Department of Biochemistry

3 Years B.Sc. Biochemistry (Honours) Course Structure
Total Credits - 150

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE - DEPARTMENT OF BIOCHEMISTRY **(Course Code: SBC)** BACHELOR OF SCIENCE (Honours) **SEMESTER - I**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC31101**	**Theory Molecules of Life**	Foundation of Bio-chemistry Water Carbohydrates &Lipids Amino Acids Nucleic acids	4	3	**1**	**0**	**4**
CORE Practical	**SBC31201**	**Practical Molecules of Life**	List of experiments will be provided separately	3	0	**0**	**2**	**2**
CORE Theory	**SBC31103**	**Theory Enzymes**	Introduction to enzymes Features of enzyme Catalysis Enzyme Kinetics Bi-substrate Reaction Enzyme Activity Regulation	4	3	**1**	**0**	**4**
CORE Practical	**SBC31203**	**Practical Enzymes**	List of experiments will be provided separately	3	0	**0**	**2**	**2**
CORE Theory	**SBC31105**	**Chemistry 1**	Atomic structure, Chemical Bonding, Chemical Thermodynamics I	3	3	**0**	**0**	**3**
FOUNDATION I	**HEN31105**	**Theory**	English Language & Literature	2	2	**0**	**0**	**2**
GENERIC ELECTIVE I (GE 1)*		**Theory**	To be chosen from the list	4	3	**1**	**0**	**4**
		Practical	List of experiments will be provided separately	3	0	**0**	**2**	**2**
TOTAL				**23**	**11**	**3**	**6**	**23**

*** 6 credit course for non-lab based subjects**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE – DEPARTMENT OF BIOCHEMISTRY BACHELOR OF SCIENCE (Honours) **SEMESTER - II**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC31102**	**Theory Proteins**	Introduction to Proteins Covalent structure of Proteins Separation Techniques Characterization of Proteins Folding and Unfolding of Protein Database	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC31202**	**Practical Proteins**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC31104**	**Theory Human Physiology**	Homeostatics Cardiovascular physiology Respiration Gastrointestinal and hepatic physiology	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC31204**	**Practical Human Physiology**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Core Theory	**SBC31106**	**Chemistry II**	Organic Chemistry : Bonding, Stereo chemistry and reaction mechanisms S_N1, S_N2	**3**	**3**	**0**	**0**	**3**
FOUNDATION	**SGY31106**	**Theory**	**Environmental Sciences and Energy Resources**	**2**	**2**	**0**	**0**	**2**
GENERIC ELECTIVE (GE 1)*		**Theory**	To Be Chosen From the List Given Below	**4**	**3**	**1**	**0**	**4**
		Practical	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
TOTAL				**23**	**11**	**3**	**6**	**23**

*** 6 credit course for non-lab based subjects**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE - DEPARTMENT OF BIOCHEMISTRY BACHELOR OF SCIENCE (Honours) **SEMESTER - III**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC32101**	**Theory Cell Biology**	Introduction Tools of Cell Biology Protein Trafficking Cytoskeletal Proteins Cell Cycle	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC32201**	**Practical Cell Biology**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC32103**	**Theory Concepts of Genetics**	Model Organism and Mandelism Genetic Definition of Gene Genetics of Bacteria and Virus Linkage and Crossing Over Human Pedigree analysis Evolutionary Genetics	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC32203**	**Practical Concepts of Genetics**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Core Theory	**SBC32105**	**Theory Metabolism of Amino Acids and Nucleotides Carbohydrates and Lipids**	Catabolism of Aminoacids Biosynthesis of amino acids Integration of Metabolism Glycolysis Gluconeogenesis and pentose phosphate pathway Synthesis of carbohydrates Biosynthesis of membrane lipids	**4**	**3**	**1**	**0**	**4**
Core Practical	**SBC32205**	**Practical Metabolism of Amino Acids and Nucleotides Carbohydrates and Lipids**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
FOUNDATION (Skill Enhancement Course **SEC I)**	**SBC32109/11**	**Theory**	**Choice Based (**List of options will be provided separately**)**	**2**	**2**	**0**	**0**	**2**
GENERIC ELECTIVE (GE 2)*		**Theory**		**4**	**3**	**1**	**0**	**4**
		Practical	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
TOTAL				**30**	**14**	**4**	**8**	**26**

*** 6 credit course for non-lab based subjects**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE - DEPARTMENT OF BIOCHEMISTRY BACHELOR OF SCIENCE (Honours) **SEMESTER - IV**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC32102**	**Theory Genetic Engineering and Biotechnology and Nano Biotechnology**	recombinant DNA technology Cloning vectors for prokaryotes and eukaryotes clone identification DNA sequencing genetic engineering in Biotechnology Nano-Biotechnology	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC32202**	**Practical Genetic Engineering and Biotechnology**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC32104**	**Theory Immunology**	Cells and organs of the immune system Immunogens and antigens Generation of receptor diversity cytotoxic responses autoimmunity and hypersensitivity	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC32204**	**Practical Immunology**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC32106**	**Theory Chemical Energetics and Bioenergetics**	Chemical and Ionic equilibrium Colligative Properties Introduction to bioenergetics Oxidative - phosphorylation Photophosphorylation	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC32206**	**Practical Metabolism of Carbohydrates and Lipids**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
FOUNDATION (Skill Enhancement Course **SEC II)**	**SBC32110/12**	**Theory**	**Choice Based (**List of options will be provided separately**)**	**2**	**2**	**0**	**0**	**2**
GENERIC ELECTIVE (GE 2)*		**Theory**	To Be Chosen From the List Below	**4**	**3**	**1**	**0**	**4**
		Practical	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
TOTAL				**30**	**14**	**4**	**8**	**26**

*** 6 credit course for non-lab based subjects**

ADAMAS UNIVERSITY								
FACULTY OF SCIENCE - DEPARTMENT OF BIOCHEMISTRY BACHELOR OF SCIENCE (Honours) **SEMESTER - V**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Week**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC33101**	**Theory Gene Organization, Replication and Repair**	Structure of DNA Replication of DNA Genes and genomic organization Molecular basis of mutations DNA repair	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC33201**	**Practical Gene Organization, Replication and Repair**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC33103**	**Theory Gene Expression and Regulation**	Biosynthesis of RNA RNA splicing The genetic code Protein targeting and degradation Regulation of gene expression in eukaryotes and Prokaryots	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC33203**	**Practical Gene Expression and Regulation**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Elective Theory DSE I (Discipline Specific)	**SBC33105/07/09**	**Bioinformatics/ Biostatistics/Animal Diversity Techniques in Biochemistry**		**4**	**3**	**1**	**0**	**4**
Elective Practical (Discipline Specific) DSE Practical I	**SBC33205/07/09**	**Bioinformatics/ Biostatistics/Animal Diversity**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Elective Theory DSE II (Discipline Specific)	**SBC33111/13/15**	**Developmental Biology / Medical Microbiology/ Ecology and Environment Management**		**4**	**3**	**1**	**0**	**4**
Elective Practical (Discipline Specific) DSE Practical II	**SBC33211/13/15**	**Developmental Biology / Medical Microbiology/ Ecology and Environment Management**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
FOUNDATION	**SBC33601**	**Industry Internship-I**						**2**
TOTAL				**28**	**1**	**4**	**8**	**26**

