COURSE OUTLINE AND SYLLABUS FOR M.Sc BIOCHEMISTRY UNDER CBCS SCHEME

SEMESTER-I

S. No	Paper	Title of the Paper	Instruction Hrs per Week	Credits	Duration of the Exam (Hrs)	Marks		
						IA Marks	Exam Marks	Total Marks
1	CPT-1.1	Physico-Chemical Aspects of Biology	4	4	3	20	80	100
2	CPT-1.2	Analytical Biochemistry	4	4	3	20	80	100
3	CPT-1.3	Biomolecules	4	4	3	20	80	100
4	SPT-1.4.1	Physiology and Nutrition	4	4	3	20	80	100
	SPT-1.4.2	Microbiology and Toxicology	4	4	3	20	80	100
5	CPP-1.5 (1.1)	Physico-Chemical Aspects of Biology	4	2	4	10	40	50
6	CPP-1.6 (1.2)	Analytical Biochemistry	4	2	4	10	40	50
7	CPP-1.7 (1.3)	Biomolecules	4	2	4	10	40	50
8	SPP-1.8 (1.4.1)	Physiology and Nutrition	4	2	4	10	40	50
	SPP-1.8 (1.4.2)	Microbiology and Toxicology	4	2	4	10	40	50
Total				**24**				**600**

SEMESTER-II

S. No	Paper	Title of the Paper	Instruction Hrs per Week	Credits	Duration of the Exam (Hrs)	Marks		
						IA Marks	Exam Marks	Total Marks
1	CPT-2.1	Enzymology	4	4	3	20	80	100
2	CPT-2.2	Metabolism of Fuel Molecules	4	4	3	20	80	100
3	SPT-2.3.1	Cell Biology and Endocrinology	4	4	3	20	80	100
	SPT-2.3.2	Medical Biochemistry	4	4	3	20	80	100
4	OET-2.4	Biological Macromolecules	4	4	3	20	80	100
5	CPP-2.5 (2.1)	Enzymology	4	2	4	10	40	50
6	CPP-2.6 (2.2)	Metabolism of Fuel Molecules	4	2	4	10	40	50
7	SPP-2.7.1 (2.3.1)	Cell Biology and Endocrinology	4	2	4	10	40	50
8	SPP-2.7.2 (2.3.2)	Medical Biochemistry	4	2	4	10	40	50
	OEP-2.8 (2.4)	Biological Macromolecules	4	2	4	10	40	50
Total				**24**				**600**

SEMESTER-III

S. No	Paper	Title of the Paper	Instruction Hrs per Week	Credits	Duration of the Exam (Hrs)	Marks		
						IA Marks	Exam Marks	Total Marks
1	CPT-3.1	Metabolism of Nitrogen Compounds	4	4	3	20	80	100
2	CPT-3.2	Immunology	4	4	3	20	80	100
3	SPT-3.3.1	Plant Biochemistry	4	4	3	20	80	100
	SPT-3.3.2	Clinical Biochemistry and Dietetics	4	4	3	20	80	100
4	OET-3.4	Biochemical Toxicology	4	4	3	20	80	100
5	CPP-3.5 (3.1)	Metabolism of Nitrogen Compounds	4	2	4	10	40	50
6	CPP-3.6 (3.2)	Immunology	4	2	4	10	40	50
7	SPP-3.7.1 (3.3.1)	Plant Biochemistry	4	2	4	10	40	50
8	SPP-3.7.2 (3.3.2)	Clinical Biochemistry and Dietetics	4	2	4	10	40	50
	OEP-3.8 (3.4)	Biochemical Toxicology	4	2	4	10	40	50
Total				**24**				**600**

SEMESTER-IV

S. No	Paper	Title of the Paper	Instruction Hrs per Week	Credits	Duration of the Exam (Hrs)	Marks		
						IA Marks	Exam Marks	Total Marks
1	CPT-4.1	Molecular Biology	4	4	3	20	80	100
2	CPT-4.2	Biochemical Genetics and Gene Regulation	4	4	3	20	80	100
3	SPT-4.3.1	Genetic Engineering and Biotechnology	4	4	3	20	80	100
	SPT-4.3.2	Biostatistics, Bioinformatics and Drug Discovery	4	4	3	20	80	100
5	CPP-4.4 (4.1)	Molecular Biology	4	2	4	10	40	50
6	CPP-4.5 (4.2)	Biochemical Genetics and Gene Regulation	4	2	4	10	40	50
7	SPP-4.6.1 (4.3.1)	Genetic Engineering and Biotechnology	4	2	4	10	40	50
8	SPP-4.6.2 (4.3.2)	Biostatistics, Bioinformatics and Drug Discovery	4	2	4	10	40	50
	Project-4.7	Project Work	12	6		20 10	Report-80 Viva-Voice- 40	150
Total				**24**				**600**

CPT: Core Paper Theory **CPP**: Core Paper Practical **SPT**: Special Paper Theory

SPP: Special Paper Practical **OET**: Open Elective Theory **OEP**: Open Elective Practical

4 Credits of Theory = 4 hours of teaching/ week

2 Credits of Practical = 4 hours/ week

SEMESTER-I

CPT-1.1: PHYSICO-CHEMICAL ASPECTS OF BIOLOGY (4 Credits: 64 h)

Atoms and Chemical bonds: Electron theory of valence. Hybridization of chemical bonds. Hybrid orbitals and hybrid molecules. Hydrophobic interactions and Van der waals interaction. Covalent bond, coordinate bond, coordinate bond formation in transition metals. Crystal field theory, ligand field theory, valence bond theory. Structure, bonding and special properties of water. Bonding of iron in hemoglobin and cytochromes, cobalt in Vit B12, magnesium in chlorophyll. Chelates: Types of ligands and complexes. 16 Hr

Stereochemistry: Isomerism, types of isomers. Importance of stereochemistry, position and order of groups around carbon. Geometric and optical isomerism, absolute and relative configuration. Symmetry view of chirality, relation between chirality and optical activity, representation of chiral structures by Fischer. Structure and stereochemistry of glucose; anomer, epimer, enantiomer, stereoisomer, D and L, + and -, R and S notation and stereochemistry of amino acids. 12 Hr

Mechanism of organic reactions: Characteristic aspects of ionic, radical and concerted reactions. Classification of rearrangement reactions. Energy profiles of reactions, transition state theory. Mechanisms and stereochemistry of substitution (electrophilic and nucleophilic- SN1 and SN2 reactions), addition, elimination and rearrangement reactions. Mechanisms of ester hydrolysis, property of aromaticity and resonance. 14 Hr

Heterocyclic systems: Occurrence in biological systems, structure and properties of Furan, Pyrrole. Indole, Thiazole, Imidazole, Pyridine, Pyrimidine, Purine, Quinine, Pteridine and Isoalloxazine. Chemistry of porphyrins and heme. 7 Hr

Secondary metabolites:Structure, properties and importance of phytochemicals; Terpenes, Polyphenols, Procyanidins, Flavonoids, Xanthones, Alkaloids and Pigments. 4Hr

Free Radicals: Introduction to free radicals. Generation and reaction of free radicals with biological materials and their adverse effects. 4 Hr

Thermodynamics: Basic concepts of entropy, free energy changes, standard free energy change and its relation to equilibrium constant, oxidation-reduction reactions, oxidation reactions in biological systems. 7 Hr

REFERENCES

1) Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers (2012).
2) Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).
3) Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.
4) Physical Biochemistry. David Frifielder. 2nd Edn. W.G. Freeman and Co
5) Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
6) Introduction to Biophysical Chemistry, Bruce Martin

7) Organic Chemistry. R.T. Morrison and R.N. Boyd. 6th Edn. Prentice Hall, India.
8) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. MacmillanPublications (2012).
9) Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2nd Edition, Academic Press

CPT-1.2: ANALYTICAL BIOCHEMISTRY (4 Credits: 64 h)

Preliminary techniques in Biochemistry: Animal models, types of studies, mutant organisms (auxotroph), cultured animal and plant cells and plant as models. 4 Hr

Cell fractionation techniques: Cell lysis, homogenization, extraction, salting in and salting out. Dialysis and ultrafiltration-Artificial membranes, semipermeable membranes, Donnan membrane equilibrium and biological significance of osmosis. 4 Hr

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium.

Ultra centrifugation: Differential and density gradient centrifugation, construction of preparative and analytical ultracentrifuge. 8 Hr

Chromatographic techniques: Principles, procedure and applications of paper, TLC, adsorption, ion exchange, gel filtration, affinity, GLC, chromatofocusing, HPLC and FPLC.

Electrophoretic techniques: Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachophoresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram. 16 Hr

Spectroscopic techniques: Principles of colorimeter, spectrophotometer, fluorimeter. Beer- Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications. Principle and applications of NMR, IR, CD/ORD. 10 Hr

Radioisotope techniques: Radioactivity, stable and radioactive isotopes. Methods of detection of isotopes. GM counters, liquid scintillation counters and autoradiography. Units of radioactivity, half-life of radioisotopes. Radiation monitoring and its hazards. Application of radioactive tracer in biology. 6 Hr

Radioisotopes in Biology: 3H, 14C, 32P, 131I, 35S, concept of half-life, decay constant, detection and quantitation- GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications. 6 Hr

Mass spectroscopy: Theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI. 4 Hr

Labelling: Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose1-14C) and enzymatic methods (disaccharides). Labelling of ATP (α-P32 and γ-P32),

proteins and nucleic acids. 6 Hr

REFERENCES

1) Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. Himalaya Publishing House, Delhi.
2) Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
3) Principle and techniques in Biochemistry and Molecular biology; Keith Wilson and JohnWalker (2005).
4) Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University Press (2014)
5) Immuno Assay Hand Book; David Wild, Elsevier (2013).
6) Isoelectric Focusing; Theory, Methodology and Applications; P.G. Righetti , Elsevier (2013).
7) Principles and Techniques of Practical Biochemistry- Wilson. K. And Walker. J. Pub: Cambridge Press.
8) The Tools of Biochemistry, Cooper TG, John Wiley and Sons.
9) Biochemistry Laboratory: Modern Theory and Techniques. Rodney F. Boyer. 2011, Pearson Education.
10) Physical Biochemistry: Applications to Biochemistry and Molecular Biology. David Freifelder. W. H. Freeman Publishers 1982.

