Two-Year Postgraduate Program

Master of Science

Biochemistry

Faculty of Applied Sciences

Parul University

Vadodara, Gujarat, India

Faculty of Applied Sciences

Master of Biochemistry

1. Vision of the Department

To evolve a right blend of traditional and modern sciences which are essential for the present-day innovations in science.

2. Mission of the Department

M1	Awaken the young minds and discover their talents both in theory and in practical through dedication to teaching, commitment to students and innovative instructional methods.
M2	To support the developmental activities of the College and make the Department vibrant
M3	To organize critical contributions in areas of emphasis such as faculty, modern labs, department library and demonstrate a high level of competence in the study of Biochemistry.

3. Program Educational Objectives

The statements below indicate the career and professional achievements that the M.Sc. Biochemistry curriculum enables postgraduates to attain.

PEO 1	Demonstrate the ability to critically analyze complex biochemical problems, formulate hypotheses, design experiments, and interpret data to contribute meaningfully to scientific advancement and innovation.
PEO 2	Advanced knowledge and skills in biochemical principles, methodologies, and technologies, enabling them to excel in research, academia, industry, or healthcare.
PEO 3	Professional development opportunities to enhance their expertise, adapt to emerging trends in biochemistry, and advance their careers in diverse professional settings.
PEO 4	Collaborate effectively with professionals from diverse disciplines, integrating knowledge and perspectives to address complex challenges at the interface of biochemistry with fields such as biology, chemistry, medicine, and engineering.

4. Program Learning Outcomes

Program Learning outcomes are statements conveying the intent of a program of study.

PLO 1	**Disciplinary Knowledge**	Execute strong theoretical and practical understanding generated from the specific programme in the area of work.
PLO 2	**Critical Thinking and Problem Solving**	Identify the problem by observing the situation closely, take actions and analytical skills to design the solutions.
PLO 3	**Social Competence**	Exhibit thoughts and ideas effectively, build effective interactive and presenting skills to meet global competencies.
PLO 4	**Research-related Skills and Scientific Temper**	Infer scientific literature, build sense of enquiry and identify and consult relevant sources to find answers.
PLO 5	**Trans-disciplinary Knowledge**	Create new conceptual, theoretical and specific approaches to address a common problem.
PLO 6	**Personal and Professional Competence**	Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PLO 7	**Effective Citizenship and Ethics**	Demonstrate empathetic social to professional ethics and responsibility.
PLO 8	**Environment and Sustainability**	Understand the impact of the scientific solutions in societal and environmental contexts.
PLO 9	**Self-directed and Life-long learning**	Acquire the ability to engage in independent and life-long learning in broadest context of socio-technological changes.

5. Program Specific Learning Outcomes

PSO 1	**Recent Research trends**	Demonstrate advanced skills in employing quantitative and qualitative research methods, data collection, analysis, and synthesis, with an emphasis on addressing real-world applicative challenges.in different areas of biochemistry.
PSO 2	**Data Analysis and Interpretation**	Apply appropriate techniques for the qualitative and quantitative analysis of chemicals in laboratories and industries.
PSO 3	**Interdisciplinary Skills**	Expect to diagnose the pathogenic microbes in the laboratory by applying the knowledge of microbial culture techniques.

6. Credit Framework:

Semester wise Credit distribution of the Programme	
Semester-1	22
Semester-2	22
Semester-3	22
Semester-4	29
Total Credits	**95**

Category wise Credit distribution of the Programme	
Category	**Credit**
Major Core	48
Multidisciplinary (Interdisciplinary)	20
Skill Enhancement Courses	7
Research Project/Dissertation	20
Total Credits	**95**

7. Program Curriculum:

Semester 1						
Sr. No.	**Subject Code**	**Subject Name**	**Credit**	**Lect**	**Lab**	**Tut**
1	11203108	Advanced Enzymology	4	4	0	0
2	11203109	Biophysical Chemistry	4	4	0	0
3	11203110	Chemistry Of Biomolecules	4	4	4	0
4	11203111	Analytical Methods Lab 2	2	0	4	0
5	11203113	Cell Biology and Physiology	4	4	0	0
6	11203112	Biochemical Analysis Lab 1	2	0	4	0
7	11203114	Seminar	2	0	0	2
Total			22	16	08	2
Semester 2						
8	11203155	Intermediary Metabolism	4	4	0	0
9	11203156	Plant Biochemistry	4	4	0	0
10	11203157	Microbial Biochemistry	4	4	0	0
11	11203159	Lab-1 Enzymology	2	0	4	0
12	11203160	Lab-2 Plant Biochemical Analysis	2	0	4	0
13	11203180 11203181	Nutritional Biochemistry and Analytical Methods (Elective-1) Ecology And Environmental Biochemistry	4	4	0	0

		(Elective-2)				
14	11203161	Seminar	2	0	0	2
Total			**22**	**16**	**8**	**2**
Semester 3						
15	11203201	Genetics and Biostatistics	4	4	0	0
16	11203203	Immunology	4	4	0	0
17	11203204	Molecular Biology-I	4	4	0	0
18	11203205	Lab-1 Microbiology	2	0	4	0
19	11203206	Lab-2 Molecular Biology	2	0	4	0
20	11202230 11203234	Genomics and Proteomics (Elective-1) Endocrinology (Elective-2)	4	4	0	0
21	11203207	Seminar	2	0	0	2
Total			**22**	**16**	**08**	**2**
Semester 4						
22	11203217	Clinical Biochemistry	4	4	0	0
23	11203280 11203281	Molecular Biology-II & Bioinformatics Basics of Hormones	4	4	0	0
24	11203219	Dissertation Work	20	0	10	0
25	11202256	Seminar	1	0	0	1
Total			**29**	**08**	**10**	**1**
Total			**95**			

Semester 1

a. **Course Name:** Advanced Enzymology

b. **Course Code:** 11203108

c. **Prerequisite:** Inclination to learn advanced techniques of enzyme catalysis with examples and different mechanisms of catalysis with applications.

d. **Rationale:** The course will provide in depth knowledge about mechanisms of enzyme catalysis which are important for metabolic pathways. The concept of turnover number and Kcat values for optimization of industrial enzymes. The different regulatory strategies of enzyme catalysis.

e. **Course Learning Objective:**

CLOBJ 1	Interpreting the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms.
CLOBJ 2	Apply biochemical calculation for enzyme kinetics.
CLOBJ 3	Analyzing the factors affecting enzymatic reactions.
CLOBJ 4	Explaining the concepts of co-operative behavior, enzyme inhibition and allosteric regulation.

f. **Course Learning Outcomes:**

CLO 1	Identifying structure of action of enzymes.
CLO 2	Exemplifying the structure, Function and kinetics of enzymes.
CLO 3	Identifying the on current applications and future potential of enzymes.
CLO 4	Defining in detail law of thermodynamics

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P**- Practical; **C**- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** Introduction of enzymes-Classification of enzymes (IUB), Remarkable properties of enzymes, catalytic power, specificity, Formation of Enzyme Substrate complex − Fischer and Koshlandmodels. Holoenzyme, apoenzyme, coenzyme and cofactors. Purification of enzymes, enzyme assay- coupled kinetic assay, ELISA, RIA and manometric assay and Enzyme units. Isoenzymes, multienzyme complexes (pyruvate dehydrogenase complex), Ribozyme and Abzyme.	**18%**	**12**
2	**UNIT 2** Enzyme kinetics-Velocity of a reaction, order of a reaction, progress curve for enzyme catalyzed reactions. Transition state theories, methods use in the investigation of kinetics of enzyme catalyzed reactions − initial velocity studies, ionselective electrode studies and rapid reaction technology. Factors affecting enzyme catalysis − pH, Temperature and substrate concentration on enzyme kinetics. Enzyme kinetics of single substrate reaction-Derivation Michaelis-Menton equation.Significance of Km and Vmax values. Linear transformations of Michaelis-Menton equation	**22%**	**13**
3	**UNIT 3** Kinetics of bi substrate reactions- Terminology and classification of Bisubstrate with examples of each class. Kinetics of multisubstrate reactions. Rate equations for Ping Pong and ordered Bi-Bi reaction mechanism. Differentiating Bi substrate mechanisms. Enzyme inhibition: reversible inhibition- competitive, noncompetitive, uncompetitive and mixed inhibition −	**18%**	**11**

	partial inhibition substrate inhibition and allosteric inhibition. Irreversible inhibition. Suicide inhibition (DFMO-Di fluoro methoxy ornithine, 5 Fluro dUMP).		
4	**UNIT 4** Enzyme catalytic mechanisms: general acid base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis, and enzyme catalysis. Mechanistic role of following coenzymes in enzyme catalyzed reactions − thiamine pyrophosphate, nicotinamide nucleotides, flavin nucleotides, PLP, biotin and tetrahydrofolate. Mechanisms of reaction catalyzed by chymotrypsin, lysozyme, Ribonuclease and Carboxypeptidase A	**20%**	**11**
5	**UNIT 5** Regulation of enzyme activity- covalent modification , zymogen activity and protein proteininteraction. Allosteric enzyme action: Cooperativity − the Hill equation. Sigmoidal kinetics the MWC and KNF models − significance of sigmoidal behaviors − study of ATCase as a typical allosteric enzyme. Enzyme Technology: Industrial uses of enzymes-Food and Pharmaceutical industries. Clinical Enzymology-Serum enzymes in health and diseases. Immobilized enzymes	**22%**	**13**
	Total	**100%**	**60 hr**

i. Text Book and Reference Book:

1. "Principles of Biochemistry, 1993A..L.Lehninger, Nelson and Cox (C.B.S., India).
2. Principles of Biochemistry General Aspects 1983 –Smith et al., general.(Mc Graw Hills)
3. Biochemistry, (2 nd edition) –Voet &Voet.
4. Biochemistry (4 th edition) –A.Stryer (Freeman)
5. Text book of biochemistry with clinical correlations. (4 th edition) – Thomas M.Devlin
6. Text book of Biochemistry, (1908) –West and Todd. (Mac Milan)
7. Biochemistry –Zubay.
8. Nucleic acid Biochemistry and Molecular biology –Main Waring, et al.
9. Understanding enzymes. (1985) –Trevor Palmer (John Wiley)
10. Fundamentals of Enzymology (II ed) by Nicholas C Price and Lewis Stevens, Oxford UnivPress.
11. Principles of Enzymology for Food Science (1972) by J R Whitkar, M Dekker Publishers.
12. Enzymes (3 rd ed 1979) Dixon M and Webb, E C, Longmans, London.
13. The chemical kinetics of enzyme action by K J Laidler and P S Bunting, Oxford University Press, London.
14. Enzyme structure and function by S Blackburn, Marcel Dekker, Inc., NY.

