Department of Biochemistry

Government college for Women (Autonomous), Guntur

Program Specific Outcomes for Biochemistry

At the completion of a Bachelor of Science degree in Biochemistry, a graduate will be able to

PSO-1: Demonstrate knowledge and understanding of structure and metabolism of macromolecules, the basic molecular machinery & relate between the regulation and disorders of different metabolic & signaling pathways.

PSO-2: Gain proficiency in laboratory techniques in both biochemistry and molecular biology and implement to apply the scientific method to plan and carry out simple investigations.

PSO-3: Able to understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind. And realize the impact of science in society and plan to pursue higher studies

Program Specific Outcomes for Molecular Genetics & Bioinformatics

At the completion of a Bachelor of Science degree in Biochemistry, a graduate will be able to

PSO1 - Graduates will demonstrate a comprehensive understanding of molecular genetics principles & be able to proficiently apply molecular biology methods to analyze and effectively interpret experimental data in the context of genetics research.

PSO2 - Graduates will exhibit skills in bioinformatics, including the ability to use computational tools for sequence analysis, structural biology, and genomics.

PSO3 - Graduates will possess the capability to address complex biological questions by integrating molecular genetics and bioinformatics approaches.

Course structure for I - VIII Semesters of B. Sc. Biochemistry Honours – Major Programme (w.e.f.2023-24)

Year	Semester	Course	Theory / Practical	Title of Course	Course code
I	I	1	T	Introduction to Classical Biology	1BC-01
		2	T	Introduction to Applied Biology	1BC-02
	II	3	T	Biomolecules	2BC-03
			P	Biomolecules	2BC-03P
		4	T	Cell Biology	2BC-04
			P	Cell Biology	2BC-04P
II	III	5	T	Analytical Techniques	3BC-05
			P	Analytical Techniques	3BC-05P
		6	T	Basic Microbiology	3BC-06
			P	Basic Microbiology	3BC-06P
		7	T	General Physiology	3BC-07
			P	General Physiology	3BC-07P
		8	T	Genetics	3BC-08
			P	Genetics	3BC-08P
	IV	9	T	Bioenergetics and Metabolism of Carbohydrates and Lipids	4BC-09
			P	Bioenergetics and Metabolism of Carbohydrates and Lipids	4BC-09P
		10	T	Clinical Biochemistry	4BC-10
			P	Clinical Biochemistry	4BC-10P
		11	T	Immunology	4BC-11
			P	Immunology	4BC-11P
III	V	12	T	Nutritional Biochemistry	5BC-12
			P	Nutritional Biochemistry	5BC-12P
		13	T	Enzymology	5BC-13
			P	Enzymology	5BC-13P
		14	T	Molecular Biology	5BC-14
			P	Molecular Biology	5BC-14P
		15	T	Metabolism of Nitrogen Compounds	5BC-15
			P	Metabolism of Nitrogen Compounds	5BC-15P
	VI	**Long term Internship/ Apprenticeship**			
IV	VII	16	T	Recombinant DNA Technology	7BC-16
			P	Recombinant DNA Technology	7BC-16P
		17	T	Endocrinology	7BC-17
			P	Endocrinology	7BC-17P
		18	T	Biomedical Correlation of Diseases	7BC-18
			P	Biomedical Correlation of Diseases	7BC-18P
	VIII	19	T	Applied Biochemistry	8BC-19
			P	Applied Biochemistry	8BC-19P
		20	T	Fundamentals of Biostatistics and Bioinformatics	8BC-20

			P	Fundamentals of Biostatistics and Bioinformatics	8BC-20P
		21	T	Plant and Environmental Biochemistry	8BC-21
			P	Plant and Environmental Biochemistry	8BC-21P

Course structure for I - V Semesters of B. Sc. Biochemistry Honours – Minor Programme

Year	Semester	Course	Theory / Practical	Title of Course	No. of Credits
I	II	1	T	Biomolecules	3
			P	Biomolecules	1
II	III	2	T	Analytical Techniques	3
			P	Analytical Techniques	1
	IV	3	T	Bioenergetics and Metabolism of Carbohydrates and Lipids	3
			P	Bioenergetics and Metabolism of Carbohydrates and Lipids	1
		4	T	Clinical Biochemistry	3
			P	Clinical Biochemistry	1
III	V	5	T	Nutritional Biochemistry	3
			P	Nutritional Biochemistry	1
		6	T	Enzymology	3
			P	Enzymology	1

Course structure for I - V Semesters of B. Sc. Molecular Genetics and Bioinformatics – *Minor Programme*

Year	Semester	Course	Theory / Practical	Title of Course	No. of Credits
I	II	1	T	Cell Biology & Principles of Genetics	3
			P	Cell Biology & Principles of Genetics	1
II	III	2	T	Human molecular genetics	3
			P	Human molecular genetics	1
	IV	3	T	Molecular techniques in genetic engineering	3
			P	Molecular techniques in genetic engineering	1
		4	T	Clinical genetics and genetic counselling	3
			P	Clinical genetics and genetic counselling	1
III	V	5	T	Cellular and molecular immunology	3
			P	Cellular and molecular immunology	1
		6	T	Bioinformatics	3
			P	Bioinformatics	1

Course structure for I - VI Semesters of Three major B. Sc. Biochemistry

Year	Semester	Paper	Title of the course	Course code
III	V	6A	Genetic Engineering & Bioinformatics- Theory	BC 403-6A
			Genetic Engineering & Bioinformatics- Practical	
		7A	Immunology & Endocrinology- Theory	BC 403-7A
			Immunology & Endocrinology- Practical	
		6B	Genetic Engineering- Theory	BC 403-6B
			Genetic Engineering- Practical	
		7B	Advances in Biochemistry- Theory	BC 403-7B
			Advances in Biochemistry- Practical	
	VI		Semester End Internship	

Semester – I

(Common Core Course)

COURSE WISE SYLLABUS WITH OUTCOMES
SINGLE MAJOR

COURSE – I **SEMESTER – I**
Title: INTRODUCTION TO CLASSICAL BIOLOGY **Course Code: 1BC-01**

Course Outcomes

1. Learn the principles of classification and preservation of biodiversity
2. Understand the plant anatomical, physiological and reproductive processes.
3. Knowledge on animal classification, physiology, embryonic development and their economic importance.
4. Outline the cell components, cell processes like cell division, heredity and molecular processes.
5. Comprehend the chemical principles in shaping and driving the macromolecules and life processes.

Unit 1: Introduction to systematics, taxonomy and ecology.

1.1. Systematics –Definition and concept, Taxonomy –Definition and hierarchy.
1.2. Nomenclature –ICBN and ICZN, Binomial and trinomial nomenclature.
1.3. Ecology –Concept of ecosystem, Biodiversity and conservation.
1.4. Pollution and climate change.

Unit 2: Essentials of Botany.

2.1. The classification of plant kingdom.
2.2. Plant physiological processes (Photosynthesis, Respiration, Transpiration, phytohormones).
2.3. Structure of flower –Micro and macro sporogenesis, pollination, fertilization and structure of mono and dicot embryos.
2.4 Mushroom cultivation, floriculture and landscaping.

Unit 3: Essentials of Zoology

3.1. The classification of Kingdom Animalia and Chordata.
3.2 Animal Physiology –Basics of Organ Systems & their functions, Hormones and Disorders
3.3 Developmental Biology –Basic process of development (Gametogenesis, Fertilization, Cleavage and Organogenesis)
3.4 Economic Zoology –Sericulture, Apiculture, Aquaculture

Unit 4: Cell biology, Genetics and Evolution

4.1. Cell theory, Ultrastructure of prokaryotic and eukaryotic cell, cell cycle.
4.2. Chromosomes and heredity –Structure of chromosomes, concept of gene.
4.3. Central Dogma of Molecular Biology.
4.4. Origin of life

Unit 5: Essentials of chemistry

5.1. Definition and scope of chemistry, applications of chemistry in daily life.
5.2. Branches of chemistry
5.3. Chemical bonds –ionic, covalent, noncovalent –Vander Waals, hydrophobic, hydrogen bonds.
5.4. Green chemistry

References

1. Sharma O.P., 1993. Plant taxonomy. 2nd Edition. McGraw Hill publishers.
2. Pandey B.P., 2001. The textbook of botany Angiosperms. 4th edition. S. Chand publishers, New Delhi, India.
3. Jordan E.L., Verma P.S., 2018. Chordate Zoology. S. Chand publishers, New Delhi, India.
4. Rastogi, S.C., 2019. Essentials of animal physiology. 4th Edition. New Age International Publishers.
5. Verma P.S., Agarwal V.K., 2006. Cell biology, genetics, Molecular Biology, Evolution and Ecology. S. Chand publishers, New Delhi, India.
6. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.
7. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.
8. Karen Timberlake, William Timberlake, 2019. Basic chemistry. 5th Edition. Pearson publishers.
9. Subrata Sen Gupta, 2014. Organic chemistry. 1st Edition. Oxford publishers.

COURSE – II **SEMESTER – I**

Title: INTRODUCTION TO APPLIED BIOLOGY **Course Code: 1BC-02**

Course Outcomes

1. Learn the history, ultrastructure, diversity and importance of microorganisms.
2. Understand the structure and functions of macromolecules.
3. Knowledge on biotechnology principles and its applications in food and medicine.
4. Outline the techniques, tools and their uses in diagnosis and therapy.
5. Demonstrate the bioinformatics and statistical tools in comprehending the complex biological data.