CPT-1.3: BIOMOLECULES (4 Credits: 64 h)

Carbohydrates: Classification of carbohydrates. Chemistry of monosaccharides: pentoses. Hexoses, deoxyglucose, amino sugars muramic acid, Linkages in sucrose, lactose and maltose, trehalose and glycosides. Isolation of polysaccharides: Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides. 9 Hr

Structure elucidation: degradation, graded acid hydrolysis, periodate oxidation, degradation of oxopolysaccharides, methylation, acetylation,. Glycoproteins: N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; agreecan, syndecan, and decorin. Pectin and pectic polysaccharides. 6 Hr

Amino acids, Peptides and Proteins: Features of the peptide bond, naturally occurring peptides: glutathione enkaphalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis. 5 Hr

Determination of amino acid compositions: Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o-glycosyl and n-glycosyl). 4 Hr

Elucidation of structure of proteins: Isolation of proteins; overview of purification and criteria of purity. Determination of primary structure: Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequanators. Determination of s-s-bond position. 5 Hr

Secondary structure of proteins: α, β sheet, β bend, β turn and super secondary structures. Secondary structure prediction methods: Ramachandran plot, Chou and Fasman algorithm. Tertiary and quaternary structures. 5 Hr

Factors responsible for protein folding: Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London forces, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phospodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin. Molecular Chaperons. 8 Hr

Lipids: Classification of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phosopholipids, glycolipids, sphingolipids, cerebrosides and gangliosides. 6 Hr

Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thrombaxanes, DAG, ceramide and PAF. 3 Hr

Nucleic acids: Isolation of RNA and DNA from biological samples. Physico-chemical properties of nucleic acids- melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA. 5Hr

Structure of nucleic acids: Primary, secondary and tertiary structure of DNA; Watson and Crick model; B and Z DNA, other models of DNA structure. palindromic sequences, cruciforms. DNA protein interaction; zinc finger,leucinc zipper, helix-turn-helix, other motifs, DNA bending and kinks. Secondary structure of tRNA and clover leaf model. Nucleic acid sequencing- Maxam- Gilbert method, dideoxy method. Chargaff's rule. 8 Hr

REFERENCES

1) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6thEdn.Macmillan Publications (2012).
2) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
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.]. Jhon Wiley and sons, (2010).
5) Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
6) Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., BlackwellScientific (1982).
7) Principles of Biochemistry; Smith et al., McGarw Hill (1986).

8) Proteins Structures and Molecular Properties 2nd Edn. Thomas E. Creighton, W HFreeman and Co. (1993).
9) Principles of Protein Structure, Function, & evolution, Dickerson &Geis 2nd Ed.Benjamin-Cummings (1983).
10) Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2nd Edition, Academic Press

SPT-1.4.1: PHYSIOLOGY AND NUTRITION (4 Credits: 64 h)

Physiology: Basic body plan in humans, location of organs and their basic functions. 2 Hr

Circulatory system: Blood-Composition, cells, plasma proteins and lipoproteins. Erythrocytes; structure and function. WBC; types, differential count, functions. Platelets and their functions. Buffer systems, hemostasis, Mechanism of blood clotting, role of vit K, digestion of clot, anticoagulants, blood volume, blood pressure and their regulations. Hematopoiesis. Plasma lipoproteins and their functions, HDL, LDL, VLDL, chylomicrons. CSF; composition and function. 12 Hr

Respiratory System: Lungs, structure and functions, gas exchange, oxygen binding by hemoglobin, factors affecting oxygenation and acid-base balance. 3 Hr

Digestive secretions - Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Mechanism of HCl production in the stomach and Gastrointestinal hormones. Digestion and absorption of carbohydrates, lipids and proteins. 5 Hr

Hepatobiliary System: Anatomy of the liver, blood supply, cells; hepatocytes, endothelial cells and Kupffer cells, secretory and excretory function and formation of bile. 3 Hr

Excretory system- Structure of nephron, formation of urine- glomerular filtration, tubular reabsorption of glucose, water and electrolytes, tubular secretion. Kidney hormones. Regulation of acid base, electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis. 8 Hr

Muscular system - Smooth, skeletal and cardiac muscles. Contractile and other proteins of muscle. Fine structure of muscle fibre, neuromuscular junctions. Mechanism of muscle contraction. 6 Hr

Concepts of Nutrition: Introduction, essential nutrients and their classification. Proximate analysis of foods. 2 Hr

Macronutrients: Carbohydrates- Digestible and non-digestible, dietary fibre. Proteins- Essential amino acids, malnutrition, Kwashiorkor and Marasmus. Lipids-triglycerols, phospholipids, cholesterol and essential fatty acids. 5 Hr

Micronutrients: Pro-vitamins, anti-vitamins, sources, requirements, functions and deficiency symptoms of vitamin-C , thiamine, riboflavin, niacin, pyridoxine, folic acid, vitamin B12, pantothenic acid, biotin & Vitamin- A,D,E and K. Absorption, requirements and functions of Zn, Ca, P, Mg, Cl, Fe. 7 Hr

Basal metabolism: Determination of Basal Metabolic Rate (BMR) - Experimentally and by calculation average BMR for Indians. Factors affecting BMR. Energy requirements for different physical activities, Standard Dynamic Action (SDA) of food. Nutritive value of proteins. 5 Hr

Recommended Daily Allowance (RDA): Calories from carbohydrates, lipids, proteins.

Special aspects: Nutrition during pregnancy, lactation and old age. Nutrition for infants and children. Factors affecting the nutritional status. 6 Hr

REFERENCES

1) The Cell, Copper, Geoffery, M., Oxford University Press, (2001).
2) Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.](1997), Wiley-Liss.
3) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th Edn. MacmillanPublications (2012).
4) Harper's Review of Biochemistry, Murray et. al., (1997) 24th Edn., Lange.
5) Molecular Biology of Cell; Albertiset. al. (2002) Garland Science.
6) Biochemistry Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).
7) Mammalian Biochemistry; White, Handler and Smith, McGraw-Hill, (1986).
8) Nutrition: Science and Applications, 3rd Edn. Lori A. Smolin, Mary B. Grosvenor, Wiley(2013).
9) Introduction to Human Nutrition, 2nd Edn. Michael J. Gibney, Susan A. Lanham-New,Aedin Cassidy, Hester H. Vorster, Wiley-Blackwell (2009).
10) Nutrition: Everyday Choices, 1st Edition; Mary B. Grosvenor, Lori A. Smolin Wiley (2006).
11) Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2nd Edition, Academic Press.
12) Modern Experimental Biochemistry. R. Boyer (2000), 3rd edition, Benjamin-Cummings (USA)
13) Essentials of Food and Nutrition By M. Swaminathan, Ganesh Publishers, India.

SPT-1.4.2: MICROBIOLOGY AND TOXICOLOGY (4 Credits: 64 h)

General Microbiology: Brief study on Discovery of Microorganisms. Classification of microorganisms: General-Prokaryotic and Eukaryotic Microorganisms and Nutritional Classification of microorganisms. Brief study of morphology of bacteria (bacilli, coci bacteria, spiral, coco-bacilli) Yeast and Molds. 5 Hr

Bacteriology: General Classification of Bacteria, Ultrastructure of bacteria and cell surface of Gram positive and Gram negative bacteria. Bacterial cell organelles: cell wall, cell envelope, capsule, flagella and pili, Brief study of important groups of bacteria: Coliform, spore formers, photosynthetic bacteria, lactic acid producing bacteria, actinomycetes, ricketisiae, mycoplasmas. 11 Hr

Eukaryotic Microorganisms: Fungi- Classification, morphology of yeasts and molds. Brief study of viruses, algae and protozoa. 3 Hr

Microscopy: Compound Microscopy, Scanning Electron Microscopy, Confocal microscopy and their applications. Staining Techniques: Principal, procedure and application of Gram staining, Acid-fast Staining, Endospore staining, Flagella staining and Fungal staining. 4Hr

Microbial Nutrition and Growth: Nutrients (C, H, O, N, P, S, water and minerals) for the growth and maintenance of microorganisms. Microbial media: complex medium, defined medium, special medium, selective medium, differential medium, and transport medium. Sterilization, Physical and chemical methods of sterilization. **Pure culture techniques**: Methods of isolation of pure culture. Enrichment culture technique. **Growth behaviour of microorganisms**: Growth curve and factors affecting growth, Chemostat, generation time, and growth rate. Enumeration of viable cells. Cultivation of halophyles, psychrophyles and thermophyles. 14 Hr

Food and Dairy Microbiology: Microbial contamination and spoilage of foods, fermented foods, canned and, packaged foods. Sources of contamination. Composition of milk, Dairy products- Preparation of cheese, Microbial contamination and spoilage of milk and milk products. Sources and levels of microbial contamination of milk. Pasteurization and sterilization of milk. Detection of *Brucella*in milk samples, Microbial foodborne diseases- GSI, foodborne intoxications, foodborne infections, foodborne toxico-infections. Microbes used in food fermentations. Food preservatives and methods of preservation. Microbial contamination of water, sources of contamination, Contamination of water by Pesticides and other toxic organic chemicals, detoxification process. Bioremediation of toxic chemicals, industrial effluents and sewage treatment. 12 hr

Medical Microbiology: Pathogenic microorganisms and diseases. Control of pathogenic organisms, Case study and mechanism of infection- Gastroenteritis, Typhoid, Diphtheria, and Tetanus. Multidrug resistance. Bacterial and fungal exotoxins and their health implications. 5 Hr

Virology: Human Immunodeficiency Virus (HIV), Foot and mouth disease virus (FMDV) and TobacoMossaic Virus (TMV). 3 Hr

Toxicology: Factors influencing toxicity, Biochemical basis for the human toxicity of aromatic hydrocarbons (benzopyrene), food based toxicants, pesticide (organophosphate, organochlorine, and carbarol), heavy metals, radiometals and synthetic dyes and dye-intermediates. Occupational toxicity, Drug toxicity and xenobiotic toxicity to different organs. Genotoxicity, carcinogenicity, teratogenicity and tissue specific toxicity of toxic chemicals and drugs. 7 Hr

Toxicity testing: Cyp assays, cell-based assays. *Invitro* Pre-clinical phase I and Phase II assays, Diagnosis of toxic effects in liver, bladder, pancreas and kidney. Pharmacodynamics study. Detection and dose response- LD_{50}, ED_{50}, Determination of Limit of detection and quantification. 4 Hr

REFERENCES

1) Microbial physiology, 2nd Edn. I.W. Dawes and I.W. Sutherland (1991) Blackwell Scientific.

