DAV UNIVERSITY, JALANDHAR

Scheme of Courses for
Master of Science - Biochemistry(Honours)

(Program ID – 36)

Course Syllabus for Semesters 1-4

Course Syllabus Applicable to Admissions in 2018

Semester 1

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH501	Bioanalytical Techniques	4	1	0	4	**Core**
2.	BCH529	Biological Macromolecules	4	1	0	4	**Core**
3.	BCH651	Advanced Cell Biology	4	1	0	4	**Core**
4.	BTY511	Molecular Biology	4	0	0	4	**Core**
5.	BCH503	Bioanalytical Techniques Laboratory	0	0	3	2	**Core**
6.	BCH530	Biological Macromolecules Laboratory	0	0	3	2	**Core**
7.	BTY512	Molecular Biology Laboratory	0	0	2	2	**Core**
8.	BCH653	Seminar Course	0	0	3	2	**Core**
		Total	**16**	**3**	**11**	**24**	

L: Lectures T: Tutorial P: Practical Cr: Credits

Semester 2

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH655	Advanced Concepts in Protein Chemistry	4	0	0	4	**Core**
2.	BCH526	Genetics and Genomics	4	0	0	4	**Core**
3.	BCH516	Intermediary Metabolism	4	0	0	4	**Core**
4	BCH527	Genetics and Genomics Laboratory	0	0	3	2	**Core**
5.	BCH658	Advanced Concepts in Protein Chemistry Laboratory	0	0	3	2	**Core**
		Departmental Elective I	4	0	0	4	**Departmental Elective**
		Open Elective I	4	0	0	4	**Open Elective I**
		Total	**20**	**0**	**6**	**24**	

L: Lectures T: Tutorial P: Practical

Departmental Electives: Choose from any theory course and the accompanyting laboratory course.

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH528	Biology of Cancer	4	0	0	4	**Departmental Elective**
2.	BCH629	Principles of Neurobiology	4	0	0	4	**Departmental Elective**
3.	BCH523	Principles of Cell Signalling	4	0	0	4	**Departmental Elective**

Semester 3

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH541	Computational Techniques and Biostatistics	4	1	0	4	**Core**
2.	BCH601A	Biochemical and Environmental Toxicology	2	0	0	2	**Core**
3.	BCH625	Concepts in Immunology	4	0	0	4	**Core**
4.	BCH627	Regulation of Gene Expression	4	0	0	4	**Core**
5.	BCH542	Computational Techniques and Biostatistics Laboratory	0	0	3	2	**Core**
6.	BCH626	Concepts in Immunology Laboratory	0	0	3	2	**Core**
7.	BCH614	Project – I	0	0	0	2	**Core**
8.		Departmental Elective II	4	0	0	4	**Departmental Elective**
		Total	**18**	**1**	**9**	**24**	

L: Lectures T: Tutorial P: Practical

Departmental Electives: Choose from any theory course and the accompanyting laboratory course.

S.No.	Paper Code	Course Title	L	T	P	Credits	Course Type
1.	BCH670	Biomembranes	4	0	0	4	**Departmental Elective**
2.	BCH605	Plant Biochemistry	4	0	0	4	**Departmental Elective**

Semester 4

S.No.	Paper Code	Course Title	L	T	P	Cr	Course Type
1.	BCH615	Project - II	0	0	0	14	**Core**
2.	BCH603	Clinical Biochemistry	4	0	0	4	**Core**
3.	BCH607	Nutritional Biochemistry	4	0	0	4	**Core**
4.	BCH604	Clinical Biochemistry Laboratory	0	0	2	2	**Core**
		Total	**14**	**0**	**3**	**24**	

L: Lectures T: Tutorial P: Practical

Course Title: Bioanalytical Techniques

L	T	P	Credits	Marks
4	0	0	4	100

Paper Code: BCH501

Course Objective: The course introduces students all the major bioanalytical techniques relevant to students of biochemistry. It covers the theoretical aspects of various techniques, along with their instrumentation and applications.

Unit A (20 hours)

Spectroscopy – Concepts of spectroscopy, Visible and UV spectroscopy, Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, Fluorescence Spectroscopy.

Chromatography – Principles of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC

Unit B (20 hours)

Centrifugation – Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Mass Spectrometry – Principle of MS, ionization modes, equipment, MS of proteins/peptides, interface of MS with other methods – MS/MS, LC/MS, and GC/MS, peptide mapping, post-translation modification analysis of proteins, protein sequencing by MS.

Unit C (10 hours)

Electrophoretic techniques – Principles of electrophoretic separation.Continuous, zonal and capillary electrophoresis, different types of electrophoresis including paper, cellulose, acetate/nitrate and gel.Electroporation, pulse field gel electrophoresis.

Immunochemical techniques – Making antibodies, Immunoassay formats, Immunomicroscopy, Lateral flow devices, Epitope mapping, Immunoblotting, Fluorescent activated cell sorting (FACS), Cell and tissue staining techniques, Immunocapture, polymerase chain reaction (PCR) Immunoaffinity chromatography (IAC), Antibody-based biosensors, Therapeutic antibodies

Unit D (10 hours)

Bioinformatics – Overview, Sequence databases – DNA, protein, genome, EST and SNP databases, BLAST programs, ClustalW, Tertiary protein structure databases, PDB, Rasmol, Pymol and Swiss-PDB viewer, Homology modeling.

Recommended books:

1. Analytical Biochemistry (1998) 3rd edition, David Holme and Hazel Peck, Pearson Education Ltd. ISBN: 9780582294387.

2. Physical Biochemistry: Principles and Applications (2010) 2nd edition, Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd edition, Freifelder, D., W.H. Freeman and Company (New York), ISBN:0716713152.
4. An Introduction to Practical Biochemistry (1998) 3rd edition, Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN: 9780070994874.
5. Principles and Techniques of Biochemistry and Molecular Biology (2010) 7th edition; Wilson K, Walker J, Cambridge University Press, ISBN: 9780521178747.

Course Title: Bioanalytical Techniques Laboratory

L	T	P	Credits	Marks
0	0	3	2	50

Paper Code: BCH503

Experiments:

1. Titration of a weak acid using a pH meter, preparation of buffers.

2. Verification of Beer-Lambert's law and determination of absorption coefficients.

3. Paper chromatography – Separation of amino acids and carbohydrates in a mixture.

4. Thin layer chromatography of fatty acids.

5. Column chromatography – Separation of a mixture of proteins and salt using Sephadex column.

6. Separation of restricted DNA fragments using Agarose gel electrophoresis.

7. Separation of mixture of proteins using SDS-PAGE.

8. Analysis of enzyme activity in a mixture of proteins using zymography.

Course Title: Biological Macromolecules
Paper Code: BCH529

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective:

The course is intended for master's course students. This course is a broad survey of all the major concepts of biochemistry with emphasis on all the important categories of biomolecules and their biochemistry.