Unit 1: Essentials of Microbiology and Immunology

1.1. History and Major Milestones of Microbiology; Contributions of Edward Jenner, Louis Pasteur, Robert Koch and Joseph Lister.
1.2. Groups of Microorganisms –Structure and characteristics of Bacteria, Fungi, Archaea and Virus.
1.3. Applications of microorganisms in –Food, Agriculture, Environment, and Industry.
1.4. Immune system –Immunity, types of immunity, cells and organs of immune system.

Unit 2: Essentials of Biochemistry

2.1. Biomolecules I –Carbohydrates, Lipids.
2.2. Biomolecules II –Amino acids & Proteins.
2.3. Biomolecules III –Nucleic acids -DNA and RNA.
2.4. Basics of Metabolism –Anabolism and catabolism.

Unit 3: Essentials of Biotechnology

3.1. History, scope, and significance of biotechnology. Applications of biotechnology in Plant, Animal, Industrial and Pharmaceutical sciences.
3.2. Environmental Biotechnology –Bioremediation and Biofuels, Biofertilizers and Biopesticides.
3.3. Genetic engineering –Gene manipulation using restriction enzymes and cloning vectors; Physical, chemical, and biological methods of gene transfer.
3.4. Transgenic plants –Stress tolerant plants (biotic stress –BT cotton, abiotic stress –salt tolerance). Transgenic animals –Animal and disease models.

Unit 4: Analytical Tools and techniques in biology – Applications

4.1. Applications in forensics –PCR and DNA fingerprinting
4.2. Immunological techniques –Immunoblotting and ELISA.
4.3. Monoclonal antibodies –Applications in diagnosis and therapy.
4.4. Eugenics and Gene therapy

Unit 5: Biostatistics and Bioinformatics

5.1. Data collection and sampling. Measures of central tendency –Mean, Median, Mode.
5.2. Measures of dispersion –range, standard deviation and variance. Probability and tests of significance.
5.3. Introduction, Genomics, Proteomics, types of Biological data, biological databases-NCBI, EBI, Gen Bank; Protein 3D structures, Sequence alignment
5.4. Accessing Nucleic Acid and Protein databases, NCBI Genome Workbench

REFERENCES

1. Gerard J., Tortora, Berdell R. Funke, Christine L. Case., 2016. Microbiology: An Introduction. 11th Edition. Pearson publications, London, England.

2. Micale, J. Pelczar Jr., E.C.S. Chan., Noel R. Kraig., 2002. Pelczar Microbiology. 5th Edition. McGraw Education, New York, USA.

3. Sathyanarayana U., Chakrapani, U., 2013. Biochemistry. 4th Edition. Elsevier publishers.

4. Jain J.L., Sunjay Jain, Nitin Jain, 2000. Fundamentals of Biochemistry. S. Chand publishers, New Delhi, India.

5. R.C. Dubey, 2014. Advanced Biotechnology. S. Chand Publishers, New Delhi, India.

6. Colin Ratledge, Bjorn, Kristiansen, 2008. Basic Biotechnology. 3rd Edition. Cambridge Publishers.

7. U. Sathyanarayana, 2005. Biotechnology. 1st Edition. Books and Allied Publishers pvt. ltd., Kolkata.

8. Upadhyay, Upadhyay and Nath. 2016. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.

9. Arthur M. Lesk. Introduction to Bioinformatics. 5th Edition. Oxford publishers.

10. AP Kulkarni, 2020. Basics of Biostatistics. 2nd Edition. CBS publishers.

Semester – II

(Core Course)

COURSE – III **SEMESTER – II**
Title: BIOMOLECULES **Course Code: 2BC-03**

COURSE OUTCOMES:
CO-1. Recall & demonstrate knowledge of the different types of biomolecules, their classifications, & basic monomeric structures
CO-2. Understand significance of Biochemistry. Explain physical & chemical properties of biomolecules
CO-3. Apply basic knowledge of monomers to construct oligomers & polymers
CO-4. Analyze & predict structures based on reactions and demonstrating comprehension of their contributions to cellular processes

Unit 1: **14 Hours**

- Fundamentals of Biochemistry: Definition, Scope & Milestones in the history of biochemistry
- Water as biological solvent., Definition of pH, Buffers
- Classification of carbohydrates -Monosaccharides, Oligosaccharides & Polysaccharides
- Configuration (D & L), Optical isomerism, Mutarotation, Definitions of Epimers and anomers
- Open chain structure of Glucose, Mannose & Galactose, Fructose & Ribose
- Cyclic structures: Pyranose structure of Glucose, Furanose structure of Fructose
- Chemical reactions of carbohydrates (Due to functional group & hydroxyl group)
- Structural & Biological importance of disaccharides: Sucrose, lactose, maltose, Isomaltose
- Structural Polysaccharides: cellulose & chitin; Storage polysaccharides: Starch, Inulin & Glycogen.
- Glycosaminoglycans: Heparin & Hyaluronic acid

Unit - II: Lipids : **8 hours**

- Functions of lipids; Classification of lipids: Simple, compound, derived lipids
- Saturated and unsaturated fatty acids.
- Triacylglycerols; Properties of Triacylglycerols: Acid number, saponification, iodine values, and rancidity.
- Phospholipids: Glycerophospholipids -Lecithins, Cephalins & Plasmalogens; and Sphingophospholipids. Functions of Phospholipids.
- Structure and importance of Cholesterol
- Membrane composition and organization - Fluid mosaic model
- Definition of micelles, bilayers, liposomes, Emulsions
- Types & Functions of Lipoproteins

Unit-III: Amino Acids & Peptides : **8 Hours**

- Structure, stereochemistry of amino acids

- Classification of amino acids based functional group, polarity, nutritional requirement and metabolic fate.; Non-protein amino acids
- Physical & Chemical properties of amino acids; Titration curve of glycine;
- Peptide bond - nature and conformation.
- Naturally occurring peptides - Glutathione and oxytocin.

Unit-IV: Proteins: 8 hours

- Classification of proteins based on function, solubility (Simple, Conjugated & derived) & shape(Globular & Fibrous)
- General properties of proteins, denaturation & characteristics of denaturation of proteins.
- Organization of proteins: Primary, secondary, tertiary and quaternary structures.
- Structure of Myoglobin & Hemoglobin.

Unit - V: Nucleic Acids : 7 hours

- Introduction to nucleic acids. Structure of purines (A, G) and pyrimidines (C, T & U), nucleosides, nucleotides (AMP, ADP, ATP). Formation of phosphodiester linkage.
- Structure of Watson & Crick DNA. Types of DNA: A, B & Z DNA
- Denaturation of DNA - hyperchromic effect - Tm value & its significance; cot curves & its significance.
- Types of RNA: mRNA, tRNA & rRNA. Differences between DNA & RNA.

Additional Inputs:

- Donan membrane equilibrium
- Structural & Biological importance of Trisaccharides: Raffinose, Melizitose
- Prostaglandins
- Forces stabilizing the structure of protein: Hydrogen bonds, disulphide bonds, ionic bonds, hydrophobic interactions.

REFERENCES

- Biochemistry by Dr. U. Satyanarayana, and Chakrapani.U
- Biochemistry by J.L. Jain., S. Jain., N. Jain
- Lehninger's Principles of Biochemistry – Nelson,D.L and Cox.M.M., Freeman &co.
- Biochemistry by Stryer.L., Berg.J.M., Tymoczko.J.L., Freeman & co.
- Biochemistry by Voet.D and Voet.JG., John Wiely & sons.
- Biochemistry by Conn and Stumpf
- Experimental Biochemistry A Student Companion - V. Deshpande and B. Sasidhar Rao
- Practical Biochemistry – Upadhayay, and Nath
- An introduction to Practical Biochemistry - T. Plummer Biochemistry – Viva Series
- Lab manual in Biochemistry – Pattabhiraman
- Lab manual in Biochemistry – Jayaraman

Course -3 BIOMOLECULES **Practical Syllabus** **Course Code: 2BC-03P**

Introduction to Good Laboratory Practice (GLP). Principles of Laboratory Hygiene and Safety.
List of experiments:

1. General reactions for identification of Carbohydrates
2. Qualitative identification of carbohydrates- Glucose, fructose, maltose, sucrose, lactose, starch
3. Preparation of Osazones and their identification.
4. General reactions for identification of Amino acids
5. Qualitative identification of amino acids - His, Tyr, Trp, Cys, Arg & Pro.
6. Qualitative tests for lipids: solubility, saponification, acrolein test, Salkowski test, Lieberman-Burchard test.
7. pH meter & Measurement of pH
8. Preparation of Acetate buffer.
9. Absorption maxima of colored substances-p-Nitrophenol / Methyl orange.
10. Absorption spectra of DNA.
11. Isolation of DNA and RNA from tissues / cells.

COURSE – IV **SEMESTER – II**

Title: CELL BIOLOGY **Course Code: 2BC-04**

Course Outcomes:

1. This gives them a strong foundation on the basic unit of life, its structure and various cellular events
2. Explain the role of compartmentalization and signaling in cellular biology;
3. Evaluate and apply knowledge of modern techniques in cellular biology.
4. Interpret, analyze, describe and present new experimental data.

