

Department of Biochemistry

Credit Matrix for M.Sc. Biochemistry programme w.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 to 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.

The Syllabus of M.Sc. and Pre-Ph.D. prepared by Department of Biochemistry is communicated to the students by the teachers. The teachers also apprise the students of specific areas of which they are going to gain knowledge. The teachers instruct the student what they are supposed to obtain at the end of each programme. The program outcomes of all the subjects are made clearly known to the students and regarding the same, the doubts and confusions of students are also clarified by the teachers. Throughout the programme duration, the attainment of objectives by students is assessed through various tests and examinations and suggestions for improvement are given. The Department collects the feedback from the students on course structure, infrastructure, faculty, information resources, evaluation, and on the overall OBE system, to establish quality and continuously improve the program.

Program Specific Outcomes:

PSO1: Demonstrate in-depth knowledge of structure and metabolism of macromolecules and understand the regulation of metabolic and cell signalling pathways.

PSO2: Gain proficiency in laboratory techniques of various aspects of biochemistry and also be able to apply processes of experimentation and hypothesis testing to biochemical methods.

PSO3: Acquire thorough knowledge in molecular biology, biochemical techniques, immunology, physiology and plant system physiology and genetic engineering.

PSO4: Learn to work independently and as a team for retrieving information, carry out research investigations and result interpretations.

PSO5: Develop the ability to comprehend and practise the ethics involving scientific Research

PSO6: Students acquire analytical and presentational skills from skills lectures, classes and seminars, and dissertation. They also acquire knowledge of the written presentation of research through the provision of a minimum six month research project for each student.

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	
Sub Total				28	36		

Semester II

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	IntAss
Core Courses							
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
Discipline Specific Courses (Choose any one)							
4.	16BCH22D1	Proteomics	Discipline Specific	4-0-0	4	80	20
5.	16BCH22D2	Nutritional Biochemistry					
Foundation Elective**To be chosen from university pool of fundamental elective papers						2 Credits	

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	
Sub Total				28	48		

Grand Total:

112

Department of Biochemistry offer open elective paper as follows:

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

SEMESTER I				
PAPER: Biomolecules & Bioenergetics				
Core Paper	Paper Code: 16BCH21C1	Credits 4	Max Marks: 80	Time 3hrs
<p>Course Outcomes</p> <p>CO1⇒ Enrichment about basic concepts of buffers, their role in biological system.</p> <p>CO2⇒ Knowledge of bond formation among biomolecules and their importance in thermodynamics.</p> <p>CO3⇒ Knowledge of role of carbohydrates in biochemical reactions and human physiology.</p> <p>CO4⇒ Knowledge of fatty acids and their properties and their relevance to human health and nutrition</p> <p>CO5⇒ Knowledge of Proteins, amino acids, Nucleic acids & Porphyrins and their properties and their relevance to cellular physiology</p>				
<u>Instructions</u>				
<p>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.</p>				
<i>Syllabus</i>				
<i>UNIT 1</i>				
<p><i>Introduction:</i> Water as biological solvent- bonds, thermal properties and solvent properties. Weak acids and bases, pH& its calculation, Handerson-Hasselbalch equation, physiological buffers.</p> <p><i>Bioenergetics:</i> 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.</p>				
<i>UNIT 2</i>				
<p><i>Carbohydrates:</i> Classification, structure, occurrence and biological functions. Glycoconjugates. Physicochemical properties of monosaccharides. Derivatives of monosaccharides.</p> <p><i>Lipids:</i> 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.</p>				
<i>UNIT 3</i>				

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 insolution, 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 4th 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) 3rd 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.

SEMESTER I

PAPER: Cell Structure & Signalling

Core Paper	Paper Code: 16BCH21C2	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

CO1 ⇒ Enrichment about advanced concepts of cell structure, cellular functioning, cell transport and cell-cell interactions

CO2 ⇒ Detailed knowledge of layout of connective tissue components that hold cell together,

DNA mobile elements and dynamics of cell divisions

CO3⇒ Knowledge of working of cell organelles, cytoskeleton and travel of signals inside cells

CO4⇒ Advanced cell biology of neurons and associated cells

CO5⇒ Effective knowledge to successfully face questions of cell biology- a major component of NET exam

Instructions

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.

