

DAVANGERE UNIVERSITY



Syllabus for

M.Sc., Biochemistry **Choice Based credit system (CBCS)** **Effective from 2016-17**

Department Studies and Research in Biochemistry
Davangere University, Shivagangothri,
Davangere-577007.

BOS - 2016

Proceedings of the meeting of Board of Studies (BOS), Department of Biochemistry, Davangere University, held on 16th December, 2015 at 12.00 noon

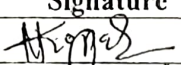
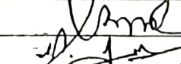
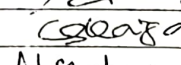
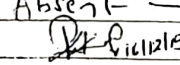

The 1st meeting of the BOS for the Academic Session 2015-16 was held in the Professor's chamber of the Biochemistry Department on 16th December, 2015 at 12.00 Noon under the chairmanship of Professor Dr. Gopal M Advirao. At the outset, Chairman welcomed the members of the BOS. The Chairman raised the agenda one by one and each agenda item was thoroughly discussed.

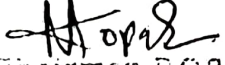
1. Discussion regarding the revision of the B.Sc Syllabus according to CBCS Scheme.

The B.Sc syllabus as prepared by the members and staff was placed before the BOS and after threadbare discussion the BOS accepted the revised syllabus with modification.

2. The existing syllabus for M.Sc Biochemistry was thoroughly discussed; many alterations were made to incorporate various recent and relevant topics to keep pace with developments in the respective fields.
3. The panel of examiners for both UG and PG Biochemistry was modified and approved.
4. The BOS approved the panel of examiners for adjudication of Ph.D thesis of the 2012-2013 batch students.

The meeting ended with the vote of thanks from the Chairman.

Sl.No	Name		Signature
1.	Dr. Gopal M Advirao	Chairman	
2.	Dr. Basavaraj Madhusudhan	Member	
3.	Dr. Vdlapudi Kumar	Member	
4.	Dr. C.S Karigar	External Member	
5.	Smt. Premalatha SJ	Member	Absent
6.	Smt. Komal K.P	Member	

 16/12/2015
 Chairman, BOS
 Dept of Biochemistry, Davangere University
 Shri Gangolli, Davangere - 577 002
 Davangere Dist. Karnataka.

**SCHEME OF EXAMINATION FOR
I to IV SEMESTER M. Sc. BIOCHEMISTRY COURSE**

SEMESTER-I							
Theory Papers							
Paper Code	Title of the paper	Instruction Hrs./Week	Exam. hours	Credits	Marks	IA	Total Marks
BC-1.1	Biomolecules	4	3	4	75	25	100
BC-1.2	Biochemical Techniques	4	3	4	75	25	100
BC-1.3	Human Physiology and Microbiology	4	3	4	75	25	100
BC-1.4	Biostatistics and Computer Applications	4	3	4	75	25	100
Practical Papers							
BC-1.5	Biomolecules	4	3	3	50	--	50
BC-1.6	Biochemical Techniques	4	3	3	50	--	50
BC-1.7	Human Physiology and Microbiology	4	3	3	50	--	50
BC-1.8	Biostatistics and Computer Applications	4	3	3	50	--	50
Total							600
SEMESTER-II							
Paper Code	Title of the paper	Instruction Hrs./Week	Exam. hours	Credits	Marks	IA	Total Marks
BC-2.1	Enzymology	4	3	4	75	25	100
BC-2.2	Bioenergetics and Intermediary Metabolism	4	3	4	75	25	100
BC-2.3	Clinical Biochemistry & Research Methodology	4	3	4	75	25	100
BC-2.4	Molecular Genetics and Developmental Biology	4	3	4	75	25	100
Practical Papers							
BC-2.5	Enzymology	4	3	3	50	--	50
BC-2.6	Bioenergetics and Intermediary Metabolism	4	3	3	50	--	50
BC-2.7	Clinical Biochemistry	4	3	3	50	--	50
BC-2.8	Molecular Genetics and Developmental Biology	4	3	3	50	--	50
Total							600

SEMESTER-III							
Theory Papers							
Paper Code	Title of the paper	Instruction Hrs./Week	Exam. hours	Credits	Marks	IA	Total Marks
BC-3.1	Molecular Biology	4	3	4	75	25	100
BC-3.2	Membrane Biochemistry and Bioinformatics	4	3	4	75	25	100
BC-3.3	Molecular Endocrinology	4	3	4	75	25	100
BC-3.4	Plant Biochemistry	4	3	4	75	25	100
BC-3.5	Clinical Biochemistry (Interdisciplinary/Elective Paper)	2	2	2	40	10	50
Practical Papers							
BC-3.6	Molecular Biology	4	3	3	50	--	50
BC-3.7	Membrane Biochemistry and Bioinformatics	4	3	3	50	--	50
BC-3.8	Molecular Endocrinology	4	3	3	50	--	50
BC-3.9	Plant Biochemistry	4	3	3	50	--	50
						Total	650
SEMESTER-IV							
Paper Code	Title of the paper	Instruction Hrs./Week	Exam. hours	Credits	Marks	IA	Total Marks
BC-4.1	Molecular Immunology	4	3	4	75	25	100
BC-4.2	Genetic Engineering and Industrial Biotechnology	4	3	4	75	25	100
BC-4.3	Cell Signaling and Cell Communication	4	3	4	75	25	100
Practical Papers							
BC-4.4	Molecular Immunology	4	3	3	50	--	50
BC-4.5	Genetic Engineering and Industrial Biotechnology	4	3	3	50	--	50
BC-4.6	Cell Signaling and Cell Communication	4	3	3	50	--	50
BC-4.7	Project Work/Dissertation	-	3	4	75	25	100
						Total	550

Department of Studies in Biochemistry
Subject: BIOCHEMISTRY
Courses having focus on Employability/Entrepreneurship/Skill Development
2016-17 Syllabus

Course Code	Name of the Course	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development
BC 1.1	Biochemical Techniques	Skill development/Employability: Separation and isolation methods develop skills for Quality Control/ Officer in Pharma Industry Pharma Industry Food and Beverages Industry.
BC 1.4	Biostatistics and Computer Applications	Skill development/Employability: Biostatistics helps for analysis & presentation of research data and computer skills develops employability
BC 2.3	Clinical Biochemistry and Research Methodology	Employability/Entrepreneurship: Officer in Clinical Diagnosis Laboratory, Clinical Diagnosis kits development.
BC 4.1	Molecular Immunology	Skill development/Employability: helps to develop Clinical Diagnosis kits development.
BC 4.2	Genetic Engineering and Industrial Biotechnology	Skill development/Employability: Practical skills helps to Gene expression, develop MG food and plants, Biocatalysis/ Clinical Diagnosis kits development
BC 1.6	Biochemical Techniques Practical	Skill development/Employability: Technical skills helps for Technical Associate/ Officer in Quality Control/ Officer in Pharma Industry/ Clinical Diagnosis Laboratory.
BC 1.7	Cell Biology, Microbiology and Human Physiology Practical	Skill development & Employability: Practical skills help in research & development centers, s & Hospitals /Clinics.
BC 1.8	Biostatistics and Computer Application Practical	Skill development/Employability: Practical skills of Biostatistics helps for analysis & presentation of research data and computer skills develops employability
BC 2.5	Enzymology Practical	Skill development/Employability & Entrepreneur: Practical skills of enzyme technology of Biocatalysis/ Biotransformation/ Clinical Diagnosis kits development/Food Industry and Beverages Industry.
BC 2.7	Clinical Biochemistry & Research Methodology Practical	Employability/Entrepreneurship: Officer in Clinical Diagnosis Laboratory, technical skills helps for Clinical Diagnosis kits development.
BC 3.6	Molecular Biology Practical	Skill development and Employability: Practical skills helps for development of Diagnosis kits development
BC 3.7	Membrane Biochemistry and Bioinformatics Practical	Skill development and Employability: Practical skills help for research and development centers and bioinformatics laboratory and industry.
BC 4.4	Molecular Immunology Practical	Skill development & Employability : Practical skills in hospitals or Food Service Institutions & Hospitals /Clinics
BC 4.5	Genetic Engineering and Industrial Biotechnology Practical	Skill development/Employability: Practical skills helps to develop MG food and plants, Biocatalysis/ Clinical Diagnosis kits development
BC 4.7	Project Work/Dissertation	Skill development, Activities & Entrepreneurship in Research laboratories, R&D centers and industry.

B.C-1.1: BIOMOLECULES**Total: 52 hrs****UNIT-I**

Water-Importance of water in biological systems with special reference to the maintenance of native structure of biological molecules. pH. buffers, buffer capacity and their importance in biological systems. Henderson-Hasselbalch equation, physiological buffer systems.

