M.Sc Biochemistry

(Effective from the admitted batch of 2021-2022)

Scheme and Syllabus

DEPARTMENT OF BIOCHEMISTRY
COLLEGE OF SCIENCE AND TECHNOLOGY
ANDHRA UNIVERSITY, VISAKHAPATNAM

M.Sc. Biochemistry Semester System
Credit System
SCHEME OF INSTRUCTION AND EXAMINATION FOR 2021-2022

Paper No. Title of the Paper	Periods / Week	No. of Credits	Duration of Exam (hrs)	Max. Marks
I Semester:				
***Theory**				
BC 1.1 Chemistry of Biomolecules	4	4	3	100
BC 1.2 Biochemical Techniques	4	4	3	100
BC 1.3 Physiology and Bioenergetics	4	4	3	100
BC 1.4 Enzymology	4	4	3	100
***Practicals:**				
BC 1.5 Qualitative Analysis and Biochemical Techniques	6	3	6	100
BC 1.6 Enzymology- I and II	6	3	6	100
Total marks of I Semester				600
II Semester:				
***Theory**				
BC 2.1 Microbiology	4	4	3	100
BC 2.2 Cell Biology and Genetics	4	4	3	100
BC 2.3 Intermediary Metabolism	4	4	3	100
BC 2.4 Molecular Biology	4	4	3	100
***Practicals:**				
BC 2.5 Microbiology and Cell Biology, Genetics	6	3	6	100
BC 2.6 Quantitative Analysis and Molecular Biology	6	3	6	100
Total marks of II Semester				600
III Semester:				
***Theory**				
BC 3.1 Plant Biochemistry and Human Nutrition	4	4	3	100
BC 3.2 Immunology	4	4	3	100
BC 3.3 Regulation of Gene Expression and Genetic Engineering	4	4	3	100
BC 3.4 Industrial Biotechnology	4	4	3	100
***Practicals:**				
BC 3.5 Immunology and Food Analysis	6	3	6	100
BC 3.6 Industrial Biotechnology and Genetic Engineering	6	3	6	100
MOOC's Course 1 (Optional for students)	-	2	30 Hours	50
IPR	-		Exam	--
Total marks of III Semester				650
IV Semester:				
***Theory**				
BC 4.1 Clinical Biochemistry and Endocrinology	4	4	3	100
BC 4.2 Genomics and Proteomics	4	4	3	100
BC 4.3 Biostatistics and Bioinformatics	4	4	3	100
BC 4.4 Applied Biochemistry	4	4	3	100
***Practicals:**				
BC 4.5 Clinical Biochemistry	6	3	6	100
BC 4.6 Biostatistics and Bioinformatics	6	3	6	100
BC 4.7 Viva – Voce	-	1	-	25
BC 4.8 Project Work	-	4	-	100
MOOC's Course 2 (Optional for students)	-	2	30 Hours	50
Research Methodology	-		Exam	--
Total marks of IV Semester				775
Grand Total marks for 4 Semesters				**2625**

*Theory marks include 20 marks for internal assessment and 80 marks for semester-end examinations; practical marks include 20 marks for continuous assessment and 80 marks for semester-end examinations.

Curriculum & Syllabus

Under Choice Based Credit System (CBCS)
[Effective from 2021-2022 Admitted Batches]

M.Sc. Biochemistry

Department of Biochemistry
College of Science and Technology
Andhra University
Visakhapatnam.

DEPARTMENT OF BIOCHEMISTRY

M. Sc. Biochemistry

(2 Year Programme)

Under Choice Based Credit System (CBCS)

2021-22

Program Outcomes

PO1: To ensure students acquire the necessary knowledge and experience in conducting advanced scientific research in the field of Biochemistry.

PO2: To inculcate scientific approaches of inquiry in students such that they develop critical thinking and equip themselves with contemporary research methods.

PO3: To train students on effective domain-specific verbal and written communications of scientific knowledge.

PO4: To encourage responsible scientific contributions that abide by academic integrity, adhere to intellectual ethics, and promote sustainable development.

PO5: To impart a strong sense of continuous self-learning and collaborative teamwork.

Program Educational Outcomes

PEO1: To provide quality post–graduation education in Biochemistry and to prepare students for entering teaching in degree, PG colleges and Universities, PhD/research programs within India (either in CSIR laboratories or in R&D wings of various industries/university laboratories) or abroad

PEO2: To pursue jobs in Pharmaceutical, Biopharmaceutical, and Biotechnological industries among other related fields

PEO3: To equip students with the knowledge and ability to solve biological problems of social relevance and to know the importance of biochemistry in the domains of nutrition and medicine

PEO4: To apply their biochemistry skillset in clinical diagnoses, treatment

of diseases, manufacturing of biological products, strategic agricultureand hygiene protocolin ways that would be conducive to long-term sustainable development

Program Specific Outcomes

PSO1: Students will be equipped to understand three fundamental aspects

in biological phenomenon: a) what to seek; b) how to seek; c) why

to seek?

PSO2: Students will be able to (a) To elaborate concepts of biochemistry

with easy to run experiments; (b) To familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry

PSO3: Students will be able to (a) Describe fundamental molecular

principles of genetics; (b) Understand relationship between phenotype and genotype in human genetic traits; (c) Describe the basics of genetic mapping; (d) Understand how gene expression is regulated

PSO4: Students will be able to understand various facets of molecular

procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases

PSO5: Students will be able to gain hands on experience in gene cloning,

protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

Program Learning Outcomes

PLO1: To understand clarity of concepts on structure, building, and

function of biomolecules, different means of generation of energy, processing of information and its complexity in the cell as well as organisms

PLO2: The study of body function in physiology has broadened their

understanding of how biochemical changes relate to physiological alteration in the body and to understand the chemical aspects of biological processes such as digestion, hormonal action, and muscle contraction–relaxation

PLO3: To develop analytical skills to understand experimental basis of

generating information in biology, to be able to read and interpret the methodologies and hypotheses tested in generating data. To analyze data statistically and to quantify observations/results

PLO4: To critically examine data that lead to hypotheses, to be able to

extrapolate observations to conclusions. To be able to apply learned concepts in correct situations

PLO5: To be skillful in the laboratory techniques learnt. To be able to

apply them in the context of getting employment in academic research laboratories, biotechnology, and pharmaceutical industries, diagnostic centers etc. To be skilled in data analysis and interpretation

M.Sc. BIOCHEMISTRY
I SEMESTER
BC 1.1: CHEMISTRY OF BIOMOLECULES

Course Outcomes:

CO1: To offer detailed knowledge of biomolecules for living systems
CO2: To provide basic concepts of structural organization and characterization of proteins
CO3: To learn about Oligosaccharides and lectin interactions in biochemical processes
CO4: To acquire knowledge on physicochemical properties and characterization of fats and oils
CO5: To understand the structure of DNA and RNA and their types

Course Specific Outcomes:

CSO1: To provide the concept of Oligosaccharides and lectin interactions in biochemical process
CSO2: To study salient features of Bacterial and Plant lipids
CSO3: To gain knowledge on nucleotides as energy carriers and other important functions

Course Learning Outcomes:

LO1: Students will acquire an insight into various biomolecules which constitute the living organisms
LO2: Students will learn the structure and properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins, glycolipids and their importance in biological systems
LO3: Students will develop perception on the sequencing of proteins and nucleic acids
LO4: Students will gain knowledge on the Structure and properties of Porphyrins

Unit – 1

Carbohydrates: Classification, Physicochemical properties; Chemistry, Biological roles and Structural elucidation of polysaccharides - homo and heteropolysaccharides, Peptidoglycans, Glycosaminoglycans; Glycoconjugates – Proteoglycans, Glycoproteins and Glycolipids; Oligosaccharides - Lectin interactions in biochemical processes

Unit – 2

Amino acids: Classification, Structure and Physicochemical properties; Peptide bond, Peptides of biological importance; Chemical synthesis of peptides – Solid phase peptide synthesis; Proteins – Classification, Isolation, Purification and Characterization of proteins, Criteria of homogeneity; Protein sequencing; Structural organization of Proteins – Ramachandran plots; Denaturation of proteins

Unit – 3

Lipids: Classification; Structure, Properties and Biological roles of Phospholipids and Sphingolipids; Fatty acids and their physicochemical properties; Fats and Waxes - Physicochemical properties and characterization of fats and oils; Structure, Properties and functions of Eicosanoids - Prostaglandins, Prostacyclins, Thromboxanes, Leukotrienes; Chemistry and Properties of Sterols and Steroids – Bile acids and Bile salts; Salient features of Bacterial and Plant lipids

Unit – 4

Nucleic acids: Bases, Nucleosides, Nucleotides; Nucleotides as Energy carriers, Enzyme co-factors and Chemical messengers; Synthetic nucleotide analogs; Chemical synthesis of oligonucleotides; Structure of DNA and different types of DNA, Supercoiled DNA; Structure of RNA and different types of RNA

Unit – 5

Physicochemical properties of Nucleic acids: Denaturation and Renaturation kinetics of nucleic acids - Melting temperature, Cot curves; Sequencing of Nucleic acids – Enzymatic and Chemical methods; Porphyrins – Structure and properties of Porphyrins –Heme, Chlorophylls, Bacteriochlorophylls and Cytochromes

Reference books:

1. Text book of Biochemistry –E.S.West, W.R.Todd et al., 4th ed
2. Principles of Biochemistry by Lehninger –D.L.Nelson, M.M.Cox7th ed
3. Text book of Biochemistry with clinical correlations-Thomas M.Devlin, 7th ed
4. Harper's review of Biochemistry –D.W. Martin, 19th ed
5. Biochemistry – J.M.Berg, J.L.Tymockzo, L.Stryer, 5th ed
6. Biochemistry-Reginald H. Garret, Charles M.Grisham 6th ed
7. Biochemistry-R.W.McGilvery
8. Biochemistry –J.David Rawn

M. Sc. BIOCHEMISTRY

I SEMESTER

BC1.2: BIOCHEMICAL TECHNIQUES

Course Outcomes:

CO1**:** Enable the students to acquaint with basic principle, instrumentation, procedure, and applications of various classical as well as sophisticated Biochemical techniques

CO2: Develop competence in various chromatographic techniques and apply them in isolating and characterizing different biological molecules

CO3: Develop Understanding the principles of Electrophoresis and its applications in biological investigations/experiments and expose the students with various microscopic techniques to study subcellular organelles

CO4: Provide information on fundamental laws relating to photochemistry and Applications of UV-visible, Fluorescence and IR spectrophotometry in analytical determination and characterization of biomolecules

CO5: Apply the principles of radiochemistry to analytical determination of biomolecules and life processes

Course Specific Outcomes:

CSO1: Students will be exposed to various chromatographic techniques and their applications in isolation of different biological molecules

CSO2: In addition to understanding the applications of centrifugation and chromatography in biological investigations, they will gain insight into purification of proteins by affinity chromatography using epitope tags

CSO3: In addition, Advanced instrumental techniques learned by students may be used for the determination of nutrients, major ions and trace elements, biological samples

CSO4: The gained knowledge in Photochemistry enables the students to undertake further studies in biochemistry and related areas or in multidisciplinary areas that involve biochemistry

CSO5: To develop a range of generic skills that are relevant to wage employment, self- employment, and entrepreneurship

Learning Outcomes:

After completion of the course, a student will be able to achieve these outcomes.

LO1: The students will the exposed to different chromatographic techniques like gel filtration, Ion-exchange, thin layer, etc. Students will also learn about various Electrophoretic techniques such as Polyacrylamide Gel Electrophoresis, A garose Gel electrophoresis etc., and their applications in analysing proteins and nucleic acids

LO2: The students will learn about Homogenization and Centrifugation techniques

LO3: The students will also learn the principles of electron microscopy more especially of SEM and TEM and their applications in characterizing biological samples

LO4: The students will be able to implement the use of instruments like and UV-VIS

spectroscopy, NMR, CD, ORD in biological research

LO5: The students will get the theoretical knowledge of various instruments and their practical applications like Geiger-Muller counter, Liquid scintillation counter, Radioactive Isotopes, and safety. X-ray crystallography

Unit–1

Chromatography separation Techniques: Principles, methods, types, and applications of chromatography Techniques – Paper chromatography, Thin layer chromatography, High performance thin layer chromatography, Ion-exchange chromatography, Gel-filtration chromatography and Affinity chromatography: Gas Chromatography, High performance Liquid Chromatography and Chromatofocussing

Unit- 2

Techniques of Electrophoresis: Principles,methods, types anda pplications of electrophoresis: Moving boundary electrophoresis, Zone electrophoresis,P aper and High voltage electrophoresis Polyacrylamide Gel Electrophoresis, A garose Gel electrophoresis, Pulsed Field Gel electrophoresis, Isoelectric focusing of proteins, T wo-dimensional electrophoresis of proteins, Capillary electrophoresis

Unit– 3

Tissue homogenization Techniques – Disruption of tissues & Cells: Centrifugation Techniques – Basic Principles, instrumentati on, types, and applications. Differential and density gradient centrifugation, Preparative and analytical ultra-centrifuge:
Principles and applications of Manometer and Oxygen electrode
M icroscopy: Principle, types and applications of microscopes; Phase Contrast, Fluorescent and Electron Microscope

Unit– 4

Spectrophotometry: basic laws of light absorption, instrumentation, and applications of UV –Visible spectrophotometer and IR spectrophotometer
NMR and ESR spectroscopy, Atomic absorption and Mass spectroscopy,
Fluorimetry, Flamephotometry and Nephelometry: Optical Rotatory Dispersion (ORD), Circular Dichroism (CD) and X-ray Diffraction

Unit–5

Radioactive isotopes: Nature of radioactivity, Biochemical uses of Radioactive isotopes: Detection and measurements of radioactivity- Liquid scintillating counting, Geiger-Muller counting; Radioactive isotopesand safety- Radiation hazardsandmethodsof radioactivematerial disposal

Reference Books:

1. Principles and Techniques of Biochemistry and Molecular Biology- K. Wilson, John Walker, 6th ed
2. Biophysical chemistry – Upadhyay, Upadhyay, Nath (Himalaya publications)
3. Physical Biochemistry – D. Friefelder, 2nd ed
4. Physical Biochemistry – K.E. VanHolde, W.Curtis Johnson et al.,
5. Techniques in Molecular biology- J.M. Walker, Wim Gaastra, vol II
6. An introduction to spectroscopy for Biochemists – S.B. Brown
7. Analytical Biochemistry- David J.Holme, Hazel Peck, 3rd ed
8. Lehninger Principles of Biochemistry-David L. Nelson, Michael M. Cox, 7th ed
9. Text book of Biochemistry – E.S.West, W.R.Todd et al., 4th ed
10. Asokan P, Analytical biochemistry, 2009, Chinna publication

M.Sc. BIOCHEMISTRY
I SEMESTER
BC 1.3: PHYSIOLOGY AND BIOENERGETICS

Course Outcomes:

CO1: To understand the role of various physiological processes in the body
CO2: To know the general mechanism of muscle contraction and nerve impulse transmission
CO3: To understand the energy transformations in the living system
CO4: To know the mechanism of ATP synthesis
CO5: To know the importance of various components involved in photophosphorylation

Course Specific Outcomes:

CSO1: The course highlights the importance of blood clotting and factors involved
CSO2: The course highlights the role of lungs in exchange of gases and kidneys in acid base balance
CSO3: Major emphasis was on the mechanism of muscle contraction and nerve impulse transmission
CSO4: Particular emphasis on understanding the organization of mitochondrial electron transport system and mechanism of ATP synthesis
CSO5: The course covers the role and importance of photophosphorylation in plants

Learning Outcomes:

LO1: Students will understand various physiological and biochemical processes taking place in the living system
LO2: Students will acquire a good knowledge in biochemistry of muscle contraction, nerve impulse transmission and biochemistry of vision
LO3: Students will be aware of free energy transformations, oxidation and reduction reactions that take place in the cells
LO4: Students will understand the transport of electrons in mitochondria through a series of electron carriers and how ATP synthesis takes place
LO5: Students will acquire knowledge about absorption of light by chlorophylls and other accessory pigments and mechanism of photophosphorylation

Unit –1

Digestion and Absorption of Carbohydrates, Lipids and Proteins
Blood: Composition, properties, and functions - Erythrocytes, Leucocytes, Thrombocytes; Mechanism and Regulation of Coagulation of Blood and Fibrinolysis
Respiration - Mechanism of respiration, Hemoglobin, and transport of gases
Physiology of Heart; Kidney - Structure of kidney and nephron, Regulation of electrolyte, water and acid base balance

Unit –2

Muscle Cell: Structure and organization, Types of muscles, Mechanisms of contraction and relaxation of muscle, Biochemical changes associated with muscle contraction and relaxation
Nerve Cell: Structure and organization, Membrane potential, Mechanism of propagation of nerve impulse in unmyelinated and myelinated nerve fibers; Synapse – Types of synapses, Neurotransmitters, Transmission at adrenergic and cholinergic nerve endings; Blood brain barrier; Biochemistry of vision - Rods and Cones, Sensory transduction in vision

Unit – 3

Bioenergetics and Thermodynamics: Principles of thermodynamics - Free energy, Enthalpy and Entropy, Free energy changes in biological transformations in living systems, Equilibrium constant, Coupled reactions; High-energy compounds - Phosphoryl group Transfers and ATP, Thioesters
Biological oxidation and reduction reactions: Electrochemical cell, Nernst Equation, Redox potential; Oxidation and reduction enzymes, Superoxide dismutase, Catalase

Unit – 4

Mitochondrial electron transport system: Organization of components and importance, Q cycle, Thermodynamics of electron transport, Respiratory chain inhibitors, Microsomal electron transport system
Oxidative phosphorylation - Mechanism and theories of Oxidative Phosphorylation, Structure of ATP synthase, Regulation of oxidative phosphorylation – Acceptor control; Uncouplers and Inhibitors of oxidative phosphorylation; Mitochondrial shuttle systems; Substrate level phosphorylation; Bioluminescence

Unit – 5

Photophosphorylation: Light harvesting complexes – Chlorophylls, accessory pigments; Reaction centers -PSI and PS -II -their location; Mechanism of quantum capture and energy transfer between photo systems, Structure of ATP synthase of chloroplasts, Proton gradient and ATP synthesis, Inhibitors of PS-I & PS-II

Reference books:

1. Textbook of Medical Physiology – A. G. Guyton and J. E. Hall, 10th ed
2. Ganong's Review of Medical Physiology - Kim E. Barrett, Susan M. Barman, 29th ed
3. Human Physiology - Stuart Fox, 15th ed
4. Text Book of Human Physiology – S.Subrahmanyam, K.Madhavankutty
5. Human Physiology – C.C. Chatterjee's, 13th ed
6. Human Physiology - Bryan H. Derrickson, 2nd ed
7. Biochemistry - Reginald H. Garret, Charles M.Grisham, 6th ed
8. Principles of Biochemistry - Lehninger 7th ed
9. Principles of Bioenergetics - Skulachev Vladimir P, Alexander V. Bogachev et al.,
10. Bioenergetics: The Molecular Basis of Biological Energy Transformations – Albert L. Lehninger, 2nd ed

M.Sc. BIOCHEMISTRY
I SEMESTER
BC 1.4: ENZYMOLOGY

Course Outcomes:

CO1: To understand the enzymes, one of the most important types of proteins in the living organisms, enzyme names and commission numbers relate to reactions they catalyze, specific properties
CO2: To acquire knowledge of biochemical principles with specific emphasis on different metabolic pathways and regulators
CO3: To gain knowledge on models of enzyme active site, formation of enzyme-substrate complex, enzyme mapping, factors influencing enzyme activity
CO4: To know about kinetics of enzymatic reactions and different types of enzyme inhibitions explain how enzymes work and behave in living organisms
CO5: To learn the general principles of mechanism of enzyme catalysis including the role of coenzymes
CO6: To study the enzyme regulation including allosteric enzymes – characteristics, models, examples and Multi - enzyme systems
CO7: To understand the molecular basis of various pathological conditions from the perspective of biochemical reactions

Course Specific Outcomes:

CSO1: To understand structure, and functions of enzymes. Learning kinetics of enzyme catalysed reactions and regulatory process, Enzyme activity, Enzyme Units, Specific activity
CSO2: Have a deeper insight in to the fundamentals of enzyme structure, function and kinetics of enzymes. Discussion on current applications and future potential of enzymes.
CSO3: Have a complete understanding of rate of reactions and order of reactions. To gain knowledge on enzyme catalysis and isoenzymes and on multienzyme complexes
CSO4: To learn the models of enzyme action and mapping of enzyme active site
CSO5: To acquire knowledge on latest concepts of evolution of catalysis
CSO6: To provide concept of importance of kinetics of enzyme inhibitions and how they influence drug action
CSO7: To learn the role of enzyme inhibitors in drug discovery and drug design
CSO8: To gain insight into catalytic mechanisms of enzymes and allosteric regulation of enzymes

Learning Outcomes:

LO1: The students will be able to assign systemic name to enzymes and from the E.C. number they can explain the reaction it catalyzes
LO2: They will acquire knowledge to analyze the kinetics of different

enzymatic reactions.

LO3: The students will be able to learn how to analyze mechanistic data and they will be able to design experiments to investigate the enzyme inhibition

LO4: They will be able to perform enzyme purification, handling and to characterize new enzymes

LO5: The students will be able to understand the regulation of enzyme activity is so important to coordinate the different metabolic processes and for homeostasis

Unit – 1

Introduction to Enzymes – Nomenclature and Classification of enzymes (IUB), Remarkable properties of enzymes – catalytic power, specificity. Enzyme localization and assay of enzymes, Units of enzyme activity. Active site – Fisher and Koshland models, formation of enzyme – substrate complex and experimental evidences. Nature of active site, mapping of enzyme active site through chemical procedures and site directed mutagenesis. Factors affecting enzyme activity. Modern concepts of evolution of catalysis, ribozymes, abzyme and synzymes

Unit – 2

Enzyme kinetics-Velocity of a reaction, order of a reaction, progress curve for enzyme catalyzed reactions.Kinetics of single substrate enzyme catalyzed reactions, Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots. Significance of Vmax, Km, Kcat, specificity constant (Kcat/Km)

Kinetics of multisubstate reaction – Classification with examples. Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms.Use of initial velocity, Inhibition and exchange studies to differentiate between multi substrate reaction mechanisms. Flexibility and conformational mobility of enzymes. Reversible inhibition – competitive, non-competitive, uncompetitive and mixedinhibition; Irreversible inhibition -suicide inhibition, Determination of Ki values

Unit – 3

Strategies of enzyme catalysis – General acid – base, electrostatic, covalent, intermolecular, metal – ion catalysis; Proximity and orientation.Mechanism of reaction catalyzed by serine proteases – trypsin and chymotrypsin; carboxypeptidase, Subtilisin, lysozyme, triose phosphate isomerise, ribonuclease. Rotational catalysis – ATPase

Unit – 4

Roleof coenzymes in enzyme catalyzed reactions– Coenzymes and Cofactors. Pyridoxal phosphate, Nicotinamide nucleotides, Flavin nucleotides, Thiamine pyrophosphate, Biotin, Tetrahydrofolate, Pantothenic acid, Cobalamine, Lipoic acid; Metalloenzymes,Isoenzymes-LDH, Creatine phosphokinase. Multifunctional enzymes, properties, Mechanism of action of Pyruvate dehydrogenase and Fatty acid synthase complex

Unit-5

Regulation of enzyme activity – covalent modification, zymogen activity and protein proteininteraction.Allosteric enzymes (ATCase).Cooperativity phenomenon. Hill and Scatchard plots. Sigmoidal kinetics and their physiological significance, Symmetric and sequential models of action of allosteric enzymes and their significance. Feedback inhibition and feed forward stimulation.Control of enzymatic activity by products and substrates.Reversible and irreversible activation. Regulation of Multi-enzyme systems, Pyruvate dehydrogenase and Fatty acid synthase complex

Reference books:

1. Biochemistry - Reginald H. Garret/Charles M.Grisham 6th ed
2. Principles of Biochemistry - Lehninger 7th ed
3. Understanding enzymes: Palmer T., Ellis Harwood ltd.,2nd ed
4. Enzyme structure and mechanism. Alan Fersht, Freeman & Co 2nd ed
5. Enzyme kinetics Siegel interscience – Wiley
6. LehningerPrinciples of Biochemistry - David L. Nelson, Michael M.CoxPublisher: W.H. Freeman 8th ed
7. Enzyme kinetics-Kent M. Plowman
8. Biological chemistry; H.R. Mehler& E.H Cordes Harper &Rev.
9. Lecture notes on Enzymology-L.G.Whitby, et al.,
10. The Enzyme Molecule-W.Ferdinand
11. Enzymes:Physical Principles-H.Gutfreund
12. Fundamentals of Enzymology, The cell and molecular basis of catalytic proteins - Nicholas C price , Lewis Stevens, 3rd ed
13. Enzyme Kinetics: A Modern Approach - Alejandro G. Marangoni, Wiley online library

M.Sc. BIOCHEMISTRY
I SEMESTER
PRACTICAL – I
BC 1.5: QUALITATIVE ANALYSIS AND BIOCHEMICAL TECHNIQUES

Course Outcomes:

CO1: To acquire hands on experience to perform general and confirmatory qualitative tests For identification of Carbohydrates (Monosaccharides, Disaccharides, Polysaccharides), Proteins and amino acids, Lipids, Nitrogen bases – Purines, Pyrimidines/Nucleic acids

CO2: To get hands on experience on various biochemical techniques such as Paper chromatography, Thin layer chromatography, Ion-exchange chromatography, Affinity chromatography, Gel filtration, Paper electrophoresis, SDS-PAGE, 2D Electrophoresis, Differential and Density gradient centrifugation, and handling Colorimeter, Spectrophotometer, and Polarimeter

Course Specific Outcomes:

CSO1: Students exposure to basic reactions of biomolecules

CSO2: To gain knowledge to determine presence of biomolecules like carbohydrates, proteins, lipids etc. in known and unknown samples

CSO3: The students should be able to determine the extent of adulteration in samples containing Biomolecules

CSO4: The students should obtain hands-on training in basic separation techniques in biochemistry like chromatography, electrophoresis, etc.

CSO5: They gain expertise in the isolation of various biomolecules and organelles

CSO6: To develop competence in applying various chromatographic techniques in isolating and characterizing different biological molecules

CSO7: Understanding the principles and applications of chromatography, centrifugation, electrophoresis, spectrophotometry and ELISA tools in biological investigations/experiments

Learning Outcomes:

LO1: The students will be able to learn to identify carbohydrates, proteins, amino acids, lipids, nitrogen bases - purines, pyrimidines/Nucleic acids from a given unknown sample

LO2: The students will get the expertise for analysis of any biological or non biological sample for identification of its chemical composition

LO3: The students will develop skills to perform various Biochemical Techniques such as Paper chromatography, Thin layer chromatography, Ion-exchange chromatography, Affinity chromatography, Gel filtration, Paper electrophoresis, SDS-PAGE, 2D Electrophoresis, Differential and Density gradient centrifugation, and their applications for separation of different biomolecules and isolation of cells and tissues for studying their functional abnormalities

LO4: The students will be able to learn techniques for isolation, purification and chemical characterization of compounds from plants and microbes which will have medical or commercial importance

LO5: The students will be able to measure and detect the biomolecules and molecules involved in a reaction using the colorimeter

LO6: The students will be able to learn application of UV-visible spectroscopy

LO7: The students will learn different methods of protein estimation

LO8: The students will be able to learn the principles of Peptide mapping and Isoelectric focusing

LO9: The expertise gained by the student from this practical experiments can be useful in Pharmaceutical and Biotech industries

QUALITATIVE ANALYSIS (A)

General reactions of Carbohydrates
Reactions of Polysacharides
General colour reactions of proteins
Identification of unknown sugars
Identification of unknown amino acids
General reactions of lipids
Reactions of cholesterol
Identification of unknown lipids
General reactions of nitrogen bases
Reactions of nucleic acids
Identification of unknown nitrogen bases/ nucleic acids

BIOCHEMICAL TECHNIQUES (B)

Separation of amino acids by ascending paper chromatography
Separation of amino acids by descending paper chromatography
Separation of sugars by ascending paper chromatography
Separation of nucleic acids by ascending paper chromatography
Separation of amino acids by thin layer chromatography
Separation of lipids by thin layer chromatography
Separation of plant pigments by column chromatography
Separation of amino acids by ion exchange chromatography
Affinity Chromatography
Separation of amino acids by paper electrophoresis
Separation of serum proteins by Polyacraylamide Gel Electrophoresis
Molecular weight of protein by SDS-PAGE
Absorption spectrum of chlorophyll extracted from green leaves
Absorption spectrum of aromatic amino acids, purines, pyramidines and heme
Estimation of proteins by Spectrophotometric method
Determination of Molar absorption coefficient of tyrosine
Sub – cellular fraction of organelles of liver cells and identification by the marker enzymes.
Optical rotation of glucose and fructose using polarimeter.

N and C terminal analysis of proteins. (End group analysis of proteins)
Peptide mapping
Density gradiant centrifugation – Isolation of rat liver mitochondria
2- Dimensional electrophoresis of proteins
Isoelectric focussing

Reference books:

1. Experimental Biochemistry-B.Sashidhar Rao, Vijay Deshpande
2. Principles and Techniques of Practical Biochemistry-Wilson and Walker
3. An introduction to Practical Biochemistry-David T.Plummer, 3rd ed
4. Laboratory Manual in Biochemistry-J.Jayaraman
5. Principles and Techniques of practical Biochemistry. Eds. Williams and Wilson.
6. A Biologists guide to Principles and Techniques of practical Biochemistry
   – Ed.Bryan, L.Willians& Keith Wilson (Edward Arnold).

