SCHEME OF STUDY AND EXAMINATION								
Semester	Subject code	Title of the paper	Instruction hr/week	Exam marks			Duration of exam (hrs)	Credits
				Exam	CIA	Total		
I	BCHT- 01	Basic Biophysical and general chemistry	4	70	30	100	3	4
	BCHT- 02	Metabolism-I	4	70	30	100	3	4
	BCHT-03	Analytical Biochemistry – I	4	70	30	100	3	4
	BCHT-04	General Physiology	4	70	30	100	3	4
	BCHSCT-05	Clinical Biochemistry and Nutrition	3	70	30	100	3	2
	BCHP – 06	Gen. Biochemistry	8	70	30	100	4	4
	BCHP – 07	Bioanalytical techniques	8	70	30	100	4	4
Total credits for the semester								**26**
II	BCHT- 08	Protein structure and Enzymology	4	70	30	100	3	4
	BCHT- 09	Metabolism-II	4	70	30	100	3	4
	BCHT-10	Analytical Biochemistry – II	4	70	30	100	3	4
	BCHT-11	Immunology and Microbiology	4	70	30	100	3	4
	BCHSCT-12	Bioinformatics and Research methodology	3	70	30	100	3	2
	BCHP – 13	Immunochemistry and Informatics	8	70	30	100	4	4
	BCHP – 14	Enzymology	8	70	30	100	4	4
Total credits for the semester								**26**
III	BCHT-15	Molecular Biology	4	70	30	100	3	4
	BCHT-16	Biochemistry of Cell Signaling	4	70	30	100	3	4
	BCHT-17	Membrane Biochemistry	4	70	30	100	3	4
	BCHT-18	Open elective	4	70	30	100	3	3
	BCHP -19	Clinical Biochemistry	8	70	30	100	4	4
	BCHP -20	Molecular Biology	8	70	30	100	4	4
Total credits for the semester								**23**
IV	BCHT-21	Gene Regulation and Genomics	4	70	30	100	3	4
	BCHT-22	Molecular Genetics	4	70	30	100	3	4
	BCHT-23	Genetic Engineering	4	70	30	100	3	4
	BCHT-24	Drug Discovery and Clinical Research	4	70	30	100	3	4
	BCHP-25	Genetic Engineering and Protein chemistry	8	70	30	100	4	4
	BCHPR- 26	Project (Report and Viva-Voce; 45+25)	12	70	30	100	-	5
Total credits for the semester-IV								**25**
Total credits for the course								**100**

Scheme for Continuous Evaluation:

Theory Paper (each)	
Attendance:	5 Marks
Tests[#]:	20 Marks
Seminar/assignment	05 Marks
Total:	**30 Marks**

[#]Two tests will be conducted and average of marks from two tests shall be computed for continuous evaluation

Practical (each Practical)	
Attendance:	5 Marks
Tests[#]:	20 Marks
Record	05 Marks
Total:	**30 Marks**

[#]Two tests shall be conducted and average of marks from two tests shall be computed for continuous assessment.

Question paper pattern for End semester theory Examination

Instruction to the students: *Answer Question No. 1 and* ***any four each*** *from section-**B** and-**C.***

Question No. 1 shall have **nine** sub questions ***a*** **to** ***i*** of two marks each, and the student has to answer ***any seven*** of them. **(2X7=14)**

Section-B

Question No. 2 to 6 carry **four marks** each and the student has to answer ***any four*** of them.

(4X4=16)

Section-C

Question No.7 to 11 will have two sub questions of **5+5** or **6+4** marks; student has to answer ***any four*** main questions.

(10X4=40)

Question paper pattern for end semester Practical Examination

Time: 4h **Max. Marks: 70**

1. Give the principle and procedure for ….	10
2. Perform any one of the experiments listed in the syllabus for the semester.	35
3. Viva-Voce.	15
4. Practical record.	10

Project Evaluation: **Max. Marks: 100**

Internals Max.30	Report Max. 50	Viva-Voce (Max.20)
to be provided by the Supervisor through the Chairman/Principal	To be evaluated for overall objective and quality of work presented in the report.	performance of the candidate

BCHT – 101: Basic Biophysical and General Chemistry

4 units (52 hrs)

Properties of water: Physical and chemical properties of water, ionization and ionic product of water, structure of liquid water and ice. Unusual properties of water. Hydrophilic, hydrophobic and amphipathic molecules in aqueous solution. Effect of solutes on colligative properties of water. Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. Biological relevance of pH and pKa, determination of pKa of weak acid. Buffers, buffer action, and buffer capacity. Henderson–Hasselbalch equation, preparation of buffers. Importance of buffers in biological systems (cytosol and blood).

7 hrs

Thermodynamics: First law of thermodynamics, basic concepts of entropy and second law of thermodynamics, free energy changes, standard free energy change and its relation to equilibrium constant. Oxidation – reduction reactions in biological systems. **5 hrs**

Stereochemistry: Optical isomerism, chirality, symmetry elements, enantiomers, diastereomers, DL and RS notations, racemization, stereoisomerism and geometrical isomerism, *cis* – *trans* and E – Z conventions. **5hrs**

Mechanism of Bio-organic reactions: Introduction, meaning of the term, kinetic and non-kinetic. Fundamental aspects: Homo and heterolytic cleavage, structure and reactivity of carbocation (C^+), carbanion (C^-) and carbon free radical ($C^\cdot$) characteristic aspects of ionic, radical and concerted reactions, substitution, addition, elimination and rearrangements. Energy profiles of reactions, transition state theory, kinetically and thermodynamically controlled reactions. Reactions SN^1, SN^2, SN^i neighbouring group participation. E_2, E_i, Curtin-Hammett principle. Electrophilic addition to C=O, detailed discussion of all aspects of aldol condensation, related condensations, Cannizaro and Manich reactions, Michael addition. Esterification and hydrolysis. **12 hrs**

Rearrangements: Migration to electron deficient C, N and O; Wagner-Meerwein, Pinacol, Beckmann, Hoffmann, Bayer-Villiger reactions, allylic rearrangements. Benzilic acid rearrangement.

6 hrs

Free radicals: Introduction, formation– photolysis, thermolysis, redox reactions, radical reactions with biomolecules. **3 hrs**

Heterocyclic systems: Occurrence in biological systems, structure and properties, and reactivities of furon, pyrrole. Indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine containing biomolecules.

