

## Department of Biochemistry

### Credit Matrix for M.Sc. Biochemistry programmew.e.f. session 2016-17

Semester	Core (C)	Discipline Specific (D)	Fundamental (F)	Open Elective (Interdisciplinary)	Practicals/ Dissertations	Total
I	20	--	--	--	8	28
II	12	4	2	3	8	29
III	8	8	--	3	8	27
IV	8	--	--	--	20	28
	48	12	2	6	44	112

### INSTRUCTIONS FOR THE STUDENTS

#### *Course Types:*

- **Core (C):-** There are Core Courses in every semester. These courses are to be compulsorily studied by a student as a core requirement to complete the requirement of a programme in a said discipline of study.
- **Discipline Specific Elective (D):-** Discipline Specific course is a course which can be chosen from a pool of papers. It will be supportive to the discipline of study & mandatory as per course curriculum.
- **Foundation Course (F):-** The Foundation Course is based upon the content that leads to- Knowledge enhancement. It is mandatory as per course curriculum. Student has opt it from University pool.
- **Open Elective (O):-** Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum.

**Choice Based Credit System****Examination Scheme of M.Sc Biochemistry (Semester System)**

w.e.f. academic session 2016-17.

**Semester I**

S. No	Course Code	Title of Paper	Type	L-T-PCredits	Hours	Marks	
						Theory	Int Ass
1.	16BCH21C1	Biomolecules and Bioenergetics	Core	4-0-0	4	80	20
2.	16BCH21C2	Cell Structure and Signalling	Core	4-0-0	4	80	20
3.	16BCH21C3	Human Physiology	Core	4-0-0	4	80	20
4.	16BCH21C4	Metabolism and Regulation	Core	4-0-0	4	80	20
5.	16BCH21C5	Bioanalytical Techniques	Core	4-0-0	4	80	20
6.	16BCH21CL1	Lab Course I	Core	0-0-4	8	100	
7.	16BCH21CL2	Lab Course II	Core	0-0-4	8	100	
<b>Sub Total</b>				<b>28</b>	<b>36</b>		

**Semester II**

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	IntAss
<b>Core Courses</b>							
1.	16BCH22C1	Immunology	Core	4-0-0	4	80	20
2.	16BCH22C2	Enzymology	Core	4-0-0	4	80	20
3.	16BCH22C3	Molecular Biology	Core	4-0-0	4	80	20
<b>Discipline Specific Courses (Choose any one)</b>							
4.	16BCH22D1	Proteomics	Discipline Specific	4-0-0	4	80	20
5.	16BCH22D2	Nutritional Biochemistry					
<b>Foundation Elective**</b> To be chosen from university pool of fundamental elective papers						2 Credits	
<b>Open Elective#</b> To be chosen from university pool of open elective papers						3 Credits	
<b>Lab Course</b>							
6.	16BCH22CL1	Lab Course III	Core	0-0-4	8	100	
7.	16BCH22CL2	Lab Course IV	Core	0-0-4	8	100	
<b>Sub Total</b>				<b>29</b>	<b>37</b>		

\*\*M.Sc. Biochemistry students will opt one paperout of University Pool of Foundation Elective papers

**Semester III (Dec-2017)**

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
<b>Core Courses</b>							
1.	17 BCH23C1	Microbial Biochemistry	Core	4-0-0	4	80	20
2.	17 BCH23C2	Clinical Biochemistry	Core	4-0-0	4	80	20
<b>Discipline Specific Courses (Choose any one)</b>							
3.	17 BCH23DA1	Principles of Genetics	Discipline Specific	4-0-0	4	80	20
4.	17 BCH23DA2	Biochemical Toxicology		4-0-0	4	80	20
<b>Discipline Specific Courses (Choose any one)</b>							
5.	17 BCH23DB1	Biostatistics	Discipline Specific	4-0-0	4	80	20
6.	17 BCH23DB2	Bioinformatics					
<b>Open Elective#</b> To be chosen from university pool of open elective papers						3 Credits	
<b>Lab Course</b>							
7.	17 BCH23CL	Lab Course V (Based on core papers)	Core	0-0-4	8	100	
8.	17 BCH23DL	Lab Course VI (Based on Discipline specific papers)	Core	0-0-4	8	100	
<b>Sub Total</b>				<b>27</b>	<b>31</b>		

**Semester IV (May-2018)**

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Marks
1.	17BCH24C1	Genetic Engineering	Core	4-0-0	4	80	20
2.	17BCH24C2	Plant Biochemistry	Core	4-0-0	4	80	20
3.	17BCH24C3	Dissertation/Project Work	Core	0-0-20	40	300	
<b>Sub Total</b>				<b>28</b>	<b>48</b>		

**Grand Total:****112**

# Department of Biochemistry offer open elective paper as follows:

- 16BCHO1 Basic Biochemistry (IInd Semester)
- 16BCHO2 Human Health & Nutrition (IIIrd Semester)

## 16BCH21C1: Biomolecules and Bioenergetics

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All five questions to carry equal (16) marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Introduction:* Water as biological solvent- bonds, thermal properties and solvent properties. Weak acids and bases, pH & its calculation, Henderson-Hasselbalch equation, physiological buffers.

*Bioenergetics:* Elements of importance in biochemistry (H, C, N, O, P, S), types and energy of bonds and interactions (ionic, covalent, coordinate, H-bonds, van der Waals, hydrophobic interactions). Laws of thermodynamics, Gibbs free energy, relevance of entropy and enthalpy in biological systems and reactions; first and second-order reactions. Biological oxidation, high energy compounds.

### **UNIT 2**

*Carbohydrates:* Classification, structure, occurrence and biological functions. Glycoconjugates. Physicochemical properties of monosaccharides. Derivatives of monosaccharides.

*Lipids:* Classification, structure, occurrence and biological functions of lipids. Nomenclature and properties of fatty acids and triglycerides, saponification number, acid number, Reichert-Meissel number, rancidity of fats. Steroids and carotenoids of biological origin, liposomes. Ether linked lipids. Classes and properties of apolipoproteins.

### **UNIT 3**

*Amino acids:* Nomenclature, classification and chemical structure of amino acids. Physicochemical properties of amino acids with their titration curve, reaction with ninhydrin, amino acids as zwitterions and isoelectric point.

*Proteins:* Classification, structure (primary, secondary, tertiary and quaternary; structure of peptide bond), properties and biological functions of proteins. Protein denaturation and renaturation. Chemical synthesis of polypeptides. Methods to determine amino acid sequence- N- and C-terminal amino acid identification. Salting in and salting out of proteins. Forces stabilizing, unfolding/ refolding in the proteins.

### **UNIT 4**

*Protein structure:* Quaternary structure – hemoglobin. Ramachandran plot. Helix coil transitions.

*Nucleic acids:* Nature of genetic material, properties of DNA in solution, evidence of DNA as genetic material and evidence for semi-conservative nature, Composition of RNA and DNA, features of DNA double helix, denaturation and annealing of DNA. Structure and roles of different types of DNAs and RNAs. Sanger's dideoxynucleotide chain termination sequencing, Applications of DNA & RNA Sequencing.

**Suggested Readings for 16BCH21C1: Biomolecules and Bioenergetics:**

1. Lehninger Principles of Biochemistry 4<sup>th</sup> Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules: an Introduction (Paperback) **By** Richard J. Simmonds. Publisher: Royal Society of Chemistry
3. Principles of Biochemistry (Hardcover) **By** Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry **By** Lubert Stryer. WH Freeman and Co.
5. Biochemistry: The Molecular Basis of Life (Paperback) **By** Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
6. Bioenergetics **By** David G. Nicholls and Stuart J. Ferguson. Academic Press.
7. Bioenergetics at a Glance: An Illustrated Introduction (At a Glance) (Paperback) **By** D. A. Harris. Publisher: Wiley Blackwell
8. Bioenergetics: 0 (Paperback) **By** Lars Garby and Poul S. Larsen. Cambridge University Press.
9. Biochemistry and Molecular biology **By** William H. Elliott and Daphne C. Elliott. Oxford University Press.
10. Biochemistry (Hardcover) 3<sup>rd</sup> Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
11. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
12. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) **By** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
13. Principles of Biochemistry (Paperback) **By** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
14. Biochemistry **By** U. S. Satyanarayana
15. Outlines of Biochemistry **By** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

## 16BCH21C2: Cell Structure and Signalling

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

Membrane structure and models, composition, dynamics, structure of membrane, forces stabilizing membranes. transport of ions and macromolecules, pumps(channel proteins, passive carrier proteins, coupled transporters and ATP-driven pumps, and secretory pathways in cell), carriers and channels; endo- and exocytosis, membrane carbohydrates and their significance in cellular recognition, cellular junctions and adhesions(cadherins, integrins, IgSF, selectins, tight/gap junctions).