Semester 1

a. Course Name: Biophysical Chemistry

b. Course Code: 11203109

c. Prerequisite: Prior knowledge on modern methods and technologies used in biochemical analysis

d. Rationale: The main objective of the course is qualitative and quantitative analysis of different molecules taking place in a biochemical reaction. It includes the development of different tools and methods for identification, analysis and examination of physical properties of different biochemical compositions to provide better chemical information.It helps the biochemistry students in understanding the basic science in a variety of applications.

e. Course Learning Objective:

CLOBJ 1	Demonstrate broad knowledge in modern analytical instrumentation with deep knowledge in its core concepts and its applications.
CLOBJ 2	Understand the principle, Instrumentation of different types of Light microscopy and electron microscopy and its applications in various fields of research.
CLOBJ 3	Acquire knowledge about the basics and latest developments in the instrumentation techniques of Centrifugation, Electrophoresis (IEF, 2D PAGE) and Chromatography and their applications in various research fields.

f. Course Learning Outcomes:

CLO 1	Finding the Basic techniques useful to handle the laboratory.
CLO 2	Evaluate the theory and principles of all Spectrophotometric techniques.
CLO 3	Develop the biological samples to learn principles and instrumentation part.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Basic TechniquesBuffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques Spectroscopy Techniques UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS,NMR, PMR, ESR and Plasma Emission spectroscopy.	**25%**	**15**
2	**UNIT-II** Chromatography Techniques-TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse- phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity .Electrophoretic techniquesTheory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2D Electrophoresis; Disc gel electrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis	**25%**	**15**
3	**UNIT-III** Centrifugation-Basic principles; Mathematics & theory (RCF, Sedimentation coefficient etc); Types of centrifuge - Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods	**25%**	**15**
4	**UNIT-IV**	**25%**	**15**

	Blotting techniques: Southern blot, western blot, and northern blot – general methodology and applications. Spectroscopic techniques: Principles of Spectroscopy; Beer-Lambert's Law. Instrumentation and biological applications-colorimetry, Spectrophotometry, Fluorimetry, Flame photometry, Atomic absorption Sectroscopy (AAS), I.R. Spectroscopy.		
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. John M.Wriggelssorth.
2. Principles & Techniques of Practical Biochemistry – Wilson and Walker.
3. Analytical Biochemistry. David. J.Home & Hazelpeck. (Longman).
4. Practical Clinical Biochemistry, (5 th edition) – H.Varley, A.H.Cowenlock & M.Bell
5. A manual of Radiology. J.C.Steward & D.M. Hawcroft. (Sidgwick)
6. Instrumental methods of chemical analysis – B.K. Sharma publications)
7. Physical principles and Techniques of Protein chemistry – Leach. (Parts A, B, C)
8. Text book of biochemistry – west and Todd
9. Physical Biochemistry (II ed 1983) by D Friefelder, WH Freeman & Co., USA
10. Biophysical chemistry – Upodhya and Nath (Himalaya publications)
11. Physical Biochemistry (II ed 1985) by van Holde KE, Prentice Hall Inc., New Jersey.
12. Chromatography: A laboratory handbook of chromatographic and electrophoretic methods. (IIIrd 1975) by Erich Heftman, van Nostrand Reinhold,

Semester 1

a. Course Name: Chemistry of Biomolecules

b. Course Code: 11203110

c. Prerequisite: Basic knowledge about biomolecules and their role.

d. Rationale: The objective is to study about the structure and biological functions of macromolecules such as proteins, polysaccharides, lipids, and nucleic acids, as well as small molecules such as primary metabolites, secondary metabolites, and natural products.

e. Course Learning Objective:

CLOBJ 1	Defining the classification of biomolecules
CLOBJ 2	Inferring the basic reaction types and mechanisms of biomolecules.
CLOBJ 3	Identifying the structures and functions of biomolecules.
CLOBJ 4	Associating and finding the chemical and biochemical properties of biomolecules.

f. Course Learning Outcomes:

CLO 1	Correlate the basic structure of Biomolecules.
CLO 2	Relating Conformation, isomerism of the bimolecular structures and their importance.
CLO 3	Illustrating role of Building blocks of carbohydrates and proteins and their appearance in biological matters.
CLO 4	Assessing nucleic acids structure, properties and their functions and enzymatic hydrolysis techniques.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Stereochemistry: Relation between chirality and optical activity. Representation of chiral structure by Fishers projection, perspective, Newman and Sawhare formulas, molecular models.Classification of chiral compounds – DL, RS methods. Geometrical isomerism (E and Z nomenclature). Porphyrins: Sturcture, properties and Identification. Structure of metalloporphyrins-heme, cytochromes and chlorophylls	**18%**	**11**
2	**UNIT-II** Carbohydrates: Classification of carbohydrates, reactions of monosaccharides, structural elucidation of starch and glycogen. Structure and biological importance of aminosugars, Glycoproteins, proteoglycons, Bacterial cell wall polysaccharides, blood group substances and Lectins. Lipids: classification, physicochemical properties of fats and oils. Characterization of natural fats and oils, structure and biological role of triacyl glycerol, phospholipids, sphingolipids,gangliolipids. Prostaglandins, thromboxanes,leucotrines – steroids – cholesterol, and bile acids.	**22%**	**13**
3	**UNIT-III** Aminoacids and proteins: Classification of amino acids, acid base properties of amino acids, pKa of functional groups of amino acids, chemical reaction of aminoacids, Nonprotein amino acids.Peptide bond – structure and conformation-Ramachandran plot. Merrifield solid phase	**18%**	**12**

	peptide synthesis, naturally occurring peptides. Isolation and purification of proteins. Criteria of purity of proteins.		
4	**UNIT-IV** Structural organization of proteins, elucidation of primary structure, secondary structure alpha,beta pleated sheet structure and triple helical structure. Tertiary structural features of myoglobin, lysozyme, ribonuclease, chymotrypsin, Quaternary structure – Hemoglobin – protein folding (Molecular chaperones) Denaturation and renaturation of proteins. Chemical modification of proteins.	**20%**	**11**
5	**UNIT-V** Nucleic acids: Structure of nucleic acids – purine and pyrimidine bases – nucleosides, nucleotides, polynucleotides – secondary and tertiary structure of DNA, different types of DNA, types of RNA structures of RNAs. Isolation, fractionation and characterization of nucleic acids, properties of nucleic acids in solution denaturation and renaturation, hypo and hyper chromic effects, Tm, cot curves. Enzymatic hydrolysis of Nucleic acids. DNA sequencing methods: Maxam and Gilbert's method. Sanger's dideoxy chain termination method.	**22%**	**13**
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. Lehininger's Principles of Biochemistry (2000) by Nelson, David L and Cox, M M, Macmillan/worth, NY.
2. Fundamentals of Biochemistry (1999) by Donald Voet, Judith G Voet and Charlotte W Pratt, John Wiley & Sons, NY.
3. Biochemistry III ed (1994) by Lubert Stryer, WH Freeman and Co., San Francisco.
4. Outlines of Biochemistry (1987) by Eric E Conn, P K Stumpf, G Bruening and Ray H Doi, John Wiley & Sons, NY.

5. Principles of Biochemistry General aspects 1983 Smith etal. (McGraw Hills)
6. Biochemistry (4 th edition) – Thomas M.Devlin.
7. Text book of Biochemistry (1908) west and Todd. (Mac Milan)
8. Text book of Biochemistry – Zubay.
9. Biochemistry – Garret and Girsham

Semester 1

a. Course Name: Lab 2-Analytical Methods

b. Course Code: 11203111

c. Prerequisite: Basic Knowledge about properties of biomolecules

d. Rationale: The "Biochemical analysis lab " is vital as it offers hands-on experience, reinforcing theoretical knowledge by applying basic biochemical concepts, fostering practical skills essential for life sciences disciplines.

e. Course Learning Objective:

CLOBJ 1	Acquire knowledge about different analytical techniques
CLOBJ 2	Infer basic and advanced techniques for identification and differentiation.
CLOBJ 3	Deduce Knowledge about different techniques for isolation of biomolecules from biological samples
CLOBJ 4	To apply knowledge about advanced techniques for analysis of clinical samples.

f. Course Learning Outcomes:

CLO 1	Demonstrate broad knowledge in modern analytical instrumentation with deep knowledge in its core concepts and its applications
CLO 2	Gain extensive exposure from basic to latest techiques.
CLO 3	Demonstrate skills to explainabout principle, Bioinstrumentation and applications of latest spectroscopy techniques like UV-Visible spectroscopy
CLO 4	Compare and contrast different analytical techniques based on biomolecules properties

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
	-	**4**	**2**	**-**	**20**	**20**	**-**	**60**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	Effect of solvent system on the Rf value of two solutes using paper and Thin layer Chromatography.
2	Separation of purines and pyrimidines by paper chromatography.
3	Separation of amino acids by paper chromatography
4	Separation of sugars by TLC.
5	Separation of lipids by and TLC
6	Separation of amino acids by Ion exchange chromatography (demonstration)
7	Separation of metalloenzymes by affinity chromatography
8	Determination of Molecular weight of protein by gel permeation chromatography.
9	Precipitation of serum proteins and desalting by Dilaysis (or) Spin gel permeation chromatography – Lyophilization of desalted protein fractions.
10	Separation of Serum proteins by paper electrophoresis
11	Determination of subunit composition of protein by SDSPAGE
12	Absorption spectra of phenol red, Amino acids and Nucleic acids.
13	Verification of Beer's law and determination of molar extinction coefficient using Bromophenol blue (or) Para nitrophenol.
14	Isolation and spectrophotometric characterization of metalloporphyrin.
15	Measurement of specific rotation of sugars by polarimeter

i. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers.
3. .S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Harold Varley, Practical Clinical Biochemistry, CBS.edition, 2006.
5. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
6. Enzyme Assays: A Practical Approach (Practical Approach Series) Oxford University Press, U.S.A. 2 edition, 2002.