FACULTY OF SCIENCE - DEPARTMENT OF BIOCHEMISTRY BACHELOR OF SCIENCE (Honours) **SEMESTER - VI**								
Type of the Paper	**Paper Code**	**Theory / Practical**	**Brief Contents**	**Contact Hour Per Semester**	**L**	**T**	**P**	**Credit**
CORE Theory	**SBC33102**	**Theory Plant Biochemistry**	Plant Cell structure Photosynthesis and Carbon Assimilation Nitrogen Metabolism Respiration Plant Growth Plant Tissue Culture	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC33202**	**Practical Plant Biochemistry**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
CORE Theory	**SBC33104**	**Theory Hormone: Biochemistry and Function**	Endocrinology Hormone mediated signaling Hypothalamic and pituitary hormones Pancreatic and GI tract hormones Growth factors	**4**	**3**	**1**	**0**	**4**
CORE Practical	**SBC33204**	**Practical Hormone: Biochemistry and Function**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Elective Theory DSE III (Discipline Specific)	**SBC33106/08/10**	**Environmental Biotechnology/ Intellectual Property Rights/ Microbial Physiology/ Advanced spectroscopy in Biochemistry**		**4**	**3**	**1**	**0**	**4**
Elective Practical (Discipline Specific) DSE Practical III	**SBC33206/08/10**	**Environmental Biotechnology/ Intellectual Property Rights/ Microbial Physiology**	List of experiments will be provided separately	**3**	**0**	**0**	**2**	**2**
Elective DSE IV (Discipline Specific)	**SBC33712**	**Dissertation**		**9**	**6**	**0**	**0**	**6**
FOUNDATION	**SBC33602**	**Industry Internship-II**						**2**
TOTAL				**30**	**15**	**3**	**6**	**26**

LIST OF 'GENERIC ELECTIVE (GE1)' SUBJECTS OFFERED BY THE DEPT. OF BIOTECHNOLOGY IN 1st YEAR:

1. Zoology
2. Botany
3. Physiology
5. Physics
4. Mathematics*
***6 credit course, non-lab based**

LIST OF 'GENERIC ELECTIVE (GE2)' SUBJECTS OFFERED BY THE DEPT. OF BIOTECHNOLOGY IN 2nd YEAR:

1. Zoology
2. Botany
3. Physiology
5. Physics
4. Mathematics*
***6 credit course, non-lab based**

LIST OF 'SKILL ENHANCEMENT' SUBJECTS OFFERED BY THE DEPT. OF BIOTECHNOLOGY*:

Skill Enhancement Course SEC I (For Semester III) (Choose any one)	Skill Enhancement Course SEC I (For Semester IV)(Choose any one)
1. Molecular Diagnostics (**SBT32109)**	1. Enzymology **(SBT32110)**
2. Molecular Modeling and Drug Designing (**SBT32111)**	2. Basics of Forensic Science **(SBT32112)**

*Offering of subjects will vary from year to year subject to availability of faculty

LIST OF 'DISCIPLINE SPECIFIC ELECTIVE' PAPERS OFFERED BY THE DEPT. OF BIOTECHNOLOGY*:

DSE – I (Theory)
1. Bioinformatics [SBT33105]
2. Biostatistics [SBT33107]
3. Evolutionary Biology [SBT33109]
4. Techniques in Bio-Chemistry I [SCY33110]

DSE – I (Practical)
1. Bioinformatics [SBT33205]
2. Biostatics [SBT33207]
3. Evolutionary Biology [SBT33209]
4. Techniques in Bio-Chemistry I [SCY33210]

DSE – II (Theory)

1. Developmental Biology [SBT33111]
2. Medical Microbiology [SBT33113]
3. Ecology and Environment Management [SBT33115]
4. Advanced Spectroscopy in Biochemistry [SCY 33109]

DSE – II (Practical)

1. Developmental Biology [SBT33211]
2. Medical Microbiology [SBT33213]
3. Ecology and Environment Management [SBT33215]

DSE – III (Theory)

1. Environmental Biotechnology [SBT33106]
2. Intellectual Property Rights [SBT33108]*
3. Microbial Physiology [SBT33110]
4. Advanced Spectroscopy in Biochemistry [SCY 33209]

DSE – III (Practical)

1. Environmental Biotechnology [SBT33206]
2. Microbial Physiology [SBT33208]
3. 4. Advanced Spectroscopy in Biochemistry [SCY 33209]

*** Purely Theoretical Papers with 6 credits.**

DSE IV: Dissertation

***Offering of subjects will vary from year to year subject to availability of faculty**

B.Sc. (HONOURS) BIOCHEMISTRY (CBCS STRUCTURE)

C1: MOLECULES OF LIFE (THEORY)

SEMESTER - I

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 The foundations of biochemistry **No. of Hours: 2**

Cellular and chemical foundations of life

Unit 2 Water **No. of Hours: 4**

Unique properties, weak interactions in aqueous systems, ionization of water, buffers, water as a reactant and fitness of the aqueous environment.

Unit 3 Carbohydrates and glycobiology **No. of Hours: 16**

Monosaccharides - structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers, structure of biologically important sugar derivatives, oxidation of sugars. Formation of disaccharides, reducing and non-reducing disaccharides. Polysaccharides – homo- and heteropolysaccharides, structural and storage polysaccharides. Structure and role of proteoglycans, glycoproteins and glycolipids (gangliosides and lipopolysaccharides). Carbohydrates as informational molecules, working with carbohydrates

Unit 4 Lipids **No. of Hours: 14**

Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Plant steroids. Lipids as signals, cofactors and pigments

Unit 5 Amino acids **No. of Hours : 8**

Structure and classification, physical, chemical and optical properties of amino acids

Unit 6 Nucleic acids **No. of Hours : 10**

Nucleotides - structure and properties. Nucleic acid structure – Watson-Crick model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. Nucleic acid chemistry - UV absorption, effect of acid and alkali on DNA. Other functions of nucleotides - source of energy, component of coenzymes, second messengers.

Unit 7 Vitamins **No. of Hours: 6**

Structure and active forms of water soluble and fat soluble vitamins, deficiency diseases and symptoms, hypervitaminosis

C-1 : MOLECULES OF LIFE (PRACTICALS)

SEMESTER - I

TOTAL HOURS : 60 **CREDIT : 2**

1. Safety measures in laboratories.

2. Preparation of normal and molar solutions.
3. Preparation of buffers.
4. Determination of pKa of acetic acid and glycine.
5. Qualitative tests for carbohydrates, lipids, amino acids, proteins and nucleic acids.
6. Separation of amino acids/ sugars/ bases by thin layer chromatography.
7. Estimation of vitamin C.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN:978-0-470-28173-4.

C-2 : ENZYMES (THEORY)

SEMESTER – I

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Introduction to enzymes **No. of Hours: 2**

Nature of enzymes - protein and non-protein (ribozyme). Cofactor and prosthetic group, apoenzyme, holoenzyme. IUBMB classification of enzymes.]

Unit 2 Features of Chemical Kinetics **No. of Hours: 6**

Concept of Chemical Kinetics and its significance, Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Unit 3 Enzyme kinetics **No. of Hours: 10**

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant - monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot, Eadie-Hofstee and Hanes plot. K_m and V_{max}, K_{cat} and turnover number. Effect of pH, temperature and metal ions on the activity of enzyme.

Unit 4 Bisubstrate reactions **No. of Hours: 2**

Types of bi bi reactions (sequential – ordered and random, ping pong reactions). Differentiating bi substrate mechanisms (diagnostic plots, isotope exchange).

Unit 5 Enzyme inhibition **No. of Hours: 8**

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors - antibiotics as inhibitors.

