

**BHARATHIAR UNIVERSITY: COIMBATORE – 641 046**

**M.Sc. BIOCHEMISTRY (UNIVERSITY DEPT.)**

(For the students admitted during the academic year 2016– 2017 batch & onwards)

**SCHEME OF EXAMINATION – CBCS Pattern**

Paper	Subject	Hrs / week	University Examination			TotalMar ks	Credits
			Dur/ Hrs.	INT.	EXT		
	SEMESTER I						
Paper-I	Biomolecules and Bioenergetics	4	3	25	75	100	4
Paper – II	Cell and Molecular Biology	4	3	25	75	100	4
Paper – III	Analytical Biochemistry	4	3	25	75	100	4
Paper – IV	Genetics and Developmental Biology	4	3	25	75	100	4
Elective – 1	Microbiology / Nutrition	4	3	25	75	100	4
Supportive-1	Offered from other Departments	2	2	12	38	50	2
Practical – I	Biochemistry, cell biology and microbiology	6	6	25	75	100	4
	SEMESTER II						
Paper – V	Enzymology	4	3	25	75	100	4
Paper – VI	Intermediary metabolism and Plant Biochemistry	4	3	25	75	100	4
Paper – VII	Human Physiology	4	3	25	75	100	4
Paper- VIII	Immunology	4	3	25	75	100	4
Elective – 2	Molecular Physiology	4	3	25	75	100	4
”	Nano science and Technology						
Supportive-2	Offered from other Departments	2	2	12	38	50	2
Practical –II	Enzymology and Immunology Lab	6	6	25	75	100	4
	Summer Training*	-	-	-	-	-	-
	SEMESTER III						
Paper IX	Clinical Biochemistry	4	3	25	75	100	4
Paper X	Recombinant DNA Technology	4	3	25	75	100	4
Paper XI	Pharmacology and Toxicology	4	3	25	75	100	4
Paper – XII	Biostatistics and Research Methodology	4	3	25	75	100	4
Elective -3	Bio-Informatics	4	3	25	75	100	4
”	Biology of Cancer and Stem cell						
Supportive- 3	Offered from other Departments	2	2	12	38	50	2
Practical- III	Clinical Biochemistry & Molecular Biology Lab	6	6	25	75	100	4
	Summer Training*			50		50	2
	SEMESTER IV						
	Industrial Visit**		-	50	-	50	2
	Project Work***		-	50	150	200	8
	Total					2250	90

\* **Summer Training:** All the students have to undergo summer training for period of minimum 30 days. Final reports have to submit which will be evaluated.

**\*\* Industrial visit:** Students have to undertake an industrial /institutional visit and have to submit report for evaluation

**\*\*\*Project work:** The report is the bonafied work carried out by the candidate under the guidance of a faculty authenticated and countersigned by the HOD. This project work must be presented and defended by the candidate in the department attended by all faculties and reviewed by external examiner.

Candidate who has presented the work as „Not qualified as per CBCS“ must resubmit the project again in the ensuing academic year.

#### **SUPPORTIVE PAPERS OFFERED FOR OTHER DEPARTMENT STUDENTS**

Paper I : Tools and Techniques in Bioscience  
Paper II : Medical Lab Technology  
Paper III : Clinical Diagnosis in health and disease

## BIOMOLECULES AND BIOENERGETICS

### Paper-I

**Unit-I:** Water - Unique properties, weak interactions in aqueous systems, ionization of water, buffers. Classification, chemical properties of carbohydrates, Chemistry and biological roles of homo and heteropolysaccharides. Structural elucidation of polysaccharides; Oligosaccharides – lectin interaction in biochemical processes. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides).

**Unit-II:** Classification of Lipids, Biological significance of lipids, Fatty acids and their physiochemical properties. Structure and properties of Prostaglandins. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Lipids as signals, cofactors and pigments.

**Unit-III:** Amino acids – classification, structure and physiochemical properties, chemical synthesis of peptides – solid phase peptide synthesis. Proteins – classification, purification, and criteria of homogeneity. Structural organization, sequence determination and characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins.

**Unit-IV:** Nucleotides- structure and properties, physicochemical properties of nucleic acids, cleavage of nucleic acids by enzymatic methods, non – enzymatic transformation of nucleotides and nucleic acids, methylation, Sequencing, chemical synthesis of DNA. Three dimensional structure of DNA. Different forms of DNA – circular DNA and Supercoiling. Types of RNA. Structure of t-RNA. Nucleotides as source of energy, component of coenzymes, second messengers. Porphyrins – Structure and properties of porphyrins – heme , Chlorophyll and Cytochromes.

**Unit-V:** Principles of thermodynamics, free energy, enthalpy and entropy, Free energy changes in biological transformations in living systems. Redox potential, phosphate group transfer potential and ATP, High-energy compounds, oxidation and reduction reactions. Mitochondrial electron transport system – organization of components and importance. Substrate level phosphorylation, oxidative phosphorylation, Respiratory control, Mechanism and theories of oxidative phosphorylation. Respiratory chain inhibitors and uncouplers of oxidative phosphorylation.

### Reference Books:

1. Principles of Biochemistry, Lehninger C Rs. Publ. (1982).
2. Biochemistry, L. Stryer, W.H. Freeman, San Francisco.
3. Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W. Kuchel and G.B. Ralston. Int. Ed., McGraw-Hill Book Co.
4. Problem Approaches in Biochemistry. Wood and Hood.
5. Biochemistry by Voet and voet 6. Biochemistry by Zubay

## CELL AND MOLECULAR BIOLOGY

### Paper-II

**Unit-I:** Structure and function of cells – prokaryotes and eukaryotes, difference, Structure and organization of membrane – structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes. Extracellular matrix, cell-cell communication.

**Unit-II:** Plasma membrane, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility and Mechanism of cell division: Mitosis; meiosis and genetic recombination; regulation of cell cycle; factors and genes regulating cell cycle.

**Unit-III:** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extra chromosomal replicons, and DNA damage and repair mechanisms.

**Unit-IV:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation RNA transport. gene regulation – lac and trp operon.

**Unit-V:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proof-reading, translational inhibitors, post- translational modification of proteins.

### Reference Books:

1. Molecular and Cell Biology – Baltimore
2. Molecular Cell Biology – Darnell et al.
3. Biochemistry – Lehninger, Cox, Nelson
4. Biochemistry – Cohn and Stum.

## ANALYTICAL BIOCHEMISTRY

### Paper-III

**Unit-I:** Light microscope, Fluorescence microscope, Phase contrast microscope, Electron microscope, Confocal microscopy. Centrifugation: Small bench top centrifuges, large capacity refrigerated centrifuges, High speed refrigerated centrifuges, preparative and analytical ultra centrifuge. Electrochemical techniques: Principles of electrochemical techniques, redox reactions, the pH electrode, ion-sensitive and gas-sensitive electrodes, The Clark oxygen electrode, Biosensors. Spectrophotometry: visible and UV spectrophotometry.

**Unit-II:** Principles of chromatography, size exclusion, Ion-exchange and affinity chromatographies. High performance liquid chromatography (HPLC), Gas liquid chromatography (GLC), Thin layer chromatography (TLC), Paper chromatography, GC-MS, LC-MS, MaldiTof, ICPMS.,

**Unit-III:** Spectroscopic techniques: Properties of electromagnetic radiation, interaction with matter. Gamma ray spectroscopy, X-ray spectroscopy, UV and Visible spectroscopy, Infrared and Raman spectroscopy, Electron spin resonance spectroscopy, Nuclear magnetic resonance spectroscopy, Circular dichroism spectroscopy, Atomic absorption spectroscopy. Lasers, Spectrofluorimetry, turbidometry and nephelometry.