Semester 1

a. Course Name: Cell biology and physiology

b. Course Code: 11203113

c. Prerequisite: Awareness on structure and function of cell organelles and cell division

d. Rationale: To study the structure and function of cells and to know about extracellular Matrix and cell communication. Understanding the function of intracellular organelles and cell cycle mechanism

e. Course Learning Objective:

CLOBJ 1	Inferring the origin of life, from the abiotic world to multicellular organisms, including an account of endosymbiosis
CLOBJ 2	Determining the structural characteristics of prokaryotic and eukaryotic cells
CLOBJ 3	Interpreting the structure, properties and functions of various classes of macromolecules in cells
CLOBJ 4	Correlating the intricate relationship between various cellular organelles and their corresponding functions

f. Course Learning Outcomes:

CLO 1	Analyzing Cells theory and their evolution.
CLO 2	Interpreting role of different cell organelles.
CLO 3	Associating Cells and their cellular movements with formation.
CLO 4	Differentiation of cells like meristem in plants, stem cells from animals will understand.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Cell Theory & Methods of Study Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy, etc. Membrane Structure and Function Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata.	**20%**	**12**
2	**UNIT-II** Organelles Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Cell cycle and control mechanisms; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.	**20%**	**12**
3	**UNIT-III** **Endo-membrane System and Cellular Motility** Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization	**18%**	**11**

	and role of microtubules and microfilaments; Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function; Molecular motors; Intermediate filaments; Extracellular matrix in plants and Animals		
4	**UNIT-IV** **Cellular Movements and Pattern Formation** Laying of body axis planes; Differentiation of germ layers; Cellular polarity; Model plants like Fucus and Volvox; Maternal gene effects; Zygotic gene effects; Homeotic gene effects in Drosophila; Embryogenesis and early pattern formation in plants; Cell lineages and developmental control genes in Caenorhabditis	**18%**	**11**
5	**UNIT-V** **Differentiation of Specialized Cells** Stem cell differentiation; Blood cell formation; Fibroblasts and their differentiation; Cellular basis of immunity; Differentiation of cancerous cells and role of proto- oncogenes; Phase changes in Salmonella; Mating cell types in yeast; Surface antigen changes in Trypanosomes; Heterocyst differentiation in Anabaena; Sex determination in Drosophila. Plant Meristem Organization and Differentiation Organization of Shoot Apical Meristem(SAM); Organization of Root Apical Meristem(RAM); Pollen germination and pollen tube guidance; Phloem differentiation; Self-incompatibility and its genetic control; Embryo and endosperm development; Heterosis and apomixis.	**24%**	**14**
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. Cell biology – De Roberties and DeRoberties.
2. Cell and Molecular biology – Shieler and Bianchi.
3. Cell biology (1991) – David E.Sadva (Johnes & Barrette, C. H Best & B.T.Taylor. Biochemistry –West et al.
4. Introduction to Biological membranes (2nd edn 1988) M K Jain, John Wiley & Sons, NY.
5. Comprehensive introduction to membrane biochemistry (1987) by D B Datta.
6. Biological membranes: Their structure and function (2 nd edn 1980) Harrison R.
7. Text Book of Medical Physiology (10th edn 2001) by A G Guyton and Hall J E. Harcourt,Asia.
8. Review of Medical Physiology (12th ed, 1985) Ganong W F lange Medical Pub. Cell biology Karp et al.

Semester 1

a. Course Name: Lab 1-Biochemical Analysis

b. Course Code: 11203112

c. Prerequisite: Basic Knowledge about properties of biomolecules

d. Rationale: The "Biochemical analysis lab " is vital as it offers hands-on experience, reinforcing theoretical knowledge by applying basic biochemical concepts, fostering practical skills essential for life sciences disciplines.

e. Course Learning Objective:

CLOBJ 1	Identify and describe different types of chemical reactions of biomolecules.
CLOBJ 2	Apply different biochemical properties of biomolecules in their separation and applications.
CLOBJ 3	Analyse and apply different biochemical techniques to understand their properties.
CLOBJ 4	To study about variations in properties of biomolecules based on functional groups and side chains.

f. Course Learning Outcomes:

CLO 1	Illustrating how to standardize various biomolecules
CLO 2	Assessing various techniques adopted for separation of biomolecules.
CLO 3	Analyze separation of protein by electrophoresis.
CLO 4	Determining types carbohydrates by paper chromatography

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
	-	**4**	**2**	**-**	**20**	**20**	**-**	**60**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	General reactions of carbohydrates. Specific reactions of different sugars: Ribose, Glucose, Fructose, Galactose, Sucrose, Maltose, Lactose, Starch and Glycogen.
2	General reactions of proteins and Amino acids.
3	General reactions of lipids and Cholesterol.
4	Isolation and estimation of cholesterol from Zak's method.
5	Isolation and estimation of glycogen/starch
6	Estimation of Fructose in Fruit juice.
7	Estimation of proteins in biological samples: a.)Biuret method b) Folin-lowry method c.)UV method, d.)Bradford dye binding method.
8	Titration curve of amino acids and calculation of pk and pi values.
9	Estimation of amino acids by formal titration.
10	Estimation of amino acid by ninhydrin method.
11	Estimation of tyrosine by Millions method.
12	Estimation of praline by Colorimetric method.
13	Identification of N-Terminal group of proteins by Sanger's method
14	Preparation of Casein from milk.
15	Crystallization of egg albumin.

i. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers.
3. .S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Alpha Science International, Ltd. 2 edition, 2005.
5. Harold Varley, Practical Clinical Biochemistry, CBS.edition, 2006.
6. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
7. Enzyme Assays: A Practical Approach (Practical Approach Series).
8. Oxford University Press, U.S.A. 2 edition, 2002

Semester 2

a. **Course Name:** Intermediary Metabolism

b. **Course Code:** 11203155

c. **Prerequisite:** Basic knowledge in chemistry of biomolecules with their properties.

d. **Rationale:** This course intends to provide a basic understanding of the biochemical reactions of molecules, Role of enzymes as key elements that govern the biochemical transformations, break-down and synthesis of various biomolecules and the turnover of carbohydrates, proteins, lipids and nucleic acids.

e. **Course Learning Objective:**

CLOBJ 1	Discuss the different principles of metabolism in accordance with bioenergetics.
CLOBJ 2	Differentiate how various organs control metabolism.
CLOBJ 3	Explain homeostasis of different metabolic pathways like anaplerosis.

f. **Course Learning Outcomes:**

CLO 1	Understand the concepts of carbohydrate metabolism and its regulation.
CLO 2	Explain glucose homeostasis (pathways and hormonal regulation). Discuss Krebs cycle, electron transport, and the pentose phosphate pathway.
CLO 3	Discuss the overall concept of cellular metabolism – anabolic and catabolic pathways, energy storage and release.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Carbohydrate Metabolism: Glycolysis and Fermentation. Different forms of fermentation.Pasteur effect. Control of glycolysis in muscle. Metabolism of fructose, galactose and mannose. Reactions of TCA cycle. Anaplerotic reactions.Amphibolic nature Energy yields and central importance of the pathway. The Coricycle. Gluconeogenesis.	**18%**	**11**
2	**UNIT-II** Glucose-alanine cycle. Lactose synthesis. Glycoprotein synthesis. Hexose monophosphate shunt. Uronic acid pathway. Amino sugar pathway. Glycogen metabolism. Breakdown and synthesis of glycogen. Control of glycogen metabolism. Mechanism of oxidative phosphorylation: Electron transport system, Organization of electron carriers and enzymes in mitochondria, Inhibitors of electron transport system, Mechanism of oxidative phosphorylation – various theories, uncouplers of oxidative phosphorylation, Microsomal electron transport.	**22%**	**14**
3	**UNIT-III** Lipid Metabolism: Fatty acid oxidation, role of carnitine,metabolism of triacyl Glycerophospholipids and glycolipids. Biosynthesis of fatty acids, Regulation of fattyacid metabolism. Biosynthesis of cholesterol and itsregulation. Ketone bodies metabolism, Archidonate metabolism – synthesis of prostaglandins, prostacyclins, thromboxanes and leukotrienes. Amino acids metabolism: General modes of amino acid catabolism, decarboxylation, transamination, oxidative deamination and other mechanisms, Role of pyridoxal phosphate in amino acid metabolism. Urea cycle and its regulation.	**22%**	**12**
4	**UNIT-IV**	**17%**	**11**

	Biosynthesis and degradation of Non Essential amino acids:Alanine, Cysteine, Glycine, Serine, Tyrosine, Asparagine,Aspartate, Glutamate, Glutamine and Proline.Biosynthesis and degradation of Essential amino acids: Histidine, Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophan and Valine.		
5	**UNIT-V** Biosynthesis and degradation of heme and its regulation.Biosynthesis of Biogenic amines. Importance of Biogenic amines.Nucleic Acid Metabolism: Biosynthesis of purines and its regulation. Biosynthesis of pyrimidines and its regulation. Salvage pathways of nucleic acid biosynthesis. Biosynthesis of deoxyribonucleotides and its control. Catabolism of purine and pyrimidines	**21%**	**12**
	Total	**100%**	**60 hr**

i. Text Book and Reference Book:

1. Principles of Biochemistry. –A.L.Lehninger (CBS Publishers).
2. Biochemistry –Lubert Stryer (5 th edition).
3. Principles of Biochemistry –General aspects –Smith et al., (7 th edition)
4. Harper's Review of Biochemistry –Martin et al., (Lange).
5. Text book of Biochemistry with Clinical correlation –Thomas M.Devlin ; John Weiley)(2 nd edition).
6. Text book of Biochemistry West et al.,(1966)(Mac Milan:)
7. Biochemistry –Voet and Voet

Semester 2

a. Course Name: Plant Biochemstry

b. Course Code: 11203156

c. Prerequisite: Knowledge about plant system, plant hormones and metabolism of plants.

d. Rationale: This course provides insights into the primary metabolic pathways occurring in plants, the types of plant metabolites and the industrial potential of those metabolites and the role of hormones in plant growth.