Chemical bonding and reactions - Types of bonding in biological molecules. Characteristics of chemical bonds-sigma and Pi bonds, properties of covalent, coordinate, hydrogen and ionic bonds, hydrophobic and Vander-Waals interactions and their importance in biological systems. Homo and heterolytic cleavage, structure and reactivity and C^+ , C^- and C^\cdot , Nucleophile, electrophile, free radicals in biological systems. Role of metal ions in biological systems, metalloporphyrins, metalloenzymes, cytochromes, iron-sulfur proteins.

Heterocyclic compounds- Occurrence in biological systems, structure and properties of furan, pyrrole. Indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine.

-13 hrs.**UNIT-II**

Amino acids – Structure and classification of aminoacids. Non-protein amino acids, non-standard aminoacids. Stereo chemistry and titration studies of amino acids, peptide bond and synthesis and properties by Merrifield solid-phase synthesis.

Proteins - Classification, biological functions, properties of proteins. Structural hierarchy of proteins – primary, secondary, tertiary and quaternary structure of proteins. Sequencing of proteins. Secondary structure of proteins with examples, helix, β -pleated sheet, 3_{10} -helix reverse turns, super secondary structure (collagen). Ramachandran plot and its significance. Tertiary structure of proteins, forces involved in the maintenance of tertiary structure of proteins. Quaternary structure hemoglobin as an allosteric protein. Protein folding, role of molecular chaperons. Denaturation and renaturation of proteins.

Lipids - Classification, structure and function of major lipid subclasses-acylglycerols, phosphoglycerides, sphingolipids, steroids, prostaglandins, lipoproteins, lipopolysaccharides, cerebositides, bile acids and ganliosides.

-13 hrs.

UNIT-III

Carbohydrates - Brief review of configuration aspects of carbohydrates, structure, properties and importance of starch, pectin and chondroitin sulphates. Structural elucidation of carbohydrates- methylation and periodate oxidation.

Nucleic acids - chemistry of purine and pyrimidine bases. Nucleoside and nucleotides. Physico-chemical properties of nucleic acids-melting of DNA, buoyant density. Denaturation and renaturation kinetics of DNA, effects of salts on DNA and Cot curves. Solution properties of DNA - molecular weight - UV absorption. Structure DNA and RNA and micro RNA Recent models of DNA- Supercoils, cruciform single stranded DNA and satellite DNA. Recent methods of sequencing of nucleic acids.

-13 hrs.

UNIT-IV

Vitamins - Chemical nature, sources, requirement, biochemical role and deficiency symptoms water and fat soluble vitamins, water soluble vitamins -vit c and B-Complex (Thiamine riboflavin pantothenic acid nicotinic acid pyridoxine biotin folic acid and cyanocobalamin), fat soluble vitamin like compounds- inositol PABA, liponic acid, ubiquinones, flavonoids.

Minerals - Sources, distribution requirement and metabolism of Calcium, phosphorus, sodium, potassium and chloride the major electrolytes - magnesium and sulfur. Trace elements-iron, zinc, iodine, fluoride selenium, cobalt, molybdenum and copper.

-13 hrs.

References:

1. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & Sons, Inc.
2. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York.
3. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS Publishers and Distributors.
4. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stamford, Connecticut.
5. Biochemistry; David Rawn, J., Neil Patterson Publishers.
6. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific.

B.C-1.2: BIOCHEMICAL TECHNIQUES

Total: 52 hrs.

UNIT-I

Introduction for separation methods and isolation methods - Separation Methods and their classification; Zonal and Frontal methods. Approaches to Biochemical investigations - whole organism, perfusion, slices, cultured tissues and cell techniques; Cell fractionation, extraction, methods of precipitation, solubilisation and concentration. Precision; accuracy; sensitivity; specificity; random error; systematic error.

Biochemical calculations - Specific gravity, percent solution, dilution and dilution factors, ionic strength; molarity, normality, mole concept, Avogadro principles; LD50, ED50, IC50 methods of their determination.

Centrifugation - Principle and Definition; Relative centrifugal force (RCF); Different types of rotors used and their importance. Svedberg coefficient; Preparative centrifugation; Differential, Rate-Zonal, isopycnic (Equal density) and equilibrium isodensity centrifugation; Density gradient centrifugation; analytical ultra-centrifugation; Analytical sub cellular fractions. Molecular weight determination of proteins and nucleic acids by sedimentation velocity and sedimentation equilibrium methods.

-13 hrs.

UNIT-II

Chromatography-Basic principles of chromatography. Distribution coefficient. Paper, TLC, gel permeation, ion-exchange chromatography, Affinity Chromatography, GLC, HPLC, FPLC. Different detectors of GLC and their applications. Different types of supporting matrices, pumps and detectors of HPLC and their applications.

Electrophoresis-Basic principle and definition; Types of electrophoresis-Moving boundary and Zone electrophoresis; Factors affecting electrophoretic separation of molecules. Low voltage and High voltage electrophoresis. PAGE and SDS-PAGE, Isoelectrofocussing, Agarose gel electrophoresis, Southern blotting; Northern blotting; Pulse field electrophoresis; Isotachophoresis; capillary electrophoresis.

-13 hrs.

UNIT-III

Spectroscopy-Electromagnetic spectrum, Laws governing light absorption (Beer-Lambert law) and their limitations. Visible light-colour complementation, principle and construction of colorimeter and spectrophotometer. Principle, instrumentation and biological applications of UV- Visible spectrophotometry, Turbidimetry, Nephelometry Fluorimetry, Flame photometry, Atomic absorption spectrophotometry. Basic principles of IR spectroscopy; Electron spin resonance spectroscopy; Nuclear magnetic resonance spectroscopy and Mass spectrometry, MALDI-TOF, MS/MS and their applications in structural analysis of biomolecules and metabolic pathways.

Biophysical Methods – Principle and applications X-ray diffraction, Optical rotatory dispersion (ORD); Circular dichroism, Drude equation, Motiff equations, Cotton effect; Application for the analysis of few biomolecules. Principle and applications of light scattering for the analysis and characterization of macromolecules.

-13 hrs.

UNIT-IV

Radio isotope (Tracer) Techniques - Definition and types of radiation. Units of radio activity. General methods for the production of radioactive isotopes; Basic Principles and applications of GM Counter, Liquid scintillation counter and Cerenkov counting, Autoradiography.

Immunochemical Techniques - Immunodiffusion-radial immunodiffusion, Ouchterlony double immunodiffusion, Immuno electrophoresis- Rocket immune electrophoresis, Counter immunoelectrophoresis, Complement fixation test, Radio immunoassay, ELISA, Western blotting, Immunofluorescence- Fluorescent antibody techniques, Flow cytometry.

-13 hrs.

References:

1. The Tools of Biochemistry – Terrance E. Cooper (John Wiley)
2. Analytical Biochemistry – David Homes and Hazel Peak (Longman)
3. A Manual of Radiobiology – J.C.Steward and D.M.Hawcroft
4. Practical Clinical Biochemistry, 5th Edn.–H.Varley; A.H.Gowenlock and M. Bell (Heinemann)
5. A Biologists Guide to principles and Techniques of Bio-chemistry – K.Wilson and Goulding K.H. (ELBS edn. 1986)
6. Physical Biochemistry – Van Holde (Prentice-Hall, 1998)
7. Instrumental Methods of Chemical Analysis – Chatwal and Anand (1991) 7th Edn., H.P. House
8. Practical Biochemistry – Wilson and Walker (Edward Arnold, 3rd Edn.,1981)
9. Biophysical Chemistry – Upadhyay and Upadhyay (Himalayan Publishing House)
10. Protein Purification Methods – Eds. Harris, E.L.V. and Angal.S (IRL-press; 1990)
11. Lehninger's Principles of Biochemistry – Nelson and Cox (Worth Publishers; 2000)
12. Molecular Biology – David Freifelder.
13. Physical Chemistry with application to Biological Systems (2 Edn.) Raymond Chang (1977)
14. Principles and techniques of Biochemistry and Molecular Biology; Keith Wilson and John Walker; 7th Edn. (2010) Cambridge University Press.

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B.C-1.3: CELL BIOLOGY, MICROBIOLOGY AND HUMAN PHYSIOLOGY

Total: 52 hrs.

UNIT-I

Cell - Structural organization and function of intracellular organelles : Cell wall, Nucleus , mitochondria, golgi bodies, lysosomes, ER, peroxisomes, vacuoles, chloroplast, and other Plastids , glyoxysoms ,melanasomes and flagella. Structure and function of cytoskeleton and its role in motility. Cell division, cell cycle regulation and control of cell cycle.