**Unit-IV:** Radio isotope techniques: The nature of radioactivity, detection and measurement of radioactivity: detection based on gas ionization- Geiger Muller counter- principles and applications. Detection based on excitation- Liquid Scintillation counter-principle and applications. Supply, storage and purity of radiolabelled compounds, specific activity, inherent advantages and restrictions of radiotracer experiments, safety aspects, applications of radio isotopes in biological sciences. Flowcytometry, ELISA, immunoblotting.

**Unit-V:** Electrophoresis: General principles, Electrophoresis of proteins: SDS-PAGE, Native gels, Gradient gel, Isoelectric focusing, 2-D gel electrophoresis (2-D PAGE), cellulose acetate electrophoresis, continuous flow electrophoresis; Detection, estimation and recovery of proteins, Western blotting. Electrophoresis of nucleic acids: agarose gel electrophoresis of DNA, DNA sequencing gels, Pulse field gel electrophoresis, electrophoresis of RNA, Capillary electrophoresis.

### References:

1. Keith Wilson and John Walker. Practical Biochemistry- principles and techniques; Cambridge University press, London, UK.
2. David T Plummer, Tata McGraw- Hill publishing company limited; McGraw office, New Delhi.
3. C.R. Kothari, 2<sup>nd</sup> Edition, 2004. Research methodology- methods and techniques. New Age International (P) limited publishers, New Delhi.
4. Instrumental methods of chemical analysis – P.K. Sharma
5. Biophysical chemistry – Upadhyay., Upadhyay and Nath
6. A Biologist's guide to principle and techniques of practical biochemistry – Brian L. Williams.
7. Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill

## GENETICS AND DEVELOPMENTAL BIOLOGY

### Paper-IV

**Unit-I:** Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Environmental effects and twin studies; human intelligence. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; Extra chromosomal inheritance.

**Unit-II:** Prenatal diagnosis of genetic diseases- amniocentesis, karyotyping, DNA/RNA probes. DNA probes in the diagnosis of infectious diseases; Tuberculosis, Malaria, Chagas disease, AIDS, HPV, Lymph disease and periodontal diseases. DNA probes in diagnosis of genetic diseases: Cystic fibrosis, Sickle cell anemia, Cancer(breast cancer, Leukaemia, Burkets lymphoma).

**Unit-III:** Gametogenesis – Origin of germ cells – Significance of gametogenesis Oogenesis – Types of eggs–growth, development and maturation of oocyte, Egg envelopes, Polarity and symmetry, Spermatogenesis–Sperm Structure, Types of sperm, Fertilization – Approach of spermatozoon–Reaction of egg, essence of activation – Changes in egg cytoplasm caused by fertilization.

**Unit-IV:** Cell division in cleavage – Chemical changes–Patterns of embryonic cleavage – Morula and Blastula – Role of egg cortex – Morphogenetic gradients – Fate map – Gastrulation – Primary organ, Rudimental organs, Organizer – Morphogenetic movements.

**Unit-V:** Organogenesis: Induction and differentiation of Brain, eye, ear, limb, Heart, kidney, Development of Immune system, Chemical basis of differentiation – selective action of genes–gene action in development – Nuclear transplantation–cell death in development– aging–Teratogenesis.

### Reference Books:

1. Developmental Biology, Berrill N.J., 1974, TMH Edition
2. Animal Regeneration, Diwan A.P., Dhakad N.K., 1996, Anmol Publications Ltd
3. Developmental Biology, Browder L.W., Erickson C.A., And Jeffery W.R, 1991 Saunder College Publishing House, Philadelphia.
4. Genetics, 3rd edition, 2002, Strickberger, Prentice Hall of India
5. Genes VII, Benjamin Lewin, 2000, Oxford University Press
6. Genetics, Sarin C, 1990, Tata McGraw–Hill Publishing Co., Ltd., New Delhi
7. Genetics, Gupta PK., 1996, Rastogi Publications, Meerut, India.

## MICROBIOLOGY

**Elective-Unit-I:** Microbiological techniques: Culture techniques: Isolation of microbes from various sources, serial dilution techniques, pure culture techniques, Anaerobic culture methods – chemical and physical methods. Culture preservation techniques. Nutritional requirements: - different kinds of media, composition of media-carbon sources, nitrogen sources, vitamin and growth factors, mineral, inducers, precursors and inhibitors. Sterilization methods. Anaerobic fermentation- Alcoholic fermentation, propionic acid fermentation, formic acid fermentation.

**Unit-II:** Energy from inorganic compounds - ET in chemolithotrophs, production of reducing power in chemolithotrophs; Energy from visible radiation – photosynthesis in eukaryotes, blue-green algae, bacteria. Energy from aromatic compounds – two carbon compounds, one carbon compounds, endogenous reserve polymers). Energy from hydrocarbons – alkanes, alkenes, acyclic aromatic hydrocarbons.

**Unit-III:** Food poisoning – Food borne diseases- Bacterial and Non- Bacterial. Microbial quality and safety – Determining microorganisms in food culture, Microscopy and sampling methods – Chemical and immunological methods. Principles of food preservations: Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives.

**Unit-IV:** Medical Microbiology - Infectious Diseases process – Diagnosis – Process of sample collection, transport and examinations of the specimens. Antibigram. Bacteriology: Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of Gram positive organisms - *Staphylococcus aureus*, *Mycoplasma*; Gram negative organisms: *E.coli*.

**Unit-V:** Pathogenicity And Laboratory Diagnosis : Virology -Basic concepts of virology - General properties of Human viruses, Approaches to viral diagnosis- Serological and Molecular techniques of viral infections - Hepatitis, Polio, Ebola, SARS. Mycology: General properties and approaches to laboratory diagnosis. Mycosis – Superficial, Subcutaneous and Systemic infections –*Candida albicans*. **Parasitology:** Pathogenicity and laboratory diagnosis of *Entamoeba histolytica*, *Plasmodium vivax*.

### Reference Books:

1. Microbiology by Pelczar M.J., Ried, RD and Chan, ECS
2. Principles of Fermentation Technology – By Standby and Wittaker , second Edition.
3. Chemical microbiology – An introduction to microbial physiology – AH Rose, Butterworth, London
4. Microbial Physiology – S. Meenakumari
5. Brock Biology of Microorganisms – 10<sup>th</sup> edition – MT Madigan, JM Martinko & Jack Parker, Pearson and Education Inc., New Jersey
6. Medical Microbiology, Vol. 1: Microbial Infection, Vol. 2: Practical Medical Microbiology, - Mackie and McCartney.
7. Food Microbiology by Frazier
8. Basic food microbiology (Abridged edition) by George J. Banwart.
9. Text Book of Microbiology by Ananthanarayanan and Jayaram Paniker

## NUTRITION

### Elective-1

**Unit-I:** Composition of human body. Energy content of foods. Measurement of energy expenditure: direct and indirect calorimetry. Definition of BMR and SDA and factors affecting these. Carbohydrates – Dietary requirements and sources of available and unavailable carbohydrates. Physico-chemical properties and physiological actions of unavailable carbohydrates (dietary fibre). Lipids – Major classes of dietary lipids. Properties and composition of plasma lipoproteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

**Unit-II:** Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for men and concept of protein quality. Cereals proteins and their limiting amino acids. Protein requirements at different stages of requirement. Protein energy malnutrition, clinical features, metabolic disorders and management of marasmus and Kwashiorkor diseases: starvation – Techniques for the study of starvation. Protein metabolism in prolonged fasting. Proteins during treatments during fasting. Basic concepts of high protein and low calorific weight reduction diets.