2) Microbial physiology, 4th Edn. Albert G. Moat, John W. Foster and Michael P. Spector, Wiley-Liss (2002).
3) Modern Food Microbiology; James M. Jay (1996) CBS Publishers.
4) A Modern Introduction to Food Microbiology; Board, R.G. (Ed.) (1983) Blackwell Scientific Publications.
5) Biology of Microorganisms, Brock Prentice Hall (1996).
6) Industrial Microbiology; Miller and Litsky (Eds.) (1976) McGraw Hill Publishers.
7) Microbiology; Lansing M. Prescot, Hartley and Klein, 5th Edn. McGraw Hill (2002).
8) Microbiology; Essentials and Applications, Larry Mckane and J. Kandel (19) McGraw Hill publishers.
9) Basic and Practical Microbiology, Ronald L. Atlas (1986) McMillan Publication Co.
10) General Microbiology, Stainer et al., 4th Edn. McMillan (1975).
11) Microbiology, Pelczer, Reid and Kreig Tata McGraw Hill (1996).
12) Biology of Microorganisms, Brock Prentice Hall (1996).
13) Molecular Toxicology; Nick Plant, Garland Science (2003).
14) Introduction to Exotoxicology, En. D.W. Connell, Blackwell Scientific (2000).
15) Molecular Pharmacology, ed. T. Kenakin, Blackwell Science Inc (1997).
16) Toxicological Chemistry and biochemistry; Manahan, Stanley E. CRC Press LLC (2003).

CPP-1.5(1.1): PHYSICO-CHEMICAL ASPECTS OF BIOLOGY (2 Credits: 32h)

1) Measurement of pH by pH meter
2) Titration curve of weak acids and determination of pKa
3) Preparation of buffers
4) Titration curve of amino acids.
5) Polari metric analysis of carbohydrates.
6) Acid hydrolysis of sucrose and starch.
7) Hydrolysis of proteins.

CPP-1.6 (1.2): ANALYTICAL BIOCHEMISTRY (2 Credits: 32 h)

1. **pH - metric titrations**: Strong acid against a strong base, Weak acid against a strong base, Poly basic acid against a strong base, Amino acid (Neutral) against a strong base and acid.
2. **Paper chromatography**: Ascending and Descending, Two –dimensional.
3. **Protein isolation**: Isolation and Estimation of Casein from milk, Starch from potato, Lecithin from egg.
4. **Column Chromatography**: Ion exchange chromatography of proteins, Carbohydrates and nucleic acids. Anion and Cation exchange chromatography. Elution of proteins by linear gradient technique. Molecular sieve chromatography- separation of mixture of proteins and molecular weight determination of proteins. Affinity chromatography - Isolation of glycoproteins, antibodies and double anti bodies**.**
5. **Electrophoresis:** Paper electrophoresis - Separation of amino acids and proteins in serum. Polyacrylamide Gel Electrophoresis- Anionic and Cationic PAGE of proteins. SDS-PAGE; Determination of Molecular weight of proteins.

CPP-1.7 (1.3): BIOMOLECULES (2 Credits: 32h)

1) Estimation of reducing sugars by DNS method.
2) Quantitative estimation of sugars by phenol-sulfuric acid method.
3) Hydrolysis of starch or glycogen and estimation of its purity by titrimetric method.
4) Determination of Pka value of an amino acid.
5) Analysis of fats: Saponification number, Iodine number and acid value of oil.
6) Estimation of Nitrogen in amino acids, urea and casein by Micro-Kjeldahl Method.
7) Estimation of protein by Lowry's method.
8) Estimation of protein by Biuret method.
9) Isolation of cholesterol and lecithin.
10) Isolation of nucleic acids from plant source.

SPP-1.8.1 (1.4.1): PHYSIOLOGY AND NUTRITION (2 Credits: 32h)

1) Blood group analysis.
2) Isolation of liver mitochondria.
3) RBC and WBC count.
4) Estimation of Hemoglobin.
5) Isolation and Separation of Hemoglobin.
6) Determination of moisture, fibre and ash contents of biological samples.
7) Determination of carbohydrate, protein and fat contents of biological samples.
8) Estimation of Iodine, Calcium, Phosphate and Iron from biological samples.
9) Estimation of Vitamin A and Vitamin C of from biological samples.

SPP-1.8.2 (1.4.2): MICROBIOLOGY AND TOXICOLOGY (2 Credits: 32 h)

1) Preparation of liquid and solid media for the growth of microorganisms.
2) Isolation of microorganisms by plating, streaking and serial dilution methods.
3) Preparation of slants and stab cultures.
4) Preservation and maintenance of microorganisms
5) Growth curve of bacterium, measurement of bacterial population.
6) Effect of temperature, pH, Carbon and nitrogen sources on the growth.
7) Study of microorganisms by Gram stain, acid fast stain and staining of spores.
8) Assay of antibiotics and demonstration of antibiotic resistance.
9) Analysis of water for potability and determination of MPN.

SEMESTER-II

CPT-2.1: ENZYMOLOGY (4 Credits: 64 h)

Introduction to Enzymes: Nature of enzymes, localization, isolation, purification and characterization of enzymes. Criteria of purity of enzymes, fold purity. Nomenclature and IUB classification of enzymes. Enzyme specificity, specific activity, assay methods; coupled enzyme assays, continuous, end point and kinetic assay. Units of enzyme activity, IU and Katal. Industrial and Biomedical applications of enzymes. 4 Hr

Enzyme kinetics: Michaelis-Menten equation, initial velocity approach, steady state approach. Vmax, Km and their significance. Linear transformation of Michaelis-Menten equation; Lineweaver-Burk plot, Eadie-Hofstee, Wolf and Cornish-Bowden. Scatchard plot. Rate of a reaction, order and molecularity. Ist order reaction kinetics. Rectangular hyperbola, Michaelis- Menten equation as rectangular hyperbola, asymptote, linear transformation, calculation of slope, intercept. Effect of pH, temperature and substrate concentration. 8 Hr

Enzyme Inhibition: Types of reversible inhibitors - competitive, non-competitive, un-competitive and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible inhibition. 4 Hr

Kinetics of bi-substrate reactions: Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between different kinetic pathways using primary and secondary plots. Inhibition studies in the characterisation of bi-substrate reactions. 8 Hr

Mechanisms of enzyme catalysis: Active site structure; methods of determining active site structure, isolation of ES complex, affinity labelling, chemical modification studies and active site structure investigation. 7 Hr

Nature of enzyme catalysis: Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophoilic catalysis, intramolecular catalyses, entropy effects. Effect of temperature and pH on enzyme catalysed reaction. 7 Hr

Mechanisms of action of specific enzyme: Chymotrypsin; zymogen activation, acid-base catalysis, charge relay network. Lysozyme, alcohol dehydrogenase, ribonuclease, carboxypeptidase A, RNA as an enzyme. 8 Hr

Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions- nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme A, thiamine pyrophosphate and biotin, Folate coenzymes. 6 Hr

Monomeric and oligomeric enzymes: Monomeric enzymes-the serine proteases, zymogen activation. Sulphahydryl enzymes-papain. Oligomeric enzymes-isoenzymes (LDH) and multi-enzyme complexes- (Pyruvate dehydrogenase complex). 4 Hr

Allosteric enzymes: Binding of ligands to proteins - Co-operativity, the Hill equation, equilibrium dialysis technique. **Sigmoidal kinetics:** The MWC and KNF models. Significance of sigmoidal behaviour. Allosteric enzymes and metabolic regulation. Study of ATCase- as typical allosteric enzyme. 8 Hr

REFERENCES

1) Fundamentals of Enzymology, Price.NC. And Stevens. L., Oxford University Press.
2) Enzymes- Biochemistry, Biotechnology, Clinical chemistry- Palmer, T., Affiliated East-West press.
3) Fundamentals of Enzyme Kinetics, Segel I H; Wiley Interscience-Wiley.
4) Biochemical calculations, 2nd Edition By Irwin H. Segel. John Wiley & Sons,
5) Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
6) Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
7) Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
8) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn) Horwood Chemical Science Series.
9) Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), BlackwellScience.
10) An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg, (1997) Jonesand Bartlett publishers.
11) Lehninger Principles of Biochemistry; D.L. Nelson and M.M. Cox, 6th Edn. MacMillan Publications (2012).
12) Principles of Biochemistry; Smith et al., Ed. McGraw Hill,(1986).

CPT-2.2: METABOLISM OF FUEL MOLECULES (4 Credits: 64h)

Introduction: Basic concepts in metabolism: catabolism, anabolism, catabolic, anabolic and amphibolic pathways. 2 Hr

Carbohydrate metabolism*:* Introduction, glycolytic pathway, energetics and regulation of glycolysis, fate of pyruvate, oxidation of pyruvate. Citric acid cycle and its regulation, energetics, anaplerosis. Gluconeogenesis and its regulation, Cori cycle, glyoxylate cycle. glucose paradox. Futile cycles and their applications. Entry of other carbohydrates into glycolysis-fructose and galactose. 10 Hr

Glycogen and starch metabolism: Biosynthesis and degradation of starch and glycogen and its regulation. Glycogen storage disorders. Lactose intolerance, fructosuria, galactosemia. HMP pathway and its regulation. 4 Hr

Hormonal regulation of glucose metabolism: Effect of insulin and glucogon, catecholamines, growth hormones and carticosteroids on carbohydrate and lipid metabolism in different tissues. Action of thyroid hormones and their mechanisms. 4 Hr

Lipid Metabolism: Degradation of triacylglycerols, phospholipids and sphingolipids and regulations; lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. Fatty acid degradation; α and β and ω-oxidation. Knoop's experiment, saturated and unsaturated fatty acids. Formation of ketone bodies and their oxidation. Energetics and biosynthesis of fatty acids; fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals, conversion of linoleate to arachiodnante (scheme only). 12 Hr

Cholesterol synthesis and degradation and regulations: Metabolism of circulating lipids; chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Foam cell formation. Regulation of blood cholesterol, triglycerides, LDL and HDL. Obesity, and mechanisms, exercise and regulation of energy metabolism. 7 Hr

Phospholipid biosynthesis and regulations: Denovo pathway and inter conversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Biosynthesis of prostaglandins, thromboxanes andleukotrienes. 9 Hr

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation. 2 Hr

Thermodynamics: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. High energy compounds-Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound. 5 Hr

Mitochondrial electron transport: Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis. 9 Hr

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1) Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3rd Ed. Jhon Wiley and sons.
2) Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3) Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
4) Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
5) Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.
6) Hawk's Physiological Chemistry, Oser (1976) 14th Edn Tata-McGraHill.
7) Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin, Wiley-Liss (2012).
8) Lehninger-Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).
9) Biochemistry; David Rawn, Panima Publishers (2012).