Unit A **(10 hours)**

Introduction

Structure of atoms, molecules and chemical bonds, Cellular and chemical foundations of life.Water as a biological solvent.The concept of pH, pKa, dissociation and ionization of acids and bases, Physiological buffers and their buffering mechanism, Henderson-Hasselbalch equation.

Carbohydrates

Structure of monosaccharides.Stereoisomerism and optical isomerism of sugars. Reactions of aldehyde and ketone groups. Ring structure and anomeric forms, mutarotation. Reactions of sugars due to hydroxyl groups. Important derivatives of monosaccharides, disaccharides and trisaccharides (structure, function and occurrence of important ones). Structure, occurrence and biological importance of monosaccharides, oligosaccharides and polysaccharides - cellulose, chitin, agar, algenic acids, pectins, proteoglycans, sialic acids, blood group polysaccharides, glycogen and starch. Bacterial cell wall polysaccharides.Glycoproteins.

Unit B **(20 hours)**

Proteins
Definition, importance and functions, amino acids as building blocks of proteins, essential amino acids, non-protein amino acids, structure of peptide bond, organizational levels of protein structure, relationship between primary and higher order structures, supramolecular assemblies of proteins, solubility, denaturation, functional diversity and species specificity of proteins, protein classification, chemical synthesis of polypeptides, Conformation of proteins: Ramachandran Plot, Secondary, tertiary and quaternary structure; domains; motif and folds. Stabilizing interactions: Vander waals, electrostatic, hydrogen bonding, Hydrophobic interactions. Stability of protein structure.

Unit C **(20 hours)**

Porphyrins:
Nucleus and classification of porphyrins, important metallo porphyrins occurring in nature, chemical nature and physiological significance of bile pigment.

Lipids
Definition, importance and functions, classification of lipids, fatty acids and essential fatty acids, general structure and functions of major lipid subclasses, acylglycerols, phosphoglycerides, sphingolipids, terpenes, steroids, eicosanoids.

Vitamins and Minerals
Definition, chemistry and functions of water and fat soluble vitamins, major trace minerals, their bound forms and functions.

Unit D **(10 hours)**

Nucleic acids
Structure and functions of different nitrogeneous bases, nucleosides, nucleotides and different types of nucleic acids (DNA, RNA). DNA with unusual structures, DNA denaturation and renaturation.

Overview of metabolite pathways: glycolysis, citric acid cycle, pentose phosphate pathway, oxidation of fatty acids, oxidative phosphorylation and photophosphorylation.

Books Recommended

1. Berg JM, Tymoczko JL, Gatto GJ and L (2015) Biochemistry, 8th Edition, WH Freeman &Co., New York. ISBN: 9781464126109.
2. Lehninger Principles of Biochemistry (2017), 7th edition, Nelson DL & Cox MM, WH Freeman & Company, New York, ISBN: 9781464126116.
3. Biochemistry (2010), 4th edition, Voet D & Voet JG, John Wiley & Sons Inc., Singapore, ISBN: 9780470570951.
4. Harper's Illustrated Biochemistry (2015), 30th edition, Murray, R.K., Granner, D.K. and Rodwell, V.W. McGraw Hill Company Inc. Singapore, ISBN: 9780071825344.

Course Title: Biological Macromolecules Laboratory
Paper Code: BCH530

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Quantitative estimation of blood glucose by Folin-Wu/Anthrone/DNSO - Toluidine/Enzymatic method.

2. Estimation of proteins by Biuret method

3. Quantitative estimation of cholesterol in the blood

4. Estimation of alkaline and acid phosphatases

5. Estimation of blood glucose.

6. Estimation of cholesterol

7. Sugar Fermentation in Microorganisms.

8. Estimation of Glucose 6-Phosphate.

9. Estimation of Urea.

10. Estimation of Uric acid.

11. Estimation of Creatinine.

Course Title: Molecular Biology

Course Code: BTY511

L	T	P	Credits	Marks
4	1	0	4	100

Course Objective: A comprehensive knowledge of molecular aspects of biological function at the molecular level, particular emphasis on the structure and regulation of genes, as well as, the structure and synthesis of proteins and applications of these concepts in human medicine and health, agriculture, study evolution and other areas.

Introduction to molecular biology, basic techniques in molecular biology. DNA and its various forms, super coiling of DNA, DNA melting, repetitive sequences, cot and rot curves, C value paradox, DNA protein interaction, DNA super coiling. Prokaryotic & eukaryotic DNA replication, enzymes and accessory proteins involved in DNA replication, replication origin & replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, gene amplification, mobile genetic elements, homologous and site specific recombination**. (12 hours)**

Prokaryotic and eukaryotic transcription, RNA polymerase, transcription factors, regulatory elements, transcriptional activator, repressor & mechanism of transcription regulation, post-transcriptional processing of mRNA, rRNA &tRNA.(12 hours)

Protein synthesis and processing: Ribosome structure, genetic code, prokaryotic & eukaryotic translation, the translation machinery, mechanism and regulation of translation & translation proof-reading, translational inhibitors, Post- translational modification of proteins and intracellular protein targeting, import into nucleus, mitochondria and peroxisome. **(10 hours)**

Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Cell signaling: signal transduction pathways and their regulation.**(10 hours)**

Genome sequencing: Genome sizes, organelle genomes, genomic libraries, YAC, BAC libraries, and strategies for sequencing genome, packaging, transfection and recovery of clones, application of sequence information for identification of defective genes. **(8 hours)**

Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression.Molecular mechanism of nitrogen fixation. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and tempreture; and biotic stresses like bacterial, fungal and viral disease. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. **(8 hours)**

Recommended Books:

1. Lodish, H.F. *Molecular Cell Biology*. 6th Edition. W.H. Freeman & Company. 2007. Print. 2. Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. *Lewin's GENES XI*. 11th Edition.Jones &Bartlett Learning. 2012. Print.
3. Sambrook, J., Fritsch, E.F. and Maniatis, T.*Molecular cloning: A Laboratory Manual.* Vol. I-III. 2nd Edition.Cold Spring Harbor Laboratory, 1989. Print.
4. Watson, J.D. *Molecular Biology of the Gene.* 7th Edition. Benjamin Cummings. 2013. Print.