UNIT-I Cell and subcellular organelle: (CO-1, 3, 4) **9 Hrs**

1.1 Difference between Prokaryotic and Eukaryotic cells
1.2 Structure and functions of nucleus
1.3 Structure and functions of mitochondria
1.4 Structure and functions of endoplasmic reticulum, cytoskeleton
1.5 Structure and functions of golgi, lysosomes, ribosomes.

Unit – II Biomembranes & Membrane Transport: (CO-1, 2, 4) **9 Hrs**

2.1 Chemical composition of Membranes; Lipids, proteins, and Carbohydrates distribution of membrane lipids; fluid mosaic model of biological membranes
2.2 Molecular structure of membranes: bilayer, miscelle, and liposomes.
2.3 Passive transport- Simple, facilitated & ion channels
2.4 Active transport- types of pumps – P class, V class, F class
2.5 Bulk transport- Endocytosis, exocytosis, phagocytosis.

UNIT-III Protein Sorting and Targeting: (CO-1, 2, 4) **9 Hrs**

3.1 Signal hypothesis, signal peptide, NLS, NES
3.2 Import across ER – post translational modifications of proteins in ER
3.3 Sorting of lysosomal proteins- secretory, membrane proteins
3.4 Trafficking and localization of mitochondrial proteins.

UNIT-IV Cell communication & Signal transduction: (CO-1, 2, 4) **9 Hrs**

4.1 General principles of cell communication- Signaling molecules, reception, transduction, cellular response.
4.2 Cell adhesion and roles of different adhesion molecules (immunoglobulin, integrins)
4.3 Cell junction (tight junction, gap junction, desmosomes); Extracellular matrix.
4.4 Cell surface receptor (G-protein coupled receptors); Second messengers (cAMP, Ca^{+2})
4.5 Signal transduction pathways and regulation (cAMP, inositol mediated).

UNIT-V Cell cycle and its regulation: (CO-1, 2, 3) **9 Hrs**

- Cell cycle - phases of cell cycle
- Cell division - mitosis, meiosis.
- Regulation of cell cycle- Cyclins, MPF, Cyclin dependent kinases, Growth factors(EGF, IGF), Nuclear Laminins, Check points. Inhibition of cell cycle progression. Apoptosis

Additional Inputs:

- Plastids, vacuole, micro bodies
- Membrane fluidity- role of unsaturated fatty acids and cholesterol

- Na^+ K^+ pump, Transport systems- uniport, symport, antiport.

Recommended Books

1. Cooper, G.M. & R.E. Hausman (2009) The Cell – A Molecular Approach, A.S.M. Press, Washington
2. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, James Darnell; Molecular cell biology, 5th ed
3. Goldman, Emanuel, and Lorrence H. Green, eds. Practical handbook of microbiology. CRC Press, 2015.
4. Thomas D. Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham T. Johnson; Elsevier, 3rd ed 2017
5. Dubey, R. C., and D. K. Maheshwari. Practical microbiology. S. Chand, 2002.
6. Microbiology: A laboratory manual by Cappuccino and Sherman, Pearson Education, 6th Ed.
7. P.S. Verma, V.K. Agarwal Cell biology, genetics, molecular biology, evolution and ecology. S. Chand, 2008.
7. S. C. Rastogi (2008) Cell Biology,New Age International (P) Ltd. Publishers, New Delhi
8. P. K. Gupta (2002) Cell and Molecular biology, Rastogi Publications, New Delhi

Course -4 CELL BIOLOGY Practical Syllabus Course Code: 2BC-04P

1. Microscopic observation of plant and animal cells
2. Estimation of Chlorophyll
3. Isolation of chloroplast
4. Isolation of mitochondria from the liver
5. Mitosis experiment
6. Meiosis experiment

Minor COURSE – I **SEMESTER – II**

Title: Principles of Genetics **Course Code: 1MGB-01**

COURSE OUTCOMES

Upon successful completion of course the student will be able:

CO1-To know about structure of a cell and the differences between a prokaryotic and a Eukaryotic cell

CO2-To understand the structure of DNA and morphology of chromosome

CO3-To Understand Mendel's Law's and their deviations

CO4-Gene interactions and their outcome through gene mapping and genetic recombination

UNIT-I: CELL AND ITS ORGANELLE (9 Hrs)

- Cell theory; prokaryotic vs eukaryotic cell; animal vs plant cell;
- A brief account on Structure of a bacterial cell, plant cell and animal cell.
- Ultra-structure of plasma membrane and various theories on its organization.
- Ultrastructure of mitochondria, ER, golgi, ribosomes

UNIT-II HUMAN CHROMOSOME ORGANIZATION (8 Hrs)

- Structure of DNA
- Packaging of DNA – multiple hierarchies of DNA folding (Nucleosome and Solenoid model)
- Morphology of Chromosomes –size, shape-morphological types, structure, centromere & kinetochore, telomere, satellite.
- Karyotype and ideogram; heterochromatin and euchromatin.

UNIT-III HISTORY OF GENETICS (8 Hrs)

- Pre-mendelian Genetic concepts, Heredity, environment, the concept of phenotype and genotype, pure lines and inbred lines, alleles.
- Mendel's experiments on pea plants, Mendel laws
- Deviations of Mendelism - Incomplete dominance and codominance;
- Multiple alleles, Lethal alleles, Pleiotropy, Penetrance, and Expressivity, Epistasis

UNIT- IV SEX LINKED INHERITANCE AND SEX DETERMINATION (8 Hrs)

- Sex linked inheritance (hemophilia, hairy ear rims), sex limited (cock-hen feathering) and sex influenced inheritance (horned character in sheep)
- Chromosome theory of Sex determination: Heterogametic males -XX- XY and XX-XO; Heterogametic females- ZO-ZZ and ZZ-ZW systems
- Sex determination in invertebrates (Drosophila), Genic balance theory of Bridges, Intersexes and Super sexes in Drosophila.
- Sex determination in vertebrates (Man), Structure and role of human X and Y chromosomes.

UNIT-V LINKAGE, CROSSING OVER, AND GENE MAPPING (12 Hrs)

- Linkage - Definition, Linkage group- Drosophila and man;

  Types of linkage-complete linkage and incomplete linkage, Significance of linkage.
- Crossing over - definition; recombination and recombination frequency

- Mechanism of crossing over: Chiasma Interference and coincidence; Coupling and Repulsion hypothesis.
- Gene Mapping – physical mapping and genetic mapping, mapping in eukaryotes

Additional inputs

- Polytene Chromosomes and Lampbrush Cromosomes
- Overview of genetically controlled Sex determining mechanisms

REFERENCES

1. Pandey, B.P. (2013) College Botany, Volume-III, S. Chand Publishing, New Delhi

2. Ghosh, A.K., K.Bhattacharya&G. Hait (2011) A Text Book of Botany, Volume-III, New Central Book Agency Pvt. Ltd., Kolkata

3. A.V.S.S. Sambamurty (2007) Molecular Genetics, Narosa Publishing House, New Delhi

4. S. C. Rastogi (2008) Cell Biology, New Age International (P) Ltd. Publishers, New Delhi

5. P. K. Gupta (2002) Cell and Molecular biology, Rastogi Publications, New Delhi

6. B. D. Singh (2008) Genetics, Kalyani Publishers, Ludhiana

7. Cooper, G.M. & R.E. Hausman (2009) The Cell – A Molecular Approach, A.S.M. Press, Washington

Minor Course -1 Practical Syllabus Course Code: MGB -01P

1. Study of Mendel's laws through seed ratios & Drosophila mutants
2. Study of linkage, recombination, and chromosome mapping using test cross data.
3. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism.
4. Demonstration of Mitosis & Meiosis using squash technique
5. Blood Typing: ABO groups & Rh factor.
6. Observation of various stages of Mitosis in permanent slides
7. Observation of various stages of Meiosis in permanent slides

Semester – III

(Core Course)

Wef 2024-25

COURSE – V **SEMESTER – III**

Title: ANALYTICAL TECHNIQUES **Course Code: 3BC-05**

COURSE OUTCOMES

After completing this course, the student will be able:

CO1- To gain knowledge of the separation, purification methods; essential analytical techniques; and result quantification which are vital for biochemical research.

CO-2 To get insight into the basic and advanced chromatographic techniques and their applications in various fields.

CO-3 To perceive the principles, procedures, applications and examples of free flow and zone electrophoresis and to understand the principle of sedimentation, Calorimetry and spectrophotometry

CO-4 To explore various centrifugation techniques for the separation of macromolecules and understand the concept of radioactivity and its applications in research

UNIT-I Chromatography Techniques (CO-1, 2)

1.1 Methods of tissue homogenization (Mechanical methods, Sonication), Dialysis, ultrafiltration

1.2 Chromatography- Principle, procedure and applications of Partition Chromatography - Paper Chromatography (Ascending, Descending, Radial) and Thin layer chromatography, Adsorption chromatography.

1.3 Types of chromatographic gels- Dextran, Silica; Principle, procedure and applications of Gel Permeation, Ion exchange and Affinity chromatography.

1.4 Principle and applications of GLC and HPLC.

UNIT-II Electrophoretic Techniques (CO- 1, 3)

2.1 Electrophoresis: Principle, procedure and application of free flow electrophoresis zone electrophoresis

2.2 Principle, procedure and application of Paper electrophoresis- Horizontal, vertical, Gel Electrophoresis: Type of gels- polyacrylamide, agarose; Solubilizers- SDS, Urea, CTAB, β-mecaptoethanol.