### **UNIT 2**

*The extracellular matrix:* collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

*Organelles:* Structure and function of nuclear envelope, lamina and nucleolus, macromolecular trafficking, chromatin organization and packaging, organelle DNA, transposons, retrotransposons, LINES and SINES. Cell cycle and its regulation mechanisms.

### **UNIT 3**

Endo-membrane system and cellular motility, structure and function of microbodies, golgi apparatus, lysosomes and endoplasmic reticulum, organization and role of microtubules and microfilaments, cell shape and motility, actin-binding proteins and their significance; muscle organization and function; molecular motors; intermediate filaments.

*Signal transduction:* Receptors and its types, role of receptors in signal transduction, Signal transduction pathways. Regulation of signaling transduction pathways.

### **UNIT 4**

*Neurotransmission:* Introduction to neurons, The Neuron Doctrine, The Nissl and Golgi stains, Components of neurons, Classification and types of neurons, Cytology of neurons, Dendrites structure and function, Axons structure and functional aspects, ultrastructure, myelination and synapses. Types, synthesis, release and functions of neuromodulators. Resting potentials and action potentials of excitable cells.

*Glial cells:* Structure and function of glial cells, Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells.

**Suggested Readings for 16BCH21C2:Cell Structure and Signalling:**

1. Molecular Cell Biology 4<sup>th</sup> Ed **By** James E. Darnell, Harvey Lodish, Arnold Berk, and Lawrence Zipursky, W.H. Freeman and Co.
2. Molecular Biology of the Cell 4<sup>th</sup> Ed **By** Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Garland Publishers.
3. Cell Biology **By** Thomas D. Pollard and William C. Earnshaw. Publisher: Saunders.
4. Cell and Molecular Biology: Concepts and Experiments (Hardcover) 5<sup>th</sup> Ed **By** Gerald Karp. John Wiley and Sons.
5. Cell and Molecular Biology **By** EDP de Robertis and EMF de Robertis (Jr.). Lippincott Williams & Wilkins, Philadelphia.
6. The Biochemistry of Cell Signalling **By** Ernst JM Helmreich, Oxford University Press.
7. Signal Transduction (Modular Texts in Molecular and Cell Biology) (Paperback) **By** C.H. Heldin, Carl-HeldinHeldin and Mary Purton. Bios Scientific Publishers Ltd.
8. Fundamental Neuroscience 2<sup>nd</sup> Edition **By** Larry Squire, James Roberts, Nicholas Spitzer, Michael Zigmond. Academic Press

### 16BCH21C3:Human Physiology

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions of 1 or 2 marks. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All five questions to carry equal (16) marks.

Max. Marks: 80

Max. Time: 3 hrs

#### **UNIT 1**

Composition, molecular functions and regulation of salivary, gastric, pancreatic, intestinal and bile secretions. Absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins.

Molecular mechanisms of contraction and control of skeletal, cardiac and smooth muscles. Neurochemistry of vision, gustation, olfaction and hearing.

#### **UNIT 2**

*Central Nervous system:* Types and structure of neurons. Myelin sheath- composition and function. Resting membrane and action potential. Mechanism and initiation of action potential. Synaptic transmission, post-synaptic potentials. Spinal cord and motor functions, role of brain stems in controlling motor functions, functions of cerebellum, functions of cortical areas, the limbic system and cerebrospinal fluid system.

#### **UNIT 3**

*Cardiovascular System-* Heart structure; rhythmical excitation of heart; cardiac cycle and dynamics; regulation of cardiac output and arterial blood pressure; mechanics and control of blood flow; functions of lymphatic system. Microcirculation.

Composition and functions of plasma, hemopoiesis, erythrocytes including Hb, leukocytes and thrombocytes, plasma proteins and their role. Blood coagulation and fibrinolysis—molecular events and regulation. Blood groups and Rh factor. Transfers of blood gases – oxygen and carbon dioxide. Role of 2,3-BPG, Bohr effect and chloride shift.

#### **UNIT 4**

*Excretory system-* Ultrastructure of nephron; formation of urine (glomerular filtration, tubular reabsorption of glucose, water, organic acids, amino acids and electrolytes); tubular secretion of protons,  $K^+$ , ammonia and organic molecules. Concentration of urea- countercurrent mechanism and urea recycling. Role of kidneys in regulation of blood pressure.

*Special physiology-* Effect of low oxygen pressure on body, effects of acceleratory forces on body, effects of high partial pressures of gases on body



**Suggested Readings for 16BCH21C3: Human Physiology:**

1. Textbook of Medical Physiology 10<sup>th</sup> Ed **By** Arthur C. Guyton and John E. Hall, Harcourt Asia Pte Ltd.
2. Essential Medical Physiology 3<sup>rd</sup> Ed **By** Leonard R. Johnson, Elsevier Academic Press.
3. Endocrinology: An Integrated Approach **By** SS Nussey and SA Whitehead. BIOS Scientific Publishers
4. Physiology 3<sup>rd</sup> Ed, **By** Linda Costanzo, Saunders Publishers.
5. Principles of Anatomy and Physiology 10<sup>th</sup> Edition **By** Gerard J. Tortora and Sandra Grabowski. Publisher: John Wiley and Sons.
6. Principles of Human Physiology **By** Cindy L. Stanfield and William J. Germann. Publisher: Pearson Education.
7. Samson Wright's Applied Physiology 13<sup>th</sup> Ed. CA Keele, E Neil & N Joels. Oxford University Press.
8. Principles of Biochemistry: Mammalian Biochemistry **By** Emil Smith. McGraw Hill Publications.
9. Human Physiology: The Mechanisms of Body Function **By** Arthur J. Vander, James Sherman, Dorothy S. Luciano, Eric P. Widmaier, Hershel Raff and HershhalStrang. McGraw Hill Education.
10. Medical Physiology: Principles for Clinical Medicine 3<sup>rd</sup> Ed. **By** Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.

### 16BCH21C4: Metabolism and Regulation

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions of 1 or 2 marks. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

#### **UNIT 1**

*Carbohydrate Metabolism:* Reactions and energetics of glycolysis, Reactions and energetics of TCA cycle, gluconeogenesis, glycogenesis and glycogenolysis. Reactions and physiological significance of HMP pathway, regulation of glycolysis and gluconeogenesis, cataplerosis and anaplerosis, biosynthesis of starch and oligosaccharides, Uronic acid pathway and glyoxylate cycle. Hormonal regulation of carbohydrate metabolism.

#### **UNIT 2**

*ETC and Oxidative phosphorylation:* Sequence of electron carriers, sites of ATP production, inhibitors of ETC, mechanism and regulation of mitochondrial oxidative phosphorylation, ATP synthase (mitochondrial vs. bacterial), uncouplers of oxidative phosphorylation, transport of reducing potential and ions across mitochondrial membrane, microsomal electron transfers, energy rich compounds

*Amino acid metabolism:* General reactions of amino acid metabolism- transamination, deamination and oxidative decarboxylation. Biosynthesis and degradation of amino acids and their regulation. Feedback regulation of amino acid biosynthesis. Urea cycle and its regulation. Amino acids as biosynthetic precursors.

#### **UNIT 3**

*Lipid catabolism:* Transport and mobilization of lipids, oxidation of saturated fatty acids, oxidation of unsaturated and odd-chain fatty acids, role of carnitine in transport of fatty acids, metabolism of ketone bodies and its biological significance.

*Lipid anabolism:* Biosynthesis of saturated and unsaturated fatty acids. Biosynthesis of triglycerides, phospholipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism. Metabolism of lipoproteins. Biosynthesis of eicosanoids.

#### **UNIT 4**

*Nucleic acid Metabolism:* Biosynthesis and degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide reductase. Purine salvage pathway. Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis.

*Porphyrin Metabolism:* Porphyrin nucleus and classification of porphyrins, important metalloporphyrins occurring in nature. Biosynthesis and degradation of porphyrins, significance and production of bile pigments.

**Suggested Readings for 16BCH21C4: Metabolism and Regulation:**

1. Lehninger Principles of Biochemistry 4<sup>th</sup> Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Principles of Biochemistry **By** Geoffrey Zubay. Publisher: McGraw Hill College.
3. Harper's Biochemistry (Lange Medical Books) (Paperback) **By** Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
4. Bioenergetics **By** David G. Nicholls and Stuart J. Ferguson. Academic Press.
5. Bioenergetics at a Glance: An Illustrated Introduction (At a Glance) (Paperback) **By** D. A. Harris. Publisher: Wiley Blackwell
6. Bioenergetics: **By** Lars Garby and Poul S. Larsen. Cambridge University Press.
7. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) **By** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
8. Biochemistry 3<sup>rd</sup> Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
9. Biochemistry of Lipids, Lipoproteins and Membranes (4<sup>th</sup> Ed.) D.E. Vance and J.E. Vance. Pub: Elsevier Science B.V
10. Medical Biochemistry 4<sup>th</sup> Ed. by NV Bhagavan. Pub: Elsevier India Pvt. Ltd.
11. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 **By** D Voet. John Wiley and Sons.
12. Biochemistry **By** Lubert Stryer. WH Freeman and Co.
13. Principles of Biochemistry **By** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
14. Harper's Biochemistry **By** RK Murray, DK Granner, PA Mayes and VW Rodwell. Appelton and Lange, Stanford.
15. Biochemistry **By** U. S. Satyanarayana
16. Outlines of Biochemistry **By** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

### 16BCH21C5: Bioanalytical Techniques

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

#### **UNIT 1**

*Basic principle of electromagnetic radiation:* Laws of photometry. Principle and applications of colorimetry, absorbance and transmittance, flame photometry, atomic absorption spectrophotometer

*Spectroscopy:* Basic concepts and applications of x-ray diffraction, principles and applications of UV-Visible, infra red, NMR, ESR, mass spectrometry, ORD and CD spectroscopy.