Course Title: Molecular Biology Laboratory

Course Code: BTY512

L	T	P	Credits	Marks
0	0	3	2	50

1. Isolation of genomic DNA from bacteria.
2. Isolation of genomic DNA from plant.
3. Isolation of total RNA from tissue.
4. Demonstration of DNA protein interaction.
5. Quantitation of nucleic acids and proteins.
6. Gel electrophoresis: Nucleic acid - Protein

Course Title: Advanced Cell Biology
Paper Code: BCH651

L	T	P	Credits	Marks
4	1	0	4	100

Unit A **(20 hours)**

Protein targeting and membrane trafficking - Historical roots of the secretory pathway**,** Maintaining organelle identity**.**

Cytoskeletal organization and dynamics - Polymerization dynamics**,** Coupling polymerization to nucleotide hydrolysis**,** Molecular motors**,** Signaling to the cytoskeleton**,** Morphogenesis of complex cytoskeletal arrays.

Unit B **(20 hours)**

Cell adhesion and extracellular matrix - Specificity of cell adhesion**,** Regulating adhesion**,** Linking adhesion molecules to the cytoskeleton**,** Signaling through adhesion molecules.

Cell division cycle - Ordering the events of the cell cycle**,** Duplicating the genome**,** Preparing chromosomes for mitosis**,** Segregating the genome**,** Checkpoints that monitor cell cycle progression**,** Segregating the cytoplasm**,** Rebuilding an interphase cell and preparing for the next cell cycle.

Unit C **(10 hours)**

Genome Organization - Chromosome architecture, structure of genome, Genomic "domains", "territories" and other spatial aspects of genome, Use of Next-Generation Sequencing Technologies in elucidation of genome structure and function.

Unit D **(10 hours)**

Chromosome Structure and Function - Multiple Forms of Chromatin, Polytene chromosomes, chromatin loops and their structural changes with gene expression, Condensation of chromosomes during cell division.

Genome Evolution - Genome comparisons, genome alterations by transposable elements, construction of phylogenetic trees, divergence of duplicate genes, ancient genomes.

Recommended Books:

1. Molecular Cell Biology (2013) 7th edition, 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: 9781464109812.

2. Molecular Biology of the Cell (2014). 6th edition, Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K. and Walter, P. Garland Science, ISBN: 978-0815344322

3. Karp's Cell Biology (2013) 7th edition, Karp G, John Wiley & Sons Inc., Singapore, ISBN: 978-1118318744.

L	T	P	Credits	Marks
0	0	2	2	50

Course Title: Seminar Course
Course Code: BCH653

Seminar Objective:
During the course students will come to know about the general understanding of the most common problems, recent advances in biotechnology research. The instructor shall allot each student a topic. Student will have to understand the topic, collect literature and prepare the presentation. Through this the students will develop habit of reading newer topics, will become inquisitive and develop confidence of presentation and discussion before audience.
The students shall submit a project report on the allotted topic, which shall be evaluated by the concerned internal faculty. He/She then would present a seminar on the concerned topic. The students will be encouraged to explore all available literature as well as the internet to prepare the seminar report and present the same using informative slides made using Power Point or projectors.

Seminar Contents:
Students will present their work on a selected topic with the following headings:
• Title
• Objectives
• Review of Literature
• Materials and Methods
• Results
• Conclusion/recommendations

Examination Scheme (Weightage in %):
Literature study/ Fabrication/ Presentation : 50%
Written Report : 25%
Question answer session : 25%

Course Title: Advanced Concepts in Protein Chemistry
Paper Code: BCH655

L	T	P	Credits	Marks
4	0	0	4	100

Unit A

Introduction to Proteins **(10 hours)**

Structure of amino acids and peptide, Protein structure; Ramachandran plot, alpha helix, beta strands, dipole, Protein structural motifs; alpha-domain structures, alpha/beta structures, beta-structures.

Protein folding; free energy, entropy, enthalpy, folding pathways.

Protein domain architecture, multi-domain proteins, unstructured proteins, misfolded proteins.

Fibrous proteins: collagen and myosin.

Unit B **(20 hours)**

Binding, interaction and recognition

DNA recognition and binding: prokaryotic and eukaryotic DNA binding proteins and their motifs; helix turn helix motifs, zinc-finger motifs, leucine zippers.
Proteins of the immune system: Structure of antibodies, antibody diversity, antigen-antibody interactions, structure of MHC and T-cell receptor.
Structure-function studies of oxygen binding proteins: Structure of hemoglobin and myoblobin, reversible binding of oxygen, mechanisms of cooperative binding, regulation of oxygen-hemoglobin binding.

Unit C **(15 hours)**

Proteins in signal transduction: Structure of G-proteins, Ras proteins, rhodopsin, receptor tyrosine kinases.
Membrane proteins: Basic concepts, structure-function of bacteriorhodopsin, porins, pore-forming toxins, gated-ion channels, ABC transporters.
Determination of protein structure: X-ray diffraction, nuclear magnetic resonance.

Unit D **(15 hours)**

Proteins in industry and medicine
Therapeutic proteins and antibodies, therapeutic hormones and growth factors, industrial enzymes

Recommended Books:
1. Introduction to Protein Structure (1999). Branden C &Tooze J., 2nd Edition, Garland Publishing Inc., New York. ISBN: 978-0815323051
2. Lehninger Principles of Biochemistry (2017), 7th edition, Nelson DL & Cox MM, WH Freeman & Company, New York, ISBN: 9781464126116.
3. Proteins: Biochemistry and Biotechnology (2014). Walsh G., 2nd Edition, WILEY Blackwell. ISBN: 978-0470669853.
4. The Molecules of Life (2013). Kuriyan J, Konforti B, Wemmer D., 1st Edition, Garland Science, Taylor and Francis Group. ISBN: 978-0815341888

Course Title: Genetics and Genomics
Paper Code: BCH526

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to basic concepts of genetics and transmission of genetic information.

Unit A (15 hours)

Model systems in Genetic Analysis: Bacteriophage, *E. coli, Neurosporacrassa, yeast, Arabidopsis thaliana,* Maize, *Drosophila, C. elegans, Danio rerio, Homo sapiens* - General outline of life cycle, importance in Genetic analysis.

Laws of inheritance: Mendel's Laws, concept of dominance, segregation, independent assortment; Chromosome theory of inheritance. Allelic and non-allelic interactions: Concept of alleles, types of dominance, lethal alleles, multiple alleles, test of allelism, complementation; Epistasis.

Linkage: Concepts, recombination, gene mapping in prokaryotes and eukaryotes, fine structure mapping. Sex-linked inheritance: Conceptual basis, sex influenced traits, mechanism of sex determination.

Unit B (15 hours)

Quantitative inheritance – Concept, Genes and Environment - heritability, penetrance and expressivity.

Cytoplasmic inheritance – Basis and mechanism, role of organellar genes.

Mutation – Classification, mechanism, repair, role in genetic analysis and evolution.