Unit 6 Mechanism of action of enzymes **No. of Hours: 8**

General features - proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Unit 7 Regulation of enzyme activity **No. of Hours: 8**

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Proteolytic cleavage- zymogen**.** Multienzyme complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes - properties and physiological significance (lactate dehydrogenase).

Unit 8 Involvement of coenzymes in enzyme catalysed reactions **No. of Hours: 6**

TPP, FAD, NAD, pyridoxal phosphate, biotin, coenzyme A, tetrahydrofolate, lipoic acid.

Unit 9 Applications of enzymes **No. of Hours: 10**

Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), enzyme immunoassay (HRPO), enzyme therapy (Streptokinase). Immobilized enzymes.

C-2 : ENZYMES (PRACTICAL)

SEMESTER – II

TOTAL HOURS : 60 **CREDITS: 2**

1. Partial purification of acid phosphatase from germinating mung bean.

2. Assay of enzyme activity and specific activity, e.g. acid phosphatase.
3. Effect of pH on enzyme activity
4. Determination of K_m and V_{max} using Lineweaver-Burk graph.
5. Enzyme inhibition - calculation of K_i for competitive inhibition.
6. Continuous assay of lactate dehydrogenase.
7. Coupled assay of glucose-6-phosphate dehydrogenase.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

2. Biochemistry (2011) 4th ed., Donald, V. and Judith G.V., John Wiley & Sons Asia Pvt. Ltd. (New Jersey), ISBN:978-1180-25024.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.

C-3: CHEMISTRY 1(THEORY)
Credit 3 ; SEMESTER – I; Lectures :45

Unit 1: Atomic Structure (8 Lectures)

Introductory Quantum Mechanics associated to atomic structure, Quantum numbers, introduction to the concept of atomic orbitals; shapes, radial and angular probability diagrams of s, p and d orbitals (qualitative idea). Many electron atoms and ions: Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation. Linear combination of atomic orbitals, hybrid orbitals; orbital picture of bonding.

Unit 2: Chemical Bonding (12 Lectures)

Ionic Bonding: Size effects, radius ratio rules and their limitations. Packing of ions in crystals, lattice energy, Born- lande equation and its applications, polarizing power and polarizability, ionic potential, Fajan's rules.

Covalent Bonding: Lewis structures, formal charge. Valence Bond Theory, directional character of covalent bonds, hybridizations, equivalent and non-equivalent hybrid orbitals, Bent's rule, VSEPR theory, shapes of molecules and ions containing lone pairs and bond pairs (examples from main group chemistry), Partial ionic character of covalent bonds, bond moment, dipole moment and electronegativity differences.

Weak chemical forces: dipole-induced, dipole interactions and hydrogen bonding

Unit 3: Thermodynamics and its Significance in Biology (25 Lectures)

Importance and scope of thermodynamics in Biology, definition of system and surroundings: type of systems (isolated, closed and open); extensive and intensive properties; steady state versus equilibrium state; concept of thermal equilibrium and the zeroth law of thermodynamics; thermodynamic coordinates, state of a system, equation of state, state functions and path functions; partial derivatives and cyclic rule; concept of heat and work (IUPAC convention); first law of thermodynamics, internal energy (U) as a state function; enthalpy as a state function; energy conservation in the living organism; heat changes at constant volume and constant pressure; relation between C_p and C_v using ideal gas; joule‘s experiment; explanation of term $(\delta U/\delta V)_T$; isothermal and adiabatic processes; thermo chemistry: heat changes during physicochemical processes at constant pressure/volume; bond dissociation energies; changes of thermodynamic properties in different chemical changes, Introduction to second law of thermodynamics , concept of entropy

C-4: PROTEINS

Semester-II

Credit-4 **Lectures-60**

Unit 1 Introduction to amino acids, peptides and proteins **No. of Hours: 2**

Amino acids and their properties - hydrophobic, polar and charged. Biologically important peptides - hormones, antibiotics and growth factors. Multimeric proteins, conjugated proteins and metallo proteins. Diversity of function

Unit 2 Extraction of proteins for downstream processing **No. of Hours: 4**

Solubilization of proteins from their cellular and extracellular locations. Use of simple grinding methods, homogenization, ultrasonication, French press and centrifugation.

Unit 3 Separation techniques **No. of Hours: 10**

Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography, HPLC and FPLC

Unit 4 Characterization of proteins **No. of Hours: 8**

Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.

Unit 5 Covalent structure of proteins **No. of Hours: 12**

Organization of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques - Edman degradation. Generation of overlap peptides using different enzymes and chemical reagents. Disulfide bonds and their location. Mass spectrometric analysis, tandem MS. Solid phase peptide synthesis

Unit 6 Three dimensional structures of proteins **No. of Hours: 6**

Nature of stabilizing bonds - covalent and non covalent. Importance of primary structure in folding. The peptide bond - bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Techniques used in studying 3-D structures - X-ray diffraction and NMR. Motifs and domains. Tertiary and quaternary structures. Structures of myoglobin and haemoglobin

Unit 7 Protein folding and conformational diseases **No. of Hours: 4**

Denaturation and renaturation of Ribonuclease A. Introduction to thermodynamics of folding and molten globule. Assisted folding by molecular chaperones, chaperonins and PDI. Defects in protein folding. Diseases –Alzheimer's and Prion based.

Unit 8 Introduction to protein structure databases **No. of Hours: 2**

Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using *in silico* tools.

Unit 9 Myoglobin and haemoglobin **No. of Hours: 6**

Oxygen binding curves, influence of 2,3-BPG, CO_2 and Cl^-. Hill plot. Cooperativity between subunits and models to explain the phenomena - concerted and sequential models. Haemoglobin disorders.

Unit 10 Specialized proteins - antibodies and actin-myosin motors No. of Hours: 4

Antibody structure and binding to antigens. ATP activated actin - myosin contractions.

Unit 11 Membrane proteins No. of Hours: 2

Integral and membrane associated proteins. Hydropathy plots to predict transmembrane domains. Significance of membrane proteins - bacteriorhodopsin.

C-4: Proteins(Practical)

SEMESTER – II

TOTAL HOURS : 60 CREDIT: 2

1. Estimation of proteins using UV absorbance and Biuret method.
2. Microassay of proteins using Lowry/Bradford method.
3. Isoelectric pH of casein.
4. Ammonium sulphate fractionation of serum proteins.
5. Separation of albumin from serum using anion-exchange chromatography.
6. SDS-PAGE analysis of proteins.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13: 978-1-4641-0962-1 / ISBN:10:1-4292-3414-8.

2. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.

3. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

C-5: HUMAN PHYSIOLOGY (THEORY)

SEMESTER – II

Credit-4 **Lectures-60**

Unit 1 Homeostasis and the organization of body fluid compartments No. of Hours : 6
Intracellular, extracellular and interstitial fluid. Homeostasis, control system and their components. Plasma as an extracellular fluid, RBC, molecular mechanism of blood coagulation, role of vitamin K in coagulation, anticoagulant and fibrinolytic systems. Anemias, polycythemia, haemophilia and thrombosis.

Unit 2 Cardiovascular physiology No. of Hours : 10

Pressure, flow and resistance. Anatomy of heart. Physiology of the cardiac muscle, automacity of the cardiac muscle contraction, excitation contraction coupling, relationship between cardiac cycle, heart sound, ventricular volumes and the ECG, control of cardiac function and output. The arterial system, venous system, the microcirculation and mechanics of capillary fluid exchange. Control of blood flow to the tissues. Portal circulations. Arterial pressure and its regulation. Hypertension, congestive heart disease, atherosclerosis and myocardial infarction.