2.3 Principle, procedure and applications of Gel Electrophoresis- native PAGE, SDS-PAGE and Agarose Electrophoresis.

2.4 Principle and applications of Isoelectric focusing, High voltage electrophoresis, Immuno-electrophoresis.

UNIT-III Centrifugation Techniques (CO-1, 3, 4)

3.1 Centrifugation: Principle of sedimentation technique, Different types of centrifuge and rotors.

3.2 Principle, procedure and applications of differential centrifugation

3.3 Principle, procedure and applications of density gradient centrifugation (rate zonal centrifugation, isopycnic centrifugation)

3.4 Ultra centrifugation- Principle and applications of preparative, analytical centrifugations

UNIT-IV Colorimetry & Spectrophotometry (CO-1, 3)

4.1 Colorimetry and spectrophotometry: Laws of light absorption - Beer - Lambert's law, molar extinction coefficient.

4.2 UV and visible absorption spectra.

4.3 Principle and instrumentation of colorimetry and spectrophotometry.

4.4 Principle of fluorometry, Atomic absorption spectrophotometer

UNIT-V Radio Isotope Techniques (CO-1, 4)

5.1 Important stable radioisotopes used in biochemical research. P^{32}, I^{125}, I^{131}, Co^{60}, C^{14}

5.2 Half-life, β and γ emitters, Units of Radioactivity, Radiation hazards and precautions taken while handling radioisotopes.

5.3 Principle and application of RIA.

5.4 Measurement of radioactivity by GM counter

Additional Inputs:

- Principle and applications of Pulse field electrophoresis
- Principle of Nephlometry
- Principle of Atomic emission spectrophotometer

Reference Books

1. Physical Biochemistry- Application to Biochemistry and Molecular Biology: Friefelder D. WH Freeman and Company
2. Principles and Techniques of Biochemistry and Molecular Biology: - Ed. K. Wilson and J. Walker, Cambridge Univerity Press.
3. The Tools of Biochemistry: Cooper T.G., John Wiley and Sons Publication.
4. Biophysical chemistry. Principles and Techniques: Upadhayay A, Upadhayay K and Nath N., Himalaya publishing house.
5. Experimental Biochemistry. Cark Jr J. M. and Switzer R.L, W.H. Freeman and Company.
6. Research Methodology for Biological Sciences: Gurumani.N. M.J.P. Publishers., Chennai, India.
7. Instrumental Methods of Chemical Analysis: Chatwal. G and Anand.S., Himalaya Publishing House, Mumbai, India.
8. A Biologist's Guide to Principles and Techniques of Practical Biochemistry: Williams. B.L. and Wilson. K. (ed.) Edward Arnold Ltd. London
9. Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd.
10. Sadasivam, S. and Manickam, A. (2005). Biochemical Methods, Second edition, New Age International (P) Ltd.

Course -5 ANALYTICAL TECHNIQUES **Course Code: 3BC-05P**

Practical Syllabus

COURSE OUTCOMES

After completing this course, the student will be able:

CO1-To acquire skills in separating biomolecules using chromatography techniques

CO2- To understand and apply gel filtration techniques to separate proteins based on size and to learn separation of the handling of centrifuge equipment for separation of serum.

CO3-To measure and interpret the absorption maxima of DNA and proteins, and use spectrophotometry for their quantification

PRACTICAL SYLLABUS

1. Separation of amino acids by paper chromatography.
2. Separation of plant pigments by paper chromatography
3. Separation of amino acids by TLC.
4. Separation of Plant pigments by TLC
5. Separation of proteins by Gel filtration
6. Separation of proteins by Gel Electrophoresis.
7. Separation of Serum from blood by Centrifugation
8. Absorption maxima of the DNA/protein

COURSE – VI **SEMESTER – III**

Title: BASIC MICROBIOLOGY **Course Code: 3BC-06**

COURSE OUTCOMES:

After completing this course, the student will be able:

CO1- To understand basic concepts of microbiology, including the characteristics, classification and biology of bacteria, algae, fungi, and viruses

CO2- To understand microbial diversity and learn about the cultivation of bacteria

CO3- To understand the basic principles of microbial interactions and the industrial applications of microbes in water and sewage treatment.

CO4- To understand the pathogenicity of various bacterial, fungal, and viral diseases, their prevention and treatment.

UNIT-I BACTERIA (CO -1, 2) **12 Hrs**

1.1 Microbial Diversity-Groups of Microorganisms.
Structure of Bacteria, Classification of Bacteria based on morphology and cell wall composition.

1.2 Culture media and methods- Pure culture; Types of media based on Composition-Basal media, Selective media, Enrichment media and Differential media;
Methods of isolating a pure culture -Streak plate, Pour plate and Spread plate methods;
Bacterial growth curve and its significance

1.3 Bacterial staining techniques- Simple staining, Differential staining -Grams staining, Acid fast staining

1.4 Methods of sterilization –Physical (Heat, Filtration, Radiation) and chemical methods (Alcohols, aldehydes) and Pasteurization.

UNIT-II ALGAE & FUNGI (CO-1,3) **8 Hrs**

2.1 Algae- Morphology, Classification, General characteristics

2.2 Fungi – Morphology, Classification, General characteristics

2.3 Economical and industrial uses of algae.

2.4 Economic importance of Fungi.

UNIT-III MICROBES IN FOOD & DAIRY (CO-3,4) **8 Hrs**

3.1 Microbial interactions – mutualism, commensalism, parasitism, competition, symbiosis in complex system.

3.2 Role of microorganisms in domestic and industrial sewage treatment

3.3 Microbiology of fermented foods- Role of microorganism in food spoilage and its control (Preservation methods)

3.4 Food borne diseases – Pathophysiology of Botulism and Salmonellosis.

UNIT-IV MICROBIAL DISEAES (CO-4) **9 Hrs**

a. Pathogenesis of bacterial diseases – virulence, virulence factors, exotoxins, enterotoxins, endotoxins, and neurotoxins.

b. Airborne diseases– Pathophysiology of Tuberculosis and Streptococcal pneumonia

c. Direct contact Diseases –Pathophysiology of Leprosy (Bacterial), Candidiasis (Fungal).

d. Pathophysiology of Plague (Arthropod borne), Malaria (Protozoan), Syphilis (STD)

UNIT-V VIRUSES (CO- 1,4) 8 Hrs

5.1 Viruses-General Characteristics (nature, Composition, size, host specificity)
5.2 Viruses- structure, Classification.
5.3 Viral diseases – Pathophysiology of Dengue, Hepatitis, HIV.
5.4 Inactivation of viruses – photodynamic inactivation. Antiviral agents-chemical and biological agents.

Additional Inputs:

- Brief Introduction to Classification of living Organisms-Whittaker five kingdom, Carl woes three domain concept
- Disease mechanism of Mycoses; Pathophysiology of E. coli infection, Diarrhea, Shigellosis; pathogenic mechanism of Diphtheria
- Pathophysiology of Polio
- Outlines of Methods of assay and cultivation of viruses

REFERENCE BOOKS

1. Vasanthakumari.R, (2009) Practical Microbiology, BI Publishers Pvt Ltd, India
2. Dubey.R.C and Maheshwari D.K., (2002), Practical Microbiology, S.Chand& comp Ltd, NewDelhi.
3. Microbiology by Pelczar, Chan and Krieg 5th edn. 1995 Mc Grew- Hill.
4. General Microbiology: Boyd, R.F., Times Mirror/ Mosby College, 1984.
5. A Textbook of Microbiology, R.C.Dubey and D.K.Maheswari, S.Chand Co (2001).
6. Pharmaceutical Microbiology, By Hugo and Russell, Blackwell Scientific (1987).
7. An Introduction to Viruses by S.B.Biswas, Vikas Publishing house.
8. Microbiology 4th edition, Prescott, Harley, Klein (Mc grew Hill)
9. Fundamentals of Microbiology – M. Frebisher.

Course -6 BASIC MICROBIOLOGY Course Code: 3BC-06P

Practical Syllabus

Skill Outcomes:

After completing this course, the student will be able:

CO1-To understand various methods of sterilization and preparation of culture media.
CO2-To learn about the isolation of bacterial colonies by various techniques.
CO3-To understand the theory and application of different bacterial staining techniques.

PRACTICAL SYLLABUS

1. Sterilization Techniques-Autoclaving, hot-air oven sterilization.
2. Preparation of culture media – Nutrient Broth, Nutrient Agar, Mac Conkey's agar.
3. Isolation of bacteria – Streak plate and pour plate methods
4. Identification of bacteria by staining techniques – simple, differential staining methods- Gram staining and acid-fast staining.
5. Motility of Bacteria – "Hanging drop" technique
6. Bacteriological examination of water and milk

COURSE – VII **SEMESTER – III**

Title: GENERAL PHYSIOLOGY **Course Code: 3BC-07**

COURSE OUTCOME

CO1: Describe the composition, functions, and clotting mechanism of blood to contribute homeostasis.

CO2: Explain the structure and functions of the muscular, nervous, and endocrine systems to explain their interrelated functions in maintaining bodily functions.

CO3: Identify the components of the urinary system and explain urine formation.

CO4: Describe the structure and function of the digestive system and explain the processes involved in the digestion and absorption of nutrients.

