Semester- I

Course Name: Molecules of Life

Course Code: BSCHBCMC101

Course Type: **CC**	Course Details: **CC-1**		L-T-P: **4-0-4**	
Credit: 6…	Full Marks: 100..	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

MOLECULES OF LIFE (THEORY)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

- Exposure with the nature of various biomolecules present in living cells.
- Get exposed to key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan, etc. in order to create scientific interest amongst students in life processes.
- To understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems.
- To understand the process of fermentation and manufacture of Biodiesel.
- To develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

Students will be exposed to the history of Biochemistry and key contributions of scientists such as Hans Kreb, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, HarGobind Khorana, Watson and Crick and Venky Ramakrishnan. They will study the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems. They will understand the process of fermentation and manufacture of Biodiesel. They will understand the methods of determination of amino acid and nucleotide sequence of proteins and DNA respectively.

Course Content:

The foundations of biochemistry

Cellular and chemical foundations of life

Water

Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Carbohydrates and glycobiology

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and nonreducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans,

glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Lipids

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments

Amino acids

Structure and classification, physical, chemical and optical properties of amino acids

Nucleic acids

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Vitamins

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis

MOLECULES OF LIFE (PRACTICALS)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

- Exposure to basic reactions of biomolecules.
- Determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknown samples.
- Determine the extent of adulteration in samples containing biomolecules.

The student will gain awareness about basic reactions of biomolecules and their utility in identification of adulterants.

Course Content:

1. Safety measures in laboratories.
2. Preparation of buffers.
3. Determination of pKa of acetic acid and glycine (pH metric titration).
4. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
5. Separation of amino acids/ sugars/ bases by thin layer chromatography.
6. Estimation of vitamin C (Iodimetric method).

References/ Suggested Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 /ISBN:10:1-4292-3414-8

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

Semester- I

Course Name: … Cell Biology…

Course Code: … BSCHBCMC102……..

Course Type: **…CC……**	Course Details: **…CC-2……**			L-T-P: **…4-0-4…….**	
Credit: 6**…**	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

CELL BIOLOGY (THEORY)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

- Understanding of the structure of cell and various cellular events.
- Understanding of the function of various subcellular organelles.
- Students will learn about cell theory and techniques for fractionation of sub-cellular organelles.
- They will be acquainted to various microscopic techniques to visualize subcellular organelles.
- Students will have an understanding of the composition of cytoskeleton and extracellular matrix.
- Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

This course will provide an understanding of the structure of cell and function of various subcellular organelles. Students will learn about cell theory, basic cell structure, cell fractionation and cell visualization techniques. Besides, students will have an understanding of the composition of cytoskeleton and extracellular matrix. Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.

Course Content:

Introduction to cell biology

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models.

Tools of cell biology

Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.

Structure of different cell organelles

Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome.

Structure and functions of mitochondria, chloroplasts and peroxisomes.

Zellweger syndrome.

Protein trafficking

Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Cytoskeletal proteins

Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

Cell wall and extracellular matrix

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cellcell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata.

Cell cycle, cell death and cell renewal

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

CELL BIOLOGY (PRACTICAL)

CREDITS: 2 (Marks 50)

Course Learning Outcomes:

- Students will learn the handling of microscope.
- Obtain hands-on training in basic separation techniques in biochemistry
- Gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Students will learn thehandling of microscope. They will gain knowledge about the structure and function of various cell organelles. The students will obtain hands-on training in basic separation techniques in biochemistryand gain expertise in the isolation of various cell organelles and staining of cellular biomolecules.

Course Content:

1. Visualization of animal and plant cell by methylene blue.
2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis / onion flower bud.
4. Visualization of nuclear fraction by acetocarmine stain.

References/ Suggested Readings:

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.

3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M.,Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

Semester-I

Course Name: Biochemistry of Cell

Course Code: BSCHBCMGE101

Course Type: **GE**	Course Details: **GE-1**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		……30	10	…20…	40

Biochemistry of Cell (Theory)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

- After completion the students will able to get exposed to strong theoretical background in fundamental concepts of Biochemistry of Cell
- They will be able to get insights of multiple important technical areas of Biochemistry of Cell.
- They will be able to demonstrate professional and ethical attitude with enormous responsibility to serve the society.

Biochemistry of Cell (Practical)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

- They will be able to apply contextual knowledge and modern tools of biochemical research for solving problems Biochemistry of Cell.
- They will be able to express ideas persuasively in written and oral form to develop their leadership qualities.

Semester- II

Course Name: Proteins

Course Code: BSCHBCMC201

Course Type: C	Course Details: CC-3			L-T-P: 4 - 0 - 4	
Credit: 6	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

Core course-III

PROTEINS (THEORY)

CREDITS: 4 (Marks 50)

Course Learning Outcomes:

(to be written according to the course requirement, total number of learning outcome may vary from course to course)

Course Learning Outcomes After completion of the course, a student will

- Understand the diverse functions of proteins in a cell

- Understand the hierarchy of protein architecture – primary, secondary, tertiary & quaternary structure, with the ability to distinguish features of globular & fibrous proteins

- Be able to comprehend the fundamental mechanisms of protein folding and stability and their relation to conformational diseases

- Be able to describe and discuss the separation and purification techniques used in protein chemistry • Learn to access and use the databases related to protein sequence and structure

- Understand specialized proteins like membrane proteins, defense proteins and motor proteins

- Gain comprehension of structure-function relationship of proteins and their significance in physiology, diseases and applications in industry and medicine.

Content/ Syllabus: Unit wise course content distribution

Unit -1:Introduction to amino acids, peptides and proteins

Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function

Unit-2: Extraction of proteins for downstream processing

Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation.

Unit -3: Separation technique

Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ionexchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC

Unit -4: Characterization of proteins

Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF,SDSPAGE and 2-D electrophoresis.

