SAURASHTRA UNIVERSITY

RAJKOT

(ACCREDITED GRADE "A" BY NAAC)

FACULTY OF SCIENCE

Syllabus for

M.Sc. (BIOCHEMISTRY)

Choice Based Credit System

With Effect From: 2016-17

Department of Biochemistry
Course Structure and Scheme of Examination
For Choice Based Credit System (CBCS)
(Total 96 credits)
Effective from June 2016

M. Sc. Biochemistry
Program Outcomes (PO)

PO1:
Academic Competence

Disciplinary knowledge and understanding of biochemistry, structure and function of biological molecules. By the end of four semesters of M.Sc. Biochemistry, students will gain the breadth and depth of scientific knowledge in 'Biochemistry' and allied areas.

PO2:
Critical thinking

Students will be able to demonstrate an experiential learning and critical thinking with problem solving abilities.

PO3:
Research and development

Students will be able to generate ideas for research, analyze them and execute them. Demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level.

PO4:
Personal and Behavioural Competence

Basic professional skills pertaining to biochemical analysis, carrying out clinical diagnostic tests and gain the ability to use skills in specific areas related to biochemistry such as industrial production, clinical, health etc.

PO5:
Effective Communication

Students will develop the ability for articulation of ideas, scientific writing and authentic reporting, effective presentation skills. Also they will learn conversational competence including communication and effective interaction with others, listening, speaking, and observational skills.

PO6:

Social Competence

They will be able to plan and manage projects in order to achieve objectives along with ability to work in a group or community.

PO7:

Self directed and Continuous learning

They will be able to recognize the need for continuous up gradation of their knowledge and skills for continuing professional development.

M. Sc. Biochemistry
Program Specific Outcomes (PSO)

PSO1:
Obtain essential knowledge and skills to pursue a career in research, industry and in academic set up.

PSO2:
Apply the understanding of experimental approaches to solve problems and will have an ability to implement solution to new problems.

PSO3:
Integrate and apply the techniques in Analytical biochemistry, Clinical biochemistry, Microbiology, Molecular biology and Bioinformatics.

PSO4:
Evaluate the depth of scientific knowledge in the broad range of fields including Cell biology, Metabolism, Pharmaceutical Biochemistry, Genetics, Nutritional Biochemistry, Immunology and Enzymology.

PSO5:
Describe and express the biochemical basis of human diseases, protein structure and conformation, non-invasive diagnostics, biochemical pathway regulation and drug development and synthesize this knowledge and apply the same for multitude of laboratory applications.

Semester -1

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
CBC 1	Fundamentals of Biochemistry	4	4	30	70	100	2.5
CBC 2	Metabolism	4	4	30	70	100	2.5
CBC 3	Enzymology	4	4	30	70	100	2.5
	Interdisciplinary						
IBC 1	Analytical Techniques	4	4	30	70	100	2.5
PBC 1	Practical	6	18	-	150	150	06
-	Assignment	2	2	-	50	50	-
Total		24				600	

Semester -2

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
CBC 4	Cell Biology and Genetics	4	4	30	70	100	2.5
CBC 5	Human Physiology and Endocrinology	4	4	30	70	100	2.5
CBC 6	Molecular Biology	4	4	30	70	100	2.5
	Interdisciplinary						
IBC 2	Bioinformatics and Biostatistics	4	4	30	70	100	2.5
PBC 2	Practical	6	18	-	150	150	06
-	Seminar	2	2	-	50	50	-
Total		24			600		

Semester -3

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Core						
CBC 7	Immunology	4	4	30	70	100	2.5
CBC 8	Clinical and Nutritional Biochemistry	4	4	30	70	100	2.5
	Elective (Any One)						
EBC 1	Microbial Biochemistry	4	4	30	70	100	2.5
EBC 2	Pharmaceutical Biochemistry and Regulatory affairs	4	4	30	70	100	2.5
EBC 3	Plant Biochemistry	4	4	30	70	100	2.5
PBC 3	Practical	8	18	-	200	200	06
-	Research article presentation	4	2	-	100	100	01
Total		24				600	

Semester -4

Subject Code	Title of the Course	Course Credits	No. of Hrs. Per Week	Weightage For Internal Examination	Weightage For Semester End Examination	Total Marks	Duration of Semester End Exam in Hrs.
	Elective (Any One)						
EBC 3	Research Methodology	4	4	30	70	100	2.5
EBC 4	Animal Cell Tissue Culture	4	4	30	70	100	2.5
-	**Project Work**						
-	Dissertation work	20	30	-	500	500	01
Total		24				600	

SEMESTER-1

CBC 1: FUNDAMENTALS OF BIOCHEMISTRY

Objectives:

The objective of this paper is to provide students with a basic understanding of…

- The physical and chemical properties of the components of living things
- The principles of bioenergetics
- Structural, chemical biology and three-dimensional construction of macromolecules (carbohydrates, proteins, nucleic acids and lipids)
- Functional properties and importance of carbohydrates, proteins, nucleic acids and lipids.

Course Outcome:

CO1: To understand the concepts of preparation of buffers, molarity, normality, ionization, molality.

CO2: The understanding of different types of chemical bonding, molecular machinery of living cells, principles that govern the structures of macromolecules and their participation in living system.

CO3: To identify with the classification and structural properties of carbohydrates, proteins, nucleic acids and lipids,glycoproteins and glycolipids and their significance in biological systems.

CO4 : By the end of the course, the students will be able to demonstrate advanced knowledge and understanding of aspects of physical and chemical properties of aqueous solutions, concepts of free energy

UNIT 1: Overview of Biochemistry

Properties of Aqueous Solutions, Concepts of Acid – Base, pH, pK, Titration Curve and Buffers. Different Kinds of Bonds, Molarity, Normality, Ionization, Molality, Osmolarity

UNIT 2: Bioenergetics

First and Second Law of Thermodynamic, Internal Energy, Enthalpy, Entropy, Concept of Free Energy, Standard Free Energy change of a Chemical Reaction, Redox Potentials, ATP and high Energy Phosphate Compounds

UNIT 3: Fundamentals of Proteins and Nucleic Acids

Protein structure, functions, Classification and Importance, Amino acids: Common structural features, Physical and Chemical Properties, Titration of Amino acids, Separation of Amino acids, Essential Amino acids. Nature of Genetic Material, Composition of DNA and RNA, Classification of Nucleic acids, Structure and Role of different types of RNA

UNIT 4: Fundamentals of Carbohydrates and Lipids

Carbohydrates: Classification, Basic Chemical structure, Monosaccharides, Aldoses, and Ketoses, Cyclic structure of Monosaccharides, Steroisomerism, Anomers and Epimers. Sugar Derivatives, Deoxy Sugars, Amino Sugars, and Sugar acids, disaccharides, oligosaccharides and polysaccharides. Lipids: General Reaction and Properties. Classification, Structure and Function of major lipids, Circulating lipids, Separation Techniques lipoproteins, LDL, HDL, and VLDL.