e. Course Learning Objective:

CLOBJ 1	To gain knowledge about primary and secondary metabolites of plants.
CLOBJ 2	Illustrate different metabolic pathways of plants.
CLOBJ 3	Assess role and functions of different plant hormones and their effects on growth.

f. Course Learning Outcomes:

CLO 1	Annotating the physiological roles of plant cell.
CLO 2	Elaborate the Photosynthesis processes in plants.
CLO 3	Compare the functions of various hormones in plants.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Structure and functions of plant cell (including cell wall, plasmodesmata, meristematic cells, vacuoles, secretary systems and root quiescent zone) organization as tissues, Isolation of cell organelles, absorption, adsorption and transport of water and ions in plants. Evapotranspiration. Antioxidative defence system in plants reactive oxygen species and their generation, enzymic and non-enzymic components of antioxidative defence mechanism.	**18%**	**12**
2	**UNIT-II** Photosynthesis Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, path of carbon in photosynthesis C3 and C4 pathway of carbon reduction and its regulation, Photorespiration.	**22%**	**13**
3	**UNIT-III** Plant hormones-structure, functions and mechanism of actionof plant hormones such as auxins, cytokinins, abscisic acid,ethylene and gibberallins. Brassicosterols, Jasmonales and other peptide like plant hormones. Photochemical and hormonal control in plants. Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.	**18%**	**12**
4	**UNIT-IV**	**22%**	**13**

	Special features of secondary plant metabolism, diversity in plant secondary metabolites, and their role, and commercialization of secondary metabolites by humans. Terpenes (classification, biosynthesis), lignin, tannins, pigments, phytochrome, waxes, alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components. Stress metabolism in plants Environmental stresses, salinity, water stress, heat, chilling,anaerobiosis, pathogenesis, heavy metals, radiations and their impact on plant growth and metabolism,criteria of stress tolerance.		
5	**UNIT-V** Nitrogen Metabolism: Nitrogen fixation, nitrogenase complex,electron transport chain and mechanism of action of nitrogenase. Structure of 'NIF' genes and its regulation. Hydrogen uptake and bacterial hydrogenases. Nitrate assimilation, structural features of nitrate and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation.	**20%**	**10**
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. Plant Biochemistry (James Bonner and J.R.Varner)
2. Introduction to plant Biochemistry (Goodwin)
3. Plant physiology (Salisbery)
4. Plant Biochemistry and Molecular Biology (P.J Lea and R.G.Heagood)
5. Handbook of photosynthesis (ed) Mohammad Pe sarakle, Marcel Dekkar, I nc. NY. Basel.Hong Kong 1997.
6. Introduction to plant biochemistry (1983) T W Goodwin and E I Mercer. Pergaman Press, Oxford, NY, Toronto, Sydney, Paris, Frankful.
7. Biochemistry of energy utilization in plants D T dennis Blackie, Glasgow and London 1987.
8. Plant Biochemistry by P M Dey and J B Harborne. Harcourt Asia PTE Ltd., Singapore

Semester 2

a. **Course Name:** Microbial Biochemistry

b. **Course Code:** 11203157

c. **Prerequisite:** Basic knowledge of microorganism and microbial techniques.

d. **Rationale:** Microbial biochemistry provides insights into the basic biological processes that sustain life. Microorganisms often serve as model systems for studying biochemical pathways in higher organisms.

e. **Course Learning Objective:**

CLOBJ 1	Discuss the different biochemical pathways in microbes.
CLOBJ 2	Differentiate how various microbes are cultivated and used.
CLOBJ 3	Explain applications of microbes in learning metabolism.

f. **Course Learning Outcomes:**

CLO 1	Understand the concepts of carbohydrate metabolism in microbes.
CLO 2	Explain the cultivation of microbes.
CLO 3	Discuss sterilisation and disinfection processes for microbes.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. **Course Content:**

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Microbial biochemistry: Outlines of Bergey's manual of classification Gram positive and gram negative bacteria. General characteristics of actinomycetes, rickettsia, mycoplasms, spirochetes, fungi. Ultrastructure of bacterium, variant and invariant components of Bacterial cell wall, cell membrane, capsule, cyst, external appendages, cytoplasmic inclusions, nuclear material, ribosomes, Plasmids and endospore. Staining techniques-Endospore and Gram's staining.	**21%**	**13**
2	**UNIT-II** General methods of isolation and cultivation of bacteria. Sterilization methods. Bacterial growth. Phases of growth and kinetics. Diauxic growth. Synchronous growth, chemostatic cultures. Continuous cultivation of microbes. Microscopy: Brightfield microscopy, Darkfield microscopy, fluorescence microscopy, phase contrast microscopy, transmission electron microscopy, scanning electron microscopy, Applications of Microscopy.	**22%**	**14**
3	**UNIT-III** Nutritional requirements in microorganisms: Modes of nutrition – phototrophy, chemotrophy, methylotrphy, organotrophy, mixotrophy, and saprophytic, symbiotic and parasitic mode of nutrition. Control of microorganisms: Fundamentals of control by physical agents control by chemical agents, antibiotics and other chemotherapeutic agents. Role of microorganisms in food spoilage, food borne infections, sewage (domestic and industrial) disposal.	**21%**	**13**
4	**UNIT-IV** Virology: Classification of viruses, Composition and structure	**18%**	**10**

	of viruses, virusoids, prions, Virus-host interactions. General methods of virus isolation with examples of TMV and T phages; Assay of TMV; Plaque assay for Bacteriophage. Bacteriophage life cycles Qβ, M13 and fx174. Llytic and Lysogenic cycle in lambda phage		
5	**UNIT-V** Biosynthesis Eukaryotic viruses: Animal viruses, General features and outlines of adenovirus, poliovirus, herpes virus, SV 40, Retrovirus and HIV/AIDS, Hepatitis. Plant viruses – TMV, CaMV, Peanut clump virus and Tomato yellow leaf curl virus. General features of SARS and Bird flu.	**18%**	**10**
	Total	**100%**	**60 hr**

i. Text Book and Reference Book:

1. Brock Biology of Microorganisms (14th Edition) by Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl, and Thomas Brock.
2. Microbiology: An Introduction (13th Edition) by Gerard J. Tortora, Berdell R. Funke, and Christine L. Case.
3. Prescott's Microbiology (9th Edition) by Joanne Willey, Linda Sherwood, and Christopher J. Woolverton.
4. Bailey & Scott's Diagnostic Microbiology (13th Edition) by Patricia Tille.
5. Jawetz, Melnick, & Adelberg's Medical Microbiology (26th Edition) by Michael V. Potter and Nancy M. Drobenbeck.
6. Sherris Medical Microbiology (6th Edition) by Kenneth J. Ryan and C. George Ray

Semester 2

a. Course Name: Lab 1-Enzymology

b. Course Code: 11203159

c. Prerequisite: Basic knowledge of enzymes

d. Rationale: To develop familiarity with biochemical laboratory techniques, and to introduce students to various practical aspects of enzymology and their correlation in disease conditions.

e. Course Learning Objective:

CLOBJ 1	To gain knowledge on enzymology in the aspects of isolation and purification, kinetics as well as native PAGE analysis.
CLOBJ 2	Analyse the kinetics of enzyme catalysis and learn the basics of isolation and purification of enzymes.
CLOBJ 3	Understand the concepts of isoenzyme analysis and inhibitory mechanisms of enzyme activity

f. Course Learning Outcomes:

CLO 1	Learn kinetics of enzyme catalyzed reactions and enzyme inhibitory and regulatory processes.
CLO 2	Able to perform immobilization of enzymes.
CLO 3	Utilize knowledge of enzymes and wide applications of them to improve medicines and human health care system.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
	-	**4**	**2**	**-**	**20**	**20**	**-**	**60**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	Amylase from Saliva.
2	Urease from Horsegram
3	Acid phosphatase from potato
4	Alkaline phosphatase from serum
5	SDH from liver
6	Trypsin.
7	Invertase.
8	LDH from Serum (Isoenzymes).
9	Acetylcholine esterase activity.
10	Purification and study of enzyme kinetics with respect to substrate and enzyme
11	Concentrations pH, temperature, activators and inhibitors and immobilization

i. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers.
3. .S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Alpha Science International, Ltd. 2 edition, 2005.
5. Harold Varley, Practical Clinical Biochemistry, CBS.edition, 2006.
6. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
7. Enzyme Assays: A Practical Approach (Practical Approach Series). Oxford University Press, U.S.A. 2 edition, 2002

Semester 2

a. Course Name: Lab 2-Plant Biochemical Analysis

b. Course Code: 11203160

c. Prerequisite: Basic Knowledge about planta and phytochemicals

d. Rationale: The main objective of this paper is to learn about different phytochemicals their function and extraction processes.

e. Course Learning Objective:

CLOBJ 1	Outlining about physiology of plants.
CLOBJ 2	Inferring Knowledge about different phytochemicals and their properties.
CLOBJ 3	Analysis, identification and separation of phytochemicals.

f. Course Learning Outcomes:

CLO 1	Associating a basic understanding of biochemical events associated with structural arrangement of plant cell and organization
CLO 2	Analyze and understand the biochemistry of photosynthetic process and its relation to man and its environment.
CLO 3	Predicting knowledge about the importance of secondary metabolites and its industrial applications.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
	-	**4**	**2**	**-**	**20**	**20**	**-**	**60**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	Estimation of plant pigments – Carotenoids, Chlorophyll
2	Estimation of total phenols in plants.
3	Estimation of Flavonols and Tannins in plants
4	Estimation of Capasicin by spectrophotometric method.
5	Estimation of reduced ascorbic acid by DCPIP method.
6	Estimation of total Ascorbic acid by DNPH method.
7	Estimation of thymine by colorimetry, Fluorimetry
8	Estimation of riboflavin by fluorimetry
9	Estimation of niacin by cyanogen bromide method.
10	Estimation of available lysine in fruits
11	Estimation of magnesium, copper, iron, calcium, Phosphorus in food.
12	Estimation of protein in plant seeds by micro Kjeldahl method.
13	Estimation of fat in plant seeds (Gravimetry).
14	Determination of saponification value in seed oil.
15	Determination of iodine value in oil

i. Text Book and Reference Book:

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers.
3. .S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry.
4. Harold Varley, Practical Clinical Biochemistry, CBS.edition, 2006.
5. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
6. Enzyme Assays: A Practical Approach (Practical Approach Series) Oxford University Press, U.S.A. 2 edition, 2002.

