1    | 1    | 2    | 3    | 2    | 2    | 2    | 2     |
| CO-4  | 3    | 2    | 2    | 3    | 3    | 3    | 3    | 2    | 3    | 1     |
| CO-5  | 2    | 3    | 3    | 2    | 3    | 3    | 3    | 3    | 3    | 3     |

**Correlation level: 1 – Low 2 – Moderate 3 – High**