Unit -5: Covalent structure of proteins

Organization of protein structure into primary, secondary, tertiary and quaternary structures. Nterminaland C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass pectrometric analysis, tandem MS. Solid phase peptide synthesis

Unit -6: Three dimensional structures of proteins

Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures -X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin

Unit -7: Protein folding and conformational diseases

Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based.

Unit- 8: Introduction to protein structure database

Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using in silico tools.

Unit -9: Myoglobin and haemoglobin

Oxygen binding curves, influence of 2,3-BPG, CO2 and Cl-. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders.

Unit- 10: Specialized proteins - antibodies and actin-myosin motors

Antibody structure and binding to antigens. ATP activated actin - myosin contractions.

Unit – 11: Membrane proteins

Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

Core course-III

PROTEINS (PRACTICAL)

CREDIT: 2 (Marks 50)

1.Estimation of proteins using UV absorbance and Biuret method.

2.Microassay of proteins using Lowry/Bradford method.

3.Isoelectric pH of casein.

4.Ammonium sulphate fractionation of serum proteins.

5.Separation of albumin from serum using anion-exchange chromatography.

6. SDS-PAGE analysis of proteins.

References/ Suggested Readings

1.Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

2.Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.

3.The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

The credit and marks distribution will vary according to the course type (Theoretical, Practical and Theoretical+Practical)

Course Name: Enzymes

Course Code: BSCHBCMC202

Course Type: C	Course Details:CC-4			L-T-P: 4- 0 - 4	
Credit:6	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

CORE COURSE-IV
ENZYMES (THEORY)
CREDITS: 4 (Marks 50)

Course Learning Outcomes:

(to be written according to the course requirement, total number of learning outcome may vary from course to course)

- Students will learn the nature and importance of enzymes in living systems

- Students will gain insight into the thermodynamic and molecular basis of catalysis by enzymes and the underlying basis of their specificity

- Students will understand the mechanisms of enzyme action, kinetics of enzyme catalyzed reactions and clinical importance of enzyme inhibitors

- Students will also learn to appreciate how enzymes are regulated and the physiological importance of enzyme regulation in the cell

- The course will introduce students to the applications of enzymes in research and medicine as well as in industry, which will bolster their foray into industrial and biomedical research.

Content/ Syllabus: Unit wise course content distribution

Unit -1: Introduction to enzymes

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes.

Unit-2: Features of enzyme catalysis

Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit -3: Enzyme kinetics

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofsteeand Hanes plot. Km and Vmax, Kcat and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.

Unit - 4: Bisubstrate reactions

Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit -5: Enzyme inhibition

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors.

Unit – 6: Mechanism of action of enzymes

General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Unit -7: Regulation of enzyme activity

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen. Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit -8: Involvement of coenzymes in enzyme catalysed reactions

TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

Unit – 9: Applications of enzymes

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.

Core course – IV

ENZYMES (PRACTICAL)

CREDIT 2 (Marks 50)

1.Partial purification of acid phosphatase from germinating mung bean.

2.Assay of enzyme activity and specific activity, e.g. acid phosphatase.

3.Effect of pH on enzyme activity

4.Determination of Km and Vmax using Lineweaver-Burk graph.

References/ Suggested Readings

1.Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

2.Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.

3.Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

The credit and marks distribution will vary according to the course type (Theoretical, Practical and Theoretical+Practical)

Semester- III

Course Name: Metabolism of carbohydrates and lipids

Course Code: BSCHBCMC301

Course Type: CC	Course Details: CC5			L-T-P: 4-0-4	
Credit: 6	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

METABOLISM OF CARBOHYDRATES AND LIPIDS (THEORY)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

1. Exposure with the nature of various biomolecules present in livingcells.
2. Get exposed to key contributions of scientists such as Hans Krebs, G. N. Ramachandran, Melvin Calvin, Louis Pasteur, Har Gobind Khorana, Watson and Crick and Venky Ramakrishnan, etc. in order to create scientific interestamongst
3. students in lifeprocesses.
4. To understand the properties of carbohydrates, proteins, lipids, cholesterol,DNA,
5. RNA, glycoproteins and glycolipids and their importance in biologicalsystems.
6. To understand the process of fermentation and manufacture ofBiodiesel.
7. To develop skills to determine amino acid and nucleotide sequences of proteins and DNArespectively.

Content/ Syllabus: Unit wise course content distribution

Unit 1 Basic design of metabolism

Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.

Unit 2 Glycolysis

Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.

Unit 3 Gluconeogenesis and pentose phosphate pathway

Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Unit 4 Glycogen metabolism

Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Unit 5 Citric acidcycle
Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxylate pathway, coordinated regulation of glyoxylate and citric acidpathways.

Unit 6 Synthesis of carbohydrates
Calvin cycle, regulation of Calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C4 and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell.

Unit 7 Fatty acid oxidation
Digestion, mobilisation and transport of cholesterol and triacyl glycerol's, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis.

Unit 8 Fatty acid synthesis
Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.

Unit 9 Biosynthesis of cholesterol, steroids and isoprenoids
Synthesis of prostaglandins, cholesterol, steroids and isoprenoids. Regulation of cholesterol synthesis.

Unit 10 Biosynthesis of membrane lipids
Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

Unit 11 Starve-feed cycle
Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis.

METABOLISM OF CARBOHYDRATES AND LIPIDS (PRACTICALS)

CREDIT: 2 (Marks 50)

1. Exposure to basic reactions ofbiomolecules.
2. Determine presence of biomolecules like carbohydrates, proteins, lipids, etc. in known and unknownsample.
3. Determine the extent of adulteration in samples containingbiomolecules.

Content/ Syllabus: Unit wise course content distribution:

1. Estimation of blood glucose (spectrophotometric/colorimetricmethod).

2. Sugar fermentation of microorganisms.

3. Assay of salivary amylase.

4. Isolation of lecithin from egg yolk, identification byTLC.

5. Isolation of cholesterol from egg yolk and itsestimation.

References/ Suggested Readings

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 /ISBN:10:1-4641-0962-1.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey),ISBN:978-0-470-28173-4.

3. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5,ISBN:13:978-1-4292-2936-4.

Course Name: MEMBRANE BIOLOGY AND BIOENERGETICS

Course Code: BSCHBCMC302

Course Type: CC	Course Details: CC6			L-T-P: 4-0-4	
Credit: 6	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

MEMBRANE BIOLOGY AND BIOENERGETICS (THEORY)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

1. Bio membrane structure and composition, Bio membrane asymmetry and fluidity, Fluid Mosaic Model of biological membrane, Model membranesystems
2. Membrane dynamics. Membrane lipids. Membrane proteins. RBC membrane architecture

3. Transport of metabolites across the plasma membrane, Passive and active transport, Symport and antiport systems, ATP-poweredpumps
4. Na+/K+ ATPases and Ca2+ ATPases, Secondary active Transporters, ABC family of transporters, Vesiculartransport
5. Ion channels, Principles of chemical thermodynamics – concept of free energy, enthalpy and entropy, Equilibrium state, open and closed systems, Oxidation-reduction reactions and reductionpotential
6. Nernst equation and free energy changes, Role of ATP in cellular Metabolism, Chemiosmotic theory, Universal electroncarriers
7. Types of phosphorylation, Oxidative phosphorylation and Mitochondrial electron transport, Inhibitors of ETC and uncouplers, Glycolysis
8. TCA cycle, Beta oxidation of fatty acids, Thermogenesis, Alternative respiratory pathways inplants,
9. Photosynthetic pigments, Photophosphorylation in plants, Molecular analysis of photosystems I and II, Z scheme of photosynthetic electronflow.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Introduction to bio membranes

Composition of bio membranes - prokaryotic, eukaryotic, subcellular membranes. Study of membrane proteins. Fluid mosaic model with experimental proof.

Unit 2 Membrane structures

Polymorphic structures of amphiphilic molecules in aqueous solutions - micelles and bilayers. Membrane asymmetry. Macro and micro domains in membranes. Membrane skeleton. RBC membranearchitecture.

Unit 3 Membrane dynamics

Lateral, transverse and rotational motion of lipids and proteins. Transition studies of lipid bilayer.
Membrane fluidity, factors affecting membrane fluidity.

Unit 4 Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport-glucose transporter, anion transporter and porins**.** Primary and secondary active transporters. Na+-glucose symporter. ABC family of transporters. Group translocation. Ion channels - voltage-gated ion channels (Na+/K+ voltage-gated channel), ligand-gated ion channels (acetyl choline receptor), aquaporins, bacteriorhodopsin. Ionophores - valinomycin, gramicidin.

Unit 5 Introduction to bioenergetics

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials. Universal electron carriers.

Unit 6 Oxidative phosphorylation

Mitochondria. Electron transport chain (ETC) - its organization and function. Inhibitors of ETC and uncouplers. Mitchell’s chemiosmotic hypothesis. Proton motive force. F_oF_1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways inplants.

Unit 7 Photophosphorylation

General features of photophosphorylation, historical background, Hill reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, green sulfur bacteria. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Evolution of oxygenicphotosynthesis.

MEMBRANE BIOLOGY AND BIOENERGETICS (PRACTICALS)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

1. Understanding of the fundamental aspects of composition, structure and functioning of biological membranes and energy transformation in livingorganisms.

2. Ability to state the laws of chemical thermodynamics, to describe the main terms, to understand energetical processes in living cells, biological role of membrane structures, and the associated energy transformationmechanisms.

3. Ability to describe ways of energy transformation in animal and plant cells, archaea and bacteria, to describe the membrane transport mechanisms; to describe the process of synthesis of ATP by chemiosmosis.

4. Ability to understand how artificial membranes are prepared, to describe the applications and limits of the membrane researchmethods.

Content/ Syllabus: Unit wise course content distribution:

1. Determination of CMC ofdetergents.

2. RBC ghost cell preparation and to study the effect of detergents onmembranes.

3. Separation of photosynthetic pigments byTLC.

4. Study photosynthetic O2 evolution in hydrillaplant.

5. Isolation of chloroplast from spinach leaves, estimation of chlorophyll and photosynthetic activity.

References/ Suggested Readings:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 /ISBN:10:1-4641-0962-1.

2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.

3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston),ISBN-13:978-0-495-11464-2.

4.sssPrinciples of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13:978-0470-23396-2

Course Name: METABOLISM OF AMINO ACIDS AND NUCLEOTIDES

Course Code: BSCHBCMC303

Course Type: CC	Course Details: CC7			L-T-P: 4-0-4	
Credit: 6	Full Marks: 100	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	10	20	40

METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (THEORY)

CREDIT: 4 (Marks 50)

Course Learning Outcomes:

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

1. Draw or describe the structure of amino acids, proteins, enzymes, chemical messengers, carbohydrates, lipids, and nucleicacids.

2. Explain the function of the above listedbiomolecules.

3. Explain how biochemical energy is generated in the cells using principles of thermodynamics (free energy, enthalpy). Write coupled reactions to show how an endergonic reaction can occur by coupling it with a very exergonicreaction.

4. Write the chemical reactions involved in biochemical pathways that produce ATP, such as citric acid cycle and electrontransport.

5. Describe the metabolism of carbohydrates, lipids, proteins and amino acids. Write chemical reactions for the individual steps in eachpathway.

6. Perform pertinent laboratory experiments, record observations, analyze data, and present the results in writtenform.

7. To understand the importance of lipids as storage molecules and as structural component of biomembranes.

8. Understanding the importance of high energy compounds, electron transport chain, Synthesis of ATP under aerobic and anaerobicconditions.

9. To acquire knowledge related to the role of TCA cycle in central carbonmetabolism, importance of anaplerotic reactions and redox balance.

10. Students will be exposed with the fact that perturbations in the carbon metabolism can lead to various disorders such as diabetes and cancer.