Changes in Chromosome number and structure: Polyploidy, aneuploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation. Meiotic consequences in structural heterozygotes, role in speciation and evolution.

Unit C (15 hours)

Human genome - Gross structure and Content of the human genome**,** Protein-coding and non-coding genes**,** Complexity of splicing, splicing regulation, diversity of isoforms**,** Telomeres and centromeres**,** Transposable elements**,** Regulatory sequences and control of gene expression**,**

Genetic variation among humans - Origins of variation**,** Spread of variation through population**,** Genetic variation across the human population**,** SNPs, indels and structural variants**,** Geographic distribution of variation, What is "race"**?,** Admixture**,** Recombination and haplotype structure of human genome Reconstruction of recent and distant history with genetics**,** Mitochondria and Y chromosomal history, Case study - Genghis Khan, Use of DNA in forensics

Human evolution - Comparison of human genome to other primates and mammals, Archaic humans**,** Neanderthals and Denisovans**,** Interbreeding between modern and archaic humans**,** Human-specific traits**,** Selection along human lineage

Unit D (15 hours)

Phenotype and Disease - allelic variation linked to disease, OMIM**,** inferring phenotype from genotype: what's possible, what are the limitations**,** mitochondrial diseases, somatic variation/heteroplasmy in mtDNA, sex-linked traits, dosage compensation and phenotypic variation

Mapping – GWAS**,** Common vs. rare variation in human disease and its impact on mapping**,** "missing" heritability of traits

Cancer genomics - extent of somatic variation**,** types of variation seen in cancer, targeted therapeutics.

Personal genomics.

Recommended Books

1. Genetics (2012) 6th edition, Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 9781118092422.

2. Genetics - A Conceptual Approach (2012), 4th edition, Pierce, B.A., W.H. Freeman & Co. (New York), ISBN: 9781429276061.

3. An Introduction to Genetic Analysis (2010), 10th edition, Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN: 1429229438.

4. For the Genomics portion – no texts, only primary research articles and review articles will be assigned.

Course Title: Genetics and Genomics Laboratory
Paper Code: BCH527

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Preparation of mitotic and meiotic spreads and analysis of various stages of cell division (*Phlox, Allium* and *Rhoeo*).

2. Extraction of genomic DNA from plants by CTAB method.

3. Analysis of molecular polymorphism in parental lines and derived mapping population using different types of molecular markers.

4. Construction of a linkage map using available data.

5. Restriction digestion of plasmid and genomic DNA.

6. Isolation and quantitation of RNA.

L	T	P	Credits	Marks
4	0	0	4	100

Course Title: Intermediary Metabolism
Paper Code: BCH515

Course Objective:
The course covers the concepts of bioenergetics and pathways of metabolism with emphasis on animal cells.

Unit A **(15 hours)**
Bioenergetics – Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change, biological standard state & standard free energy change in coupled reactions. Biological oxidation-reduction reactions, redox potentials, relation between standard reduction potentials & free energy change (derivations and numericals included). High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates along with reasons for high ΔG. Energy charge.
Coenzymes and Cofactors – Role and mechanism of action of NAD+/NADP+, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B12 coenzymes and metal ions with specific examples.

Unit B **(15 hours)**
Carbohydrates – Glycolysis, various forms of fermentations in micro-organisms, citric acid cycle, its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Gluconeogenesis, glycogenesis and glycogenolysis,glyoxylate and Gamma aminobutyrate (GABA) shunt pathways, Cori cycle, anaplerotic reactions, Entner-Doudoroff pathway, glucuronate pathway. Metabolism of disaccharides. Hormonal regulation of carbohydrate metabolism. Energetics of metabolic cycle.

Unit C **(20 hours)**
Amino Acids – General reactions of amino acid metabolism - Transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Special metabolism of methionine, histidine, phenylalanine, tyrosine, tryptophan, lysine, valine, leucine, isoleucine and polyamines. Urea cycle and its regulation.
Lipids – Introduction, hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids.Oxidation of odd numbered fatty acids – fate of propionate, role of carnitine, degradation of complex lipids. Fatty acid biosynthesis, Acetyl CoA carboxylase, fatty acid synthase, ACP structure and function, Lipid biosynthesis, biosynthetic pathway for tri-acylglycerols, phosphoglycerides, sphingomyelin and prostaglandins. Metabolism of cholesterol and its regulation. Energetics of fatty acid cycle.

Unit D **(10 hours)**
Nucleotides – Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase. Biosynthesis ofdeoxyribonucleotides and polynucleotides, including inhibitors of nucleic acid biosynthesis. Other Molecules - Porphyrins – Biosynthesis and degradation of porphyrins. Production of bile pigments, Biochemistry of biological nitrogen fixation, plant hormones – Growth regulating substances and their mode of action, molecular effects of auxin in regulation of cell extension, effects of gibberllic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development, Biosynthesis of Vitamins – Ascorbic acid, thiamine, pantothenic acid and Folic acid.

Recommended Books:

1. Lehninger Principles of Biochemistry (2017), 7th edition, Nelson DL & Cox MM, WH Freeman & Company, New York, ISBN: 9781464126116.

2. Biochemistry (2010), 4th edition, Voet D & Voet JG, John Wiley & Sons Inc., Singapore, ISBN: 9780470570951.

3. Harper's Illustrated Biochemistry (2015), 30th edition, Murray, R.K., Granner, D.K. and Rodwell, V.W. McGraw Hill Company Inc. Singapore, ISBN: 9780071825344.

Course Title: Advanced Concepts in Protein Chemistry Laboratory
Paper Code: BCH658

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Colorimetric enzyme assay.
2. Coupled enzyme assay.
3. Determination of Km & Vmax of the enzymes
4. Column Chromatography
5. Partial purification of enzyme & enzyme kinetics
6. Enzyme Kinetics – determination of rate constant
7. Enzyme inhibition studies
8. Comparison of enzyme activity of soluble and immobilized enzyme.
9. Protein tagging using FITC.

Course Title: Biology of Cancer
Paper Code: BCH528

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to mechanism of cancer and tumorigenesis.

Unit A (15 hours)

Introduction to Cancer

Nature of Cancer, Classification of tumors, Altered energy metabolism in tumors, Cancers induced by specific lifestyles and chemical agents, Mutagens

Tumor Viruses

Rous Sarcoma Virus (RSV), Oncogenes, *myc,src*, proto-oncogenes.

Growth Factors, Receptors and Cancer

EGF Receptor – Receptor Tyrosine Kinases and their mechanism of action, transphosphorylation, G proteins – Ras.