Syllabus

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 4th Ed **By** James E. Darnell, Harvey Lodish, Arnold Berk, and Lawrence Zipursky, W.H. Freeman and Co.
2. Molecular Biology of the Cell 4th 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) 5th 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 2nd Edition **By** Larry Squire, James Roberts, Nicholas Spitzer, Michael Zigmond. Academic Press

SEMESTER I

PAPER: Human Physiology

Core Paper	Paper Code: 16BCH21C3	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Enrichment of students advanced concepts of most important systems of human body.
- CO2⇒ Recent knowledge of signalling events involved in various organs of human body.
- CO3⇒ Imparting latest knowledge of human physiology to students, that would be very useful in NET exams.
- CO4⇒ Students will be having knowledge of inter-relation among human organs for integrated functions of human body.

Instructions

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.

Syllabus

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 10th Ed **By** Arthur C. Guyton and John E. Hall, Harcourt Asia Pte Ltd.
2. Essential Medical Physiology 3rd Ed **By** Leonard R. Johnson, Elsevier Academic Press.
3. Endocrinology: An Integrated Approach **By** SS Nussey and SA Whitehead. BIOS Scientific Publishers
4. Physiology 3rd Ed, **By** Linda Costanzo, Saunders Publishers.
5. Principles of Anatomy and Physiology 10th 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 13th 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 HershalStrang. McGraw Hill Education.
10. Medical Physiology: Principles for Clinical Medicine 3rd Ed. **By** Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.

SEMESTER I

PAPER: Metabolism and Regulation

Core Paper	Paper Code: 16BCH21C4	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Insights of carbohydrate metabolism in a cell for enabling students to understand metabolic role of the carbohydrates in a cell.
- CO2⇒ Knowledge of cellular processes required to utilize various metabolic substrates (Carbohydrates, lipids, amino acids) to generate energy rich molecules to meet its biological energy demand.
- CO3⇒ Understanding of the metabolism of various biomolecules within a cell.
- CO4⇒ This paper will enable the students to generate their knowledge base to correlate and understand syllabus content of papers like clinical biochemistry, plant biochemistry etc. going to be studied in next semesters

Instructions

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.

Syllabus

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 4th 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 3rd Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
9. Biochemistry of Lipids, Lipoproteins and Membranes (4th Ed.) D.E. Vance and J.E. Vance. Pub: Elsevier Science B.V
10. Medical Biochemistry 4th 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.

SEMESTER I

PAPER: Bioanalytical Techniques

Core Paper	Paper Code: 16BCH21C5	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

CO1⇒ Knowledge of working of spectrophotometers and applications of UV-visible spectroscopy, IR spectroscopy, NMR, ESR etc.

CO2⇒ Understanding of application of electrophoresis (PAGE and agarose gel electrophoresis); denaturing PAGE and separation and detection methods for proteins and nucleic acids.

CO3⇒ Students will be versed with chromatographic techniques like gel filtration chromatography, affinity, ion exchange and gas chromatography for using these to purify biomolecules based on their interactions with different solvents.

CO4⇒ Knowledge of centrifugation and their applications for isolation and identification of different biomolecules or cell organelles.

CO5⇒ Students understand the concept of radioactivity, application of radioactive substances and use of biosensors for measurement of different analytes.

Instructions

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.

Syllabus

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, 3rd 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 3rd 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.

SEMESTER I **PAPER: Lab Course I**

Practical	Paper Code: 16BCH21CL1	Credits 4	Max Marks: 100	Time 6 hrs
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Course Outcomes

- CO1⇒ Hands-on training to biochemically analyze proteins for their quantities
- CO2⇒ Identification/quantification of organic acids and amino acids by their titration behaviour against acids/bases
- CO3⇒ Hands-on training of students to analyze biochemical properties of various lipids
- CO4⇒ Quantification of nucleic acids i.e. RNA and DNA by respective methods
- CO5⇒ Second section of Cell Biology trains students on counting and visualization of cells in microscope. Higher training for cell separation and mutation testing is also given.

Syllabus

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.

SEMESTER I
PAPER: Lab Course II

Practical	Paper Code: 16BCH21CL2	Credits 4	Max Marks: 100	Time 6 hrs
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Course Outcomes

- CO1⇒ Identification of sugars, amino acids based on their physico-chemical properties
- CO2⇒ Quantification of lipids, proteins and various biological and non biological samples
- CO3⇒ Methods for physicochemical characterization of proteins
- CO4⇒ Qualitative analysis of metabolism of carbohydrates, lipids, amino acids and proteins in microbial systems
- CO5⇒ To synchronize theoretical information gained from Intermediary metabolism with practical information

Syllabus

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.

SEMESTER II
PAPER: Immunology

Core Paper	Paper Code: 16BCH22C1	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Immunology not only provides understanding of immune system but it is also fundamental to the life sciences industry
- CO2⇒ The discipline is core to the development of modern antibody therapies, cellular therapies, small molecule drugs, vaccines and 'biologics' (therapeutic biomolecules).
- CO3⇒ It makes the students versed with functioning of immune system, consequence of failure to mount response and exploitation of knowledge to circumvent in treatment of disease due to under response/ hypersensitivity.