#### **UNIT 2**

*Electrophoretic techniques:* Theory of electrophoresis; continuous and discontinuous PAGE, SDS-PAGE; western blotting, Agarose-gel electrophoresis, Other electrophoretic methods - isoelectric focusing, 2-dimensional gel electrophoresis, capillary electrophoresis and pulse field gel electrophoresis

*Chromatography Techniques:* Adsorption vs. partition chromatography. Principle and applications of Paper, Thin layer chromatography, ion exchange, reverse phase, gel filtration, affinity, HPLC and gas chromatographic techniques.

#### **UNIT 3**

*Viscosity & Centrifugation:* measurement of viscosity using viscometer, applications of viscosity, relationship of viscosity with conformational changes. Basic principle of sedimentation, factors affecting sedimentation, Types of centrifuges – low speed, high speed centrifuges and Ultracentrifuges, differential and density gradient centrifugation and their applications.

*Microscopy:* Resolving powers of different microscopes, Light, electron (scanning and transmission), phase contrast and fluorescence microscopy; Preparation of specimen for electron microscopy; freeze- fracture methods for electron microscope

#### **UNIT 4**

*Radioisotope techniques:* Isotopes and nature of radioactivity, types of radioactive decay, interaction of radioisotopes with matter, half-life. Measurement of radioactivity, uses of radioisotopes in biological research; double labeling, quenching, internal standard ratio and external standard ratio; autoradiography.

*Biosensor Technology:* Concept and design of biosensors, types and uses of biosensors. Principle and applications of biosensors for glucose, triglyceride, uric acid, cholesterol, and oxalate.

**Suggested Readings 16BCH21C5: Bioanalytical Techniques:**

1. Bioenergetics, 3<sup>rd</sup> Edition, **By** David G. Nicholls and Stuart J. Ferguson. Publisher: Academic Press.
2. Biophysics, 5th Edition, **By** R. Glaser, Springer, Netherlands
3. Principles and Techniques of Biochemistry and Molecular Biology **6thEd.** Keith Wilson & John Walker, Cambridge University Press
4. Encyclopedia of Spectroscopy and Spectrometry (3-Volume Set with Online Version) **By** George E. Tranter, John L. Holmes and John C. Lindon, Academic Press
5. Methods in Modern Biophysics, 2nd Edition, **By** Bengt Nolting, Springer Netherlands
6. Biophysical Chemistry: Principles & Techniques Handbook **By** Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath, Himalaya Publishing House.
7. Microbiology **By** Lansing M. Prescott, John P Harley and Donald A. Klein. Publisher: McGraw Higher Education.
8. Chromatography: Concepts and Contrasts (Hardcover) **By** James M. Miller, Wiley, Interscience
9. Modern Experimental Biochemistry 3<sup>rd</sup> Edition, **By** Rodney Boyer, Benjamin Cummings Press.
10. Methods in Molecular Biology: Organelle proteomics, **By** Delphine Pflieger and Jean Rossier. Publisher: Humana Press
11. Biochemical Techniques: Theory and Practice **By** John F Roby. Publisher: SOS Free Stock.
12. Introduction to Electron Microscopy for Biologists: Methods in Cell Biology **By** Terry D. Allen. Academic Press.
13. Enzyme and Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) **By** Ashok Mulchandani. Humana Press Inc., U.S.

### **16BCH21CL1:LAB Course I**

**Lab Practicals for Biomolecules:**Preparation of buffers and measurement of pH, Determination/calculation of normality and molarity of solutions. Titration curve for amino acids and determination of pKa value Determination of acid value, saponification value and iodine number of lipid samples, Quantification of DNA and RNA, Determination of protein in given sample, Formol titration of Glycine, acetic acid and determination of pKa.

**Lab Practicals for Cell Biology:**Cell counting with hemocytometer and viability. To identify the blood cell types in human blood smear. Study prokaryotic and eukaryotic cell using a light microscope. Cell Division.Gram Staining.Cell Fractionation and organelle separation.Survival curve using UV as mutation source; Petite mutants' isolation in *S. cerevisiae*; Ames Test.

### **16BCH21CL2:LAB Course II**

**Lab Practicals for Bioanalytical Techniques:**Verification of Beer-Lamberts law..Qualitative and quantitative analysis of carbohydrates, lipids and amino acids. Gel filtration/ion exchange chromatography. Qualitative and quantitative analysis of protein in different samples (SDS-PAGE, Western Blotting etc.).Native discontinuous polyacrylamide gel electrophoresis.Sub-cellular fractionation of given tissue, organelles specific enzymatic assays to assess their purity.

**Lab Practicals for Metabolism:** Catabolism of carbohydrates (Monosaccharide, Oligosaccharides, Polysaccharides), proteins and lipids. Biochemical estimation of cholesterol, free fatty acids, vitamin C etc.

## 16BCH22C1: Immunology

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Introduction to Immune System:* Innate and acquired immunity, active and passive immunity, structure and functions of primary and secondary lymphoid organs, immunological memory, self vs non-self discrimination, adjuvants in immune response.

*Cells & organs Involved in Immune Responses:* Phagocytic cells and their killing mechanisms; T and B lymphocytes, differentiation of lymphoid cells, granulocytic cells (neutrophils, eosinophils and basophils), mast cells and dendritic cells.

*Nature of Antigen and Antibody:* Antigen vs immunogen, haptens, general organization of immunoglobulin, properties and functions of various types of immunoglobulins, isotypic, allotypic and idiotypic variations of immunoglobulins.

### **UNIT 2**

*Generation of Diversity in Immune System:* Clonal selection theory. Organization and expression of immunoglobulin genes: generation of antibody diversity. T cell receptor diversity.

*Humoral and Cell Mediated Immune Responses:* Kinetics of primary and secondary immune response. Complement activation and its biological consequences. Antigen processing and presentation. Cytokines and costimulatory molecules: Role in immune responses. T and B cell interactions.

### **UNIT 3**

*Major Histocompatibility Complex (MHC) Genes and Products:* Polymorphism of MHC genes, role of MHC antigens in immune responses. MHC antigens in transplantation.

*Antigen-Antibody Interactions:* Nature and kinetics of antigen-antibody interactions.

*Applications:* Agglutination and precipitation techniques, radioimmunoassay, ELISA, Western blotting and immunofluorescence. Flow cytometry of cells complexed with tagged antibodies. Immunoelectron microscopy, Hybridoma and Production of monoclonal antibodies.

### **UNIT 4**

*Tolerance vs Activation of Immune System:* Immunotolerance, immunosuppression, Hypersensitivity (Types I, II, III and IV) and allergy.

*Disorders of immune responses:* Autoimmunity, congenital immunodeficiencies, acquired immunodeficiencies.

*Immune Responses in Diseases:* Immune responses to infectious diseases: viral, bacterial and protozoal. Immunodeficiency disorders. Autoimmunity. Chemokines.

*Immunization:* Active immunization (immunoprophylaxis), Passive immunization (Immunotherapy).

**Suggested Readings for 16BCH22C1: Immunology:**

1. Fundamental Immunology **By** William E. Paul. Publisher: Lippincott Williams and Wilkins.
2. Immunology: International Edition **By** Janis Kuby, Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. WH Freeman and Co. Ltd.
3. Immunology **By** Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne and Janis Kuby. WH Freeman and Co. Ltd.
4. Immunology **By** Ivan M. Roitt, Jonathan Brostoff and David Male. Publisher: Mosby.
5. Introduction to Medical Immunology **By** Gabriel Virella, Marcel Dekker Inc.
6. Roitt's Essential Immunology **By** Ivan M. Roitt and Peter J. Delves, Blackwell Publishing
7. Understanding Immunology (Cell and Molecular Biology in Action) **By** Peter Wood. Publisher: Prentice hall.
8. Basic Immunology: The Functions of the Immune System **By** Abul K. Abbas and Andrew H. Lichtman. Publisher: Saunders.
9. A Handbook of Practical Immunology, **By** G. P. Talwar, Pub: Vikas Publishing House.
10. Fundamental Immunology **By** Robert M. Coleman and M.F. Lombard. Publisher: Brown (William C.) Co, U.S.
11. Atlas of Immunology **By** J.M. Cruse Author: Robert E. Lewis. CRC Press Inc.
12. Immunology **By** Edwards S Golub. Sinauer Associate, Sunderland.