M.Sc. BIOCHEMISTRY
I SEMESTER
PRACTICAL – II
BC 1.6: ENZYMOLOGY I AND ENZYMOLOGY - II

Course Outcomes:

CO1: To become familiar with the basic methods of studying enzymes
CO2: To understand the mechanism of action of enzymes
CO3: To get familiar with the kinetics of enzyme reactions
CO4: To apply appropriate methods for determination of catalytic parameters
CO5: To adopt the systematic procedure to purify enzymes

Course Specific Outcomes:

CSO1: The course gives in depth knowledge in understanding the mechanism of enzyme action
CSO2: The effect of parameters like P^H, temperature on enzyme activity were thoroughly understand by students
CSO3: To understand the effect of inhibitors on the mechanism of enzyme action

Learning Outcomes:

LO1: Students will acquire practical knowledge on isolation of enzymes from different sources, handling and preservation of enzymes without losing their activity
LO2: Students will learn how to calculate enzyme activity and how the velocity of the reaction changes in presence of inhibitors
LO3: Students will learn different techniques for purification of enzymes which enable them to use these techniques in future research and also to find appropriate jobs in scientific-research laboratories
LO4: Students will gain knowledge about applying enzymes and their inhibitors in medicine and various industries

ENZYMOLOGY - I (A)

Assay of Amylase from saliva
Assay of Acid phosphatase from potato
Assay of Trypsin
Assay of urease from Horse – gram
Assay of Succinate dehydrogenase from the liver
Enzyme purification by 3 or 4 steps

a) Acetone precipitation
b) Ammonium sulphate fractionation
c) Ion – exchange chromatography
d) Gel filtration
e) Electrophoresis

Isoenzymes of LDH – electrophoretic separation and specific staining technique

ENZYMOLOGY - II (B)

Time course of enzyme activity
Effect of pH on enzyme activity and determination of optimum pH
Effect of temperature on enzyme activity and calculation of energy of activation Effect of substrate concentration on enzyme activity and determination of Michealis constant
Effect of metal ions on enzyme – Alcohol dehydrogenase
Effect of substrate and regulators on allosteric enzyme – Phosphorylase or ATCase
Enzyme inhibition – irreversible inhibition of Papain or Serine proteases by appropriate inhibitors

Reference books:

1. An introduction to Practical Biochemistry-David T.Plummer, 3rd ed
2. Hans Bisswanger, Practical Enzymology, 2nd Edition, Wiley Online Library
3. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis- - Robert A. Copeland, 2nd ed

M.Sc. BIOCHEMISTRY
II SEMESTER
BC 2.1: MICROBIOLOGY

Course Outcomes:

CO1: To learn the world of microorganisms – their history, classification of bacteria according to Bergey's Manual of Systematic Bacteriology, modern taxonomical aspects, isolation, cultivation, culturing methods, maintenance, cultures' preservation, evolution of microbiology and human gut microbiome

CO2: Master in the preparation and sterilization of microbial medias, as well as identification of different types of microorganisms by various staining techniques.

CO3: To study classification, characteristics and reproduction of Fungi including Molds and Yeasts; to learn the general characteristics of Actinomycetes, Rickettsia, Spirochaetes and Mycoplasma

CO4: To understand the role of algae, the many positive and negative microbial interactions within ecosystems, and to comprehend the role of microorganisms in sewage disposal, fermentation of foods, food spoilage, food poisoning and control measures

CO5: To be knowledgeable onthe pathogenesis of various microbial diseases (bacterial, fungal, air-borne, Arthropod-borne, and direct contact)

CO6: To closely study the evolution of virology, classification, virus replication, transmission (vector/non vector), isolation, cultivation, characterization, identification, purification of viruses, sub genomic RNAs, Virusoids, Viroids and Prions

CO7: To be informed on the architecture of viruses, interactions between viruses, and host immune systems

CO8: To grow aware of the management of plant viruses, animal viruses, physiology of human viruses, inactivation, prevention, and their control strategies

Course Specific Outcomes:

CSO1: To theoretically learn how to isolate and cultivate bacteria through various methods, and to develop the ability to apply that knowledge to microbial diagnosis in laboratory or industry settings

CSO2: To learn maintenance, preservation, and handling of pure cultures, which should help pave the way to carry out research in any microbiology-related domain

CSO3: To get acquainted with the discovery of antibiotics and their targets, drug/antibiotic resistance, preventive and therapeutic approaches of infectious diseases, and hospital acquired infections

CSO4: Understanding the importance of microorganisms as model systems in genetics and biochemistry

CSO5: To gain exposure to the basic concepts of metabolic engineering and synthetic biology

CSO6: To know the contribution of gut microbiome in human health

CSO7: Students should be able to demonstrate and evaluate interactions between microbes, hosts, and their environment, with the additional ability to determine BOD, DO, and COD of different effluent samples in order to assess their microbial load and degree of organic pollution

CSO8: To appreciate and contribute to the fight against major killer diseases such as tuberculosis, HIV, and malaria

CSO9: Students should develop the necessary skills to isolate, cultivate, characterize, and identify viruses that are routinely studied in any virology laboratory, which will bolster their ability to seek employment in those settings

Learning Outcomes:

LO1: Students will know the historical discoveries made in the discipline of microbiology
LO2: Students will learn isolation techniques, cultivation of microorganisms (bacteria, fungi, viruses), culturing, identification, maintenance, preservation strategies, bacterial diversity, classification, and identification
LO3: Students will possess knowledge of the general characteristics of bacterial phyla and importance of human gut microbiome in health and disease
LO4: Students can identify the morphological differences of different microorganisms, recognize industrially and economically useful microorganisms, and apply their use in different fields
LO5: Students will master aseptic techniques and can perform routine culture-handling tasks aseptically
LO6: Students will also gain insight into cellular composition, function, and physiology of bacteria, fungi and viruses
LO7: Students will learn the economical and industrial applications of algae, microbial interactions in Agro-Ecological Perspectives, and importance of microorganisms in sewage disposal and fermentation of foods; they will know how microorganisms can spoil or poison food and be well-versed in preservation strategies
LO8: Students will be able to understand the pathogenesis of bacterial, fungal and virus diseases
LO9: Students will study virus replication strategies, sub genomic RNAs, Virusoids, Viroids and Prions
LO10: Students will gain management knowledge of plant, animal, and human viruses, including their inactivation, prevention and control

Unit - 1

Introduction to Microorganisms - Morphology and classification of bacteria – phenotype, numerical and phylogenetic tree - rRNA, DNA and Proteins, Microbial diversity, Major characteristics used in taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations- (protein, nucleic acid composition), Isolation and cultivation of bacteria, bacterial growth curves. Culture media and methods of maintenance of cultures, Preservation of cultures (Glycerol stocks, freeze drying), differences between Gram-positive and Gram-negative bacteria, Human gut microbiome and disease

Unit-2

Molds – characteristics, classification and reproduction. Yeasts – morphology, characteristics and reproduction. General characteristics of Actinomycetes, Rickettsiae, Spirochaetes and mycoplasma. Economical and industrial uses of algae.Microbial interactions – mutualism, protocooperation, commensalism, predation, parasitism, amensalism, competition, symbiosis in complex system.Role of microorganisms in domestic and industrial sewage.Microbiology of fermented foods, food spoilage and its control (Preservation). Food borne diseases – Botulism, Salmonellosis, *E.coli*diarrhoea, Shigellosis, Staphylococcal food poisoning

Unit-3

Microbial diseases-Pathogenesis of bacterial diseases – maintenance, transport, invasion and multiplication and regulation.Airborne diseases – Diphtheria, Meningitis, Pneumonia, Tuberculosis and Streptococcal diseases. Arthropod borne – Lyme, Plague. Direct contact – Anthrax, Gonerrea, Conjunctivitis, Gastritis, Syphilis, Tetanus, Leprosy, Staphylococcal diseases. Sepsis, Mycoses, Malaria, Amoebiasis, Candidiasis

Unit-4

Introduction to Virology-Origin and evolution of viruses, ICTV criteria for classification of viruses. Morphology, structure and chemical composition of viruses; replication, transmission (vector/non-vector) and purification of viruses. Isolation and cultivation of viruses
Characterization and identification of viruses and virus strains - Biological, physical, immunological and molecular approaches. Bacteriophages - Biology of T_4, lambda. Biology of sub-viral agents - Satellite viruses, sat-RNAs, Viroids and prions

Unit-5

Plant viruses - Tobacco mosaic virus, and tomato yellow leaf curl virus; control strategies for plant viruses, Animal viruses - Foot and mouth disease virus and Avian Influenza virus
Human viruses -Structure and physiology of:polio virus, rabies virus, Human Immunodeficiency Virus(HIV), human coronaviruses (SARS-CoV-2), chikungunya virus, dengue virus, hepatitis C virus, influenzas virus, Ebola virus, Zika virus and human papilloma virus (HPV)
Inactivation of viruses – Photodynamic inactivation. Prevention and control of animal and human viruses - Sanitation, vector control, vaccines and chemotherapy (antiviral drugs, Interferons)

Reference books:

1. Microbiology - Prescott (Willey, Sherwood,Woolverton)
2. Microbiology – Tortora, Funke, Case
3. Microbiology – R.Y.Stanier, E.A.Adelberg, J.L.Ingraham 4th ed.
4. Biology of Microorganisms - M.T. Medican, J.M. Martiniko and J. Parker 10th ed
5. Microbiology by Pelczar, Chan and Krieg 5thed Mc Grew-Hill
6. General Microbiology: Boyd R.F., Times Mirror/ Mosby College
7. A Textbook of Microbiology, R.C.Dubey and D.K.Maheswari, S.Chand Co
8. An Introduction to Viruses by S.B.Biswas, A.Biswas, Vikas Publishinghouse
9. Microbiology 4th ed, Prescott, Harley, Klein (Mc grawHill)
10. Fundamentals of Microbiology – M.Frobisher, 8th ed
11. Text book of Microbiology – WilliamBurrows, J.W.Moulder, R.M.Lewert, J.W.Rippon, 19th ed
12. Biology of Microorganisms – Sandes T.Lyles
13. Microbial Ecology – Atlas, Bartha 4th ed

M.Sc. BIOCHEMISTRY
II SEMESTER
BC 2.2: CELL BIOLOGY AND GENETICS

Course Outcomes:

CO1: To provide the knowledge about cellular architecture, cell cycle and its regulatory mechanisms
CO2: To understand the structure and dynamics of the biological membranes and transport mechanisms
CO3: To understand the proper function of cell receptors and cell signalling pathways
CO4: To know about the Mendelian Genetics and its extensions, chromosomes and inheritance
CO5: To provide the knowledge about linkage maps, quantitative inheritance and biochemistry of mutations

Course Specific Outcomes:

CSO1: The course covers the importance of cytoskeletal elements and extracellular matrix in maintaining cellular architecture
CSO2**:** Major emphasis was on cell cycle, characteristics of cancer cells and mechanism of apoptosis
CSO3: The course highlights the structure, composition, distribution of molecules and transport across the membrane
CSO4: More focus on cell-to-cell communication through the receptors and mechanism of generation and action of cell signalling molecules
CSO5: The course covers basic Mendelian principles and deviations, concept of alleles and inheritance of sex-linked characters
CSO6: The course gives knowledge about changing concept of gene
CSO7: Major emphasis was on chromosomal mapping and extra chromosomal inheritance and mutations and their mechanism of action

Learning Outcomes:

LO1: Students will understand the role of cytoskeleton and extracellular matrix in cellular organization
LO2: Students will learn about role of cyclins in cell cycle and its regulation and also about mechanism of apoptosis
LO3: Students will obtain a good knowledge about membrane structure, composition, transport of molecules and ions across the cell membrane
LO4: Students will acquire knowledge about cell receptors and their functions, signalling molecules and the mechanism of generation of signals
LO5: Students will learn the phenotypic and genotypic ratios and how these ratios differ during gene interactions
LO6: Students will acquire knowledge about sex determination with respect to sry gene in humans and sex-linked inheritance
LO7: Students will learn about concept of linkage and crossing, types of mutations, and their impact

Unit-1

Cytoskeleton – Microtubules, Intermediate filaments, Microfilaments; Extracellular matrix – Collagen, Elastin, Fibrillin, Fibronectin, Laminin, Proteoglycans, Integrins; Cell- Cell interactions – Tight Junctions, Gap Junctions, Desmosomes

Cell division by Mitosis and Meiosis; Cell cycle – Role of Cyclins, Cyclin dependent kinases in cell cycle progression; Apoptosis – Pro-apoptotic and Anti-apoptotic regulators, Mechanism of necrosis and autophagy

Biochemistry of Cancer – Carcinogenesis, Characteristics of cancer cell, Agents promoting carcinogenesis

Unit-2

Membrane structure: The lipid bilayer, Membrane lipids and Membrane Fluidity, Membrane carbohydrates, Asymmetric distribution of membrane proteins; Artificial membranes – Liposomes and its applications

Membrane transport: Channels and Pumps – Diffusion, Passive, Active and Facilitated transport, Role of Na^+ K^+ ATPase, Group translocation; Ionophores - Ligand gated ion channels, Ionic channels

Unit – 3

Cell communication and Types of signal molecules, Cell receptors - Nature and types of receptors and their structure, G protein linked cell surface receptors, Mechanism of signal transduction, Inositol phospholipid signalling pathway - IP3, DAG and Ca^{2+} as second messengers

GPCR - Regulation of cyclic nucleotide gated ion channels (eg.Smell and Vision), GPCR signal termination, Tyrosine kinase receptors mediated signalling (eg. Insulin, growth factors EGF, VEGF), Ras, MAPK pathways, Second messengers - cAMP, cGMP, Nitric Oxide- Mechanism of their generation and action, Role of different protein kinases

Unit – 4

Basic principles of Mendelian Genetics: Dominance, segregation, independent assortment; Extensions of Mendelian principles- Codominance, Incomplete dominance, Gene Interactions, Pleiotropy, Genomic imprinting, Penetrance and Expressivity

Concept of alleles - Complementation Test, Multiple alleles, Pseudo alleles, Benzer's rII alleles; Concept of Cistron, Recon, and Muton; Sex determination with special reference to genetic basis of sex determination in Humans-*Sry* gene, Sex linked inheritance

Modern concept of the gene - Split genes, overlapping genes, assembled genes, Repeated genes, Polyprotein genes, Nested genes

Unit-5

Linkage and crossing over: 2-point test cross, 3-point test cross, Recombination as a basis for variation; Quantitative inheritance – Polygenic inheritance; Extra chromosomal inheritance - Inheritance of mitochondrial and chloroplast genes, Maternal inheritance

Mutations: Types of mutations - Mutagens and their mechanism of action, Molecular mechanism of mutations; Structural and Numerical alteration of chromosomes – Deletion, Duplication, Inversion, Translocation, Ploidy and their genetic implications

Reference books:

1. Cell and Molecular Biology – E.D.P. De Roberties , E.M.F. DeRoberties, 8th ed
2. Cell biology - David E. Sadava
3. Karp's Cell and Molecular Biology - Gerald Karp, Janet Iwasa, Wallace Marshall, 9th ed
4. Molecular Cell Biology - Arnold Berk, Chris A. Kaiser, Harvey Lodish, et al., 8th ed
5. Molecular Biology of the Cell - Albert Bruce et al., 6th ed
6. Biological membranes: Their structure and function - Harrison R, 2nd ed
7. Comprehensive introduction to membrane biochemistry – Datta, Dipak B
8. Principles of Biochemistry by Lehninger- D.L.Nelson, M.M.Cox, 7th ed
9. An Introduction to Genetic Analysis - Griffiths, Wessler, Lewontin, et al., 11th ed
10. Genetics - M. W. Strickberger, 3rd ed
11. Principles of Genetics - E. J. Gardner, M. J. Simmons, D. P. Snustad, 8th ed
12. Genetics: A Conceptual approach. - Benjamin A. Pierce 5th ed
13. Genetics – G. Zubay
14. Genetics - P.K Gupta

M.Sc. BIOCHEMISTRY
II SEMESTER

BC 2.3: INTERMEDIARY METABOLISM

Course Outcomes:

CO1: To learn the intracellular process by which nutritive material is converted into cellular components, enzymatic digestion of large nutrient molecules such as carbohydrates, proteins, fats into smaller molecules like glucose, amino acids and fatty acids. Monosaccharides predominantly glucose to generate energy by the cells in both aerobic and anaerobic conditions, glycolysis, significance of TCA cycle in central carbon metabolism, importance of anaplerotic reactions, and redox balance, gluconeogenesis, glycogenesis, glycogenolysis, role of specific enzymes in regulation of above processes and diseases involved due to metabolic block in reaction sequences

CO2: To learn the management of biochemical reaction with enzymes is an important part of cellular maintenance and in turn enzymatic activity allows a cell to respond to changing environmental demands and regulate its metabolic pathways, essential to its survival

CO3: To learn the biosynthesis and degradation of glycogenic and ketogenic amino acids, regulation of the above pathways by enzymes, conversion of ammonia into urea by urea cycle and its regulation, disorders associated with protein metabolism due to deficiency of enzymes

CO4: To learn the importance of oxidation of fatty acids, biosynthesis and regulation of fatty acids, arachidonic acid, phospholipid, sphingolipid and cholesterol metabolisms, diseases of lipid metabolism

CO5: To learn the biosynthesis, regulation and degradation pathways of purines, pyrimidines, ribonucleotides, deoxyribonucleotides, polynucleotides, and heme, Formation of bile pigments, bile acids, role of inhibitors in nucleic acid biosynthesis and disorders of nucleic acid and porphyrin metabolism

Course Specific Outcomes:

CSO1: The students will be able to gain conceptual knowledge on Intermediary metabolism as highly integrated network of biochemical reactions that provides cells with forms of energy for immediate use (i.e., metabolic energy), reducing power and biosynthetic intermediates

CSO2: To learn the chemical principles governing classical metabolic pathways of intermediary metabolism were firmly established, as were the mechanistic principles behind the energy transducing processes and further in understanding of Intermediary metabolism regulation

CSO3: To understand the importance of lipids as storage molecules and as structural component of biomembranes

CSO4: Understanding the importance of high energy compounds, electron transport chain, synthesis of ATP in aerobic and anaerobic conditions

CSO5: To gain knowledge on crucial role of intermediary metabolism at the crossroads of all aspects of cellularfunction,from cell growth, proliferation and death to epigenetics and immunity

CSO6: To provide broad concept of study of intermediate metabolismis crucial for understanding of many diseases, ranging from the classical metabolic diseases, such as type 2 diabetes and obesity, to cancer. Students will be exposed with the fact that perturbations in carbon metabolism can lead to various disorders such as diabetes and cancer

CSO7: To offer a deep knowledge of intermediary metabolism has also undeniable practical value, as exemplified by the production of highvalue products, such as fuels and drugs, through rational metabolic manipulation. Appreciation of the fact that differences in the properties of metabolic enzymes of the host and pathogens can be exploited for the

development of new drugs and further to gain insights into metabolic engineering for the production of useful biomolecules

CSO8: To gain insights into Inborn errors of carbohydrate, protein, lipid, nucleic acids, and porphyrin metabolism are rare genetic (inherited) disorders in which the body cannot properly turn food into energy due to lack of specific enzymes that help break down (metabolize) parts of food

Learning Outcomes:

LO1: The students will be able to understand the digestion of macromolecules (Carbohydrates, Proteins, Lipids into monomers (glucose, amino acids, fatty acids) in the humans by enzymes, absorption and assimilation of the products to other parts of the body

LO2: The students will be able to understand how glucose can be converted to generate ATP, the principal molecule for storing and transferring energy in cells required for biosynthetic processes and role of specific enzymes in regulating the above process and disorders involved due to metabolic block in reaction pathways

LO3: The students will be able to understand the importance of glucose as the main source of energy for the brain, under low blood glucose levels the liver tissue can synthesize glucose by gluconeogenesis and it will supply glucose to brain and role of glucose-6-phosphate, a metabolic intermediate in giving NADPH for fatty acid biosynthsis and formation of different sugar intermediates consumed in various metabolic reactions

LO4:The students will be able to understand the role of transaminase enzymes in the over all degradation of amino acids and making use of various metabolic products for synthesis of amino acids in cells and understanding how microorganisms and plants are able to synthesize all the amino acids, the importance of amino acids in the synthesis of complex porphyrins as well as various important hormones in the body and regulation of various biosynthetic processes

LO5:The students will be able to know the importance of amino acids in the synthesis of complex porphyrins as well as various important hormones in the body

LO6: The students will be able to understand the degradation of fatty acids in the cells for the production of acetyl Co A, to deliver the acetyl group to the citric acid cycle to be oxidised for energy production and lipid derivatives as functional units in cellular architecture, importance of cholesterol and its role in formation of important vitamins

LO7:The students will be able to know the importance of nucleotides, ribo and deoxyribonucleotides, their biosynthesis and metabolism in cells. Biosynthesis and regulation of pyrimidine and purine nucleotides and role of tetrahydrofolate in one carbon metabolism as well as the disorders associated with nucleotide metabolism will be understood

LO8: The students will be able to understand the types of reactions involved in porphyrin metabolism and their significance

Unit-1

Carbohydrate Metabolism - Approaches for studying intermediary metabolism. Glucose as fuel, glucose transporters, Glycolysis and its regulation. Substrate cycling, TCA cycle – function and regulation, Glyoxylate cycle, Gluconeogenesis and its regulation, HMP shunt and its significance, Uronic acid pathway, Glycogen metabolism and its regulation with special reference to phosphorylase and glycogen synthase, Metabolism of fructose, galactose and lactose, Biogenesis of amino sugars, peptidoglycans, glycosyl aminoglycans and glycoproteins.In born errors of carbohydrate metabolism – Hemolytic Anemia, Galactosemia

Unit-2

Protein Metabolism - General metabolic reactions of amino acids. Catabolism of individual amino acids Ketogenic and glycogenic amino acids. Formation of creatinine, ammonia and urea. Regulation of urea cycle. Essential and non- essential amino acids. Biosynthesis and regulation of branched chain amino acids, aromatic amino acids, histidine and methionine. In born errors of amino acid metabolism – Phenylketonuria, Alkaptonuria.Proteins turn over – Role of ubiquitin

Unit-3

Lipid Metabolism - Fats as energy stores, Oxidation of fatty acids, Formation and utilization of ketone bodies. Biosynthesis of fatty acids and regulation. Metabolism of arachidonic acid – formation of prostaglandins, thromboxanes, leucotrienes. Biosynthesis of triglycerides. Metabolism of phospholipids, sphingolipids. Biosynthesis of cholesterol and its regulation.Role of liver and adipose tissue in lipid metabolism. In born errors of lipidmetabolism - Niemann-pick disease, Gaucher’s disease

Unit-4

Nucleic acid Metabolism - Biosynthesis and regulation of purines and pyrimidines.Catabolism of purines and pyrimidines Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. In born errors of nucleic acid metabolism–Lesch-Nyhan syndrome, OroticAcidurias

Unit-5

Porphyrin Metabolism - Biosynthesis and Regulation of heme, catabolism of heme to bile pigments, Formation of bile acids, Jaundice – Classification of jaundice,In born errors of porphyrin metabolism– Porphyrias: Types of porphyrias – Acute intermittent porphyria, congenital erythropoietic porphyria

Reference books:

1. Biochemistry – J.M.Berg, J.L.Tymoczko, G.J.Gatto Jr., LubertStryer 9th ed
2. Lehninger - Principles of Biochemistry- D.L.Nelson, M.M.Cox, 7th ed
3. Text Book of Biochemistry Authors ES West, WR Todd, HS Mason and JT Van Bruggen, 4th ed
4. Review of Physiological Chemistry - Harold Anthony Harper
5. Principles of Biochemistry, White. A, Handler, P,Smith et al., 6th ed
6. Biochemistry, David E.Metzler, 2nd ed
7. Outlines of Biochemistry, E.E. Conn, P.K. Stump, 3rd ed
8. Chemical pathways of Metabolism–Greenberg, 1st ed
9. The Structure of Mitochondria- E.A. Munn
10. Biochemistry-G.L.Zubay, 4th ed

M.Sc. BIOCHEMISTRY

II SEMESTER

BC 2.4: MOLECULAR BIOLOGY

Course outcomes:

CO1: Acquiring in-depth knowledge in Molecular Biology course is an added advantage to the students who are curious and excited about the cellular, genetic, and molecular mechanisms in living organisms

CO2: By providing a comprehensive training in Molecular Biology to the students will enable them well prepared to pursue rewarding careers in healthcare, genetic technologies, pharmacology, neuroscience, basic and applied research, agricultural science, food science and technology and forensics

CO3: Study the discovery of DNA as genetic material, DNA replication, transcription, DNA repair and translation

CO4: Exposure to the concepts of DNA repair and their importance in human health

CO5: Acquire information about the DNA and, RNA from bacteria, Viral, yeast and plant

Course Specific Outcomes:

CSO1: Students will acquire knowledge related to the fundamentals of molecular biology like nucleic acids as genetic material, replication, transcription and translation, gene organization and its regulation etc

CSO2: Information about coding and non-coding regions of eukaryotic genome and their importance will be gained

CSO3: Expose the students to a wide range of careers that combine biology, plants and medicine

CSO4: Develop the student the ability to apply the molecular biology knowledge that they acquired to the solution of specific industrial, health and environment problems

CSO5: The application of the course lays the foundation to understand the disease processes at molecular level

Learning Outcomes:

At the end of the course, the student will be able to acquire the knowledge related to

LO1: Discovery of DNA as genetic material, Prokaryotic and Eukaryotic DNA Replication, repair and DNA Recombination

LO2: Students will get hold of basic knowledge related to processes of transcription and translation in prokaryotes and eukaryotes

LO3: They will develop understanding of the molecular basis of RNA processing and RNA splicing and the ways in which the biological processes are regulated and the significance of regulation in maintaining different life forms

LO4: The student will understand the fundamentals of translation in prokaryotes and Eukaryotes, Properties of Genetic code, Ribosomes, formation of initiation complex, transpeptidation and translocation and protein targeting

LO5: The student will be able to learn about the classes of DNA sequences, Tandem repeats, prokaryotic and Eukaryotic Transposable elements

Unit-1

DNA Replication in Prokaryotes: Origin and Direction of replication, Semi-discontinuous replication, DNA polymerases of prokaryotes and their mechanism of action; Helicase, Primase, Ligase, Single strand binding proteins and DNA Topoisomerases and their types Replication strategies for replicating circular DNA: 'ϕ' mode of replication, σ mode or Rolling circle mode of replication and D-loop mode of replication. Eukaryotic DNA Replication: Eukaryotic DNA Polymerases, Reverse transcriptase, Strategies for replicating linear DNA, Fidelity and Processivity of replication, Inhibitors of replication

Unit-2

DNA Repair mechanisms: Photo reactivation, Excision repair mechanism, Post replication repair mechanisms- Recombinationrepair, Mismatchrepairsystem,SOSresponse, Transcription-repair coupling
DNA Recombination - Models of general recombination; Holyday model, asymmetric strand transfer model, double strand break repair model: Site-specific recombination Transposition of DNA-Types and Properties of Transposable elements
Prokaryotic transposons, Eukaryotic transposons

Unit-3

Principles of Transcription, Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiation of transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes

Unit -4

Post Transcriptional Modifications: Modifications of pre-mRNA - 5' end capping, 3'polyadenylation, Significance; Heterogeneous Nuclear RNA Splicing; Introns and Exons, Self-splicing mechanism of group-1 and group-11 Introns, Alternative splicing and its importance, Processing of ribosomal RNA, transfer RNA, Regulation of RNA processing: RNA editing-types of changes

Unit-5

General features of Genetic code: Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes-aminoacylation of tRNA, protein synthesis initiation, elongation and chain termination, Protein synthesis inhibitors, Translational control in eukaryotes: Protein targeting and processing-Signal sequences, signal recognition particle, signal hypothesis, Molecular chaperons

Reference books:

1. Molecular Biology of the Gene - J. D. Watson et al., 7th ed
2. Molecular Biology of the Cell – H. Lodish, Arnold Berk et al.,7th ed
3. Molecular Biology of the Cell – Bruce Alberts, Alexander D.Johnson et al.,
4. Molecular biology: a comprehensive introduction to prokaryotes and eukaryotes – D.Frefeilder, 2nd ed
5. Fundamental Molecular Biology – Lizabeth A. Allison
6. Leininger's Principles of Biochemistry- Nelson and Cox, Worth Publish., Inc. New York
7. Biochemistry - L. Stryer., 4th ed, W.H. Freeman Press, San Fransisco, USA
8. Principal of Genetics - E.J. Gardner and D.P. Snustad. John Wiley & Sons, Ney York

M.Sc. BIOCHEMISTRY
II SEMESTER
PRACTICAL – I
BC 2.5: MICROBIOLOGY, CELL BIOLOGY AND GENETICS

Course Outcomes:

CO1: To acquire hands on experience on various sterilization techniques such as Autoclaving, hot-air oven sterilization, Sieve filtration, membrane filtration; Preparation of culture media such as Nutrient Broth, Nutrient Agar, Blood agar MacConkey's agar, Potato dextrose agar; Isolation of bacteria by Streak plate, pour plate methods and Motility of Bacteria by "Hanging drop" technique

CO2: To learn on how to identify microorganisms by staining techniques such as simple, differential, Gram staining, acid-fast staining; Identification of bacteria by Morphological, cultural and biochemical characteristics

CO3: To learn how to perform bacteriological examination of water, milk; bacterial growth curve; Analysis of domestic and industrial effluents such as MPN, BOD, COD and DO; Isolation of phage and plaque formation units (PFU); Microbiological assay of a vitamin/amino acid

CO4: To gain hands on experience on sectioning of onion root tip cells to study various stages of mitosis and sectioning of onion flower buds to study various stages of meiosis

CO5: To learn how to do karyotyping, problems in genetics on monohybrid ratio, dihybrid ratio, gene interaction, linkage and crossing over – 2 point test cross

Course Specific Outcomes:

CSO1: To isolate microbes from provided samples and to perform bacterial cultures in different Media

CSO2: To get trained in performing routine microbiological practices such as sterilization, media preparation, maintenance of microbial culture, staining, etc.