**Unit-III:** Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water soluble vitamins. Hyper vitaminosis, Symptoms of fat-soluble vitamins. Nutrition requirements during pregnancy, lactation and of infants and children. Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

**Unit-IV:** Role of diet and nutrition in the prevention and treatment of diseases: Dental caries, Fluorosis, Renal failure, Hyperlipidemia, Atherosclerosis & Rheumatic disorders, Inherited metabolic disorders: Phenylketonuria, Maple syrup diseases, Hemocystinuria, Galactosemia, Gout, Diabetes Insipidus and Diabetes Mellitus.

**Unit-V:** Types of diagnosis and management of allergy. Naturally occurring food borne toxicants: protease inhibitors, haemoagglutinins, Hepatotoxins, Allergens, Oxalates, Toxins from mushrooms, animal food stuffs and sea foods.

### References Books:

1. Nutrition: An integrated approach (3<sup>rd</sup> edition 1984) R.L. Pike and M.L. Brown, Wiley & Sons Inc., NY
2. Text Book of Biochemistry and Human Biology G.P. Talwar Prentice Hall
3. Mechanism and Theory in Food chemistry (1996) DWS Wong, CBS, New Delhi
4. Text Book of Human nutrition (1996) M.S. Bamji N. Pralhad Rao and V. Reddy, Oxford & IBH publishers
5. Nutritional Biochemistry and metabolism. Maria C. Linder
6. Principles of Food Science – I (Food Chemistry) Fennemona D.R.
7. Human Nutrition and Dietetics (8<sup>th</sup> Ed. 1982) by Davidson and Passmore ELBS
8. Modern Nutrition in Health and Diseases (7<sup>th</sup> Ed. 1988) by Maurice E Skills and V. R. Young K.M. Varghese Co. Bombay.
9. Nutritional Biochemistry. S. Ramakrishnan and S. Venkat Rao, T.R. Publications, 1995.
10. Antinutrients and natural toxicants in foods. Robert L. Ory, Food & Nutrition Press, 1981.



## **BIO-CHEMISTRY, CELL BIOLOGY & MICROBIOLOGY**

### **Practical - I**

#### **Bio-chemistry**

1. Estimation of reducing sugar.
2. Estimation of lipids.
3. Separation of amino acids using paper chromatography.
4. Separation of amino acids and lipids using thin layer chromatography (TLC).
5. Separation of two proteins using column chromatography.
6. Estimation of proteins using Bradford and Lowry's methods.
7. Estimation of DNA using DPA.
8. Estimation of RNA using Orcinol reagent.
9. Estimation of sugar by Phenol- Sulfuric acid / Anthrone method.
10. Estimation of Tyrosine by Million's method.
11. Estimation of Lysine

#### **Cell biology**

1. Squash preparation of giant chromosome of salivary gland of chironomous larva.
2. Squash preparation of onion root tip and anther lobes.
3. Preparation of buccal smear.
4. Determination of apoptosis by Staining method.

#### **Microbiology**

1. Preparation of culture media- Nutrient Broth, Nutrient Agar, Blood Agar, Macconkey Agar, Potato Dextrose Agar.
2. Isolation of bacteria from soil and air.
3. Staining techniques – simple, differential and special staining, streaking method.
4. Plotting of bacterial growth curve.
5. IMVIC test.
6. Motility of bacteria by hanging drop method.
7. Assay of antibiotics by disc diffusion method.
8. Bacteriological examination of water / Industrial effluents.
9. Isolation of Phage from sewage water and plaque forming unit.

#### **Reference Book:**

1. Experimental Biochemistry: A Student companion- Sashidhar Rao, B and Deshpande, V. IK International (P) Ltd.
2. Experiments and Techniques in Biochemistry: by Sheel Sharma, Galgotia publications.
3. Industrial Microbiology by Casida, LE Industrial Microbiology by Patel.
4. AH Industrial Microbiology by Miller.
5. BM and Litsky Industrial Microbiology by Prescott
6. Dunn Microbial Technology by Peppler, JH and Perlman, D

## ENZYMOLGY

### Paper-V

**Unit-I:** Introduction to Enzymes- Nomenclature and classification of enzymes. Specificity and active site. Fundamentals of enzyme assay – enzyme units, coupled kinetic assay, immobilized enzymes. Enzyme localization. Criteria of purity of enzymes. Monomeric and oligomeric enzymes- Monomeric enzymes; serine proteases, zymogen activation, multifunctional enzymes, oligomeric enzymes and multi- enzyme complexes.

**Unit-II:** Kinetics of enzyme-catalyzed reactions-Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies, rapid reaction techniques and relaxation technique. Enzyme kinetics of single substrate reactions – Michaelis-Menten and Briggs and Haldane theory (rapid equilibrium and steady state theory). Kinetic data evaluation-linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Integrated velocity equation. Haldane equation. King-Altman procedure for deriving the rate equation. Effect of pH & temperature on enzymatic reactions, Arrhenius plot, determination of activation energy.

**Unit-III:** Mechanism of Enzyme Action – Acid-base catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, glyceraldehyde 3-phosphate dehydrogenase, aldolase, carboxypeptidase, triose phosphate isomerase and alcohol dehydrogenase.

**Unit-IV:** Enzyme Regulation – General mechanisms of enzyme regulation, product inhibition. Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. Feed back inhibition and feed forward stimulation. Allosteric enzymes, qualitative description of “concerted” & “sequential” models for allosteric enzymes. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase & phosphofructokinase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

**Unit-V:** Application of enzymes in food, Pharmaceutical, pulp, textile and other industries; diagnostic & therapeutic applications. Immobilized enzymes-Techniques of enzyme immobilization; applications of immobilized enzymes.

### References Books:

1. Fundamentals of Ezymology; 3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
2. Enzymes; Trevor Palmer, East – West Press Pvt. Ltd., Delhi (2004).
3. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis; Robert A. Copeland , Wiley-VCH Publishers (2000).
4. Enzyme Kinetics and Mechanism; Paul F. Cook, W. W. Cleland, Garland Science (2007).
5. Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
6. Methods in Enzymology; Colowick S.P. et al., Vol. 152, Academic Press, (1987).
7. Methods of Enzymatic Analysis; Berg Meyer Vol. 1-X, (1974).

8. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack (1995) Oxford University.
9. Enzyme Kinetics; Roberts, D.V. (1977), Cambridge University Press.
10. The Enzymes; Boyer, Academic Press, (1982).
11. Enzyme Kinetics; Irwin H. Segel (1976) Interscience-Wiley.
12. Enzyme Kinetics; the Steady state approach; Engel, P.C. (1981) 2nd Edn. Champman and Hall.
13. Nature of Enzymology; Foster, (1980), Croom Helm.
14. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.
15. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn) Horwood Chemical Science Series.
16. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), Blackwell Science.
17. An Introduction to Enzyme and Coenzyme Chemistry; Timothy B. Bugg, (1997) Jones

## INTERMEDIARY METABOLISM AND PLANT BIOCHEMISTRY

### Paper-VI

**Unit-I:** Intermediary metabolism of carbohydrates - Reactions, energetics and regulation of glycolysis; Feeder pathways for glycolysis; Fate of pyruvate under aerobic and anaerobic conditions; Pyruvate dehydrogenase complex and its regulation; Reactions, regulation and amphibolic nature of TCA cycle; Anaplerotic reactions; Glyoxalate cycle; Poylol pathways; Pentose phosphate pathway; Gluconeogenesis; Cori cycle; Biosynthesis of lactose, sucrose and starch; Glycogenesis and Glycogenolysis; Control of glycogen metabolism;

**Unit-II:** Metabolism of Lipid - Fatty acid oxidation - Franz Knoop's experiment;  $\beta$ -oxidation of saturated, unsaturated and odd carbon fatty acids; Peroxisomal  $\beta$ -oxidation;  $\alpha$ - and  $\omega$ - oxidations of fatty acids; Ketone bodies – Formation and utilization; Biosynthesis of saturated fatty acids; Elongation and desaturation of fatty acids; Triacylglycerols – Biosynthesis, and mobilization from adipose tissue; Regulation of fatty acid metabolism; Cholesterol biosynthesis and its regulation; Biosynthesis of phosphoglycerides and sphingolipids.