## 16BCH22C2: Enzymology

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### UNIT 1

*Introduction:* History, general characteristics, nomenclature, IUB classification, Holoenzyme, apoenzyme, coenzymes, prosthetic groups, cofactors, activators, inhibitors, metalloenzymes, isozymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes. Units of enzyme activity (definition of IU, Katal), specific activity of enzyme, measurement of enzyme activity, enzyme turnover, ribozymes and abzymes, Enzyme active site: Fisher lock and key hypothesis, Khosland Induced fit hypothesis, Strain or Transition state stabilization hypothesis

*Enzyme Catalysis:* Role of enzymes in energy of activation, factors of affecting action of enzymes- proximity and orientation, strain and distortion, acid base catalysis and covalent catalysis. Determination of active site. Mechanism of action of chymotrypsin, ribonuclease, carboxypeptidase and lysozyme.

### UNIT 2

*Enzyme kinetics:* Factors affecting enzyme activity- pH, temperature, time of incubation, enzyme concentration and substrate concentration. Derivation of Michaelis-Menten equation for unisubstrate reaction,  $K_{cat}/K_m$  and its significance, Lineweaver-Burk plot and its limitations; Eadie-Hofstee Plot, Eadie Plot, Hanes plot and Eisenthal-Cornish-Bowden plot. Significance and calculation of energy of activation from Arrhenius plot.

Reversible and irreversible inhibition; competitive, non-competitive and uncompetitive inhibitions with determination of  $K_m$  and  $V_{max}$  in presence of reversible inhibitor. Derivation of  $K_i$  and Dixon plot. Kinetics of multisubstrate reactions, introduction to sequential and ping-pong mechanisms and their classifications & double reciprocal plots with examples.

### UNIT 3

Protein-ligand binding, Kinetics for ligand binding: Hill equation, Adair equation, Allosteric enzymes, symmetric and sequential modes for action of allosteric enzymes and their significance, cooperativity, sigmoidal kinetics and their physiological importance. Sigmoidal kinetics: MWC and KNF models. Significance of sigmoidal behavior. Study of ATCase as typical allosteric enzyme.

*Enzyme Regulation:* Reversible and irreversible covalent modification, feedback inhibition, control of enzyme by products, substrates and adenylate energy charge, monocyclic and multicyclic cascade systems. Enzyme activation, induction and repression.

### UNIT 4

*Multienzyme system:* Occurrence, isolation & their properties, mechanism of action and regulation of pyruvate dehydrogenase & fatty acid synthase complexes. Enzyme-enzyme interaction, multiple forms of enzymes with special reference to lactate dehydrogenase.

*Immobilization of enzymes:* Investigation of enzymes in biological preparations, Extraction and purification of enzymes, Enzyme assays: End point assay, continuous assays, introduction, classification, various methods of immobilization, kinetics of immobilized enzymes and its significance, applications of immobilized enzymes in analysis of biological materials, food industry and medicine.

**Suggested Readings for 16BCH22C2: Enzymology:**

1. Fundamentals of Enzymology: Cell and Molecular Biology of Catalytic Proteins (Paperback) **By** Nicholas C. Price and Lewis Stevens. Oxford University Press.
2. Advances in Enzymology: v. 47 **By** Alton Meister. John Wiley and Sons Inc.
3. Lehninger Principles of Biochemistry 4<sup>th</sup> Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
4. Principles of Biochemistry **By** Geoffrey Zubay. Publisher: McGraw Hill College.
5. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 **By** D Voet. John Wiley and Sons.
6. Basic Biochemical Laboratory Procedures and Computing **By** R. Cecil Jack, Oxford University Press.
7. Enzyme Kinetics: Principles and Methods (Hardcover) **By** Hans Bisswanger. Publisher: Wiley VCH.
8. Enzymatic Reaction Mechanisms **By** Perry A. Frey and Adrian D. Hegeman. Oxford University Press.
9. Comprehensive Enzyme Kinetics **By** Vladimir Leskovic. Publisher: Kluwer Academic / Plenum Publishers.
10. Enzyme Kinetics: A Modern Approach **By** Alejandro G. Marangoni. Publisher: WileyBlackwell.
11. Enzyme Kinetics and Mechanisms **By** Kenneth B. Taylor. Kluwer Academic Publishers.
12. Nature of Enzymology **By** RL Foster
13. A textbook of enzyme biotechnology **By** Alan Wiseman.
14. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry **By** Trevor Palmer.
15. Enzymes **By** M Dixon and EC Webb. EC Longmans, London.
16. The chemical kinetics of enzyme action **By** KJ Laidler and PS Bunting. Oxford University Press, London.

### 16BCH22C3: Molecular Biology

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

#### **UNIT I**

*DNA replication:* Mechanism of replication, the replicons, origin, primosome and replisomes, properties of prokaryotic and eukaryotic DNA polymerases, synthesis of leading and lagging strands, difference between prokaryotic and eukaryotic replication, inhibitors of replication, telomeres and telomerase, homologous and site-specific recombination.

#### **UNIT II**

*RNA synthesis and processing:* transcription factors and machinery, formation of initiation complex, transcription activators, repressors and insulators; RNA polymerases, capping, elongation, and termination, Post-transcriptional modifications of mRNA and processing of pre-tRNA & pre-rRNA, Turnover of RNA, Transport of processed mRNA, Reverse transcription.

#### **UNIT III**

*Protein synthesis and processing:* Ribosomes, structure, functional domain and subunit assembly, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins, protein targeting and degradation,

#### **UNIT IV**

*Regulation of Transcription and Translation:* Positive and negative control. Repressors, activators and insulators in regulating the expression of phages, viruses, prokaryotic and eukaryotic genes. Role of chromatin in gene expression and gene silencing. DNA binding motifs in pro- & eukaryotes, helix-turn-helix, zinc fingers, leucine zippers/b zip, helix-loop-helix motifs. Non-coding RNAs (miRNA, snRNA, pRNA).

**Suggested Readings for 16BCH22C3: Molecular Biology:**

1. Basic Biotechnology **By** Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Introduction to Biotechnology **By** William J. Thieman and Michael A. Palladino. Benjamin Cummings; US Ed edition.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA **By** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
4. Molecular Cloning: a laboratory manual (Vol 1, 2 & 3) **3<sup>rd</sup> Ed. By** J. Sambrook and DW Russel. Cold Spring Harbor Laboratory Publications, NY
5. Methods of DNA and RNA sequencing. **By** Sherman M. Weissman. Pub: Praeger
6. Analytical Techniques in DNA sequencing **By** Brian Nunnally. Pub: Taylor and Francis.
7. Gene Cloning and DNA Analysis: An Introduction **By** Terence. A. Brown. WileyBlackwell.
8. Gene Cloning: An Introduction **By** Terence A. Brown. Nelson Thornes Ltd.
9. Molecular Biology of the gene **By** J Watson, NH Hopkin, JW Roberts, JP Stertz and AM Weiner. WH Freeman and Co., San Fransisco.
10. Gene IX **By** Benjamin Lewin. Oxford University Press.
11. Biotechnology: Expanding Horizons **By** B. D. Singh, Kalyani Publishers.
12. Textbook of Biotechnology **By** PK Gupta, Rastogi Publications.
13. Biotechnology **By** U. Satyanarayana.
14. Advances in Biotechnology **By** Prof. SN Jogdand, Himalaya Publishing House

## 16BCH22D1: Proteomics

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Overview in proteomics:* Introduction to proteins, proteomics and functional proteomics, application of proteomics.

*Classic approach in proteome research:* Gel electrophoresis techniques (SDS-PAGE, Tricine-PAGE, Blue Native PAGE, 2D-electrophoresis), Western blotting and immunodetection, Capillary electrophoresis analysis of peptides and proteins, Liquid chromatography, Chemical and enzymatical protein fragmentation, Aminoacid sequence analysis.

### **UNIT 2**

*Technologies in proteomics:* Tools of proteomics and their strengths and weaknesses (1-D & 2-D gel electrophoresis and mass spectrometry-based approaches x-ray crystallography, and NMR). Fundamentals of mass spectrometry (basic theory, ionization techniques and mass analyzers, electrospray ionization (ESI) and matrix adsorption laser dissociation ionization (MALDI) and triple quadropole (QQQ), Reversed-phase HPLC and Microcapillary LC, protein and peptide separation technique).

### **UNIT 3**

*Qualitative and quantitative proteome analysis:* Mass data interpretation, whole proteome and sub-proteome analysis, expression proteome analysis (isotope-labeling and label-free approaches).

*Computational Bioinformatics:* Protein identification and analysis, Post-protein database search tools, World Wide Web bioinformatics resources, Network-based data analysis.