Microbiology - History and scope of microbiology

Classification of microorganisms- Virus ,five kingdom classification , based on their mode of nutrition, requirement of physical factors (temperature, pH , salinity, pressure) extremophiles. Study of salient features, structure, life cycle and economic importance of virus (T4 phage) ,algae (Chlamydomonas) ,fungi (Jeast, *Rhizopus*), protozoa (*Plasmodium*).

-13 hrs.

UNIT-II

Techniques in microbiology - Staining techniques isolation and cultural methods sterilization techniques - physical and chemical methods, antibiotics.

Study of growth curve of bacteria- monophasic, biphasic and synchronous. Measurement of microbial growth.

Bacterial and viral diseases – pathogenesis, symptoms , diagnosis and treatment.

Microscopy-Resolving power of different microscopes. Light microscopy, bright field microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, atomic force microscopy, confocal microscopy, Electronmicroscopy : SEM and TEM specimen preparation.

-13 hrs.

UNIT-III

Human Physiology

Tissues - Epithelial tissues, Connective tissues, Muscular tissue and Nervous tissue.

Blood and Circulation-Blood composition- formation and functions of erythrocytes, leucocytes and thrombocytes, formed elements, plasma composition and function, haemostasis. Blood clotting factors and their mechanism, clotting disorders, clot dissolution and anti-clotting factors. Blood volume and its regulation, haemoglobin.

Digestive System- Digestion, absorption and assimilation of carbohydrates, dietary fibers, proteins, fats, water, vitamins and minerals. Gastrointestinal hormones, BMR and energy balance.

Respiratory System- Gaseous transport, mechanics of respiration, molecular mechanisms of the movement of O₂ and CO₂ through lungs, arterial and venous circulation, Bohr effect, O₂ and CO₂ binding haemoglobin. Regulation of respiratory system and waste elimination.

-13 hrs.

UNIT-IV

Neurochemistry: Introduction, Neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Neurogenesis, neuron, glial and other cells of nervous system, myelin Sheath composition and function. Resting membrane Potential of excitable cells -Nernst and Goldmann equations. Synapse: types, properties and synaptic transmissions, action potential, post-synaptic potential (excitatory and inhibitory). Mechanism of initiation and propagation of action potential, voltage gated ion channels (Na⁺, K⁺, Ca⁺⁺). Types of neurotransmitter and their receptors, neuromuscular junction. Termination of Neurotransmitter action, use of agonists and antagonists of neurotransmitters, neural control of muscle tone and posture.

Muscle System-Types of muscle: Smooth, skeletal and cardiac muscle, contractile and other proteins of muscle. Fine structure of muscle fiber, fast and slow muscle, mechanism of contraction of smooth and skeletal muscle. Regulation of contraction in striated muscle, calmodulin and its regulatory role.

Biochemistry of vision- Structure of rod cells and cone cells, photosensitive pigments and mechanism of rod vision -sensory transduction in vision.

Excretory system - Anatomy of kidney and nephron, urine formation, urine concentration, waste elimination and micturition. Role of kidney in the regulation of water balance, electrolyte balance and acid-base maintenance.

Cardiovascular system - Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-its principle and significance. Cardiac cycle, cardiac output, Starling hypothesis. Blood pressure and its regulation, neural and chemical regulation of all above.

-13 hrs.

References:

1. Microbiology- Principles and applications, John. G. Creager, Jacquelyn, G. Black and Vee. E. Davison.
2. General Microbiology, Eds. Boyd. R.F. Times Mirror, 1984.
3. General Microbiology, Eds. Stanier et.al., Mc. Millan 4th Edn. 1975.
4. Text book of Microbiology – W. Burroughes.
5. Fundamental Principles of Bacteriology – A.J. Sale.
6. Microbiology, Eds, Pelzer, Reid and Krieger, Tata Mc.Graw Hill.
7. Microbiology-Davis et.al, Harper and Row 1990.

B.C- 1.4: BIOSTATISTICS, COMPUTER APPLICATIONS

Total: 52 hrs.

UNIT-I

Aim , scope, definition and elementary idea of statistics in biology

Basic terminology - population , sample, variable, parameter, primary and secondary data, screening and representation of data, tabulation and diagrammatic representation of statistical data, pie charts. Sampling: representative sample, sample size, sampling bias and sampling techniques.

Measures of central tendency and dispersion: measures of central tendency- mean, median, mode, quartiles and percentiles. Measures of dispersion; range, variance, standard deviation, standard error, coefficient of variation, symmetry, measures of skewness and kurtosis.

-13 hrs.

UNIT-II

Bivariate data: Scatter plot, correlation coefficient(r)- positive and negative correlation, properties(without proof), interpretation of r, linear regression. Fitting of lines of regression, regression coefficient, coefficient of determination.

Tests of significance: Sample sample test (chi square, t-test, F –test), large sample test(z test) and standard error, p value of the statistics, ANOVA- one way and two way classification.

-13 hrs.

UNIT-III

Probability and distributions: sample space, events, equally likely events. Definition of probability (frequency approach), independent events. Addition and multiplication rules, conditional probability. Examples- Bernouli, binomial poisson and normal distributions. Mean and variance of these distributions (without proof). Sketching of p.m.f and p.d.f use of these distributions to describe in biological models, mode, sampling and simulation study.

Application of computer in biostatistics: Introduction to MS EXCEL – use of worksheet to enter datd, edit data, copy data, move data, use of in-built statistical functions for computations of mean , SD, correlation, regression coefficient etc. Use of bar diagram, histogram, scatter plots etc, graphical tools in EXCEL for presentation of data.

-13 hrs.

UNIT-IV

Introduction to computers and computer applications: Introduction to computers – Basic components of computers- hardcore, cpu, input, storage devices, software, concept of file, folders and directories, commonly used commands, flow charts and

programming techniques. Introduction in MS OFFICE, software concerning word, processing, spreadsheets and presentation software, operating system. Introduction to MS WORD, word processor- editing , copying, moving, formatting, table insertion, drawing flow charts etc.

Networking concepts: networking fundamentals, client, server, LAN, WAN, Flp, TelNET, INTERNET, NIC NET, WWW, html, email, introduction to MEDLINE, eCOO and PUBMED, for accessing biological information.

-13 hrs.

References:

1. Statistics in biology, vol, by Bliss , C .I.K (1967) Mc .Graw Hill New York.
2. Practical statistics for experimental biologist by Wardlaw, A.C (1985).
3. How computers work – 2000 by Ron white, Tech media.
4. Statistical methods in biology – 2000 by Bailey, N. T.J English univ, press
5. Biostatistics – 7 th edn by Daniel.
6. Fundamentals of Biostatistics by Khan and Khanum.
7. INTERNET- CDC publication India.

B.C-2.1: ENZYMOLOGY

Total: 52 hrs.

UNIT-I

Introduction - a brief history, remarkable properties of enzymes
Specificity and types of specificity: active site, lock and key hypothesis, induced fit hypothesis.

Kinetics of single substrate enzyme catalyzed reactions: Michaelis -Menten equation, Briggs- Haldane equation Lineaweaver-Burk plot, Aude- Hoftee plot, Hanes plot, Eissenthal and Cornish Bowden plot, Significance of K_m and V_{max} .

Investigation of active site structure: trapping the E-S complex, use of psedosubstrate, use of affinity labeling reagents, photo oxidation, site directed mutagenesis.

-13 hrs.

UNIT-II

Enzyme inhibition: Reversible inhibition: Competitive, noncompetitive, uncompetitive, mixed and partial inhibition, substrate and allosteric inhibition, irreversible inhibition, suicide inhibition, Determination of k_i (Dixon plot), The effect of changes in pH, temperature.

Sigmoidal kinetics and allosteric enzymes : Introduction, properties, cooperativity, kinetics of ATCase, MWC model, KNF model, Covalent modification of enzymes, Zymogen activation, amplification of initial signals, substrate cycle, enzyme interconvert able cycles, feedback inhibition, multi branched feedback inhibition
Mechanism of enzyme action: acid base catalysis, electrostatic, covalent catalysis.

-13 hrs.

UNIT-III

Kinetics of multi substrate enzyme catalyzed reactions: single displacement reactions, double displacement (ping-pong) reactions, Alberty and Cleland notation, Investigation of reaction mechanisms, primary and secondary plots.

Mechanism of enzyme action without cofactors: 1.Chymotrpsin 2 .Ribonuclease 3. Lysozyme

Mechanism of enzyme action with cofactor: 2. Carboxy peptidase A

Mechanism of co-enzyme action: Introduction, Nicotinamide nucleotides(NAD^+ $NADP^+$), Flavin nucleotides (FMN and FAD), Thiamine pyrophosphate (TPP), Pyridoxal Phosphate (PLP), Tetra hydro folate (THF) coenzyme A(CoA)

-13 hrs.