8 hrs

Bioinorganic chemistry: Ligand field theory of complexes, stability of complex ions in solution, kinetics and mechanism of reactions of complexions. Ligand replacement reactions and electron transfer reactions of organometallic moieties of biological macromolecules (cytochromes, chlorophyll and hemoglobin). **6 hrs**

References

1. Physical Biochemistry, Kansal Edward Van Halde. Prentice Hall.
2. Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
3. Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).
4. Physical Biochemistry. David Frifielder. 2nd Edn. W.G.Freeman and Co ( )
5. Organic Chemistry. Vol. I. Fundamental principles. I. L .Finar. 6th Edn. ELBS
6. Inorganic Biochemistry. G.L. Eicharn. Elsevier.
7. Organic Mechanisms, Peter Sykes, Longman, (1977).
8. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
9. Introduction to Biophysical Chemistry, Bruce Martin
10. Organic Chemistry. R.T. Morrison and R.N.Boyd. 6th Edn. Prentice Hall, India.
11. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
12. Chemistry- An Introduction to General, Organic and Biological Chemistry, 7th Edn. Karen C. Timberlake, Benjamin Cummings, (1999).
13. Physical Chemistry of Macromolecules, C. Tanford.
14. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science (2000).

BCHT– 102: Metabolism-I

4 units (52 hrs)

Biological oxidation: Integration of intermediary metabolism, Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Mitochondrial electron transfer system- Chemical nature, topology and thermodynamic design of electron carriers. Sequence of electron carriers-isolation of mitochondrial complexes, reconstitution experiments and study of specific inhibitors of Electron Transport Chain. **6 hrs**

Oxidative phosphorylation: Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase- structure and mechanism, O^{18} exchange. Coupling of electron transfer to ATP synthesis. Uncouplers, inhibitors and ionophores, partial reactions of OP, P/O ratios and their use in localization of sites of ATP synthesis along the chain. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Microsomal electron transport. Proton motive force in Halobacteria, ATP synthesis in bacteria. H^+ pumping by bacteriorhodopsin, Photosynthetic electron transport. Structure and function of chloroplast ATP- synthase.

8 hrs

Carbohydrates: Brief review of configurational and conformational aspects of carbohydrates. Structure, properties and importance of structural (cellulose and chitin) and storage polysaccharides (starch and glycogen), glycosaminoglycans, Structure elucidation of polysaccharides (starch, glycogen and cellulose). Glycoproteins – structure and functions, blood group antigens, sequence analysis of oligosaccharides. Lectins – characteristics and functions in biological system.

8 hrs

Carbohydrate metabolism; Introduction, glycolytic pathway and regulation. Gluconeogenesis. and regulation. Role of LDH. The TCA cycle and its regulation. Alternate pathways: HMP pathway, Enter – Doudoroff, Glucuronate and Glyoxylate pathway, Cori's cycle, Futile cycles and anaplerotic reactions. Shuttle systems; glycerol-3-phosphate and malate-aspartate shuttle, Pasteur Effect, fermentative pathways in microorganisms.

13 hrs

Glycogen and starch metabolism: Degradation, synthesis and regulation. Regulation of blood glucose level, hypo- and hyperglycemia.

3 hrs

Photosynthesis: Introduction, chloroplast/thylakoid structure. Ultra structure and organization of chloroplast membranes, lipid composition of chloroplast membranes. Chlorophylls and accessory pigments, Photosynthetic reaction centre, photosynthetic apparatus, Hill reaction, light reaction, cyclic- and non-cyclic photophosphorylation. Dark reactions, CO_2 fixation into C_4-dicarboxylic acids, RUBISCO. Biosynthesis of Starch Sugars and Cellulose from Glucose. Photosynthesis in Bacteria, fungi, and algae.

8 hrs

Plant Hormones –Growth regulators and their mode of action, molecular effects of auxin in regulation of cell extension, effects of gibberllic acid, abscisic acids and cytokinins in regulation of seed dormancy, germination, growth and development.

6 hrs

References

1. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. Macmillan Publications (2012).
2. Biochemistry VII Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2010).
3. Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
4. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. Jhon Wiley and sons, (1999).
5. Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
6. Complex Carbohydrates, Sharon, N. Addison Wisely, (1975).
7. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).
8. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
9. Principles of Biochemistry; Smith et al., McGraw Hill (1986).
10. Proteins Structures and Molecular Properties 2nd Edn. Thomas E. Creighton, W H Freeman and Co. (1993).
11. Principles of Protein Structure, Function, & evolution, Dickerson & Geis, 2nd Ed. Benjamin-Cummings (1983).
12. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons Inc.(2010).
13. Practical Biostatistics; Mendel Suchmacher and Mauro Geller, Academic Press (2012).

BCHT- 103: Analytical Biochemistry – I

4 Units (52 hrs)

Introduction to Biochemistry: **1hr**

Overview of Biochemical Investigations: Introduction to biochemistry, outline of strategies in biochemical investigations employing whole animal studies, isolated organs, tissues, and cell cultures. Cell disruption methods, investigations with isolated organelles; mitochondria and ER. Model organisms; *E.coli* and its mutants, yeast, *Ceanorhabditis elegans, Arabidopsis thaliana* and *Drosophila melanogaster*. Basic equipments and methods, and safety considerations in animal cell culture. Types of animal cells and their characteristics in culture, culture media. Plant cell culture, media for plant cell culture, potential of plant cell culture in biochemical investigations.

Extractions; Preparation of extracts for biochemical investigations, physicochemical properties of metabolites and drugs extracts from biological materials. Physico-chemical properties of solvents, solubility and miscibility, ionic bonds, and salting out. Partition, ionization, buffering and their effects on extraction. Choice of solvent for solvent extraction, mixed solvents, solid phase extraction.

9 hrs

Microscopic techniques: Review of light microscope, resolution of microscopes, Optical contrast, phase contrast, and dark field microscopy, preparation of specimen for biochemical investigations. Electron microscopy; Working principle and applications, specimens for electron microscopy, fixatives, immune-gold microscopy and its advantages. Metal shadowing, design and applications of **s**canning electron microscopy (SEM), Transmission electron microscopy (TEM), and cryo-electron microscopy. 3-D images, negative staining, single particle reconstruction.

6 hrs

Fluorescence Microscopy: Fluorophores, principle and applications of fluorescence microscopy, design and uses of Epifluorescence microscoy, and immuno-fluorescence microscopy. Imaging live cells and tissues; time lapse imaging, fluorescence stains of living cells, reporter molecules, multidimensional imaging. Measuring cellular dynamics; calcium imaging in live cells, Fluorescence resonance energy transfer (FRET). Use of ion-selective electrodes, light emitting indicators and optical tweezers in study of cellular dynamics.

5 hrs

Centrifugation: Principle of centrifugation, the Swedberg equation, types of centrifuges and rotors. Density gradient centrifugation- Caesium chloride and sucrose density gradients; examples of separations, Sub-cellular fractionation. Design and working of analytical ultracentrifuges, sedimentation velocity and sedimentation equilibrium analyses. basic calculations of centrifugation.