Instructions

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.

Syllabus

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.

SEMESTER II
PAPER: Enzymology

Core Paper	Paper Code: 16BCH22C2	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Students are enriched about advanced concepts of enzymes as drivers of living systems including catalysis mechanisms.
- CO2⇒ Students have advanced knowledge of kinetics of enzymes as affected various types of inhibitors and also various possibilities of substrates.
- CO3⇒ Higher knowledge of behaviour of enzymes in human physiology
- CO4⇒ Advanced knowledge of physiological behaviour of enzymes and their immobilization principles.

Instructions

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.

Syllabus

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 4th 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.

SEMESTER II

PAPER: Molecular Biology

Core Paper	Paper Code: 16BCH22C3	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

CO1 ⇒ How the genetic contents of a cell replicate and how it helps a cell transfer its genetic information to the daughter cell without any loss.

CO2⇒ How the genomic content of cell develops its biocatalytic machinery utmost for cellular functioning.

CO3⇒ How various cellular molecular processes are highly coordinated?

CO4⇒ Students are embarked with the in-depth information about cellular molecular processes like gene transcription & translation.

Instructions

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.

Syllabus

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, Posttranslational 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 rd 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

SEMESTER II
PAPER: Proteomics

Soft Core	Paper Code: 16BCH22D1	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Principles and advances of various modes of electrophoresis- the first step in proteomics
- CO2⇒ Advanced knowledge about x-ray crystallography and Mass Spectroscopy for ultrafine analysis of bio-molecules.
- CO3⇒ Use of bioinformatics tools for processing of data of proteomics and modelling of proteins according to findings of data processing

Instructions

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.

Syllabus

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 quadrupole (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.

SEMESTER II

PAPER: Nutritional Biochemistry

Soft Core	Paper Code: 16BCH22D2	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

- CO1⇒ Students are enriched with role of physiological buffers, respiratory system and renal system in regulation of blood pH. Also they will learn about metabolic disorders related to pH imbalance in body.
- CO2⇒ Students are versed with sources and metabolic functions of fat and water soluble vitamins, the benefits and deficiency diseases of vitamins. They will also be enriched with knowledge of sources of minerals and their functions in human body.
- CO3⇒ Students learn about specific causes and mechanisms of different types of anemia, protein energy malnutrition and causes and consequences of obesity and its management.
- CO4⇒ The knowledge of these contents targets to make students aware about role of diet and nutrition in health and diseases and hence can help them to decide food according to their body requirements.

Instructions

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.

Syllabus

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 B₁₂, 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, 7th Ed., Pub: Lea &Febiger.
4. Handbook of Nutrition and Food 2nd 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 5th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.

Practical	Paper Code: 16BCH22CL1	Credits 4	Max Marks: 100	Time 6 hrs
<p>Course Outcomes</p> <p>CO1⇒ Isolation and purification of enzymes from biological samples</p> <p>CO2⇒ Hands-on training to analyze kinetics of isolated enzymes for their understanding their behaviour in aqueous medium</p> <p>CO3⇒ Enrichment on methods to experimentally analyze effects of external agencies i.e. activators and inhibitors on isolated enzymes</p> <p>CO4⇒ Various techniques based on immunology and antigen-antibody interaction are practically performed in this paper.</p> <p>CO5⇒ Simple blood group detection, lymphocyte isolation to complex like ELISA, Immunoelectrophoresis, Immunodiffusion (single and double) are also routinely performed for better understanding of concepts learned in theory paper.</p>				
<p><i>Syllabus</i></p>				
<p>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.</p> <p>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.</p>				

<p>SEMESTER II</p> <p>PAPER: Lab Course IV</p>				
Practical	Paper Code: 16BCH22CL2	Credits 4	Max Marks: 100	Time 6 hrs
<p>Course Outcomes</p> <p>CO1⇒ Enrichment of the students about the various methods available for qualitative and quantitative assessment of DNA & RNA</p> <p>CO2⇒ Various methods to explore and utilize the genetic information for genetic engineering.</p> <p>CO3⇒ This paper content enables the students to monitor the quality and quantity of various nucleic acids (DNA & RNA) for various biotechnological applications.</p> <p>CO4⇒ Students are trained to have knowledge to experimental test food items for some important metals and vitamins.</p> <p>CO5⇒ Students are trained to test milk and drinks for important constituents and also contaminants</p>				
<p><i>Syllabus</i></p>				
<p>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.</p> <p>Lab Practical for Nutritional Biochemistry: Estimation of copper, iron, calcium and vitamin C in foodstuffs.</p>				

Chemical test for bio-constituents. Bacterial and chemical analysis of domestic and industrial effluents. Food chemistry, Nutrition and Statistics. Analytical techniques and nutritional physiology.