UNIT-I Blood

1.1 Blood – composition & functions, Erythropoiesis, blood cells – morphology and functions

1.2 Plasma proteins and their functions; Composition & functions of lymph

1.3 Mechanism of blood clotting, anticoagulants (heparin, coumarin derivatives, EDTA, Oxalate compounds, citrates)

1.4 Blood groups – ABO, Rhesus factor

UNIT-II Muscular and Nervous System

2.1 Muscular system: Types and functions of muscle; Microscopic structure of sarcomere

2.2 Mechanism of muscle contraction

2.3 Nervous system: Organization of nervous system, Structure of brain, spinal cord, neuron

2.4 Mechanism of synaptic nerve impulse – action potential, resting potential, synaptic transmission; neurotransmitters.

UNIT-III Excretory System

3.1 Structure and functions of kidney and nephron

3.2 Role of kidney in maintaining blood pressure.

3.3 Mechanism of urine formation

3.4 Normal and abnormal constituents of urine

UNIT-IV Digestive System

4.1 Structure of Gastrointestinal tract and functions of ancestry organs- liver and pancreas

4.2 Mechanism of secretion of HCL

4.3 Role of hormones and enzymes involved in digestion process.

4.4 Digestion and absorption of carbohydrates, lipids and proteins

UNIT-V Endocrine System

5.1 General organization of endocrine system- classification of hormones.

5.2 Biological role of Thyroid gland and Para Thyroid gland hormones

5.3 Biological functions of Insulin, Glucagon

5.4 Biological functions of adrenal glands and gonadal hormones.

REFERENCE BOOKS

1. Textbook of Medical Physiology –Guyton & Hall, 11th edition ,2006
2. Davidson's Principles and Practice of Medicine (XX Edition)-John.A.A.Hunter
3. Human Anatomy & Physiology –Elaine N.Marieb ,3rd edition ,1995
4. Essentials of Medical Physiology –Sembulingam ,1999 5. Medical Physiology –Ganong
5. Text book of Medical Biochemistry Physiology –MN.Chatterjee and , Rana Shinde,7th edition.
6. Animal physiology –Mariakuttikan and Arumugam

Course -7 HUMAN PHYSIOLOGY Course Code: 3BC-07P

Practical Syllabus

Skill Outcomes: After completing the course, students will achieve skill to

SO-1: Acquire proficiency in using the microscope to examine blood cells and recognize their structural features.

SO-2: Acquire the ability to determine ESR, clot and bleed time, blood group.

List of Practicals

1. Microscopy
2. RBC count & WBC count
3. Differential leucocyte count by Leishman' s staining
4. Estimation of Hemoglobin by Sahli's acid haematin method
5. Determination of Erythrocyte sedimentation rate (ESR)
6. Determination of clotting time & bleeding time
7. Determination of blood group
8. Urine analysis

COURSE – VIII **SEMESTER – III**

Title: GENETICS **Course Code: 3BC-08**

COURSE OUTCOMES

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

CO1: Describe the fundamentals of genetics, including DNA, chromosomes, and gene functions.

CO2: Explain gene arrangement in prokaryotes and eukaryotes and discuss extra-nuclear inheritance.

CO3: Analyze bacterial genetics, including transformation, transduction, conjugation, and the role of transposable elements in antibiotic resistance.

CO4: Understand and explain the bacteriophage lifecycle and the principles of CRISPR-Gene editing.

UNIT-I Genetic Material & Hierarchy

1.1 DNA as genetic material – direct and indirect evidences, experimental proof; RNA as genetic material.

1.2 Genes and Chromosome: Definition of gene; Interrupted genes; Structure of chromatin – nucleosomes and higher orders of organization;

1.3 Chromosome banding, genetic mapping of chromosomes; transposition in human chromosome and chromosomal abnormalities.

UNIT-II – Bacterial Genetics

2.1 Bacterial genetics: Bacterial chromosome, Bacterial genes

2.2 General characteristics and types of plasmids - F plasmid, R plasmid, colicinogenic plasmid, synthetic plasmid pBR 322.

2.3 Transposable genetic elements: IS elements and composite transposons

2.4 Recombination in bacteria: transformation, transduction and conjugation

UNIT-III – Viral Genetics

3.1 Bacteriophage T_4 and λ: Structure and life cycle

3.2 Transduction – generalized, specialized and abortive

3.3 Cosmids as gene cloning vector

3.4 Bacterial defense: CRISPR/Cas9- Gene editing tool

UNIT-IV – Eukaryotic genetics-1

4.1 Gene structure in eukaryotic organisms - introns, exons, pseudogenes, gene clusters, spacers repetitive sequences - Alu, copia, satellite

4.2 Single and multiple copy genes in eukaryotes - Histones

4.3 Cell memory – epigenetic modifications

UNIT-V – Eukaryotic genetics-2

5.1 Mapping of human genes– techniques used (Linkage analysis, RFLP, FISH, PCR, Chromosome walking and jumping, next generation sequencing)

5.2 Outlines of mechanism of recombination – homologous, non homologous, end joining, site specific, transpositional recombination

5.3 Extra nuclear inheritance – mitochondrial inheritance

RECOMMENDED BOOKS:

1. Molecular Genetics by D Friefelder
2. Cell molecular biology, Albert Bruce
3. Gene VII by Lewin
4. Molecular cloning by Maniatis and Co Vol I, II, III
5. Genetics by Gardner
6. Molecular Biology of the gene by Watson.
7. Genetics by G Zubay
8. Molecular Biology of the Cell by Albert Bruce.
9. Cell molecular Biology by Baltimore.
10. Molecular Biology by D Friefelder.
11. Genes VII Benjamin Lewin (2000). Oxford Univ. Press. London.
12. Cell and Molecular Biology 2ndEdit. (2002) By P. K. Gupta, Rastogi Publ.

Course -8 GENETICS **Course Code: 3BC-08P**

Practical Syllabus

Skill Outcomes: After completing the course, students will achieve skill to

SO1: Ability to isolate, amplify, and manipulate DNA through techniques like PCR, restriction digestion, and ligation.

SO2: Proficiency in bacterial transformation and selection of recombinant clones using molecular diagnosis techniques such as PCR and restriction analysis.

List of Practicals

1. Isolation of bacteriophages from sewage and quantification by plaque assay.
2. PCR amplification of insert
3. Restriction digestion of the vector and the insert
4. Ligation of restricted DNA fragments
5. Preparation of competent E.coli cells, transformation and expression of cloned gene
6. PCR and restriction diagnosis-based identification of positive clones

Minor COURSE – II **SEMESTER – III**

Title: HUMAN MOLECULAR GENETICS **Course Code: MNR 3MGBIO-02P**

COURSE OUTCOMES

Upon successful completion, students could able to

CO1: Recall & Understand the structure, function and interplay of DNA, RNA, and proteins.
CO2: Comprehend and elucidate the process of gene expression
CO3: Interpret DNA replication, damage & repair
CO4: Understand basic details of human genome and chromosome organization.

Unit 1 DNA, RNA and Protein Structure (9hr)

1.1 Building blocks and chemical bonds in DNA, – structure of DNA, A-B-Z and triplex DNA
1.2 Building blocks and chemical bonds in RNA – Structure of RNA- tRNA
1.3 Building blocks and chemical bonds in peptides- Classification of proteins, Peptide bond, Bonds stabilizing structure of proteins
1.4 Structural organization of proteins: Primary, secondary, tertiary and quaternary structure of proteins

Unit 2 Gene expression (9hr)

2.1 Central dogma of molecular biology
2.2 Transcription – RNA Polymerase, Mechanism of Transcription
2.3 Translation – Genetic Code, Activation of Aminoacids, Mechanism of Translation

Unit 3 DNA replication, Mutagenesis and DNA repair (9hr)

3.1 DNA replication – modes of Replication, Semi-conservative replication of DNA, DNA Polymerases, DNA ligase, Mechanism of Replication
3.2 Mutations- Brief account on Types of mutations
3.3 DNA repair – Mis-match repair, Base excision Repair, Nucleotide Excision Repair, Direct Repair, Recombination repair

Unit 4 Human Chromosome Organization (9hr)

4.1 Packaging of DNA – Nucleosome model, hierarchies of DNA folding
4.2 Chromosomes as functional organelles –origins of replication, telomeres, centromeres
4.3 Heterochromatin and euchromatin

Unit 5 Human Genome organization (9hr)

5.1 Mitochondrial genome – Brief account on replication, genes, genetic code
5.2 Nuclear genome – protein coding genes, RNA genes
5.3 Nuclear genome – highly repetitive DNA, heterochromatin and transposon repetitive

Course-02 Human Molecular Genetics Course Code: MNR 3MGBIO-02P

Practical Syllabus

SKILL OUTCOMES

On successful completion of practical course, students shall be able to

CO1: To plan the experiment through rigourous work on prtocols & chemicals needed
CO2: Understand and demonstrate the process of isolations & separation techniques
CO3: Develop proficiency in interpreting results

List of Practicals:

1. Extraction of DNA from human lymphocytes
2. Paper chromatography of amino acids
3. Electrophoresis: agarose gel electrophoresis,
4. PAGE
4. Study of isozymes by PAGE
5. Comet assay to measure DNA damage
6. Problem-based on homologous and site-specific recombination
7. Effects of mutagens and repair deficient *E.coli* strains.
8. Preparation of Human chromosome spread and banding
9. Isolation of DNA from onion / E.coli

Suggested Readings :

1. Human Molecular Genetics by T. Strachan
2. Human Molecular Genetics by Gerard Meurant
3. Human Molecular Genetics by Christopher G Mathew.
4. Human Molecular Genetics by Sudbury
5. Human Genetics: From Molecules to Medicine by Christian Patrick Schaaf, Johannes Zschocke.