### **UNIT 4**

*Proteomic data interpretation:* Omics data interpretation by network modeling, data preprocessing, identification of differentially expressed proteins, and network modeling for prediction of key regulators. Analysis of post-translational phosphorylation, ubiquitination, acetylation, nitration and glycosylation modifications.

General introduction on homology modelling, and protein target prediction.

**Suggested Readings for 16BCH22D1: Proteomics:**

1. Introduction to Proteomics: Principles and Applications, Nawin Mishra, Print ISBN: 9780471754022; Book Series: Methods of Biochemical Analysis, Wiley Publications.
2. Sample Preparation in Biological Mass Spectrometry; Alexander R. Ivanov and Alexander V. Lazarev (Eds.); Wiley Publications.
3. Protein and Peptide Mass Spectrometry in Drug Discovery; Michael L. Gross, Guodong Chen, Birendra N. Pramanik (Eds.) Wiley & Sons, 2011, pp. 488 ISBN 978-0-470-25817-0.
4. Bioinformatics and Biomarker Discovery: "Omic" Data Analysis for Personalized Medicine; Francisco Azuaje, Wiley & Sons, 2011.
5. *Principles of Proteomics*, Second Edition, Author(s): Richard Twyman, ISBN: 9780815344728; Garland Publishers.

## 16BCH22D2: Nutritional Biochemistry

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Basic concepts:* Concept of balanced diet and energy content of foods; basal metabolic rate (BMR), determination of BMR, factors affecting BMR, specific dynamic action (SDA) and factors affecting them; Thermogenic effects of foods; Antinutrients: Protease inhibitors.

*Carbohydrates:* Dietary requirements and sources of available and unavailable carbohydrates; Physico-chemical properties and physiological actions of unavailable carbohydrates (dietary fibers); Glycemic index and glycemic load.

*Proteins:* Nitrogen balance studies and factors influencing nitrogen balance, Biological value of protein (B.V), protein efficiency ratio (PER), Essential amino acids and concept of protein quality, Cereal proteins and their limiting amino acids.

### **UNIT 2**

*Lipids:* Chemical composition and distribution, Major classes of dietary lipids, role of lipids in diet; composition and metabolism of lipoproteins; Essential fatty acids and their physiological functions.

*Electrolytes and pH balance:* Electrolyte concentrations of body fluids, production of acids and bases in body; regulation of blood pH by blood buffers, respiratory and renal mechanisms of pH regulation; Disorders of acid base regulation - concept of metabolic and respiratory acidosis and alkalosis.

### **UNIT 3**

*Vitamins:* Dietary sources, biochemical functions and specific deficiency diseases associated with fat and water soluble vitamins; Hypervitaminosis symptoms of fat-soluble vitamins.

*Minerals:* Nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

### **UNIT 4**

*Nutritional disorders:* Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor, Nutritional anemia - mechanism, etiology and clinical symptoms of vitamin B<sub>12</sub>, folate and iron deficiency anemia.

*Obesity:* Definition, classification and biochemical basis; Genetic and environmental factors leading to obesity; Obesity related diseases and management of obesity; metabolic changes in obesity; Role of leptin in regulation of body mass.

*Food Preservation:* Control of microorganism in foods using high and low temperature, dehydration, freezing, freeze-drying, irradiation and preservatives.

**Suggested Readings for 16BCH22D2: Nutritional Biochemistry:**

1. Textbook of Medical Biochemistry **By** MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Essentials of Food and Nutrition Vol I & II, **By** M. Swaminathan. Bangalore Printing and Publishing Co. Ltd.
3. Modern Nutrition in Health and Diseases, **By** Maurice E Shils and Vernon Robert Young, 7<sup>th</sup> Ed., Pub: Lea &Febiger.
4. Handbook of Nutrition and Food 2<sup>nd</sup> Ed., **By** Carolyn Berdanier, Johanna Dwyer and Elaine Feldman, CRC Press
5. Nutritional Biochemistry **By** Tom Brody. Academic Press.
6. Nutritional Biochemistry **By** S Ramakrishnan and S. Venkat Rao. TR Publications
7. Food and Nutrition **By** Anita Tull. Oxford University Press.
8. Nutritional Biochemistry and Metabolism: With Clinical Applications **By** Maria C. Linder. Publisher: Appelton and Lange
9. Introduction to Nutrition and Metabolism **By** David A. Bender. CRC Pre-ss Inc.
10. Principles of Human Nutrition **By** Martin Eastwood. Publisher: Wiley Blackwell.
11. Human Nutrition with CD-ROM **By** Catherine Geissler and Hilary Pow-ers. Publisher: Churchill Livingstone.
12. Food Science: The Biochemistry of Food and Nutrition **By** Kay YockeyMehas and Sharon Lesley Rodgers. Publisher: McGraw-Hill/Glencoe.
13. Lehninger Principles of Biochemistry 5<sup>th</sup> Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.



### **16BCH22CL1:Lab Course III**

**Lab practicals for Enzymology:** Extraction of enzymes from plant, animals and microbes, Partial and complete purification of enzymes, Enzyme assays, Study the effect of pH, temperature, ions, substrate & product concentration, Time of incubation on the stability and catalytic efficiency of enzymes, Effect inhibitors and activators on enzymatic activity. Separation of isoenzymes.

**Lab Practical for Immunology:** Serum and plasma isolation, determination of the blood group type, TLC (total leucocyte count) in blood sample, TLC separation, Western blot analysis. Antigen-antibody precipitation and titration-in fluid and gel, immunodiffusion-Radial Immuno diffusion, DID, Immunoelectrophoresis, immunoblotting, Rocket electrophoresis, ELISA, antibody generation.

### **16BCH22CL2: Lab Course IV**

**Lab Practical for Molecular Biology:** Extraction of Genomic DNA from Plant, Animal tissues, blood and microbes, Qualitative and quantitative analysis of nucleic acids, Cloning and construction of Recombinant clones, Preparation of cloning DNA: PCR, Restriction endonuclease digestion, Ligation, Competent cell preparation, DNA transformation, Characterization of recombinant clone: Blue white screening, Plasmid DNA isolation, RFLP analysis.

**Lab Practical for Nutritional Biochemistry:** Estimation of copper, iron, calcium and vitamin C in foodstuffs. Chemical test for bio-constituents. Bacterial and chemical analysis of domestic and industrial effluents. Food chemistry, Nutrition and Statistics. Analytical techniques and nutritional physiology.

## 17 BCH23C1: Microbial Biochemistry

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*General:* Types of micro-organisms, Cell structure and function, General characteristics and classification of micro-organisms, criteria used in the classification of micro-organisms: cytology, genetics, serology. Gram +ve and Gram -ve organisms, Mycoplasma, Archaeobacteria. Quantitative measurement of bacterial growth. Staining methods for bacteria.

*Microbial growth and nutrition:* Nutrition, physiology and different phases of microbial growth. Culture media, types of media, isolation of pure bacterial cultures.

### **UNIT 2**

*Microbial metabolism:* Requirements and regulation, oxidation-reduction vs fermentation, types of fermentations.

Structure and functions of peptidoglycan in gram positive and gram negative micro-organisms. Functions of polymeric components in outer membrane and acidic polymers in gram-negative organisms. Control of Microorganisms by Physical and Chemical Agents. Bacterial chemotaxis and quorum sensing.

*Genetic recombination in bacteria:* Transformation (general and restrictive), transduction and conjugation. Special features of bacterial transcription and translation.

### **UNIT 3**

*Virology:* General characteristics, and structure of virus including viral proteins, virus classification, lytic/lysogenic life cycles in viruses. Replication of DNA and RNA viruses

Fungi: General characteristics of yeasts and molds, mode of nutrition.

### **UNIT 4**

*Food and industrial Microbiology:* Food spoilage, fermentation, food-borne infections and intoxications. Domestic and industrial utility of micro-organisms. Application of microbes in production of useful metabolites.

*Microbial diseases and their control:* Pathogenicity of micro-organisms, Diseases caused by bacteria, fungi and protozoans, Evasion of host-defense mechanisms. Mechanism of action of antibiotics/antifungals.