**Unit-III:** Protein, amino acid and nucleotides metabolism-Degradation of amino acids oxidative and nonoxidative deamination, transamination, decarboxylation, detoxication of ammonia, catabolism of carbon skeletons of amino acids - ketogenic and glucogenic amino acids -nitrogen balance conversion of amino acids to specialised products. Biosynthesis of purines and pyrimidines- De novo and salvage pathways and their regulation. Catabolism of purines and pyrimidines. Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides and deoxyribonucleotides. Overview of metabolism of Porphyrins, Biosynthesis and degradation of heme.

**Unit-IV:** Photosynthesis –organization of thylakoid; role of photosynthetic pigments; light absorption and energy conservation. Light absorption by pigment molecules; the reaction centre complex. The photo systems I and II; cyclic and noncyclic photophosphorylation. Carbon reactions in C<sub>3</sub>, C<sub>4</sub> and CAM plants - Calvin cycle; Hatch-Slack pathway. pathways of glucose oxidation in plants; starch biosynthesis and degradation; .Photorespiration: role of photorespiration in plants.

**Unit-V:** Nitrogen fixation – symbiotic and non-symbiotic. Symbiotic nitrogen fixation in legumes by Rhizobia– enzymology of nitrogen fixation; regulation of nif and nod genes of nitrogen fixation. Interaction between nitrate assimilation and carbon metabolism. Sulphur chemistry and functions; reductive sulfate assimilation pathway. Synthesis and function of glutathione and its derivatives. Metabolic transport between organelles.

### Reference Books:

1. Principles of Biochemistry - L. Stryer (W.H. Freeman & Co.)
2. Principles of Biochemistry - A.L. Lehninger, D.W. Nelson & M.M. Cox (Macmillan)
3. Biochemistry - D. Voet & J.G. Voet (John Wiley)
- 4 Harper's Illustrated Biochemistry - R.K. Murray et al. (McGraw Hill).

## HUMAN PHYSIOLOGY

### Paper-VII

**Unit-I:** Composition and functions of blood and plasma. Blood volume, blood volume regulation, immunity, haemostasis, blood groups. Haemopoiesis. Blood coagulation - mechanism, fibrinolysis, anticoagulants. Hemoglobin - structure, abnormal types, anemia, Blood corpuscles.

**Unit-II:** Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above.

**Unit-III:** Digestive secretions - composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestions and absorption of carbohydrates, lipids, proteins and nucleic acids. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance, acid-base balance.

**Unit-IV:** Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Muscle physiology.

**Unit-V:** Exo and Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, neuroendocrine regulation.

### Reference Book:

1. Review of Medical Physiology by William. F. Ganong. McGraw-Hill Medical; 22 edition (2005)
2. Human Physiology and Mechanisms of Disease by Guyton. Saunders Publications; 6th edition (1996)
3. Human physiology by C.C. Chatterjee. 11th edition (1985).

## IMMUNOLOGY

### Paper-VIII

**Unit-I:** Cells of the immune system-Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. Organs of the immune system: Thymus, Bone marrow, Spleen, lymph nodes, MALT, GALT. Haemopoiesis and differentiation, lymphocyte trafficking. Antigen- biology, structure and functions of different classes of Immunoglobulin. Biology of Superantigens.

**Unit-II:** Antigen antibody reactions, Applications of Immunological techniques, genetic control of immune response, effector mechanisms, MHC, antigen recognition and presentation, activation of B and T lymphocytes.

**Unit-III:** Humoral and cell mediated immunity. Cell mediated Cytotoxicity: Mechanism of T cell and NK Cell mediated lysis, Antibody dependent cell mediated Cytotoxicity and macrophage mediated Cytotoxicity. Cytokines and their role in immune regulation, Biology of Complement system, Complement fixation test and assessment of immune complexes in tissues. Immune suppression and immune tolerance.

**Unit-IV:** Hyper sensitivity reactions, Autoimmune disorders, Transplantation immunology- MLR, HLA Typing, Bone marrow transplantation, Organ transplants. Immunity to Infectious agents - Bacteria, Viruses, Malaria, and Helminthes. Tumor immunology, Tumor antigens, immune response to tumors, cancer immunotherapy, Vaccines. AIDS and other immunodeficiencies, Structure of HIV, envelope glycoproteins, destruction of T cells: immunologic symptoms of AIDS, AIDS vaccine.

**Unit-V:** Vaccine technology and recombinant vaccines, Identification of B and T epitopes for vaccine development. *In situ* characterization of cells from tissues, Immunoscreening of Recombinant library, Hybridoma – Monoclonal Antibody production and applications ; MAbs in diagnosis and therapy.

### References Books:

1. J.Kuby, 2003, Immunology 5<sup>th</sup> edition , W.H. Freeman and Company, Newyork..
2. C.V.Rao. 2002, An Introduction to Immunology, Narosa Publishing House, Chennai.
3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
4. I.R.Tizard, 1995, Immunology: An Introduction , 4<sup>th</sup> edition , Saunders College Publishers, New York.
5. I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.  
A. Bul and K.Abbas, 1994, Cellular and Molecular immunolog

## MOLECULAR PHYSIOLOGY

### Elective-2

**Unit-I:** Signaling Components: Endocrine, Paracrine and Autocrine signaling; Signaling molecules- Hormones (agonists and antagonists) NO; Receptor Classification: Receptor linked to Trimeric G proteins (G proteins linked Receptors), Receptors with intrinsic or associated enzymic activity (TGF- $\beta$ , cytokine, Receptor Tyrosine kinase, Receptor guanylyl cyclase, Receptor Phosphotyrosine phosphatase, T-Cell Receptor), Ion Channels as receptors, receptors involving proteolysis (Wnt, Hedgehog Hh, Notch/ Delta, NF - $\kappa$ B), intracellular receptor (NO. Pathway, Nuclear receptor). Membrane anchoring process - myristoylation, palmitoylation, Farnesylation, Geranylation, GPI anchor.

**Unit-II:** Nuclear Receptors: Principle of signaling with nuclear receptors, classification and structures; Transcriptional regulation by nuclear receptors-coactivators, co-repressors; Regulation and variability of signaling; Signaling pathways via steroids hormones receptors, Nuclear localized (retinoid, vit D3 and T3 hormones).

**Unit-III:** G Protein Coupled Signal Transmission: GPCR Structure and classification, ligand binding domain; Signaling pathways via cAMP, ion Channel regulation, Phospholipase C; Trimeric and monomeric G proteins and their effectors; Regulation - GTPase super family and GTP hydrolysis; Regulation of GPCR signaling - GDP-GTP cycling, GTPase activity, phosphodiesterase activity, feedback inhibition, heterologous desensitization, phosphorylation of receptors,  $\beta$ -arrestin in regulation of GPCR.