Signaling pathways and Cancer

Ras-regulated signalling pathways, Jak-STAT pathway, Wnt-β-catenin pathway and cell proliferation, GPCRs, Negative and Positive feedback controls in signalling pathways.

Unit B (15 hours)

Tumor Suppressor Genes

Retinoblastoma tumor and the genetic puzzle of tumor suppressor genes, Identification of tumor suppressor genes, Inheritance of mutant tumor suppressor genes, Promoter methylation in inactivation of tumor suppressor genes.

Cell Cycle and Cancer

Control of cell cycle, Regulator proteins of cell cycle, Role of Cyclins and CDKs in cell cycle control, E2F-Rb axis and cell cycle control, role of Myc protein in proliferation/differentiation decision, Perturbation of pRb function in human cancers.

p53 and Apoptosis

p53 and its discovery, stabilization of p53 by DNA damage and deregulated growth, Mdm2 protein, Role of p53 as a transcription factor, Causes of cell death, Apoptosis and its dependence on mitochondria, Necrosis and autophagy – two additional forks in the road of tumor progression

Unit C (15 hours)

Cell Immortalization and Tumorigenesis

Need for immortality in cancer cells, role of telomeres in limiting proliferation of cultured cells, expression of telomerase in incipient cancer cells, maintenance of telomeres in immortalized cells without telomerase, biology of telomerase-negative mice.

Multi-step Tumorigenesis

Development of human cancers, evidence of multi-step tumorigenesis, Darwinian evolution in tumorigenesis, Tumor stem cells and tumorigenesis, role of inflammation in tumorigenesis.

Unit D (15 hours)

Invasion and Metastasis

Colonization, EMT transition, Role of TFs, proteases, and Small Ras-like GTPases in EMT, Metastasis and Bone cancer.

Cancer Treatment and Therapy

Major pillars of cancer treatment – surgery, radiotherapy and chemotherapy. Development of drugs against cancer, Clinical trials and their phases, Rational drug design and design of cancer drugs, Case study – Gleevec.

Recommended Books:

1. The Biology of Cancer (2013), 2nd edition; Weinberg, Robert, Garland Science. ISBN: 9780815342205.
2. Principles of Cancer Biology (2016) 1st edition; Kleinsmith, Pearson Education India, ISBN: 9789332577480.
3. Molecular Biology of Cancer (2014), 3rd edition; Pecorino, Oxford University Press, ISBN: 978-0198728696.

L	T	P	Credits	Marks
4	0	0	4	100

Course Title: Principles of Neurobiology
Paper Code: BCH629

Course Objective: The course covers in detail various aspects of neurobiology.

Unit A (15 hours)

Introduction

Brain and behaviour.Nerve cells, neural circuitry and behavior, genes and behaviour.

Cell and Molecular Biology of the Neuron

Cells of the nervous system, ion channels, Membrane potential and the passive electrical properties of the neuron, Action potential.

Synaptic transmission

Signals at the nerve-muscle synapse: directly gated transmission, synaptic integration in the CNS. Second messengers and modulation of synaptic transmission, neurotransmitters, diseases of the motor and nerve unit.

Neural basis of cognition

Organization of CNS, functional organization of perception and movement, internal representations of space and action, organization of cognition, cognitive functions of the premotor systems.

Perception

Sensory coding, somatosensory system, touch, pain, constructive nature of visual processing, Low, Intermediate, and High-level visual processing, visual processing and action, auditory CNS.

Movement

Organization and planning of movement, The motor unit and muscle action, spinal reflexes, locomotion, voluntary movement – primary motor cortex, control of gaze, vestibular system, posture, The cerebellum, The Basal Ganglia. Genetic mechanisms in degenerative diseases of the nervous system.

Unconscious and Conscious Processing of Neural Information

Sensory, Motor, and Reflex functions of the brain stem, modulatory functions of the brain stem, autonomic motor system and the hypothalamus, emotions and feelings, seizures and epilepsy, sleep and dreaming.

Development and Emergence of Behaviour

Patterning the nervous system, differentiation and survival of the nerve cells, growth and guidance of axons, formation and elimination of synapses, experience and refinement of synaptic connections, sexual differentiation of the nervous system.The Aging brain.

Recommended books:

1. Principles of Neural Science (2012), 5th edition, Kandel, E.R., Schwartz, J.H., Jessell, T.M., Siegelbaum, S.A., and Hudspeth, A.J. McGraw Hill Education. ISBN: 9780071390118.
2. Neurobiology: Molecules, Cells and Systems (2000), 2nd edition, Matthews G G, Wiley-Blackwell, ISBN: 978-0632044962.
3. Neurobiology (1994) 3rd edition, Shepherd G M, OUP USA, ISBN: 9780195088434

Course Title: Principles of Cell Signalling

L	T	P	Credits	Marks
4	0	0	4	100

Paper Code: BCH523

Course Objective: The course covers in detail various aspects of signal transduction in various living systems.

Topics:

1. Introduction
2. G-protein coupled receptors
3. Receptor tyrosine kinases (RTKs)
4. Small G proteins
5. Phospholipid signalling
6. PI3Kinase and Protein Kinase B
7. Adenylate cyclase and Protein Kinase A
8. Ca^{2+}-activated kinases
9. Signaling scaffolds
10. TOR signalling
11. Visual transduction
12. Cell Death Signaling

Recommended Books:

Most of the readings will be assigned from relevant research papers and review articles of topical interest.

Course Title: Computational Techniques and Biostatistics
Paper Code: BCH541

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of computational techniques commonly used in biological data analysis.

Topics:

Unit A (15 hours)

Manipulating text files, Regular Expressions
The Shell - Command-line Operations, Handling Text in the Shell, Scripting with the Shell

Unit B (15 hours)

Python and Programming - Components of Programming, Beginning Python Programming, Decisions and Loops, Reading & Writing Files, Merging Files, Modules and Libraries, Debugging Strategies

Unit C (15 hours)

Introduction to Biological databases and tools – NCBI, PubMed, UCSC Genome Browser, KEGG, Clustal-Omega, BLAST, MEGA.

Unit D (15 hours)

Biostatistics: Expression and critical evaluation, interpretation and presentation of data, Statistical methods for analysis of data- Probability, mean, median, frequency, t-test (paired and unpaired), ANOVA and correlations, statistical software

Recommended Books:
1. Haddock, S.D. and Dunn, Casey (2010). Practical Computing for Biologists. Sinauer Associates. ISBN: 978-0878933914.
2. Biostatistics (2014), 10th edition. Daniel W.W., John Wiley & Sons. ISBN: 9788126551897

Course Title: Computational Techniques for Biologists Laboratory
Paper Code: BCH542

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. Python programming
2. Manipulation of genome sequences
3. Retrieval and access of major sequence repositories
4. Analysis of DNA and protein sequences
5. Programming exercises based on regular expressions
6. Programming exercises related to sequence databases and their manipulation.
7. Basic statistical analysis using MS-Excel (Mean, Standard deviation, Standard Error, t-test).
8. Use of Graphpad Prism for data analysis using ANOVA.