UNIT-IV

Multi enzyme complex: Properties and mechanism of action PDC.

Isoenzymes: Introduction, properties and mechanism of LDH.

Purification of enzymes: Introduction, objectives and strategy, choice of source, methods of homogenization, separation (based on size / mass, polarity, solubility, specific binding) and criteria of purity.

Applications of enzymes: Immobilized enzymes, preparation and properties, industrial applications. Brief introduction and applications of Biochips and Biocomputers.

-13 hrs.

References:

1. Trevor plamer 2008 Enzymes, Horwood Publications, England
2. Nicholas Price and Lewis Stevens, 2010 Fundamentals of Enzymology, Oxford University Press
3. Nelson D.L and Cox M.N (2010), Lehninger principals of Biochemistry
4. Voet D and Voet – J-G (2006) Biochemistry Wiley publications.
5. Zuby G.L 2008. Biochemistry, 6th Edn. Brown publications.

B.C-2.2: BIOENERGETICS AND INTERMEDIARY METABOLISM

Total: 52 hrs.

UNIT-I

Thermodynamics: Laws of thermodynamics, free energy, free energy change, enthalpy and entropy. High energy compounds and group transfer reactions. Biological energy transducers, Coupled reactions. Measurement of ΔH and ΔG . Redox systems in biology, redox potential, membrane potentials.

Oxidative phosphorylation: Mechanism of oxidative phosphorylation- role of inhibitors, uncouplers and ionophores in understanding mechanism of oxidative phosphorylation, chemiosmotic theory, substrate level phosphorylation, futile cycles, thermo genesis, brief account on ATP- synthase.

Oxygen utilizing enzymes: Generation of reactive oxygen species (ROS), Role of Mixed function oxidases, hydroxylase & monooxygenase, catalase, peroxidase and superoxide dismutase.

-13 hrs.

UNIT-II

Carbohydrate Metabolism : Introduction, glycolysis, regulation of glycolysis. Fates of pyruvate under aerobic and anaerobic conditions. Feeder pathways for glycolysis. Energetics of TCA cycle, Anapleurosis. Alternative pathways- HMP Shunt, glyoxylate cycle, Glucuronate pathway. Gluconeogenesis, Glycogen metabolism: synthesis, degradation and regulation. Hormonal regulation of carbohydrate metabolism.

-13 hrs.

UNIT-III

Lipid metabolism : Degradation of triglycerols, phospholipids and glycolipids. β oxidation of even and odd numbered fatty acids, Energetics of β oxidation scheme, ω -oxidation, oxidation of unsaturated fatty acids, Alternate route for fatty acid oxidation – formation of ketone bodies and their oxidation. Biosynthesis of fatty acids, mitochondrial and extra mitochondrial chain elongation and desaturation pathways. Biosynthesis of prostaglandins, leukotrienes and thromboxanes. Biosynthesis of triglycerols, phospholipids & sphingolipids. Regulation of fatty acid metabolism. Hormonal regulation of lipid metabolism. Biosynthesis and degradation of cholesterol and related steroids, regulation of cholesterol synthesis. Integration of lipid and carbohydrate metabolism.

-13 hrs.

UNIT-IV

Nitrogen metabolism: General metabolic reactions of amino acids, oxidative deamination, transamination decarboxylation, racemisation reactions and their mechanism, Role of PLP, Degradation of individual amino acids. Biosynthesis of individual amino acids. Regulation of amino acid metabolism, Aromatic amino acid family, Asp family metabolism. Urea cycle and its regulation.

Biosynthesis and degradation of porphyrins. Biosynthesis of Purine and Pyrimidine, nucleotides and their interconversion. Regulation of biosynthesis, Salvage pathway of Purines & Pyrimidine nucleotides. Biosynthesis of deoxynucleotides and co-enzyme nucleotides. Chemical inhibition of biosynthesis of nucleic acid precursors. Degradation of purines and Pyrimidines.

-13 hrs.

References:

1. Principles of Biochemistry: Lehninger. A.L, Indian Edn. CBS Pub.
2. Biochemistry of Plants: Eds. Stump and Conn. Vol.8 Academic Press,
3. Text Book of Biochemistry with Clinical Correlations. Eds. T.M. Devlin 2/Ed. Wiley.
4. Harper's Review of Biochemistry. Eds. Martin et al. Lanje, 22edn.
5. Biochemistry, Eds. Geoffrey Zubay.
6. Biochemistry, Ed. Stryer.
7. Biochemistry, Ed. Donald Voet & J.G. Voet.
8. Students Companion to Stryer Biochemistry Gumpert et al., Freeman.
9. Biochemistry – Mechanisms of Metabolism. Ed. Cunningham E.B. Mc.Graw Hill.
10. Amino Acid Metabolism, Ed. Bender, Wiley.
11. Biochemistry of the Amino acids, Ed. Meister, A., Academic press. Vol I & II Ed.
12. The Metabolic Basis of Inherited Diseases, Edn. Stanbury et al. Mc.Graw Hill, 5/Ed.
13. Biochemistry; David Rawn, J., Neil Patterson Publishers.

B.C-2.3: CLINICAL BIOCHEMISTRY & RESEARCH METHODOLOGY

Total: 52 hrs.

UNIT-I

Disorders of carbohydrate metabolism: Glycogen storage disorders, lactose intolerance, Hypoglycemia, hyperglycemia, factors influencing blood glucose level, diabetes mellitus- types, diagnosis of diabetes mellitus GTC/GTT glycosylated hemoglobin, role of oral anti-diabetic drugs.

Disorders of lipid metabolism: Significance of plasma lipoproteins, cholesterol triglycerides and phospholipids in health and diseases hyperlipidemia, hyperlipoproteinemia, Gauchers diseases Tay sach's and Niemann pick's disease, Ketone bodies abetalipoproteinemia, Hypercholesterolemia Atherosclerosis..

Disorders of amino acids and nucleotide metabolism: Hyperurecemia, phenyl Ketonuria, alkaptonuria, maple syrup urine, gout, Lesh –Nyhan Syndrome, albinism.

-13 hrs.

UNIT-II

Digestive diseases: Role of pancreatic enzymes, malnutrition, malabsorption, steatorrhea, pancreatitis, Assay of pancreatic enzyme in duodenal content.

Disorders of liver : functions of liver, role of liver in detoxification of xenobiotics, of, disorders; Jaundice, Hepatitis, Gall bladder stone and its analysis, liver function tests, Lipid profiling.

Hematology and Hematological disorders: significance of plasma proteins and its electrophoretic profile in health and diseases, hemorrhagic disorders – Hemophilia, von will brand diseases, purpura, thalassemia, porphyria.

Diagnostic enzymes: Biochemical diagnosis of diseases by enzyme assays – SGOT, SGPT, CPK cholinesterase LDH.

-13 hrs.

UNIT-III

Disorders of kidneys: Formation and composition of urine, Abnormal constituents of urine, role of kidneys in maintenance of acid base balance renal diseases – nephritis, kidney stones, dialysis, kidney transplantation, Renal function tests ; clearance tests.

Endocrinopathies: Abnormalities due to over and under production of the hormones secreted by pituitary, thyroid, parathyroid, pancreas, adrenals, and gonads.

Diagnosis of neurological disorders: composition and significance of cerebrospinal fluid, neurological disorders- Meningitis, Alzheimers disease, Parkinson's diseases, multiple sclerosis.

-13 hrs.

UNIT-IV

Research methodology: Meaning of Research; Objectives of Research; Motivation in Research; Types of Research; Research Approaches; Significance of Research; An overview of Research Process.

Definition of Research problem selecting the problem; Techniques involved in defining a problem.

Collection and review of research literature, sources of literature and their evaluation. Designing research methodologies. General strategies for preparation of research proposals. Data representation in technical reports, posters, presentation in scientific conferences and workshops. Preparation of manuscripts for publication in national and international journals. Yardsticks employed in evaluation of manuscripts for publications.

-13 hrs.

References:

1. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
2. Clinical Biochemistry-Controw & Trumper, , W.B. Saunders Pub.
3. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al.
4. Outlines of Biochemistry – White, Handler & Smith.
5. Clinical Biochemistry – Zilva and Pannal.
6. Research Methodology – Methods and Techniques. - C.P. Kothari. New Age International Publishers.
7. Practical Research Methods. A User-friendly guide to mastering research. – Dr. Catherine Dawson. How to Books Ltd., U.K.

B.C- 2.4: MOLECULAR GENETICS & DEVELOPMENTAL BIOLOGY

Total: 52 hrs.