SEMESTER III

PAPER: Microbial Biochemistry

Core Paper	Paper Code: 17BCH23C1	Credits 4	Max Marks: 80	Time 3hrs
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Course Outcomes

CO1⇒ Understanding of classification of microbes including bacteria based on structure, shape, biochemical tests, nutrient utilization and nucleic acids' based techniques

CO2⇒ Imparting knowledge of growth patterns, culture, maintenance of microbes

CO3⇒ Introduction of viruses including classification, life cycles, culture methods and interactions with hosts.

CO4⇒ Understanding of applications of microbes in industries in food production, vaccines, metabolite production and disease manifestation.

Instructions

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.

Syllabus

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.
- Basic Virology (Paperback) **By** Edward K. Wagner; Authors: Martinez J. Hewlett, David C. Bloom and David Camerini. Publisher: WileyBlackwell

SEMESTER III**PAPER: Clinical Biochemistry**

Core Paper	Paper Code: 17BCH23C2	Credits 4	Max Marks: 80	Time: 3hrs
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Course Outcomes

- CO1⇒ Understanding the biochemical mechanism and pathophysiological process of diabetes and dyslipidemia and the importance of diagnosis.
- CO2⇒ Importance of diagnostic enzymes in clinical conditions, understanding of biochemistry and pathophysiology of amino and nucleic acid associate disorders.
- CO3⇒ Understanding the consequences of hormonal unbalance with reference to biochemistry and pathophysiology.
- CO4⇒ Biochemistry and diagnosis of hematology and cancer conditions and the import-ance of diagnosis.

Instructions

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.

Syllabus***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 aminoacidurias, 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 5th 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) 15th 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) 3rd 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.

SEMESTER III

PAPER: Principles of Genetics

Soft Core

Paper Code: 17BCH23DA1

Credits 4

Max Marks: 80

Time: 3hrs

Course Outcomes

- CO1⇒ Enrichment of students about advanced concepts of population genetics and related concepts of molecular evolution.
- CO2⇒ Knowledge to students about how to prepare linkage maps of important genes and also will have advanced knowledge of crossing over of chromosomes that lead to variations.
- CO3⇒ Knowledge on how to carry out quantitative analysis on data of population genetics and linkage mapping, which are the two very important topics of NET exams.
- CO4⇒ Knowledge to students on analysis of genetic maps and human genetics to understand major genetic disorders faced by humans.

Instructions

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.

Syllabus

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

SEMESTER III

PAPER: Biochemical Toxicology

Soft Core	Paper Code: 17BCH23DA2	Credits 4	Max Marks: 80	Time: 3hrs
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Course Outcomes

CO1⇒ This paper is available as option in lieu of 'Principles of Genetics' paper and contents provide information about how a cell/tissue/organ responds towards an exposure to the toxicants, what are deleterious effects of various toxins and how our body tries to nullifies their toxic effects.

CO2⇒ Knowledge of mode of actions of various xenobiotics to induce cellular toxicity and mutagenesis and also tests for assessing the same.

CO3⇒ Understanding of types of insecticides and their modes of action. It also describes the ecological and economical benefits of Integrative pest management approach.

CO4⇒ Knowledge of biological toxins and mechanisms involved to induce their toxicity

Instructions

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.

Syllabus

UNIT 1

Definition and Scope of Toxicology: Dose-response relationship, synergism and antagonism, determination of ED50 & LD50, 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 alcohals, 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 Lorriss G. Corkerhem and Barbara SS Shane CRP Press Inc.
3. Introduction to food technology Takayurki Shibamoto & Leonard F. Bzeldaanes
A textbook of Modern Toxicology 3rd Edition 2004 by Ernest Hodgson
4. Casarett and Doull's Toxicology 7th Edition 2008 By Curtis D. Klaassen
5. Molecular biotechnology 2nd Ed 1994 by Barnard R Glick & JJ Pasternak

SEMESTER III

PAPER: Biostatistics

Soft Core	Paper Code: 17BCH23DB1	Credits 4	Max Marks: 80	Time: 3hrs
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Course Outcomes

CO1⇒ Knowledge of advanced concepts of design and carrying of research process.

CO2⇒ Information on methods to carry out basic arithmetical processing and probability-based calculations of numerical data.