Course Title: Biochemical and Environmental Toxicology
Paper Code: BCH601

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: This course introduces students to basic concepts of toxicology and mechanism of action of various toxins, along with various techniques used in toxicology.

Unit A **(5 hours)**

Definition, scope and relationship of toxicology to other sciences.Nature of toxic effects.Acute and chronic exposure.

Dose: response relationship, determination of LD-50, no effect observe level, acceptable daily intake, bioavailability, volume of distribution, plasma half life, total body burden, total body clearane. Synergism and antagonism

Unit B **(10 hours)**

Metabolism of toxicant- Introduction, absorption and distribution.Cytochorome P-450, MFO system and their role in xenobiotic metabolism.Non-microsomal oxidation. Phase-I and Phase-II reactions, conjugations, glucoronide conjugates, conjugations catalysed by sulfotransfereases, methyl transferases and acetyl transferases. Glutathione conjugation and amino acid conjugations.

Unit C **(5 hours)**

Toxicity testing- Decision-tree protocol, Ames test, Host mediated assay and dominant lethal test,

Drosophila sex linked recessive lethal test, micronucleus test.

Unit D **(10 hours)**

Toxicity of pesticides-Classes of pesticides: organoclorine, organophosphates and carbamates. DDT: metabolism, toxicity, persistence and bioaccumulation.
Organophosphats-metabolism and mechanism of insecticidal action.
Metal toxicity-Toxicity of lead and its effect on heme synthesis.Toxicology of various forms of mercury.
Drug toxicity-Paracetamol, metabolism and its toxic effects.

Books Recommended:

1. Lu's Basic toxicology (2017) 7th edition; Frenhe LY, CRC Press, ISBN: 9781138089273
2. Principle & Methods of Toxicology (2014) 6th edition; A. Wallace Hayes, CRC Press, ISBN: 9781842145364.
3. Introduction to Biochemical Toxicology (2001) 3rd edition; E. Hodgson & R.C. Smart, Wiley-Blackwell, ISBN: 978-0471333340.
4. Casarett & Doull's Toxicology, the Basic science of Poison (2013) 8th edition. Curtis D. Klassen, Mc Graw Hill Education, ISBN: 978-0071769235.

Course Title: Concepts in Immunology
Paper Code: BCH 625

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of immunology.

Unit A (15 hours)

Three fundamental concepts in immunology: Specificity, discrimination of self from non-self and memory.

Immune cell receptors: Detailed structure and development of B cell (Ig) and T cell (TcR) receptors; Structure of CD4, CD8, MHC-I, MHC-II molecules, cellular adhesion molecules (ICAM, VCAM, MadCAM, selectins, integrins); Pattern Recognition Receptors (PRRs) and Toll-like receptors (TLR); Markers of suppressor / regulatory cells - CD4+ CD25+ Foxp3+ Treg , iNKT

Unit B (15 hours)

Genetic organization: Organization of the genes for B and T cell receptors. Genetic organization of MHC-I and MHC-II complex (both HLA and H-2).Molecular mechanisms responsible for generating diversity of antibodies and T cell receptors.Peptide loading and expression of MHC-I and MHC-II molecules; Hybridoma technology and monoclonal antibodies, antibody engineering.

Immune response and signaling: Humoral and cell-mediated immune response; Innate immune response and pattern recognition; Recent advances in innate immune response especially NK-DC interactions; Major cytokines and their role in immune mechanisms: TNF, IFN, IL-1, IL-2, IL-4, 1L-6, 1L-10, 1L-12, IL-17, TGFβ; Cell signaling through MAP kinases and NF-κB.

Unit C (15 hours)

Tolerance and autoimmunity: Central and peripheral tolerance, and their mechanism; Mechanisms of autoimmunity; Autoimmune components of diabetes mellitus (DM), multiple sclerosis (MS), experimental autoimmune encephalitis (EAE); Infections leading to autoimmune diseases.

Unit D (15 hours)

Immunological disorders and hypersensitivity: Deficiencies / defects of T cells, B cells, complement and phagocytic cells; Comparative study of Type I-V hypersensitivities with examples.

Transplantation and tumor immunology: Alloreactive response; Graft rejection and GVHD; HLA-matching; Transgenic animals for xenotransplantation; Tumor antigens, immune response to tumors and immunotherapy of tumors.

Recommended Books:

1. Kuby Immunology (2007) 6th edition, Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN: 9780716785903.

2. Immunology: A Short Course (2009) 6th edition, Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 9780470081587.

3. Janeway's Immunobiology (2012) 8th edition, Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 9780815342434.

Course Title: Concepts in Immunology Laboratory

Paper Code: BCH626

L	T	P	Credits	Marks
0	0	2	1	25

Experiments:

1. To perform immunoelectrophoresis.
2. To perform radial immunodiffusion assay.
3. To perform rocket immunoelectrophoresis.
4. To stain a tissue by immunohistochemical reaction
5. To study quantitative precipitation assay
6. To perform dot-ELISA.
7. To perform latex agglutination test
8. To perform western blotting.
9. To study morphological and staining characteristics of lymphocytes, neutrophils, monocytes, eosinophils, and basophils.

Course Title: Regulation of Gene Expression
Paper Code: BCH627

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course introduces students to mechanisms of gene regulation in prokaryotes and eukaryotes.

Unit A (15 hours)

Introduction to Gene Expression

Central dogma, tools and techniques – DNA separation techniques, DNA Sequencing, DNA microarrays, PCR and RT-PCR, Chromatin Immunoprecipitation (ChIP), Gene Knockouts and transgenics.

The Operon

*lac*operon, *cis* and *trans*-acting mutations, *lac* repressor, inducer molecule, *trp*operon, Attenuation

Unit B (15 hours)

Bacteriophage and Gene Expression

Lytic and Lysogenic modes of development, Lambda repressor protein and its function, Antitermination

Unit C (15 hours)

Eukaryotic Transcription Regulation

Gene activation in eukaryotes, role of activators and repressors, nucleosome organization at gene promoter, histone acetylation and transcription activation, Yeast *GAL* genes – a model for activation and repression

Unit D (15 hours)

Epigenetic effects

Heterochromatin and its interaction with histones, Role of Polycomb and Trithorax proteins, CpG islands, Role of DNA methylation in imprinting, inheritance of epigenetic effects.