11. Appreciation of the fact that differences in the properties of metabolic enzymes of the host and pathogens can be exploited for the development of newdrugs.

12. To gain insights into metabolic engineering for the production of usefulbiomolecules.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Overview of amino acid metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups.
Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus.
Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Krebs bicycle, urea cycle.

Unit 2 Catabolism of amino acids

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease.

Unit 3 Biosynthesis of amino acids

Overview of amino acid synthesis. Biosynthesis of amino acids (aspartate, glutamate, pyruvate and aromatic families) and regulation.

Unit 4 Precursor functions of amino acids

Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Unit 5 Biosynthesis of purine and pyrimidine nucleotides

De novo synthesis of purine (adenine, guanine) and pyrimidine (cytosine, uracil, thymine) nucleotides, regulation and salvage pathways.

Unit 6 Deoxyribonucleotides and synthesis of nucleotide triphosphate

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Unit 7 Degradation of purine and pyrimidine nucleotides

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Unit 8 Integration of metabolism

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).

METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (PRACTICALS)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

1. To understand the concepts of preparation ofbuffers.
2. To estimate biomolecules such as glucose, proteins, cholesterol in clinicalsamples.
3. To isolate of lipids fromegg.

Content/ Syllabus: Unit wise course content distribution:

1. Assay of serum transaminases – SGOT and SGPT.
2. Estimation of serumurea.

3. Estimation of serum uricacid.

4.Estimation of serumcreatinine.

References/ Suggested Readings:

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 /ISBN:10:1-4641-0962-1.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN:978-0-470-60152-

Semester- III

Course Name: TOOLS AND TECHNIQUES IN BIOCHEMISTRY

Course Code: BSCHBCMSEC301

Course Type:SEC	Course Details:SEC-1		L-T-P:0-0-8
Credit:2	Full Marks: 50	CA Marks	ESE Marks
		Practical	Practical
		30	20

TOOLS AND TECHNIQUES IN BIOCHEMISTRY(PRACTICALS)

CREDIT: 2 (Marks 50)

Course Learning Outcomes:

1. Understanding Good laboratory practices in a chemistry/biochemistrylaboratory.
2. Learn safety and precautionary measures for working in alaboratory.
3. Develop skill and proficiency in preparation of laboratoryreagents.
4. Use of handling of glass wares, minor equipment for conductingexperiments.
5. Develop skills to prepare standard chemical solutions and secondarystandards.
6. Demonstration of basic oxidation and reductionreactions.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Biochemical reagents and solutions

Safety practices in the laboratory. Preparation and storage of solutions. Concepts of solution concentration and storing solutions. Quantitative transfer of liquids. Concept of a buffer, Henderson-Hassel Bach equation, working of a pH meter.

Exercise

Preparation of a buffer of given pH and molarity.

Unit 2 Spectrophotometric techniques

Principle and instrumentation of UV-visible and fluorescence spectroscopy.

Exercises

Determination of the absorption maxima and molar extinction coefficient (of a relevant organic molecule).

Measurement of fluorescence spectrum.

Determination of concentration of a protein solution by Lowry/BCA method.

Unit 3 Introduction and importance of virtual labs in biochemistry

References/ Suggested Readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 / ISBN:978-0-470-85603-1.

2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D.,W.H. Freeman and Company (New York), ISBN:0-7167-1315-2/ISBN:0-7167-1444- 2.
3.An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10:0-07-099487-0.

Course Name: PROTEIN PURIFICATION TECHNIQUES

Course Code: BSCHBCMSEC302

Course Type: SEC	Course Details: SEC-2		L-T-P: 0-0-8
Credit: 2	Full Marks: 50	CA Marks	ESE Marks
		Practical	Practical
		30	20

Course Learning Outcomes:

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

1. Demonstrate sound knowledge of current protein purification techniques used in biomedical research and the biotechnology industry
2. Demonstratepracticallaboratoryskillsinchromatographyandproteinpurification.
3. Documentlaboratoryproceduresanddataeffectivelyinanelectronicnotebook.
4. Interpretandcriticallyanalyzeexperimentaldatarelatingtoproteinpurification.
5. Effectively communicate results and conclusions to a broadaudience.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Purification and characterization of a protein from a complex mixture (native or heterologously expressed) involving the following methods/techniques Exercises Preparation of the sample.

Ion-exchange chromatography. Gel filtration chromatography. Affinity chromatography. Electrophoresis.

Unit 2 Demonstration of High Performance Liquid Chromatography (HPLC)

References/ Suggested Readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D.,Wiley Blackwell (West Sussex), ISBN:978-0-470-85602-4 /ISBN:978-0-470-85603-1.

2. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder, D., W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

3. An Introduction to Practical Biochemistry (1998) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN:13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Course Name: CLINICAL BIOCHEMISTRY

Course Code: BSCHBCMSEC303

Course Type: SEC	Course Details: SEC-3		L-T-P: 0-0-8
Credit:3	Full Marks: 50	CA Marks	ESE Marks
		Practical	Practical
		30	20

Course Learning Outcomes:

The student

1) will be able to clinically assess the laboratory indicators of physiologic conditions and diseases

2) will know the biochemical and molecular tools needed to accomplish preventive, diagnostic, and therapeutic intervention on hereditary and acquireddisorders

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Introduction

Organization of clinical laboratory, Introduction to instrumentation and automation in clinical biochemistry laboratories safety regulations and first aid. General comments on specimen collection, types of specimen for biochemical analysis. Precision, accuracy, quality control, precautions and limitations.

Exercises

Collection of blood and
storage. Separation and
storage of serum.

Unit 2 Evaluation of biochemical changes in diseases

Basic hepatic, renal and cardiovascular physiology. Biochemical symptoms associated with disease and their evaluation. Diagnostic biochemical profile.

Unit 3 Assessment of glucose metabolism in blood

Clinical significance of variations in blood glucose. Diabetes.