Ultra-filtration; Principle, instrumentation and application. Dialysis, principle and uses of equilibrium dialysis. Precipitation; methods and applications.

Flow Cytometry; Principle and design of flow cytometer, cell sorting. Detection strategies in flow cytometry and parameters measured by flow cytometry.

7 hrs

Biocalorimetry: Arrhenius equation, determination of energy of activation from Arrhenius plots. Main thermodynamic parameters; enthalpy, and entropy. Isothermal titration calorimetry, design of experiments, determination of change in heat capacity, eg., oligomerization of valinomycin, DNA duplex. Determination of specific heat from enthalpy. Differential scanning calorimetry; design of experiment, application of DSC, microcalorimetry. Determination of thermodynamic parameters by non-calorimetric data.

5 hrs

Manometry: Instrumentation, types of manometry; Warburg constant volume manometer, Gilson's differential respirometer, applications.

3 hrs

Radioisotopic methods of analysis: Atomic stability and radiation, types of decay, rate of radioactive decay, half life, units of radioactivity. Detection and measurement of radioactivity, Design and applications of Geiger-Muller Counter, and types of scintillation counters. Disadvantages of scintillation counters, quenching, Chemiluminescence and phospholuminescence counting efficiency, channel ratio, sample preparation, scintillation cocktails, Cerenkov counting. Autoradiography; principle and applications. Radio tracer techniques; Supply storage and purity of radio-labeled compounds, specific activity, radio-labeled nucleotides, metabolites. Pulse chase experiments.

7 hrs

Quantitative biochemical measurements: Analytical considerations and experimental errors, nature of experimental errors- random and systemic errors. Identification of systemic errors, SOPs. Performance of analytical methods, precision, accuracy, detection limit, analytical range, specificity, sensitivity, and robustness. Gaussian distribution (normal) of data, quantification of precision by standard deviation, coefficient of variation and variance, (data to be provided for calculation of each parameter). Assessment of accuracy; Population statistics- confidence limits and confidence intervals, student's t-test, standard error of mean, examples for calculation. Q-tests, examples and applications, Null hypothesis, use of t-test to validate analytical methods-unpaired, paired, one-sample, two-sample tests with examples. Calibration methods; Least mean square method of fitting straight line to data with example. Correlation and regression analyses. ANOVA, one way and two-way ANOVA.

9 hrs

References

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011)
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, (2018).
4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993),
5. Biochemical Techniques 87th Edn., John F. Roby,& Bernard J White Waveland Press Inc. (1987).
6. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
7. Choosing and Using Statistics; A Biologist Guide, Clavin Dythan, Blackwell Scientific (1999).

8. Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998).
9. Biophysical Tools for Biologists *In Vivo* Techniques; John Correia H. Detrich, III Elsevier (2008).
10. Recent Advances in Electron Microscopy- Part-A; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2010).
11. Recent Advances in Electron Microscopy- Part-B; B.V. Venkartarmaprasad, and Steve Ludtke, Academic Press (2011).
12. Introduction to Electron Microscopy for Biologists; Terry Allen, Academic Press (2008).
13. Fluorescence Microscopy; Anda Carnea and P. Michael Conn; Academic Press (2014).

BCHT – 104: General Physiology

4 units (52 hrs)

Tissues: Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue – extra cellular matrix, Collagens – types, composition, structure and synthesis, Elastin, fibronectins, and other proteins of the extra – cellular matrix. Basal lamina; laminins and associated proteins and their functions. **6 hrs**

Cytoskeleton and Cellular dynamics: *Microfilaments;* Assembly and polymerization of G-actin, role of Thymosin-B4, Profilin and Cofilin in polymerization, structural and functional property of F-actin, Capping proteins and assembly of actin filaments, branched and unbranched filament assemblies, Arp2/3, intracellular cellular movement and actin polymerization, use of toxins in study of actin dynamics. Role of cross-linking and adaptor proteins in actin bundling and membrane association.

Structure and organization of microtubules; dynamics of microtubules, assembly by MTOC, dynamic instability, tubulin polymerization as target of drugs. Side and end-binding proteins, capping and severing proteins. *Kinesins and dyneins;* vesicular transport along microtubule, role of kinesin-1 and dynein motors in organelle transport. Role of microfilaments and microtubules in cell migration.

Intermediate filaments; Assembly and tissue specific expression, dynamic nature of intermediate filaments, diseases associated with Lamins and Keratins defects.

7 hrs

Nervous System: Types and structure of neuron. Myelin sheath; composition and function. Resting membrane and action potent ial. Nernst and Goldman equations. Mechanism of initiation and propagation of action potential – voltage gated ion channels, ionophores and toxins in study membrane transport. Design and use of Patch-Clamp in measuring membrane potential. Neurotransmitters and receptors; synaptic transmission, post-synaptic potentials. Outline and functions of autonomic and central nervous systems. **6 hrs**

Muscular System: Ultra structure of smooth, skeletal and cardiac muscle fibers. Contractile and other proteins of muscle. Energy metabolism in muscle; Phosphagens, neuro-muscular junctions, excitation of striated muscles. Organization of sarcolemma, transverse-tubular system and sarcoplasmic reticulum, mechanism of muscle contraction. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies.

6 hrs

Digestive System: Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins, lipids, nucleic acids and vitamins. Liver – structure and functions. Detoxification mechanisms. Liver function tests. **5 hrs**

Cardio – vascular System: Systemic and pulmonary circulation. Structure of blood vessels. Regulation of cardiac activity. Blood volume, blood pressure. Plasma composition and functions of plasma liproproteins. Mechanism of blood clotting, role of vitamin K, clot dissolution, anti-clotting factors, Formation, counting and functions of erythrocytes, leukocytes and thrombocytes. Lymph, Cerebro spinal fluid (CSF); composition and analysis in diagnosis. **6 hrs**

Respiratory System: Mechanics and regulation of respiration, pulmonary and alveolar ventilation and its control, transport of respiratory gases, respiratory mechanism of acid-base balance. **5 hrs**

Excretory System: Mechanism of urine formation and composition of urine. Urine analysis for abnormal constituents, tubular function tests. Nephritis and nephrosis. Kidney hormones. Regulation of acid-base electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis. **5 hrs**

Endocrine system: Hormones, feedback regulation, biosynthesis, storage, secretion, Circulation in blood. Degradation and peripheral transformation. Receptors and the mechanism of hormone action. Measurement of hormones, and receptors. Disorders of endocrine system. **6 hrs**

References

1. The Cell, Copper, Geoffery, M., Oxford University Press, (2001)
2. Text Book f Biochemistry with Clinical correlations; Thomas Devlin [Ed.] Wiley–Liss, (1997).
3. Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds], 6th Edn. Macmillan Publications (2012).
4. Principles of Human Physiology; 4th Edn. Cindy L. Stanfield Pearson, (2010).
5. Cellular Physiology & Neurophysiology 2nd Edn., Mordecai, P. Blaustein, Elsevier Sceince,(2012).
6. Human Biochemistry, Orten and Neuhans , 10th Edn. Mosbey International, (1983).
7. The Neuron,; Cell and Molecular Biology, Irwin B Lavitan, Leonard K Kaczmarck, Oxford University press (2015).
8. Human Physiology: The mechanisms of Body functions. A.J. Vander, et. Al., McGraw-Hill, (1985).
9. Molecular Biology of the Cell, Bruce Alberts, Alexander D Johnson, Julian Levis, David Morgan, Martin Raff, Garland Science (2014).
10. Cellular Physiology of Nerve and Muscle. Gary G Mathew (1998) Balckwell Scientific Inc.