Regulatory RNA
Riboswitches, ncRNAs and regulation of gene expression, Regulator RNAs in bacteria, RNAi, MicroRNAs and regulation of gene expression in prokaryotes.
Recommended Books:

1. Krebs, J.E., Goldstein, E.S., and Kilpatrick, S.T. Lewin's Genes XI (2014).11th Edition.Jones and Bartlett Learning. ISBN: 9781449659073.
2. Regulation of Gene Expression (2007); Perdew GH, Heuvel JP, Peters JM, Humana Press, ISBN: 9781588292650

L	T	P	Credits	Marks
4	0	0	4	100

Course Title: Biomembrane
Paper Code: BCH670

Course Objective: This course introduces students to basic concepts of membrane organization, structure and transport.

Unit A (15 hours)

Introduction: A historical perspective of different models of membranes, their characteristics with experimental basis of the model (Langmuir trough experiment, freeze fracture technique, X- ray diffraction).

Composition of Biomembranes: Lipids, proteins (Integral, peripheral& lipid anchored) & Carbohydrates. Hydropathy plots & membrane Topology. Composition variation between membranes (Prokaryotic / Eukaryotic / neuronal, Membranes / Sub cellular compartments).

Unit B (15 hours)

Model Membrane Systems: Monolayers, Planar bilayer & Liposomes (synthesis and drug targeting tool). Isolation & purification of membrane and membrane proteins, use of detergents, density gradient centrifugation etc., Criteria of membrane purification & enzyme markers.
Membrane Structures: Polymorphic structures of amphiphilic molecules (soaps, detergents, lipids) in aqueous solutions : Micelles & Bilayers. Thermodynamic forces and other factors affecting the formation of different structures. Critical packing parameter.

Unit C (15 hours)

Asymmetry in Membranes: Lipid and Protein Lateral and Transverse Asymmetry. Macro and micro domains in membranes, Specialized features of plasma membrane : Lipid rafts, Caveolae, Tight Junctions. Membrane Skeleton: Role in maintaining cell structure, and membrane asymmetry. Gates and fences model. RBC membrane as a model.

Membrane Dynamics: Lateral diffusion, Transverse / Flip Flop diffusion & rotational motion of lipids and proteins. Techniques used to study different motion of molecules in membranes: FRAP, FRET. Translational diffusion coefficient. Phase Transition studies of lipid bilayer. Transition temperature. Membrane fluidity. Factors affecting membrane fluidity: Composition, Temperature, salt /water stress, Anesthetics, Age, pH, Nutrition etc. Homeoviscous adaptation. Membrane fusion. Membrane biogenesis

Unit D (15 hours)

Membrane transport: Study of different transport systems; their structure, thermodynamics (free energy change involved, electro chemical potential, membrane potential , Nerst equation) , kinetics regulators, Inhibitors / blockers biochemical function and significance. Simple diffusion, Facilitated diffusion: Passive transport (Glucose transporter, anion transporter); Active transport (P type ATPases V type ATPases , F type ATPases, Na+ / H+ symport systems) . ABC family of transporters (MDR ATPase family, CFTR). Transport processes driven by light (Bacteriorhodopsin, Halorhodopsin). Group translocation. Specialized membrane Pores: Porins in Gram –ve bacterial membranes (*E. coli* OmpF, OmpC, LamB), Pore forming toxins (colicins ,α hemolysin, anthrax toxin protective antigen) and Aquaporins. Ion channels: Voltage gated ion channels (Na+ / K+ voltage gated ion channel) , Ligand gated ion channels (Acetyl choline / IP3 / cGMP gated ion channel) , Leaky channels. Role of ion channels in nerve transmission & action potential propagation. Neurotransmitters: Acetyl choline, glutamate, & glycine (Metabolism, & signaling with type of receptors). Ionophores: Carriers and channel forming (valinomycin, gramicidin).

Reference Books:

1. Membrane Structural Biology with Biochemical and Biophysical Foundations (2014), 2nd edition. Luckey, M., Cambridge University Press, New York, ISBN: 9781107030633.
2. The Membranes of Cells (2016), 3rd edition; Philip L. Yeagle, Academic Press, New York, 2016. ISBN: 9780128000472.
3. Lehninger Principles of Biochemistry (2017), 7th Edition. Nelson, David L., and Cox, Michael M., WH Freeman & Company, ISBN: 9781464126116
4. Biochemistry (2016), 5th Edition; Voet, Donald and Voet, Judith G., John Wiley & Sons Inc., Singapore, ISBN: 9781118918401
5. Molecular Cell Biology (2016), 8th Edition. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., and Scott, M.P., W.H. Freeman, ISBN: 9781464183393

Course Title: Plant Biochemistry
Paper Code: BCH 605

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: The course covers in detail various aspects of biochemistry involved in plant physiology and metabolism.

Unit A (15 hours)

Plant Cell wall: Chemical and physical composition of higher plant cell wall

Photosynthesis: Introduction, photosynthetic pigments, biosynthesis of chlorophyll and its regulation, absorption of sunlight and transfer of the excitation energy of the photons to the reaction canters, van Niel's equation, Hill equation, electron transport in photosynthetic reaction center of purple bacterium, Red drop and Emerson enhancement effect, photosynthetic electron transport chain- Non-cyclic, cyclic and pseudocyclic, reagents affecting photosynthetic electron flow- electron acceptors, electron donors, inhibitors of electron flow and herbicides as inhibitors of photosynthesis, regulation of energy distribution between PS I and PS II, Photophosphorylation- chemiosmotic mechanism, chloroplast ATP synthase, binding change mechanism of ATP synthesis and uncouplers of photophosphorylation. Transport of light- generated ATP from the chloroplast into the cytosol.

Unit B (15 hours)

Pathway of CO_2 assimilation and its regulation in C3, C4, & CAM plants

Photorespiration- pathway and its role

Sucrose and starch: Biosynthesis and regulation of Starch (in chloroplasts and amyloplasts), degradation of starch, biosynthesis and degradation of sucrose, and role of fructose 2, 6-bisphosphate in carbon partitioning between sucrose and starch

Plant mitochondrial electron transport chain: Electron transport complexes and pathway of electron flow in plant mitochondria and cyanide - resistant respiratory pathway.

Unit C (15 hours)

Nitrate Assimilation- nitrate uptake, nitrate & nitrite reductases and regulation of nitrate assimilation. Sulphate assimilation: sulphate uptake and assimilation of sulphate into cysteine

Biological N2-fixation: N2 - fixing organisms, structure and mechanism of action of nitrogenase, A brief account of legume-Rhizobium symbiosis, Leghaemoglobin, strategies for protection of nitrogenase against the inhibitory effect of oxygen, hydrogen evolution and uptake, ammonia assimilation, nif genes of Klebsiellapneumoniae including their regulation, synthesis of amides and ureides.