Exercises

Estimation of blood glucose by glucose oxidase peroxidase method.

Unit 4 Lipid profile

Composition and functions of lipoproteins. Clinical significance of elevated lipoprotein.

Exercises

Estimation of triglycerides.

Unit 5 Liver function tests Exercises

Estimation of bilirubin (direct and indirect).

Unit 6 Renal function tests and urine analysis

Use of urine strip / dipstick method for urine analysis.

Exercises

Quantitative determination of serum creatinine and urea.

Unit 7 Tests for cardiovascular diseases

Involvement of enzymes in diagnostics of heart disease including aspartate transaminase, isoenzymes of creatine kinase and lactate dehydrogenase and troponin.

Exercises

Estimation of creatine kinaseMB.

References/ SuggestedReadings:

1. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol. I (2010), Mukherjee, K.L., Tata Mc Graw–Hill Publishing Company Limited (New Delhi). ISBN:9780070076594 /ISBN:9780070076631
2. Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests VoI. II (2010), Mukherjee, K.L., Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi), ISBN:9780070076648.
3. Medical Biochemistry (2005) 2nd ed., Baynes, J.W. and Dominiczak, M.H., Elsevier Mosby Ltd. (Philadelphia), ISBN:0-7234-3341-0.
4. Experimental Biochemistry: A Student Companion (2005) Rao, B.S. and Deshpande, V., IK International Pvt. Ltd. (New Delhi),ISBN:81-88237-41-8.

Semester-IV

Course Name: Human Physiology

Course Code: BSCHBCMC401

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **CC-8**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Human physiology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

1. Students will have an enhanced knowledge on overall Human physiology.
2. Acquire deep understanding on the functional importance of physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems.
3. Having knowledge on integrated physiological responses for specific actions such as exercise, fasting and ascent to high altitude, and how they can sometimes fail.
4. Getting exposed to complex neural & cognitive functions of neuro-endocrinology.
5. Acquire knowledge on reproductive system & biochemical events of fertilization.
6. To develop concept on the anatomy and physiology of endocrine system and sense organs and its disorders.
7. Getting knowledge over physiology of muscle contraction and its disorders along with glimpse of sport physiology , drugs and athletics

Content/ Syllabus: Unit wise course content distribution

Unit 1 Homeostasis and the organization of body fluid compartments:
Intracellular, extracellular and interstitial fluid.Homeostasis, control system and their components.Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems.Anemias, polycythemia, haemophilia and thrombosis.

Unit 2 Cardiovascular physiology Pressure, flow and resistance:
Anatomy of heart.Physiology of the cardiac muscle, automacity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes

and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues.Portal circulations.Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.

Unit 3 Respiration Organization of the pulmonary system:
Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation.Principles of gas exchange and transport.Regulation of respiration.Pulmonary oedema and regulation of pleural fluid.Hypoxia, hypercapnea, pulmonary distress, emphesema, ARDS.

Unit 4 Renal physiology Anatomy of the kidney and the nephron:
Regulation of renal blood flow.Cell biology of the Bowmans' capsule.Physiology of glomerular filtration and GFR.Tubular processing of the glomerular filtrate.Micturition reflex and voluntary control of micturition.Regulation of ECF electrolyte and water content, blood volume and long term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function.Acidosis and alkalosis.Glomerular nephritis, renal failure, dialysis and diuretics.

Unit 5 Gastrointestinal and hepatic physiology Histology of the gastrointestinal tract:
Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, regurgitation, diarrhea and constipation.Anatomy of the hepatic lobule and blood flow into the liver.Formation and secretion of bile.enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests.Jaundice, liver cirrhosis and fatty liver.

Unit 6 Musculosketetal system:
Bone structure and formation.Physiology of muscle contraction in striated and non-striated muscle.

Unit 7 Reproductive physiology Sex determination and differentiation:
Development of female and male genital tracts.Spermatogenesis, capacitation and transport of sperm, blood testis barrier.Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.

Unit 8 Neurochemistry and neurophysiology Central Nervous system:
Peripheral Nervous system. Blood brain barrier. Membrane potentials.Synaptic transmission.Neurotransmitters.Sensory receptors and neural pathways.Somatic sensation, EEG, sleep, coma, learning and memory.

HUMAN PHYSIOLOGY (PRACTICALS)
CREDITS: 2Marks: 50

Course Learning Outcomes:

1. Exposure common blood analyzing techniques.
2. Hands on expertize of several instruments used in all laboratory.
3. Having knowledge on histological appearance of vital organs.
4. Getting exposed on clinical correlation.
5. Having knowledge on critical case studies.

Content/ Syllabus: Unit wise course content distribution

1. Hematology. a. RBC and WBC counting b. Differential leucocyte count. c. Clotting time.
2. Estimation of haemoglobin.
3. Separation of plasma proteins.
4. Determination of total iron binding capacity.
5. Pulmonary function tests, spirometry and measurement of blood pressure.
6. Histology of connective tissue, liver and brain (permanent slides).
7. Case studies (Renal clearance, GFR, ECG).

SUGGESTED READINGS

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.
2. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.
3. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.
4. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321- 53910-6

Course Name: Gene Organization, Replication and Repair

Course Code: BSCHBCMC402

Course Type: **Core (Theoretical &Practical)**	Course Details: **CC-9**			L-T-P: **4-0-4**	
Credit: 6	Full Marks:	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Gene Organization, Replication and Repair(Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

1. Student can understand how the DNA replicates.
2. How the DNA repair mechanisms rectify DNA damage.
3. Student get to know the different types of mutations.
4. Student will learn what are these chemical and physical mutagens ; mutation caused by them and how they are repaired.
5. The student will demonstrate proficiency in understanding the basic structure of atom and interpret the inheritance of characters by using linkage and crossing over.
6. The student can apply this in the identification of parents and recombinants.