Unit 3 Respiration No. of Hours : 10
Organization of the pulmonary system. Mechanism of respiration, pulmonary ventilation and related volumes, pulmonary circulation. Principles of gas exchange and transport. Regulation of respiration. Pulmonary oedema and regulation of pleural fluid. Hypoxia, hypercapnea, pulmonary distress, emphesema, ARDS.

Unit 4 Renal physiology No. of Hours : 6
Anatomy of the kidney and the nephron. Regulation of renal blood flow. Cell biology of the Bowmans' capsule. Physiology of glomerular filtration and GFR. Tubular processing of the glomerular filtrate. Micturition reflex and voluntary control of micturition. Regulation of ECF electrolyte and water content, blood volume and long term blood pressure. Blood buffer systems, renal and pulmonary control of blood pH, renal clearance. Assessment of kidney function. Acidosis and alkalosis. Glomerular nephritis, renal failure, dialysis and diuretics.

Unit 5 Gastrointestinal and hepatic physiology No. of Hours : 6
Histology of the gastrointestinal tract. Propulsion and motility of food and digested material. Enteric reflexes, secretory functions of the gastrointestinal tract, digestion and absorption of macro and micronutrients. Peptic ulcer, Sprue, celiac disease, IBD, regurgitation, diarrhoea and constipation. Anatomy of the hepatic lobule and blood flow into the liver. Formation and secretion of bile. enterohepatic cycle, reticuloendothelial system, metabolic importance of liver. Liver function tests. Jaundice, liver cirrhosis and fatty liver.

Unit 6 Musculosketetal system No. of Hours : 4

Bone structure and formation. Physiology of muscle contraction in striated and non-striated muscle.

Unit 7 Reproductive physiology No. of Hours : 8

Sex determination and differentiation. Development of female and male genital tracts. Spermatogenesis, capacitation and transport of sperm, blood testis barrier. Ovarian function and its control. Uterine changes, fertilization and implantation. Placenta as a feto- maternal unit, gestation and parturition.

Unit 8 Neurochemistry and neurophysiology **No. of Hours : 10**

Central Nervous system. Peripheral Nervous system. Blood brain barrier and CSF. Membrane potentials. Synaptic transmission. Neurotransmitters. Sensory receptors and neural pathways. Somatic sensation, EEG, sleep, coma, learning and memory**.**

C-5 : HUMAN PHYSIOLOGY (PRACTICALS)

SEMESTER - II

TOTAL HOURS : 60 **CREDITS: 2**

1. Hematology.
   a. RBC and WBC counting
   b. Differential leucocyte count.
   c. Clotting time.
2. Estimation of haemoglobin.
3. Separation of plasma proteins.
4. Determination of total iron binding capacity.
5. Pulmonary function tests, spirometry and measurement of blood pressure.
6. Separation of isoenzymes of LDH by electrophoresis.
7. Histology of connective tissue, liver and/ brain permanent slides.
8. Case studies (Renal clearance, GFR, ECG).

SUGGESTED READINGS

1. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T., McGraw Hill International Publications (New York), ISBN: 978-0-07-128366-3.

2. Harper's Biochemistry (2012) 29th ed., Murray, R.K., Granner, D.K., Mayes and P.A., Rodwell, V.W., Lange Medical Books/McGraw Hill. ISBN:978-0-07-176-576-3.

3. Textbook of Medical Physiology (2011) 10th ed., Guyton, A.C. and Hall, J.E., Reed Elseviers India Pvt. Ltd. (New Delhi). ISBN: 978-1-4160-4574-8.

4. Fundamental of Anatomy and Physiology (2009), 8th ed., Martini, F.H. and Nath, J.L., Pearson Publications (San Francisco), ISBN: 10:0-321-53910-9 / ISBN: 13: 978-0321-53910-6.

C-6: Chemistry-II
Semester-II

Credit: 3 **Lectures-45**

Unit 1 - General Introduction and Bonding Features in Organic Molecules (15L)
Functional group based classification and nomenclature. Sources / origin of different compounds.Molecular formula and IHD / DBE.

Valence bond theory: Concept of hybridisation, resonance (including hyperconjugation), inductive effect, steric effect, steric inhibition of resonance. Orbital pictures of bonding (sp^3, Sp^2, sp: C-C, C-N & C-O system).
MO theory: Sketch and energy levels of MOs of i) acyclic π orbital system (C=C, conjugated diene and allyl systems) ii) cyclic π orbital system (neutral system: [4], [6] annulenes; charged system: 3, 4, 5-membered ring system); Frost diagram, Huckel's rules for aromaticity, antiaromaticity; homoaromaticity.
Physical properties: Melting point, boiling point; solubility; dipole moment; acid and base strength.

Unit 2 - Stereochemistry and Conformation (15L)

Stereochemistry: Symmetry, chirality, optical activity, optical purity. Stereogenic units i) stereocentres: systems involving 1, 2, 3 centres, stereogenicity, chirotopicity. pseudo asymmetric (D/ Land R/S descriptor, threo / erythro and syn / anti nomenclatures (for aldols) ii) stereoaxis: chiral axis in allenes& biphenyls, R / S descriptor; cis / trans, syn / anti, E / Z descriptors (for C=C, C=N). Topicity of ligands and faces (elementary idea) and descriptors.

Conformation: Conformational nomenclature; factors affecting stability of conformations, conformational analysis of ethane, propane, butane, haloethane, 1,2-haloethane, 1,2-glycol, 1,2-halohydrin; invertomerism of trialkylamines. Conformational analysis: 4, 5, 6-membered rings; substituted cyclohexane.

Unit-3 Reaction mechanism (15L)

Reaction kinetics: Rate const and free energy of activation, free energy profiles for one step andmulti step reactions, catalyzed reactions, kinetic control and thermodynamic control, kinetic isotopic effect, principle of microscopic reversibility, Hammond postulate.

Nucleophilic substitution at sp^3centre: Mechanism: S_N1, S_N2, S_Ni mechanisms, effect ofsolvent, substrate structure, leaving group, nuc1eophiles including ambident nucleophiles, substitution involving NGP; relative rate &stereochemical features [systems: alkyl halides, allyl halides, alcohols, ethers, epoxides]

Reference books:

- Eliel, E. L. & Wilen, S. H. *Stereochemistry of Organic Compounds*, Wiley: London, 1994.
- Kalsi, P. S. *Stereochemistry Conformation and Mechanism*, New Age International, 2005.
- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt.Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry (Volume 1)*, Dorling Kindersley (India) Pvt. Ltd.(Pearson Education).
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.

C-7 : CELL BIOLOGY (THEORY)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Introduction to cell biology **No. of Hours: 4**

Prokaryotic (archaea and eubacteria) and eukaryotic cell (animal and plant cells), cells as experimental models.

Unit 2 Tools of cell biology **No. of Hours: 8**

Light microscopy, phase contrast microscopy, fluorescence microscopy, confocal microscopy, electron microscopy, FACS. Centrifugation for subcellular fractionation.

Unit 3 Structure of different cell organelles **No. of Hours: 10**

Structure of nuclear envelope, nuclear pore complex. ER structure. Organization of Golgi. Lysosome. Structure and functions of mitochondria, chloroplasts and peroxisomes. Zellweger syndrome.

Unit 4 Protein trafficking **No. of Hours: 14**

Selective transport of proteins to and from the nucleus. Regulation of nuclear protein import and export. Targeting proteins to ER, smooth ER and lipid synthesis. Export of proteins and lipids from ER and into ER. Lipid and polysaccharide metabolism in Golgi. Protein sorting and export from Golgi. Mechanism of vesicular transport, cargo selection, coat proteins and vesicle budding, vesicle fusion. Protein import and mitochondrial assembly, protein export from mitochondrial matrix. Import and sorting of chloroplast proteins.