Unit D (15 hours)

Biochemical defense mechanisms in plants, plant hormones: Physiological effects and molecular mechanism of action of auxins, gibberellins, cytokinins, ABA and ethylene

Recommended Books:

1. Biochemistry and Molecular Biology of Plants by Bob, B. Buchanan, W. Gruissen and R.L.Jones (2000). Published by American Society of Plant Physiologists and distributed by Panima Educational Book Agency, New Delhi. ISBN: 9780470714218.

2. Plant Biochemistry and Molecular Biology (1999), 2nd edition, by Peter J. Lea and Richard C. Leegood. John Wiley and Sons. ISBN: 9780471976837.

3. Plant Biochemistry & Molecular Biology, 3rd edition, by Hans –Walter Heldt (2005), Academic Press. ISBN: 9780120883912

4. Introduction to Plant Biochemistry, T.W. Goodwin and E.I. Mercer (1983). Pergamon Press, ISBN: 9780080249216

5. Plant physiology, 2nd edition, by L. Taiz and E-Zeigler (1998), Sinauer Associates, Inc., Publishers. ISBN: 978-0878938568.

Course Title: Clinical Biochemistry
Paper Code: BCH 603

L	T	P	Credits	Marks
4	0	0	4	100

Course Objective: This course covers various aspects of clinical biochemistry with relevance to their mechanistic aspects and diagnostic applications.

Unit A **(15 hours)**

Diagnostic enzymology-enzyme determination in serum/plasma, urine and cells.Clinically mportant enzymes, use of isoenzymes in diagnosis.

Function tests: Hepatic: Tests based upon the metabolism of carbohydrates, lipids, protein and detoxification. Differential diagnosis of jaundice

Renal: GFR and its clinical importance, clearance tests (urea and creatinine) Intestinal: Malabsorption of fats, carbohydrates and proteins.

Pancreas: amylase, lipase and trypsin assays in serum

Unit B **(15 hours)**

Disorders of metabolism:

Carbohydrates- glycogen storage diseases, galactosemia

Amino acids- disorders of glycine, sulfur containing amino acids, aromatic amino acids, histidine, branched chain amino acids and proline, disorders of propionate and methylmalonate metabolism. Disorders in urea biosynthesis.

Unit C **(15 hours)**

Lipids: hyperlipoproteinemia, hyperlipidemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick disease, Gaucher's disease, Krabb's disease, Metachromatic leukodystrophy and Fabry's Disease, Wolman's Disease.

Disorders of porphyrin and heme metabolism

Unit D **(15 hours)**

Myocardial infarction and atherosclerosis Quality control in clinical Biochemistry

Water & electrolyte balance, acid base balance

Recommended Books:

1. Marshell W.J. and Bangert, S.K. Clinical Chemistry 8th edition (2016) International edition MOSBY, Elsevier, ISBN: 9780723438816

2. Burtis, C.A., Awood, E.R. and Bruns, D.E. TIETZ Text book of Clinical Chemistry and Molecular Diagnosis, 4th Ed. Elsevier. ISBN: 978-1455734122.

3. Bishop, M.L., Fody, E.P and Schoeff, L. Clinical Chemistry- Principles, Procedures, Correlations. 5th edition. Lippincort Willimy & Wilkins. ISBN: 9780781746113.

4. Lieberman, M and Marks, A.D. MARK'S Medical Biochemistry, A Clinical Approach, 3rd edition. LippinWilliman & Wilkins, ISBN: 9781496324818.

5. Crook M.A., Clinical Biochemistry and Metabolic Medicine (2012) 8th edition. CRC Press, ISBN: 9781444144147

Course Title: Clinical Biochemistry Laboratory
Paper Code: BCH604

L	T	P	Credits	Marks
0	0	3	2	50

Experiments:

1. Isolation and estimation of RNA and DNA from yeast, liver, and plants

2. Isolation and estimation of serum cholesterol.

3. Qualitative and quantitative analysis of:

(i) Saliva (α-amylase)

(ii) Urine (urea, uric acid, glucose, proteins, Bence-Jones proteins, Cl^-, PO_3^{-3}, Ca^{+2})

4. Experiments on blood

(a) Identification and count of blood corpuscles

(b) Estimation of haemoglobin

(c) Determination of A/G ratio in serum

(d) Serum creatinine and uric acid

(e) Serum enzyme assays: alkaline phosphates, SGOT, SGPT

5. Gel Electrophoresis of serum proteins.

Course Title: Nutritional Biochemistry
Paper Code: BCH607

L	T	P	Credits	Marks
2	0	0	2	50

Course Objective: This course is intended to cover all the basic aspects of biochemistry relevant in human nutrition.

Unit A **(05 hours)**

Basic concepts – Function of nutrients. Measurement of the fuel values of foods. Direct and indirect calorimetry. Basal metabolic rate: factors affecting BMR, measurement and calculation of BMR. Measurement of energy requirements.Specific dynamic action of proteins.

Unit B **(10 hours)**

Elements of nutrition – Dietary requirement of carbohydrates, lipids and proteins.Biological value of proteins.Concept of protein quality.Protein sparing action of carbohydrates and fats.Essential amino acids, essential fatty acids and their physiological functions.

Unit C **(05 hours)**

Minerals – Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Vitamins – Dietary sources, biochemical functions, requirements and deficiency diseases associated with vitamin B complex, C and A, D, E & K vitamins.

Unit D **(10 hours)**

Malnutrition – Prevention of malnutrition, improvement of diets. Recommended dietary allowances, nutritive value of common foods.Protein-calorie malnutrition.Requirement of proteins and calories under different physiological states- infancy, childhood, adolescence, pregnancy, lactation and ageing.

Starvation – Techniques for the study of starvation. Protein metabolism in prolonged fasting.

Obesity – Definition, Genetic and environmental factors leading to obesity.

Recommended Books:

1. Harper's Illustrated Biochemistry (2015), 30th edition, Murray, R.K., Granner, D.K. and Rodwell, V.W. McGraw Hill Company Inc. Singapore, ISBN: 9780071825344.

2. Textbook of Biochemistry with Clinical Correlations, 7th ed. by T.M. Devlin (2010), Wiley-Liss. ISBN: 9780470281734

3. Foundations and Clinical Applications of Nutrition by M. Grodner et al. (1996) 5th edition, Mosby ISBN: 9780323266888.

4. Modern Nutrition in Health & Disease, 10th edition, by Maurice E. Shils, James A. Oslon, M. Shihe and A. Catherine Ross (1999) Lippincott Williams & Wilkins, New York. ISBN: 9780683307696