Semester – IV
(Core Course)

Wef 2024-25

COURSE – IX **SEMESTER – IV**

Title: BIOENERGETICS AND METABOLISM OF CARBOHYDRATES AND LIPIDS

Course Code: 4BC-09

COURSE OUTCOMES

After the completion of this course, the student will be able:

CO1-To learn basic concepts of Bioenergetics, free energy transformations in biological systems, the significance of ATP and other high-energy compounds in cellular reactions

CO2-To understand the organization of Mitochondrial Electron transport chain, mechanisms of oxidative phosphorylation

CO3-To have a comprehensive understanding of cellular metabolism of carbohydrates, Lipids, their regulation, and the associated metabolic diseases.

CO4-To understand the significance of arachidonic acid pathways in physiological processes and to comprehend the role of liver and adipose tissue in maintaining lipid homeostasis.

UNIT-I BIOENERGETICS (CO-1) 8 Hrs

1.1 Principles of thermodynamics;

1.2 Concept of free energy -Free energy changes in biological transformations in living systems; enthalpy and entropy

1.3 Redox potential, phosphate group transfer potential and ATP

1.4 High-energy compounds, oxidation and reduction reactions

UNIT-II BIOLOGICAL OXIDATION (CO-1,2) 9 Hrs

2.1 Ultra structure of Mitochondria

2.2 Mitochondrial Electron transport system - Electron carriers- Nicotinamide, Flavoproteins, Fe-S Proteins, Ubiquinone,Cytochromes

2.3 Electron transport chain (ETC)- Organization of the carriers into Complex I, II, III, IV and flow of electrons, Substrate level phosphorylation; Respiratory chain inhibitors

2.4 Mechanism of Oxidative phosphorylation- Chemiosmotic hypothesis, Structure of F1-FO ATP synthase and synthesis of ATP, Uncouplers and inhibitors of oxidative phosphorylation

UNIT-III CARBOHYDRATE METABOLISM (CO-3) 12 Hrs

3.1 Introduction to metabolism-concept of anabolism and catabolism; Glycolysis-energy yield, regulation, fate of pyruvate- formation of acetyl CoA, lactate and ethanol

3.2 TCA cycle – energy yield, regulation; Anaplerotic reactions

3.3 Gluconeogenesis, and its regulation, HMP shunt and its significance; Glycogen metabolism- Glycogenesis, Glycogenolysis and its regulation; Biogenesis of amino sugars- Glucosamine.

3.4 In born errors of carbohydrate metabolism-**Von Gierke's disease**, Lactose intolerance.

UNIT-IV LIPID METABOLISM – I (CO- 3, 4) 8 Hrs

3.5 β-Oxidation of fatty acids (Palmitic acid)

3.6 De novo synthesis of fatty acids and regulation

3.7 Metabolism of arachidonic acid; formation of prostaglandins, thromboxanes, leukotrienes,

3.8 Biosynthesis of triglycerides

UNIT-V LIPID METABOLISM – II (CO- 4) 8 Hrs

5.1 Metabolism of Phospholipids-Phosphatidylcholine, Ethanolamine and Sphingomyelin

5.2 Biosynthesis of cholesterol and its regulation; Formation of bile acids.
5.3 Role of liver and adipose tissue in lipid metabolism.
5.4 In born errors of lipid metabolism- Niemann -Pick disease, Gaucher's disease.

Additional Inputs:

- Glyoxylate cycle
- Uronic acid pathway
- Formation of ketone bodies

RECOMMENDED BOOKS

1. Principles of Biochemistry, White. A, Handler, P and Smith.
2. Biochemistry, Lehninger A.L.
3. Biochemistry, David E. Metzler.
4. Biochemistry, LubertStryer.
5. Text of Biochemistry, West and Todd.

Course-9: BIOENERGETICS AND METABOLISM OF CARBOHYDRATES AND LIPIDS Course Code: 4BC-09P

Practical Syllabus

COURSE OUTCOMES

After the completion of this course, the student will be able:

CO-1 To perform the isolation of proteins using appropriate precipitation and centrifugation techniques
CO-2 To learn the quantification methods for estimating various biologically important compounds.
CO-3 To analyze and interpret the data to interpret the clinical relevance.

PRACTICAL SYLLABUS

1. Isolation of casein from milk
2. Preparation of lactalbumin from milk
3. Estimation of reducing sugar by DNSA (dinitrosalicylic acid) method
4. Titration of glucose by Benedict's method
5. Estimation of urea by Diacetyl monoxime method
6. Estimation of creatinine in serum
7. Estimation of cholesterol by ZAK's method

COURSE – X **SEMESTER – IV**
Title: CLINICAL BIOCHEMISTRY **Course Code: 4BC-10**

COURSE OUTCOMES
CO 1: Gain basic knowledge of specimen collection and electrolyte balance.
CO2: Interpret diagnostic tests for renal, gastric, and liver functions.
CO3: Understand antinutrient factors and inherited disorders, including hemoglobin metabolism.
CO4: Evaluate blood glucose regulation and key clinical enzymes.

UNIT-I Clinical Biochemistry Laboratory and Investigation of Homeostasis
1.1 Specimen: types of specimen and their collection; Automation and Computerization.
1.2 Homeostasis: Water and electrolyte homeostasis - renin angiotensin – aldosterone system.
1.3 Pathological variations of water and electrolytes- diagnosis and Interpretations.

UNIT-II Inherited Disorders and Abnormal Hemoglobin 9hrs
2.1 Inborn errors of carbohydrate metabolism: Glycogen storage diseases
2.2 Inborn errors of amino acid Metabolism: Alkaptonuria, phenyl ketonuria, albinism
2.3 Inborn errors of lipid metabolism: Taysachs disease, Nieman pick disease
2.4 Inborn errors of nucleic acid metabolism: Gout, Leshnyhan syndrome
2.5 Abnormal hemoglobin: Sickle cell anemia, hemoglobinopathies - thalassemias, porphyrias,

UNIT-III Investigation of Renal and Gastric Functions.
3.1 Renal functions tests: Preliminary investigations - urine examination; Analysis of blood – estimation of blood urea, serum creatinine
3.2 Tests based on GFR – urea clearance and creatinine clearance tests
3.3 Tests based on tubular function – urine concentration, urine acidification tests
3.4 Gastric function tests: Examination of resting content, fractional test meal, stimulation tests, augmented histamine test meal, tubeless gastric analysis, insulin test meal and pancreatic function tests.

UNIT-IV Liver Function Tests and Lipid Disorder
4.1 Liver function tests: Tests based on excretory function - abnormalities of bile pigment metabolism(Diagnosis of different types of jaundice), bromosulphthaline
4.2 Tests based on serum enzymes - ASP, ALP, GGT, alkaline phosphatase
4. Tests based on metabolic capacity - galactose tolerance; synthetic function – serum albumin, prothrombin time; detoxification - hippuric acid test
4.4 Lipid Disorder: Lipoprotinemias, atherosclerosis, coronary heart diseases and hypertension.

UNIT- V Blood Glucose Regulation and Enzymes of Diagnostic Importance 9 hrs
5.1 Role of hormones in blood glucose homeostasis, blood glucose regulation – hypoglycemia, hyperglycemia, Diabetes mellitus, Glycosuria and GTT and its clinical significance.
5.2 Clinical significance of enzymes and isoenzymes - CK, phosphatase, 5' nucleosidase, amylase, lipase, acetyl cholinesterase, transaminase, gamma glutamyl transferase and LDH.

Additional input:

- Acid base balance and imbalance - Mechanism of regulations, Anion gap, Acidosis and Alkalosis
- Plasma proteins in health and diseases
- Biochemical changes in cancer - detection of tumor markers
- Meningitis, encephalities, epilepsy, Parkinson's, Alzheimer's, cerebral palsy

REFERENCE BOOKS

1. Gowenlock, A.H. and Donald, J(2002). Varley's practical clinical Biochemistry, sixth edition, CBS publications and Distributors, New Delhi.

2. Sembulingam, K and Sembulingam, P(2010). Essentials of Medical Physiology, fifth edition. Jaypae Brothers (p) ltd, New Delhi.

3. Burtis and Ashwood (2007) Tietz Fundamentals of Clinical chemistry, 6th edition, WB Saunders Company, Oxford Science Publications USA.

4. Chatterjee and Shindae(2012). Text book of medical biochemistry, 8th edition.

5. Devlin, T.M(2010). Text Book of Biochemistry with clinical correlations, 7th edition. NewYork.

6. Gans, G and Murphy, J.M. (2008). Clinical Biochemistry, fourth edition, Churchill Livingstone, Elsevier

Course-10: CLINICAL BIOCHEMISTRY Course Code: 4BC-10P

Practical Syllabus

Skill Outcomes: After completion of the course , students will acquire skill to

SO1- Competence in performing biochemical assays to assess blood, serum, and urine components, including metabolic markers and electrolyte levels.

SO2- Ability to analyze and interpret results of lipid, liver, and kidney function tests to evaluate physiological and pathological states.