REFERENCES

1. Laboratory Manual in Biochemistry by Jayraman
2. Biochemistry by Stryer
3. Dynamics of Proteins and Nucleic Acids by Mccammon, J. A. & Harvey, S. C.
4. Fundamentals of Protein Structure and Function by Buxbaum, E.
5. Instant Notes in Biochemistry by Hames, B. D. & Hooper, N. M.

CBC 2: METABOLISM

Objectives:

The Metabolism paper aims to provide:

- An advanced understanding of the core principles and topics of metabolic process and their biochemical reactions.
- To enable students to acquire a specialized knowledge and understanding of how enzymes and metabolites in living system works to produce energy and synthesizing different biomolecules
- To study biochemical pathways involved in intermediary metabolism.
- The metabolism of dietary and endogenous carbohydrate, lipid, and protein
- To understand the principles and major mechanisms of metabolic control and of molecular signaling by hormones

Course Outcome:

CO1: Metabolism refers to all biochemical reactions which occur in the living organisms.

CO2: By studying this paper students will able to differentiate the anabolic and catabolic pathways and their important enzymatic steps, understand how glycolysis produces metabolic energy as well as producing intermediates for further metabolic reactions.

CO3 :To acquire knowledge related to the principles and basic mechanisms of metabolic control and how regulation of biochemical pathways leads to normal integrated metabolism, understand the organization of a typical mitochondrion, locating membranes, enzymes, respiratory complexes, the F_0-F_1 complex, important transporter proteins and how it functions to synthesize ATP

CO4: To understand the importance of Integration of Metabolism, degradation, catabolism, hormonal regulation of metabolism etc will be exposed with the fact that perturbations in the bimoleculas lead to various diseases. To open new way into metabolic engineering for the production of useful compounds.

UNIT 1: Carbohydrate Metabolism

Glycolysis, Feeder Pathways for Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, Glycogen Metabolism, Citric Acid Cycle, Glyoxylate Cycle, Regulation and Stoichiometry of

Carbohydrate Metabolism, Integration of Metabolism – Tissue Specific Metabolism, Hormonal Regulation of Metabolism.

Unit 2: Metabolism of Proteins and Amino Acids

Metabolic Fates of Amino Groups, Amino Acid Degradation Pathway, Biosynthesis of Amino Acids, Amino Acid Decarboxylation, Protein degradation, Nitrogen Excretion and the Urea Cycle.

UNIT 3: Lipid & Nucleotide Metabolism

Lipids digestion, Absorption and Transport, Functions of Prostaglandins, Metabolism of Fatty Acids, Cholesterol and other Lipids, Stoichiometry of Fatty Acid Catabolism, Regulation of Fatty Acid Metabolism, Metabolism of Nucleotides

UNIT 4: Oxidative Phosphorylation

Architecture of the Mitochondrion, Electron-Transfer Reactions in Mitochondria: Components of the Mitochondrial Electron Transport System, Sequence of Electron Carriers, Structures and Functions of the Individual Complexes, Inhibitors of ETC

REFERENCES

1. Biochemistry by Voet & Voet
2. Lehninger Principles of Biochemistry by Nelson, D. L. & Cox, M. M.
3. Biochemistry by Mathews
4. Biochemistry by Satyanarayana, U.
5. Biochemistry: The Chemical Reactions of Living Cells by Metzler, D. E.

CBC 3: ENZYMOLOGY

Objectives:

To study classification and basic structural properties of enzyme
Detailed study on mechanical and kinetics properties of enzyme including various models of kinetics and various types of inhibition
To acquire a detail knowledge of mechanism of enzyme action, regulation and allostery in enzyme
To develop an understating on application and technological aspects of commercial valuable enzyme

Course Outcome:

CO1: Students will be prepared for theoretically & practically to understand properties of enzyme.

CO2 :Enzymes are functional and its role in living system is unique. To understand ability to difference between a chemical catalyst and biocatalyst along with concept of enzymes-substrate kinetics and its importance in biological reactions.

CO3 :Enzymology paper is core Biochemistry subject, detailed understating of enzymology will help students to prepare their mind for interdisciplinary functional properties of protein.

CO4 : This paper gives platform to develop vast range of application of industrially valuable enzymes.

UNIT 1: Introduction and basics of Enzymology

Scope of enzymology, Classification and Nomenclature, Specificity of enzyme action, kinetics and catalysis of chemical and enzymatic reactions

UNIT 2: Kinetics and Inhibition

Kinetics of single substrate enzyme-catalyzed reaction: M.M. equation, L.B. Plot, Edie-Hofstee and Hanes plot, Eisenthal and Cornish-Bowden plot, Haldane reaction, Rapid reaction kinetics, Kinetics of multi-substrate catalyzed reaction: Mechanism of enzyme reaction, Investigation of reaction mechanism, Enzyme inhibition: Reversible and Irreversible inhibition

UNIT 3: Enzyme Catalysis and Allostery

Enzyme Catalysis (Acid, Base, Electrostatic, Metal ion), Mechanism of enzyme action with and without cofactor, Active site determination, Cooperativity in Hemoglobin, Various Models of Allostery, Regulation of Enzyme Activity.

UNIT 4: Enzyme technology and applications

Immobilization of Enzymes, Enzyme Technology for Industrial, Medicine and Clinical Applications, Uses of Enzymes Electrodes and Biosensor, Biotransformation. Enzyme Engineering: Chemical Modification and Site Directed Mutagenesis to Study Structure and Functional Relationship, Asymmetric Reactions thought Enzyme and Nonaqueous Enzyme Technology.