Semester 2

a. Course Name: Nutritional Biochemistry and analytical methods

b. Course Code: 11203180

c. Prerequisite: Inclination to learn about nutrients, diseases which occurs due to deficiencies and analytical techniques to learn nutrient analysis.

d. Rationale: The main objective of this course is to introduce about Dietary requirements and energy content in foods needed for human body.

e. Course Learning Objective:

CLOBJ 1	Finding of macro and micronutrients and their effects.
CLOBJ 2	Knowing concept of growth and Nitrogen balance.
CLOBJ 3	Inferring Different techniques used in detection of diseases and organ perfusion techniques.
CLOBJ 4	Appraising knowldge of radioactivity and its potential applications.

f. Course Learning Outcomes:

CLO 1	Understand the basic national value of the foods and their calorific value in life.
CLO 2	Assess Nutritive value of the fats, proteins and carbohydrates and their calorific values provides the diet regulations.
CLO 3	Integarting experimental approaches like estimations and isolation of these macromolecules provides skill development.
CLO 4	Measuring how this radioactivity useful in diagnostic techniques.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT-I** Nutritional Biochemistry: Calorific values of carbohydrates,fats and proteins, specific dynamic action. Measurement of energy expenditure direct and indirect colorimetry,respiratory quotient and BMR. Factors effecting BMR.Essential and nonessential amino acids. Nitrogen balance,Determination of biological value of proteins, Kwashiorkor and Merasmus.	**23%**	**13**
2	**UNIT-II** Essential fatty acids and phospholipids in nutrition. Water soluble and fat soluble vitamins. Requirement, Sources and deficiency symptoms. Macro and trace elements in nutrition and their biochemical role, recommended allowances,sources, deficiency symptoms. Special aspects of nutrition for the pregnant, lactating women, infants, children, Adults and old age. Obesity, Importance of nutrition under stress conditions.	**25%**	**15**
3	**UNIT-III** Experimental approaches in study of metabolism - Metabolic inhibition, growth studies and Biochemical genetics, isotopic biochemistry, isolated organs, cells and sub cellular organelles Organ perfusion. Use of experimental animals, tissue slices, homogenates and mutant organisms in the study of intermediary metabolism.Centrifugation Techniques: Basic principles of centrifugation, preparative centrifugation differential, rate zonal, isopycnic and equilibrium isodensity centrifugation, analysis of subcellular fractions, assessment of	**27%**	**17**

	homogeneity. Analytical ultracentrifuge and its applications.Flow cytometry.		
4	**UNIT-IV** Radioactivity: Stable and radio isotopes, Nature of radioactivity-half life, decay constant and units of radioactivity. Detection and measurement of radio activitytechniques-G.M. counters, proportional counter, scintillation counters and auto radiography. Radiation dose units,Roentgen, REP, REM, maximum permissible dose, lethal dose and tolerance doses. Evaluation of exposed doses-dosimetry and dosimeters. Biological effects of radiation,Application of radioisotopes in biochemical sciences.	**25%**	**15**
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. Nutrition: An integrated approach (3 rd edn. 1984) R L Pike and M L Brown,Wiley and Sons Inc. NY.
2. Text Book of Biochemistry and Human Biology G P Talwar, Prentice Hall.
3. Mechanism and Theory in Food Chemistry (1996) DWS Wong, CBS, New Delhi.
4. Text Book of Human Nutrition (1996) M S Bamji N Pralhad Rao and V Reddy, Oxford & IBH Publishers.
5. Nutritional Biochemistry and Metabolism Linten.
6. Principles of Food Science –I (Food Chemistry) Fennemona D R.
7. Human Nutrition and Dietetics (8 th Ed. 1982) by Davidson and Passmore ELBS.
8. Modern Nutrition in Health and Diseases (7 th ed 1988) by Maurice E Skills and VR Young K M Varghese Co. Bombay.
9. The tools of Biochemistry – Terrace.E.Cooper (John Willey).

Semester 2

a. Course Name: Ecology and Environmental Biochemistry

b. Course Code: 11203181

c. Prerequisite: Basic knowledge of environment and ecological aspects and its impact on population.

d. Rationale: The objectives of the course is to introduce and sensitize all students to the issue of ecology, environment and sustainability. To incorporate sustainability and a sensitivity to ecology and environment and their impact.

e. Course Learning Objective:

CLOBJ 1	Infer complex relationships between natural and human system
CLOBJ 2	Knowing about ecosystem
CLOBJ 3	Illustrating the ecological knowledge and its consequences.

f. Course Learning Outcomes:

CLO 1	Understand the concept, types, development and functions of various ecosystems and their communication
CLO 2	Discuss various environmental factors governing these ecosystems are also clearly implicated.
CLO 3	Knowledge can help to form strategies for conservation and sustainable management under the given legislative measures.

g. Teaching & Examination Scheme:

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content:

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement. Ecosystem Structure and functions: Structures – Biotic and Abiotic components. Functions – Energy flow in ecosystems, energy flow models, food chains and food webs. Biogeochemical cycles, Ecological succession. Species diversjity, Concept of ecotone, edge effects, ecological habitats and niche. Ecosystem stability and factors affecting stability. Ecosystem services. Basis of Ecosystem classification. Types of Ecosystem: Desert (hot and cold), forest, rangeland, wetlands, lotic, lentic, estuarine (mangrove), Oceanic. Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain forest	**23%**	**13**
2	**UNIT 2** Population ecology: Characteristics of population, concept of carrying capacity, population growth and regulations. Population fluctuations, dispersion and metapopulation. Concept of 'r' and 'k' species. Keystone species. Community ecology: Definition, community concept, types and interaction– predation, herbivory, parasitism and allelopathy. Biological invasions. Biodiversity and its conservation: Definition, types, importance of biodiversity and threats to biodiversity. Concept and basis of identification of	**25%**	**15**

	'Hotspots'; hotspots in India. Measures of biodiversity. Strategies for biodiversity conservation: in situ, ex situ and in vitro conservation. National parks, Sanctuaries, Protected areas and Sacred groves in India. Concepts of gene pool, biopiracy and bio-prospecting. Concept of restoration ecology. Extinct, Rare, Endangered and Threatened flora and fauna of India.		
3	**UNIT 3** Environmental Chemistry Fundamentals of Environmental Chemistry: Classification of elements, Stoichiometry, Gibbs' energy, chemical potential, chemical kinetics, chemical equilibria, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radioisotopes. Composition of air. Particles, ions and radicals in the atmosphere. Chemical speciation. Chemical processes in the formation of inorganic and organic particulate matters, thermochemical and photochemical reactions in the atmosphere, Oxygen and Ozone chemistry. Photochemical smog. Hydrological cycle. Water as a universal solvent. Concept of DO, BOD and COD. Sedimentation, coagulation, flocculation, filtration, pH and Redox potential (Eh). Inorganic and organic components of soils. Biogeochemical cycles – nitrogen, carbon, phosphorus and sulphur. Toxic chemicals: Pesticides and their classification and effects. Biochemical aspects of heavy metals (Hg, Cd, Pb, Cr) and metalloids (As, Se). CO, O3, PAN, VOC and POP. Carcinogens in the air.	**27%**	**17**
4	**UNIT 4** Principles of analytical methods: Titrimetry, Gravimetry, Bomb Calorimetry, Chromatography (Paper Chromatography, TLC, GC and HPLC), Flame	**25%**	**15**

	photometry, Spectrophotometry (UV-VIS, AAS, ICP-AES, ICP-MS), Electrophoresis, XRF, XRD, NMR, FTIR, GC-MS, SEM, TEM.s		
	Total	**100%**	**60 Hr**

i. Text Book and Reference Book:

1. Environmental Engineering By Howard S. Peavy, Donald R. Rowe, George Tchobanoglous | McGraw-Hill
2. Environmental Biotechnology: Basic concepts and applications By Indu Shekar Thakur
3. Environmental Sciences By Daniel B Botkin & Edward A Keller | John Wiley & Sons
4. Environmental Studies By Benny Joseph | TMH publishers
5. A textbook of Environmnetal Science By Vidya Thakur
6. Environmental Biotechnology By S. K. Agarwal

Semester 3

a. **Course Name:** Genetics and Biostatistics

b. **Course Code:** 11203201

c. **Prerequisite:** Inclination to learn fundamentals of molecular biology, genetics and statistics.

d. **Rationale:** Genetics is essential for comprehending the fundamental principles of life, advancing medical science, improving agriculture, and addressing various societal challenges. It empowers individuals to make informed decisions about their health, contributes to scientific advancements, and has far-reaching implications in diverse fields.

e. **Course Learning Objective:**

CLOBJ 1	Understand the basic principles of genetics, including Mendelian inheritance, chromosome structure, and gene regulation.
CLOBJ 2	Describe the mechanisms of genetic variation, including mutation, recombination, and gene flow.
CLOBJ 3	Explain the principles of population genetics, including Hardy-Weinberg equilibrium, genetic drift, and natural selection.
CLOBJ 4	Discuss the inheritance patterns and molecular basis of human genetic disorders, including single-gene disorders, chromosomal disorders, and complex traits.

f. **Course Learning Outcomes:**

CLO 1	Determine methodology and techniques for evolutionary genetics study
CLO 2	Elobarate the Concepts of genetic engineering for new gene construct.
CLO 3	Discuss the construction of vector
CLO 4	Conduct the experiments basic statistical analysis of data