BCHSCT – 105: Clinical Biochemistry and Nutrition (2 Credits)

3 units (39 hrs)

Introduction: Automation in clinical biochemistry laboratory and factors in quality control. Specimen collection and processing: Blood collection methods, anticoagulants. Collection of urine - urine preservatives, Timed urine specimens.

Tests and Clinical significance of urinary compounds with reference to sugars, proteins, ketone bodies, bilirubin and porphyrins. Stool – chemical examination and clinical significance. CSF – collection and composition, clinical significance. Origin, collection, composition and analysis of amniotic fluid.

5 hrs

Metabolic disorders

Disorders of Carbohydrate Metabolism: Diabetes mellitus - type I, II and gestational DM. metabolic abnormalities, diagnosis and management, acute and long term complications. glycogen storage diseases, galactosemia.

Disorders of Lipid Metabolism: Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease, hyperlipoproteinemia, Abeta lipoproteinemia. Lipid storage diseases - Taysach's and Niemann picks diseases, fatty liver. Atherosclerosis; risk factors, biochemical findings and management.

Abnormalities in Nitrogen Metabolism: hereditary Ortoticaciduria, Uremia, hyperuricemia, porphyria and factors affecting nitrogen balance. Inborn Errors of Metabolism– Phenylketonuria, alkaptonuria, albinism, tyrosinosis, maple syrup urine disease, Lesch-Nyhan syndrome, sickle cell anemia, Histidinemia.

8 hrs

Disorders of liver and kidney – Liver function test: clinical significance of AST, ALT, ALP and GGT. Jaundice – types and differential diagnosis. Pancreatic function test. Gastro intestinal function test: fractional gastric analysis, stimulation tests.

Renal function test: clearance tests, tests for renal blood flow, concentration and dilution tests. Acute and chronic renal failure, glomerulonephrities, nephritic syndrome, urinary calculi and dialysis.

4 hrs

Blood Clotting –Disturbances in blood clotting mechanisms– hemorrhagic disorders– hemophilia, von Willbrand's disease, purpura, Rendu-Osler-Werber disease, thrombotic thrombocytopenic purpura, disseminated intravascular coagulation, acquired prothrombin complex disorders, circulating anticoagulants.

4 hrs

Nutrition

Energy metabolism: Introduction on Nutrition: Food factors for human being. Nutritional classification, foods, Energy – Energy value of food and its determination, energy expenditure – components – basal metabolism, physical activity and thermogenesis- foods'

Basal metabolism: Definition, determination of basal metabolic rate (BMR). Standards of BMR factors affecting BMR, energy utilization in cells and energy balance. Dietary fiber- Definition, types of fiber in plant foods, sources, composition, role of dietary fiber and resistant starch in nutrition, effect of over consumption of fiber.

7 hrs

Protein nutrition: Nutritional consequences and Dietary Allowances Nutritive value of protein' Protein calorie malnutrition in children. protein and energy/ requirements Nitrogen balance and imbalance. Deficiency Disease of Vitamins and Minerals (Iron, sodium, potassium, fluoride, magnesium and calcium) Infant nutrition, nutrition for preschool children, school children, adolescents, pregnant and lactating mothers. Industrial workers. Geriatric nutrition and Lathyrism. Obesity: Etiology and occurrence, physiological regulation of foods intake assessment, complication, treatment and prevention of obesity. Therapeutic diets.
Regulation of food intake: role of hunger and satiety centers, effect of nutrients.
Basis for computing nutrient requirements: latest concepts in dietary recommendations, RDA-ICMR and WHO: their uses and limitations.

7 hrs

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.

4 hrs

References:

1. Teitz Fundamentals of Clinical Chemistry, Burtis,C. and Bruns, D. 2007 3rd Edition, W.B. Saunders Company.
2. Clinical Chemistry, Principles, Techniques, Correlations with Access, 8th Edn. Michael Bishop, Edward Fody, & Larry Schoeff, Lippincott William & Wilikns (2018).
3. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).
4. Advanced Nutrition and Human Metabolism 7th Edn. Sareen S Gropper, Jack L Smith, & Timothy P Carr, Cenage Learning (2018).
5. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
6. Modern Nutrition in Health and Disease, 10 Ed. Shills et al;, Lippincott Williams & Wilkins (2006).
7. Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
8. Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease; Watson Elseveir (2012).
9. Nutrition and Metabolism, 2nd Edn., Lanham S, Mac Donald I and Roche H. The Nutrition Society, London, UK, (2012).
10. Introduction to Human Nutrition, 2nd Edn., Gibney M, Lanham S, Cassidy A and Vorster H. The Nutrition Society, London, UK, (2012).

BCHP – 106: Gen. Biochemistry – I (4 Credits)

1. Preparation of buffers; Acetate, phosphate and tris buffer.
2. Determination of saponification number and acid value of oils and fats.
3. Determination of iodine number and peroxide value of oils and fats.
4. Determination of pKa of weak acids and amino acids by pH metric titration.
5. Isolation of potato starch / liver glycogen.
6. Hydrolysis of starch / glycogen and estimation of its purity by H.J. method.
7. Hydrolysis of starch / glycogen and estimation of its purity by Somogy's method.
8. Analysis of water: estimation of calcium and magnesium by EDTA method.
9. Determination of pI of casein from milk.
10. Determination of phytic acid.
11. Estimation of vitamin -C by dichlorophenol indophenol method.

References

1. Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
2. Basic Methods for the Biochemical Lab; Martin Holtzhauer, Springer, (2007).
3. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology, 8th Edn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, (2018).
4. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood,, Blackwell Science, (1993).
5. Protein Purification Applications, S.L.V. Harris and Angal IRL Press, (1990)
6. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work Vol. I & II, North Holland, (1969).
7. Biochemical Techniques 87th Edn., John F. Roby,& Bernard J White Waveland Press Inc. (1987).