**Unit-IV:** Signaling Pathway That Control Gene Activity: TGF $\beta$  Receptors and Smad activation ;cytokine receptors and JAK -STAT pathway; RTK and Ras activation; MAP Kinase pathways; phosphoinositides as signal transducers; Signal induced protein cleavage (NF- $\kappa$ B, Notch /Delta, Wnt, Hedgehog).

**Unit-V:** Integration Of Signals And Gene Controls: Responses of cells to environmental influences control of cell fates by graded amounts of regulators, boundary creation by different combination of transcription factors; Boundary creation by extra cellular signals; Reciprocal induction and lateral inhibition; Integrating and controlling signals; Down modulation of receptor signaling.

### Reference Books:

1. Biochemistry of signal transduction and regulation. Gerhard krauss, III edition Wiley VCH GmbH &co, (2003).
2. Molecular Cell Biology – Lodish et al. 2004. W.H Freeman & Co., New York

## NANOSCIENCE AND TECHNOLOGY

### Elective-2

**Unit-I:** Introduction to Nanoscience and Nanotechnology; Milestones in Nanotechnology; Overview of Nanobiotechnology and Nanoscale processes; Physicochemical properties of materials in Nanoscales. Polymers in nano material synthesis- natural and synthetic polymers.

**Unit-II:** Types of Nanomaterials (Quantum dots, Nanoparticles, Nanocrystals, Dendrimers, Buckyballs, Nanotubes); Gas, liquid, and solid phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.

**Unit-III:** characterization of Nano material; Absorption, Fluorescence, and Resonance; Microscopy measurements: SEM, TEM, AFM and STM. Confocal and TIRF imaging.

**Unit-IV** Reactive groups on biomolecules (DNA & Proteins); Surface modification and conjugation to nanomaterials. Fabrication and application of DNA nanowires; Nanofluidics to solve biological problems. Bio mimics

**Unit-V:** Properties of nanocarriers; drug delivery systems used in nanomedicine; Enhanced Permeability and Retention effect; Blood-brain barrier; Active and passive targeting of diseased cells; Health and environmental impacts of nanotechnology.

### Reference Books:

1. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor) , Wiley-VCH; 1 edition , 2004.
2. NanoBioTechnology: BioInspired Devices and Materials of the Future by Oded Shoseyov and Ilan Levy, Humana Press; 1 edition 2007.
3. NanoBiotechnology Protocols (Methods in Molecular Biology) by Sandra J Rosenthal and David W. Wright , Humana Press; 1 edition, 2005.
4. Bio-Nanotechnology\_ Concepts and applications. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza, Ane Books Pvt Ltd, 1 edition 2012
5. Microscopy Techniques for Material Science. A. R. Clarke and C. N. Eberhardt (Editors) CRC Press. 1st Edition, 2002.



## IMMUNOLOGY AND ENZYMOLOGY LAB

### Practical-II

#### Immunology

1. Immunodiffusion – single radial and double diffusion
2. Immunoelectrophoresis
3. Rocket immunoelectrophoresis
4. Haemagglutination and passive hemagglutination
5. Identifying blood group and Rh typing
6. ELISA-Direct and Indirect
7. Isolation and purification of IgG from serum
8. Dissection and identification of Thymus, Spleen, Lymph node from rat.

#### Enzymology

1. Isolation and Purification of Salivary Amylase enzyme.
2. Determination of total and specific activity of salivary amylase.
3. Effect of pH on enzyme activity (Acid phosphatase/Alkaline phosphatase).
4. Effect of temperature on enzyme activity (ACP/ALP) and determination of activation energy.
5. Effect of substrate concentration on enzyme activity (Salivary Amylase) and determination of Km value.
6. Effect of inhibitor on activity of Salivary Amylase.
7. Assay of lactate dehydrogenase (LDH).
8. Isoenzyme analysis (LDH) from serum sample- Native PAGE.

#### Reference Books:

1. Experimental Biochemistry- R.W. Switzer & L.F. Garritty (W.H.Freeman & Co.)
2. Modern Experimental Biochemistry - R. Boyer (Pearson Education)
3. Practical Biochemistry - K. Wilson & J. Walker (Cambridge Univ. Press)
4. Laboratory Manual in Biochemistry - J. Jayaraman (Narosa Publishing House)
5. Practical Biochemistry - D.T. Plummer (TATA McGraw-Hill)
6. Practical Biochemistry - R.C.Gupta & S. Bhargava
7. Experimental Physiology and Biochemistry - P.V.Chadha
8. Experiments in Microbiology - Gilstrap-Kleyn-Nester
9. Experimental Biochemistry – A Student Companion - B.S. Rao & V. Deshpande, I.K. Interational Pvt. Ltd. (N. Delhi, Mumbai, Bangalore) 2005.
10. K. Wilson and J. Walker (ed.), Practical Biochemistry, Principles and Techniques, Cambridge University Press, 1995.
11. R. Boyer, Modern Experimental Biochemistry, 3<sup>rd</sup> Ed., Pearson Education (Singapore) Pvt. Ltd., 2001.
12. R. L. Switzer and L. F. Garritty, Experimental Biochemistry, 3<sup>rd</sup> Ed., W. H. Freeman, 1999.

## CLINICAL BIOCHEMISTRY

### Paper-IX

**Unit- I:** Clinical investigation of sugar levels in blood and urine; factors influencing blood glucose level; carbohydrate tolerance tests-procedures and interpretation, biochemical basis of Diabetes, glycogen storage diseases; carbohydrate metabolic disorders. Biosynthesis of bile acids, bile pigments and steroid hormones, plasma lipoproteins, Disorders associated with lipid metabolism and its therapeutic intervention, ketone bodies and ketosis; Fatty liver, Atherosclerosis, biochemical basis of Jaundice.

**Unit II:** Hemoglobin, Met-Hb, embryonic-Hb, heme metabolism associated Diseases, sickle cell anemia, thalassemia, metabolic disorders of amino acid metabolism and urea cycle, phenylketonuria, Alkaptonuria, Albinism, Lesch-Nyhan syndrome.

**Unit-III:** Disorders of nucleic acids metabolism, Biochemistry of cancer, carcinogens; oncogenes, protooncogenes and tumor suppressor genes; metastasis and cancer stem cells; anticancer drugs and their mechanism of actions, Resistance against anticancer drugs and cancer therapy. Biochemical mechanism of blood Clotting and hemorrhagic disorders, disseminated intravascular coagulation, anticoagulants, acquired prothrombin complex disorders. Biochemistry of vitamins and micronutrients, and their deficiency.

**Unit-IV:** Functional test of liver, kidney, thyroid, gastrointestinal and pancreas, biochemical diagnosis of diseases by enzymatic assays-ALP, SGOT, SGPT, Creatinine, cholinesterase, Creatine kinase and LDH. Electrolytes, reabsorption of electrolytes, metabolism of iron, calcium and phosphorus, acid-base balance, regulation of electrolyte content of body fluids and maintenance of pH, disorders of acid base balance.

**Unit-V:** Metabolism of Xenobiotics, phase I and Phase II transformation reactions, basic component of Cytochrome P450 systems and its role in xenobiotic metabolism. Disorders of nitrogen metabolism - Assimilation and excretion of nitrogen with reference to ammonia, urea, uric acid, creatine, creatinine - excretion of nitrogenous waste products - abnormalities of nitrogen metabolism including uremia, porphyrias, porphyrinurias, aminoaciduria - factors affecting nitrogen balance.