Unit 5 Cytoskeletal proteins **No. of Hours: 8**

Structure and organization of actin filaments. Treadmilling and role of ATP in microfilament polymerization, organization of actin filaments. Non-muscle myosin. Intermediate filament proteins, assembly and intracellular organization. Assembly, organization and movement of cilia and flagella.

Unit 6 Cell wall and extracellular matrix **No. of Hours: 6**

Prokaryotic and eukaryotic cell wall, cell matrix proteins. Cell-matrix interactions and cell-cell interactions. Adherence junctions, tight junctions, gap junctions, desmosomes, hemidesmosomes, focal adhesions and plasmodesmata.

Unit 7 Cell cycle, cell death and cell renewal **No. of Hours: 10**

Eukaryotic cell cycle, restriction point, and checkpoints. Cell division. Apoptosis and necrosis - brief outline. Salient features of a transformed cell.

C-7 : CELL BIOLOGY (THEORY)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 2**

1. Visualization of animal and plant cell by methylene blue.

2. Identification of different stages of mitosis in onion root tip.
3. Identification of different stages of meiosis in grasshopper testis.
4. Micrographs of different cell components (dry lab).
5. Sub-cellular fractionation.
6. Visualization of nuclear fraction by acetocarmine stain.
7. Staining and visualization of mitochondria by Janus green stain.

SUGGESTED READINGS

1. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.

2. Molecular Cell Biology (2012) 7th ed., Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2 / ISBN:10: 1-4641-0981-8.

3. Molecular Biology of the Cell (2008) 5th ed., Alberts, B., Johnson,A., Lewis, J., and Enlarge, M., Garland Science (Princeton), ISBN:0-8153-1619-4 / ISBN:0-8153-1620-8.

C-8 : CONCEPTS IN GENETICS (THEORY)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Introduction to model organisms and Mendelism **No. of Hours : 4**

Model organisms: *Escherichia coli*, *Saccharomyces cerevisiae*, *Drosophila melanogaster*, *Caenorhabditis elegans*, *Danio rerio* and *Arabidopsis thaliana*, Basic principles of heredity.

Unit 2 Applications of Mendel's principles & chromosomal basis of heredity **No. of Hours : 6**

Laws of probability & binomial expansion, formulating and testing genetic hypothesis, chromosomal basis of Mendelism -Sutton and Boveri hypothesis with experimental evidences.

Unit 3 Extensions of Mendelism **No. of Hours : 4**

Allelic variation and gene function - dominance relationships, multiple alleles, lethal alleles and null alleles. Pleiotropy gene interaction - epistatic and non epistatic, interaction between gene(s) and environment. Penetrance and expressivity, norm of reaction and phenocopy.

Unit 4 Genetic definition of a gene **No. of Hours : 4**

Complementation test, limitations of *cis-trans* test, intragenic complementation, rII locus of phage T_4 and concept of cistron

Unit 5 Genetics of bacteria and viruses **No. of Hours : 6**

Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

Unit 6 Linkage, crossing over and mapping techniques **No. of Hours : 6**

Linkage and crossing over, genetic mapping in eukaryotes, centromere mapping with ordered tetrads, cytogenetic mapping with deletions and duplications in *Drosophila*, detection of linked loci by pedigree analysis in humans and somatic cell hybridization for positioning genes on chromosomes.

Unit 7 Human pedigree analysis **No. of Hours : 6**

Pedigree conventions, characteristics of dominant and recessive inheritance. Applications of pedigree analysis.

Unit 8 The genetic control of development and sex determination **No. of Hours : 6**

Model organism for genetic analysis, *Drosophila* development, maternal effect genes, morphogens and zygotic gene activity in development, sex chromosomes and sex determination, dosage compensation of X-linked genes.

Unit 9 Organelle heredity and epigenetics **No. of Hours : 4**

Extra nuclear inheritance, tests for organelle heredity and maternal effect, epigenetic mechanisms of transcriptional regulation & genomic imprinting.

Unit 10 Chromosomal aberrations **No. of Hours : 4**

Variations in chromosome number- monosomy and trisomy of sex and autosomes. Variations in chromosome structure - inversions, deletions, duplications and translocations.

Unit 11 Inheritance of complex traits & population genetics **No. of Hours : 6**

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hardy- Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle.

Evolutionary genetics **No. of Hours : 4**

Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, phenotypic evolution and speciation.

C-8 : CONCEPTS IN GENETICS (PRACTICALS)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 2**

1. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.

2. Induction of polyploidy in onion roots.
3. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
4. Monohybrid crosses in *Drosophila* for studying autosomal and sex linked inheritance.
5. PTC testing in a population and calculation of allele and genotype frequencies.
6. Study of abnormal human karyotype and pedigrees (dry lab)
7. Conjugation in bacteria

SUGGESTED READINGS

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

C-9 : METABOLISM OF AMINO ACIDS AND NUCLEOTIDES, Carbohydrates and Lipids (THEORY)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Overview of amino acid metabolism

Nitrogen cycle, incorporation of ammonia into biomolecules. Metabolic fates of amino groups. Digestion and absorption of dietary proteins. Protein calorie malnutrition - Kwashiorkar and Marasmus. Nitrogen balance, transamination, role of pyridoxal phosphate, glucose-alanine cycle, Kreb's bicycle, urea cycle and inherited defects of urea cycle.

Unit 2 Catabolism of amino acids

Catabolic pathways of individual amino acids. Glucogenic and ketogenic amino acids. Metabolism of one carbon units. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic acidemia (MMA), homocystinuria and Hartnup's disease.

Unit 3 Biosynthesis of amino acids

Overview of amino acid synthesis. Biosynthesis of non-essential amino acids and its regulation.

Unit 4 Precursor functions of amino acids

Biosynthesis of creatine and creatinine, polyamines (putresine, spermine, spermidine), catecholamines (dopamine, epinephrine, norepinephrine) and neurotransmitters (serotonin, GABA). Porphyrin biosynthesis, catabolism and disorders of porphyrin metabolism.

Unit 5 Biosynthesis of purine and pyrimidine nucleotides

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.

Unit 6 Deoxyribonucleotides and synthesis of nucleotide triphosphate

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Unit 7 Degradation of purine and pyrimidine nucleotides

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Unit 8 Integration of metabolism

Integration of metabolic pathways (carbohydrate, lipid and amino acid metabolic pathways), tissue specific metabolism (brain, muscle, and liver).
Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.

Unit 9 Glycolysis

Glycolysis - a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.

Unit 10 Gluconeogenesis and pentose phosphate pathway **No. of Hours: 4**

Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Unit 11 Glycogen metabolism **No. of Hours: 4**

Glycogenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Unit 12 Citric acid cycle **No. of Hours: 6**

Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Unit 13 Synthesis of carbohydrates **No. of Hours: 8**

Calvin cycle, regulation of calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C_4 and CAM pathways, synthesis of cell wall polysaccharides, integration of carbohydrate metabolism in plant cell.

Unit 14 Fatty acid oxidation **No. of Hours : 10**

Digestion, mobilisation and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondria, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acids, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis.

Unit 15 Fatty acid synthesis **No. of Hours: 6**

Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation.

Unit 16 Biosynthesis of eicosanoids, cholesterol, steroids and isoprenoids No. of Hours: 6

Synthesis of prostagladins, leukotrienes and thromboxanes. Synthesis of cholesterol, regulation of cholesterol synthesis. Synthesis of steroids and isoprenoids.