REFERENCES

1. Enzymes : Biochemistry Biotechnology And Clinical Chemistry by Palmer, T.
2. Fundamentals of Enzymology by Price & Stevens
3. Enzyme kinetics - A modern approach by Marangoni, A. G.
4. Enzyme Kinetics Principles and Methods by Bisswanger, H

IBC 1: ANALYTICAL TECHNIQUES

Objectives:

- The objectives of this paper is to develop student's knowledge and capabilities in areas of analytical chemistry that are particularly relevant to the analysis of a range of sample types.
- To understand the physical principles of a range of quantitative and quantitative analytical techniques.
- To study the range of spectroscopic technique to characterize the biomolecules.
- To understand the governing mechanisms and driving forces of various advanced separation processes.

Course Outcome:

CO1: Analytical science is the study of the determination of the chemical composition of natural and artificial materials using both classical and modern instrumental techniques.

CO2: From this paper students will gain a deep understanding of chemical principles, especially those relevant to the chemistry of chemical analysis.

CO3 :Students will gain theoretical and practical knowledge of experimental methods and analytical instrumentation.

CO4 :Students will be able to safely and efficiently select and apply appropriate analytical methods to the analysis of real problems; able to interpret data from analytical methods, and will understand approaches for the validation of these analytical methods.

UNIT 1: Microscopy and Autoradiography

Theories of Tissue Fixation and Staining Techniques. Principles of Transmission and Scanning Electron Microscopy, Confocal Microscopy. Principles of Phase Contrast and Fluorescence Microscopy. Principle and Applications of Autoradiography

UNIT 2: Spectroscopy

Basic Principles of Spectroscopy, UV, IR, Raman, ESR, ORD. CD and Structure of Proteins using NMR and ESR. Neutron and X-Ray Diffraction for Elucidation of 3D Structure. Molecular Modelling, Mass Spectrometry

UNIT 3: Chromatographic Techniques

Basic Principle and types of Chromatography. Gas Chromatography, GC-MS, LC – MS / MS. Ion Exchange Chromatography, Gel permeation, Affinity and Reverse Phase Chromatography. HPLC and FPLC

UNIT 4: Centrifugation and Electrophoretic Techniques

Principle and Applications of Centrifugation Techniques. Basic Principles of Electrophoresis, Agarose Gel, Native and SDS-PAGE. Isoelectric Focusing, 2D-PAGE and their uses in Protein Research and Protein Fractionation.

REFERENCES

1. Analytical Biochemistry by Holme, D. J. & Peck, H.
2. Biochemical calculation by Segel
3. Introduction to Protein Architecture: The structural biology of proteins by Lesk, A. M.
4. Modern Experimental Biochemistry by Boyer, R.
5. Biochemistry by Todd, W. B., Mason, M., Bruggen, R. V. & Macmillan

PBC-1: PRACTICAL

1. Protein extraction from the milk.
2. Protein estimation by UV Spectroscopy.
4. Protein estimation by Biuret method.
5. Protein estimation by Folin Lowry's method.
6. Protein estimation by Bradford method.
7. Extraction method of sugar.
8. Sugar estimation by DNSA method.
9. Sugar estimation by Phenol Sulphuric acid method.
10. Cholesterol estimation by Libermann and Buchard method.
11. Lipid extraction and estimation by Suphovanillin method.
12. Estimation of DNA by diphenylamine method.
13. Estimation of RNA by Orcinol method.
14. Estimation of amino acid by Ninhydrin method
15. Standard curve of maltose

17. Enzyme curve of amylase
18. Temperature curve of amylase
19. pH curve of amylase
20. Substrate curve
21. Specific activity of amylase
22. Activity staining of amylase
23. Standard curve of Maltose
24. Activity of Immobilized Amylase
25. Paper chromatography
26. Thin layer chromatography
27. Enzyme inhibition
28. Activity Staining

SEMESTER 2

CBC 4: CELL BIOLOGY AND GENETICS

Objectives

- To equip students with a basic knowledge of the structural and functional properties of cells.
- To examine properties of differentiated cell systems and tissues.
- Aspect of cell cycle and cell death.
- To introduce the fascinating mechanism of cell signaling along with brief overview on developmental biology.
- To provide thorough knowledge on classical genetics.

Course Outcome:

CO1: Students will understand the structures and purposes of basic components of cell, especially membranes and organelles.

CO2: Appreciate the cellular components underlying cell division along with a deep insight to cell division, cell death and uncontrolled cell division.

CO3 :Students will learn the basic principles of inheritance and patterns of heredity.

CO4: Students will test and deepen their mastery of genetics by applying this knowledge in a variety of problem-solving situations.

UNIT 1: Cells, Cell Organelles & Membrane Biochemistry

Evolution and Introduction of Cell Types including Cellular Specialization and Differentiation, Differences in Plant and Animal Cells, Eukaryotic Cell Organelle's Structure, Functions and Biochemistry, Chemical Composition and function of Biomembranes, Model

of Lipid Membranes, Models of Plasma membranes and techniques to study fluidity, Structural and Functional aspects of Cytoskeleton

UNIT 2: Cell Signaling and Developmental Biology

Signal Transduction: Heterotrimeric G-Protein, Tyrosine Kinase Based Signaling, Phosphoinositide Cascade. Embryogenesis, Patterning in Early Vertebrate Embryo, Control of Body Segmentation.

UNIT 3: Cell Cycle

Phases of Cell Cycle, Functional Importance of each Phase, Molecular Events during Cell Cycle, Cytoskeleton in Cell Division, Regulation of Cell Cycle, Apoptotic Pathway and Cell Death, Uncontrolled Cell Division (Mutations in Proto-oncogenes, tumor suppressor genes and DNA repair genes)

UNIT 4: Classical Genetics

Fundamentals of genetics: Mendelian pattern of Inheritance, Variations to Mendelian pattern (Incomplete dominance, epistatis, etc.,). Quantitative inheritance (Inheritance of complex traits), Multiple alleles and physical basis of heredity, Population Genetics (Hardy-Weinberg's law), Linkage, Crossing over, Chromosome mapping and tetrad analysis in higher organisms. Molecular mechanisms of recombination.