CSO3: To acquire expertise to culture and screen microbes for antibiotic resistance

CSO4: Students should learn the handling of microscope

CSO5: Obtain hands-on training in basic separation techniques in biochemistry

CSO6: Gain expertise in the isolation of various cell organelles and staining of cellular biomolecules

CSO7: To gain knowledge on experiments to determine Mendel's law

CSO8: Students should be able to demonstrate monohybrid and dihybrid cross using plants

Learning Outcomes:

LO1: The students will learn techniques on various sterilization techniques such as Autoclaving, hot-air oven sterilization, Sieve filtration, membrane filtration; Preparation of culture media such as Nutrient Broth, Nutrient Agar, Blood agar MacConkey's agar, Potato dextrose agar; Isolation of bacteria by Streak plate, pour plate methods and Motility of Bacteria by "Hanging drop" technique

LO2: The students will develop skills to perform various staining techniques such as simple, differential, Gram staining, acid-fast staining and how to identify bacteria by Morphological, cultural and biochemical characteristics

LO3: The students will be able to learn how to perform bacteriological examination of water, milk; bacterial growth curve; Analysis of domestic and industrial effluents such as MPN, BOD, COD and DO; Isolation of phage and plaque formation units (PFU); Microbiological assay of a vitamin/amino acid

LO4: The students will develop skills on sectioning of onion root tip cells for studying various stages of mitosis and sectioning of onion flower buds for studying various stages of meiosis

LO5: The students will be able to learn how to perform karyotyping, to develop problem solving skills in genetics on monohybrid ratio, dihybrid ratio, gene interaction, linkage and crossing over – 2 point test cross

MICROBIOLOGY (A)

Sterilization Techniques-Autoclaving, hot-air oven sterilization, Sieve filtration, membrane filtration.
Preparation of culture media – Nutrient Broth, Nutrient Agar, Blood agar MacConkey's agar, Potato dextrose agar.
Isolation of bacteria – Streak plate and pour plate methods.
Motility of Bacteria – "Hanging drop" technique
Identification of bacteria by staining techniques – simple, differential, Gram staining and acid-fast staining
Bacterial growth curve
Identification of bacteria – Morphological, cultural and biochemical characteristics
Microbiological assay of a vitamin/amino acid
Bacteriological examination of water and milk
Analysis of domestic and industrial effluents - MPN, BOD, COD and DO
Isolation of phage and plaque formation units (PFU)

CELL BIOLOGY AND GENETICS (B)

Mitosis in onion root tip cell
Meiosis in onion flower buds
Karyotyping
Problems on monohybrid ratio, dihybrid ratio, gene interaction, linkage and crossing over, 2 point test cross

Reference books:

1. Laboratory Experiments in Microbiology-M.Gopal reddy et al.,
2. Microbiology-A laboratory Manual-Cappuccino, Sherman, 7th ed
3. Practical Microbiogy-R.C.Dubey, D.K.Maheswari
4. Microbiology-A laboratory Manual-Cappuccino, Sherman, 7th ed
5. Cell Biology : Practical Manual – Dr. Renu Gupta, Dr. Seema Makhija et al.,
6. Problems on Genetics Molecular Genetics and Evolutionary Genetics – Pranab Kumar Banerjee

M.Sc. BIOCHEMISTRY
II SEMESTER
PRACTICAL – II

BC: 2.6: QUANTITATIVE ANALYSIS AND MOLECULAR BIOLOGY

Course Outcomes:

CO1: To learn about various good lab practices, bacterial handling etc.
CO2: To become familiar with the basic quantitative methods used for analysis in biochemistry
CO3: To understand the basic principles of colorimetry and titrimetric analysis in biochemistry
CO4: To impart training on tools and techniques used in molecular biology lab
CO5: To apply appropriate methods for induction of mutations for strain improvement

Course Specific Outcomes:

CSO1: The course gives in depth knowledge in understanding various methods used in estimation of proteins, carbohydrates and nucleic acids.
CSO2: It gives knowledge about isolation of DNA and RNA from different sources
CSO3: To gain knowledge about strain improvement in bacteria

Learning Outcomes:

LO1: Students will acquire hands on practical training in molecular biology tools
LO2: Students will learn how to extract and purify DNA and RNA from different samples
LO3: Students will gain detailed insight in learning quantitative techniques
LO4: Students will gain knowledge about applying molecular aspects in R and D industries

QUANTITATIVE ANALYSIS (A)

Determination of P^{ka} and P^{I} values of an amino acid by titrimetric method
Estimation of proteins by Lowry, Bradford methods
Determination of carbohydrates by Anthrone method
Determination of RM value and polensky number of oils
Estimation of pyruvate by 2,4 Dinitrophenyl hydrazine method
Estimation of Ca^{++}/Zn^{++} by EDTA titrimetric method

MOLECULAR BIOLOGY (B)

Determination of melting temperature (T_m) of DNA
Isolation of DNA from bacterial, plant and animal cells.
Estimation of DNA by Diphenylamine method.
Isolation of RNA from yeast cells.
Estimation of RNA by Orcinol method.
Estimation of DNA and RNA by UV absorption method and determination of purity of

nucleic acids.

Determination of sugar and phosphate ratios in DNA and RNA samples.

Conjugation: Use of broad host range plasmid RP in demonstrating conjugation transfer of plasmid bacteria.

Catabolite repression: Evidence of *B*-Galactosidase induction in presence of lactose in *E.coli lac* strains.

Mutations: UV damage and repair mechanism in *Escherichia coli* Or *Seratia marcesens*

Strain improvement of *Aspergillus niger* using chemical mutagen – Ethidium bromide

Reference books:

1. Experimental Biochemistry-B.Sashidhar Rao, Vijay Deshpande
2. Techniques in Molecular biology - J.Walker (Goom Helns, London).
3. Practical methods in molecular - R.F.Shecleif and P.C.Wensik (Springer veriag)

M.Sc. BIOCHEMISTRY

III SEMESTER

BC 3.1: PLANT BIOCHEMISTRY AND HUMAN NUTRITION

Course Outcome

CO1: To offer basic concepts of carbon dioxide fixation in plants and biochemistry of nitrogen fixation
CO2: To acquire knowledge on factors effecting seed germination and secondary metabolites in plants
CO3: To learn biological values of proteins, dietary needs of lipids, Physiological roles and deficiency disorders of vitamins and minerals
CO4: To understand the need for specialized food for people with special needs - Pregnancy and lactating women, atherosclerosis, cardiovascular disorders and Obesity
CO5: To gain knowledge on biological effects of non-nutrients

Course Specific Outcome

CSO1: To offer detailed knowledge on Nitrogenase enzyme complex and its function
CSO2: To provide concept of role of leptin in regulation of body mass
CSO3: To gain knowledge on food contaminants and food additives

Course Learning Outcome:

LO1: Learning outcomes for this course include detailed understanding of metabolic processes specific for plants such as nitrate assimilation, photorespiration, nitrogen fixation and the role of different phytohormones in plant growth and development
LO2: Students will also gain insight into secondary metabolites and their functions in plants
LO3: Students will learn the basic concept of nutrition for maintaining normal health, role of nutrients for the body, dietary requirements of carbohydrates, proteins and fats
LO4: Students will understand the importance of essential fatty acids, vitamins and minerals for the body

Unit – 1

Carbon dioxide fixation in plants – Calvin cycle & its regulation, C-4 and CAM pathways, Photorespiration, RUBISCO

Nitrogen metabolism: Biochemistry of Nitrogen fixation, Nitrogenase enzyme complex & its function, Nitrogen fixation genes, Formation of root nodules in Legumes, Assimilation of Nitrate and Ammonia

Unit – 2

Seed germination: Biochemical changes during Seed germination, Factors effecting Seed germination; Seed Dormancy: Types of Dormancy, Methods to break Seed Dormancy. Structure, physiological function and mechanism of action of phytohormones – Auxins, Gibberellins, Cytokinin's, Ethylene and Abscisic acid

Secondary metabolites in plants – Nature, distribution, biosynthesis and function of plant Terpenes Phenolics and Nitrogen containing compounds

Unit – 3

Animal and vegetative foods – chemical composition. Nutrients – Essential Nutrients and their classification. Digestibility, absorption and biochemical functions of macro nutrients, Carbohydrates – dietary requirements. Proteins – Nitrogen balance studies, Determination of Biological values of proteins, Specific Dynamic Action, improvement of protein quality by supplementation and fortification. Lipids – Dietary needs of lipids, essential fatty acids. Calorific values of foods, Basal metabolic rate and its determination, factors influencing BMR
Vitamins: sources, physiological role and deficiency disorders of vitamins A, D, E, K, Vitamin C and B complex vitamins–Thiamine, riboflavin, niacin, pantothenic acid, lipoic acid, pyridoxine, biotin, folic acid and Vitamin B_{12}

Unit – 4

Biological effects of non-nutrients, dietary fibre, physiological actions. Antinutrients – Protease inhibitors, hemeagglutinins, hepatotoxin, goitrogens, cyanogenic glucosides, methyl xanthines, oxalates. Toxins from mushrooms. Biological effects of food contaminants – Hexachlorobenzene, arsenic, DDT, cadmium, mercury, lead, aflatoxins, food additives – saccharin and sodium nitrite. Animal foods and seafoods. Food allergy – role of allergens, diagnosis and management of food allergy. Food processing and loss of nutrients during processing and cooking

Unit -5

Clinical nutrition – role of diet and nutrition in prevention of atherosclerosis, cardiovascular disorders and obesity, role of leptin in regulation of body mass. Starvation – Protein sparing treatment during fasting, Protein calorie malnutrition – Kwashiorkar and Marasmus, Nutritional requirements for pregnant and lactating women and agedpeople.Functions and deficiency disorders of minerals

Reference books:

1. Plant Biochemistry-Hans-Walter Heldt, BirgitPiechulla, 4th ed
2. Plant Biochemistry - Dr. V.Arunkumar, Dr.K.Siva Kumar, Dr. N. Senthil Kumar
3. Plant Biochemistry-James Bonner,J.R.Varner
4. Introduction to plant Biochemistry-Goodwin, Mercer, 2nd ed
5. Handbook of photosynthesis-Mohammad Pessarakli et al., 3rd ed
6. Seed: Physiology of development and germination –J. D. Bewley, M. Black, 2nd
7. Nutritional Elements and Clinical Biochemistry- M.A. Brewster, H.K.Naito
8. Nutritional Biochemistry and Metabolism: With Clinical Applications- Maria C. Linder, 2nd ed
9. Advanced textbookon Food and Nutrition-M.S.Swaminathan, Vol. I & II
10. Handbook of Nutritional Biochemistry: Genomics, Metabolomics and Food Supply - Sondre Haugen, Simen Meijer

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.2: IMMUNOLOGY

Course Outcomes:

CO1: The course is designed to make the students to understand the principles of immunology which will empower them to gain a broad foundation on the molecular defense mechanisms of the human body
CO2: Foundation in immunology course will enable the student to pursue doctoral program and carry out advanced research
CO3: The course enables the student to get acquainted with the importance of antigen-antibody interaction in disease diagnosis
CO4: The course will enlighten the student about the importance of immunization and the significance of conventional vs. recombinant vaccines
CO5: To acquire expertise in immunological diagnostics approaches and their use

Course Specific Outcomes:

CSO1: The specific outcome of this course is to apprise the students about the components associated with immune system, molecular mechanisms, and their working, which will develop an awareness of key concepts from a vast amount of experimental data that is rapidly emerging in this field
CSO2: The course also deals with implications of deregulation of basic regulatory networks that lead to immune system related disorders
CSO3: The students will be able to describe the roles of the immune system in both maintaining health and contributing to disease
CSO4: To understand the genetic basis of antibody diversity and the importance of humoral, cell-mediated, and innate immune responses in combating pathogens
CSO5: To understand the principles of tolerance, autoimmunity, and the role of immunity in protection against pathogens

Learning Outcomes:

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

LO1: Compare and contrast innate and adaptive immunity, describe which cell types and organs present in the immune system and distinguish T and B cells in regarding to their cell surface receptors
LO2: Able compare humoral versus cell-mediated immune responses, distinguish and characterize antibody isotypes, development, and functions
LO3: Understand various mechanisms that regulate immune response and role of MHCs
LO4: Exemplify the adverse effects of immune system including Allergy, Hypersensitivity, Transplantation, Autoimmunity and Cancer
LO5: Apply basic immunological techniques in identifying and quantifying antigen and antibody for disease diagnosis

Unit-1

Immune response–Innate and adaptive, Antigens, Superantigens, Adjuvants:Cells and organs of the immune system -Thymus, bone-marrow, spleen, lymph node, T and B Cells – Origin, characteristics, and functions; T and B cells activation, differentiation, T and B cell surface receptors

Unit-2

Immunoglobulins - Structure, classes, and biological activities. Isotypes, Allotypes, Idiotypes: Humoral immune response and Cell-mediated immune responses: Immunoglobulin genes and Antibody diversity, Class switching; Cytokines-Interleukins (ILs) and Interferons(IFNs)

Unit-3

The Complement system- pathways activate the complement system - the Classical complement pathway, the Alternative complement pathway and the lectin pathway, Biological consequences of complementactivation, Regulation
Major Histocompatibility Complex-HLA, Polymorphism of MHC molecules. MHC restriction and its role in immune response: Antigen presenting cells, Processing, andpresentationofantigens

Unit-4

Immune effector mechanisms – Hypersensitivity: immediate (type I, type II, type III) and delayedhypersensitivityreactions: Immunedeficiencies diseases-SCIDandAIDS Autoimmunity-organ specific(Hashimoto's thyroiditis)andsystemic diseases (Rheumatoid arthritis). Tissue transplantation - auto, allo, iso and xenografts, tissue matching, transplantation rejection, mechanism and control, immunosuppressive agents: Cancer immunology– Tumor associated antigens, Immunological surveillance of cancer

Unit-5

Antigen-antibody interactions and quantification: Antibody affinity and avidity, Precipitation reactions Immunodiffusion, Radial immunodiffusion, double immunodiffusion; Immunoelectrophoresis, Rocket Immunoelectrophoresis: Agglutination reactions: hemagglutination and Complement fixation: Immunofluorescence, FACS, RIA, ELISA, Immunoblotting, Hybridoma technology- production of monoclonal antibodies and their applications, humanized antibodies

References books:

1. Kuby Immunology- Owen, Punt, 10th ed
2. Parham, The immune System, 3rd ed
3. Wiley: Roitt's Essential Immunology - Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt , 13th ed
4. Cellular and Molecular Immunology -Abul Abbas, Andrew H. Lichtman, Shiv Pillai , 9th ed
5. Fundamental Immunology - WilliumE.Paul, 7th ed
6. Janeway's Immunobiology - Kenneth Murphy and Casey Weaver, 9th ed
7. Introduction to Immunology – JohnW.Kinball , 3rd ed
8. Immunology – D.M.Weir, John Stewart, 8th ed
9. Veterinary Immunology - Ian R. Tizard, 9th ed
10. Fundamental of Immunology – Otto Bier, 2nd ed
11. Fundamentals of Immunology – William C. Boyd
12. Cellular and Molecular Immunology - Abbas, Saunders, 3rd ed

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.3: REGULATION OF GENE EXPRESSION AND GENETIC ENGINEERING

Course Outcomes:

CO1: To understand the basic aspects of gene regulation in prokaryotes
CO2: To gain the knowledge about various regulatory molecules and proteins involved in eukaryotic gene regulation
CO3: To know the importance of various enzymes of rDNA technology and cloning vectors used
CO4: To gain knowledge about gene transfer techniques and expression of foreign gene
CO5: To understand the construction of DNA libraries and applications of genetic engineering

Course Specific Outcomes:

CSO1: The course highlights the importance of operons in prokaryotic gene regulation and regulation of bacteriophage λ
CSO2: The course covers broad range of regulatory elements in eukaryotes and various levels of gene regulation
CSO3: Major emphasis was on restriction endonucleases and other modifying enzymes, and different types of cloning vectors used in rDNA technology
CSO4: Particular emphasis on introduction of DNA in to living cells like bacteria and other eukaryotes like yeast, mammals and expression of foreign gene
CSO5: The course covers different aspects of identification of recombinants and their applications

Learning Outcomes:

LO1: Students will understand the role of various operons in regulating gene expression in prokaryotes and phage variation in *Salmonella*
LO2: Students will acquire a good knowledge in regulation of eukaryotic gene expression at transcription and translational levels and various transcription factors involved
LO3: Students will gain knowledge about the machinery required for manipulating gene and methods of cloning
LO4: Students will be able to understand the difference between cloning and expression vectors and to identify the recombinant clones
LO5: Students will acquire knowledge about different types of DNA libraries and their uses and also about various types of hybridization techniques

Unit-1

Lac operon: Structure and function, Induction of *lac* operon – a negative control system, Catabolite repression – a positive control system; Function and regulation of *trp* operon, Attenuation of *trp* operon, *Ara* operon - Dual functions of the repressor
Diversity of sigma factor - Bacterial sporulation and Phage infection in *Bacillus subtilis,* Heat-shock response in *E.coli,* Regulation of phage variation in *Salmonella*
Regulation of lytic phase and lysogenic phase of Bacteriophage λ

Unit-2

Chromatin and Gene regulation: Hypersensitive sites, DNA methylation, Histone acetylation, Histone code, Chromatin remodeling; Heterochromatin and Silencing
Different levels of Eukaryotic gene control: Transcriptional Control – Eukaryote promoter and enhancer sequence organization, Transcription activators and silencers, DNA binding protein motifs - Zinc-Fingers, Homeodomains, Helix-Loop-Helix, Leucine Zipper; Post-transcriptional control – Alternate splicing, Trans splicing, RNA editing, RNA transport, RNA stability
Regulation of Gene Expression by Small RNAs (RNA Interference, RNAi) Translational control; Regulation of galactose metabolism in Yeast; Steroid hormone mediated gene expression and regulation

Unit-3

Discovery and Properties of Restriction endonucleases: Restriction modification system, Restriction maps, DNA modifying enzymes
Cloning vectors: Vectors for *E. coli*: Plasmids, M 13 bacteriophage vectors, λ bacteriophage, Cosmids, Phagemids; Eukaryotic cloning vectors: Cloning vectors for Yeast, YAC, Cloning vectors for higher Plants - Ti plasmid, Ri plasmid,
Cloning vectors for Insects, Viruses as cloning vectors for Mammals
Ligation of fragments - Cohesive and Blunt ends, Linkers, Adaptors, Homopolymer tailing

Unit-4

Introduction of DNA in living cells: Transformation, Identification of recombinants, Introduction of Phage DNA into bacterial Cells (Transfection), Identification of recombinant phage
Expression of foreign gene: Gene expression in E coli, Production of recombinant proteins in Eukaryotes, Fungi, Yeast, Mammalian and Insect cell systems; Gene transfer techniques - Biological and Artificial

Unit-5

DNA libraries: Methods used for construction of Genomic and c DNA libraries, Identification of recombinant clones - Colony and Plaque hybridization, Probing, Southern blotting, Northern blotting, South-Western blotting

Polymerase chain reaction: concept, types, methods and applications; Biological, Medical and Industrial applications of recombinant DNA technology

Refernce books:

1. Genes V - Benjamin Lewin
2. Recombinant DNA: A Short course - J.D.Watson et al., 3rd ed
3. Gene cloning and DNA Analysis – T.A.Brown, 6th ed
4. Principles of Gene Manipulation: An Introduction to Genetic Engineering - Sandy B. Primrose, Richard Twyman, Bob Old, 6th ed
5. Genetic Engineering by Sandhya Mitra.
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA - Bernard R. Glick, Jack. J. Pasternak

M.Sc. BIOCHEMISTRY
III SEMESTER
BC 3.4: INDUSTRIAL BIOTECHNOLOGY

Course Outcomes:

CO1: To learn the principle of fermentation and its types such as surface, submerged and solid state fermentations, different types of culture techniques for bacteria and fungi, design and operation of fermentors and types of fermentors such as continuous stirred tank fermentor and air-liftfermentor

CO2: To understand types of reactions in fermentations, criteria of selection and characteristics of industrial microorganisms, role of primary and secondary metabolites, different strategies for strain improvement and maintenance of the industrial strains

CO3: To understand the need for using raw materials, different types of fermentation media, recovery of products, steps involved in downstream processing and applications of bioreactors

CO4: To learn the production of ethyl alcohol, n-butanol, wine, beer; fermentative production of organic acids, antibiotics, enzymes, amino acids, vitamins and production of biogas from agricultural waste

CO5: To understand the advantages for preparing immobilized enzymes and cells, methods of immobilization, immobilization of multienzyme systems, effect of partition on kinetic properties of enzymes, types of enzyme reactors, what are the problems in using immobilized biocatalysts, industrial and medical applications of immobilized enzymes, principle, types and applications of biosensors, principle and applications of protein engineering

CO6: To learn the production and applications of single cell protein, importance of microbial transformations, types (steroidal transformations), applications, bioleaching, biosorption, biodegradation, bioremediation, Biofertilizers – Blue-green algal fertilizers (*Azolla*, *Aneabena*), seaweed fertilizers, *Mycorrhiza*, Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses

Course Specific Outcomes:

CSO1: The objectives of this course are to introduce students to developments/advances made in field of microbial technology for use in human welfare and solving problems of the society

CSO2: Students should be able to appreciate relevance of microorganisms from industrial context

CSO3: Students should be able to carry out stoichiometric calculations and specify models of their growth

CSO4: To understand the basics of process of fermentation technology and learnt the concept of Screening, optimization and maintenance of industrially important microbial cultures and further in production of biodiesel

CSO5: Students should be able to give an account of design, development and operations of various bioreactors and production optimization, and preparation of sterile base materials for downstream processing

CSO6: Students should be able to calculate yield and production rates in a biological production process, and also interpret data

CSO7: Students should be able to give an account of important microbial/enzymatic industrial processes

CSO8: The course will introduce major groups of microorganisms tools in biotechnology and their most important environmental applications

Learning outcomes:

LO1: The students will be able to understand the principles of fermentation culture techniques, design and operation of fermentors
LO2: The students will be able to know fermentation reactions, characteristics of industrial Microorganisms, role of metabolites, strategies for strain improvement and maintenance of the industrial strains
LO3: The students will be able to understand the use of raw materials, fermentation mediaand bioreactors, recovery of products, anddownstream processing
LO4: The students will learn the fermentative production of alcohols, organic acids, antibiotics, enzymes, amino acids, vitamins and biogas
LO5: The students will be able to understand the concept of preparing immobilized enzymes and cells, immobilization and its effect on kinetic properties of enzymes, applications of immobilized enzymes, biosensors, protein engineering
LO6: The students will learn the production and applications of single cell protein, microbial transformations,bioleaching, biosorption, biodegradation, bioremediation, biofertilizers, biocontrol agents, biopesticides
LO7: On completion of this course, students would develop deeper understanding of the industrial biotechnology and its applications

Unit-1

Introduction to Fermentation technology – Bacterial growth and factors effecting growth.Principles of fermentation, surface, submerged and solid state fermentations. Batch, fed batch, semi-continuous and continuous culture techniques. Design and operation of fermentors, Agitation and aeration, Types of fermentors- continuous stirred tank fermentor (CSTF), air-liftfermentor

Unit-2

Types of reactions in fermentations, selection and characteristics of industrial microorganisms, Primary and secondary metabolites, Strategies for strain improvement and maintenance of the industrial strains. Raw materials, different types of fermentation media, Recovery of products, steps in downstream processing, Bioreactors

Unit-3

Production of ethyl alcohol, n-butanol, beer and wine. Fermentative production of Organic acids - citric acid, lactic acid, acetic acid; Antibiotics - penicillin, streptomycin, tetracycline;Amino acids - glutamic acid, lysine; Enzymes - amylase, proteases, streptokinase, and Vitamins - $B_{12,}$ $B_{2,}$ and vitamin C. Production of biogas from agricultural waste

Unit-4

Introduction to Immobilization of enzymes and cells – methods of immobilization, effect of partition on kinetic properties of enzymes, immobilization of multienzyme systems. Enzyme reactors - packed bed reactors, fluidized bed reactors, problems in using immobilized biocatalysts, Industrial and medical applications of immobilized enzymes and cells. Principle, types and applications of Biosensors. Principle and applications of Protein engineering

Unit – 5

Production and applications of single cell protein, Microbial transformations (bioconversions)-: Types and applications, steroidal transformations. Bioleaching, biosorption, biodegradation, bioremediation. Biofertilizers – Blue-green algal fertilizers (*Azolla, Anabaena*), seaweed fertilizers, *Mycorrhiza*. Biocontrol agents- Siderophores, biopesticides – Insecticidal toxin of *Bacillus thuringiensis*, mode of action and control, Bacculoviruses

Reference books:

1. Biotechnology-A text book of Industrial Microbiology-W.Crueger, A.Crueger, 3rd ed
2. Industrial Microbiology-L.E.Casida, 2nd ed
3. Molecular Biology and Biotechnology-J.M.Walker, E.B.Gingold, 4th ed
4. Concepts in Biotechnology-D.Balasubramanian et al.,
5. Text book of Biotechnology-T.T.Pandian, D.Kandavel
6. Essentials of Biotechnology-U.K.Patil, K.Muskhan
7. Molecular Biotechnology-S.Ramreddy, K.Venkateswarlu et al.,
8. Biotechnology - U.Satyanarayana
9. Principles of fermentation technology - Stanbury, P. F., & Whitaker, A Press.

M.Sc. BIOCHEMISTRY
III SEMESTER
PRACTICAL -I
BC 3.5: IMMUNOLOGY AND FOOD ANALYSIS

Course Outcomes:

CO1: To offer hands on experience on various immunology techniques such as Radial Immunodiffusion, Immunoelectrophoresis, Rocket Immunoelectrophoresis and Western blotting.
CO2: To provide skills in performing purification of bovine serum immunoglobulin and ELISA.
CO3: To learn to extract and estimate total lipids from oil seeds.
CO4: To provide hands on experience in the preparation of carotene, chloroplasts and haemoglobin and isolation of glycogen and glutamic acid from foods.
CO5: To learn to analyse minerals from foods.

C**ourse Specific Outcomes:**

CSO1: To offer hands on experience on various advanced immunology techniques.
CSO2: To provide skills in performing various diagnostic tests-typhoid, VDRL and pregnancy tests.
CSO3: To provide hands on experience in the preparation of glycogen, carotenes, chloroplasts and glutamic acid from various foods.

Course Learning Outcomes:

LO1: Students will develop skills to perform various immunoassays such as Ouchterlony immunodiffusion, Western Blotting, ELISA for diagnosis of various diseases.
LO2: Students will also learn techniques to purify immunoglobulins and the principles of blood typing.
LO3: Students will acquire expertise in the determination of moisture in food, and determination of minerals, amino acids in various foods.
LO4: Students will learn to isolate glycogen from sheep liver and preparation of haemoglobin from blood.