Unit 17 Biosynthesis of membrane lipids **No. of Hours: 4**

Synthesis of membrane phospholipids in prokaryotes and eukaryotes, respiratory distress syndrome, biosynthesis of triacylglycerol, biosynthesis of plasmalogens, sphingolipids and glycolipids, lipid storage diseases.

Unit 17 Starve-feed cycle **No. of Hours: 4**

Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis

C-9 : METABOLISM OF AMINO ACIDS AND NUCLEOTIDES (PRACTICAL)

SEMESTER - III

TOTAL HOURS : 60 **CREDITS: 2**

1. Assay of serum transaminases – SGOT and SGPT.
2. Estimation of serum urea.
3. Estimation of serum uric acid.
4. Estimation of serum creatinine.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New York), ISBN: 978-0-470-28173-4 / BRV ISBN: 978-0-470-60152-
3. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

4. Biochemistry (2012) 7th ed., Berg, J.M., Tymoczko, J.L. and Stryer L., W.H. Freeman and Company (New York), ISBN:10:1-4292-2936-5, ISBN:13:978-1-4292-2936-4
5.

C-10 : GENETIC ENGINEERING AND BIOTECHNOLOGY (THEORY)

SEMESTER - IV

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Introduction to recombinant DNA technology **No. of Hours : 6**

Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other enzymes used in manipulating DNA molecules, separation of DNA by gel electrophoresis. Extraction and purification of plasmid and bacteriophage DNA.

Unit 2 Cloning vectors for prokaryotes and eukaryotes **No. of Hours : 10**

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli* plasmids, pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Vectors for yeast, higher plants and animals.

Unit 3 Joining of DNA fragments **No. of Hours : 4**

Ligation of DNA molecules. DNA ligase, sticky ends, blunt ends, linkers and adapters. Synthetic oligonucleotides, synthesis and use.

Unit 4 Introduction of DNA into cells and selection for recombinants

No. of Hours : 6

Uptake of DNA by cells, preparation of competent cells. Selection for transformed cells. Identification for recombinants - insertional inactivation, blue-white selection. Introduction of phage DNA into bacterial cells. Identification of recombinant phages. Introduction of DNA into animal cells, electroporation.

Unit 5 Methods for clone identification **No. of Hours : 6**

The problem of selection, direct selection, marker rescue. Gene libraries, identification of a clone from gene library, colony and plaque hybridization probing, methods based on detection of the translation product of the cloned gene.

Unit 6 Polymerase chain reaction **No. of Hours : 4**

Fundamentals of polymerase chain reaction, designing primers for PCR. Studying PCR products. Cloning PCR products. Real time PCR.

Unit 7 DNA sequencing **No. of Hours : 6**

DNA sequencing by Sanger's method, modifications based on Sanger's method. Automated DNA sequencing. Pyrosequencing.

Unit 8 Expression of cloned genes **No. of Hours : 6**

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Challenges in producing recombinant protein in *E. coli*. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

Unit 9 Applications of genetic engineering in Biotechnology **No. of Hours : 12**

Site–directed mutagenesis and protein engineering. Applications in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy. Applications in agriculture - plant genetic engineering, herbicide resistant crops, problems with genetically modified plants, safety concerns.

C-10 : GENETIC ENGINEERING AND BIOTECHNOLOGY (PRACTICALS)

SEMESTER - IV

TOTAL HOURS : 60 **CREDITS: 2**

1. Isolation of plasmid DNA from *E. coli* cells.

2. Digestion of plasmid DNA with restriction enzymes.
3. Amplification of a DNA fragment by PCR.
4. Transformation of *E. coli* cells with plasmid DNA.
5. Hyper expression of poly histidine-tagged recombinant protein and purification using Ni-affinity resin.

SUGGESTED READINGS

1. Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.

Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC)

C-11 : IMMUNOLOGY (THEORY)

SEMESTER - IV

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Cells and organs of the immune system **No. of Hours : 4**

Hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT).

Unit 2 Innate immunity and leukocyte extravasation **No. of Hours : 6**

Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response.

Unit 3 Immunogens and antigens **No. of Hours : 4**

Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.

Unit 4 Antibody structure and function **No. of Hours : 4**

Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family**.**

Unit 5 Generation of receptor diversity **No. of Hours : 4**

Dreyer-Bennett hypothesis, multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification.

Unit 6 Biology of the B lymphocyte **No. of Hours : 6**

Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response, anatomical distribution of B cell populations.

Unit 7 Complement system **No. of Hours : 4**

Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies.

Unit 8 MHC complex and antigen presentation **No. of Hours : 4**

General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, linkage disequilibrium, pathways of antigen processing and presentation.

Unit 9 Biology of the T lymphocyte **No. of Hours : 4**

Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation.

Unit 10 Cell mediated cytotoxic responses **No. of Hours : 4**

General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Unit 11 Tolerance, autoimmunity and hypersensitivity **No. of Hours : 8**

Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity.

Unit 12 Transplantation immunology and vaccines **No. of Hours : 8**

Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy and privileged sites. Vaccines - active and passive immunization, types of vaccines.

C-11 : IMMUNOLOGY (PRACTICALS)

SEMESTER - IV

TOTAL HOURS : 60 **CREDITS: 2**

1. Isolation of lymphocytes from blood and macrophages from peritoneal cavity or spleen.

2. Purification of immunoglobulins.
3. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
4. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
5. Enzyme linked immune-sorbent assay (ELISA).

SUGGESTED READINGS

1. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590-0.
2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

3. Janeway's Immunobiology (2012) 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN: 978-0-8153-4243-4

C12: Chemical Energetics and Bioenergetics

Semester-IV

Credit: 4 **Lectures:60**

Unit-1 Chemical Equilibrium and Ionic Equilibrium **No. of hours: 20**

Thermodynamics and equilibrium, degree of advancement, vant Hoff's reaction isotherm (deduction from chemical potential), equilibrium constant and standard Gibbs free energy change; definition of K_p, K_C, K_X; vant't Hoff's reaction isobar and isochore from different standard states; shifting of equilibrium due to change of external parameters like temperature and pressure and influence of inert gas; Le Chatelier principle of dynamic equilibrium (thermodynamics approach) and its application to homogeneous chemical equilibria.

Ionic equilibrium: concept of pH, hydrolysis of salts, buffer solution, elementary idea of biological buffers, acid-base indicators; solubility equilibria and influence of common and indifferent ions there on.

Unit-2 Colligative properties **No. of hours: 12**

ΔG, ΔS, ΔH and ΔV of mixing for binary solutions, vapour pressure of solution, ideal solutions, ideally dilute solutions and colligative properties, Raoult's law, thermodynamic derivation (using chemical potentials) of colligative properties of solution and their inter-relationships, abnormal colligative properties, van't Hoff factor; biomedical application: osmosis and dialysis.

Unit 3 Introduction to bioenergetics **No. of Hours: 6**

Laws of thermodynamics, state functions, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, other phosphorylated compounds and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

Unit 4 Oxidative phosphorylation **No. of Hours : 12**

Mitochondria. Electron transport chain - its organization and function. Inhibitors of ETC and uncouplers. Peter Mitchell's chemiosmotic hypothesis. Proton motive force. F_o F_1ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis. Alternative respiratory pathways in plants.