### Reference Books

1. Clinical Chemistry in Diagnosis and Treatment. - Ziwa J.F.P Peter, Mayne P.D.
2. Medical Biochemistry – A.C Deb
3. Medical Biochemistry - M.N. Chatterjee, Shinde
4. Textbook of Biochemistry for Medical Students. by Dr. D.M. Vasudevan and Dr. Sreekumari.
5. Metabolic control and disease – Ed. Roxenburg and Philip K. Bondy W.B. Saunders -Latest.
6. Biochemistry - A case oriented approach by Montogommoiry-CVMoshy Vo./ Latest.
7. Biochemistry - A functional approach by Mc Gilvery - W.B. Saunders Co., Latest.
8. Principles of Biochemist Vol. I and II by White Handler Smith al - Latest Edition McGraw Hill Publication.
9. Text book of Clinical Chemistry by Norbert Tietc – 1986 W.B. Saunders Co, Latest
10. Metabolic Basis of inherited diseases by Stanbury, Wyngarden et al, W.B. Saunders Co., Latest.

## RECOMBINANT DNA TECHNOLOGY

### Paper-X

**Unit-I:** DNA modifying enzymes and their uses in Molecular Biology a) Restriction enzymes b) DNA Polymerase i) Klenow ii) DNA polymerase I iii) T4/T7 DNA Polymerase c) Reverse Transcriptase d) Terminal Transferases e) T4 Polynucleotide kinases & Alkaline phosphatase f) DNA dependent RNA polymerases. g) DNA ligases h) Nucleases: - Bal 31, S1 nucleases, DNase I, Mungbean nucleases, Ribonucleases, EXO III. Thermostable DNA polymerases used in PCR.

**Unit-II:** Host cells and Vectors- Host Cell Types (Prokaryotic and eukaryotic). Plasmid vectors for use in *E. coli* and Gram positive bacteria. Bacteriophage - Lambda and M13 vectors c) Cosmids d) Phagemids. Artificial chromosomes (YACs, PACs, BACs, MACs and HACs). Specialized vectors & their uses a) Expression vectors for Prokaryotes & Eukaryotes - Inducible vectors; vectors with tags (Histidine tags, signalling peptides for exportation), b) Gene fusion vectors.

**Unit-III:** Cloning strategies: DNA cloning a) Sticky ends b) Blunt ends c) Homopolymeric tailing d) Use of adapters & linkers. Construction of genomic DNA libraries (shotgun cloning) and cDNA libraries. Screening of recombinants - Antibiotic resistance, lacZ complementation (Blue-white selection), fluorescent markers (e.g. GFP). Preparation of radiolabelled/non-radiolabelled DNA & RNA probes. Southern/Northern/Western blot, dot blot and Zoo blot. Screening of genomic libraries with oligo-probe. Immunological screening for expressed genes.

**Unit-IV:** PCR – basic process, types and applications. DNA sequencing- Principle of chemical and enzymatic methods. Automated DNA sequencing, high throughput Pyrosequencing, next generation sequencing - Lynx Therapeutics' Massively Parallel Signature Sequencing (MPSS), Polony sequencing, Ligation based sequencing (SOLiD sequencing), Ion semiconductor sequencing, DNA nanoball sequencing, sequencing based on reversible dye-terminators (Illumina or Solexa sequencing), Real-Time DNA sequencing, Optical sequencing, Microchip based Sanger Sequencing of DNA, Deep sequencing. Site-directed mutagenesis and protein engineering. DNA footprinting, chromosome jumping, chromosome walking.

**Unit-V:** Biotechnological applications of rDNA technology: Synthesis and purification of proteins from cloned genes- Native and fusion proteins. Yeast expression system. Production of enzymes. Therapeutic products for use in human health care- insulin, growth hormones, TPA, alpha interferon, Hepatitis B vaccine and Factor VIII. Medical and forensic applications of rDNA technology- DNA Profiling, Multiplex PCR, Diagnosis of inherited disorders and infectious diseases, diagnosis and management of cancer. Treatment using rDNA technology- gene therapy. Gene therapy for ADA and cystic fibrosis.

### Reference Books:

1. Principles of Gene Manipulation and Genomics (2006) by S. B. Primrose and R. M. Twyman, Blackwell Scientific Publications.
2. Gene Cloning (2007) by Julia Lodge, Pete Lund and Steve Minchin, Taylor and Francis.

3. An introduction to Genetic Engineering (2004) by Desmond S.T. Nicholl, Cambridge University Press.
4. Gene Cloning and DNA Analysis. An Introduction (2006) by T. A. Brown, Blackwell Scientific Publications.
5. Next-Generation Genome Sequencing (2008) by Michal Janitz, Wiley-Blackwell Publications.
6. Recombinant DNA (1992) by J.D. Watson, M. Gilman, J. Witowski and Mark Zoller, Scientific American Books.
7. From Genes to Clones: Introduction to gene technology (1987). Winnacker, E.L.
8. Molecular cloning: A Laboratory Manual (2001). Sambrook, J., Russell, D.W., Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

## PHARMACOLOGY AND TOXICOLOGY

### Paper-XI

**UNIT-I:**General Principles: Basic principles of drug action-Pharmacokinetics:Absorption, distribution and elimination of drugs, routes of drug administration. Pharmacogenetics. origin of drug from plants and animals.

**UNIT-II:** Drug metabolism – general pathways of drug metabolism (different types of reaction in phase I and phase II with examples), metabolism and excretion of drugs. Mechanism of drug action, combined effect of drugs. Factors modifying drug action, tolerance and dependence.

**UNIT-III:** Pharmacodynamics - receptor concepts, theory, drug receptor interaction (DRI), Factors affecting DRI, Cholinergic and anticholinergic drugs, Adrenergic and adrenergic blockers, General anesthetics, Local anesthetics. Adverse reactions to drugs and common drug receptor interactions.

**UNIT-IV:** Principles of therapeutics: Chemotherapy of microbial diseases, Chemotherapy of fungal infections, Chemotherapy of parasitic infections, rational use of antibiotics. Application for New Drug Discovery (NDD) according to Indian Control Authority and USFDA guidelines. Ethical considerations in utilizing human subjects for drug discovery process. Helsinki's declaration.

**UNIT-V:** Toxicology: Principles of toxicology and treatment of poisoning. Heavy metals and antagonists. Non metallic environmental toxicants. Methods involved in the development of new drugs. Preclinical toxicological studies: Calculation of LD50 and ED50.Acute, subacute and chronic toxicity studies; Irwin profile test, Pre-clinical pharmacokinetic and dynamic studies.Lipinski's rule for drug like molecule, High throughput screening (in-vitro and in-vivo) for pre-clinical pharmacokinetic and pharmacodynamic studies.

### Reference Books:

1. Shargel,L. et al., 2012. Applied Biopharmaceutics and Pharmacokinetics, 6th Edition, McGraw-Hill Medical,
2. Foreman,J.C. and Johansen,T.J. 1996. Text Book of Receptor Pharmacology,2nd Edition, CRC Press.
- 3.Goodman,L.S. et al., Goodman and Gillman's the pharmacological basis of therapeutics, 6th Edition,, McGraw Hill, 1996.
- 4.Tripathi,K.D. 2013. Essentials of Medical Pharmacology, 7th Edition, Jaypee Brothers.
5. Pharmacology and Pharmacotherapeutics, 23rd Edition, Popular Prakasham, Bombay.
6. Foye's Principles of Medicinal Chemistry, 6th Edition, Lippincott Williams & Wilkins.
7. Ghosh,M.N. 1984. Fundamentals of Experimental Pharmacology, 2nd Edition, Scientific Book Agency, Kolkatta.