**Suggested Readings for 17 BCH23C1: Microbial Biochemistry:**

1. Microbiology: An Introduction, Eighth Edition **By** Gerard J. Tortora, Berdell R. Funke, Christine L. Case. Pearson Education.
2. Fundamentals of Microbiology **By** I. Edward Alcamo. Benjamin-Cummings Pub Co.
3. Microbial Life **By** Jerome Perry, James Staley and Stephen Lory. Pub: Sinauer Associates Inc.
4. Microbiology: Concepts and Applications **By** MJ Pelczar, ECS Chan and NR Krieg, McGraw-Hill.
5. Microbiology **By** Lansing M. Prescott, John P Harley and Donald A. Klein. Publisher: McGraw Higher Education.
6. Principles of Microbiology **By** Ronald M. Atlas
7. Microbiology **By** BD Davis, R Delbecco, HM Eisent and HS Ginsberg. Medical Division, NY.
8. Microbial Biochemistry **By** ML Srivastava, Alpha Science Intl Ltd.
9. Microbial Biochemistry **By** GN Cohen, Publisher: Springer.
10. Microbial Physiology **By** Albert G. Moat, John Watkins Foster, Michael P. Spector. Publisher: John Wiley & Sons.
11. Cofactor Biosynthesis: A Mechanistic Perspective, Volume 61 (Vitamins and Horm-ones) **By** Gerald Litwack, Tadgh Begley. Publisher: Academic Press.
12. Principles of Virology: Molecular Biology, Pathogenesis and Control. **By** SJ Flint, LW Enquist, RM Krug, VR Racaniello and AM Skalka. ASM Press.
13. Fundamentals of Molecular Virology **By** Nicholas H. Acheson. John Wiley & Sons.
14. Basic Virology (Paperback) **By** Edward K. Wagner; Authors: Martinez J. Hewlett, David C. Bloom and David Camerini. Publisher: WileyBlackwell

## 17 BCH23C2: Clinical Biochemistry

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Disorders of carbohydrate metabolism:* Diabetes, glycohemoglobins, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases.

*Disorders of lipid metabolism:* Dyslipidosis and multiple sclerosis. Causes and diagnosis of the disorders of HDL-cholesterol, LDL-cholesterol and triglycerides. Hyperlipoproteinemia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick Disease, Gaucher's Disease, Krabb's Disease.

### **UNIT 2**

*Disorders of amino acid metabolism-* Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and animoacidurias, Disorders in urea biosynthesis

*Diagnostic enzymology:* Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase, amylase, lipase and trypsin. Enzyme tests in determination of myocardial infarction, Differential diagnosis of jaundice and clinical importance of bilirubin.

*Disorders of nucleic acid metabolism-* Disorders in purine/ pyrimidine metabolism.

### **UNIT 3**

*Hormones:* Secretion, molecular mechanisms protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and testosterone and ovarian hormones. Role of endothelins.

Role of receptors, cAMP, cGMP, phosphoinositides, calcium, diacylglycerol and nitric oxide in hormone action. Secretion and regulation of hypothalamic hormones. Thyroid function tests.

### **UNIT 4**

*Biochemical aspects of hematology:* Disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, and thrombosis.

*Renal function tests:* Renal: GFR and its clinical importance, clearance tests (urea and creatinine).

*Biochemistry of cancer:* carcinogenesis, characteristics of cancer cell, classification of carcinogens, agents promoting carcinogenesis, biochemical markers in cancer.

**Suggested Readings for 17 BCH23C2: Clinical Biochemistry:**

1. Textbook of Medical Biochemistry **By** MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger Principles of Biochemistry 5<sup>th</sup> Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
3. Davidson's Principles and Practice of Medicine: A Textbook for Students and Doctors (Hardcover) 15<sup>th</sup> Ed **By** LSP Davidson, J MacLeod and CRW Edwards. Publisher: Churchill Livingstone.
4. Medical Biochemistry (Paperback) **By** John W. Baynes and Marek Dominiczak. Publisher: Mosby.
5. Clinical Biochemistry: An Illustrated Colour Text (Paperback) 3<sup>rd</sup> Ed **By** Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.
6. Review of Medical Physiology (Lange Basic Science) (Paperback) **By** William F. Ganong. Publisher: McGraw-Hill Medical
7. Harper's Biochemistry (Lange Medical Books) (Paperback) **By** Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange.
8. Clinical Biochemistry **By** Richard Luxton. Scion Publishing Ltd.
9. Principles of Medical Biochemistry: With STUDENT CONSULT Online Access (Paperback) **By** Gerhard Meisenberg and William H. Simmons. Publisher: Mosby.

## 17 BCH23DA1: Principles of Genetics

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions of 1 or 2 marks. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1:**

Introduction, history, classical and molecular genetics. Mendel's Laws of inheritance and its applications, monohybrid and dihybrid crosses, types of dominance, test cross and back cross.

*Gene interactions:* Incomplete dominance, codominance, duplicate genes, complementary genes, supplementary genes, lethal genes, pleiotropic genes and multiple alleles.

### **UNIT 2:**

*Mutation:* Spontaneous and induced mutation, physical and chemical mutagens; mechanism of gene mutation and importance of mutation; detection of mutation and directed mutagenesis, mechanism of DNA repair.

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

### **UNIT 3:**

*Population genetics:* Populations, gene pool, gene frequency, factors affecting gene frequencies. molecular clock and evolution, genetic variations, sources of variations: Hardy-Weinberg principles and its applications.

*Genetic mapping and Linkage:* Gene mapping by in-situ hybridization; gene mapping from two point and three point test cross; linkage: complete and incomplete linkage, linkage analysis and genetic maps, crossing over, cytological basis of crossing over, mechanism of crossing over; homologous recombination in eukaryotes and bacteria.

### **UNIT 4:**

*Genome maps:* Genetic maps (linkage maps, cytogenetic maps including FISH); genetic markers; linkage mapping of DNA markers (AFLP, and STSs); physical mapping of genomes.

*Human genetics:* Chromosomal theory of inheritance, sex determination and sex differentiation in animals, sex linkage, extra chromosomal inheritance; disorders of autosomes, disorders of sex chromosomes, disorders of sexual differentiation.

**Suggested Readings 17 BCH23DA1: Principles of Genetics:**

1. Principles of Genetics **By** Gardner E.J, Simmons, M.J. & Snustad, D.P. John Wiley & Sons Inc, N.Y
2. Genetics: Analysis and Principles **By** Robert J. Brooker, 2011. McGraw Hill.
3. Essentials of Genetics, 2nd Ed. **By** William S. Klug & Michael R. Cummings 1996. Prentice Hall Internationals
4. Essential Genetics, 2nd Ed. **By** Daniel L. Hartl & Elizabeth W. Jones, 1999. Jones & Bartlett Publishers
5. Molecular Techniques in Crop Improvement **By** S. Mohan Jain and DS Brar. Springer
6. Plant Breeding and Biotechnology **By** Denis Murphy. Cambridge
7. Modern Livestock and Poultry Production **By** James R. Gillespie and Frank B. Flanders. Delmar Cengage Learning.
8. Biotechnology for Livestock Production **By** Food and Agricultural Organization. Plenum Press.
9. Evolutionary Quantitative Genetics **By** Derek A. Roff. Chapman & Hall.
10. Evolutionary Genetics- From Molecules to Morphology **By** R.S. Singh & C. Krimbas. Cambridge University Press.
11. Human genetics: The molecular evolution **By** Edwin H. Mcconkey. Jones and Barlett Publishers.
12. Human Molecular Genetics (2nd Edition) **By** Tom Strachan & Andrew P. Read John Wiley & Sons.
13. Human Genetics-Concepts & Applications (3rd Edition) **By** Ricki Lewis. McGraw-Hill.
14. Vogel and Motulsky's Human Genetics **By** MR Speicher, SE Antonarakis and AG Motulsky. Springer
15. Human Genetics: From molecules to medicine **By** Christian P. Schaaf, Johannes Zschocke and Lorraine Potocki. Lippincott Williams & Wilkins.

## 17 BCH23DA2: Biochemical Toxicology

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions of 1 or 2 marks. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Definition and Scope of Toxicology:* Dose-response relationship, synergism and antagonism, determination of ED<sub>50</sub> & LD<sub>50</sub>, acute and chronic exposure; clinical signs of systemic toxicity, Toxicity Influencing factors

*Xenobiotic metabolism:* absorption & distribution, phase I reactions; oxidation, reduction, hydrolysis and hydration; phase II reactions/conjugation; Glucouronidation, Sulfation, Acetylation, methylation, glutathione and amino acid conjugations, detoxification.

### **UNIT 2**

*Biochemical basis of toxicity:* Chemical Nature of Toxicants; Biochemical and Genetic mechanism of toxicity, Biochemistry of Mutagenesis, Biochemistry of Carcinogenesis; Genetic Susceptibility to Toxicants; Toxic response in Skin, Liver; Cardiovascular system; Endocrine system; Nervous system; Reproduction system; Kidney and Bladder.

*Toxicity testing:* genetic toxicity testing & mutagenesis assays - bacterial mutation tests, reversion test, ames test and fluctuation tests; *in vivo* mammalian mutation tests-host mediated assay & dominant lethal test.

### **UNIT 3**

*Pesticide toxicity:* Insecticides and their classification, mode of action, Insecticides- anti-cholinesterases insecticides, role of biopesticides in environmental management.

*Metal & Metalloid toxicity:* Toxicity of Arsenic, Mercury, Lead, Chromium and Cadmium

*Toxic natural products:* Mycotoxins; Toxic Substance of Plant; Insect Toxins; Spider Toxins Reptile Toxins & Non reptile Toxins.

### **UNIT 4**

*Toxic organic Compounds:* toxicity of alkanes; toxicity of unsaturated non aromatic compounds; Toxicity of Benzene, Naphthalene.