SPT-2.3.1: CELL BIOLOGY AND ENDOCRINOLOGY (4 Credits: 64 h)

Cell Biology: Types of cells, Extracellular matrix, Cytoskeletal elements and cell-cell interactions-Adhesion. Cell division and Cell cycle-Mitosis and meiosis, Cell cycle phases and Programmed cell death. Biomembranes-Composition of plasma and organelle membranes, Singer and Nicholson's

model and its salient features. Membrane domains- Caveolae and Rafts. Technique used to study the membranes structure-FRAP and single particle tracking. Preparation and usage of liposomes and erythrocytes ghosts. Membrane asymmetry. Protein-protein and protein-lipid interactions in membranes. Protein and lipid trafficking in membranes. Membrane Transport: Passive, facilitated and exchange diffusion, Fick's law of diffusion and active transport. Structure and function of Na-K ATPase and $Ca2^{+}$ATPase. Ion channels, ionophores and aquaporins. Receptor mediated endocytosis and exocytosis. **Disorders associated with membrane transport systems**-Cystic fibrosis. Bacterial transport system. 16 Hr

Nervous system: Division of nervous system-neutron structure and types. Role of NGF, N-CUM and other specialized proteins. Resting membrane potential of excitable cells. Mechanism of initiation and propagation of action potential. Voltage gated ion channels (sodium, potassium and calcium). Design and use of patch clamp in measuring membrane potential. Depolarization and hyperpolarization in post-synaptic cells. Synaptic transmission, neurotransmitters, biogenic amines, amino acids and neuropeptides. Storage and exocytosis of neurotransmitters. Termination of neurotransmitters action. Acetylcholine receptors, nicotinic and muscarinic adrenergic receptors, other neurotransmitters receptors. Mechanism of synaptic transmission, receptor integrated ion channels and G-protein mediated ion channels. Use of agonists and antagonists of neurotransmitters in Biochemistry and medicine. 15 Hr

Endocrine System: Endocrine organs in man. Location and inter relationship of endocrine glands in man; chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, gonads and intestine. Functions and abnormalities- hypo and hyper production of hormones secreted by; pituitary, thyroid, pancreas, adrenals and gonads. Structure and control of hypothalamus: Hormones produced; GRH, somatostatin, TRH, CRH, GnRH. 10 Hr

Pituitary-anatomy and structure- Hormones of anterior, posterior and median lobes. Proopiomelanocortin. Testes and ovaries- hormones produced by testes and ovaries, menstrual cycle. Regulation of hormone production and release: hypothalamus-pituitary-target organ axis and regulation by feedback mechanism. Conversion of cholesterol to steroid hormone. 8 Hr

Mechanism of action of Hormone: Peptide hormones-General mechanisms of cell signalling by hydrophilic factors, transmembrane receptors, G protein coupled receptors, receptor tyrosine kinase, eicosanoid receptors. **Second messengers:** 1P3, DAG, cAMP, protein kinases. Nitric oxide signalling; generation and action. **Growth factors:** Structure, mechanism of action and receptors of EGF, PDGF, NGF and IGF. Isolation and characterization of insulin receptor. **Steroid hormones**- Steroid receptors, isolation and characterization of steroid receptors. Receptor down regulation, desensitization and up regulation. Pineal gland, Melotonin and circadian rhythm. 10 Hr

Insect hormones: Structure and function of moulting hormone, ecdysone, juvenile hormones, Biochemistry of Plant hormones. 3 Hr

Pheromones: Mechanism of perception and action. Use of pheromones in control of agricultural pests. 2 Hr

REFERENCES

1) Molecular Biology of the Cell, 3rdedition. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson. Publisher New York: Garland Science.
2) The Cell: A Molecular Approach, Fifth Edition, by Geoffrey M. Cooper and Robert E. Hausman, published by ASM Press.
3) Lehninger- Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
4) Molecular Cell Biology; Lodish et al., 7thEdn. W.H. Freeman and Co. (2012).
5) Biochemistry 5th Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
6) Harper's Illustrated Biochemistry; 27th Edn. Robert K. Murray, Daryl K. Granner, Victor W. Rodwell, The McGraw-Hill (2006).
7) Lipid Biochemistry; 5th Edn. Michael I. Gurr, John L. Harwood and Keith N. Frayn, Blackwell Science (2002).
8) Principles of Human Physiology; 4th Edn. Cindy L. Stanfield Pearson, (2010).

SPT-2.3.2: MEDICAL BIOCHEMISTRY (4 Credits: 64 h)

Basic concepts: Health and disease. Normal and pathological changes affecting cells in the body. Cell death and the physiological causes; physical, chemical, biological agents and nutritional deficiency. 6 Hr

Hematology and Hematology disorders: Blood composition: Blood cells, serum and plasma content. Different types of anemias-nutritional and sickle cell anemia. Complete blood count (CBC). Total and differential and platelet counts and their clinical significance. Blood groups, blood group substances, Rhessus factor, nature of blood group antigens and rare blood groups. Hospital-laboratory method of blood grouping and Rh typing. Erythrocyte sedimentation rate (ESR) determination and its importance in the diagnosis of certain diseases. 15 Hr

Enzymes of clinical and diagnostic importance: Enzymes as markers in the diagnosis of diseases. Clinical significance of cholinesterass, alkaline and acid phosphatases, LDH, CPK, SGOT and SGPT. 8 Hr

Biochemical investigations in kidney diseases: Kidney profile in health and disease. Urine analysis for normal and abnormal constituents, urine microscopy culture and antibiotic sensitivity test. Clearance test and its importance in the assessment of kidney function. Kidney diseases like urinary tract infection (UTI) and nephritis. Kidney transplantation and dialysis. 10 Hr

Biochemical investigations in Liver diseases: Liver profile in health and disease. Hepatocellular functions, with special emphasis on its participation in the various detoxification mechanism. Liver function tests (LFT), and their clinical significance in the diagnosis of liver diseases like cirrohosis and jaundice. Gall-bladder-stone analysis and its clinical significance. Hepatitis infections. 10 Hr

Cardio-vascular diseases: Brief mention of heart diseases. Atherosclerosis and its complications. 3 Hr

Cancer biology: Clinical and classical signs of cancer. Different stages and types of cancer, diagnostics. Chemotherapy (Natural and synthetic drugs) and radiation therapy. Molecular basis of cancer and mechanism of apoptosis. 6 Hr

Diabetes mellitus: Regulation of blood sugar, classification, stages and diagnosis (urine analysis, GTC/GTT, Glycosylated Hb. Role of anti-diabetic oral drugs and different types of insulins. 4 Hr

Gastric profile in health and diseases: Gastric function tests (gastric analysis). Hypo and hyper acidity and Gastric ulcers. Malabsorption syndrome. 2 Hr

REFERENCES

1) Human Physiology –Chatterjee.C.C, Medical Allied Agency.
2) Manipal Manual of Clinical Biochemistry: For Medical Laboratory and MSc StudentsBy S. Nayak, Shivnanda Nayak B, JAPEE Brother Medical Publications, New Delhi.
3) Human Biochemistry, Orten and Neuhans, 10thEdn. Mosbey International, (1983).
4) Review of Medical Physiology, Gannong, W.F.15th Edn., Maruzen Asial, (1991).
5) Textbook of Medical Physiology- Pal, G.K, Ahuja Publishing House, Delhi, 2007.
6) Textbook of Medical Physiology- Hall. J.E. Guyton and Hall. 12th ed. Saunders, Elsevier Inc., 2011.
7) Review of Medical Physiology- Barrett KE, Brooks HL, Boitano S and Barman SM Ganong's, 23rd Ed., McGraw-Hill Medical, 2009.

OET-2.4: BIOLOGICAL MACROMOLECULES (4 Credits: 64 h)

Properties of water: Importance of water in biological systems. Ion product of water and its measurement. Biological relevance of pH and pKa, Hendersson-Hesselbach equation. Buffers and their importance in biological systems. Preparation of buffers. 8 Hr

Carbohydrates: Monosaccharides- Classification, Sugar derivatives. Disaccharides- structure of sucrose, lactose, maltose and cellobiose. Structure, Properties and importance of homo and heteropolysaccharides–starch, glycogen, cellulose, dextran, agarose and alginate. Glycosaminoglycans, glycoproteins, antifreeze glycoproteins, bacterial cell wall polysaccharides and blood group antigens. 13 Hr

Amino acids and proteins: Classification and structure of amino acids. Acid-base properties of amino acids. Essential amino acids and Non-protein amino acids. Peptide bond-structure and conformation. Naturally occurring peptides-glutathione enkaphalins and endorphins. Ionic properties of peptides and proteins. Separation of amino acids mixtures and analysis of amino acids. 10 Hr

Proteins: Introduction, classification and biological functions. Composition of proteins. The size and conformation of proteins. Supramolecular assemblies of proteins. The functional diversity of proteins. 7 Hr

Lipids: Brief account of the chemistry and classification of lipids (without structural elucidation). Biological role of the following: Fatty acids, Aryl glycerols, Cholesterol, Terpenes, Waxes and Bile salts, Phospholipids, Sphingolipids, Glycolipids, Steriods, Prostaglandins, Thromboxanes and Leukotrienes. Properties of lipids aggregates-micelles, Bilayer and Liposomes. 12 Hr

Nucleic Acids: Structure and properties of nucleosides and nucleotides. Properties of nucleic acids in solution. Hydrolysis of nucleic acids by acid and base. Enzymatic hydrolysis, Nuclease specificity and restriction endonucleases. Chemistry of DNA- Structures and functions of DNA, staining of DNA, PCR and its applications. Chemistry of RNAs: Structures and functions of mRNA, tRNA and rRNA. 12 Hr

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1) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6thdn. Macmillan Publications (2012).
2) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, W H Freeman and Co. (2006).
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.] 3rdEd. Jhon Wiley and sons, (1999).
5) Biochemistry; David Rawn, J, Neil Patterson Publishers.
6) Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., BlackwellScientific (1982).
7) Biochemistry Ed. Donald Voet & Judith G. Voet, John Wiley & Sons, Inc.(2010).