IMMUNOLOGY (A)

Determination of A, B, O and Rh blood groups in human beings
Dissection and Identification of thymus, spleen and lymph nodes
Techniques of Immunization and Bleeding
Ouchterlony immunodiffusion for detection of Antigens
Radial Immunodiffusion
Immunoprecitation and precipitin curve
Immunoelectrophoresis
Rocket immunoelectrophoresis

Purification of bovine serum IgG by ammonium sulphate precipitation
Enzyme Linked Immuno Sorbent Assay (ELISA)
Western blotting
Diagnostic test for typhoid fever
VDRL Test
Pregnancy Test

FOOD ANALYSIS (B)

Isolation of Glycogen from Sheep Liver Preparation
of Carotenes from Carrots Preparation of
Haemoglobin from Blood Preparation of
Chloroplasts from green leaves Isolation of Glutamic
acid from Gluten of Wheat
Extraction and estimation of total lipids from oil seeds (solvent extraction)
Quantitative analysis of foods for -

Moisture
Ash
Iron
Calcium
Copper

Reference books:

1. Keith Wilson and John Walker, Principles and techniques of Practical Biochemistry, 2010, Seventh edition, Cambridge University Press
2. Holme. D. J. and Peck. H., Longman Analytical Biochemistry, 1998, 3rd edition.
3. Chatwal, G & Anand, S, Instrumental methods of chemical analysis, 2005, Himalaya Publishing House
4. S. K. Sawhney & Randhir Singh, Introductory Practical Biochemistry, 2014, Narosa Publications House

M.Sc. BIOCHEMISTRY
III SEMESTER
PRACTICAL -II
BC 3.6: INDUSTRIAL BIOTECHNOLOGY AND GENETIC ENGINEERING

Course Outcomes:

CO1: To provide the laboratory skills for fermentative production of industrially important products
CO2: To gain hands on experience for preparation of immobilized enzymes and microbial cells
CO3: To offer basic skills on use of UV spectrophotometer for quantification of DNA
CO4: To provide hands on experience on use of restriction enzymes and other ligation methods
CO5: To offer hands on experience on separation of nucleic acids and their recovery from gels
CO6: To provide practical knowledge about different DNA markers

C**ourse Specific Outcomes:**

CSO1: Development of laboratory skills for the production of antibiotics, organic acids, enzymes, amino acids, vitamins etc.
CSO2: Gain basic knowledge for preparation of immobilized enzymes and cells
CSO3: Gain thorough knowledge on use of instruments required to carry out genetic engineering practicals

Course Learning Outcomes:

LO1: Students will be able to get hands on experience on fermentative production of industrially important products.
LO2: After completion of practicals students will be familiar in quantification of Nucleic acids using UV spectrophotometer.
LO3: Students will be able to get hands on experience on Immobilization enzymes and cells by entrapment method.
LO4: Students will acquire the hands on experience on experiments related to genetic engineering.
LO5: After completion of the course students will be familiar in RFLP, PCR and southern blotting techniques

INDUSTRIAL BIOTECHNOLOGY (A)

Fermentative production and quantification of:

Antibiotics - penicillin/ streptomycin/tetracycline
Organic acid: citric acid/ lactic acid/ acetic acid
Enzymes: amylase/ protease/urease
Amino acid: glutamic acid/ lysine
Vitamins: B_{12}/ B_2/vitamin C
Ethyl alcohol/ fruit wine and calculation of fermentation efficiency

Methods of immobilization of protein/enzyme and microbial cells

GENETIC ENGINEERING (B)

Isolation of plasmids and estimation of plasmid DNA by UV method
Restriction digestion of λ DNA, Ligation of RE fragments
Agarose and Polyacrylamide gel electrophoresis of nucleic acids
Recovery of DNA/RNA fragments from agarose gels Preparation of competitive *E.coli* cells and transformation Expression of cloned gene (GFP)
DNA finger printing (RFLP or RAPD)
PCR
Southern blotting

Reference books

1. Genome Mapping: A practical approach. Dear P (Editor). 1st Ed. 2000. Oxford University Press: Oxford
2. Molecular Cloning – A Laboratory Mannual, Sambrook.
3. Manual of Industrial Microbiology and Biotechnology - Richard H. Balt et al., 3rd ed

M.Sc. BIOCHEMISTRY

IV SEMESTER

BC 4.1: CLINICAL BIOCHEMISTRY AND ENDOCRINOLOGY

Course Outcome:

CO1: To offer detailed knowledge about the Gastrointestinal hormones and methods of evaluation

CO2: To provide basic concepts on study of Liver diseases and liver functional tests

CO3: To offer basic concepts of the significance of Pancreatic and Thyroidal hormones

CO4: To offer detailed knowledge on the role of enzymes in diagnosis of various diseases

CO5: To provide basic concepts on the biological actions of Hypothalamic and Adenohypophysial hormones

Course Specific Outcome:

CSO1: To offer detailed knowledge on disorders of gastric function, Abnormalities in blood formation

CSO2: To provide basic concepts on biochemical investigations of renal disorders and endocrine disorders of pancreas

CSO3: To offer detailed knowledge on biochemistry of reproductive disorders and hypothalamic disorders

Course Learning Outcome:

LO1: Students will acquire knowledge on Plasma proteins and their variation in diseases

LO2: Students will learn the functions of thyroidal and parathyroidal hormones

LO3: Students will acquire insight into the functions of Renal hormones and biochemical investigation of Renal disorders

LO4: Students will gain insight into biosynthesis of adrenal medullary and adrenal cortical hormones

Unit -1

Gastrointestinal hormones - Gastrin, secretin and cholecystokinin. Disorders of gastric function, methods of evaluation. Pancreatic exocrine secretions, pancreatic diseases, steatorrhoea. Malabsorption syndrome – tests for their evaluation and significance

Plasma proteins – Properties, functions and their variations in diseases, Plasma lipids and lipoproteins, Interrelationship of lipids, lipoproteins and apolipoproteins. Erythropoiesis, abnormalities in blood formation. Anemias. Heamoglobinopathies. Cerebrospinal fluid – composition in health and diseases

Unit – 2

Liver function tests, their significance, Liver diseases – Jaundice, hepatitis, gall stones, cirrhosis and fatty liver. Free radical mechanism and role of reactive oxygen species in diseases. Role of liver in metabolic regulation and drug metabolism. Clinical chemistry of new born

Kidney – Renal hormones –Renin, erythropoietin and angiotensin. Investigations of renal functions, biochemical investigation of renal disorders. Nephritis, nephrotic syndrome and urolithiasis. Compensatory mechanism for acidosis and alkalosis

Unit – 3

Pancreatic hormones – Biosynthesis of insulin, regulation of secretion of insulin and glucagon, their role in carbohydrate,lipid and protein metabolism. Endocrine disorders of pancreas – Diabetes mellitus, melliturias, hypoglycemia. Glucose tolerance test
Thyroidal hormones – Chemistry, function and metabolism. Hypo and hyper thyroidism, tests for thyroid function. Parathyroid hormones – Parathormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of parathyroid functions and methods of evaluation

Unit – 4

Clinical enzymology - Plasma enzymes in diagnosis and prognosis, Isoenzymes in health and diseases (Liver, cardiac and skeletal muscle enzymes)
Adrenals - Chemistry and biosynthesis of adrenal medullary and adrenal cortical hormones. Disorders of adrenal cortex and adrenal medulla, tests for the evaluation of adrenal functions. Biochemical effects of tumours

Unit – 5

Synthesis,secretion, transport, and biological actions of hypothalamic, Adeno hypophysial and neurohypophysial hormones. Hypothalamic disorders. Pituitary - Clinical syndromes and their evaluation. Penial hormones – Melatonin and serotonin
Chemistry, biosynthesis and role of androgens, estrogens and progesterone. Hormonal regulation of menstrual cycle, Hormonal contraception. Placental hormones. Biochemistry of reproductive disorders, pregnancy toxemia, pregnancy tests

Reference books:

1. Nutritional Elements and Clinical Biochemistry -M.A. Brewster, H.K.Naito
2. Text Book of Biochemistry with clinical correlations-Thomas M. Devlin, 7th ed
3. Clinicalchemistryindiagnosisandtreatment–JoanF.ZilvaandP.R.Pannall
4. Clinical Biochemistry – S.Ramakrishnan,Rajiswami
5. Chemical chemistry -W.J.Marshall&S.K.Bangert, 5th ed
6. Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3rd Ed by Allan Gaw, Michael Murphy, et al., 3rd ed

7. Text book if endocrine physiology- J. E. Griffin, S. R. Ojeda, 4th ed
8. Endocrinology - Mac Hadley, 5th ed
9. Williams Text book of endocrinology- S.Melmed et al., 13th ed
10. General Endocrinology –Turner C.D, J.T.Bagnara, 6th ed

M.Sc. BIOCHEMISTRY

IV SEMESTER

BC 4.2: GENOMICS AND PROTEOMICS

Course Outcomes:

CO1: Enable the students to learn and understand the detailed developments and applications of genomics, proteomics and computational biology studies and their relevance on research platform

CO2: The knowledge acquired by the students will enable them to perform *in-silico* experiments to predict the structures of proteins and there by drug discovery for real life situations

CO3: To expose the students to the available bioinformatics tools to understand the protein and DNA sequence analysis

CO4: To enable the students to get trained in the application of programs used for database searching

CO5: To enable the students to access software which will clarify sequence alignments and predicting the structures of biomolecules

Course Specific Outcomes:

CSO1: The specific outcome of this course is to facilitate the students to understand the fundamental principles of Genomics and proteomics and to develop an understanding of key concepts from the enormous amount of experimental data that is rapidly emerging in this field

CSO2: To enable the student to understand the different areas of genomics

CSO3: To learn about evolutionary relationship of different organisms at molecular level

CSO4: Expose the student to the methods that analyze the protein coding potential of the gene sequence of the DNA

CSO5: Enable the student to explore the possible structure prediction vs expected functional outcome of the desired biomolecule

Learning Outcomes:

The students who complete this course, will be able achieve these outcomes

LO1: It enables the students to understand fundamental principles of structural, functional, and comparative Genomics

LO2: To comprehend the sequence alignment, Database Similarity Searches like BLAST, FASTA etc.,

LO3: The course will aid in learning Phylogenetic analysis which includes phylogenetic tree evolution and phylogenetic programs

LO4: Students will get trained in the principles of proteomics and its application along with fundamental aspects of techniques used in *in-silico* protein structure prediction

LO5: The course will help the student to acquaint with Homology Modeling, molecular docking, and Drug Designing

Unit- 1

Structural genomics- Genome annotation, Gene finding, Gene Prediction Programs - Ab Initio based and Homology based Programs
Functional Genomics – Sequence based, and Microarray based Approaches
Comparative genomics - Orthologs, paralogs, and homologs

Unit-2

Sequence alignment: Similarity, identity and homology. Concept of Alignment –Pair-wise sequence alignment, gaps, gap-penalties, scoring matrices, PAM250, BLOSUM62, local and global sequence alignment, multiple sequence alignment, Application of multiple sequence alignment. Progressive Alignment Algorithm, BLAST, FASTA

Unit- 3

Molecular phylogeny concept. Tree types, Tree construction – Clustering based methods - UPGMA, Neighbor joining; Character based methods - Maximum Parsimony, Maximum Likelihood. Boot strapping - Parametric and Nonparametric; Phylogenetic programs-Clustal-W, COBALT, Phylip, PHYML

UNIT- 4

Types of Proteomics - Protein expression proteomics, Structural proteomics, Functional proteomics, Significance, and applications of proteomics in Biology

Introduction to principle and techniques – 2D gel electrophoresis, DIGE electrophoresis, MALDI- TOF/TOF, Q –TOF. LC-MS, Tandem MS (MS-MS), Micro-arrays of proteins

UNIT- 5

Molecular Modeling –Advancements and Applications, Structural organization of proteins; Understanding Molegro Molecular viewer for protein 3D visualization – RASMOL. Protein secondary structure prediction – Chou Fasman method; Tertiary structure prediction- Homology modeling

Docking studies (Using Molegro Virtual Docker) - Molecule Import and preparation from PDB. Docking, Analysis, Constrains, Data analyser, sidechain flexibility and templet docking

Drug discovery – target identification, target validation, lead identification, lead optimization, Phase I, II and III clinical trials

Reference books:

1. Principles of Genome Analysis: a guide to mapping and sequencing DNA from different organisms - Primrose S.B, 2nd ed
2. Essential Genetics- A Genomics Perspective – Daniel L.Hartl, 5th ed
3. Principles and Practices of Plant Genomics - Chittaranjan Kole, Albert G. Abbott, vol – II
4. Genomes 4 - T. A. Brown
5. Recombinant DNA by J. D. Watson, latest edition
6. Proteome Research Concepts Technology And Application - M.R. Wilkins
7. Principles of Proteomics – Ian Moore
8. Introduction to Proteomics - Mishra Nawin C
9. Principles of Proteomics – Richard Twyman, 2nd ed
10. Introduction to Proteomics - Liebler Daniel C
11. Proteomics- Principles, Techniques and Analysis- Wyatt
12. M. Michael Gromiha, 2010. Protein Bioinformatics: From Sequence to Function, Academic Press.
13. Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring HarborLaboratory Press (New York)

M.Sc. BIOCHEMISTRY

IV SEMESTER

BC 4.3: BIOSTATISTICS AND BIOINFORMATICS

Course Outcomes:

CO1: To offer detailed knowledge on study of the measures of central tendency and measurement of dispersion
CO2: To provide basic concepts to learn the laws of probability and probability distributions
CO3: To offer basic concepts of correlation and regression and statistical tests of significance and Analysis of variance
CO4: To provide the basic knowledge on different devices, organization and operating systems used in computers
CO4: To offers the basic knowledge on importance of Human Genome Project, features of organism genome and current trends in genome sequencing.
CO5: To provide the knowledge on features of various data bases and its importance, deposition of data and retrieval of the data from the database.

Course Specific Outcomes:

CSO1: To offer basic concepts of probability theory and distributions, Statistical tests of significance for making statistical inferences
CSO2: To provide basic concepts of different devices and operating systems of computer for making efficient use in day-to-day life
CSO3: To offers the basic knowledge on genome sequence similarities/differences of various organisms in order to understand its functions
CSO4: To offer basic concepts of databases, types, and for making data deposition and retrieval

Learning Outcomes:

LO1: Students will have insight into proper statistical analysis of the data
LO2: Students will learn the importance of mean, standard error, standard deviation and their significance in presenting the data
LO3: Knowing statistical methods will help students in improving their analytical and interpretation skills
LO4: Knowing the devices and operating systems will help students in improving their usage of computers
LO5: Knowing the genome features and genome sequences will help the students to understand the functions of genes
LO6: Students will learn the importance of databases that will be helpful in getting sequences for alignment and for docking studies

Unit-1

Principles of Biostatistics - Biostatistics fundamentals (sample, population, variable); Measures of central tendency - mean, median, mode; Measurement of dispersion - range, variance, standard deviation
Events, Basic principles of probability theory - Addition and Multiplication laws of probability, Bayes theorem, Normal distribution, Binomial distribution, Poisson distribution; Study of bivariate data - correlation, scatter diagram, coefficient of correlation; Regression, Regression lines

Unit- 2

Statistical tests of significance - Statistical inferences - Types of errors; Level of significance - Null hypothesis, Alternate hypothesis; Standard error, Student's 't' test for comparison of means, 'F' - test for comparison of variances, chi square test - goodness of fit; Analysis of variance (ANOVA) - one way classification and two way classification

Unit-3

Organization of computers, External and internal storage devices, Basics of operating systems, Introduction to DOS, Windows, Unix, Linux systems and basic commands; WWW, HTML, HTTP, Intra net and Internet concepts
Introduction to Bioinformatics - History and major developments; Branches of bioinformatics, Scope and applications of Bioinformatics in biology and medicine

Unit-4

Genome projects: Human genome projects, features of yeast genome and Arabidopsis genome.
Sequencing: High throughput DNA sequencing, Whole genome sequencing, Next Generation Sequencing, Strategies for sequencing genomes- shot gun sequencing contig assembly, sequencing editing

Unit- 5

Data Bases: Introduction to Data Bases, features and types of data bases
INSD-International Nucleotide Sequence Database - Gen Bank, EMBL, DDBJ, special focus on NCBI; Protein sequence Data base - Swissprot , Tr- EMBL, PIR, Uniprot and Pfam; Structural Data bases-PDB, CATH, SCOP, MMDB

Reference books:

1. Introduction to Bioinformatics - T.K. Attwood, D.J.Parry-Smith
2. Fundamental Concepts of Bioinformatics - Dane E. Krane, Michael L. Raymer
3. Bioinformatics (Sequence and Genome Analysis)- David W. Mount, 2nd ed
4. Discovering Genomics, Proteomics and Bioinformatics – A. Malcom Campell, L.J Heyer, 2nd ed
5. Biostatistics For Dummies - John Pezzullo
6. Essential Medical Statistics - Betty R. Kirkwood, Jonathan S.C. Sterne, 2nd ed
7. Statistical methods- S.P. Gupta
8. Biostatistics – P.N. Arora, P.K. Malhan, Himalaya Publishing House
9. Schaum's Outline Series on Statistics – Murray L. Spiegel, Larry J. Stephens