REFERENCES

1. Cell Biology Protocols by Harris, R., Graham, J. & Rickwood, D.
2. Color Atlas of Biochemistry by Koolman, J. & Roehm, K. H.
3. Molecular Biology of The Cell - Bruce Alberts
4. Molecular Cell Biology by Lodish, H.
5. Molecular biology of the gene by Watson.
6. Genes IX by Lewin, B.
7. Essential Molecular Biology by T. A. Brown

8. Cell Biology Protocols by Harris, R., Graham, J. & Rickwood, D.
9. Color Atlas of Biochemistry by Koolman, J. & Roehm, K. H.
10. Current Protocols in Protein Science (All Vol) John Wiley & Sons

CBC 5: HUMAN PHYSIOLOGY AND ENDOCRINOLOGY

Objectives:

- The course is designed to assist the students to learn and understand fundamental concepts and principles of respiratory, renal, digestive, cardiovascular, muscle and neuro physiology.
- To develop a vocabulary of appropriate terminology to effectively communicate information related to anatomy and physiology.
- To study the interrelationships within and between anatomical and physiological systems of the human body.
- To understand the basic mechanisms of homeostasis by integrating the functions of cells, tissues, organs, and organ systems.
- To study the roll and mechanism of endocrine system in metabolism, regulation of normal homeostatic condition of body and other physiological functions.

Course Outcome:

CO1: This course will provide a sound basis in human physiology to support in-depth understanding of physiological processes of all body systems in detail and on an appropriate level.

CO2: Students will able to explain how the activities of organs are integrated for maximum efficiency.

CO3 :Students will be prepared to identify how changes in normal physiology lead to disease and it will support further study in health and medical sciences or related fields.

CO4: This paper will also provide understanding of hormonal action in human body to regulate normal physiological activity of different organ system as well as metabolic process.

UNIT 1: Respiration, Renal Physiology and Fluid Balance

Functional Anatomy of Respiratory System, Pulmonary Ventilation, Lung Volumes and Capacities, Principles and Mechanism of Gas Exchange, Oxygen and Carbon-Dioxide Transport, Regulation of Respiration, Body Fluid Compartments, Regulation of Fluid Balance, Regulation of Extracellular Sodium and osmolarity, Acid-Base Balance, Functional Anatomy of Kidney, Glomerular Filtration, Urine Formation, Renal Mechanisms for The Control of Blood Volume, Blood Pressure and ionic Composition.

UNIT 2: Digestive System and Cardiac System

General Anatomy and Principles of Gastrointestinal Function, Propulsion and Mixing of Food in the Alimentary Tract. Composition, Mechanism of Secretion and Functions of Different Digestive Juices. Digestion and Absorption of Various Dietary Components in the Gastrointestinal Tract, Functional Anatomy of Heart, Blood Circulation, Cardiac Cycle, Electrocardiogram.

UNIT 3: The Muscular System and Nervous System

Contraction and Excitation of Skeletal Muscles, Smooth Muscles and Cardiac Muscle, Organization of the Nervous System, Basic Functions of Synapses, Sensory Receptors, Nerve Impulse Transmission, Neurotransmitters and their Receptors. Neurophysiology of Vision, Sense of Hearing, Chemical Senses, Motor and Integrative Neurophysiology.

UNIT 4: Endocrinology

Introduction to Endocrinology, Pituitary Hormones and Their Control by the Hypothalamus, Thyroid Hormones, Hormones of Adrenal Gland, Insulin, Glucagon, Parathyroid Hormone, Calcitonin. Reproductive Hormones of the Male and Female.

REFERENCES

1. Principles of Anatomy & Physiology by Tortora, G.J.

2. Textbook of Medical Physiology by Guyton and Hall
3. Essentials of Medical Physiology by Sembulingam K.
4. Proteins: structure and function by Whitford, D.
5. Human Physiology by Devis

CBC 6: MOLECULAR BIOLOGY

Objectives:

- Detailed understanding of prokaryotic and eukaryotic replication, types of DNA polymerases and inhibitors of DNA replication
- To gain detail on prokaryotic and eukaryotic transcription, translation and gene expression regulation
- In depth study of various types of vectors, hybridization technique and its application
- To develop an understating of advanced technologies like RFLP, Sequencing, SSR, REMAP, SCAR and various types of PCR

Course Outcome:

CO1: Students will choose appropriate experimental strategy for research in basic and molecular biology.

CO2: To perform laboratory techniques in basic biology, molecular biology, and advanced techniques. Explanation and integration of biological principles, as applied to basic and molecular biology.

CO3 :Development of strong diversified background in modern biology, appropriate to the individual student goals. Develop critical-thinking, and problem based learning skills.

CO4: This paper will open an understanding of current trends in molecular and genetic research, and critically appraise published work. Students will be prepared to demonstrate an ability to design, undertake, and interpret, a research project, presented in the form of a dissertation.

UNIT 1: DNA Replication

DNA and Chromosome Structure, Importance of DNA Replication, DNA Polymerases, Other Enzymes and Protein involved in DNA Replication, Mechanisms and Regulations of DNA Replication, Inhibiters of DNA Replications, Major Differences between Prokaryotic and Eukaryotic DNA Replication.

UNIT 2: Transcription & Translation

Transcription in Prokaryotes, RNA Polymerases, Promoters, Initiation, Elongation and Termination of RNA synthesis, Inhibitors of RNA Synthesis, Concept of Reverse Transcriptase. Post-transcriptional Modifications, Basic Features of Genetic Code, Mechanisms of Translation, Ribosome Structure, A and P sites, Importance of Different Codon, Regulation of Gene Expression in Prokaryotes: Enzyme Induction and Repression, Operon Concepts, LAC Operon, TRP Operon

UNIT 3: Vectors and Characterization of Nucleic Acids

Principles and Uses of Nucleic Acid Hybridizations; Principles and Methods of Nucleic Acid Sequencing; Immuno-Chemical Techniques (DNA, RNA and Protein). Properties and Applications of Plasmids, Phagemids, Phage Vectors, Cosmids, YAC, BAC, etc.