List of Practicals

1. Blood analysis: Iron and Hemoglobin, Glucose, GTT. 10hrs
2. Serum and Urine analysis: Creatine, chloride, phosphorus, calcium. 10 hrs
3. Lipid profiles (Serum) – Total cholesterol, triglycerides, HDL, LDL 5 hrs
4. Liver function tests – Total Bilirubin, total protein, albumin, globulin, albumin/globulin ratio, AST, ALT, ALP 10 hrs
5. Kidney function tests - Urea, creatinine, uric acid.

COURSE – XI **SEMESTER – IV**

Title: IMMUNOLOGY **Course Code: 4BC-11**

COURSE OBJECTIVES

1. Appreciate organization of Immune system
2. Understand Types of antibodies, immune mechanisms
3. Applying concepts of immunity to understand their response during disease conditions.

Unit-I: **9 hrs**

1.1 Organization of immune system – over view in plants & animals

1.2 Organs of immune system: Hematopoiesis,

1.3 Primary lymphoid organs -Thymus & Bone marrow

1.4 Secondary lymphoid organs - Lymph node & spleen

1.5 Cells of immune system: T-lymphocytes, B-lymphocytes, Macrophages, Dendritic cells, Mast cells & NK cells, Neutrophils, Eosinophils, Basophils.

Unit-II: **6 hrs**

2.1 Antigens and Concept of haptens, Adjuvants, epitopes and determinants of antigenicity,

2.2 Classification of immunoglobulins , Structure & specific biological functions of IgG, IgM, IgD, IgE, IgA

UNIT-III **9 hrs**

3.1 Antigen antibody reactions - precipitation, agglutination, complement fixation, opsonization

3.2 Types of Immunodiagnostic tests - RIA, ELISA

3.3 Types of immunity: Innate immunity (Anatomical, biochemical, phagocytic, inflammation) and acquired immunity (Active & passive immunity)

UNIT-IV: **11 hrs**

4.1 Immune Response: Humoral & Cell mediated Immune response

4.2 Vaccines and their classification. Traditional vaccines-live and attenuated, toxoids. Modern vaccines- recombinant and peptide vaccines.

4.3 Role of MHC class I & class II proteins, exocytic and endocytic pathways of antigen processing & presentation

4.4 T and B cell - Maturation

UNIT-V : **10 hrs**

5.1 Outlines of hypersensitivity reactions: Type I, Type II, Type III, & Type IV hypersensitivity

5.2 Outlines of autoimmunity – organ specific auto immune disease (Type I diabetes mellitus), systemic auto immune disease (Systemic lupus erythematosus)

5.3 Immunodeficiencies; Transplantation Immunology; Immune response against major classes of pathogens.

Additional Inputs:

- Innate immunity in plants and animals Plants - Chemical and morphological defence in plants; elicitors, receptors, Basal resistance
- Adaptive Immunity in Plants and Animals Plants - Biotic- interactions with symbionts, pathogens., Biochemical host defences

REFERENCE BOOKS

1. Immunology, T .J. Kindt, R. A. Goldsby, and B.A. Osborne. (2007) W.H.Freeman and Co, New York.
2. Biochemistry,Voet, D. and Voet, J.G. (2004). 3rd Edition, John Wiley & Sons, Inc.USA.
3. Immunology Kuby
4. Immunology J. Kannan, MJP Publishers, Chennai 5 Immunology Roitt Ivan, Jonathan Brastoff, David Male, 1993.
5. Immunology Janis Kuby, 4th edition, 2000.
6. Immunology An introduction, Tizarrd, R. 1995.
7. Fundamentals of Immunology LippincotPraven publications, 4th edition.
8. Essential and clinical Immunology Halen chapel, Mansal Haney, Siraj Misbah and NialSnowdan.
9. Immunology Geoffrey Zubay, W.M.C, Brown publishers, 4th edition 1992.
10. Immunology The immune system in health and disease, 3rd edition.

Course-9: IMMUNOLOGY Course Code: 3BC-11P

Practical Syllabus

COURSE OUTCOMES

After successfully completing this course, the students will be able to:
CO-1. Apply knowledge for basic understanding of immune system
CO-2. Plan the experiment through rigourous work on prtocols & needed chemicals
CO-3: Demonstrating the ability to draw conclusions and assess significance and to create scientific temper.

List of Practicals

1. Survey of structural plants defences: viz. cuticle, wax, lignin, bark, thorns, prickles, trichomes.
2. Immunodiffusion SRID. Rocket IEP
3. Spleen cell isolation and counting.
4. ABO and Rh blood grouping
5. Latex agglutination assay
6. Quantitative immunoprecipitation assay

Minor COURSE – III **SEMESTER – IV**

Title: Molecular Techniques in Genetic Engineering **Course Code: MNR 4MGBIO-03**

Course Outcomes: Upon successful completion, each student will have the basic knowledge on :

CO 1. Different methods of isolation of DNA

CO 2. PCR and types, hybridization methods

CO 3. Ssequencing of DNA and protein isolation techniques

Unit-1 Nucleic Acid Isolation and Agarose Gel Electrophoresis

1.1 Isolation of nucleic acids-Plasmid DNA, Genomic DNA from Bacterial cells, Plant cells and animal cells

1.2 RNA isolation and m-RNA purification by affinity chromatography

1.3 Agarose gel electrophoresis, Pulse field gel electrophoresis,

1.4 Staining techniques – Acetocarmine, Ethidium bromide, Silver.

Unit-2 PCR Techniques

2.1 Principle and applications of Polymerase Chain Reaction (PCR)

2.2 Design of Gene specific primer

2.3 Types of PCR – Reverse transcription PCR and Real time PCR.

Unit-3 Hybridization Methods

3.1 Nucleic acid Probes –Definition, use and applications

3.2 Radioactive probe (P^{32}) and non-radioactive probe (horse radish peroxidase)

3.3 Detection techniques – Southern hybridization, Western blotting

Unit-4 DNA Sequencing and Gene Synthesis

4.1 Sangers's method of DNA sequencing – Manual and automated methods.

4.2 Pyrosequencing- principle and applications

4.3 Illumine sequencing

UNIT-5 Protein Techniques

5.1 Electrophoresis of protein –native and denaturing conditions (SDS PAGE)

5.2 Gel electrophoresis, 2D gel electrophoresis, ELISA

5.3 Yeast hybrid system-one hybrid system, Phage display

Course-03 Molecular Techniques in Genetic Engineering Course Code: MNR 4MGBIO-03P

Practical Syllabus

SKILL OUTCOMES: After completion of the course students will able to
SO1: Develop expertise in molecular biology techniques:
SO2: Master the use of electrophoresis and blotting techniques for biomolecule analysis

PRACTICAL

1. Primer designing
2. Insertion deletion polymorphism
3. DNA Fingerprinting – RFLPs and VNTRs
4. Amplification and purification of DNA fragments - PCR
5. DNA sequencing methods
6. SDS-Gel electrophoresis
7. Southern blotting
8. Western blotting

Minor COURSE – IV **SEMESTER – IV**
Title: Clinical Genetics & Genetic Counselling **Course Code: MNR 4MGBIO-04**

COURSE OUTCOMES : Upon successful completion, each student will will be able to:
1. Understand various types of Genetic Disorders
2. Role, process & legal issues of Genetic Counselling
3. Could able to address the Genetic counselling suiting to relevant disorder

Unit-1 Genetic Disorders I (9hr)
1. Monogenic diseases – Cystic fibrosis, Tay-Sachs syndrome, Marfan syndrome
2. Inborn errors of metabolism – Phenylketonuria, Maple syrup urine syndrome, galactosemia
3. Genome imprinting syndromes –Prader Willi and Angelman syndrome

Unit-2 Genetic Disorders II (9hr)
1. Genomic syndromes – Neurofibromatosis I
2. Neurogenetic disorders – Charcot Marie Tooth syndrome, spinal muscular atrophy, Alzheimer's diseases
3. Muscle genetic disorders – dystrophies, myotonias, myopathies

Unit-3 Genetic Disorders III (9hr)
1. Genetic Disorders of Haemopoietic systems- sickle cell anaemia, thalassemia's, haemophilia
2. Genetic disorders of eye – colour-blindness, retinitis pigmentosa, glaucoma
3. Complex polygenic syndromes – atherosclerosis, diabetes mellitus
4. Mitochondrial syndromes

Unit-4 Genetic Counselling (9hr)
1. Role of genetic counselling
2. Causes and factors for seeking counselling
3. Dysmorphology
4. Prenatal and preimplantation diagnosis

Unit-5 Practical Genetic Counselling (9hr)
1. Process of genetic counselling - Constructing a family tree, diagnostic information, risks and odds, estimation of risks
2. Genetic counselling in Mendelian disorders
3. Genetic counselling in non-Mendelian disorders
4. Ethical and legal issues in genetic counselling

SUGGESTED READINGS
1. Chen, Harold Atlas of Genetic Diagnosis and Counseling Springer 2012.
2. Thompson and Thompson & Thompson Genetics in Medicine, Robert L. Nussbaum, Roderick R. McInnes, Huntington F. Willard (eds)

Course-04 Clinical Genetics & Genetic Counselling Course Code: MNR 4MGBIO-04P

Practical Syllabus

Skill Outcomes: On successful completion of practical course students shall be able to
CO1: To plan the experiment through rigourous work on prtocols & chemicals needed
CO2: Understand and demonstrate the different processes
CO2: Develop proficiency in interpreting results

Practical

1. Metaphase chromosome preparations from bone marrow of mouse, rat, human
2. Chromosome preparation from lymphocyte culture
3. G-banding, C-banding, R-banding
4. Karyotyping
5. Meiosis in mouse testis
6. Sex chromatin (buccal mucosa, hair bud)
7. Micronuclei assay
8. Chromosome preparation from chorionic villi, stem cells, cell line
9. Sister Chromatid Exchange (SCE)
10. Molecular markers for tumour detection
11. Genetic counseling (pedigree analysis in disease conditions, risk calculation)
12. Y-chromosome microdeletion
13. Biochemical tests for sugar, albumin, Creatine phosphokinase-CPK, glucose 6 phosphate dehydrogenase-G6PD

Semester – V
(Core Course)

Wef 2022-23

THREE MAJOR SYLLABUS

COURSE – VI **SEMESTER – V**

Title: GENETIC ENGINEERRING & BIOINFORMATICS **Course Code: BC-403-6A**

Course Outcomes :

After the completion of the course, the student will be able to:

CO1 – Recall key principles of genetic engineering & bioinformatics including gene manipulation techniques and molecular tools used in the field.