CPP-2.5: Enzymology (2 Credits: 32h)

1. Kinetic study of the following enzymes; amylase (from saliva/potato/wheat). Transaminases (from liver/plant embryos), lipase (from caster seeds), urease (from horse gram), esterases (from peas and insects). Acid and alkaline posphatases (from potato, green gram and serum). Protease and amylase inhibitors from plant sources.
2. Study of enzyme kinetics with respect to substrate, enzyme concentration, time, pH, temperature, activators, inhibitors with at least any three of the above mentioned enzymes.
3. Biochemical changes during germination of seeds and the development of embryo/seeds-specifically, the amylase, phosphatase and proteinases and their inhibitors.

CPP-2.6 (2.2): Metabolism of Fuel Molecules (2 Credits: 32h)

1) Preparation of mitochondria from rat liver.
2) Isolation of glycogen from the rat liver.
3) Esterase activity of rat liver homogenate.
4) LDH activity of rat liver homogenate.
5) Electrophoretic pattern of rat liver homogenate.
6) Lipase activity of rat liver homogenate.
7) Isolation of chloroplast from spinach leaves.
8) Determination of ATPase activity of mitochondria.
9) Determination of oxygen uptake of mitochondria.
10) Detection of cytochromes

SPP-2.7.1 (2.3.1): Cell Biology and Endocrinology (2 Credits: 32h)

1) Isolation of sub-cellular organelles.
2) Determination of drug induced haemolysis.
3) Determination of pro/anti-coagulant activity of plant proteins.
4) Preparation of RBC ghosts.
5) Blood cell count.
6) Determination of marker enzymes such as Serum Glutamate-Oxaloacetate Transaminase, Serum Glutamate-Pyruvate Transaminase, Lactate dehydrogenase and Creatine kinase
7) Determination of acetyl choline esterase activity.

SPP-2.7.2 (2.3.2): Medical Biochemistry (2 Credits: 32h)

1) Blood group analysis.
2) Differential count of blood (RBC, WBC and Platelets).
3) Estimation of Hemoglobin and methemoglobin.
4) Isolation and Separation of Hemoglobin.
5) Estimation of serum and plasma glucose.
6) Separation of hemoglobin using electrophoresis (Demonstration).
7) Estimation of urea and uric acid in biological samples.
8) Estimation of SGOT and SGPT.
9) Estimation of LDH and CPK.

OEP-2.8(2.4): BIOLOGICAL MACROMOLECULES (2 Credits: 32h)

1) Preparation of buffer solutions.
2) Qualitative and tests for identification of carbohydrates, amino acids, lipids and oils.
3) Quantitative estimation of sugars, amino acids and proteins.
4) Titration curve of amino acids.
5) Determination of saponification number, iodine number and acid value of fatty acids.
6) Estimation of cholesterol.
7) Isolation and estimation of nucleic acids.

SEMESTER-III

CPT-3.1: METABOLISM OF NITROGEN COMPOUNDS (4 Credits: 64 h)

Nitrogen Cycle: Introduction to biological and non-biological nitrogen fixation, brief introduction to *nif*genes, utilization of nitrate and nitrites, regulation of nitrate reductase. 3 Hr

Catabolism of amino acids: Study of degradation pathways of the individual amino acids in animal, plant and microbial systems-Glucogenic and ketogenic amino acids and their significance. Degradation of amino acids forming pyruvate (alanine, glycine, threonine, serine, cysteine, cysteine and tryptophan) oxaloacetate (aspartic acid and asparagine), α- ketoglutarate (glutamic acid, glutamine, arginine, histidine and proline), succinyl CoA (valine, isoleucine, threonine and methionine), Fumarate (phenylalanine, tyrosine) acetoacetate and/or acetyl CoA (leucine and lysine), pyruvate, formaldehyde, acetoacetate and/or acetyl CoA (tryptophan), and fumarate, acetoaetate and/or acetyl CoA (phenylalanine and tyrosine). Inherited disorders associated with glycine, aromatic, branched- chain, basic and sulfur containing amino acid metabolism. 15 Hr

Biosynthesis of amino acids: in animal, plant and microbial systems-Biosynthesis of non -essential amino acids from pyruvate (alanine), intermediates of glycolysis (serine, tyrosine), biotransformation of serine to glycine and cysteine, and TCA cycle (aspartic acid, asparagine, glutamic acid and glutamine), non- essential amino acid s(glycine, proline and arginine), and essential & non – essential amino acid (cysteine). Biosynthesis of essential amino acids from aspartate family of amino acids (threonine, lysine and methionine), pyruvate family of amino acids (valine and leucine), pyruvate and α-ketobutyrate family of amino acid (isoleucine) aromatic family of amino acids from glycolysis intermediates (phenylalanine, and tryptophan) and histidine. Regulation of amino acid biosynthesis by sequential and concerted feedback inhibition. 15 Hr

Amino acid Metabolism: General metabolic reaction of amino acids– transamination, pseudotransamnation, glucose–alanine cycle, oxidative deamination (glutamate dehydrogenase), minor pathways of amino acid degradation – transdeamination, amino acid oxidase, and non – oxidative deamination (α– deaminase, dehydrase, asparaginase and glutaminase). Assimilation of ammonia, formation of amino acid amides by glutamine synthetase and its regulation. Urea cycle– regulation and metabolic disorders. Biosynthesis of creatine and creatine phosphate, polyamines– putrescine, spermidine and spermine, glutathione (γ-glutamyl cycle), physiologically active amines (serotonin. γ-amino butyric acid, histamine, and catecholamines – dopamine, epinephrine and epinephrine). 15 Hr

Heme Metabolism: Biosynthesis and degradation of porphyrin, porphyrias, jaundice and Hemoglobinopathies. 4 Hr

Nucleotide Metabolism: Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Other pathways of purine nucleotide formation. Biosynthesis

of deoxyribonucleotides and coenzymes nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. Degradation of purine and pyrimidines, and disorders associated with their metabolism; gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. 12 Hr

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1) Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3rd Ed. Jhon Wiley and sons.
2) Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3) Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
4) Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
5) Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.
6) Hawk's Physiological Chemistry, Oser (1976) 14th Edn Tata-McGraHill.
7) Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin, Wiley-Liss (2012).
8) Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. MacmillanPublications (2012).
9) Biochemistry; David Rawn, Panima Publishers (2012).

CPT-3.2: IMMUNOLOGY (4 Credits: 64 h)

History and scope of immunology: Types of immunity- innate and adaptive. Immune reactive cells. Humoral and cell mediated immunity. Anatomy of lymphoid organs- primary lymphoid organs, secondary lymphoid organs and lymphtic system. Antigens-chemical nature, types, antigenicity, haptens, epitopes, antigenic determinants, adjuvants and super antigens. Valency of antigen, epitope analysis. 7 Hr

Immunoglobulins:Basic structure, functions, theories of antibody formation, classes and immunoglobulin super family. Antigenic determinants on immunoglobulins. Methods of raising polyclonal antibodies. Monoclonal antibodies – production and application. Antibody diversity-mechanism contributing to diversity, somatic recombination, rearrangement and generation of antibody diversity. Class switching. 10 Hr

Cellular Basis of Immunity: Primary and secondary immune response. Reticuloendothelial system, T, B and accessory cells. Development of T and B cells. Sub sets of T and B cells. T-helper cells, T-killer cells, T-suppressor cells. T and B cell receptors, antigen processing and presentation. T and B interaction. Cytokines and co-stimulatory molecules; lymphokines, interleukins, structure and function of IL-lβ, IL-2, TNF-α. Suppression of immune response, immunoglobulin genes, generation of immunoglobulin diversity, gene rearrangement and other mechanisms, clonal selection theory of Burnet. 13 Hr

MHC: MHC gene and its polymorphism, role of MHC in immune response and transplantation. **T and B cell lymphocytes**: origin, differentiation, characterization and functions. T cell and B cell receptor complexes. Antigen processing and presentation. Cytokines and co-stimulatory molecules. Role in immune response. T and B cell interactions. 8 Hr

Complement system- components, receptors, activation of complement pathways and its biological consequences. Major histocompatibility complex (MHC) genes and products. Role of MHC antigens in immune response, MHC antigens in transplantation. 5 Hr

Non-specific defences in man: Barriers to infection; skin, mucous membrane, inflammation, hyper sensitivity reactions (Type I, II, III and IV). 3 Hr

Transplantation: Autograft, isograft, allograft and xenograft. Graft rejection, graft vs. host reaction. 4 Hr

Tumour immunology: Tumour associated antigens, factors favouring tumour growth, immune surveillance. Tumour necrosis factor-α and β. 2 Hr

Disorders of immunity: Immunological tolerance, auto immune disorders, AIDS, SCID.

Vaccines: Adjuvants, vaccines and their preparations. Polyclonal and monoclonal antibodies; hybridoma technique. 5 Hr

In vitro antigen-antibody reaction: Precipitation, agglutination, complement fixation, immuno diffusion, immunoelectrophoresis, immunofluorescence, RIA, ELISA. 4 Hr

Defence system in plants: Host parasite interaction and defence system in plants. 3 Hr

REFERENCES

1) Kuby Immunology; Oven, Punt, Stranford, 7thEdn. W. H. Freeman (2013).
2) Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
3) Basic and Clinical Immunology; Stites et al., [Ed] (1982) Lange.
4) Roitt's Essential Immunology; Ivan, M. Rohitt&Petrer J Delves (2001) Blackwell Science.
5) Immunology: Roitt et al., Mosby (2001).
6) Immune System; M. C. Connel et al., Eds. (1981) Blackwell Science.
7) Immunology at a Glance: J.H.L. Playfare [ed.] Blackwell Science, (1987).
8) Immunology; Jan Klein [Ed.], Blackwell Science (1990).
9) Introduction to Immunology; Kim Bell [Ed.,] 3rdEdn. McMillan (1990).
10) Veterinary Immunology: Ian R. Tizard, I.R. Thomson press.
11) The Immune System. By Peter Parham Publisher Garland publishing.

SPT-3.3.1: PLANT BIOCHEMISTRY (4 Credits: 64 h)

Thermodynamics: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. 3 Hr

High energy compounds: Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound. 3 Hr

Photosynthesis: Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and phosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle. C3, C4 and CAM cycle. Photorespiration, bacterial photosynthesis. Regulation of photosynthesis. RUBISCO. 8 Hr

Respiration: Plant mitochondrial electron transport and ATP synthesis. 2 Hr

Nitrogen metabolism: Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and non-symbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion. 5 Hr

Plant hormones: Biosynthesis, storage, breakdown and transport. Physiological effects and mechanisms of action of auxines, gibberlines, cytokinins, ethylene, abscisic acid. 5 Hr

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, photoperiodism and biological clocks. Seed dormancy, inception of germination. Germination and growth regulators, juvenility, vernalization. 7 Hr

Solute transport and photo assimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem. Transpiration, mechanisms of loading and unloading of photo assimilates.