*Toxic organooxygen Compounds:* Toxicity of alcohols, Phenol, Formaldehyde, Carboxylic acids, Ethers, Acid Anhydrides, Esters.

*Food toxicology:* Role of diet in cardio-vascular diseases and cancer; Toxicology of various types of food additives,



**Suggested readings for 17 BCH23DA2: Biochemical Toxicology:**

1. General and applied toxicology, 1995 by Marrs and Turner Macmillan Press Ltd
2. Basic environmental toxicology 1994 by Lorris G. Corkerhem and Barbara SS Shane CRP Press Inc.
3. Introduction to food technology TakayurkiShibamoto&leonard F. Bzeldaanes  
A textbook of Modern Toxicology 3<sup>rd</sup> Edition 2004 by Ernest Hodgson
4. Casarett and Doull's Toxicology 7<sup>th</sup> Edition 2008 By Curtis D. Klaassen
5. Molecular biotechnology 2<sup>nd</sup> Ed 1994 by Barnard R Glick & JJ Pasternak

### 17 BCH23DB1: Biostatistics

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

#### **UNIT 1**

*Research Methodology:* Meaning of research, Objectives of research, Types of Research, Research process, sample design and types of sampling, Criteria for good research, Research design- Meaning and need for research design, features of good design. Different research designs and their basic principles.

*Experimental design:* experimental unit, identifying variables, replications & controls, treatment structure and design structure. Graphical analysis of data and presentation of results.

#### **UNIT 2**

Significance and limitations of statistical calculations. Measures of central tendency (mean, median, mode) and dispersion (standard deviation, CV and mean deviation). Sampling techniques. Probability theory (Addition and multiplication theorems), random variables & probability distributions (discrete and continuous), Point and interval estimation, Statistical evaluation of results- Hypothesis testing.

#### **UNIT 3**

Linear Regression. Calculation of percentiles, quartiles and deciles. Measurement of skewness and kurtosis. Relative and cumulative frequency distributions.

*Parametric tests*-ANOVA, F-test, t-test, z-test; Correlation coefficient.

#### **UNIT 4**

*Non-parametric tests*- Chi-square test, Wilcoxon signed rank test, Wilcoxon rank sum test (Mann-Whitney U test), Sign test, Runs test, Kruskal-Wallis H Test, Spearman's rank correlation, Tukey-Duckworth test and Friedman test.

**Suggested Readings for 17 BCH23DB1: Biostatistics:**

1. Essentials of Bioinformatics **By** Irfan Ali khan and AtiyaKhanum. Publisher: Ukaaz Publications.
2. Bioinformatics: Sequence and Genome Analysis (Hardcover) **By** David W. Mount. ColdSpring Harbor Laboratory Press
3. Introduction to Bioinformatics (Paperback) **By** Arthur M. Lesk. Oxford Univ Press.
4. Introduction to Bioinformatics: A Theoretical and Practical Approach (Paperback) **By** David Womble, Stephen A. Krawetz and David D. Womble. Humana Press Inc., U.S.
5. Applied Bioinformatics: An Introduction (Paperback) **By** Paul M. Selzer, Richard Marhofer and Andreas Rohwer. Publisher: Springer-Verlag Berlin and Heidelberg GmbH & Co. K.
6. Biostatistics **By** PN Arora and PK Malhan, Himalaya Publishing House.
7. Experimental Design and Data Analysis for Biologists **By** Gerry P. Quinn and Michael J. Keough. Publisher: Cambridge University Press.
8. Principles of Biostatistics (with CD-ROM) (Hardcover) **By** Marcello Pagano and Kimberlee Gauvreau. Publishers: Duxbury Press
9. Biostatistics: Experimental Design and Statistical Inference (Hardcover) **By** James F. Zolman. Oxford University Press.
10. Intuitive Biostatistics **By** Harvey Motulsky. Publisher: Oxford University Press.

## **17 BCH23DB2: Bioinformatics**

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### ***UNIT 1***

Introduction and Bioinformatics Resources: Knowledge of various databases and bioinformatics tools available at these resources, the major content of the databases, Nucleic acid sequence databases: GenBank, EMBL, DDBJ, Protein sequence databases: SWISS-PROT, TrEMBL, PIR, PDB, Genome Databases at NCBI, EBI, TIGR, SANGER, Other Databases of Patterns/Motifs/System Biology (Gene and protein network database and resources), Various file formats for bio-molecular sequences: genbank, fasta, gcg, etc

### ***UNIT 2***

Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues, paralogues. Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM series. Sequence-based Database Searches: BLAST and FASTA algorithms, various versions of basic BLAST and FASTA. Pairwise and Multiple sequence alignments: basic concepts of sequence alignment, Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments, Progressive and hierarchical algorithms for MSA. Use of pairwise alignments and Multiple sequence alignment for analysis of Nucleic acid and protein sequences and interpretation of results.

### ***UNIT 3***

Phylogeny: Phylogenetic analysis, Definition and description of phylogenetic trees and various types of trees, Method of construction of Phylogenetic trees [distance based method (UPGMA, NJ), character based methods (Maximum Parsimony and Maximum Likelihood method), disk covering methods], Computational approaches for gene identification, ORF and Human Genome Project.

### ***UNIT 4***

Protein Structure Prediction; Homology modeling, prediction of protein structure from sequences, functional sites, Protein folding problem, protein folding classes, protein identification and characterization; AACompIdent, TagIdent, PepIdent and MultiIdent; PROSEARCH, PepSea, PepMAPPER, FindPept, Predicting transmembrane helices, Primary structure analysis and prediction, Secondary structure analysis and prediction, motifs, profiles, patterns and fingerprints search. Methods of sequence based protein prediction

**Suggested Readings for 17 BCH23DB2: Bioinformatics:**

1. Computer Fundamentals: Concepts, Systems and Applications **By** PK Sinha. BPB Publications.
2. Computer Fundamentals and Programming in C **By** JB Dixit. University Science Press.
3. Computer fundamentals and programming in C **By** Amiya Kumar Rath, Alok Kumar Jagadev and Santosh Kumar Swain. Scitech Publications.
4. Computer Fundamentals (Paperback) **By** Ashok Arora, Shefali Bansai and Shefali Bansal. Publisher: Excel Books.
5. Discovering Computers: Fundamentals (Paperback) **By** Gary B. Shelly. Publisher: Course Technology.
6. Discovering Computers: Fundamentals, Fourth Edition (Shelly Cashman) (Paperback) **By** Gary B. Shelly, Thomas J. Cashman and Misty E. Vermaat. Publishers: Course Technology
7. Computer Fundamentals: Architecture and Organization (Paperback) **By** B. Ram. Publisher: New Age Publications (Academic)
8. Essential Bioinformatics (Paperback) **By** Jin Xiong. Cambridge University Press.
9. Bioinformatics: Methods & Protocols **By** Stephen Misener and Stephen A. Krawetz, Humana Press.
10. Essentials of Bioinformatics **By** Irfan Ali Khan and Atiya Khanum. Publisher: Ukaaz Publications.
11. Bioinformatics: Sequence and Genome Analysis (Hardcover) **By** David W. Mount. ColdSpring Harbor Laboratory Press
12. Introduction to Bioinformatics (Paperback) **By** Arthur M. Lesk. Oxford Univ Press.
13. Introduction to Bioinformatics: A Theoretical and Practical Approach (Paperback) **By** David Womble, Stephen A. Krawetz and David D. Womble. Humana Press Inc., U.S.
14. Applied Bioinformatics: An Introduction (Paperback) **By** Paul M. Selzer, Richard Marhofer and Andreas Rohwer. Publisher: Springer-Verlag Berlin and Heidelberg GmbH & Co. K.

### **17 BCH23CL: Lab Course V**

**Lab Practicals for Clinical Biochemistry:**Qualitative tests for urinary proteins. Qualitative and quantitative tests for reducing sugars in urine.Estimation of total proteins and albumin in serum and to calculate A/G ratio.Estimation of glucose, cholesterol, urea, creatinine, calcium, triglycerides, uric acid and bilirubin in the given blood/urine sample. Assay of ALP, AST, ALT, amylase, lipase and GGT in given blood sample. Analysis of blood group of given blood sample.Estimation of Blood hemoglobin.

**Lab Practicals for Toxicology:**Ames test, Toxic effects of arsenic, lead, chromium, cadmium, Dose response relation studies.

### **17 BCH23DL: Lab Course V**

**Lab Practicals for Microbial Biochemistry:** Autoclaving, Preparing & dispensing culture media, streaking.Culture of Bacteria, yeast and Filamentous Fungi; Pure and Mixed Culture.Preparation of wet mount, Trypan Blue exclusion assay, Mobility test (Hanging Drop) –Simple stain-Negative Stain-Gram’s stain -Capsule stain.Physiological reactions of bacteria –Catalase test –Coagulase test –Oxidase Test- Nitratetest –Carbohydrate Fermentation test – IMVIC test –TSI test, Antibiotic sensitivity test-Qualitative: Kirby Bauer’s methods, Quantitative: MIC.Germ Tube test, Biofilms formation.Hodge Test, Time Kill Kinetics.