## **BIOSTATISTICS AND RESEARCH METHODOLOGY**

### **Paper-XII**

**UNIT I:** Organising a statistical survey - Planning and executing the survey. Source of data - Primary and secondary data, Collection - observation; interview; enquiry forms, questionnaire schedule and check list. Classification and tabulation of data. Diagrammatic & graphic presentation of data.

**UNIT II:** Measures of central tendency; arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of variation: range, quartile, deviation, mean deviation, standard deviation. Correlation analysis: Scatter diagram, Karl Pearson's coefficient of correlation and Spearman's rank method. Regression analysis.

**UNIT III:** Probability - definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability. Theoretical distributions. Binomial - Poisson and normal distribution. Normal - importance, properties, conditions and constants of the distribution (proof not necessary). Simple problems.

**UNIT IV:** Sampling distribution and test of significance: Testing of hypothesis errors in hypothesis testing, standard error and sampling distribution. sampling of variables (large samples and small samples ). Student's 't' distribution and its applications. Chi - square test & goodness of fit. Analysis of variance one way and two-way classification, Duncans Multiple Range Test. Design of experiment - completely randomized block design randomized clock design

**UNIT V:** Thesis writing, Publication in a scientific journal, Preparation of Abstract and manuscript. Contents-Preamble, the problem, objectives, hypothesis to be tested, study, design, setup, measurement procedures, analysis of data, organization of report; Displaying data tables, graphs and charts – preparation of project proposal: Thrust area – funding agencies (National and International) – kinds of research program in India and abroad – career development in laboratory research – principle and method of patenting.

### **References Books:**

1. Statistical Methods, S.P.Gupta 28th Edition
2. Biostatistics – A foundation for analysis in health science Danien.
3. Biostatistical analysis - Jerrold H.Zar. Pearson Education, 4th Edition
4. Sundar Rao, Jesudian Richard – An Introduction to Bio-Statistics
5. Alwi E. Lewis. Bio-statistics, East West Press.
6. S.P.Gupta – Fundamentals of Statistics, Sultan Chand.
7. MS office; Sexena S, Vikas Publishing House.
8. Statistical methods; Snedecor GW and Cochran WG, Oxford and IBH publishing CO Pvt. Ltd.
9. Biometry; Sokal RR and Rohlf FJ, Freeman WH publishing House.
10. Biostatistical analysis; Zar JH, Prentice Hall Publishing Hous

## BIOINFORMATICS

### Elective-3

**Unit-I:** History and development of computers, mainframe, mini and super computer systems. Principles of computing: Operating systems, Basic word processing and database management soft wares: LOTUS, DBASE, Wordstar, and other scientific application packages. Data acquisition and management: Types of data-DNA, RNA and protein sequences, protein structure data, gene and protein expression data

**Unit-II:** Programming in PERL - introduction, variables and data types, Basic operators and control structures, scalars, arrays, lists, hashes, file manipulation, regular expression, patterns, input and output, HTML: basic codes for a web-page. Systems biology: Introduction - Integrating networks. Methods for prediction of tertiary structure of proteins-knowledge based structure prediction, fold recognition Suggested.

**Unit-III:** Databases: Biological databases (Eg. Genbank, SWISSPROT, PDB, etc) - searching and retrieving data form databases- FASTA – BLAST: parameters and its types. Sequence analysis with acquired data: Sequence comparison with pair wise and multiple sequence alignment. Deducing phylogenetic relationships from multiple sequence alignment. phylogenetic analysis. Genome sequencing projects.

**Unit-IV:** Bioinformatics in structure analysis: Format of a protein structure data - Primary, secondary (alpha helix and Beta sheet), Tertiary, quarternary structure of protein molecules molecular visualization tools: rasmol, SWISS PDB viewer. Predicting protein structure: comparative modelling. Profiles and motifs. Phi, psi angles. Ramachandran plot. Bioinformatics and drug discovery.

**Unit-V:** Basic knowledge of compuer systems software and programming languages. Application and advantages of Unix/Linux in bioinformatics.Programming in C: Basic algorithms – flowcharts - Arithmetic Examples.

### Reference Books:

1. Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley- Dream Tech India Pvt. Ltd.
2. Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reilly publications.
3. Introduction to bioinformatics by T.K. Attwood and D.J. Parry –smith, Pearson Education Asia.
4. Bioinformatics by David.W.Mount, CBS publishers and distributors.
5. Instant notes in bioinformatics by D.R. Westhead, J.H.Parish and R.M.Twyman

## BIOLOGY OF CANCER AND STEM CELL

### Elective-3

**Unit-I:** Introduction to Cancer: Definition; Cancer incidence and mortality; Origin of neoplastic cells; Cancer as cellular disease; Types of Cancer: Benign Tumors Vs. Malignant Tumors, Common Symptoms, Causes of Cancer: Carcinogenesis-Chemical and Irradiation; Oxygen Free Radicals, Aging and Cancer; Genetic Susceptibility and Cancer; Viral Carcinogenesis.

**Unit-II:** Molecular Mechanism Of Cancer: protooncogenes, oncogene, tumour suppressor genes involved in cancer, errors in cell cycle (Cyclins and CDKs). Apoptosis in cancer – mechanism of apoptosis, intrinsic and extrinsic pathways. Principles and methods of cancer diagnosis-Biochemical, genetic, cytotoxic, cell growth and viability tests, cancer biomarkers.

**Unit-III:** Cancer, Diagnosis & Therapy: Tumor Markers; Gene Expression Microarrays; Proteomic Methods; Circulating Epithelial Cells; Circulating Endothelial Cells and Endothelial Progenitor Cells; Molecular Imaging; Haplotype Mapping. Cancer therapy: Surgery, Radiotherapy, Chemotherapy, Hormone therapy, Immune, Prodrug and Targeted therapies.

**Unit-IV:** Introduction To Stem Cell: Definition, Types of Stem cell, characterization, pluripotency, niche specification – Drosophila germ line stem cells, self-renewal and differentiation, tooth primordia, gut specifications. Occurrence of stem cell in mammals: In Mesenchymal cells - Hemangioblasts, skeletal muscle cells, adipose cells, bladder cells; In Epidermal cells – skin, mammary gland, dental and neural cells; In Endodermal cells – liver, GI tract, pancreatic cells

**Unit-V:** Embryonic Stem Cells: Blastocyst and inner cell mass cells, Organogenesis, Adult versus embryonic stem cells, post genomic adult stem cells, stemness, characteristics, hierarchy, stem cell niche; Adult stem cell from amniotic fluid and cord blood; Stem cell characterization techniques and cryopreservation

### References:

1. Cancer Biology, Raymond W. Ruddon, 2007, 4th edition, Oxford University Press,
2. Molecular Biology of Cancer by F. Macdonald, C.H.J. Ford, and A.G. Casson; Garland Science / Bios Scientific Publishers
3. The Biology of Cancer, Weinberg. Robert A, 2007, New York: Garland Science.
4. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer.
5. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics 2<sup>nd</sup> Edition by Lauren Pecorino. Oxford University Press.