UNIT 4: Molecular Markers and Techniques

Mapping and DNA Fingerprinting: Methodology and Applications of Restriction Mapping; RFLP; RAPD; AFLP; ChIP; Chromosome Walking; ARDRA; SSR; REMAP and SCAR Analysis. Polymerase Chain Reaction: Principle and Basic types of PCR; Reverse Transcription and Real Time PCRs; Factors affecting PCR; Applications and Precautions.

REFERENCES

1. Molecular Biology of The Cell - Bruce Alberts
2. Molecular Cell Biology by Lodish, H.
3. Molecular biology of the gene by Watson.
4. Genes IX by Lewin, B.
5. Essential Molecular Biology by T. A. Brown

6. Principles Of Gene Manipulation And Genomics by Primarose
7. Molecular Cloning by Russell Sambrook
8. Introduction to Molecular Biology by Paolella, P.

IBC 2: BIOINFORMATICS AND BIOSTATISTICS

Objectives:

- Detailed understanding of genome projects, related disciplines of Bioinformatics use of Databases and Tools in Biological Discovery, Major Bioinformatics Resources
- To gain detail on biological databases like primary sequence databases, protein three dimensional databases, Protein Structure Mathematical model databases, PCR and quantitative PCR primer databases, Chemical Databases, Drug & Drug Target / Therapeutic Target Databases, Disease databases, Immunological database.
- In depth study of various types of tools including sequence submission tools, Chemical molecule designing software, Protein & Chemical molecule visualization tools, Docking software, Molecular dynamics software; QSAR, ADME Toxicity prediction, Allergen prediction, Venomics & Antivenomics.
- To develop an understating of statistical methods and calculations

Course Outcome:

CO1: Students will choose appropriate experimental strategy for research in basic and applied biology.

CO2: Explanation and integration of bioinformatics principles and its applications to basic and applied biology.

CO3:Students will gain *in silico* training on data mining, database searching, software application, quantitative analysis and interpretation, molecular modeling, QSAR and various DNA, RNA and Protein analytical tools.

CO4:Moreover, this paper enables students to acquire the knowledge of statistical analysis and its principles.

Unit 1: Basic concepts of Bioinformatics

Genome projects, History of Bioinformatics, Related disciplines of Bioinformatics (Branches of Bioinformatics), Nature of Biological data, Use of Databases and Tools in Biological Discovery, Major Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB, JCVI, SANGER, etc.., Literature databases, Scholarly Metrics-Journal, Article, Author & Book.

Unit 2: Biological Databases

Primary Sequence Databases - Nucleic acid and Protein, Protein Secondary databases, Protein three dimensional databases, Protein Structure Classification database, Genome databases, Proteomics databases, Protein model databases, Coding and noncoding RNA databases, Carbohydrate structure databases, Protein-protein and other molecular interactions databases, Signal transduction pathway databases, Metabolic pathway and Protein Function databases, Microarray databases, Exosomal databases, Mathematical model databases, PCR and quantitative PCR primer databases, Phenotype databases, Taxonomic databases, Chemical Databases, Drug & Drug Target / Therapeutic Target Databases, Disease databases, Immunological database, Antimicrobial peptide databases, and Specialized databases.

Unit 3: Bioinformatics Tools

Sequence submission tools, Computational methods of gene prediction, Database search tools: GQuery and EB-eye; Basic concepts of sequence alignment: pairwise & Multiple sequence alignment, Global & Local alignments, and Scoring matrix; Basic terminologies: motifs, fingerprints, domains, family, superfamily, profile, matrix, fold, Identity, similarity, positives, score, etc..; Basics of Database similarity search tools, and Phylogenetic analysis; Predictions: Post translational Modification, Protein secondary structure, Protein 3D structure & assessment, protein families, patterns and profiles, protein-protein interaction, RNA structure, Noncoding RNA prediction-methods & Tools; Chemical molecule designing software, Protein & Chemical molecule visualization tools, Docking software, Molecular dynamics software; New approaches / concepts: Subtractive Genomics, Reverse vaccinology, Target fishing, Polypharmacology, Bacteriocin prediction, QSAR, ADME Toxicity prediction, Allergen prediction, Venomics & Antivenomics.

UNIT 4: Statistical Tests in Biology

Mean, Median, Mode, Student's t Test, Meaning of Significance and Significance Levels

Analysis of Variance. Analysis of Covariance, Regression and Correlation Analysis, Qui square test, Confidence limits

REFERENCES

1. Fundamentals of Biostatistics by Bernard Rosner 5th Ed.
2. Bioinformatics Methods and Applications by Rastogi, S.C.
3. Bioinformatics for Dummies by Jean-Michel Claverie
4. Textbook of bioinformatics by Subramaniam, C.
5. Introductory Biostatistics by Chap T. Le
6. Fundamentals of Biostatistics by Bernard Rosner
7. Review & Research papers from Bioinformatics & related Journals
8. Arthur M. Lesk, Introduction to Bioinformatics, Oxford University Press, 2008.
9. David W. Mount, Bioinformatics – Sequence and Genome analysis, 2004.
10. G. Gibson & S.V.Muse, A Primer of Genome Science, 2009.
11. A. Baxevanis and B.F. Ouellette. Bioinformatics: A practical Guide to the Analysis of Genes and Proteins, Wiley- Interscience, Hoboken, NJ, 2005.
12. A. M.Campbell & L. J. Heyer, Discovering Genomics, Proteomics & Bioinformatics, CSHL Press, 2006.
13. S.R. Pennington & M.J. Dunn, Proteomics – from protein sequence to function, BIOS Scientific Publishers, 2002.