UNIT-I

Mendelian Principles: Principle of segregation, monohybrid crosses, Dominance, recessiveness, Principle of independent assortment, dihybrid ratios.

Concept of gene: Allele, multiple alleles- ABO blood type alleles and Rh factor alleles in man; Pseudo allele, complementation test.

Extension of Mendelian principles: Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, Phenocopy, linkage and crossing over.

Sex linkage and sex-linked inheritance: Sex linkage, Morgan's discovery of sex linked inheritance, Pattern of inheritance of sex linked genes, X-linked traits in humans, deleterious recessive sex-linked genes in man. Sex linked gene expression. Sex influenced dominance & sex limited character.

-13 hrs.

UNIT-II

Sex determination: Mechanism of sex determination, identification of sex chromosomes, XX-XY mechanism of sex determination, the Y-chromosome and sex determination in mammals, the balance concept of sex determination in drosophila, environmental factors and sex determination, dosage compensation.

Organization of Eukaryotic chromosome: Histones and Non-histones, Nucleosomes, Higher order of organization, Chromosomal banding, Gene structure in eukaryotes, pseudogenes, gene clusters, spacers, single copy genes, repetitive sequences, tandem gene clusters, RNA genes, histone genes.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids.

Recombination: Homologous and Non-homologous recombination. Recombination and crossing over, Site specific recombination, Holliday model, Transposable elements.

-13 hrs.

UNIT-III

Extrachromosomal Inheritance: Criteria for extrachromosomal inheritance, cytoplasmic organelles, organization of mitochondrial and Plastid DNA.

Microbial Genetics: Methods of genetic transfers-Transformation, Conjugation, Transduction and Sexduction. Mapping genes by interrupted mating, Fine structure analysis of genes.

Human Genetics: Pedigree analysis, lod score for linkage testing, Karyotypes, genetic disorders.

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTZ mapping.

Mutation: Nature of mutation and mutagens, different kinds of mutation, detection and isolation of mutants, temperature sensitive mutants, Mechanism of mutation, Utility of mutants, Insertional mutagenesis.

Structural & Numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, Ploidy and their genetic implications.

-13 hrs.

UNIT-IV

DEVELOPMENTAL BIOLOGY

Basic concepts of development: Potency, commitment, specification, induction, competency, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

Gametogenesis And Fertilization In Animals: Production of gametes, cell surface molecules in sperm egg recognition in animals, embryo sac development, zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals, embryogenesis.

Morphogenesis And Organogenesis: Cell aggregation and differentiation, axes and pattern formation in *Drosophila*, amphibian, and chick, organogenesis, post embryonic development, metamorphosis, environmental regulation of normal development.

Emergence Of Evolutionary Thoughts : Theories of evolution, Concept of Oparin and Haldane; experiment of Miller, neutral evolution, divergent evolution, convergent evolution, evolutionary time scale, Eras periods and Epoch, molecular clocks.

Molecular Evolution: Population genetics- population, gene pool, gene frequency, HardyWeinberg law, concept and rate of change in gene frequency, through natural selection, migration and random genetic drift. Speciation; Allopatricity and Sympatricity speciation.

-13 hrs.

References:

1. Principle of Genetics - Gardner, Simmons, Snustad, John Wiley.
2. Molecular Cell Biology. - Dornell Lodish and Balotimore
3. Molecular Biology of the gene - Watson.
4. Genes - Benjamin and Lewin.
5. The Tex Book of Genetics - U. Goodenough, 3/Ed. Saunders College Publishing
6. Principles of Biochemistry - Lehminzer
7. Genetics - Stickberger
8. Biochemistry - Luber Stryer
9. Genetics - Edgar Altenberg
10. Human Molecular Genetics - Tom Strachan and Andrew Read, Bioscientific Publishers Ltd.
11. Cell and Molecular Biology - Gerald karp
12. Biochemistry - Voet and Voet
13. Biochemistry - Geoffrey Zubey
14. Browder, L.N.C.A. Erickson, W.R. Jeffery, Developmental Biology, 3rd Edn. Saunders Philadelphia.
15. Gilberts E II, Gene Activity in Early Development 3rd Ed. Academic Press, Newyork
16. Russo V.E.A. et al. Development - The Molecular Genetic Approach. Springer - Verlag berten.
17. Organic Evolution- P.K. Gupta
18. Organic Evolution - Paras Publication.

B.C- 3.1: MOLECULAR BIOLOGY**Total: 52 hrs****UNIT-I**

DNA Replication in prokaryotes and eukaryotes: Physical and chemical properties of nucleic acids, purification and analysis of Nucleic acids; the basic rule(s) for replication of all nucleic acids; geometry and topological constraints of DNA replication; DNA super coiling; linking number, key enzymes of DNA replication, events on replication fork, Okazaki experiments; Messelson and Stahl experiment; fidelity of DNA replication; De novo initiation, Covalent extension mode of initiation. Models of viral DNA replication: ØX174 DNA; Adenovirus, SV-40, M13-phage DNA replication. Inhibitors of E.coli. DNA replication; replication of eukaryotic chromosomal DNA; telomerase and telomeric sequences; regulation of DNA replication inhibitors.

-13 hrs.**UNIT-II**

Transcription: DNA – protein interactions; protein-protein interactions; the organization of transcriptional units-structural genes and regulatory sequences; basic features of RNA; polynucleotide phosphorylase; prokaryotic transcription-RNA polymerase; transcription factors; different modes of transcription termination; regulation of transcription and inhibitors; Eukaryotic transcription-eukaryotic RNA polymerases; regulatory sequences; exons and introns; transcription factors; mechanism of splicing; regulation of transcription and inhibitors. Posttranscriptional modifications; processing and generation of rRNAs and tRNA. RNA enzymes and their characteristic features.

-13 hrs.**UNIT-III**

Translation: Genetic code, deciphering the genetic code; Nirenberg and Khorana's work; The genetic code of mitochondria and exceptions to the universal code; t-RNA structure; prokaryotic and eukaryotic translation factors; codon-anti-codon interaction; role of aminoacyl t-RNA synthetases; ribosomes-chemical composition; Regulation of translation and inhibitors. Post-translational modifications- cell organelles, protein sorting and targeting; protein turnover and role of ubiquitin system.

-13 hrs.**UNIT-IV**

Regulation of gene expression: General aspects of regulation of gene expression. DNA-protein and protein-protein interactions. Regulation of gene expression in prokaryotes; the operon concept; the fine structure of 'lac' operon and its regulation. The dual promoters – 'gal' operon model. Dual functions of the repressor – 'Ara' operon. Transcriptional control by attenuation and mechanism of attenuation; 'Trp' (biosynthesis) operon. Regulation of gene expression in eukaryotes; a brief account on DNA methylation and heterochromatin. RNA mediated regulation of gene expression, RNA interference and Riboswitches.

DNA Damage and Repair: Nature of Mutations: transitions, transversions; point mutations. DNA damage chemical agents and radiation - deamination, depurination, alkylation, oxidation nucleotide bases and pyrimidine dimerization. DNA damage caused by base analogues and intercalating agents. Recognition mechanism of DNA damage and dynamics of DNA repair. DNA repair systems - Photoreactivation repair, excision repair, nucleotide excision repair, recombinational repair, double-strand break repair and translesion DNA synthesis (SOS repair).

-13 hrs.

References:

1. Molecular Biology - David Freifelder
2. Essential of Molecular Biology - David Freifelder
3. Microbial Genetics - David Freifelder
4. Genes - Series-V to XI - Benjamin & Lewin
5. Molecular Biology of the Gene - Watson et al.
6. Principles of Biochemistry - Geoffrey Zubay
7. Molecular Biology of the Cell - Davidson, Lodish, Darnell and Baltimore.
8. Molecular Biology - Robert F Weaver

B.C-3.2: MEMBRANE BIOCHEMISTRY AND BIOINFORMATICS

Total: 52 hrs.

UNIT-I

MEMBRANE BIOCHEMISTRY:

Introduction to biological membrane.

Molecular constituents of membrane: Lipid composition, Proteins, Sterol, Carbohydrates.

Motion of membrane lipids: lateral and flip-flop, flippases,

Membrane proteins: peripheral proteins and integral proteins. Membrane asymmetry, proteinlipid interactions, factors affecting membrane fluidity. The supramolecular architecture of membrane: Unit membrane hypothesis, fluid model, fluid mosaic model. Techniques used to study membrane structure, freeze fracture, fluorescence microscopy, and Patch-clamp technique.

-13 hrs.

UNIT-II

Membrane transport: Introduction to membrane transport, thermodynamics of membrane transport, Non-mediated transport systems, mediated transport system (primary and secondary active transport), group translocation, co-transport.

Organization of transport system: Homocellular, Trans cellular, Intracellular.