## **CLINICAL BIOCHEMISTRY AND MOLECULAR BIOLOGY LAB**

### **Practical-III**

#### **Clinical Biochemistry**

1. Enumeration of blood cells (RBC, WBC)
2. Blood sugar determination by glucose oxidase method
3. Estimation of bilirubin
4. Estimation of blood urea
6. Estimation of serum enzymes - Creatine phosphokinase (CPK), ALP, AST , SGPT and SGOT
7. Normal and abnormal constituents of urine
8. Determination of Lipid Profile
9. Estimation of glycosylated haemoglobin
10. Estimation of total protein and albumin from serum

#### **Molecular Biology Lab**

1. Subcellular fractionation of organelle
2. Bacterial Transformation
3. Isolation of DNA from E. coli/ liver/ plant
4. Agarose gel electrophoresis of DNA
5. Restriction digests of DNA.
6. Isolation of plasmid
7. Separation of serum protein by SDS -PAGE
8. Western blotting

#### **Reference books:**

1. Experiments in Molecular Biology-R. J. Slater, Humana Press, 1986.
2. Molecular cloning -Sambrook and Russell, Cold Spring Harbor Laboratory Press, 2001
3. Practical Biochemistry- Keith Wilson and John Walker, Cambridge University Press, 1997.
4. Practical Biochemistry- David T Plummer, Tata McGraw-Hill, 1988.
5. Experimental Biochemistry- B. S. Rao and V. Deshpande, I.K. International Pvt. Ltd.
6. Practical Biochemistry- David T Plummer, Tata McGraw-Hill, 1988.

## **SUPPORTIVE PAPERS FOR OTHER DEPARTMENT STUDENTS**

### **TOOLS AND TECHNIQUES IN BIOSCIENCE**

#### **Supportive-1**

**Unit-I:** Cell fractionation techniques: Cell lysis, homogenization, extraction, salting in, salting out, dialysis and ultra-filtration. Radioisotopes in Biology: Concept of half-life, decay constant, detection and quantitation - GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and Applications of radioactivity.

**Unit-II:** Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium. Differential and density gradient centrifugation, centrifugal elutriation, construction of preparative and analytical ultra centrifuge. Microscopy: Principles and application of light phase contrast, fluorescence, scanning and transmission electron microscopy.

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

**Unit-IV:** Electrophoretic techniques: Polyacrylamide gel electrophoresis, SDS-PAGE, 2Delectrophoresis, agarose gel electrophoresis, isoelectric focusing, pulse field electrophoresis.

**Unit-V:** Spectroscopic techniques: Principles of colorimeter, spectrophotometer, fluorimeter. BeerLambert's Law and its limitations. Extinction coefficient, Atomic absorption spectroscopy UV-Visible, Spectrofluorimetry, Flame Photometry.

#### **Reference Books:**

1. Wilson,K. and Walker,J. 2005. Principles and Techniques of Practical Biochemistry, 6th Edition , Cambridge University.Press.
2. Upadhyay,A. Upadhyay,K. and Nath,N. 2009. Biophysical Chemistry: Principles and Techniques, Third Edition, Himalaya Publishing. 11th Edition
3. Sharma,B.K. 1981.Instrumental Methods of Chemical analysis, 5th Edition Goel Publications.
4. Homie,D.J. and Peck,H. Analytical Biochemistry, Third Edition, Longman group,1998.

## MEDICAL LAB TECHNOLOGY

### Supportive-2

**Unit-I:** Basic laboratory principles - Code of conduct of medical laboratory personnel - Organization of clinical laboratory - Role of medical laboratory technician - Safety measures - Medical laboratory professional and professionalism in laboratory workers - communication between physician and lab technician - hospital and clinic borne infection and personnel hygiene

**Unit-II:** Common glass wares in clinical laboratory - care and maintenance - Calibration of pipettes and volumetric apparatus - Cleaning and sterilization methods - antiseptics and disinfectants - staining techniques – vital stains.

**Unit-III:** Automation in Clinical Biochemistry- Instrumental concept, Selection of Instrument, Quality assurance, Control of pre-analytical and analytical variables, External and internal quality control measurements. Good Clinical Practices. Clinical laboratory records- Modern laboratory set up - Quality control: Accuracy, Precision, and Reference values.

**Unit-IV:** Clinical samples and specimens - Specimen collection, transport, storage and disposal –common laboratory infections - Anticoagulants: EDTA, Di-potassium salts of EDTA, double oxalate, single oxalate, sodium citrate and sodium fluoride.

**Unit-V:** Acid - Base balance – Electrolytes - Buffer and pH- Preparation of solution: Normal , per cent and Molar solution - normal saline -Methods of measuring liquids.

### Reference Books

1. Mukerjee, K. L. and S. Ghosh, 2010. Medical Laboratory Technology, Volume I, McGraw Hill, New Delhi.
2. Sood.R., 2006. Textbook of Medical Laboratory Technology, Jaypee, New Delhi.
3. Fischbach, F.T. and M.B. Dunning, 2009. A Manual of laboratory and Diagnostic Tests, Lippincott Williams Wilkins, New York.
4. Sonnenwirth, A.C. and L. Jarret, 2000 Gradwohls“ Clinical laboratory methods and diagnosis. M.D.B.I., New Delhi.
5. Ochei, J. and A. Kolhatkar, 2000. Medical Laboratory Science, Theory and Practice, McGraw Hill, New Delhi.
6. Text book of Medical Physiology - By Guyton.

## CLINICAL DIAGNOSIS IN HEALTH AND DISEASES

### Supportive-3

**UNIT-I:** Introduction: General health, syndrome and common diseases – communicable and noncommunicable diseases. Samples for analysis: Blood, urine, pleural fluid, synovial fluid, cerebro spinal fluid and tissues and histology. General check up: Blood group, Hb, height and weight, waist to hip ratio, electro cardio gram, X-ray, abdomen scan and appearance of scars, urine analysis – routine analysis (protein, sugar, pigments and cells).

**UNIT-II:** Detection of metabolites and its importance. Tests for liver function: Enzyme assay (SGOT, SGPT, Alkaline phosphatase, GGT), Total protein, albumin /globulin ratio and their significance. Test for kidney function: Urea and creatinine estimation and their significance.

**UNIT-III:** Test for heart function: Blood pressure (cystolic and diastolic), lipid profile (cholesterol, triglycerides, HDL, LDL estimation) and their importance. Test for lung function: Chest X-ray, Spirometry. Test for Brain function: EEG, MRI, CT. Test for Surgery: Bleeding time, clotting time. Special test: X-ray, CT, MRI, Doppler, TMT, angioplasty.

**UNIT-IV:** Infection: Bacterial, viral, fungal and protozoans. Blood: Total cell count, differential count, erythrocyte sedimentation rate. Infectious diseases: Tuberculosis, Leprosy, Malaria, Hepatitis, Cholera, Dengue, HIV, Chikun gunya and H1N1. TORCH – Panel (infertility profile), Infection in pregnancy, Koch postulations – Microscopic examination of body fluids, ELISA and PCR tests.

**UNIT-V:** Non communicable diseases: Diabetes: Blood sugar, urine sugar, glucose tolerance test, HbA1c. Hyper tension: Lipid profile, electrolyte (sodium, potassium, chloride and biocarbonate) investigation. Cancer markers: ELISA and DNA Probs.

### Reference Books:

1. Burtis,C. and Bruns,D. 2007.Teitz Fundamentals of Clinical Chemistry, 3rd Edition, W.B. Saunders Company.
2. Devlin,T.M. 1998. Text book of Biochemistry with Clinical Correlation,4th Edition, John Wiley and Sons.
3. Varley,H. 1980.Practical Clinical Biochemistry, Volume I and II, 5th Edition, CBS Publishers.
4. Mayne,P.D. 1994. Clinical Chemistry in Diagnosis and Treatment, 6th Edition, Hodder Arnold Publication.
5. Marshall,W.J. and Bangeit, S.K. 1995. Clinical Biochemistry - Metabolic concepts and Clinical aspects, Churchill Livingstone.
6. Guyton, A.C. and Hall,J.E. 2010. Text Book of Medical Physiology, 12<sup>th</sup> Edition, Saunders.