Content/ Syllabus: Unit wise course content distribution :

Unit 1 Structure of DNA
DNA structure, features of the double helix, various forms of DNA, denaturation and reassociation of DNA.

Unit 2 Genes and genomic organization
Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. Nucleosome structure and packaging of DNA into higher order structures.

Unit 3 Replication of DNA
The chemistry of DNA synthesis, DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, stages of replication of *E. coli* chromosome, relationship between replication and cell division, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine. Supercoiling of DNA and its importance, topoisomerases, critical role of topoisomerases in cell, topoisomerase inhibitors and their application in medicine.

Unit 4 Recombination and transposition of DNA
Homologous recombination, proteins and enzymes in recombination, site-specific recombination, biological roles of site-specific recombination, transposition, three classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

Unit 5 Molecular basis of mutations

Importance of mutations in evolution of species. Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test.

Unit 6 Various modes of DNA repair

Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translesion DNA synthesis, DNA repair deficiency disorder.

Gene Organization, Replication and Repair(Practicals)
Credit: 2 Marks: 50

Course Learning Outcomes:

1. Explain the basic processes involved in the expression of genetic information (DNA replication; mutagenesis and DNA repair; mRNA transcription and processing; gene regulation; protein synthesis; genome structure and evolution)
2. Apply knowledge of the roles and functions of these processes to a range of problems and examples
3. Predict outcomes when these processes are perturbed by mutation (genetic disease) or the use of inhibitors and drugs
4. Elucidate differences in gene organization between prokaryotes and eukaryotes
5. Interpret and analyse experimental and theoretical problems involving these processes
6. Apply knowledge and research applications for example, in designing experiments or analysing examples from the literature
7. Communicate experimental results and conclusions in a scientific report

Content/ Syllabus: Unit wise course content distribution :

1. Ultraviolet absorption spectrum of DNA and RNA.

2. Determination of DNA and RNA by spectrophotometric method.

3. To study the viscosity of DNA solutions.

4. Isolation of chromosomal DNA from *E. coli* cells.

SUGGESTED READINGS:

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.

3. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN:978-0-470-39842-5.

Course Name:**Hormone: Biochemistryandfunction**

Course Code: BSCHBCMC403

Course Type: **Core (Theoretical &Practical)**	Course Details: **CC-10**			L-T-P: **4-0-4**	
Credit: 6	Full Marks:	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Hormone: Biochemistry and function(Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- will able to evaluate general properties of hormones
  - explains metabolism of hormones
  - explains structure and biosynthesis of hormones
- will able to evaluate effect mechanims of hormones
  - analysis the effect mechanisms of hormones interact with intracellular receptors
  - analysis the effect mechanisms of hormones interact with cell surface receptors
- will be able to explain the function of hormones in health and disease
  - defines the biological effects of hormones
  - defines the functions related to hormonal disorders
- will able to explain hormone analysis methods

Content/ Syllabus: Unit wise course content distribution :

Unit 1 Introduction to endocrinology
Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.
Unit 2 Hormone mediated signaling
Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, Ca^{2+}, NO. Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.
Unit 3 Hypothalamic and pituitary hormones
Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and

vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.

Unit 4 Thyroid hormone
Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimato's disease.
Unit 5 Hormones regulating Ca^{2+} homeostasis
PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.
Unit 6 Pancreatic and GI tract hormones

Regulation of release of insulin, glucagon, gastrin, secretin, adipolectin and leptin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II.

Unit 7 Hormones of adrenals
Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit 8 Reproductive hormones

Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

Hormones : Biochemistry and functions(Practicals)
Credit: 2 Marks: 50

Course Learning Outcomes:

- will able to evaluate general properties of hormones
  - explains metabolism of hormones
  - explains structure and biosynthesis of hormones
- will able to evaluate effect mechanims of hormones

Content/ Syllabus: Unit wise course content distribution :

1. Glucose tolerance test.
2. Estimation of serum Ca2+.
3. Estimation of serum T4.
4. HCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

Semester-IV

Course Name: Bioinformatics

Course Code: BSCHBCMSEC401

Course Type: **SEC (Practical)**	Course Details: **SEC 2**			L-T-P: **0-0-8**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30		20	

Bioinformatics

Credit 4 Marks: 50

Course Learning Outcomes:

1. Having the knowledge **on the core concepts of Bioinformatics**, including computational biology, database design and implementation, and probability and statistics.
2. Students will have basic knowledge and awareness of principles and concepts of biology, computer science and mathematics
3. Exposure to existing software effectively to extract information from large databases and to use this information in computer modeling
4. Will have an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries
5. Problem-solving skills, including the ability to develop new algorithms and analysis methods
6. Acquire knowledge **to apply skills in a professional environment** via an industrial or academic internship in Bioinformatics.

Content/ Syllabus: Unit wise course content distribution:

Unit 1 Introduction to bioinformatics:
Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology.Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.

Unit 2 Biological databases and data retrieval:
Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (RasMol, J mol), file formats. Exercises Sequence retrieval (protein and gene) from NCBI.Structure download (protein and DNA) from PDB. Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR. Molecular viewer by visualization software.

Unit 3 Sequence alignment Similarity, identity and homology:
Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW. Exercises BLAST suite of tools for pairwise alignment.Multiple sequence alignment using CLUSTALW.

Unit 4 Phylogenetic analysis:
Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods. Exercise Generating phylogenetic tree using MEGA software.

Unit 5 Protein structure prediction and analysis:
Levels of protein structure.Protein tertiary structure prediction methods - homology modeling, fold recognition and ab-initio methods.Significance of Ramachandran map. Exercises Primary sequence analyses (Protparam). Secondary structure prediction (GOR, nnPredict).Tertiary structure prediction (SWISSMODEL). Protein structure evaluation - Ramachandran map (PROCHECK).

Unit 6 Genomics:
Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools. Exercise Gene prediction using GENSCAN and GLIMMER.