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** Mendelian Inheritance: Law of Dominance, Law of Segregation and Law of Independence assortment and deviations of Mendelian inheritance. Extra chromosomal inheritance, inheritance of Mitochondrial and Chloroplast. Sex-linked inheritance. Polygenic inheritance. Identification of Nucleic acids as genetic material. Genome Organization: in Viroids, Viruses, Prokaryotic and Eukaryotic chromosomes. Histones and non-Histones type DNA binding proteins. C-value paradox. Plasmids, Transposons	**22%**	**12**
2	**UNIT 2** Concepts of Cistrons, Recons and Mutons. Single copy genes, unique sequences, repetitive sequences and tandem genecluster-Histone genes, Immunoglobuline genes. Mutations Different types of mutations and nature of mutagens. Detection and isolation of mutants. Mechanism of mutation. Benger's fine structure of rII locus. Ames test. Site directed mutagenesis. Eugenics and Euphonics	**17%**	**10**
3	**UNIT 3** Cell growth and Cell division: Mitosis and Meiosis. Cells cycle parameters, specific events in the cell cycle, control of cell cycle, Internal and external mitotic inducers. Cell death – Apoptosis, Protooncogenes and Oncogenes. Gene transfer mechanisms: Transformation, Conjugation, and Transduction - Generalized, abortive and specialized transduction. Mechanism of general recombination, cross over, Site specific recombination	**22%**	**12**

4	**UNIT 4** Elements of gene mapping: Gene linkage. Mapping by recombination analysis. Multiple crossover and interference. The circular chromosome and mapping by conjugation. Tetrad analysis and complementation analysis. Mapping by transformation and transduction. Map units and cytological maps of eukaryotic chromosomes. Somatic cell genetics.	**17%**	**10**
5	**UNIT 5** Introduction to Biostatistics, Population and Sample Scope of Biostatistics, Population and Sample, types of data, Collection of data; Primary & Secondary data, Classification and Graphical representation of Statistical data. Concept of Population in Biostatistics, Sampling Methods, confidence level, critical region, testing of hypothesis and standard error, large sample test and small sample test. Descriptive Statistics and Presentation, classification, graphical presentation, Measures of Central Tendency, Measures of Dispersion. Regression and Correlation Introduction to Regression, Linear Regression, Concept and types of correlation, Computation of Correlation Coefficients	**22%**	**16**
	Total	**100%**	**60 Hr**

i. Text Books and Reference Books:

1. Principle of genetics-Gardner
2. Molecular Cell Biology-Lodish
3. Principles of Genetics=Edmund W Sinnott; Mcgeaw hill book company, Newyork 1950.; V Edition
4. Essentials of Genetics-Klugg and Cummings
5. Genetics-B.D .Singh
6. Cell and Molecular Biology-Gerald Karp

Semester 3

a. **Course Name:** Immunology

b. **Course Code:** 11203203

c. **Prerequisite:** Inclination to learn basic understanding of immunology concepts.

d. **Rationale:** Immunology is vital for healthcare professionals, researchers, and anyone interested in understanding the body's defense mechanisms. It has direct applications in medicine, disease prevention, and the development of innovative therapeutic approaches, making it a crucial field of study for those interested in biology, medicine, and public health.

e. **Course Learning Objective:**

CLOBJ 1	Understand the basic principles of immunology, including the structure and function of the immune system and its components.
CLOBJ 2	Describe the cellular and molecular mechanisms of innate immunity and adaptive immunity.
CLOBJ 3	Explain the processes of antigen recognition, antigen presentation, and lymphocyte activation and differentiation.
CLOBJ 4	Describe the mechanisms of antibody production, including B cell development, antibody structure, and antibody-mediated immune responses.

f. **Course Learning Outcomes:**

CLO 1	Compare innate and adaptive immunity
CLO 2	Build the model of Immunoglobulins
CLO 3	Elucidate the reasons for immunization significance of transplant procedures
CLO 4	Understand the role of the immune system in host defense against pathogens

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** Biological aspects of immunity: Innate and adaptive immunity, cell mediate and humoral immunity. Primary and secondary lymphoid organs. Specificity, self and non-self-recognition. Antigen-Antibody: Haptens and determinants epitopes and paratopes. Nature of Ag and Ab, heterogeneity, isolation and purification. Structure and enzymatic fragmentation of immunoglobulin. Classification of immunoglobulins, types and biological activities of immunoglobulins. Generation of antibody diversity. Theories of immune response.	**18%**	**11**
2	**UNIT 2** Immune Response: Primary and secondary immune response cells and accessory cell. Subsets of T&B Cells, T&B cell receptors, antigen processing and presentation. Cytokines and co-stimulatory molecules- Lymphokines, interleukins. Complement: Complement components, classical pathway Nature and alternative pathway. Biological consequences of complement adtivation.Hypersensitivity: Class fixation, hypersensitivity types, anaphylactic, antibody-dependent cytotoxic, immune complex mediated, cell mediated and stimulatory hypersensitive reactions.	**22%**	**13**
3	**UNIT 3** Major Histocompability Complex: Structure of MHC I and MCH II genes. MCH in mice and HLA in man-fine structure and functions Role of MCH in immune response. MCH in Transplantation. Immuno Deficiencies: Introduction, primary and secondary 18% 11 deficiencies, T - cell and B	**18%**	**11**

	cell combined immunodeficiencies, complement system deficiency, acquired Immuno-Deficiency syndrome.		
4	**UNIT 4** Autoimmunity and Immuno Suppression: Introduction, autorecognition, and classes of Auto Immuno Diseases. General mechanism of immuno-suppression, immune cells specific immuno tolerance. Cytokine therapy. Transplantation: Terminology, immunological basis of transplantation, organ transplantation, mechanism of rejection of transplants, prevention of graft rejection. Immunological Techniques: Precipitation and agglutination-lattice hypothesis, precipitin tests one- and two-dimensional, single radial immunodiffusion, immunoelectrophoresis, agglutination tests-Widal test, VDRL test complement fixation test, Radioimmunoassay and ELISA-principal methods and applications, FACS.	**22%**	**13**
5	**UNIT 5** Hybridoma technique and monoclonal antibody production, myeloma cell lines. Fusion methods, selection and screening methods for positive hybrids, cloning methods. Purification and characterization of monoclonal antibodies. Application of monoclonal antibodies in biochemical research, in clinical diagnosis and treatment. Production of Human monoclonal antibodies and their applications. Vaccines-Concept of immunization, routes of vaccination. Types of vaccines-Whole organism (Attenuated and inactivated) and Component vaccines (Synthetic Peptides, DNA vaccines, Recombinant Vaccines, Subunit Vaccines).	**20%**	**12**
	Total	**100%**	**60**

i. Text Books and Reference Books:

1. .Immunology-Kuby
2. Textbook of Microbiology & Immunology-S.C.Parija; Reed Elsevier

Semester 3

a. **Course Name:** Molecular Biology-I

b. **Course Code:** 11203204

c. **Prerequisite:** foundation in genetics is essential, as molecular biology often involves the study of genes, DNA, and the processes of replication, transcription, and translation.

d. **Rationale:** Molecular biology is essential for advancing our understanding of life processes, contributing to medical breakthroughs, and addressing challenges in diverse fields. It serves as the foundation for numerous scientific and technological advancements with applications ranging from medicine and agriculture to environmental science and biotechnology

e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental principles of molecular biology, including the structure and function of DNA, RNA, and proteins.
CLOBJ 2	Explain the central dogma of molecular biology, detailing the processes of DNA replication, transcription, and translation.
CLOBJ 3	Demonstrate proficiency in basic molecular biology laboratory techniques, such as DNA extraction, PCR (polymerase chain reaction), gel electrophoresis, and DNA cloning.
CLOBJ 4	Understand the mechanisms of genetic mutations, DNA repair, and the role of genetic variation in disease.

f. **Course Learning Outcomes:**

CLO 1	Relate the cell and molecular biology with its general concepts
CLO 2	Explain the storage of DNA
CLO 3	llustrate the structural organization of genes and the control of gene expression
CLO 4	Describe the protein structure and novel technologies for Protein technology

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester valuation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** **DNA Replication:** DNA Superhelicity, linking number, topological properties and mechanism of action of topoisomerases. Semiconservative replication, Experimental proof for semiconservative replication, replication forks, DNA polymerases of Prokaryotic and Eukaryotic. Continuous and discontinuous synthesis, Evidence for Okazaki model, RNA primers. Enzymes in replication-Single-stranded DNA binding proteins (SSBS), Helicases, DNA primases, DNA ligase.	**22%**	**13**
2	**UNIT 2** **Prokaryotic replication mechanism:** Replication of E.coli, rolling circle replication, Replication of ϕx174, Bacteriophage M13, Negative strand(VSV), positive strand (polio virus), retrovirus, DNA virus(SV-40, Adenovirus), Eukaryotic DNA replication, Autonomous replicating sequences (ARS).	**20%**	**12**
3	**UNIT 3** Mitochondrial DNA replication, Termination and fidelity of replication; Fusion of replicons and termination signals. Telomers. **Repair of DNA**: Direct reversal of damage, Excision repair, Recombination repair, SOS response. Identification of carcinogens. Inhibitors of DNA replication.	**18%**	**11**
4	**UNIT 4** **Transcription**: Polynucleotidephosphorylase, RNA polymerases, Structure of E.coli RNA polymerase, Interaction between RNA polymerase and template. Chain initiation, elongation and termination. Eukaryotic RNA	**20%**	**12**

	polymerases, Promoter and enhancer sequences. Inhibitors of transcription, Synthesis of different RNA molecules; synthesis of ribosomal RNA, 5S- r RNA and tRNA.		
5	**UNIT 5** **Maturation and processing of RNA:** Methylation, cutting and trimming of rRNA, capping polyadenylatin and splicing of mRNA, catalytic RNA, group I and group II intron splicing, spliceosmoses, trans-splicing, RNase P.	**20%**	**12**
	Total	**100%**	**60 Hr**

i. Text Books and Reference Books:

1. Molecular Biology-Robert Weaver
2. Lehninger Principles of Biochemistry,-David L. Nelson, Michael M. Cox,; Publisher: W. H. Freeman; Fourth Edition
3. Molecular Biology of Cell-Bruce Albert
4. TheCellular & Molecular Biology-EDP De Robertis & EMF De Robertis
5. Molecular Biology of the Gene-J.D. Watson and H.H. Nancy

Semester 3

a. **Course Name:** Lab 1-Microbiology

b. **Course Code:** 11203205

c. **Prerequisite:** Basic Knowledge about Microorganisms.

d. **Rationale:** Microbial practical play a vital role in developing essential laboratory and analytical skills, fostering a deeper understanding of microorganisms, and preparing individuals for diverse careers in microbiology and related fields.