M.Sc. BIOCHEMISTRY
IV SEMESTER
BC 4.4: APPLIED BIOCHEMISTRY

Course Outcomes:

CO1: To identify the DNA protein interactions in order to regulate gene expression in both prokaryotes and eukaryotes
CO2: To gain the knowledge about various techniques used in tissue culture to obtain high yielding and disease resistant varieties etc
CO3: To understand the propagation of animal cells and tissues under laboratory conditions and their importance
CO4: To gain knowledge about stem cells and their importance in treatment of diseases
CO5: To acquire knowledge about types of vaccines, their preparation and applications of gene therapy

Course Specific Outcomes:

CSO1: The course highlights the techniques used for identifying DNA protein interactions and DNA markers used in rDNA technology
CSO2: The course covers broad range of plant tissue culture aspects and its applications in production of transgenic plants
CSO3: Major emphasis of the course was on maintaining primary cultures and continuous cell lines and their behaviour under *in vitro* conditions
CSO4: More emphasis of the course was on different properties and types of stem cells and their preservation and applications
CSO5: The course also covers broad spectrum of vaccination strategies and types. It also covers the importance of gene therapy and nanotechnology

Learning Outcomes:

LO1: Students will understand about various types of DNA markers used in rDNA technology and importance of DNA fingerprinting in forensics and also about gene silencing and its implication
LO2: Students will acquire a good knowledge aboutregeneration of plants, somatic embryogenesis, and also about production of secondary metabolites using cell cultures, which will be useful for them to carry out research using plant tissue culture aspects in future
LO3: Students will gain thorough knowledge about the primary cultures and their maintenance, continuous cultures and their maintenance which will be useful for them to carry out research using cell lines in future
LO4: Students will be able to understand the importance of stem cells and use of stem cells in treating diseases like Parkinson's and Alzheimer's
LO5: Students will acquire knowledge about different types of vaccines and recent developments in vaccine preparation and delivery and also about the importance of nanoparticles in treatment of diseases and industrial applications

Unit- 1

Nucleic acid and protein interactions: DNA foot printing, CAT assay, Gel shift analysis. DNA markers in genetic analysis – RFLP, Minisatellites, Microsatellites, PCR based RAPD markers, Chromosomal Walking, Chromosomal jumping,DNA fingerprinting, SNPS
Mapping Genes – Somatic cell hybridization mapping, FISH, Transposon tagging; RNA silencing – siRNAs and anti- sense RNAs- their design and applications; shRNA, Epigenetic gene silencing

Unit-2

Plant tissue culture: Culture media – Composition and preparation, Totipotency, Different stages of Micropropagation, Somatic embryogenesis, Somaclonal variations, Artificial seeds, Isolation and culture of protoplasts, Somatic hybridization, cybrids, Anther culture, Plant cell suspension cultures, Production of secondary metabolites through *in vitro* culture,Transgenic plants and their applications

Unit-3

Animal tissue culture: Composition and preparation of culture media, Natural and Synthetic media. Cell culture methods: Suspension and Monolayer Cultures, Primary cultures, established cell lines, Characteristics of transformed cells. Behaviour and characteristics of cells in cultures, Three dimensional cultures - Organ culture, Histotypic culture and Organotypic culture; Transgenic animals and their applications

Unit-4

Stem cells – Properties of stem cells – Potency, Stem cell plasticity,
Types of stem cells - Embryonic stem cells, Adult stem cells, Cord blood stem cells;
Preservation of stem cells, Applications of stem cells in regenerative medicine- Parkinson's disease and Alzheimer's disease;Gene therapy –Types, Strategies and Approaches for gene therapy, Viral and Non-Viral vectors for gene therapy, Gene therapy in Cancer, Cystic Fibrosis, SCID

Unit-5

Vaccines: Principles of vaccination, Design of vaccines, Conventional vaccines – Whole organism- inactive and attenuated, Purified macromolecules,New generation vaccines- Recombinant antigen vaccines, Recombinant vector vaccines, DNA vaccines, Synthetic peptide multivalent sub unit vaccines, Vaccine delivery systems – Liposomes, Micelles, ISCOMS; Strategies for developing vaccines for Malaria, HIV and covid-19. Nanotechnology- Principle and applications in Medicine, Food Science and Environment

Reference books:

1. Plant Cell and Tissue Culture - A Tool in Biotechnology - Neumann, Karl-Hermann et al.,
2. Plant Tissue Culture- Roberta Smith, 3rd ed
3. Introduction to Plant Biotechnology – H.S.Chawla, 3rd ed
4. Textbook of Animal Biotechnology – B.Singh, S.K.Gautham
5. Vaccine Adjuvants and Delivery Systems - Manmohan Singh
6. Nanoparticulate Vaccine Delivery Systems – Martin J.D'Souza
7. Metabolic Engineering: Principles and Methodologies - Aristos A. Aristidou, Jens Nielsen et al.,
8. Human Embryonic Stem Cells - Ann Kiessling , Scott C. Anderson, 2nd ed
9. Concepts and Applications of Stem Cell Biology - Rodrigues**,** Gabriela et al.,
10. Principles of Gene Manipulation: An Introduction to Genetic Engineering - Sandy B. Primrose, Richard Twyman, Bob Old, 6th ed
11. Biotechnology – U.Satyanarayana
12. Nanotechnology : Principles and Applications – R. K. Sindhu, Mansi Chitkara, 1st ed

M.Sc. BIOCHEMISTRY
IV SEMESTER
PRACTICAL - I
BC 4.5: CLINICAL BIOCHEMISTRY

Course Outcomes:

CO1: To offer hands on experience in analyzing blood for haemoglobin, and derivatives, glucose and Glycosylated haemoglobin.
CO2: To provide skills in determining serum creatine and creatinine, uric acid, bilirubin etc.
CO3: To offer knowledge in estimating marker enzymes such as SGOT, SGPT, LDH, creatine kinase etc.
CO4: To provide skills in analysis of plasma for fibrinogen.
CO5: To offer hands on experience in analysis of urine for urea and oxogenic steroids.

Course Specific Outcome:

CSO1: To offer hands on experience in analysis of blood and plasma.
CSO2: To provide skills in analysis of serum.
CSO3: To offer knowledge in analysis of urine.

Course Learning Outcome:

LO1: Students will acquire practical training for estimation of clinically important compounds like blood glucose, serum cholesterol, Glycosylated haemoglobin, calcium, etc.
LO2: This will enable the students to perform diagnostic tests for the diseases related to varying levels of these compounds/chemicals.
LO3: Students will get hands on experience in analyzing marker enzymes in various diseases.
LO4: Students will learn analysis of urine under various conditions.

CLINICAL BIOCHEMISTRY (A)

Analysis of serum for:
Creatine and creatinine
Uric acid by chemical and enzymatic methods
Bilirubin
Chlorides
Calcium
HDL Cholesterol and LDL cholesterol
Total proteins, Albumins and globulins
Thymol turbidity and zinc sulphate turbidity tests
SGOT and SGPT
LDH, Gamma glutamyl transferase

Acid and Alkaline Phosphatase
Creatine Kinase

CLINICAL BIOCHEMISTRY (B)

Analysis of Blood for:
Hemoglobin and derivatives – Spectroscopy
Glucose by chemical and enzymatic methods
Glycosylated hemoglobin
Analysis of Plasma for:
Fibrinogen
Analysis of Urine for:
Qualitative tests and microscopic examination
Urea by micro diffusion method
17 Oxo and 17 – Oxogenic steroids

Reference books:

1. Varley's Practical Clinical biochemistry – Vol – I, Ed.Alan W.Gowen lock
2. Varley's Practical clinical Biochemistry – Vol-II, Ed. Alan W. Gowenlock
3. Clinical diagnosis and management by Lab methods - John Bernard Henry, W.B. Salunders Company, 1984).

M.Sc.BIOCHEMISTRY
IV SEMESTER
PRACTICAL - II
BC 4.6: BIOSTATISTICS AND BIOINFORMATICS

Course Outcomes:

CO1: To offer hands on experience in performing data analysis by using mean, median, mode, variance, and standard deviation
CO2: To provide skills in Data analysis by student t-test and Analysis of variance
CO3: To provide knowledge to calculate correlation coefficient and regression analysis
CO4: To provide the basic knowledge data bases and its importance, deposition of data and retrieval of the data from the database
CO5: To offer the knowledge to compare the unknown DNA/Protein sequence with the deposited sequences in the database by and to perform Pairwise/multiple sequence alignment
CO6: To provide the knowledge on construction of phylogenetic tree using molecular characters
CO7: To offer the knowledge on separation of protein using 2-Dimensional gel electrophoresis

Course Specific Outcomes:

CSO1: To provide skills in data analysis for biological interpretations
CSO2: To provide skills in deposition and retrieval of data from database
CSO3: To provide skills in Pairwise/multiple sequence alignment using BLAST/FAST/CLUSTAL-W to identify similarity
CSO4: To provide skills in Pairwise/multiple sequence alignment using BLAST/FAST/CLUSTAL-W to identify similarity
CSO5: To generate experimental skills in the construction of phylogenetic tree
CSO6: To develop the experimental skills in the separation of proteins using 2-Dimensional gel electrophoresis

Course Learning Outcomes:

LO1: Students will acquire hands-on practical training to plan biological experiments with requisite sample size
LO2: After completion of experiments based on different sample sizesstudents will be able to perform proper statistical analysis of the data using mean, median, mode, variance and standard deviation
LO3: Statistical training will improve computational, mathematical and computer skills of the students by learning theuse of ANOVA, and student t-test
LO4: Students will acquire the hands on experience to deposit and retrieve the data from database
LO5: After completion of the course students will easily perform Pairwise/multiple sequence alignment for unknown sequences using

Sequence similarity searching tools

LO6: After completion of the course students will able to construct phylogenetic tree

LO7: Students will acquire knowledge on separation of proteins

BIOSTATISTICS (A)

Data analysis - Calculating Mean, median, mode, variance, standard deviation, standard error for a given data set.
Student's 't' test and Analysis of variance (ANOVA).
Chi square test - goodness of fit.
Calculation of correlation coefficient, Regression analysis.
Learning to analyse data using SPSS software.

BIOINFORMATICS (B)

Search of databases:
Using DNA sequence, identifying the protein through database
Using amino acid sequence of a protein, identifying the gene through database
Alignment of DNA and protein sequence using BLAST, FASTA
Multiple sequence alignment (MSA) of proteins and nucleic acids
Phylogenetic tree construction using CLUSTAL tools
Demonstration of 2D electrophoresis

Reference books:

1. Bioinformatics sequence, structure and data banks - By Des Higgins Willie Taylor. Practical approach
2. Bioinformatics sequence, structure and data banks - Des Higgins, Willie Taylor –2000
3. Fundamentals of Biostatistics: Practical Approach – Naren Kr Dutta
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey).

ANDHRA UNIVERSITY

Telegrams: UNIVERSITY
Telephone: 284 4000
Fax: 0891-2755324

All Official letters, packages etc, should be addressed to the Registrar by designation and not by name

No. L.II (1)/Science & Technology/2021

Visakhapatnam,
Dt. 25-10-2021.

From: **THE REGISTRAR**

To

The Faculty Chairman,
P.G. Academic Departments,
College of Science & Technology,
Andhra University,
Visakhapatnam.

Sir,

Sub: Approval of New Education Policy given by the Government of India and UGC model Curriculum from the admitted batch of 2020-21 – Reg.

Ref: 1. The Faculty Chairman, along with the members of the P.G. Board of Studies in A.U College of Science & Technology.
2. Minutes of meeting of the Standing Committee held on 16-08-2021.
3. Minutes of meeting of the Academic Senate held on 25-08-2021 (vide item No. '20').

* * *

With reference to the above, I am by direction to inform that the Implementation of the following regulations of all the P.G Academic Departments, A.U College of Science & Technology in light of the New Education Policy given by the Government of India and UGC model Curriculum from the admitted batch 2020-21 has been approved by the Academic Senate.

1. To make mandatory of one Massive Open Online Course (MOOC) (from national or international recognized institutions) each in 3rd and 4th semesters with 2 credits each for M.Sc. courses in all the academic departments of AU College of Science & Technology.
2. To make mandatory of project work in the 4th semester for M.Sc. courses in all the academic departments of A.U College of Science & Technology.
3. To make mandatory of value added course viz., IPR course with 2 credits in 3rd semester and another value added course, Research Methodology/any other course relevant to the discipline (Duration: 30 hours) with 2 credits in 4th semester for M.Sc. courses in all the academic departments of AU College of Science & Technology.

Contd....

It is also informed to circulate the same among the Teaching staff and students concerned.

Thanking you,

Yours faithfully,

(K.UMA MAHESWARI)
DEPUTY REGISTRAR (ACADEMIC)

Copies to :

1. The Principal, College of Science & Technology, A.U., Visakhapatnam.
2. The Dean, Academic Affairs, Andhra University, Visakhapatnam.
3. The Controller of Examinations, Andhra University, Visakhapatnam.
4. The Superintendents of E-VIII & S I Sections, Andhra University, Visakhapatnam.
5. The Honorary Director, Computer Centre, Andhra University, Visakhapatnam.
6. The Secretary to Vice-Chancellor, Rector table & P.A. to Registrar, AU.
7. O.C. & O.O.F.

SYLLABUS

A.U. College of Science and Technology

IV SEMESTER

With effect from 2021- 2022 admitted batch of students

Paper - RESEARCH METHODOLOGY

Introduction of Research Methodology: Meaning of research, objectives of research, types of research, significance of research, research process.	**2 hours**
Research Problem: Definition, defining research problem, formulation of research problem, objectives of research problem. Meaning, need and features of good research design, types of research designs.	**4 hours**
Design of Data Collection and sampling: Primary and secondary data, sources of primary and secondary data, questionnaire design. Census and sample surveys, Characteristics of a good sample design, different types of sample designs, techniques of selecting a random sample.	**8 hours**
Computer Role in Research: Introduction to statistical packages; Ms-Excel and SPSS.	**4 hours**
Data Editing and Data Handling: Methods of editing and data validation.	**2 hours**
Methods of Data Analysis: Descriptive Statistics-Measures of Central Tendency, Measures of Dispersion. Correlation and regression analysis. Testing of hypothesis-t-test, F-test, ANOVA. Chi-square Test. Data reduction techniques and factor analysis.	**8 hours**
Report Writing: Basic concepts of report writing, significance of report writing, different steps in writing report, layout and types of research reports. methods of presentation of research report.	**2 hours**

Text Books:

- Research Methodology Methods & Techniques, 2008 C.R. Kothari – New Age international Publishers.
- Essentials of Research Design and Methodology, 2011,Geoffrey Marczyk, David DeMatteo and David Festinger, John Wiley & Sons, Inc.
- Fundamentals of Mathematical statistics, 1999, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons, New Delhi