SUGGESTED READINGS:

1. Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN: 0- 47147878-4.
4. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303

Semester-V

Course Name: Concepts in Genetics

Course Code: BSCHBCMC501

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **CC-11**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Concepts in Genetics (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Have conceptual understanding of laws of inheritance, genetic basis of loci and alleles and their linkage.
- Comprehend the effect of chromosomal abnormalities in numerical as well as structural changes leading to genetic disorders in plants & animals.
- Develop critical understanding of chemical basis of genes and their interactions at population and evolutionary levels.
- Analyze the effect of mutations on gene functions and dosage.
- Having knowledge on chromosomal mapping, pedigree analysis, quantitative & evolutionary genetics.

Content/ Syllabus: Unit wise course content distribution :

Unit 1 Introduction to model organisms and Mendelism

Model organisms: Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio and Arabidopsis thaliana, Basic principles of heredity.

Unit 2 Applications of Mendel's principles & chromosomal basis of heredity

Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Unit 3 Extensions of Mendelism

Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit 4 Genetic definition of a gene

Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T4 and concept of cistron

Unit 5 Genetics of bacteria and viruses

Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

Unit 6 Linkage, crossing over and mapping techniques

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in Drosophila, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes.

Unit 7 Human pedigree analysis

Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis.

Unit 8 The genetic control of development and sex determination

Model organism for genetic analysis, Drosophila development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.

Unit 9 Organelle heredity and epigenetics

Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting.

Unit 10 Chromosomal aberrations

Variations in chromosome number- monosomy and trisomy of No. sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.

Unit 11 Inheritance of complex traits & population genetics

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy- Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle.

Unit 12 Evolutionary genetics :

Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

Course Learning Outcomes:

- **Will learn chromosome visualization under microscope**
- **Having knowledge on population genetics**

C-11 : CONCEPTS IN GENETICS (PRACTICALS)

Credit 2 Marks: 50

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.

2. Induction of polyploidy in onion roots.

3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.

4. Monohybrid crosses in Drosophila for studying autosomal and sex linked inheritance.

5. PTC testing in a population and calculation of allele and genotype frequencies.

6. Study of abnormal human karyotype and pedigrees (dry lab)

7. Conjugation in bacteria

Course Name: Gene Expression and Regulation

Course Code: BSCHBCMC501

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **CC-12**		L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Gene Expression and Regulation (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- The students will acquire basic knowledge related to replication of DNA as the genetic material
- Having knowledge on how genes are transcribed and translated in prokaryotes and eukaryotes.
- Students will also understand special features of genetic code and the molecular mechanisms involved in RNA processing and RNA splicing.
- Besides, students will learn the regulation of biological processes and the significance of such regulation in maintaining life

Content/ Syllabus: Unit wise course content distribution :

Gene Expression and Regulation (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

- **Having knowledge on DNA & RNA isolation and separation techniques.**
- **Will learn about chromosomal morphology in human cells.**
- **Understandings on basic principle on protein inhibitors**

Content/ Syllabus: Unit wise course content distribution :

Course Name: Nutritional Biochemistry

Course Code: BSCHBCMDSE501

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Nutritional Biochemistry (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will acquire the understanding of the basic concept of nutrition for maintaining normal health, role of nutrients for the body, dietary requirements of carbohydrates, proteins, fats, vitamins, minerals, etc
- They will understand the importance of essential amino acids, essential fatty acids and vitamins for the body.
- This course integrates learning between Biochemistry and Nutrition

Content/ Syllabus: Unit wise course content distribution :

Nutritional Biochemistry (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- **Understanding the analysis of important food stuffs**
- **Having knowledge on ingredients of foods**
- **Will have food sample testing methods knowlwdge**

Content/ Syllabus: Unit wise course content distribution :

Course Name: Microbiology

Course Code: BSCHBCMDSE502

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Microbiology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- The students will get acquainted with the contributionsof Louis Pasteur, Edward Jenner and Robert Koch in microbiology.
- Discovery of antibiotics and their targets, drug/antibiotic resistance, preventive and therapeutic approaches of infectious diseases, hospital acquired infections will be studied .
- The importance of microorganisms as model systems in genetics and biochemistry will be explained.
- The contribution of gut microbiome to human health will be discussed.
- Students will be exposed to basic concepts of metabolic engineering and synthetic biology.
- The fight against major killer diseases – tuberculosis, HIV and malaria will be discussed.

Content/ Syllabus: Unit wise course content distribution :

Microbiology (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will acquire knowledge to identify different microbes and to perform bacterial cultures in different media.
- They will get acquainted with routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, stainingetc.
- They will acquire expertise to culture and screen microbes for antibiotic resistance.

Content/ Syllabus: Unit wise course content distribution :

Course Name: Molecular Basis of Non-infectious Human Diseases

Course Code: BSCHBCMDSE503

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Molecular basis of non-infectious human disease (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- **Understanding underlying mechanism of non-communicable diseases & their mode of infections**
- **Will learn about modern life styles diseases.**
- **Gaining knowledge on pathogenesis & diagnosis of cancer, tumor biology, anti-cancerous agesnts**
- **Having knowledge on monogenic disorders or molecular basis of disorders that occurs due to defective biochemical pathways.**

Content/ Syllabus: Unit wise course content distribution :

Molecular basis of non-infectious human disease (practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will learn to analyze anthropometric measurements of diseases.
- Will learn serum analysis of certain disorders
- Learn to distinguish histologically about transformed cells & normal cells

Content/ Syllabus: Unit wise course content distribution :

Course Name: Molecular Basis of infectious Diseases

Course Code: BSCHBCMDSE504

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Molecular basis of infectious disease (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will get acquainted with various classes of microbial infectious agents, their mode of action, biology of the diseases, transmission of diseases, the concepts of treatment, and drug resistance for various antimicrobial agents.
- Students will learn molecular basis of diagnosis and treatment of diseases as well as strategies for development of vaccines against these diseases.
- Students will be exposed to the details of important infectious diseases such as tuberculosis, AIDS, malaria, filariasis, etc. which are highly prevalent in tropical countries.
- Students will also understand the significance of hygiene, sanitation, vaccination in prevention of infectious diseases.