e. **Course Learning Objective:**

CLOBJ 1	Learn to culture and isolate microorganisms from various sources, including environmental samples, clinical specimens, and food samples.
CLOBJ 2	Understand the principles of microbial staining techniques, including Gram staining, acid-fast staining, and endospore staining.
CLOBJ 3	Learn to use basic microbiological equipment and laboratory instruments, including microscopes, incubators, autoclaves, and spectrophotometers.
CLOBJ 4	Practice data analysis and interpretation skills by recording and analyzing experimental results, including colony morphology, growth curves, and biochemical test outcomes.

f. **Course Learning Outcomes:**

CLO 1	Learn how to standardize various biomolecules.
CLO 2	Track various techniques adopted for separation of biomolecules.
CLO 3	Study different isolation techniques based on properties of amino acids.
CLO 4	Study Various properties of biomolecules based on composition

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
-	**-**	**4**	**2**	**-**	**-**	**40**	**-**	**60**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	Preparation of liquid and solid media for growth of microorganism
2	Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slant and stab cultures.
3	Isolation of pure cultures from soil and water.
4	Determination of growth curve of bacteria (*E.coli*and *Pseudomonas*)
5	Bacterial population count by turbidimetry determination method.
6	Bacterial staining by Gram's, Acid fast and spores.
7	Effect of pH on bacterial growth.
8	Assay of antibiotics and demonstration of antibiotic resistance.
9	Bacterial transformation.
10	One step growth curve of coliphage.
11	Determination of biological oxygen demand (BOD) of water

i. Text Books and reference books

1. Practical Microbiology -k.R.Aneja
2. Experimental Microbiology-Dubey and Maheshawari

Semester 3

a. **Course Name:** Lab 2-Molecular Biology

b. **Course Code:** 11203206

c. **Prerequisite:** Basic Knowledge about Genetics.

d. **Rationale:** Molecular biology practicals are integral to developing essential laboratory skills, fostering a deeper understanding of molecular processes, and preparing individuals for careers in research, biotechnology, medicine, and related fields.

e. **Course Learning Objective:**

CLOBJ 1	Learn to culture and isolate microorganisms from various sources, including environmental samples, clinical specimens, and food samples.
CLOBJ 2	Understand the principles of microbial staining techniques, including Gram staining, acid-fast staining, and endospore staining.
CLOBJ 3	Learn to use basic microbiological equipment and laboratory instruments, including microscopes, incubators, autoclaves, and spectrophotometers.
CLOBJ 4	Practice data analysis and interpretation skills by recording and analyzing experimental results, including colony morphology, growth curves, and biochemical test outcomes.

f. **Course Learning Outcomes:**

CLO 1	Learn how to isolate and estimate genetic material (DNA/RNA) from different organisms.
CLO 2	Track digested DNA on gel electrophoresis.
CLO 3	Study different isolation techniques for plasmid DNA isolation. .
CLO 4	Study conjugation, transfection and transformation.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
-	**-**	**4**	**2**	**-**	**-**	**40**	**-**	**60**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Experiment List:

Exp. No.	Name of the Experiment
1	Isolation of DNA from Bacterial, Plant and animal cells.
2	Estimation of DNA by Diphenylamine and spectrophotometric method.
3	Isolation of RNA from yeast cells.
4	Estimation of RNA by orcinol and spectrophotometric method.
5	Estimation of DNA and purity determination by UV absorption method.
6	Determination of melting temperature (Tm).
7	Separation of Restriction digested DNA fragments on agarose gel electrophoresis.
8	A Detection and differentiation of open circular, Linear and closed covalent circular (ccc) plasmid DNA by submarine gel electrophoresis.
9	Isolation of Plasmid DNA from E.coli HB.
10	Transformation of E.coli HB 101/JM 10 3 with ampicillin resistant plasmid PJA.
11	Transfection of M13 DNA into E.coli JM 103.
12	Isolation of phage M13; Isolation of single and double stranded M13 DNA.
13	Conjugation: Use of broad host range plasmid RF in demonstrating conjugal transfer of plasmid in Bacteria
14	Catabolite repression: Evidence of B-Galactosidase induction in presence of Lactose in E.coli lac strains

i. Text Books and reference books

1. 1.Fundamentals of Genetics by B D Singh
2. Principles of genetics by Eldon John Gardner
3. Genetics by V Rastogi

Semester 3

a. **Course Name:** Genomics and Proteomics

b. **Course Code:** 11202230

c. **Prerequisite:** Basic understanding of molecular biology and biomolecules.

d. **Rationale:** Genomics and Proteomics is essential for comprehending the fundamental principles of life, advancing and improving medical science, and addressing various societal challenges. It empowers individuals to make informed decisions about their health, contributes to scientific advancements, and has far-reaching implications in diverse fields.

e. **Course Learning Objective:**

CLOBJ 1	Understand the fundamental principles of genomics and proteomics, including the structure and function of genes, genomes, proteins, and their interaction
CLOBJ 2	Analyze genomic sequences to identify genes, regulatory elements, and genetic variations, including single nucleotide polymorphisms (SNPs), insertions, deletions, and structural variant
CLOBJ 3	Interpret genomic and proteomic data to elucidate biological processes, pathways, and networks involved in health and disease

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of the principles and techniques of genomics and proteomics
CLO 2	Evaluate the significance of genomic and proteomic findings in the context of human health.
CLO 3	Integrate genomic and proteomic information with other omics data, such as transcriptomics, metabolomics, and epigenomics

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P-** Practical; **C**- Credit; **MSE-** Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1 Genomics** Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA Sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis physical and genetic mapping.	**25%**	**15**
2	**UNIT 2 Genome sequencing projects** Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs	**25%**	**15**
3	**UNIT 3 Proteomics** Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing; Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; Protein-protein interactions, Yeast two hybrid system	**25%**	**15**
4	**UNIT 4 Functional genomics and proteomics** Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics	**25%**	**15**

i. Text Book and Reference Book:

1. Genomes by T.A. Brown
2. Introduction to Genomics by Arthur M. Lesk
3. Genomics and Proteomics: Principles, Technologies, and Applications by Sandrine Hughes and Nicola Stanley-Wall
4. Genomics and Proteomics in Nutrition edited by Carolyn D. Berdanier, Judy L. Bolton, and Sivakanesan Dakshanamurthy
5. Proteomics: Methods and Protocols" edited by Richard J. Simpson
6. Principles of Proteomics" by Richard Twyman

Semester 3

a. **Course Name:** Endocrinology

b. **Course Code:** 11203234

c. **Prerequisite:** Basic understanding of physiology and biomolecules.

d. **Rationale:** Endocrinology is essential for comprehending the fundamental principles of life, advancing and improving medical science, and addressing various societal challenges. It empowers individuals to make informed decisions about their health, contributes to scientific advancements, and has far-reaching implications in diverse fields.

e. **Course Learning Objective:**

CLOBJ 1	Understand the basic principles of Endocrinology, including Mendelian inheritance, chromosome structure, and gene regulation.
CLOBJ 2	Describe the he structures and function of the major endocrine glands, including the hypothalamus, pituitary, thyroid, parathyroid, adrenal glands, pancreas.
CLOBJ 3	Explain the mechanisms of hormone action, including receptor binding, signal transduction, and gene expression regulation.

f. **Course Learning Outcomes:**

CLO 1	Demonstrate a comprehensive understanding of the physiological principles governing hormone synthesis, secretion, and regulation
CLO 2	Analyze the mechanisms of hormone action at the molecular, cellular, and organ system levels
CLO 3	Demonstrate proficiency in performing endocrine-related procedures,

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1 Introduction to endocrinology** General characters, Classification hormones. Hormone Action- Signal transduction, Receptors-Types, Structure, peptides, Steroids and aminoacid derivatives (Insulin, Thyroid, steroid and Adrenergic receptors) Concept of second messengers (cAMP, IP3 calcium, and NO). Role of Calcium: Control of cellular calcium levels, transport and regulation. Interaction between cAMP and calcium. Calcium dependent proteins. Protein phosphorylation and dephosphorylation. Assay of Hormones.	**20%**	**12**
2	**UNIT 2 Hypothalamus Gland** Pituitary Hormones, feedback regulation, hypothalamus, Pituitory gland axis. Hypothalamic Hormones-Synthesis, secretion, transport and biological actions of hypothalamic, adenohypophysial and neurohypophysial hormones. Hypothalamic and pituitary disorders. Penial hormones-melatonin and serotonin.	**20%**	**12**
3	**UNIT 3** **Thyroid Hormones:** Chemistry, function and metabolism, hypo and hyper thyroidism **Parathyroid Hormones** Parathormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of parathyroid functions. Role of vitamin D in calcium and phosphate metabolism	**20%**	**12**
4	**UNIT 4** **Pancreatic Hormones** Biosynthesis of insulin and glucagon. Regulation of insulin and glucagon secretions. Role in carbohydrate, lipid and	**20%**	**12**

	protein metabolism. Endocrine disorders of pancreas- Diabetes mellitus, melliturias, hypoglycemia, Glucose tolerance test. **Adrenal Medulla**- Chemistry, biosynthesis and function of adrenal medullary hormones. Disorders of Medullary hormones		
5	**UNIT 5** **Adrenal Cortex**- Chemistry, biosynthesis and function of adrenal cortical hormones. Disorders of cortical hormones. **Gonadal Hormones**- Chemistry, biosynthesis and functions of androgens, estrogens and progesterone. Hormonal regulation of menstrual cycle and Pregnancy. **Hormones of Gastrointestinal tract**- Secretin, Gastrin and cholecystikinin.	**20%**	**12**
	Total	**100%**	**60 Hr**

i. Text Books and Reference Books:

1. Endocrinology-By Leslie J DeGroot
2. Text book of Endocrinology-By Williams
3. Harper's Biochemistry-By Rober K. Murray, Daryl K. Grammer | McGraw Hill, Lange. Medical Books
4. Lehninger's Principles of Biochemistry-By Albert Lehninge

Semester 4

a. **Course Name:** Clinical Biochemistry

b. **Course Code:** 11203217

c. **Prerequisite:** A fundamental understanding of biochemistry is crucial since clinical biochemistry focuses on the biochemical basis of diseases and the analysis of biomolecules such as proteins, nucleic acids, and metabolites.