BCHP – 107: Bioanalytical Techniques (4 Credits)

1. Absorption spectra of proteins and nucleic acids and determination of molar extinction coefficient.
1. Estimation of reducing sugars (lactose in milk) by DNS method.
2. Estimation of protein by Lowry's method.
3. Estimation of inorganic phosphate by Fiske-Subbarao method.
4. Estimation of tyrosine by Millon's method.
5. Isolation of nucleic acid from cauliflower / sheep liver.
6. Estimation of DNA by Diphenylamine method.
7. Ascending descending and circular paper chromatography of amino acids /carbohydrates
8. Two-dimensional chromatography of amino acid / carbohydrates.
9. Thin layer chromatography of carbohydrates / amino acids.

10. Gel–permeation chromatography of pigments/proteins.
11. Separation of proteins by non-denaturing PAGE.
12. Determination of molecular weight of Proteins by SDS–PAGE
13. Separation of isoenzymes by isoelectric focusing
14. Ion exchange chromatography of nucleic acids / proteins.

References

1. Biochemical Calculations, Irwin H.Segel (1976) 2nd Ed. Jhon Wiley and Sons.
2. Methods in Enzymology; Colowick , S.P. et al., [Eds.] (1987) Vol. 152, Academic Press.
3. Modern Experimental Biochemistry R.F.Boyer [Ed.] (1986) Addition Wesley.
4. Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
5. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack, Oxford University (1995).
6. Analytical Biochemistry; D.J. Holme and H. Pick Longman (1983).
7. Biochemical Techniques 87th Edn., John F. Roby,& Bernard J White, Waveland Press Inc. (1987).
8. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edn. Andreas Hoffman and Samuel Clockie, Ed., Cambridge University Press, (2018).
9. Bioanalytics, Friedrich Lottspeich, Wiley-VCH (2018).

BCHT – 301: Molecular Biology – I

4 units (52 hrs)

Introduction: Central dogma of molecular biology, Relationship between genes and proteins. Nature of genetic material, experiments confirming DNA as genetic material. RNA as genetic material. Variation in size and shape of genomes; ultracentrifugation and electron microscopic methods to study the shape and size of genomes. Size of genome and genetic capacity; C-value paradox. Organelle genomes, Genome sequence and gene numbers, *Topological problems;* Topo-isomerases, gyrases and helicases- assay, mechanism and classification.

6 hrs

Prokaryotic DNA Replication: Replicon, linear and circular replicons, unidirectional and bidirectional replication, experimental methods, mapping origin of replication, semi-conservative and semi-discontinuous replication; experimental demonstrations.
Priming DNA synthesis in bacteria; experimental evidence, components of primosome, Initiation at origin (*oriC*) of *E. Coli*. Isolation of replication intermediates. Regulation of initiation at origins, sequestration of origins after replication, role of helicase.
Enzymology of DNA replication; DNA polymerases, chemistry of nucleotide polymerization and in vitro assay. Properties and functions of DNA polymerase-I, Korenberg enzyme. Hand-palm structure of DNA polymerases. Processivity and fidelity of replication. Conditional lethal mutants, identification of replicative polymerase. Subunit composition of polymerase –III holoenzyme, functional characterization of subunits. Mechanism of replication of *E. coli* DNA-trombone model, termination of replication. Bacterial replication and its connection to cell cycle. Replication of DNA ϕX174 in *E.Coli.*

Eukaryotic DNA replication; Replicative and repair enzymes of eukaryotes. Initiation, elongation by eukaryotic DNA polymerases. SV-40 replication using eukaryotic replicative machinery. Isolation of ARS of yeast, ORC, Licensing factors and control of eukaryotic DNA replication, role of MCM proteins. Replication of organelle genomes, maintenance of ends of linear DNAs; telomeric DNA and telomerase. Regulation of eukaryotic DNA replication and inhibitors of DNA replication.

10 hrs

DNA repair: Experimental demonstration of repair in prokaryotes, damaging agents and damage recognition, direct repair, Miss-match repair assay for mismatch repair, Base excision repair (BER), Nucleotide excision repair (NER) systems; components and mechanism of repair, error prone repair, SOS and Rec-A. Eukaryotic BER and NER, controlling direction of mismatch repair, DNA damage in chromatin **5 hrs**

Transcription in prokaryotes: The transcriptome, prokaryotic RNA polymerase; molecular composition, and mechanism of transcription. Initiation of prokaryotic transcription; Structure of bacterial promoters. Structure and function of sigma factor, sigma cycle, FRET assay for sigma movement. Promoter clearance, role of α-subunit in upstream element recognition. Foot-printing of upstream elements with α-subunit. *Elongation:* Role of β-subunit in phosphodiester bond formation. Structure of elongation complex and core polymerase. Termination of

transcription: Rho- dependent and independent, termination, RNA product under Rho dependent termination.

6 hrs

Transcription in eukaryotes: Nuclear RNA polymerases- rat liver RNA pol. Sensitivity to α-amanitin and metal ions. Subunits of RNA pol-II (yeast pol-II). Heterogeneity of Rpb1 subunit. Formation and maintenance of transcription bubble.
Eukaryotic promoters: Class-II core promoter, modular organization, SV40 early promoter. Linker-scanning mutagenesis, TATA Box, downstream promoter elements, proximal promoter elements, TATA-less promoters and initiators. Class-I and Class-III promoters, Enhancers and silencers.
Class-II pre-initiation complex, foot-printing DAB. Components of TFIID, TBP and associated factors (TAFs). Phosphorylation of CTD of RNA pol-II, Mediator complex and RNA pol-II. Elongation factors: Effect of TFIIS, reversal of transcription arrest, proof reading of transcripts. Composition and working of transcription units at class-I and class-III promoters.