Content/ Syllabus: Unit wise course content distribution :

Molecular basis of infectious disease (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will acquire the knowledge to isolate bacteria from water/sewage samples, to stain bacteria, fungi, acid fast bacilli
- Will perform important diagnostic tests for infectious diseases such as WIDAL test.
- Students will be exposed to permanent slides of pathogens in order to get hands-on training to know nature of various pathogens causing diseases

Content/ Syllabus: Unit wise course content distribution :

Semester VI

Course Name: Genetic Engineering and Biotechnology

Course Code: BSCHBCMC601

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **CC13**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Genetic Engineering and Biotechnology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Coding and non-coding regions of eukaryotic genome and their importance will be analyzed. E. coli lac operon, PCR, expression vectors and their importance in Biotechnology will be studied.
- Production of insulin using recombinant DNA technology, transgenic crops-merits and demerits will be studied.
- Students will acquire basic knowledge related to processes of modern biotechnological apparatus, genome sequencings, human genome project etc.
- Will learn about different approaches of gene therapies, application of vectors & their importance in medicinal field.

Content/ Syllabus: Unit wise course content distribution :

Genetic Engineering and Biotechnology (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will learn the to isolate DNA, total nucleic acids from prokaryotic & eukaryotic cells
- Students will have knowledge on PCR and its products analysis.
- Having hands-on expertise on restriction digestion.

Content/ Syllabus: Unit wise course content distribution :

Course Name: Immunology

Course Code: BSCHBCMC602

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **CC14**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Immunology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will gain an overview of the immune system including cells, organs and receptors.
- They will understand structure and functions of different classes of immunoglobulins, the genetic basis of antibody diversity and the importance of humoral, cell-mediated and innate immune responses in combating pathogens.
- They will also understand mechanisms involved in different types of hypersensitivity, and the importance of conventional vs recombinant vaccines.
- They will be acquainted with the importance of antigen-antibody interaction in disease diagnosis.
- Students will be in a position to explain the principles of tolerance, autoimmunity and the role of immunity in protection against pathogens

Content/ Syllabus: Unit wise course content distribution :

Immunology (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will develop skills to isolate lymphocytes from blood/spleen
- Students will perform various immunoassays such as Ouchterlony double immunodiffusion (DID), Western Blotting , ELSA, DOT ELISA for diagnosis of various diseases.
- Students will also learn techniques to purify immunoglobulins and the principles of blood typing.

Content/ Syllabus: Unit wise course content distribution :

Course Name: Research Project

Course Code: BSCHBCMDSE601

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Research Project (Theory & Practical)

Credit 6 **Marks: 100**

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

Students will acquire the knowledge as how to write research plan proposal on a particular topic. They will gain knowledge of making power point/oral presentations. Writing reviews will help the students in writing research reports. Overall, the students will have a concise and definite view of proceeding to execute a scientific research project.

Course Name: Advanced Cell Biology

Course Code: BSCHBCMDSE602

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Advanced Cell Biology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- This course will provide an understanding of the structure of cell and function of various subcellular organelles.
- Students will learn about cell theory, basic cell structure, cell fractionation and cell visualization techniques.
- Besides, students will have an understanding of the composition of cytoskeleton and extracellular matrix. Students will acquire knowledge of cell cycle, cell division and cell death mechanisms.
- Students will understand modern approaches of microscopy, FACs, electron microscopy, immunohistochemistry etc.

Content/ Syllabus: Unit wise course content distribution :

Advanced Cell Biology (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will learn about different cellular assays, cell counting methods, animal cell culture etc.
- Students will learn about cell viability, cytotoxicity assay etc.
- Having knowledge on different cellular morphological changes during cell death.

Content/ Syllabus: Unit wise course content distribution :

Course Name: Plant Biochemistry

Course Code: BSCHBCMDSE603

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Plant Biochemistry (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Learning outcomes for this course include detailed understanding of metabolic processes specific for plants such as nitrate assimilation, photosynthesis, respiration, nitrogen fixation.
- Students will learn about different metabolic pathways in plant growth and development.
- Students will also gain insight to various stressful conditions of the environment that affect plant growth and productivity as well as the defense mechanisms in plants due to which plants survive under stresses.
- Students acquire knowledge on plant tissue culture
- Students will expose to modern application plant biotechnology in agriculture.

Content/ Syllabus: Unit wise course content distribution :

Plant Biochemistry (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will gain expertise to determine the contents of photosynthetic pigments, ascorbic acid, phenols, tannins, hydrogen peroxide in plant samples.
- They will understand the spectral patterns of photosynthetic pigments and will get training to extract and assay enzymes like urease from Jack bean.
- Students will have knowledge on explant culture and its application in agriculture.

Content/ Syllabus: Unit wise course content distribution :

Course Name: Research Methodology

Course Code: BSCHBCMDSE604

Course Type: **Core** **(Theoretical& Practical)**	Course Details: **DSE**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Research Methodology (Theory)

Credit 4 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will understand the objectives of doing scientific research.
- They will learn how to identify the area of research to be conducted, how to proceed for literature survey using a variety of sources and how to write research project proposal with well laid hypothesis and objectives.
- They will learn the skills of research design, nature of sample size as well as collection and analysis of data.
- They will also know the skills of writing research report and making oral presentations.

Content/ Syllabus: Unit wise course content distribution :

Research Methodology (Practical)

Credit 2 Marks: 50

Course Learning Outcomes:

(After the completion of course, the students will have ability to)

- Students will learn about writing a research plan proposal or original research article type on a particular topic.
- They will gain knowledge of making power point/oral presentations.
- Writing reviews will help the students in writing research reports.
- Overall, the students will have a concise and definite view of researches and implementation of different methods to analyze a research article.

Content/ Syllabus: Unit wise course content distribution :