Unit 5 Photophosphorylation **No. of Hours: 10**

General features of photophosphorylation, historical background, Hills reaction, photosynthetic pigments, light harvesting systems of plants and microbes and resonance energy transfer. Bacterial photophosphorylation in purple bacteria, Green sulfur bacteria and *Halobacterium salinarum*. Photophosphorylation in plants - structure of chloroplast, molecular architecture of Photosystem I and Photosystem II, Z-scheme of photosynthetic electron flow, oxygen evolving complex and action of herbicides. Cyclic photophosphorylation and its significance. Photo inhibition. Evolution of oxygenic photosynthesis.

C-12 : METABOLISM OF CARBOHYDRATES AND LIPIDS (PRACTICALS)

SEMESTER - IV

TOTAL HOURS : 60 **CREDITS: 2**

1. Estimation of blood glucose.

2. Sugar fermentation of microorganisms.
3. Assay of salivary amylase.
4. Isolation of lecithin, identification by TLC, and its estimation.
5. Isolation of cholesterol from egg yolk and its estimation.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.
2. Molecular Cell Biology (2013) 7th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York), ISBN:13:978-1-4641-0981-2.
3. Biochemistry (2010) 4th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston), ISBN-13:978-0-495-11464-2.
4. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
5. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 10th Ed., Oxford University Press (2014).
6. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
7. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004)

C-13: GENE ORGANIZATION, REPLICATION AND REPAIR (THEORY)

SEMESTER - V

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Structure of DNA **No. of Hours : 6**

DNA structure, features of the double helix, various forms of DNA, denaturation and reassociation of DNA.

Unit 2 Genes and genomic organization **No. of Hours : 10**

Genome sequence and chromosome diversity, definition of a gene, organization of genes in viruses, bacteria, animals and plants. Nucleosome structure and packaging of DNA into higher order structures.

Unit 3 Replication of DNA **No. of Hours : 20**

The chemistry of DNA synthesis, DNA polymerase, the replication fork, origin of replication, enzymes and proteins in DNA replication, various modes of replication, stages of replication of *E. coli* chromosome, relationship between replication and cell division, replication in eukaryotes. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of DNA replication and applications in medicine. Supercoiling of DNA and its importance, topoisomerases, critical role of topoisomerases in cell, topoisomerase inhibitors and their application in medicine.

Unit 4 Recombination and transposition of DNA **No. of Hours : 12**

Homologous recombination, proteins and enzymes in recombination, site-specific recombination, serine and tyrosine recombinases, biological roles of site-specific recombination, transposition, three classes of transposable elements, importance of transposable elements in horizontal transfer of genes and evolution.

Unit 5 Molecular basis of mutations **No. of Hours : 4**

Importance of mutations in evolution of species. Types of mutations - transition, transversions, frame shift mutations, mutations induced by chemicals, radiation, transposable elements, Ames test.

Unit 6 Various modes of DNA repair **No. of Hours : 8**

Replication errors and mismatch repair system, repair of DNA damage, direct repair, base excision repair, nucleotide excision repair, recombination repair, translesion DNA synthesis.

C-13 : GENE ORGANIZATION, REPLICATION AND REPAIR (PRACTICALS)

SEMESTER - V

TOTAL HOURS : 60 **CREDITS: 2**

1. Verification of Chargaff's rule by paper chromatography.
2. Ultraviolet absorption spectrum of DNA and RNA.
3. Determination of DNA and RNA concentration by A_{260nm}.
4. Determination of the melting temperature and GC content of DNA.
5. To study the viscosity of DNA solutions.
6. Isolation of chromosomal DNA from *E. coli* cells.

SUGGESTED READINGS

1. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York), ISBN:0-321-50781 / ISBN:978-0-321-50781-5.
2. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W. H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
3. Principles of Genetics (2010) 5th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons Asia, ISBN:978-0-470-39842-5

C-14 : GENE EXPRESSION AND REGULATION (THEORY)

SEMESTER - V

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Biosynthesis of RNA in prokaryotes **No. of Hours : 8**

RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, the three stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as anti-microbial drugs.

Unit 2 Biosynthesis of RNA in eukaryotes **No. of Hours : 8**

Comparison between prokaryotic and eukaryotic transcription. Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, various types of RNA processing, transcription by RNA polymerase I and III. Inhibitors of eukaryotic transcription and their applications. Comparison of fidelity of transcription and replication.

Unit 3 RNA splicing **No. of Hours : 6**

Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling, RNA editing.

Unit 4 The genetic code **No. of Hours : 4**

Degeneracy of the genetic code, wobble in the anticodon, features of the genetic code, nearly universal code.

Unit 5 Biosynthesis of proteins **No. of Hours : 10**

Messenger RNA, transfer RNA, attachment of amino acids to tRNA, the ribosome - initiation, elongation and termination of translation, regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Use of antibiotics in understanding protein synthesis and applications in medicine.

Unit 6 Protein targeting and degradation **No. of Hours : 6**

Post translational modifications, glycosylation, signal sequences for nuclear transport, bacterial signal sequences, import of proteins by receptor mediated endocytosis, specialized systems for protein degradation.

Unit 7 Regulation of gene expression in prokaryotes **No. of Hours : 8**

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins, regulation by genetic recombination, transcriptional regulation in λ bacteriophage.

Unit 8 Regulation of gene expression in eukaryotes **No. of Hours : 10**

Heterochromatin, euchromatin, chromatin remodeling, regulation of galactose metabolism in yeast, regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches, RNA interference, synthesis and function of miRNA molecules, phosphorylation of nuclear transcription factors.

C-14 : GENE EXPRESSION AND REGULATION (PRACTICALS)
SEMESTER - V

TOTAL HOURS : 60 **CREDITS: 2**

1. Extraction of total nucleic acids from plant tissue.
2. Diauxic growth curve effect.
3. Isolation of mRNA from yeast by affinity chromatography.
4. Effect of inhibitors on protein synthesis.
5. Accumulation of protein due to proteasome inhibitors.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.

Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5

C15: PLANT BIOCHEMISTRY (THEORY)
SEMESTER – VI

Total Hours : 60 **CREDITS: 4**

Unit 1 Introduction to Plant cell structure **No. of Hours : 4**
Plasma membrane, Vacuole and tonoplast membrane, cell wall, plastids and peroxisomes.

Unit 2 Photosynthesis and Carbon assimilation **No. of Hours : 14**
Structure of PSI and PSII complexes, Light reaction, Cyclic and non cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration.

Unit 3 Respiration **No. of Hours :12**
Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration.

Unit 4 Nitrogen metabolism **No. of Hours : 14**
Biological Nitrogen fixation by free living and in symbiotic association, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by Glutamine synthetase- glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

Unit 5 Regulation of plant growth **No. of Hours : 4**
Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.

Unit 6 Secondary metabolites **No. of Hours : 8**
Representatives alkaloid group and their amino acid precursors, function of alkaloids, Examples of major phenolic groups; simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

Unit 6 Plant tissue culture **No. of Hours : 4**
Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation.

C15: PLANT BIOCHEMISTRY (PRACTICALS)
SEMESTER –VI

Total Hours : 60 **CREDITS: 2**

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of Urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables
4. Separation of photosynthetic pigments by TLC
5. Culture of plant plants (explants).

SUGGESTED READINGS

1. Plant Biochemistry (2008), Caroline Bowsher, Martin steer, Alyson Tobin, Garland science ISBN 978-0-8153-4121-5
2. Biochemistry and molecular Biology of plant-Buchanan. (2005) 1 edition. Publisher: I K International. ISBN-10: 8188237116, ISBN-13: 978-8188237111.
3. Plant Biochemistry by P.M Dey and J.B. Harborne (Editors) (1997) Publisher: Academic Press ISBN-10:0122146743, ISBN-13:978-0122146749

C16: HORMONE : BIOCHEMISTRY AND FUNCTION (THEORY)
SEMESTER – VI

TOTAL HOURS : 60 **CREDITS: 4**

Unit 1 Introduction to endocrinology **No. of Hours : 6**

Functions of hormones and their regulation. Chemical signaling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.