Methods in phytochemicals: Extraction, fractionation and characterization. 7 Hr

Secondary metabolites -Terpenes, phenols, flavonoids and nitrogenous compounds and their roles in plant physiology and as alternative medicine. 5 Hr

Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress. 7 Hr

Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses, and alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogeninduced diseases in plants, cell-cell fusion in both normal and abnormal cells. 8 Hr

Plant proteinases inhibitors -General properties of plant proteinase inhibitors, proteinase inhibitors of serine proteinase, acid proteinase, metalloproteinase. Role of proteinase inhibitors in plants. 4 Hr

REFERENCES

1) Lehninger- Principles of Biochemistry; David L. Nelson and Michael M. Cox, 6thEdition,W. H. Freeman (2013).
2) Biochemistry; Donald Voet, Judith G. Voet, 4th Edition, John Wiley and sons (2010).
3) Biochemistry, Lubert Stryer et al., W.H. Freeman & Company, New York, (2003).
4) Principles of Biochemistry, Horton, Moran, Ochs, Rawn, Scrimgeour Prentice Hall, (2002).
5) Plant Biochemistry, P.M. Dey & J.B. Harborne (2000) Hart Court Asia Pte Ltd.
6) Introduction to plant Biochemistry. Goodwin and Mercer, CBS Publisher (2000).
7) Biochemistry and Molecular Biology of Plants. Buchanan, Greussem and Jones, AAPS (2000).
8) Plant Biochemistry; P. M. Dey and J. B. Harborne, Academic Press (1997).
9) Plant Biochemistry and Molecular Biology; Peter J. Lea, Richard C. Leegood, 2nd Edition, Wiley (1998).
10) Plant Biochemistry; Hans-Walter Heldt and Birgit Piechulla, Academic Press (2004).

SPT-3.3.2: CLINICAL BIOCHEMISTRY AND DIETETICS (4 Credits: 64 h)

Blood: Blood Haemostasis, Composition, blood count, total, differential and platelet count. Blood group studies, Rhesus factor, ESR- its determination and importance in disease. Blood coagulation factors, mechanism and its regulation. Plasma proteins, profile in health and diseases. Abnormal haemoglobins, Disorders of haemoglobins- thalassemmia, sickle cell anaemia. Anaemias Microcytic, macrocytic and normocytic, CSF analysis. 10 Hr

Diagnostic Enzymology: Clinical significance of enzymes like SGOT, SGPT, LDH, CPK, Alkaline and acid phosphatase, amylase. 4 Hr

Kidney profile: Assessment of renal function-clearance tests and their importance in assessment of kidney functions. Laboratory investigations of kidney disorders- UTI, kidney stones, Nephritis, Urolithiasis, Dialysis, Uremia, Hyporuricemia. 7 Hr

Liver profile: Biochemical indices of hepatobiliary diseases, Bile pigments- Formation of bilirubin, urobilinogen, bile acids, Jaundice- pre-hepatic, hepatic, post hepatic. Diagnosis Liver function tests, Diseases of liver-Hepatitis, Cholestasis Cirrhosis, Gall stone. 6 Hr

Disorders of carbohydrate metabolism: Diabetes- aetiology, classification, management, laboratory investigations. GTT, GlycatedHb, Diabetic complications, inborn errors of carbohydrate metabolism-Glycogen storage diseases, Galactosemia, Lactose intolerance, Pentosuria. Disorders of Lipid metabolism- Plasma lipoproteins and their functions, Hyperlipoproteinaemia- classification, Primary and secondary, Hypercholesterolemia, Ketosis and its significance. Disorders of amino acid and protein metabolism- Inborn errors of amino acid metabolism- PKU, Alkaptonuria. Disorders of purine and pyrimidine metabolism-Gout, Lesch-Nyhan syndrome, Xanthuria, Oroticaciduria. Cardiovascular disorders- Major cardiovascular system- Atherosclerosis- risk factors, pathogenesis, diagnosis and

prognosis. Gastrointestinal disorders: Fractional gastric analysis, Hypo and hyperacidity, Gastric ulcers, Malabsorption syndrome. 16 Hr

Dietetics: Introduction to nutrition. Food pyramid. Diet planning and introduction to diet therapy. Nutritional requirements for different age groups, anaemic child, expectant women, and lactating women. Diet planning for prevention and cure of nutritional anaemia. 4 Hr

Diet therapy: Functional foods, dietary considerations during fever, and typhoid, malaria, influenza and tuberculosis patients. Prevention, and correction of obesity, underweight, and metabolic diseases by diet therapy. Dietary interventions to correct and or manage gastrointestinal diseases (indigestion, peptic ulcer, stomach carcinoma, constipation, diarrhoea, steatorrhoea, irritable bowel syndrome. 10 Hr

Diets in liver diseases - Hepatitis, cirrhosis, cholecysthetis and cholelithiasis. Functional foods based diet therapy for diabetes, cardiovascular disease, nephritis, and genetic disorders (PKU, galactosemia, lactose-intolerance, fructosurea) and cancers. 7 Hr

REFERENCES

1) Text book of Biochemistry and Human Biology –Talwar, G.P. and Srivastava. L.M., Printice Hall of India.
2) Human Physiology -Chatterjee.C.C, Medical Allied Agency.
3) Clinical Biochemistry, 2nd Edn. W J Marshall, F I Biol and S K Bangert. Elsevier Health-Mosby Saunders. United States of America. ISBN: 9780443101861.
4) Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley-Liss.

OET-3.4: BIOCHEMICAL TOXICOLOGY (4 Credits: 64 h)

Definition and scope of toxicology: Definition, types, toxins, toxic materials. Eco-toxicology and its environmental significance. Toxic effects: Basic for general classification & nature. Dose-Response relationship: Synergism and Antagonism, Determination of ED_{50} & LD_{50}. Acute and Chronic exposures. Factors influencing Toxicity, Pharmacodynamics & Chemodynamics. 12 Hr

Diagnosis of toxic changes in liver and kidneys: Metabolism of Haloalkanes, Haloalkenes & Paracetamol with their toxic effects on tissues. 6 Hr

Xenobiotics Metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reaction/Conjugation : Methylation, Glutathione and amino acid conjugation. Detoxification. 5 Hr

Biochemical basis of toxicity: Metabolism of Toxicity : Disturbances of Exitable membrane function. Altered calcium Homeostasis. Covalent binding of cellular macromolecules & Genoatoxicity. Tissue specificity of Toxicity. 5 Hr

Toxicity testing : Test protocol, Genetic toxicity testing & Mutagenesis assays : In vitro Test systems – Bacterial Mutation Test : Reversion Test, Ames Test, Fluctuation Tests and Eukaryotic Mutation Tests. In vivo Mammalian Mutation tests – Host mediated assay & Dominant Lethal Test. Use of Drosophila in toxicity testing. DNA repair assays. Chromosome damage test. Toxicological evolution of Recombinant DNA – derived proteins. 10 Hr

Pesticide toxicity: Insecticides: Organochlorines, Anti cholinesterases – Organophosphates and Carbamates, Fungicides. Herbicides, Environmental consequences of pesticide toxicity. Biopesticides. 12 Hr

Food Toxicity: Role of diet in cardio-vascular disease and cancer. Toxicology of food additives. 6 Hr

Metal Toxicity: Toxicology of Arsenic, mercury, lead and cadmium. Environmental factors, affecting metal toxicity effect of light, temperature & pH. 6 Hr

Air pollution: Common air Pollutant & their sources. Air pollution & ozone. Air pollution due to chlorofluorocarbons (CFCS) and asbestos. 5 Hr

REFERENCES:

1) Handbook of Clinical Biochemistry R. Swaminathan Oxford Press (2004)
2) Environmental chemistry by Stanley E. Manahan Boca Raton: CRC Press LLC, 2000.
3) Environmental Toxicology. 2002. David A. Wright and Pamela Welbourn. Cambridge University Press, New York, NY. 630 pp.
4) Emergency Toxicology. Second edition. Edited by Peter Viccellio. 1277 pp. Philadelphia, Lippincott Williams. & Wilkins, 1999.
5) Introduction to Food Toxicology by Takayuki Shibamoto and Leonard S. Bjeldknes Acad. Press 2nd edn. 1993.
6) Principles of biochemical toxicology, John A. Timbrell-4th ed. Informa Healthcare USA, Inc. New York, 2008.

CPP-3.5 (3.1): Metabolism of Nitrogen compounds (2 Credits: 32h)

1) Assay of aminotransferases: (a) Aspartate (b) alanine amino transferases.
2) Assay of phenyl alanine ammonialyase.
3) Assay of nitrate and nitrite reductase.
4) Assay of Glutamine synthase.
5) Estimation of Allantoin and allantoic acid.
6) Assay of nitrogenase.
7) Estimation of plant hormones.

CPP-3.6 (3.2): Immunology (2 Credits: 32h)

1) Production of immune sera: Affinity purification of antibodies.
2) Immuno-diffusion: Ouchterlony double diffusion, Radial immunodiffusion.
3) Immuno-electrophoresis, Rocket Electrophoresis,
4) ELISA: Direct, Indirect, Sandwich and micro ELISA.
5) Conjugation of antibodies to alkaline phosphatase/HRP.

6) Western blotting of proteins and Immunodetection.
7) Determination of human blood groups.
8) Agglutination tests.

SPP-3.7.1 (3.3.1): Plant Biochemistry (2 Credits: 32h)

1) Extraction, isolation and estimation of polyphenols.
2) Extraction, isolation and estimation of lignin.
3) Extraction and estimation of flavones, tennis and quinolones.
4) Estimation of indole-3-acetic acid and gibberellin from plants.
5) Demonstration of systemic acquired resistance in plants.
6) Identification of pathogen related proteins in plants infected by pathogens.

SPP-3.7.2(3.3.2): Clinical Biochemistry and Dietetics (2 Credits: 32h)

1. **Urine analysis**: 1) Qualitative analysis of urine for abnormal constituents- glucose, albumin and ketone bodies 2) Quantitative analysis of urine- Titratable acidity, creatine, creatinine, urea, uric acid, glucose.
2. **Blood analysis**: Estimation of Blood glucose, urea, uric acid, creatinine, A/G ratio, and Cholesterol
3. **Assay of serum enzymes**: SGOT, SGPT, LDH, creatine kinase, acid and alkaline phosphatase.
4. Electrophoresis of lipoproteins and Hb (Demonstration).
5. Food analysis – 1) Moisture; 2) Crude protein; 3) Ash; 4) Crude fat; 5) Energy; 6) Crude and dietary fibre; 7) Iron; 8) Ascorbic acid and 9) Phosphorus.
6. Determination of BMR /BMI.