RNA processing: split genes, RNA splicing: R-looping experiments, splicing signals, effect of splicing on gene expression. Splicing of nuclear mRNA precursors. Mechanism of RNase T_1 and T_2, direct evidence for a branched nucleotide.
Spliceosomes: snRNPs, U1snRNP, detection of spliced product by RNase protection assay. U6snRNP, U2snRNP and U4snRNP. Spliceosome assembly and function. Alternative splicing, exon-intron definition. Commitment of precursor RNA to splicing, role of sr protein. Yeast two hybrid assay. Role of RNA pol-II in splicing, control of splicing. Self splicing RNase. Group-I introns, demonstration of exon ligation, Group-II introns.
Post transcriptional modification of mRNA: Structure of cap, purification of caps, capping substrate. Cap structure of Reo virus, functions of cap.
Polyadenylation: Function of poly A, mechanism and signals for polyadenylation. Cleavage and Polyadenylation for mRNA elongation of poly-A, poly-A binding protein (PABP), turnover of poly-A. Coordination of mRNA processing with Coupling termination and mRNA 3' end processing. **13 hrs**

Ribosomes: Prokaryotic ribosomes; molecular components, *in vivo* assembly, dissociation of subunits, and polysomes. Eukaryotic components and their assembly, organelle ribosomes. **3 hrs**

Translation: Initiation of protein synthesis in prokaryotes, Shine-Dalgarno sequence, formation of 30 S and 70 S initiation complexes; effect of GTP hydrolysis by IF2. exchange of ribosomal subunits. Eukaryotic translation initiation-scanning model, eukaryotic initiation factors, role of eIF4E, F, and G. Formation of stable 48S initiation complex, role of eIF1 and eIF1A, toeprint assay, direction of polypeptide synthesis and mRNA translation. Control of translation in bacteria and eukaryotes. Amino acyl-tRNA synthetases, formation of ternary complex among amino-acyl tRNA, EF-T, and GTP, three site model of ribosome, peptide bond formation, G-protein and translation, stop codon supression, release factors, aberrant termination, non-stop mRNAs, termination of transcription, termination codon, no-go-decay of mRNA. Inhibitors of prokaryotic and eukaryotic translation. Post-translational modifications of proteins. Mechanism of translational control.

Genetic code; breaking the code, experimental results leading to deciphering genetic code, coding properties of mRNA, Co-linearity of genes and proteins, Coding properties of tRNA, triplet binding assay, use of synthetic oligo nucleotides (works of Khorana and Neirenberg), base pairing between codon and ani-codon, Wobble base pairing. Properties of genetic code, deviation from universal genetic code.

9 hrs

References

1. Biochemistry; David Rawn, Panima Publishers (2012).
2. The Bacteriophages; Richard Calendar, 2nd Edition, Oxford University Press (2005).
3. Basic Virology; Wagner and Hewlett; Blackwell Science, (2004)
4. LEWINS Gene XII; Krebs, Jocelyn E.Burlington, MA : Jones & Bartlett Learning, (2018).
5. Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
6. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
7. Molecular Biology 5th Edn., Robert F. Weaver, McGraw Hill (2018).
8. Microbial Genetics; Maloy et al., Jones and Bartlett Publishers, (1994).
9. Principles of Developmental Genetics; S.A. Moody, Academic Press (2007).
10. Molecular Biology of Gene; Watson, J.D. et al.,7th Edn. Pearson Education; (2004).
11. Principles of Virology; S.J. Flint et al., ASM Press (2000).
12. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott Oxford University Press (2014)
13. Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2011).
14. Genome Stability: DNA Repair and Recombination; James Haber, Garland Science (2013)

BCHT – 302: Biochemistry of Cell signaling

4 Units (52 hrs)

Principle of Signal transduction:
Introduction, basic model of signal transduction pathways, Extracellular signals acting locally or at a distance, major types of signaling mechanisms, cell-cell contact, Cell surface receptors, major class of cell surface receptors, evolutionary origin, Diversity of Cellular responses, mechanisms of signal transduction; major components of a hypothetical signaling pathway, second messengers, signaling proteins, Signaling proteins as molecular switches Localization of signaling proteins.

5 hrs

G-protein coupled receptor system: Transmembrane Receptors, Domains of Transmembrane (TM) receptors, and Regulation of Receptor Activity. GTPase Superfamily: General Functions and Mechanism, G-domain as Common Structural Element of the GTPases. General mechanism of the activation of effectors molecules associated with G-protein-coupled receptors, G-protein coupled receptors that activate or inhibit adenylate cyclase, G-protein coupled receptors that activate phospholipase-C, and G-protein coupled receptors that regulate ion channels. Signaling via Arrestin.

6 hrs

Ser/Thr-Specific Protein Kinases and Protein Phosphatases;
Classification, Structure, and Characteristics, regulation of Protein kinases, The Protein Kinase Reaction, Control of Protein Kinase Activity, regulation of Protein Phosphorylation. Structure, substrate specificity, and regulation of Protein kinase–A (PKA), A-Kinase Anchor Proteins (AKAPs); The PI3 Kinase/Akt Pathway, Signaling by Akt Kinase. Classification, Structure, functions, and substrates of PKC, activation and regulation of PKC, Receptors of PKC.

6 hrs

Intracellular Messenger Substances: "Second Messengers": General Properties,
Cyclic AMP, cAMP Signaling. cGMP-Guanylyl Cyclases, Targets of cGMP, Inositol Phospholipid Messengers, PLC, PtdIns(3,4,5)P3, PtIns (4,5)P2 and Diacylglycerol. Ceramide, sphingosine, and Lysophosphatidic Acid as signalling molecules. InsP3 Receptor, Storage and Release of Ca^{++} . Ryanodine Receptor, cADP-Ribose and NAADP. Ca^{++} as a Signal Molecule, the EF Hand: A Ca-Binding Module, Calmodulin as a Ca^{++} Sensor, Target Proteins of Ca/Calmodulin, other Ca^{++} Sensors.
NO Signaling; NO and NOS, Physiological Functions of Nitrosylation, Nitrosylation of Metal Centers, NO-Sensitive Guanylyl Cyclase, Regulatory functions of Nitrosylation and Denitrosylation, Toxic Action of NO and Nitrosative Stress.

5 hr

Intracellular signaling proteins; adaptors, activators, bifurcators, integrators and effectors; Downstream cascades of Receptor Tyrosine Kinase, Extracellular-signal-regulated kinases, MAPK-Ras–Raf, SOS signaling pathways; Effectors of intercellular signaling- Adenylate cyclase, Phospholipase–C, Nitricoxide synthase, guanylate cyclase and their activation. Regulation of signaling cascades, positive modulation and negative modulation.

5 hrs

Cytokines—Interferon family: Major proteins/protein families that constitute the cytokine group of regulatory molecules; Structural classification of cytokines; Cytokine receptor super families; Human interferons (IFNs) and the cells that produce interferons; Interferon signal transduction; Interferon receptors; JAK–STAT pathway; Interferon JAK–STAT pathway; Biological effects of interferons. **6 hrs**

Regulation of hematopoiesis; cell adhesion and roles of different adhesion molecules; gap junctions; extracellular matrix; integrins**.** **3 hrs**

Cell Cycle: G0, G1, S, G2 and M-phases of cell cycles-Characteristics of each phase of cell cycles. Restriction point of cell cycle and Quiescent cells, Synchronization of mammalian cells-its importance. Determination of the length of each phase of cell cycle. Control of cell cycle in yeast, and mammalian cells. Role of various cycle-CDK complexes in the transition of various check point of cell cycle. Role of ubiquitin protein ligase –SCF and APC/C in the control of cell cycle.