Example of carrier mediated transport system. 1. Human erythrocyte glucose transporter

Examples of active transport system: 1. Sodium potassium ATPase: Discovery, specificity, Stiochemistry, structure, Model, inhibitors. 2. amino acid transport by γ -glutamyl cycle 3. ATP- ADP exchanger.

Specialized mechanism for transport of macromolecules: Molecular architecture of nuclear pore complex, nuclear localization signals, import and export of proteins and nucleic acids.

Bacterial transport system: Lactose permease, PEP-dependent phosphor transferase, bacterial porins.

Ionophores: Introduction, classification, cation carriers, channel formers.

-13 hrs.

BIOINFORMATICS:

UNIT-III

Introduction; Definition and Scope of Bioinformatics, Inter-relationship with various branches of life sciences.

Databases: Definition, Information generation, storage, editing and retrieval. Classification of databases - Database management system, RDBMS, Database management public agencies. NCBI data model, structures of EBI and Genome Net, Gene bank Sequence database.

Data Retrieval and Analysis from databases: Database search engines - Entrez and DBGET/Link DB, SRS. Searching sequence databases by similarities criteria, FASTA, BLAST and its variants.

-13 hrs.

UNIT-IV

Sequence alignment and database searching: Introduction, protein and nucleic acid sequence analysis, Models of sequence analysis. Sequence comparison, Tools, approaches and models for multiple sequence analysis.

Phylogenetic analysis: Tools and approaches for Tree building; Basic concepts and methods of phylogenesis evaluation. Cladistics and ontology, Evolutionary relationships.

Structure analysis: Structural databases – PDB, MMDB; Tools and approaches for protein structural analysis. Homology modeling and Molecular modeling.

Structure viewing: RasMol, etc., **Tools for Protein structural classification:**

CATH, SCOP. **Protein families:** protein families and pattern data bases, protein domain families.

Genome projects: Introductory aspects. An overview of Human Genome project and ELSI.

13 hrs.

References for Membrane Biochemistry:

1. Biochemistry of antimicrobial action: Fraklin J and Fraklin. Chapman and hall
2. Biochemistry, G.Zuby Addison Wesley.
3. Biochemistry, L.Stryer,
4. Principles of Biochemistry Lehinger
5. Biochemistry with clinical correlation. Thomas M.Devlin.
6. Membrane and their cellular functions. I.B. Filneaw, R.Coleman & R.H.Michell, Black Well Scientific publishers, Oxford press
7. Ann.Rev.Biochemistry
8. Ann.Rev.Biochemistry.

References for Bioinformatics:

1. Bioinformatics- Concepts, Skills and Applications. --- S'C. Rastogi, Namita Mendiratta and Parag Rastogi. CBS Publishers and Distributors, New Delhi.
2. Bioinformatics – A practical guide to the Analysis of Genes and Proteins. --- Andreas D Baxeains and B.F. Francis Ovellette. John Wiley & Sons.
3. Developing Bioinformatics – Computer Skills. An Introduction to software tools for Biological Applications. --- Cynthia Gibas & Per Jambeck. O'RELLY Pubs.
4. Bioinformatics- Managing Scientific Data. --- Zoe'Lacroix and Terence Critchlow. Morgan Kaufmann Pubs.
5. Bioinformatics- Sequence and Genome Analysis--- David Mount CBS Publishers and Distributors.
6. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. Stuart M Brown. Eaten Publishing – A Biotechniques Books Publication.
7. Bioinformatics Basics-Application in Biological Science and Medicine. -Hooman H Rashidi. M.S. and Lukas K Buehler. CRC Press, Boca Raton.
8. Bioinformatics: Sequence, Structure and databanks. Hortan, Moran, Ochs, Rawn, Scrimgeour. Prentice Hall Publishers.
9. Introduction to Bioinformatics. Teresa K Attwood and David J Parry-Smith.

B.C.3.3: MOLECULAR ENDOCRINOLOGY

Total: 52 hrs.

UNIT-I

Introduction to endocrinology. Location and inter-relationship of endocrine glands in man. Classification and chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, gonads and GI tract.

Functions and abnormalities due to over and under production of the hormones secreted by pituitary, thyroid, parathyroid, pancreas, adrenals and gonads. Regulation of hormone production and release.

Pineal gland – Melatonin and circadian rhythm.

-13 hrs.

UNIT-II

Mechanism of Peptide hormones: Second messenger- Definition, structural and functional classification and functions of second messengers like cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, diacyl glycerol, Ca^{2+} and nitric oxide (NO). Role of second messengers and protein kinases. Synthesis, release, transport, receptor binding, and termination of action of amino acid derivatives and peptide hormones.

Mechanism of steroid hormones; Mechanism of action of steroid hormones, conversion of cholesterol to steroid hormones; Production and Mechanism of paracrine action of prostaglandins, prostacylins, thromboxanes and leukotrienes. Antihormones.

-13 hrs.

UNIT-III

Protein Kinases: Functional classification of protein kinases; AGC group- cyclic nucleotide dependent protein kinases, Calcium and phospholipid-dependent protein kinases; CaMK group - Ca^{2+} /calmodulin-dependent protein kinases, SNF1/AMP-activated protein kinases and Ca^{2+} dependent calmodulin like domain protein kinases; CMGC group - Cyclin dependent kinases (CdKs), Mitogen activated protein kinases (MAPKs), Glycogen synthase kinase (GSK-3) and CKII (CaM kinase II); RLK (Receptor-like kinases) - S-domain RLKs, Leucine rich-repeat (LRR) RLKs, Epidermal growth factor-like (EGF-like) RLKs, Lectin receptor kinase; Specificity of protein kinases; Structure and regulation of protein kinases and role of phosphatases.

-13 hrs.

UNIT-IV

Neurotransmitters and Receptors: Mechanism of actions of neurotransmitters- Acetylcholine, catecholamine, serotonin, L-Dopa; amino acids- glutamate, aspartate, GABA, glycine, and neuropeptides like somatostatin/enkephalins. Structure, subtypes and functions of receptors of ACh, GABA, glycine, serotonin, glutamate and peptide neurotransmitters; activation by ligands and interaction with effectors. Biochemical basis of neurological diseases.

Growth factors: Structure, mechanism of action and receptor-EGF, PDGF, IGF.

-13 hrs.

References:

1. Principles of Biochemistry: Mammalian Biochemistry Emil Smith, Robert Hill, Robert Legman, Robert Lefkowitz, Philip Handler, Abraham White. Published by McGraw-Hill
2. Hormones - Norman, Anthony W., Litwack, Gerald, Litwack, Gerald. Academic Press.

3. Essential Endocrinology – Brook, Charles, Marshall and Nicholas J. John Wiley & Sons.
4. Endocrinology and Metabolism. Felig, Philip, Frohman, Lawrence A. McGraw-Hill Professional Publishing.
5. Endocrinology – Hadley, Mac E., Levine, Jon E. Addison-Wesley Publishers.
6. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin et al.
7. Clinical Biochemistry-Controw & Trumper, 1986, W.B. Saunders Pub.
8. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al, 22nd edn.,
9. Outlines of Biochemistry – White, Handler & Smith
10. Lehninger Principles of Biochemistry – 3rd Edn. David L. Nelson & Michael M. Cox
11. Annual Reviews of Biochemistry – Volumes.
12. Molecular Cell Biology – Eds. – Darnell, Lodish & Baltimore
13. Molecular Biology of the Cell – Bruce Alberts

B.C-3.4: PLANT BIOCHEMISTRY

Total: 52 hrs.

UNIT-I

Plant cell- structure, anatomy and molecular components; Cytoskeleton- an overview. Plant cell cycle and its regulation. Energy production in plant cells and its control. An overview of photosynthesis; C₃, C₄ plants and crassulacean acid metabolism; Carbon assimilation and other related pathways. Significance of RUBiSCO. Photorespiration.

Plant cell membranes and membrane transport: Introduction to plant cell membranes and membrane constituents. Organization of transport systems across plant membranes; Different types of pumps operate at plant cell and organellar membranes; classification and importance of H⁺-ATPases. Ion channels-properties and significance; Aquaporins and water transport.

-13 hrs.

UNIT-II

Plant growth regulators and Tissue Culture: Biosynthesis, and functional significance of auxins, cytokinins, gibberellins, abscisic acid, ethylene, brassinosteroids, polyamines, jasmonic acid, salicylic acid.

An overview of plant tissue culture – Totipotency of plant cell; preparation and surface sterilization of explants; composition and constituents of regular media, conditions for culture maintenance. Influence of plant growth regulators on *in vitro* plant regeneration, callogenesis.

-13 hrs.