PBC-2 PRACTICAL

1. Agarose Gel Electrophoresis
2. Isolation Of DNA From Blood
3. Bacterial Transformation
4. Western Blotting
5. Isolation Of Plasmid DNA By Alkaline Lysis Method
6. Bacterial Genomic DNA Isolation
7. DNA Extraction From Plant Tissue (Strawberry)
8. Nucleic Acid Purity Assessment Using A260/A280 Ratio
9. Plasmid Preparation By CTAB Method
10. Identification Of Barr Body From Buccal Smear
11. Isolation Of Chlorophyll
12. Mitosis

13. Osmosis In Onion Cells
14. Effect Of Temperature On Plant Cell Membrane
15. Isolation Of Chloroplast
16. Retrieve Sequence From Nucleotide Databases (Genbank, Ena, Ddbj)
17. Retrieve Sequence From Protein Primary Sequence Database: Unipro
18. Study Of Literature Database – Pubmed
19. Study Of Compound Database -Pubchem
20. Drug And Target Databases
21. BLAST SEARCH And Phylogenetic Tree
22. Download Protein 3D Structure From Pdb
23. Protein 3D Structure Visualization Tool –Rasmol
24. Protein Secondary Structure Prediction Tools
25. 3d Structure Prediction: Swiss-Model
26. Interpro

SEMESTER 3

CBC 7: IMMUNOLOGY

Objectives:

- In-depth knowledge and understanding of major cellular and molecular mechanisms underlying immunological processes in health and diseases
- To acquire a knowledge of immunochemical techniques in qualitative and quantitative analysis of antibodies and antigens.
- An understanding of the factors that determine the effectiveness of immune responses to microorganisms (bacteria, viruses, parasites) and tumours and how protective immunity can be elicited by vaccination

Course Outcome:

CO 1: To attain a working knowledge of current immunological principles as they relate to the cells and molecules of the immune system.

CO 2: Understanding of mechanism of interaction in defending the body against invading microorganisms.

CO 3: Students will get knowledge of development and acquisition of ability to recognize antigens and finally how they malfunction in autoimmune diseases.

CO 4: Students will extend and solidify their understanding of the presented principles through critical readings from the primary research literature.

UNIT 1: The Immune System and Effect or Mechanism

Properties and Overview of Immune Response, Innate Immunity, Cells and Tissues of The Adaptive Immune System, Cytokines, Effect or Mechanism of Cell Mediated Immunity, Effect or Mechanism of Humeral Immunity

UNIT 2: Recognition of Antigens and Maturation, Activation, Regulation of Lymphocytes

Antibodies and Antigens, The Major Histocompatibility Complex, Antigen Processing and Presentation to T Lymphocyte, Antigen Receptors and Accessory Molecules of T and B Lymphocytes, Lymphocyte Development and the Rearrangement and Expression of Antigen Receptor Genes, Activation of T Lymphocyte, B Lymphocyte and Antibody Production, Immunological Tolerance

UNIT 3: Diagnostic Immunology, Hybridoma Technology and Vaccination

Antigen and Antibody Reactions: Precipitation and Agglutination Reactions, Immunofluorescence Assay ,ELISA Assay, Immunoelectrophoresis Techniques, Production of Monoclonal and Polyclonal Antibodies, Applications of Monoclonal Antibodies, Vaccines

UNIT 4: The Immune System in Defense and Immunological Disorders

Immunity to Microbes, Transplantation Immunology, Immunity to Tumors, Hypersensitive Reactions, Autoimmune Disorders, Immunodeficiency

REFERENCES

1. Practical and Clinical Immunology by Talwar, G. P.
2. Immunology by Kuby
3. Immunology by Roitt
4. Immunology by P M Lydyard

5. Immunology by Richard

CBC 8: CLINICAL AND NUTRITIONAL BIOCHEMISTRY

Objectives:

- To study the classification and functional properties of blood components.
- To understand the coagulation, anti-coagulation mechanism of blood and its disorders.
- To study the biochemical, clinical, pathological and diagnostic aspects of diseases.
- To study dietary types, requirements, utilization and functions of different class of diet.
- To study the nutrition deficiency disorders and balance diet.

Course Outcome:

CO 1: Advanced understanding and knowledge of theoretical and practical aspects of blood biochemistry and its components.

CO 2: Connection of blood to entire organ system of body in single circulatory channel and consequences of environmental and genetic factors of blood disorders.

CO 3: Rationale and theoretical basis for methods and tools used in the diagnosis of common biochemical disorders.

CO 4: Distinguish between between fat-soluble vitamins and water-soluble vitamins, biochemical functions and synthesis for these vitamins.

UNIT 1: Blood

Functions and Components of Blood, Different Types of Blood Cells and its Physiology, Formation of Blood Cells, Blood Clotting - Extrinsic and Intrinsic Pathways of Blood Clotting, Control Mechanism for Blood Clotting, Blood groups, Blood transfusion, Laboratory Test to Measure Coagulation and Thrombolysis, Anemia, Polycythemia, Hemoglobinopathy, Tissue and Organ Transplantation.

UNIT 2: Diseases

Biochemical, Clinical, Pathological and Diagnostic Aspects of Diseases- Gastritis, Ulcer, Inflammatory Diseases. Liver: Jaundice and Cirrhosis. Kidney: Glomerulonephritis, Nephrotic Syndrome. Diabetes, Hypertension, Atherosclerosis and Myocardial Infarction, Respiratory System: Tuberculosis and Asthma. Malaria, AIDS, Cancer.

UNIT – 3: Nutritional Aspects of Carbohydrates, Lipids and Proteins:

Introduction, Different Dietary Types, Requirements, Utilization and Functions, Special Role of the Unavailable Carbohydrates, Essential Fatty Acids, Essential Amino Acids, Nutritive Value of Proteins and the Methods for its Determination, Amino Acid Imbalance, Protein Requirements, Utilization and Functions

UNIT – 4: Balanced Diet and Vitamins

Recommended Dietary Allowances for Different Categories of the Human Beings, Disorders Related to the Nutrition- Protein Energy Malnutrition, Starvation, Obesity, Classification of Vitamins, Dietary Sources, Rda, Functions and Biochemical Role of Vitamin A, Vitamin B Complex, B_1thiamine, B_2riboflavin, Niacin, Folic Acid, Vitamin B_{12}, Vitamin C, Vitamin D, Conversion of Vitamins from Precursor: β-Carotenes to Vitamin-A, Argosterol to D3, Disease of Vitamins Deficiency: Clinical Symptoms, Prevention and Treatment

REFERENCES

1. Vitamins, Their Role in the Human Body by Ball
2. The Vitamins by Gerald F. Combs
3. Human Nutrition by Geissler Powers
4. Human Nutrition and Dietetics by Ashok Kumar Sharma
5. Nutritional Biochemistry by Tom Brody
6. Human Nutrition and Dietetics by Davidson & Passmore

EBC 1: MICROBIAL BIOCHEMISTRY

Objectives

- To enable the student to learn the regulation of genes in bacteria.
- Morphology, classification and types of viruses.
- To introduce to the process of biological nitrogen fixation.
- Detailed information on antibiotics.