5 hrs

Apoptosis : Overview of Apoptotic Pathways, Caspases: Death by Proteolysis, Mechanism of Caspases, Caspase Activation and Regulation, Inhibitor and Substrates, Family of Bcl-2 Proteins: Gatekeepers of Apoptosis. The Mitochondrial Pathway of Apoptosis, Permeabilization of the Mitochondrial Outer Membrane, Apoptosome and Caspase Cascade. Other Apoptogenic Proteins Released from Mitochondria.

Death Receptor-Triggered Apoptosis, Fas/CD95 Signaling Pathway, Tumor Necrosis Factor-Receptor 1 and Apoptosis.PI3 Kinase/Akt Kinase and Apoptosis, p53 and Apoptosis Transcription-Independent Induction of Apoptosis by p53.

5 hrs

Cancer : Transformation of normal cell to tumor, Basic Characteristics of Tumor Cells, Mutations in Cancer Cell, genetic and epigenetic changes in cancer, microRNA and cancer. Cancer genes; oncogenes and tumor suppressor genes, Rb and ARF proteins, carcinogenesis an volutionary process, Hallmark of cancer. Oncogene activation, Oncogeneic receptor Tyrosine kinases, Oncogneic activation of Ras signaling, Cyclin, Oncogenic transcription factors. p53 – properties and post translational modifications. Chemotherapeutic and chemo– preventive agents; antioxidants. Drug resistance in cancer chemotherapy.

6 hrs

References

1. Biochemistry of Signal Transduction and Regulation, Gerhard Krauss, 5th Edn. Wiley-VCH Verlag GmbH & Co (2014).
2. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
3. Biopharmaceuticals Biochemistry and Biotechnology 2nd Edn. Gary Walsh, John Wiley & Sons, Ltd, England (2003).
4. Basic Neurochemistry; George Siegel et al., Wippincott, Williams and Wilkins (1999).
5. The Biochemistry of Cell signaling; Ernst J.M. Helmreich, OUP, (2001).
6. Signal transduction and human disease; Toren Finkel, and J. Silvio Gutkind, John Wiley & Sons, Inc. (2003)
7. Greenspan's Basic and Clinical Endocrinology; 9th Edn. David Gardner and Dolores Shoback Lange Clinical Medicine (2012).
8. Biochemistry of Signal Transduction and Regulation; Gerhard Krauss, Wiley-VCH (2003).
9. Elements of Molecular Neurobiology; 3rd Edn. C. U. M. Smith, John Wiley & Sons Ltd, (2002).
10. G-Proteins coupled Receptors; P. Michael Conn Academic Press (2013).
11. Molecular Biology of the Cell; 6th Edn. Bruce Alberts, Alexander Johnson, Julian Lewis David Morgan, Martin Raff, Keith Roberts, Peter Walter; Garland Science (2014).
12. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
13. Cell Signaling; Wendell Lim, Bruce Mayer, Tony Pawson; Garland Science (2014).
14. Electrochemical methods for neuroscience; Michael AC, Borland LM, editors. Boca Raton (FL): CRC Press (2007).
15. Signal Transduction; Lewis Cantley, CSHL Press (2014).
16. When Cells Die; A Comprehensive Evaluation of Apoptosis And Programmed Cell Death; Richard, A. Lockshin, and Zahra Zakeri, Wiley Liss (2004).
17. The Biology of Cancer; Robert A. Weinberg; Garland Science (2013).

BCHT – 303: Membrane Biochemistry

4 units (52 hrs)

Introduction: Review of **s**tructure, nomenclature and properties of glycerolipids, sphingolipids, glycolipids and sterols. Properties of lipids in solution, hydrophobic and hydrophilic interactions, Polar lipids and their ability to form mono, bi-layers and micelles, Langmuir trough.
Cell and organelle membranes; Physical properties of bi-layers, Polymorphic phases and molecular shapes exhibited by lipids, use of differential scanning calorimetry (DSC) and ^{31}P NMR to study transition in phases. Effect of lipid composition and modification on viscosity and fluidity; role of cholesterol, cardiolpin, engineering membrane lipid composition. Models of membranes; Metamorphic mosaic model, Singer-Nicolson fluid mosaic model, Isolation and characterization of membrane lipids. Composition of plasma- and organelle membranes; transbilayer asymmetry; methods to determine membrane sidedness. Asymmetry of lipid distribution in bacterial, plant, and animal membranes, Lateral heterogeneity of membrane lipids; lipid domains, lipid rafts, caveoli, Non bilayer lipids and their role in membranes.
Physical organization of bilayers; human erythrocyte membrane as a prototype plasma membrane, role of cytoskeleton in organization of bilayers. *Liposomes;* preparation, properties and application in membrane biochemistry. **13 hrs**

Membrane proteins: Isolation and characterization of cell membranes. Detergent solubilization of membrane proteins. Purification and reconstitution of membrane proteins. Erythrocyte ghosts; proteins of RBC membrane and their interaction with cytoskeleton. Classification of membrane proteins based on membrane-protein interaction. Types of integral membrane protein, forces responsible for holding integral proteins in membranes, secondary structure of membrane spanning portions of integral membrane proteins; transmembrane α-helices and β-barrels, hydropathic plots. 3-D structures of typical integral membrane proteins: glycophorin, bacteriorhodopsin, photosynthetic reaction centre. Role of integral proteins in cell-cell interaction and adhesion; selectins, integrins, cadherins. Lipid-anchored membrane protein-acyl-prenyl- and GPI-anchors.
Techniques for determination of membrane protein topology: *Biophysical methods:* X-ray crystallography, Freeze-fracture electron microscopy, Spin labeled ESR, NMR. *Biochemical and molecular biological methods*: Membrane protein dynamics. Lateral and rotational diffusion of integral membrane proteins. Fluorescence photobleaching recovery (FRAP). Single particle tracking. Lipid-protein interactions. Atomic force microscopy.

10 hrs

Membrane transport: Relative permeability of pure phospholipid bilayer to various molecules. Diffusion across the plasma membrane. Partition coefficient and hydrophobicity. Energetics of moving non polar and polar molecules across lipid bilayer (PM). Experimental methods for study of membrane transport: Assay of membrane transport, use of liposomes to study single types of transporters. Mechanism for transport**:** Properties of passive diffusion**,** facilitated diffusion, active transport and co-transport. Electrically neutral and electrogenic transport, Kinetics and model of Glut-1 uniport ATP–driven pumps; classification, and working mechanism. ABC-transporters; MDR1, CFTR, Channels and pores. Transport across organelle membranes. Ion channels; working and voltage gating, ion-selectivity, electrochemical gradients, Nernst Equation, working of bacterial K-channels, aquaporins, ionophores.