OEP-3.8 (3.4): Biochemical Toxicology (2 Credits: 32h)

1) Determination of drug induced hemolysis.
2) Estimation of ROS.
3) Determination of Phase I & II enzymatic activity during xenobiotic metabolism.
4) Determination of cell death markers (LDH).
5) MTT assay to study the cytotoxicity.
6) Liver and Kidney function tests
7) Determination Acetyl choline esterase activity.

SEMESTER-IV

CPT- 4.1: MOLECULAR BIOLOGY (4 Credits: 64 h)

DNA Replication: Central dogma of Molecular biology, Structure of DNA and forces stabilizing DNA structure. Genome organization in prokaryotes and eukaryotes. Experimental evidences-DNA as the genetic material and semiconservative mode of DNA replication. Models of DNA replication. Characterization, composition and mechanism of action and role of *E. coli* DNA Polymerase I, and III, E. coli and Phage DNA Ligase, topoisomerases, primosome complex, helicase, primase, ssDNA stabilizing proteins. Brief study of E. coli DNA polymerase II. Mechanism of E. coli DNA replication (trombone model). Origin of replication and events occurring on replication fork- topological problems, initiation, elongation, and termination of E. coli DNA replication. Leading strand, lagging strand, Okazaki fragments. Proof of discontinuous synthesis of DNA. Fidelity of replication-proofreading and nick translation, nearest neighbour base frequency analysis. Eukaryotic DNA polymerases, Mechanism of replication of Eukaryotic DNA, mitochondrial and chloroplast DNA. Regulation of eukaryotic DNA replication and inhibitors of DNA replication. DNA replication in adenovirus, polyoma and SV 40. Rolling circle mode of DNA replication. Replication of ss +RNA viruses, ss–RNA viruses, dsRNA- reovirus, and retroviruses. **DNA repair;** Existence of repair systems, direct repair systems, excision repair- base excision and nucleotide excision repair, photo reactivation. Post replication repair; mismatch repair, SOS repair (by passing damaged DNA during replication) and recombination repair. 20 Hr

Transcription: Structure of gene. Characterization and mechanism of action of prokaryotic RNA polymerase. Significance of sigma factor. Mechanism of transcription in E. coli. Initiation of prokaryotic transcription; bacterial promoters, Closed and open initiation complexes, promoter clearances. Sigma factors, concept of mRNA, elongation of RNA synthesis, termination; rho-dependent and independent termination. Processing of RNA in prokaryotes. Inhibitors of RNA synthesis. 10 Hr

Eukaryotic RNA polymerases: Classification and transcription units. Initiation at RNA pol I, II, and III promoters. Elongation and termination of eukaryotic transcription process. Post transcriptional modification of eukaryotic tRNA, and rRNAs, role of RNPs, RNase-P, polynuceotide kinase in modification. Post transcriptional modification of eukaryotic mRNAs; capping, and tailing. Intron splicing; Properties and role of snRNPs in splicing, mechanism of splicing by class-I (GU-AG), and class-II (GU-AC) introns, spliceosome, alternative splicing. 10 Hr

Genetic code: Genetic code and its significance. Deciphering of the genetic code; Nierenberg and Khorana's work. General features of genetic code. Mitochondrial genetic code. Co-linearity of genes and proteins. Coding properties of tRNA; wobble hypothesis. **Ribosomes:** Prokaryotic ribosomes;

molecular components, *in vivo* assembly, dissociation of subunits, and polysomes. Eukaryotic components and their assembly. Organelle ribosomes. 10 Hr

Translation: Initiation factors, elongation factors and termination factors of translation in prokaryotes and eukaryotes. Mechanism and process of protein synthesis in prokaryotes and eukaryotes; steps involved in protein synthesis, amino acid activation, exchange of ribosomal subunits, binding of mRNA to ribosomes, direction of protein synthesis and reading of mRNA. Protein chain initiation, elongation and termination. Comparative account of eukaryotic and prokaryotic translation. Inhibitors of prokaryotic and eukaryotic translation. Post-translational modifications of proteins. Synthesis of secretory and membrane proteins; signal sequence hypothesis. Mechanism of translational control. 14 Hr

REFERENCES

1) Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education; (2004).
2) Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
3) Molecular Biology, David Freifelder, Narosa Publishers, (1997).
4) Molecular Biology Robert F. Weaver, McGraw Hill (2012).
5) Microbial Genetics; Maloy et al., Jones and Bartlett Publishers, (1994).
6) Modern Microbial Genetics; Uldies N. Streips and Ronals E. Yasbin, Wiley Leis Inc. NewYork, (2002).
7) Molecular Cell Biology; Harvey Lodish 5th Edn. (2010)
8) Biochemistry 5thEdn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2011).
9) LEWINS Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barlett Publishers (2012).
10) Molecular Biology; Robert F. Weaver, McGraw-Hill (2012).
11) Molecular Biology; David Freifelder, J. (1997) Narosa publishers.
12) Nuclear Organization; Chromatin Structure and Gene Expression, Roen Van Driel and ArieP. Otte (1997) Oxford University Press.

CPT- 4.2: BIOCHEMICAL GENETICS AND GENE REGULATION (4 Credits: 64 h)

Genetics: Introduction, Nature of genetic material; Prion chromosomes and genes. Mutation, types of mutation, mutagens, mechanism of mutation, induction and isolation of mutants and their role in genetic studies. 4 Hr

Classical genetics: Review of classical genetics; work on *Pisumsativum*, *Drosophila melanogaster*, *Neurosporacrassa*etc. Inheritance (sex – linked and others), population genetics, extranuclear inheritance. Sex determination, Morgan's discovery of sex linked inheritance, pattern of inheritance of sex linked genes, X-linked traits in humans. Identification of sex chromosomes, XX, XY, mechanism of sex determination. 10 Hr

Bacterial genetics: Bacterial chromosome, plasmids; fertility, resistance, colicinogenic and others. Recombination in bacteria. Mechanism of recombination, transposable genetic elements, transformation and conjugation in bacteria. Linkage map of bacterial chromosomes. 9 Hr

Human Genetics: Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. Chromosome banding, Chromosome mapping based on recombination frequency data. Gene structure in eukaryotic organisms, introns, exons, pseudogenes, gene clusters, spacers, repetitive sequences and transposons. Overview of human genome project, mapping of human genes; techniques used, assignment of important genes. Transposition in human chromosomes. Chromosomal abnormalities. 9 Hr

Regulation of gene expression in prokaryotes: Principles of regulation of gene expression. Outline of transcriptional regulation, Induction, repression, constitutive/basal level expression. Genes involved in regulation; regulator, promoter, operator and structural genes- activators and repressors. Identification of control regions by DNase-foot printing, gel mobility assay methods. 7 Hr

The operon model; Regulation of gene expression at transcriptional level. Concept of positive regulation and negative regulation. Operon concept- study of structure and regulation of Lac operon, Jacob and Monod hypothesis- Catabolite repression; role of cAMP and cAMP-receptor protein (CRP/ CAP) in the expression of glucose-sensitive operons, structure and functions of CAP. Structure function and regulation of tryptophan operon in *E.coli*, Concept and process of negative regulation, repression and attenuation in tryptophan operon. Structure and regulation of arabinose operon, and histidine operon. Structure and functions of λ repressor, Cro, and λcII. Anti-termination as a mechanism of regulation. 12 Hr

Eukaryotic gene expression: Levels of control of gene expression in eukaryotes. Regulation of gene expression in yeast. Control of galactose genes in yeast. Regulation of gene expression- β-globin gene, DHFR gene. Histone modification. Brief study of regulation of developmental genes in Drosophila. 7 Hr

DNA binding protein motifs: Zinc finger, leucine zipper, helix-turn-helix and other motifs. **Regulation at the level of post translational modification:** proteins stability, N-end rule, PEST and other sequences, ubiquitin mediated degradation. 6 Hr

REFERENCES

1) Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley.
2) Concepts of Genetics by Klug, Cummings, Spencer and Palladino. 10th Edn. Pearson (2012).
3) Modern Genetic Analysis Anthony JF Griffiths, William M Gilbert, Jeffrey H Miller, and Richard C Lewontin. Pub. W. H. Freeman.

4) Genetics, Strick Berger, M.W. (1990) 3rd Edn. McMillan.
5) Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall.
6) Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
7) Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
8) Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., Garland Publications (2008).

SPT- 4.3.1: GENETIC ENGINEERING AND BIOTECHNOLOGY (4 Credits: 64 h)

Genetic Engineering: Extraction and purification of nucleic acids (DNA and RNA) from biological sources. Definition, aims and objectives of recombinant DNA technology, restriction-modification systems, restriction enzymes; type I, II and III, specificity, sticky ends and blunt ends, isoschizomers. 4 Hr

Gene Cloning: Basic principles and tools and techniques of gene cloning: Characteristics and applications of restriction endonucleases and modifying enzymes. Methods of Isolation of gene/ DNA fragment for cloning. Methods for gene cloning: *in vivo*- cloning in *E. coli*. *In vitro*- polymerase chain reaction. Characteristics and applications of Plasmid, Cosmid, Phagemid, M_{13}phage vector, λvector, BAC, PAC, and YAC. Selection of suitable vectors for cloning, expression and sequencing of DNA fragments. 10 hr

Ligation: Blunt end and sticky end ligation, use of linkers and adopters, homo polymer tailing, colony hybridization, plaque hybridization. 2 Hr

Transformation: Micro injection, electroporation, lipofection, calcium phosphate method, protoplast fusion/somatic cell hybridization and biolistic methods. Transgenic plants and animals, gene knock out. 4 Hr

Identifying the right clones: Direct screening; insertional inactivation of marker gene, visual screening, and plaque phenotype. Indirect screening; immunological techniques, hybrid arrest translation, hybrid select translation. Screening using probes; construction of gene probes, hybridization and labelling. 6 Hr

Techniques: DNA sequencing, shot gun and orderly sequencing, chromosome walking, PCR; analysis of products, nested PCR, applications of PCR in cloning, agriculture and medicine. RT-PCR technique and applications. Real time PCR for quantification. 6 Hr

Blotting techniques: Dot blot, Southern, Northern, Western blot, DNA finger print assay, gel retardation assay. 3 Hr