CO2 - Explain the underlying concepts of genetic engineering & bioinformatics, demonstrating comprehension of gene transfer mechanisms, cloning, and genetic modification.

CO3 - Apply genetic engineering techniques bioinformatics to design and execute experiments, demonstrating practical skills in genetic manipulation and modification.

CO4 - Analyze ethical, social, and scientific implications of genetic engineering advancements, evaluating their impact on individuals and society & predict similarity among organisms using in-silico tools

Unit 1 Basic tools in rDNA technology

1.1 Basic steps in gene cloning. Isolation of DNA: isolation of genomic DNA & plasmid DNA from bacteria.

1.2 DNA manipulating enzymes: polymerases, nucleases, ligase, phosphatase reverse transcriptase;

1.3 Restriction endonucleases- nomenclature, types and properties

Unit-II: Cloning vectors, Ligation, DNA libraries:

2.1 Cloning vectors: characteristics of plasmids,pBR 322 as cloning vector, bacteriophage λ., cosmids,

2.2 Brief introduction to bacterial artificial chromosome (BAC) & yeast artificial chromosome (YAC) Shuttle vectors & Expression vectors.

2.3 Ligation: Mechanism of action of T4 DNA ligase

2.4 Joining of DNA fragments:

2.5 Sticky end, blunt end ligation, linkers and adapters, Synthetic oligonucleotides.

2.6 DNA libraries: Genomic DNA library; cDNA synthesis & cDNA library

Unit-III: Introduction and selection of recombinants

3.1 Methods for introducing rDNA into host cells - Transformation, Electroporation, Microinjection, gene gun methods.

3.2 Any four features of E.coli & Yeast as host cells.

3.3 Identification for recombinants - Insertional inactivation (colony hybridization).

3.4 Methods based on detection of the translation product of cloned gene - Hybrid released translation (HRT) & Hybrid arrest and released translation (HART).

Unit-IV: Techniques & Applications

4.1 Principle, Method & applications of Polymerase chain reaction (PCR).

4.2 DNA sequencing by Sanger's method.

4.3 Principle & method of Southern, Northern & Western blotting techniques.

4.4 Applications of r DNA technology in Agriculture: Short note on Bt cotton, Golden rice.

4.5 Applications of r DNA technology in Medicine: Production of Insulin, Growth hormone

4.6Ethical concerns of genetically engineered plants & animals.

Unit-V: Bioinformatics

5.1 History & scope of Bioinformatics
5.2 NCBI - Resources available at NCBI
5.3 Databases – characteristics and applications of biological (primary, secondary and composite), nucleic acid (Genbank, EMBL, DDBJ), protein (Swiss Prot, PDB)
5.4 Genomics – definition of structural and functional genomics; Human genome sequencing – BAC to BAC method, whole genome shotgun sequencing
5.5 Types of Proteomics; Applications of proteomics
5.6 Sequence alignment algorithms – BLAST, CLUSTAL-W

Additional inputs:

Human genome project;

COURSE – VI GENETIC ENGINEERRING & BIOINFORMATICS

Course Code: BC-403-6AP

List of Experiments:

1. Isolation of genomic DNA from E. Coli
2. Isolation of plasmids.
3. Electrophoretic separation of DNA and visualization by UV Transilluminator.
4. Restriction digestion of DNA with any two restriction enzymes.
5. Preparation of Competent E.coli for transformation
6. Transformation of E.coli by Cac12
7. Polymerase chain reaction: Principle & problem solving
8. Sequencing of DNA by sangers method: Retrieving sequence from gel.
9. Southern blotting of DNA
10. Western blotting of proteins - Virtual lab exercise.
11. Other Virtual lab exercise on recombinant DNA techniques.
12. Sequence information retrieval (protein & gene) from NCBI
13. BLAST suit of tools for pairwise alignment
14. Multiple sequence alignment using CLUSTAL W

Text Books :

- rDNA technology
- Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell
- Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose
- Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed.
- "Bioinformatics"- CSV Murthy, Himalaya Publishing House
- Introduction to Bioinformatics - M. Lesk Oxford University Press
- Bioinformatics sequence and genome analysis - David W.Mount, Cold spring harbor laboratory press
- Bioinformatics: A Modern Approach - Vittal R. Srinivas, published by PHI Learning Pvt. Ltd
- Bioinformatics and Functional Genomics Pevsner, J., John Wiley & Sons

COURSE – VII **SEMESTER – V**
Title: IMMUNOLOGY & ENDOCRINOLOGY **Course Code: BC-403-7A**

Course Outcomes:
After the completion of the course, the student will be able to:

- CO1 – Recall Types of immunity, understand the structure of immunoglobulins
- CO2 – Study antigen-antibody interaction Imagine the power of immune system during health, illness.
- CO3 – Categorize hypersensitivity reactions and list out auto immune diseases.
- CO4 – Understand the organization of Endocrine system, the influence of hormones on metabolism and deficiency disorders.

Unit-I: Immunology – I

1.1 Organization of immune system
1.2 Types of immunity: Innate immunity (Anatomical, biochemical, phagocytic, inflammation) and acquired immunity (Active & passive immunity)
1.3 Organs of immune system: Primary lymphoid organs -Thymus & Bone marrow Secondary lymphoid organs - Lymph node & spleen
1.4 Cells of immune system: T-lymphocytes, B-lymphocytes, Macrophages, Dendritic cells, Mast cells & NK cells, Neutrophils, Eosinophils, Basophils
1.5 Immune Response: Humoral & Cell mediated Immune response

Unit - II: Immunology – II

2.1 Antigens and Concept of haptens, Adjuvants, epitopes and determinants of antigenicity,
2.2 Structure & biological functions of IgG; Classification of immunoglobulins
2.3 Antigen antibody reactions - precipitation, agglutination, complement fixation, opsonization
2.4 Types of Immunodiagnostic tests - RIA, ELISA

Unit - III: Immunology – III

3.1 Role of MHC class I & class II proteins, exocytic and endocytic pathways of antigen processing & presentation
3.2 Outlines of hypersensitivity reactions: Type I, Type II, Type III, & Type IV hypersensitivity
3.3 Outlines of autoimmunity – organ specific auto immune disease (Type I diabetes mellitus), systemic auto immune disease (Systemic lupus erythematosus)
3.4 Vaccines and their classification. Traditional vaccines-live and attenuated, toxoids. Modern vaccines- recombinant and peptide vaccines

Unit IV: Endocrinology – I

4.1 Organization of endocrine system; Classification of hormones based on chemical composition and location of hormone receptors.
4.2 Mechanism of hormonal action - signal transduction pathways for adrenaline, glucocorticoids and insulin
4.3 Hypothalamic hormones and their functions - GHRH, TSRH, GnRH, GHRIH
4.4 Physiological and biochemical actions of pituitary hormones - GH, prolactin, TSH, LH,

FSH, oxytocin and vasopressin;
4.5 Disorders – gigantism, acromegaly and diabetes insipidus

Unit V: Endocrinology – II
5.1 Physiological role of thyroid hormone; Disorders - Goiter, cretinism, myxedema
5.2 Physiological role of insulin, glucagon; Disorders - diabetes type I and type II
5.3 Physiological role of Adrenal hormones - Aldosterone, cortisol, corticosterone, epinephrine and norepinephrine; Disorders -Addison's disease, Cushing syndrome
5.4 Physiological role of gonadal hormones - Androgens (testosterone), Estrogens (estrone), Progestogens (progesterone)

COURSE – VII IMMUNOLOGY & ENDOCRINOLOGY Course Code: BC-403-7AP

List of Experiments:

1. Isolation of lymphocytes from blood
2. WBC-Differential count
3. Determination of blood group and Rh typing.
4. Visualization of antigen antibody reactions (ODD).
5. Visualization of antigen antibody reactions (RID)
6. ELISA
7. Glucose tolerance test
8. Estimation of serum Ca+2
9. Case studies

Recommended Textbooks:

- Immunology – Kuby
- Immunology – Roitt
- Harper's Biochemistry - Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill.
- Text book of Medical Biochemistry – Vasudevan
- Text book of Medical Biochemistry – Chatterjie and Shindae
- Essentials of Medical Biochemistry - RC Gupta
- An introduction to Practical Biochemistry - T. Plummer Biochemistry – Viva Series
- Lab manual in Biochemistry – Pattabhiraman
- Lab manual in Biochemistry – Jayaraman