Open elective for Non-Biochemistry PG students

BCHOET – 304.1: Biochemistry of Common Disorders

4 units (39 hrs)

Human Physiology: Introduction and brief description of cells, tissues and organs, their functions; Body fluids and their composition. Introduction to molecules as building blocks. Definition and differentiation of disease and disorder, types and causes. Relation between food, environment and illness. Analysis of various biochemical parameters in body fluids and specific tissues during disorders, diseases and forensics. **8 hrs**

Diagnostic Techniques: Collection and storage of biological samples for clinical use. Commonly used tests for diagnosis of various diseases and their interpretation.
Blood analysis: Total blood count including ESR, Total serum proteins and their fractions. Blood glucose (GTT) (Fasting and postprandial), serum lipid fraction–cholesterol, triglyceride, LDL and HDL, blood urea, and serum calcium.
Urine: Creatinine, Glucose and protein (albumin).
Enzymes: SGPT, SGOT and isoenzymes as markers in various disorders and diseases. **8 hrs**

Diseases and Disorders (common occurrence):
Aetiology; classification (if any); causative factors; incidence, symptoms and biochemical aspects and markers for-identification, monitoring, prevention and interventions; and nutritional aspects, overweight and obesity. **4 hrs**

Cardiovascular disease: Diabetes, diseases of Liver, Gall bladder & Pancreas-Hepatitis, (A, B, and C), Cirrhosis, alcoholic liver disease, Gall stones, pancreatitis, pancreatic surgery- Causes, Prevention and dietary management. **5 hrs**

Renal disease: Nephrotic syndrome, Acute and Chronic renal failure- diagnostic procedures and dietary management. Dialysis, medical and nutrition therapy. **4 hrs**

Gastrointestinal diseases/disorders: Gastro-oesophageal reflux and esophagitis, Gastritis and Peptic ulcer. Characteristics of and comparison of the stomach and duodenal ulcers. Diagnostic tests for malabsorption, sprue and tropical sprue, Crohn's disease, diarrhoea, constipation, ulcerative colitis, diverticular disease and colon cancer. **6 hrs**

Cancer and HIV/AIDS: Biochemistry of carcinogenesis, types, stages of cancer, diagnosis and existing medicines. Biochemistry of HIV infection, ART and social issues. **4 hrs**

References:

1. Biochemistry; Donald Voet, Judith G. Voet, 4th Edition, John Wiley and sons (2010).
2. Lehninger- Principles of Biochemistry; David L. Nelson and Michael M. Cox, 6th Edition, W. H. Freeman (2013).

3. Biochemistry- The Chemical Reactions of Living Cells; David E. Metzler, 2nd Edition, Academic Press (2001).
4. Outlines of Biochemistry; Eric E. Conn, Paul K. Stumpf, George Breuning, Roy H. Doi, 5th Edition, John-Wiley and sons (2009).
5. Biochemistry- The Chemical Reactions of Living Cells; David E. Metzler, 2nd Edition, Academic Press (2001).
6. Hawk's Physiological Chemistry, ed. Oser, 14th Edn. (1976), Tata-McGraw Hill.
7. Fundamentals of Practical Biochemistry. Mohanty and Basu, BI Publications, India. 2002.
8. 2. Clinical Biochemistry, 2nd Edn. W J Marshall, F I Biol and S K Bangert. Elsevier Health-Mosby Saunders. United States of America. ISBN: 9780443101861.

BCHOET – 304.2: Biochemistry in Daily Life

4 units (39 hrs)

Definition of Biochemistry: Definition of life, The different forms of life, micro-organisms to human beings. Building blocks of life. Introduction to the common macro- and micro-constituents of unicellular and multicellular organisms. Differences encountered in plant and animal kingdoms. **4 hrs**

Food and Nutrition: Importance of food for existence of life. Modes of nutrition in life forms – Comparable and contrasting features. **2 hrs**

Human Health and Disease: Nutrition (Health), definition, classification, food and non food sources.
Nutraceuticals; use of nutraceuticals in traditional health sciences. Role of omega-3 fatty acids, carotenoids, dietary fiber, phytoestrogens; glucosinolates; organosulphur compounds in health and disease (prevention and control). **5 hrs**

Prebiotics and probiotics: Mechanics and usefulness of probiotics and prebiotics in gastro intestinal health and other benefits. Beneficiary microbes; prebiotic ingredients in foods; types of prebiotics and their effects on gut microbes.
Functional foods: Definition, development of functional foods, benefits and sources of functional foods in Indian diet. Effects of processing conditions and storage.
Development of nutraceutical and functional foods; Standards for health claims. Process of developing-preclinical & clinical studies. **7 hrs**

Food additives: Definitions, functions and uses in processed food products. Chemical, technological and toxicological aspects of acid, base buffer systems, salts and chelating/sequestering agents, leavening agents, antioxidants, emulsifying and stabilizing agents, anti-caking agents, thickeners, firming agents, flour bleaching agents and bread improvers. **Sweetening agents:** Artificial sweeteners, composition, uses. Natural and synthetic colors**,** food Flavors, Spices and flavoring constituents, flavors in food industries. **7 hrs**

Enzymes: Introduction and essentiality to life forms. Use of enzyme in beverages- fruit juices, beer, wine, and distilleries; dairy, baking, oils and fats, plantation products, animal products. Malting and germination of grains – process, characteristics, nutritional benefits and uses. Domestic use products like detergents. Textiles-Denim processing. Leather industry. **6 hrs**

Food processing and fortification: Principles, objectives and rationale, selection and basis of fortificants. Technology of fortifying cereal products. Characteristics of nutrients used in cereal fortification. Fortification methods. Fortification premixes, Design and composition of premixes and quality control. Fortification of bread, pasta, noodles, biscuits, and breakfast cereals. Beverages; importance of beverage fortification, Health benefits of fortification, Selection of nutrients for fortification, Levels to be added, Characteristics of fortificants and method of fortification, Bioavailability, Organic Vs inorganic salts. *Health foods;* selection of nutrients, Technology of incorporation of fortificants, bioavailability. **8 hrs**

References

1. Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).
2. Lehninger- Principles of Biochemistry; D.L.Nelson and M.M. Cox, 7th Edn. MacMillan Publications (2017).
3. Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley (2013).
4. Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New, Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
5. Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
6. Bioactive Food as Dietary Interventions for Liver and Gastrointestinal Disease; Watson Elseveir (2012).
7. Food, Nutrition and Health. Tapsell L. Oxford University Press (2010).

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