CO3⇒ Enrichment of students with higher knowledge of parametric tests that are essential for mathematical validation of numerical data of research

CO4⇒ Students also get to know how to select and carry out non-parametric tests as alternative of parametric tests

Instructions

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.

Syllabus

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.

SEMESTER III **PAPER: Bioinformatics**

Soft Core	Paper Code: 17BCH23DB2	Credits 4	Max Marks: 80	Time: 3hrs
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Course Outcomes

- CO1⇒ Imparting of students with knowledge of accessing protein and nucleic acid databases for verification of sequence under study
- CO2⇒ Understanding of sequence alignment methods and possible applications in genomics and evolution biology
- CO3⇒ Phylogeny is final interpretation of sequence alignment to know how sequence under study has evolved

CO4⇒ Students are also given knowledge to predict structure of protein on the basis of sequence

Instructions

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.

Syllabus

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 & Wunsch, 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** JinXiong. 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 AtiyaKhanum. 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.

SEMESTER III
PAPER: Lab Course V

Practical	Paper Code: 17BCH23CL1	Credits 4	Max Marks: 100	Time 6 hrs
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Course Outcomes

- CO1⇒ Blood and urine testing is the most common applied aspect of clinical biochemistry and students get hands-on training for their testing
- CO2⇒ Estimation of important metabolites like glucose, urea, uric acid, creatinine, TG and bilirubin which are done as diagnostic tests for a number of diseases
- CO3⇒ Quantification of clinically important enzymes like alkaline phosphatase, AST, ALT, amylase, lipase and GGT which also done as diagnostic tests for a number of diseases.
- CO4⇒ Toxicity testing methods will allow the students to understand mutagenic, lethality associated with xenobiotics
- CO5⇒ It will enable the students to understand the biological process to define effective dose of medical formulations, insecticides & pesticides.

Syllabus

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.

SEMESTER III
PAPER: Lab Course VI

Practical	Paper Code: 17BCH23CL2	Credits 4	Max Marks: 100	Time 6 hrs
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Course Outcomes

- CO1⇒ Students are apprised of principles of a lab that handles microbial testing of samples
- CO2⇒ Hands-on training to identify microbes by a number of tests given to students
- CO3⇒ Hands-on training to test physiological capacity of microbes by a number of tests also given.
- CO4⇒ Students will access online database, tools and servers available to access information

about Bio-molecular system.

CO5⇒ Knowledge about available tools for genomics, proteomics and metabolic data analysis will allow the students to use them for their dissertation work

Syllabus

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.

SEMESTER IV

PAPER: Genetic Engineering

Core Paper	Paper Code: 17BCH24C1	Credits 4	Max Marks: 80	Time: 3hrs
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Course Outcomes

CO1⇒ Students get advanced knowledge of various systems used to modify DNA of target system

CO2⇒ Advanced knowledge of how these systems are applied and screened for activity

CO3⇒ Advanced knowledge of specific methods to manipulate DNA of animal systems for improvement of domestic animals

CO4⇒ Advanced knowledge of specific methods to manipulate DNA of useful plants for improvement of their nutritional property or diseases resistance.

Instructions

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.

Syllabus

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 (Paper-back) **By** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
4. Molecular Cloning: a laboratory manual (Vol 1, 2 & 3) **3rd 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.

SEMESTER IV				
PAPER: Plant Biochemistry				
Core Paper	Paper Code: 17BCH24C2	Credits 4	Max Marks: 80	Time: 3hrs
Course Outcomes				
CO1⇒ Student are taught about the concepts of plant cell biology and assimilation of nitrogen				

and sulfur in plant system

CO₂⇒ Students gain knowledge about molecular details of various carbon fixation machinery and pathways of carbon assimilation in photosynthetic organisms.

CO₃⇒ Growth regulation of plant system by various factors and also various events of seed physiology are also taught to students.

CO₄⇒ Advanced knowledge of stress metabolism mechanisms that operate in plants in various stress conditions

Instructions

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.

Syllabus

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- brassino-steroids, 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, 4th 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.

SEMESTER IV

PAPER: Dissertation

Core Paper	Paper Code: 17BCH24C3	Credits 20	Max Marks: 300	Time: NA
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Course Outcomes

CO1⇒ Students nurture their scientific capabilities

CO2⇒ Students identify own areas of interest with in depth exploration.

CO3⇒ Students define their own research questions; simultaneously experiencing the process of producing knowledge.

CO4⇒ Students consolidate communication, information-seeking and intellectual skills

CO5⇒ Dissertation offers the opportunity to further develop subject expertise and intellectual and organisational skills of the students