d. **Rationale:** Clinical biochemistry is a critical discipline that bridges basic biochemical principles with clinical applications. Its importance lies in its ability to provide valuable information for disease diagnosis, treatment monitoring, and preventive healthcare, ultimately contributing to improved patient outcomes and advancements in medical science.

e. **Course Learning Objective:**

CLOBJ 1	Discuss the metabolism of carbohydrates, lipids, and amino acids in health and disease states, including diabetes, obesity, and metabolic disorders
CLOBJ 2	Describe the role of biochemistry in the diagnosis and monitoring of diseases, including liver, heart and metabolic disorders.
CLOBJ 3	Apply critical thinking skills to analyze and solve clinical problems related to biochemistry
CLOBJ 4	Interpret laboratory tests used in clinical biochemistry, including measurements of blood glucose, lipid profiles, liver and renal function tests

f. **Course Learning Outcomes:**

CLO 1	Relate the cell and molecular biology with its general concepts
CLO 2	Explain the storage of DNA
CLO 3	Illustrate the structural organization of genes and the control of gene expression
CLO 4	Describe the protein structure and novel technologies for Protein technology

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	**Total**
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T**- Tutorial; **P**- Practical; **C**- Credit; **MSE**- Mid-Semester Evaluation, **CE**- Continuous Evaluation, **ESE**- End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** **Clinical Biochemistry:** Introduction and maintenance of clinical laboratory, hazards in clinical biochemistry laboratory, units, normal range, reference values. Factors affecting reference values, quality control in laboratory – use of external and internal standards. Automation in clinical laboratory. Collection and preservation of specimens. **Disorders of nitrogen metabolism:** Non-protein nitrogenous compounds in blood and urine, urea, creatine, creatinine, ammonia, aminoacids and their clinical significance. Aminoacidurias - overflow, renal, specific. Inbornerrors of aminoacid metabolismphenylketonuria, alkaptonuria, hartnup's disease, maple-syrup urine disease, hyperuricemiaprimaryand secondary gout, Lesh-Nyhan syndrome, orotic aciduria, xanthinuria.	**20%**	**12**
2	**UNIT 2** **Prophyrin, haemoglobin and related compounds**: Porphyrias: classification, clinical and biochemical features. Hepatic and erythropoietic porphyrias. Porphyrinuria. Tests used in investigation of porphyrias and Porphyrinuria. Occurrence of haemoglobin and related pigments in cells, plasma and urine. Identification of pigments by spectroscopy. Haemoglobinopathies, Thalassemia, sickle cell anaemia. **Disorders of gastrointestinal tract:** Test of gastric function- fractional test meal. Pentagastrin test, insulin stimulation test. Hyperchlorohydria, achlorohydria, achylia gastrica, chloride shift, alkalinetide. Pancreatic exocrine secretion –	**22%**	**14**

	composition. Duodenal contents– collection, examination following stimulation of pancreas; analysis; malaabsorption syndrome due to intestinal disease and pancreatic dysfunction; differential diagnosis. Disaccharidase deficiency.		
3	**UNIT 3** **Biochemical aspects of liver disease**: Liver function tests related to protein. Carbohydrate, lipid pigments metabolism, detoxification and excretion. Serum enzymes in liver disease. Jaundice classification and differential diagnosis. Kernicterus. **Renal function**: Tests for evaluation, concentration, dilution, excretion, clearance tests; Nephritis, nephrotic syndrome.	**18%**	**10**
4	**UNIT 4** **Clinical Enzymology:** Plasma enzyme in diagnosis and prognosis-aminotransferases, creatinekinase, LDH, amylase, phosphatases, choline esterase, glucose 6-phosphate dehydrogenase, gamaglutamyl transferase. Isozymes of LDH and alkaline phosphatase. Clinical application of plasma enzyme assays in myocardial infarction, liver disease, and muscle disease. **Lipid metabolism:** Plasma lipids and lipoproteins and their functions. Hyperlipoproteinemias classification-primary and secondary. Investigation of lipoproteinemias and lipedemias.	**20%**	**12**
5	**UNIT 5** **Disorders of carbohydrate metabolism:** Diabetes mellitus-classification, aetiology, clinicaland laboratory features, diagnosis of diabetes mellitus- glucose tolerance test, random, fasting and postpranodial glucose levels; glycosuria; Ketone bodies' glycosylated haemoglobin, plasma insulin, metabolic complications-diabetes	**20%**	**12**

	hyperglycemic coma and nonketotic coma;lactic acidosis; atherosclerosis; neuropathy-Hyperglycemia-fasting and provoked. **Diagnosis-** stimulation tests (Intravenus glucagon and leucine test) extended G.T.T.; hypoglycemia in children- neonatal and early infancy- Investigation of glycogen storage disease, galactosemia, hereditary fructosuria, lactose intolerance.		
	Total	**100%**	**60 Hr**

i. Text Books & Reference Books

1. Clinical Biochemistry: Metabolic and clinical aspects-William J. Marshall and Stephen K. Bengert
2. Clinical Biochemistry: An illustrated text Allan Gaw et. al.
3. Clinical Biochemistry -Nanda Maheshwari
4. Practical clinical Biochemistry -Ranjana Chawala
5. Clinical Biochemistry -R. Luxton

Semester 4

a. **Course Name:** Molecular Biology-II & Bioinformatics

b. **Course Code:** 11203280

c. **Prerequisite:** A fundamental understanding of Molecular Biology-II & Bioinformatics is crucial since tremendous amount of data has been generated to connect the dots, It's really needed to use bioinformatic tools.

d. **Rationale:** Molecular Biology techniques generate vast amounts of data, including DNA sequences, gene expression profiles, and protein structures. These data serve as the foundation for further analysis and interpretation. With the massive amounts of data generated by molecular biology techniques, bioinformatics provides essential methods for organizing, visualizing, and extracting meaningful information from these datasets.

e. **Course Learning Objective:**

CLOBJ 1	Gain a deep understanding of advanced concepts in molecular biology, including DNA replication, transcription, translation, gene regulation.
CLOBJ 2	Acquire skills in analyzing and interpreting genomic data, including genome sequencing, annotation, and comparative genomics.
CLOBJ 3	Learn to analyze and interpret biological data generated by molecular biology techniques using bioinformatics tools and software.

f. **Course Learning Outcomes:**

CLO 1	**Demonstrate Proficiency in Molecular Biology Techniques**
CLO 2	demonstrate the ability to use bioinformatics software and databases to analyze DNA and protein sequences, including sequence alignment.
CLO 3	Students will collaborate effectively in interdisciplinary research teams, integrating expertise from molecular biology, bioinformatics.

g. **Teaching & Examination Scheme:**

Teaching Scheme				**Evaluation Scheme**					
				Internal Evaluation			**ESE**		**Total**
L	**T**	**P**	**C**	**MSE**	**CE**	**P**	**Theory**	**P**	
4	**-**	**-**	**4**	**20**	**20**	**-**	**60**	**-**	**100**

L- Lectures; **T-** Tutorial; **P-** Practical; **C-** Credit; **MSE-** Mid-Semester Evaluation, **CE-** Continuous Evaluation, **ESE-** End Semester Examination

h. Course Content

Sr. No.	Content	Weightage	Teaching Hours
1	**UNIT 1** **Protein Synthesis:** General features of genetic code and its elucidation. Structural components of Prokaryotic and Eukaryotic ribosomes. in-vitro translation systems.t-RNA structure and role in protein biosynthesis. Mechanism of protein synthesis in Prokaryotic and Eukaryotic- Aminoacyl t-RNA synthetases Aminoacylation of tRNA initiation, elongation and termination. Wobble hypothesis. Mitochondrial genetic code. Nonsense suppression. Inhibitors of protein synthesis (Antibiotics and other inhibitors).	**20%**	**12**
2	**UNIT 2** Non ribosomal biosynthesis of polypeptides: Biosynthesis of Gramicidin-s. Post translational modifications. **Protein targetting:** Cell organelles and proteins involved in protein sorting. The signal hypothesis, signal sequences and signal recognition particle. Molecular chaperones. Protein degradation, Lysosomal degradation. PEST sequences. The Ubiquitin pathway. Protein stability and the N-end rule. Translational feedback-Synthesis of ribosomes and ribosomal RNA, Interferons.	**22%**	**14**
3	**UNIT 3** **Regulation of Gene Expression:** Regulation of gene expression at transcriptional level. The lac repressor. Fine structure of lac operon. cAMP and the catabolic activator protein. Gal operon and concept of dual promoters. Dual functions of the repressor the ara operon. Transcriptional control by attenuation. The trp operon	**18%**	**10**
4	**UNIT 4** **Eukaroytic Gene Regulation**: Positioning chromosomes for transcription. Polytene chromosomes. Gene amplification and gene rearrangements. Transcriptional control by alternative RNA processing and enhancers.	**20%**	**12**

	Bioinformatics: Introduction to bioinformatics, human genome project, Biological Database Principles, applications Primary database- Genebank, EMBL, PDB, SWISSPROT. Specialized Database SCOP/CATH. Database Querying using Key word and search engines.		
5	**UNIT 5** Homeotic genes. Gene amplification. DNA binding protein motifs- Helix-turn-helix, zinc finger and leucine zipper motifs. **Sequence Analysis-I:** Concepts of DNA/Protein sequence alignments and their importance. Sequence alignment method and programmes- BLAST and FASTA. Pair wise alignment versus multiple sequence alignment. **Sequence Analysis-II.** Phylogenetic analysis and tree construction, sequence analysis of nucleic acids. Computational analysis, determining transcriptional analysis, secondary structure prediction. Primer designing. Genome analysis.	**20%**	**12**
	Total	**100%**	**60**

i. Text Books and Reference Books:

1. Molecular Biology by Robert Weaver
2. Lehninger Principles of Biochemistry,-David L. Nelson, Michael M. Cox,; Publisher: W. H. Freeman; Fourth Edition
3. Molecular Biology of Cell-Bruce Albert
4. TheCellular & Molecular Biology-EDP De Robertis & EMF De Robertis
5. Molecular Biology of the Gene-J.D. Watson and H.H. Nancy