Unit 2 Hormone mediated signaling **No. of Hours : 16**

Hormone receptors - extracellular and intracellular. Receptor - hormone binding, Scatchard analysis. G protein coupled receptors, G proteins, second messengers - cAMP, cGMP, IP_3, DAG, Ca^{2+}, NO. Effector systems - adenyl cyclase, guanyl cyclase, PDE, PLC. Protein kinases (PKA, PKB, PKC, PKG). Receptor tyrosine kinases - EGF, insulin, erythropoietin receptor; ras - MAP kinase cascade, JAK - STAT pathway. Steroid hormone/ thyroid hormone receptor mediated gene regulation. Receptor regulation and cross talk.

Unit 3 Hypothalamic and pituitary hormones **No. of Hours : 8**

Hypothalamic - pituitary axis. Study the physiological and biochemical actions of hypothalamic hormones, pituitary hormones - GH, prolactin, TSH, LH, FSH, POMC peptide family, oxytocin and vasopressin, feedback regulation cycle. Endocrine disorders - gigantism, acromegaly, dwarfs, pigmies and diabetes insipidus.

Unit 4 Thyroid hormone **No. of Hours : 4**

Thyroid gland. Biosynthesis of thyroid hormone and its regulation; its physiological and biochemical action. Pathophysiology - Goiter, Graves disease, cretinism, myxedema, Hashimato's disease.

Unit 5 Hormones regulating Ca^{2+} homeostasis **No. of Hours : 6**

PTH, Vitamin D and calcitonin. Mechanism of Ca^{2+} regulation and pathways involving bone, skin, liver, gut and kidneys. Pathophysiology - rickets, osteomalacia, osteoporosis.

Unit 6 Pancreatic and GI tract hormones **No. of Hours : 6**

Regulation of release of insulin, glucagon, gastrin, secretin, CCK, GIP, adipolectin, leptin and ghrelin. Summary of hormone metabolite control of GI function. Physiological and biochemical action. Pathophysiology - diabetes type I and type II.

Unit 7 Hormones of adrenals **No. of Hours : 6**

Aldosterone, renin angiotensin system, cortisol, epinephrine and norepinephrine. Fight or flight response, stress response. Pathophysiology – Addison's disease, Conn's syndrome, Cushing syndrome.

Unit 8 Reproductive hormones **No. of Hours : 6**

Male and female sex hormones. Interplay of hormones during reproductive cycle, pregnancy, parturition and lactation. Hormone based contraception.

Unit 9 Growth factors **No. of Hours : 2**

PDGF, EGF, IGF-II, and erythropoietin.

C-16 : HORMONE : BIOCHEMISTRY AND FUNCTION (PRACTICALS)
SEMESTER – VI

TOTAL HOURS : 60 **CREDITS: 2**

1. Glucose tolerance test.
2. Estimation of serum Ca^{2+}.
3. Estimation of serum T4.
4. HCG based pregnancy test.
5. Estimation of serum electrolytes.
6. Case studies.

SUGGESTED READINGS

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M. W.H. Freeman & Company (NewYork), ISBN:13: 978-1-4641-0962-1 / ISBN:10-14641-0962-1.
2. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
3. Endocrinology (2007) 6th ed., Hadley, M.C. and Levine, J.E. Pearson Education (New Delhi), Inc. ISBN: 978-81-317-2610-5.
4. The Cell: A Molecular Approach (2009) 5th Ed. Cooper, G.M. and Hausman, R.E. ASM Press & Sunderland, (Washington DC), Sinauer Associates. (MA). ISBN:978-0-87893-300-6.

DSE-I BIOINFORMATICS (Theory)
SEMESTER - V

TOTAL HOURS : 30 **CREDITS: 4**

Unit 1 Introduction to bioinformatics **No. of Hours : 4**

Computer fundamentals - programming languages in bioinformatics, role of supercomputers in biology. Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches) and Systems Biology. Applications of bioinformatics.

Unit 2 Biological databases and data retrieval **No. of Hours : 8**

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Structure viewers (Ras Mol, J mol), file formats.

Exercises

- Sequence retrieval (protein and gene) from NCBI.
- Structure download (protein and DNA) from PDB.
- Molecular file formats - FASTA, GenBank, Genpept, GCG, CLUSTAL, Swiss-Prot, FIR.
- Molecular viewer by visualization software.

Unit 3 Sequence alignment **No. of Hours : 3**

Similarity, identity and homology. Alignment – local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTALW.

Exercises

- BLAST suite of tools for pairwise alignment.
- Multiple sequence alignment using CLUSTALW.

Unit 4 Phylogenetic analysis **No. of Hours : 3**

Construction of phylogenetic tree, dendrograms, methods of construction of phylogenetic trees - maximum parsimony, maximum likelihood and distance methods.

Exercise

- Generating phylogenetic tree using PHYLIP.

Unit 5 Protein structure prediction and analysis **No. of Hours : 6**

Levels of protein structure. Protein tertiary structure prediction methods - homology modeling, fold recognition and *ab-initio* methods. Significance of Ramachandran map.

Exercises

- Primary sequence analyses (Protparam).
- Secondary structure prediction (GOR, nnPredict).
- Tertiary structure prediction (SWISSMODEL).
- Protein structure evaluation - Ramachandran map (PROCHECK).

Unit 6 Genomics **No. of Hours : 6**

Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, gene prediction methods and tools.

Exercise

- Gene prediction using GENSCAN and GLIMMER.

SUGGESTED READINGS

1. Bioinformatics: Sequence and Genome Analysis (2001), 1st ed., Mount, D.W. Cold Spring Harbor Laborator Press (New York), ISBN: 0-87969-608-7.
2. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (2005), 3rd ed., Baxevanis, A.D. and Ouellette, B.F., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47147878-4.
4. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303

DSE-2: MEDICAL MICROBIOLOGY (THEORY)
SEMESTER – V

Total Hours : 60 **CREDITS: 4**

Unit 1 History of Development of Microbiology **No. of Hours: 12**

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

Unit 2 Diversity of Microbial world **No. of Hours: 8**

Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Unit 3 Viruses, viroids and prions **No. of Hours: 10**

An introduction to viruses with special reference to the structure and replication of the following: Poxvirus, Poliovirus, HIV, T4 and λ phage, lytic and lysogenic cycles.

Unit 4 Bacteria **No. of Hours: 10**

An account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles). Applications of bacteria in industry, environment and food.

Unit 5 Algae **No. of Hours: 6**

History of phycology; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Applications of Algae in agriculture, industry, environment and food.

Unit 6 Fungi **No. of Hours: 6**

Historical developments in the field of Mycology, significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Economic Importance of Fungi in Agriculture, environment, Industry, medicine, food, biodeterioration, mycotoxins

Unit 7 Protozoa **No. of Hours: 4**

General characteristics with special reference to Amoeba

Unit 3 Scope of Microbiology **No. of Hours: 4**

DSE-2 : MEDICAL MICROBIOLOGY (PRACTICALS)
SEMESTER – V

Total Hours : 60 **CREDITS: 2**

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/ pictographs
5. Staining of bacteria using Gram stain
6. Isolation of pure cultures of bacteria by streaking method.
7. Estimation of CFU count.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. W M.T.Brown Publishers.
Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company