Applications: Gene therapy, applications in agriculture medicine, industry. GM foods, terminator gene, negative impact of genetic engineering. 3 Hr

Biotechnology: Industrial microorganisms and their characteristics, Primary and secondary metabolites. Fermenter: Design of batch fermenter, CSTR, semicontinuous and continuous feed-batch fermenters. Fermentation types. Bioprocess development. **Organism and strain improvement:** origin of industrial

strain, Isolation, and strain improvement. **Medium and growth conditions:** Raw materials and fermentation media, optimization of growth and culture conditions, growth Kinetics and product formation kinetics, Rheological parameters to be considered for scale-up of bioprocess from lab to industrial scale. Methods of cell Immobilization, Fed-batch and continuous fermentations by immobilized systems. Downstream process, Recovery and purification of products. 10 Hr

Production of amino acids- glutamic acid, and lysine, organic acids- acetic acid, citric acid, Itaconic acid. Health care products- vitamins, antibiotics. Alcohols- bioethanol, butanol. Acrylonitrile, biogas and Biopolymers. **Production of enzymes** (amylase, proteases, cellulases, xylanases,) from bacterial and fungal strains by solid-substrate and submerged fermentation. 8 Hr

Environmental and agriculture Biotechnology: Natural control of insect pests, Production of biopesticides. Development of specialized microorganisms for bioremediation of toxic environmental pollutants (PAHs, pesticides, industrial effluents). Bioremediation of toxic industrial pollutants and pesticide contaminated sites 8 Hr

REFERENCES

1) Genes VIII, Lewin, B, Publish Oxford University Press.
2) Principles of Gene Manipulation: An introduction to GE- Old, R. and Primrose, S.B. Blackwell Sci. Pub.
3) Molecular Biotechnology Glick, BR and Paternak, JJ. Publish ASM Press.
4) Molecular Biology of the Gene by Whatson JD, Losick R. Pub Pearson Education.
5) Molecular Cloning; A laboratory manual; Michael R. Green, CSHL Press (2012).
6) Molecular Cell Biology; Lodish et al., 7thEdn. W.H. Freeman and Co (2012).
7) Molecular Biology of the Cell; 7thEdn. Bruce Alberts et al., (2008), Garland Publications
8) Molecular Biology; Robert F. Weaver, McGraw Hill (2012).
9) Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell Publishing (2006).
10) Molecular biology and Biotechnology; 4th Edn., J.M. Walker and R. Rapley, RSC (2000).
11) Principles and Techniques of Biochemistry and Molecular Biology; 7thEdn. Keith Wilsonand John Walker (2010).
12) Industrial Microbiology: An introduction. By Michael J. Waites, Neil L. Morgan, John S. Rockey, Gary Higton. 2013, John Wiley & Sons.
13) Brock Biology of Microorganisms. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl. 2014, Pearson's MyLab & Mastering products

SPT- 4.3.2: BIOSTATISTICS, BIOINFORMATICS AND DRUG DISCOVERY

(4 Credits: 64 h)

Introduction to Biostatistics: Population, sample, sampling techniques, random sample, mean, median, mode, range, variance, coefficient of variation, frequency, standard deviation, standard error.

Representation of statistical data line graph, histogram, bar diagram, pie chart, scatter diagram. 9 Hr

Collection of data: Relevance of sample size. Sources, methods-questionairs, records, archives, scaling-Likert and Gutman. Validation and standardization of the methods, modification and experimental design. 7 Hr

Probability: Rules of probability, binomial distribution, normal distribution, area under the curve, Z value, choosing sample size, hypothesis testing, Student's t test. One way ANOVA, correlation and regression. 8 Hr

Bioinformatics: Introduction, scope and basic principles of bioinformatics. Bioinformatics programmes and languages, Scripts and scripting languages. Running programmes over internet, software downloading and installation, database management. 6 Hr

Biological databases: Contents, structure, annotation, file formats, annotated databases, genomes and organism specific databases. 4 Hr

Retrieval and analysis of biological data: Entrez and DBGET/Link DB, SRS. Searching sequence databases by similarities criteria (sequence search, amino acid substitution matrices), FASTA and BLAST searches. Sequence alignment, multiple sequence alignments, gene and protein families, and pattern data bases, protein domain families. 9 Hr

Microarray analysis: Methods, tools and resources: SAGE, proteomic data analysis, data from 2-D PAGE and protein mass spectra. 4 Hr

Drug Discovery: Use of literature and literature sources. Design of experiments, factorial experiments, randomization, interaction among factors. Types of studies: Cohort studies, double blind, placebo control, cross over and double dummy. Overview of some studies (UKPDS, CUPS, and Framingham). Clinical studies, toxicity studies, good laboratory practices, safe disposal of used and rejected samples and materials. 8 Hr

Discovering a drug: Proof of concept, target identification and validation, identifying the lead compound, optimization of lead compound, mechanism of action, drug target, validation of target, safety pharmacology, pharmaco-kinetics and pharmaco-dynamics, acute and chronic toxicity, CNS toxicity, hERG assay, in vitro and in vivo mechanism of action, DNA microarray and mechanism of action. 9 Hr

REFERENCES

1) Choosing and Using Statistics; A Biologist Guide, Clavin Dythan, Blackwell Scientific (1999).
2) Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998).
3) Statistics, Basic Concepts and Methodology for the Health Sciences Daniel WW, Pub Wiley India.
4) Biostatistics –Arora &Malhan, Himalaya Publishing House.

5) Introduction to Bioinformatics- Attwood T K and parry –smith, D.J. Pearson Education.
6) Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH.
7) Discovering Genomics, Proteomics and Bioinformatics – Campell & Heyer, Benjamin / Cummings pub.

CPP- 4.4(4.1): Molecular Biology (2 Credits: 32h)

1) Isolation of nuclei.
2) Isolation of chromosomal DNA and characterization.
3) Isolation and purification of plasmid DNA.
4) Agarose gel electrophoresis of plasmid DNA.
5) Isolation of mutants.
6) Effect of uv dose on survival rate of bacteria.
7) Assay of phosphatase,DNase and RNase.
8) Gene induction and repression beta-galactosidase activity in *E.coli.*
9) Isolation of auxotrophic mutants.
10) Ames Test.
11) Detection plasmid for antibiotic resistance.
12) Effect of UV dose on survival rate of bacteria.
13) Blue or white colony test for lac+/lac-

CPP- 4.5(4.2): Gene regulation and Genetics (2 Credits: 32h)

1) Gene induction and repression beta-galactosidase activity in *E.coli.*
2) Isolation of auxotrophic mutants.
3) Ames Test.
4) Detection plasmid for antibiotic resistance.
5) Effect of UV dose on survival rate of bacteria.
6) Blue or white colony test for lac+/lac-
7) Mounting of different stages of mitosis and meiosis.
8) Isolation of DNA from plant source.
9) Isolation of polythene chromosome from chironomus larva.
10) Staining of chromosomes.
11) Chromosomal abnormality identification.

SPP-4.6.1 (4.3.1): Genetic Engineering and Biotechnology (2 Credits: 32h)

1) Preparation of bacterial culture for plasmid DNA isolation
2) Isolation of plasmid DNA from bacterial cells
3) Characterization of plasmid DNA by UV spectroscopy
4) Agarose gel electrophoresis of plasmid DNA
5) Transformation of DNA by CaCl2 method.
6) Restriction digestion of isolated plasmid DNA.
7) Preparation of competent cells.
8) DNA ligation demonstration.
9) Animal cell culture demonstration.

SPP- 4.6.2(4.3.2): Biostatistics, Bioinformatics and Drug Discovery (2 Credits: 32h)

1) Biostatistics and Bioinformatics related problems will be worked out and demonstrations will be organized in the laboratory.
2) DNA ladder assay
3) Drug induced hemolysis.
4) Cytotoxicity assay
5) Neurotoxicity assay (Acetyl choline esterase)
6) Liver toxicity assay (SGOT and SGPT)
7) Kidney toxicity assay (Creatinine)

REFERENCES FOR BIOCHEMISTRY PRACTICALS

1) Basic Biochemical methods. R.R. Alexander, J.M. Griffith. 2nd Edn.Wiley-Liss publications.
2) Standard methods of Biochemical analysis. S.R.Thimmaiah. Kalyani publishers.
3) Practical Biochemistry. David Plummer. Tata McGraw-Hill publishing.
4) Introduction to practical Biochemistry. S.K.Sawhney and Randir Singh. Narosa Publishing house.
5) Biochemical methods. S.Sadashivam and A.Manikam. 2ndEdn.New Age International (p) Ltd. Press.
6) Modern Experimental Biochemistry - R. Boyer (Pearson Education).
7) Experimental Biochemistry- R.W. Switzer & L.F. Garrity (W.H. Freeman& Co.)
8) Practical Biochemistry - K. Wilson & J. Walker (Cambridge Univ. Press)
9) Laboratory Manual in Biochemistry - J. Jayaraman (Narosa Publishing House)
10) Practical Biochemistry - D.T. Plummer (TATA McGraw-Hill)
11) Practical Biochemistry - R.C.Gupta & S. Bhargava
12) Experimental Physiology and Biochemistry - P.V. Chadha
13) Experiments in Microbiology - Gilstrap-Kleyn-Nester
14) Experimental Biochemistry-A Student Companion - B.S. Rao & V. Deshpande, I.K.
15) Cell Biology: A laboratory hand Book. Vol-I. Julio E. Celis. Elsevier Publishing.
16) Biochemical Calculations, Irwin H.Segel (1976) 2nd Ed. John Wiley and Sons.
17) Methods in Enzymology; Colowick , S.P. et al., [Eds.] (1987) Vol. 152, Academic Press.
18) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn) Horwood Chemical Science Series.

THEORY QUESTION PAPER PATTERN

M.Sc. Biochemistry (CBCS Scheme)

Note: Answer Question No. 1 and any FOUR of the remaining.

Max. Marks = 80

1. Answer **any eight** the following questions 8 X 2 = 16

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.

2. (a) 16
   (b)

3. (a) 16
   (b)

4. (a) 16
   (b)

5. (a) 16
   (b)

6. Write short notes on any **FOUR** of the following 4 X 4 =16

   a) a.
   b) b.
   c) c.
   d) d.
   e) e**.**

***Note: Equal weightage to be given to each unit while preparing question paper**

PRACTICAL QUESTION PAPER PATTERN

Max. Marks = 40

1. Experiment and spotters 30 marks
2. Practical record 05 marks
3. Viva-voce 05 marks