Course Outcome:

CO 1: Students will be able to appreciate the entire spectrum of microscopic life forms - from relatively simple, small but unique viruses to bacteria.

CO 2: Enable the students to understand the fine mechanism of regulation of gene expression. Awareness will be created on different types of viruses and diseases caused by them.

CO 3: Appreciate the crucial role played by bacteria in nitrogen metabolism.

CO 4: Students will get deep insight to antimicrobials.

UNIT 1: Regulation of Genes in Bacteria

Nucleic Acids as Carriers of Genetics Information, Arrangement and Organization of Gene in Prokaryotes: Operon Concept, Catabolite Repression, Instability of Bacterial RNA, Inducers and Corepressors, *E. coli* Lac Operon: Negative Regulation and Positive Regulation, *E. Coli* Arabinose Operon: Regulation by Attenuation, His and Trp Operons: Anti-termination, Genetic Transfer: Conjugation, Transformation and Transduction.

UNIT 2: Virology

Introduction to Virus, Classification, Assay Methods, Properties and Characteristic of Bacterial, Plant and Animal Viruses, Virus Host Interaction, Acute Virus Infections, Persistent of Virus Infection, Influenza, Herpes, Hepatitis A and B.

UNIT 3: Biological Nitrogen Fixation

Nitrogen Metabolism: Mechanism and Regulation of Utilization of Ammonia, Nitrate and other Nitrogen Source, Nitrogen Fixation: Mechanism and Regulation of Nitrogen Fixation, Symbiotic and Asymbiotic Nitrogen Fixation and Biochemistry of Nitrogenase.

UNIT 4: Antimicrobial Agents

The Development of Antimicrobial Agents, Past, Present and Future, Selection of Antimicrobial Agents, Synthetic Organic Antimicrobials, β-Lactam Antibiotics, Aminoglycoside Antibiotics, Antifungal Drugs, Antiviral Drugs, Resistance to Antimicrobial Drugs

REFERENCES

1. Microbiology by Pelczar, M. J.
2. Microbiology Ecology Fundamental and Application by Ronald M. Atlas
3. General Microbiology Vol-I by Powar & Daginawala
4. General Microbiology Vol-II by Powar & Daginawala
5. laboratory Manual in Microbiology by P Guanasekara

6. Experiments in Microbiology by K R Aneja

EBC 2: PHARMACEUTICAL BIOCHEMISTRY AND REGULATORY AFFAIRS

Objectives:

- To study the drug development process, absorption and metabolism
- To develop a concept of drug action, receptor interaction, roll of enzyme in stimulation or inhibition of drug activity.
- To understand the lethal and effective dose of drug; Mechanism of drug delivery systems.
- To study the different guidelines for manufacturing of drugs.
- In-depth study of intellectual property rights

Course Outcome:

CO 1: Gain detail understanding of how drug act inside the body after absorption from intestine in to blood.

CO 2: Understanding of factors that affect drug absorption, interaction with target receptors and inhibition of enzymes.

CO 3: Understanding of process of product registration and different guidelines which control the manufacturer to follow correct strategy for manufacturing of drug.

CO 4: Learn how to write and file the patent; how to document clinical data of the concern drug research.

UNIT 1: Pharmacokinetics

Introduction to Drug Absorption, Deposition, Drug Metabolism And Elimination, Important Pharmacokinetics Parameters In Defining Drug Disposition and In Therapeutics, Uses of Pharmacokinetics In Drug Development Process, Concept of Prodrug and Soft Drug

UNIT 2: Pharmacodynamics

Introduction, Concept of Receptor Agonists and Antagonists, Drug Receptors Interactions, Theories of Drug Activity Relationship, Treatment of Diseases by Enzyme Stimulation and Enzyme Inhibition, Elementary Treatment of Drug Receptor Interaction, Ld50, Ed50, Mic and Mec etc. (Mathematical Derivations of Equation Excluded), Membrane Active Drugs (Sulphonamides). Mechanisms of Drug effects, Drug Delivery Systems e.g. Liposomes

UNIT 3: **Regulatory Affairs**

Pharmaceutical Products-their Manufacturing, Analytical Aspect, Product Registration and their Requirement looking to WHO-GMP, European DMF, US-FDA Regulations, ICH Guidelines, Pharmacopael and Extra Pharmacopaeal Entry

UNIT 4: Intellectual Property Rights

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

REFERENCES

1. Pharmacology by Rang and Dele
2. Biochemistry and Molecular Biology of Antimicrobial Drug Action by Franklin, T. J. & Snow, J. A.
3. Pharmacology by S D Seth
4. Pharmacology by Tara V Shahbhag
5. Pathology by Edward
6. Pharmacology by M C Prabhakar
7. Pharmacology by Arvind Arora

EBC 3: PLANT BIOCHEMISTRY

Objectives

- To provide students with an understanding of core topics with general principles.
- To introduce the students to the structural organization of plant cells and along with the cell wall structure formation and growth.
- To give an overview of photosynthesis and its significance to plant and human environment.
- To explains the biosynthetic pathway of plant hormones. Explain secondary metabolites and their potential therapeutic and nutritional uses.
- The overall relation of water with respect to plants is made thorough.

Course Outcome:

CO 1: Understanding of the constituents of the plant cell and appreciate the role of each of the components.

CO 2: Appreciate the biological significance of photosynthesis in plants and human environment.

CO 3: Appreciate the modes and pathways involved in the biosynthesis of plant hormones and highlight their roles in the cell.

CO 4: As secondary metabolites relate to therapeutic and nutritional uses, their multidimentional aspect will be highlighted.

UNIT 1: Structure and Biochemical Aspects of Specialized Plant Cell Organelles

Structure and Biochemical Aspects of Cell Plate, Primary and Secondary Cell Walls, Plasmodesmata, Importance of Vacuoles, Characteristics of Meristematic Cells.