UNIT-III

Plant Metabolism

Metabolism of sucrose and starch. Sulfur metabolism, non-protein thiols and sulfur cycle. Nitrogen metabolism -Symbiotic nitrogen fixation, nitrate and ammonium assimilation.

Plant Secondary Metabolites: Introduction; Classification- structural, functional and biosynthesis. An overview of primary metabolism contribution to secondary metabolite biosynthesis; important routes (pathways) of biosynthesis- phenyl propanoid pathway; Mevalonate pathway; Acetate- mevalonate pathway.

Strategies and approaches for the over production of plant secondary metabolites - plant cell suspension cultures, hairy root cultures, metabolic engineering, heterologous gene expression and combinatorial biochemistry.

-13 hrs.

UNIT-IV

Plant responses to biotic and abiotic stresses: Introduction; Plant pathogens and diseases; plant defense systems - hypersensitive response; systemic acquired resistance; induced systemic resistance; Plant abiotic stress responses - Salt stress, drought and heavy metal stress responses; osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds; An overview of oxidative stress and oxidative damage. Antioxidant enzymes and stress tolerance. Plant biotic stress response-pathogen and insects.

-13 hrs.

References:

1. Lehninger's principles of Biochemistry. Nelson & Cox. CBS Publishers & Distributors.
2. Biochemistry, Donald Voet and Judith G Voet. John Wiley and Sons.
3. Biochemistry, Lubert Stryer et al., W.H. Freeman & Company, New York.
4. Principles of Biochemistry, Horton, Moran, Ochs, Rawn, Scrimgeour Prentice Hall Publishers.
5. Plant Biochemistry, P.M.Dey & J.B. Harborne Hart Court Asia Pte Ltd.
6. Plant Biochemistry & Molecular Biology. P.J. Lea & Richard C Lee good. John Wiley & Sons.
7. Introduction to plant Biochemistry. Goodwin and Mercer. CBS Publisher and Distributors.
8. Biochemistry and Molecular Biology of Plants. Buchanan, Greussem and Jones. (2000). American society of Ploant Physiologists.
9. Review articles published in THE PLANT CELL: PLANT MOLECULAR BIOLOGY.
10. Articles published in Annual Review of Plant Physiology and Molecular Biology.
11. Articles published in Trends in Plant Sciences.
12. Plant Cell Tissue and organ Culture: Fundamental Methods --- O.L. Gamborg & G.C. Phillips, Narosa Publishers, New Delhi.

B.C-3.5: CLINICAL BIOCHEMISTRY (Interdisciplinary/Elective paper)

Total: 26 hrs.

UNIT-I

Introduction and Scope of clinical Biochemistry. Blood: Composition of Blood, signification of plasma proteins, Anemia, Hemophilia, Thalassemia. Cerebrospinal fluid (CSF): Composition of CSF and its Variation in Health and disease. Meningitis, Alzemiars disease, Parkinson's diseases.

Kidneys: Anatomy of Kidney fine Structure of nephron, Composition and formation of urine, abnormal constituents of urine.

Liver: functions of liver, significance of lipoproteins, liver disorders; jaundice – types, Liver cirrhosis, Liver function tests (emphasis on enzymes).

-13 hrs.

UNIT-II

Disordes of Carbohydrates metabolism: Role of glucose as major fuel molecule glycogen storage disorders, lactose intolerance, hypoglycemia, hyperglycemia, Diabetes mellitus.

Abnormalities of Lipid metabolism: Cholesterol and Hyper cholestrolemia, betalipoproteinemia, Atherosclerosis, Ketosis and acidosis, Nieman Pick's diseases, Tay sac's diseases.

Abnormalities of amino acids and nucleotide metabolism: Phenyl ketonuria maple syrup urine, gout.

-13 hrs.

References:

1. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
2. Clinical Biochemistry-Controw & Trumper, W.B. Saunders Pub.
3. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al.
4. Clinical Biochemistry – Zilva and Pannal.

B.C-4.1: MOLECULAR IMMUNOLOGY**Total: 52 hrs.****UNIT-I**

Overview of the immune system. History of immunology, types of immunity – immunity to infection; Immunological and non-immunological surface protective mechanism. Immune response during bacterial (tuberculosis), parasitic (malaria), and viral (HIV) infections.

Cells and Organs of the immune system: Cells, tissues and organs of the immune system. The two facets of the immune response system; the thymic system and bursal system. Compartmentalization; lymph nodes and Spleen. Cells involved in immune response T- cells, B-cells, Macrophages.

Complement system – Composition, pathways of activation of complement – Classical pathway, alternate pathway.

-13 hrs.**UNIT-II**

Antigens: Definitions of self antigens, foreign antigens, haptens, epitopes, adjuvants and mitogens. Immunogenicity versus antigenicity, Factors that influence immunogenicity. Protein antigens, carbohydrate antigens, Bacterial cell surface antigens, blood group antigens, tumor antigens and viral antigens. T-dependent and T-independent antigens, super antigens. Bases of antigen specificity, forces of antigen-antibody attraction.

Immunoglobulins: Isolation and purification of immunoglobulins. Basic structure of antibodies. Fine structure of Immunoglobulins, Antibody classes and biological activities. Hypervariable region. Antigenic determinants on immunoglobulins – isotypic, allotypic and idiotypic variations and idiotypic network. Antibody mediated effector functions.

Organization and expression of immunoglobulin genes: Theories of formation of antibodies. Diversity of antibodies, genetics of Ig diversity, mechanisms contributing to antibody diversity. Immunoglobulin genes, Isotype switching. Synthesis, assembly and secretion of immunoglobulins. Regulation of Ig-gene transcription. Development of malignancy. Kinetics of Ag-Ab reactions, Specificity, affinity binding of antibodies.

Antigen-Antibody interactions- Precipitation, Agglutination, Flocculation.

-13 hrs.**UNIT-III**

Major Histocompatibility complex: General organization and inheritance of the MHC. MHC molecules and genes. Genomic map of MHC genes. MHC and immune responsiveness. MHC and disease susceptibility.

Antigen Processing and presentation: Self MHC restriction of T cells. Role of antigen-presenting cells. Endogenous antigens. The cytosolic pathway, Exogenous antigens; The endocytic pathway. Presentation of non-peptide antigens.

T-Cell structure, Maturation, Activation and Differentiation: $\alpha\beta$ and $\gamma\delta$ T- cell receptors: Structure and roles. Organization & rearrangement of TCR genes. TCRCD3 complex. Alloreactivity of T-cells. Thymic selection of the T-cell repertoire. Tcell activation-signal transduction pathways. T-cell differentiation. Cell death and Tcell populations.

B-cell generation, activation and differentiation: B-cell receptor complex. B-cell maturation. B-cell activation and proliferation. The humoral response: Phases of the humoral immune response, Germinal centres and antigen induced B-cell differentiation. Regulation of B-cell development.

Soluble factors: Cytokines and their receptors. Interleukins-structure and functions. Therapeutic uses of cytokines & their receptors. Cytokines in hematopoiesis

Cell mediated effector responses: Mechanism of T-cell cytotoxicity and NK cell cytotoxicity. Antibody dependent cell mediated cytotoxicity.

-13 hrs.

UNIT-IV

Monoclonal antibodies: Hybridoma technology for productin of mAbs. Chimeric and Hybrid monoclonal antibodies, mAbs constructed from Ig-gene libraries. Applications of monoclonal antibodies.

Hypersensitivity reactions.

Autoimmune diseases: Organ specific and systemic autoimmune diseases

Immunodeficiency disorders: Primary immunodeficiencies. AIDS and other acquired or secondary immunodeficiencies. Immunological changes during AIDS.

Transplantation Immunology: Types of grafts, ABO blood group compatibility and tissue typing, Host response to transplantation, Immunosuppressive therapy. Immune tolerance to allografts.

Tumor Immunology: Immune response to tumor antigens, immunological factors favouring tumor growth, immunotherapy.

-13 hrs.

References:

1. Immunology Eds. Kuby
2. Essential Immunology, Eds. Irvfin M. Roitt, ELBS/Blackwel Scientific Pub.
3. Cellular & Molecular Immunology-Abbas & Others.

B.C-4.2: GENETIC ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY

Total: 52 hrs.

UNIT-I

Concept and emergence of recombinant-DNA technology: Gene- concept, structure and organization, basic techniques involved in rDNA technology. Cohen and Boyer patent.

Host Restriction-Modification systems: restriction enzymes (nomenclature- type I, II and III), specificity, sticky ends and blunt ends, isoschizomers, isocaudamers) restriction modification, DNA methylation systems in E. coli, other enzymes used in cloning (ligase, exonucleases, terminal transferases, DNA polymerases, RNA Polymerases, Reverse Transcriptase, etc.)