**Lab Practicals for Bioinformatics:**Database search for literature, DNA, RNA & Proteins, ORF predictions, Characterization of DNA and protein sequences, Sequence based function prediction, Sequence alignment, Phylogeny studies, DNA and protein structure predictions. Proteins-protein interactions and prediction of Go:biological process.

## 17BCH24C1: Genetic Engineering

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **UNIT 1**

*Recombinant DNA Technology-1:* Enzymes used in molecular cloning (restriction enzymes, DNA-Polymerases, ligases, kinases, phosphatases, and nucleases); Extraction and Purification of nucleic acids, Cutting and Joining DNA, Vectors – Plasmid vectors, Vectors based on the lambda Bacteriophage, Cosmids, M13 vectors, Expression vectors, Super vectors : YACs and BACs. Amplifying DNA: PCR and Cell based DNA Cloning, Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA, Gene Recombination and Gene transfer: Bacterial Conjugation, Transformation, Transduction, Changing genes: site-directed mutagenesis (PCR based site directed mutagenesis), Random mutagenesis, Tools for analyzing gene expression - Reporter Genes assay, Northern blot, Real time PCR, Western blot, ELISA, protein gel electrophoresis

### **UNIT 2**

*Recombinant DNA technology-2:* Nucleic methods of production of recombinant DNA; construction of DNA libraries- genomic vs. cDNA library; Screening methods for genomics/cDNA libraries, Restriction mapping, RFLP, Proteins production in *E. coli* & yeast. Applications of recombinant DNA, gene therapy and recombinant vaccines. Molecular Mapping of genome: Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, simple sequence repeat loci, Southern and fluorescence in situ hybridization for genome analysis

### **UNIT 3:**

*Animal Genetic Engineering:* Gene Transfer methods in Animals - Gene cloning vectors, Techniques for genetic engineering, Gene cloning, Gene transfer and expression of induced genes, Microinjection, Embryonic-stem cells Transfer, Xenografting, Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceutical value, Development and Use of Transgenic Animals.

### **UNIT 4:**

*Plant genetic engineering:* Cloning of Plant Cells and Manipulation of Plant Genes, Agrobacterium mediated gene transfer- Biology and molecular basis of Agrobacterium mediated plant transformation and its application, Direct gene transfer methods, Gene silencing in plants - Post transcriptional and transcriptional gene silencing, Development of plant vectors for transformation and features, clean gene technology, Application of Plant Genetic Engineering - Crop improvement, Herbicide Resistance, Insect resistance, Virus Resistance,

**Suggested Readings for 17BCH24C1: Genetic Engineering:**

1. Basic Biotechnology (Paperback) **By** Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Introduction to Biotechnology (Paperback) **By** William J. Thieman and Michael A. Palladino. Benjamin Cummings; US Ed edition.
1. 3.Recombinant DNA Principles and Methodologies **By** James Joseph Greene, CRC Press.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (Paperback) **By** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
4. Molecular Cloning: a laboratory manual (Vol 1, 2 & 3) **3<sup>rd</sup> Ed.****By** J. Sambrook and DW Russel. Cold Spring Harbor Laboratory Publications, NY
5. RNA isolation and analysis **By** P. Jones, J Qiu and D. Rickwood. Bios Scientific Publishers.
6. Gene Cloning and DNA Analysis: An Introduction (Paperback) **By** Terence. A. Brown. WileyBlackwell.
7. Gene Cloning: An Introduction (Paperback) **By** Terence A. Brown. Nelson Thornes Ltd.
8. Principles of Gene Manipulation and Genomics, **By** S.B. Primrose & Richard M. Twyman, Blackwell Publishing.
9. Biotechnology: A textbook of Industrial Microbiology, **By**WulfCrueger and Thomas D. Brock. Sinauer Assoc.
10. Biotechnology: Expanding Horizons **By** B. D. Singh, Kalyani Publishers.
11. Textbook of Biotechnology **By** PK Gupta, Rastogi Publications.
12. Biotechnology **By** U. Satyanarayana.
13. Advances in Biotechnology **By** Prof. SN Jogdand, Himalaya Publishing House.



## 17BCH24C2: Plant Biochemistry

**Note:** Que. 1 will be compulsory and will cover the entire syllabus in the form of short questions of 1 or 2 marks. Que. 2 to 9 will include two questions from each unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Max. Marks: 80

Max. Time: 3 hrs

### **Unit 1**

Structure and functions of plant cell (including membrane, secretory systems, plastids, vacuoles, cell wall and plasmodesmata). Significance of alternative oxidase in plant mitochondrion. Unique features of plant glycolysis and citric acid cycle. Isolation of cell organelles with assessment of chloroplast fraction purity. Absorption and transport of water and ions in plants.

Formation, structure and metabolism of symbiotic nodules. Biological nitrogen fixation- structure, mechanism and regulation of nitrogenase. Electron allocation coefficient of nitrogen. Importance of  $Hup^+$  symbionts. Absorption and assimilation of nitrate, ammonium and sulfate- enzymatic mechanisms and regulation methods.

### **Unit 2**

Photosynthesis: Overview of organelles involved in photosynthesis in plants and bacteria (including light receptors, chlorophyll, light harvesting complex). Photosystems I & II- their location and composition. Molecular change in chlorophyll by light. Quantum yield and quantum efficiency. Bacteriorhodopsin as ion pump.

Mechanism of quantum capture and energy transfer in photosystems- roles of OEC, ferredoxin, plastocyanin, plastoquinone, carotenoids, FNR and FTR. Reduction of carbon dioxide: C3, C4 and CAM metabolism with regulation (light activation of enzymes in them). Starch and sucrose metabolism- synthesis and utilization mechanisms. Photorespiration and its efficiency.

### **Unit 3**

Functions and cellular interactions of important growth regulating substances- brassinosteroids, jasmonic acid, salicylic acid, oligosaccharines and polyamines. Functions and molecular mechanisms of auxins, gibberellins, abscisic acid, ethylene and cytokinins.

Photoperiodism- phytochromes, cryptochromes and their physiological significance. Physiology of senescence. Biochemistry of seed development (including starch synthesis) and seed germination. Seed dormancy- its mechanism, types and protein regulators. Artificial seeds- preparation and uses.

### **Unit 4**

Defense system in plants against biotic stresses- roles of phytoanticipins, NADPH oxidase, defense proteins, NO, phenolic compounds, jasmonic acid, ethylene and phytoalexins. Resistance to virus by gene silencing. Genetic basis of pathogen resistance. Effects of phytotoxins on plants.

Biochemistry of plants under various abiotic stress conditions- Defense by antioxidant enzymes and non-enzymatic antioxidants. Stress physiology of salinity, water deficit, oxygen deficit, oxidative stress, temperature stress and heavy metal stress.

**Suggested Readings for 17BCH24C2: Plant Biochemistry:**

1. Biochemistry and molecular biology of plants **By** Bob B. Buchanan, Wilhelm Gruissem and Russel L. Jones, IK International Pvt. Ltd.
2. Plant Physiology, 4<sup>th</sup> Ed., **By** Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc.
3. Introduction to Plant Physiology (Hardcover) **By** William G. Hopkins, Wiley Interscience.
4. Advances in Plant Physiology Series (Volumes 1-25), Pub: Springer Science
5. Plant Toxicology **By** Bertold Hock and Erich Elstner, Marcel Dekker.
6. Plant Hormone Signaling **By** Peter Hedden and Stephen Thomas, Blackwell Publishing.
7. Integrative Plant Biochemistry: 40 (Recent Advances in Phytochemistry) (Hardcover) **By** John Romeo. Elsevier Science.
8. Plant Biochemistry (Paperback) **By** PM Dey and JB Harborne. Academic Press Inc., US.
9. Plant Physiology, Biochemistry and Molecular Biology (Hardcover) **By** David T. Dennis and David H. Turpin. Publisher: Longman
10. Plant Biochemistry and Molecular Biology (Hardcover) **By** Hans-Walter Heldt. Oxford University Press.
11. Physiology and Molecular Biology of Stress Tolerance in Plants (Hardcover) **By** K.V. Rao Madhava, A.S. Raghavendra and K. Janardhan Reddy. Kluwer Academic Publishers.
12. Plant Biochemistry (Paperback) **By** Caroline Bowsher, Martin Steer and Alyson Tobin. Garland Publishing Inc., US.
13. Plant Physiology and Biochemistry (Paperback) **By** H.S. Srivastava and N. Shankar. Rastogi Publications.
14. Textbook of Plant Physiology, Biochemistry and Biotechnology (Paperback) **By** S. Verma and Mohit Verma. S. Chand and Co.
15. Plant Biochemistry (Hardcover) **By** Hans-Walter Heldt. Academic Press.