UNIT 2: Concepts of Photosynthesis and Phytohormons

Photochemistry, Energy Considerations, Light Reaction with Z – Scheme, CO_2 fixation, Calvin Cycle, C3, C4 and CAM, Photorespiration, Chemistry and Action of Phytohormones and Plant Growth Regulators.

UNIT 3: Secondary Metabolites

Special Features of Secondary Plant Metabolism Formation and Functions of Alkaloids, Phenolic Compounds, Tannins, Lignins, Flavonoid Pigments, Surface waxes, Cutin and Suberin – the Plant Protective Waxes, Terpenes. Different Types of Bioreactors for Mass Production.

UNIT-4: Water Relations of Plants

Role of Water, Absorption, Conduction and Transpiration, Guttation, Water balance and Stress Physiology. Osmoprotectant

REFERENCES

1. Plant Biochemistry by Heldt, H-W.
2. Plant Physiology By Taiz and Zeiger
3. Plant Biology by Andrew Lack
4. Plant Biochemistry by Hans Walter
5. Plant Biotechnology by M S Sudhir

PBC-3 PRACTICAL

1. Blood Grouping
2. Dot ELISA
3. Ouchterlony Double Diffusion
4. Radial Immuno diffusion
5. Rocket Immuno electrophoresis
6. Widal Test
7. Sandwich ELISA
8. Albumin Estimation
9. Total Protein Estimation
10. Blood Glucose Estimation
11. Urea Estimation
12. Uric Acid Estimation
13. Creatinine Estimation
14. SGPT Estimation
15. SGOT Estimation
16. Total and Direct Bilirubin Estimation
17. Triglycerides Estimation
18. Cholesterol Estimation
19. Urinalysis
20. Ascorbic Acid Estimation
21. Iron Estimation

SEMESTER 4

EBC 4: RESEARCH METHODOLOGY

Objectives:

- The main objective of this paper is to provide students with a broad introduction to the methodological foundations and tools used in research.
- To learn how to identify problems, develop hypotheses and research questions.
- To check for the validity and reliability of studies and design research projects.
- To expose the students to the broad range of designs used in research from laboratory, field experiments, surveys and content analysis.

- To study the statistical tools and computer applications used in research.

Course Outcome:

CO 1: Gain the ability to define research, explain and apply research terms, describe the research process and the principle activities, skills and ethics associated with the research process;

CO 2: Students will be able to explain the relationship between theory and research, describe and compare the major quantitative and qualitative research methods.

CO 3: Students will be able to construct an effective research proposal that will serve as the launching point for the research project, understand the importance of research ethics and integrate research ethics into the research process.

CO 4: Students will easily use the statistical tool and computer software for organization and analysis of data.

UNIT 1: Types of Research & Literature Survey

Types, Research process and steps in it, Hypothesis, Research proposals and aspects. Literature survey and review, Research design process, Errors in research. Report Writing: Pre writing considerations, Thesis writing, Formats of report writing, Formats of publications in Research journals.

UNIT 2: Design of Experiments

Research Modeling: Types of Models, Model building and stages, Data consideration and testing, Heuristic and Simulation modeling. Research Design: Need, Problem Definition, variables, research design concepts, Objectives, strategies, Factorial experimental design, Designing engineering, experiments, basic principles: replication, randomization, blocking, Guidelines for design of experiments.

UNIT 3: Statistical Methods

Single Factor Experiment: Hypothesis testing, Analysis of Variance components (ANOVA) for fixed effect model; Total, treatment and error of squares, Degrees of freedom, Confidence interval; ANOVA for random effects model, Estimation of variance components, Model adequacy checking.

UNIT 4: Computer Applications

Spreadsheet Tool: Introduction to spreadsheet application, features and functions, Using formulas and functions, Data storing, Features for Statistical data analysis, Generating charts/ graph and other features. Tools used may be Microsoft Excel, Open office or similar tool. Presentation Tool: Introduction to presentation tool, features and functions, Creating presentation, Customizing presentation, Showing presentation. Tools used may be Microsoft Power Point, Open Office or similar tool. Web Search: Introduction to Internet, Use of Internet and WWW, Using search engine like Google, Yahoo etc, Using advanced search techniques.

REFERENCES

1. Culture of Animal Cells by Freshney R. I.
2. Animal Cell Culture by Masters
3. Principles and Practice of Animal Tissue Culture by Sudha Gangal
4. Animal Cell & Tissue Culture by Mathur
5. Animal Cell Culture & Technology by M Butler

EBC 5: ANIMAL CELL TISSUE CULTURE

Objectives:

- Understating the basics of animal tissue culture i.e. laboratory design and requirements
- To acquire a knowledge of various types of media and methodologies
- An understanding of the various types of cell cultures and separation techniques

- In-depth knowledge and understanding of cell preservation, scale up and special cell cultures

Course Outcome:

CO 1: To attain a working knowledge of discrimination between the different types of cell culture technologies.

CO 2: Detailed criteria for consideration for scale up of cell culture and media composition.

CO 3: Students will gain knowledge in identifying the appropriate cell model for a large scale process.

CO 4: Gain knowledge of recent developments in cell and tissue engineering.

UNIT 1: Introduction

History, Biology of cell culture, Laboratory design and layout, equipments, aseptic condition, safety, bioethics and validation

UNIT 2: Media

Culture vessels, substrates, defined media supplements, serum free media, media preparation and sterilization

UNIT 3: Various Cell Culture

Primary culture, subculture and cell lines, cloning and selection, cell separation, characterization, differentiation, transformation and immortalization

UNIT 4: Techniques and Media

Contamination, cryopreservation, quantification, cytotoxicity, special cell type culture, culture of tumor cells, organotypic culture, scale up and specialized techniques

REFERENCES

1. Research methods and Statistics A Critical Thinking by Sherri L. Jackson
2. Methods in Biostatistics for Medical Students and Research Workers by B . K. Mahajan
3. Biostatistics by Sundar Rao
4. Stastics by D. C. Sancheti

DISSERTATION PROJECT WORK

Dissertation research work is offered to students of Semester IV to carry out research according to the provision of objectives and teacher guide. Students are allowed to apply in other national and international level research institutes, Universities and industries of high repute to pursue six month dissertation research project for the partial fulfillment of M.Sc. Biochemistry degree.