Joining of DNA molecules: Covalent linkage of DNA fragments to vector molecules: role of DNA ligase, Linkers, adapters, homopolymer tailing, restriction mapping.

-13 hrs.

UNIT-II

Vectors: Ideal properties of a vector, Plasmids - Basic proportions of plasmid (F, R and Col⁺ plasmids, copy number and its control, replication of ColE1 plasmid, plasmid incompatibility) Isolation & purification of plasmid and genomic DNA. Natural plasmids, pSC 101, Artificial plasmids: pBR322, pUC, viral vectors: λ bacteriophage vector- promoter and control circuit of bacteriophage, single stranded vector-M13 phage, T7 SV40.

High capacity vectors - Cosmids, Phagemids, brief overview of vectors based on plant and animal viruses, Ti plasmid Artificial chromosomes (YAC, BAC, HAC etc.)

Introduction of DNA into cells: Transformation, transfection, chemical methods: calcium phosphate method, electroporation, microinjection, gene gun, Short gun approach, lipofection, protoplast fusion/somatic cell hybridization and biolistic methods.

Selection and screening of recombinant clones: Direct screening; insertional inactivation of marker gene, inversion of revertible mutation. Indirect screening: Immunological techniques, nucleic acid hybridization, colony & plaque hybridization, screening using probes; construction of gene probes, and differential screening.

cDNA synthesis: Improved full length cDNA synthesis, Okayama and Berg method, nick translation selection of a clone from library.

Cloning strategies: criteria for the construction of an ideal genomic library, cDNA library, chromosome walking, chromosome jumping, jumping library construction, selection of a clone from library.

Polymerase chain reaction: Amplification, specificity, determination of Ta value, Taq polymerase, primer designing; degenerate primers, nested primers, variants of PCR techniques and their applications; Nested PCR, inverse PCR, RT_PCR, real time PCR, molecular beacon, Taqman PCR.

-13 hrs.

UNIT-III

Expression E.coli of cloned DNA : Optimization of protein expression in heterologous systems using upstream and downstream signals, transcription expression vectors (lac promoter, tryptophan promoter, lambda cl and T7 , based promoter) taq promoter, Positioning cloned sequences in correct translational reading frame. Translational expression vectors.

Fusion proteins: secretion of protein, application of fusion protein, purification of fusion protein

Micro array analysis, Proteomics - 2-D PAGE and protein mass spectra;

Applications of recombinant DNA technology: Production of recombinant proteins in bacterial and eukaryotic cells – Recombinant insulin, growth hormone, factor VIII, recombinant vaccines etc. Identification of genes responsible for human diseases, diagnostics, gene therapy. Genetically modified plants. Ethical, legal and social issues. recombinant insulin, human growth hormone, Complex human proteins, Antibiotics, Gene therapy, gene delivery systems, pro drug activation therapy, nucleic acid therapeutic agents, GM foods. . Ethical, legal and social issues related to genetic engineering.

-13 hrs.

UNIT-IV

INDUSTRIAL BIOTECHNOLOGY

Introduction: definition and scope of industrial microbiology, historical developments of industrial microbiology; Choice of microorganisms: screening – primary screening and secondary screening techniques.

Fermentation: Fermentation equipments and its uses; Media composition, bacteria, yeast and mold cultures, single and mixed cultures, propagation, maintenance and evaluation of cultures, factors affecting activity of cultures. Types of fermentation process, different types of bioreactors and biosensors.

Application of fermentation technology: Production of antibiotics (Penicillin, Streptomycin, Tetracycline, Chloramphenicol and other antibiotics as examples) - flowcharts and their design, equipment selection and manufacture process.

Production of vitamins: Vitamin B12, Riboflavin, Vitamin A as examples - flowcharts and their design, equipment selection and manufacture process.

Production of acids: Acetic acid, citric acid, lactic acid--flowcharts and their design, equipment selection and manufacture process.

-13 hrs.

References:

1. Recombinant DNA: A short course, Watson J.D.
2. Plant Protoplasts and genetic engineering, ed. Y.P.S. Bajaj Springer – Verlag – Vol I & II.
3. Guide to molecular cloning techniques. Methods in Enzymology Vol. 152 Academic press.
4. Industrial Microbiology, Eds. Miller and Litsley. Mc Graw Hill Publication
5. Industrial Microbiology, Ed. Casida L.E. Wiley Eastern Ltd.
6. Industrial Microbiology, Eds. Prescott and Dunn CBS Publication 5th ed.
7. Recombinant DNA: A short course, Watson J.D.

B.C-4.3: CELL SIGNALLING AND CELL COMMUNICATION

Total: 52 hrs.

UNIT-I

Definition of Cell Signaling, general principles of cell signaling and communication; various forms of communication between cells; signaling process and its stages – Signal recognition, transduction and cellular effect; Types of cell signaling – Autocrine signaling, Direct contact signaling, Paracrine signaling, Synaptic signaling, Endocrine (Distance) signaling.

Signal Recognition: Receptor- Definition, general characteristic features of receptors; Intra cellular receptors –Receptors for nitric oxide, steroid hormone receptors, vitamin D and thyroid hormone; Major classes of cell surface receptors- G-protein coupled receptors, cytokine receptors, Receptor tyrosine kinases, TGF β receptors, Hodgehog (Hh) receptors, Wnt receptors, Notch receptors; Regulation of receptor functions.

-13 hrs.

UNIT-II

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

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

-13 hrs.

UNIT-III

Cytokines—Interferon family: Major proteins/protein families that constitute the cytokine group of regulatory molecules; Structural classification of cytokines; Cytokine receptor superfamilies; Human interferons (IFNs) and the cells that produce interferons; Interferon signal transduction; Interferon receptors; Signalling cascades, their alteration in MAP kinases. JAK-STAT pathway; Ras pathways, TGF- β pathways Biological effects of interferons.

-13 hrs.

UNIT-IV

Cancer : Transformation of normal cell to tumor, causes of cancer. Genetic rearrangements in progenitor cells; oncogenes; tumor suppressor genes and their activation by P53, Vitamin , and TGF- β ; cancer and the cell cycle; virus-induced cancer; metastasis; interaction of cancer cell with normal cells. Therapeutic interventions of uncontrolled cell growth; Chemotherapeutic and chemo – preventive agents; antioxidants. Drug resistance in cancer chemotherapy.

Apoptosis : Programmed cell death, morphological changes, regulation of cell death; Apoptotic signaling - pro- and anti-apoptotic signaling. Role of MAP/Erk in cell death; Regulation of apoptosis by Bcl - 2 and IAP; Classification, structure and functions of caspases and their cascade in apoptosis. Role of Mitochondria in apoptosis, consequences of loss of regulation.

-13 hrs.

References:

1. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
2. Clinical Biochemistry-Controw and Trumper, W.B. Saunders Pub.
3. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al, 25th edn.,
4. Outlines of Biochemistry – White, Handler and Smith
5. Lehninger Principles of Biochemistry – 5th Edition. David L. Nelson and Michael M. Cox
6. Molecular Cell Biology – Eds. – Darnell, Lodish and Baltimore W.H. Freeman & Co..
7. Molecular Biology of the Cell – Bruce Alberts et al., Garland Science.
8. Aggarwal, B.. Human Cytokines. Blackwell Scientific, Oxford.
9. Estrov, Z.. Interferons, Basic Principles and Clinical Applications. R. G. Landes, Florence, KY.
10. Fitzgerald, K.). The Cytokine Facts Book. Academic Press, London.
11. Mantovani, A. Pharmacology of Cytokines. Oxford University Press, Oxford.
12. Mire-Shuis, A.. Cytokines. Academic Press, London.
13. Abbas, A.. Cellular and Molecular Immunology. W. B. Saunders, London.
14. Gary Walsh. Biopharmaceuticals Biochemistry and Biotechnology. 2nd Edition. John Wiley & Sons, Ltd, England
15. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3 Ed. Jhon Wiley and sons.
16. Fundamentals of Biochemistry; Voet, Voet, and Pratt. [Eds.], Jhon Wiley and sons.
17. Biochemistry; David Rawn, J. Neil Patterson Publishers.
18. Principles of Biochemistry; Smith et al., [Ed.], McGraw Hill.
19. The Biochemistry of Cell Signalling; Ernst Helmreich, OUP.
20. Basic Neurochemistry; George Siegel et al., Wippincott, Williams and Wilkins.
21. Cell biology; David E. Sadava; Jones and Bartlett Publishers
22. Biochemistry of Signal Transduction and Regulation; 3rd Edn. Gerhard Krauss, Wiley-VCH.
23. Introduction to Ecological Biochemistry, J. Harborne, Gulf. Professional Publishing.


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