

Department of Biochemistry

Credit Matrix for M.Sc. Biochemistry programme w.e.f. session 2015-16

Semester	Hard Core (HC)	Soft Core (SC)	Supportive (F)	Open Elective (Interdisciplinary)	Practicals/ Dissertations	Total
I	20	--	--	--	10	30
II	12	4	2	2	10	30
III	16	4	--	--	10	30
IV	8	--	--	--	20	28
	56	8	2	2	50	118

INSTRUCTIONS FOR THE STUDENTS

Course Types:

- **Hard 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.
- **Soft Core Elective (E):-** Soft core 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/Supportive Course (F):-** The Foundation Course is based upon the content that leads to Knowledge enhancement. It is mandatory as per course curriculum.
- **Interdisciplinary Course/Open Elective (OE):-** Open elective course may be from an unrelated discipline. It is Interdisciplinary/Open Elective & mandatory as per course curriculum.

Choice based Credit System

Examination Scheme of M.Sc Biochemistry (Semester System)

w.e.f. academic session 2015-16.

Semester I (Dec-2015)

S. No	Course Code	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
1.	BCH 101	Bio Molecules	HC	4-0-0	4	80	20
2.	BCH 102	Cell Biology	HC	4-0-0	4	80	20
3.	BCH 103	Bioorganic Chemistry	HC	4-0-0	4	80	20
4.	BCH 104	Metabolism	HC	4-0-0	4	80	20
5.	BCH 105	Bioanalytical Techniques	HC	4-0-0	4	80	20
6.	BC 106	Lab Course I (based on BC 101 & 102)		0-0-6	12	100	
7.	BC 107	Lab Course II (based on BC 103, 104 & 105)		0-0-4	8	100	
Sub Total				30	40	700	

Semester II (May-2016)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
1.	BCH 201	Plant Biochemistry	HC	4-0-0	4	80	20
2.	BCH 202	Immunology	HC	4-0-0	4	80	20
3.	BCH 203	Enzymology	HC	4-0-0	4	80	20
4.	BCS 204	Biochemical Toxicology * OR	SC	4-0-0	4	80	20
5.	BCS 205	Nutritional Biochemistry *	SC	4-0-0	4	80	20
6.	BCF 206	Communication Skills in Science	SC (sup- portive)	2-0-0	2	40	10
7.	BCO 207	Basic Biochemistry (open elective)#	Interdisc- iplinary	2-0-0	2	40	10
8.	BC 208	Lab Course III (based on BC 201 & 202)		0-0-6	12	100	
9.	BC 209	Lab Course IV (based on BC 203)		0-0-4	8	100	
Sub Total				30	40	700	

* M.Sc. Biochemistry students will opt one paper # open to students from unrelated disciplines

Semester III (Dec-2016)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
1.	BCH 301	Molecular Physiology	HC	4-0-0	4	80	20
2.	BCH 302	Clinical Biochemistry	HC	4-0-0	4	80	20
3.	BCH 303	Microbial Biochemistry	HC	4-0-0	4	80	20
4.	BCH 304	Molecular Biology	HC	4-0-0	4	80	20
5.	BCS 305	Genetics * OR	SC	4-0-0	4	80	20

6.	BCS 306	Ecological Principles and Evolution*	SC	4-0-0	4	80	20
7.	BC 307	Lab Course V (based on BC 301 & 302)		0-0-6	12	100	
8.	BC 308	Lab Course VI (based on BC 303 & 304)		0-0-4	8	100	
Sub Total				30	40	700	

* M.Sc. Biochemistry students will opt one paper

Semester IV (May-2017)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Marks
1.	BCH 401	Bioinformatics & Biostatistics	HC	4-0-0	4	80	20
2.	BCH 402	Methods in Molecular Biology	HC	4-0-0	4	80	20
3.	BC 403	Dissertation/Project Work		0-0-20	40	300	
Sub Total				28	48	500	

Grand Total: 118 168 2600

ORDINANCE

TWO YEAR MASTER OF SCIENCES

IN

Biochemistry

Existing ordinance as approved in Faculty of life Sciences meeting held on 8-11-13 vide letter no. ACS-II/F-44/2013/18136-66 will continue with following changes in the eligibility conditions for the admission to Master Degree course in Biochemistry-

(A) Biochemistry

B. Sc./ B.Sc. (Hons.) in Biochemistry/Biotechnology, or, Bachelor degree in Pharmacy, or B.Sc. (Pass) with any of the three subjects, viz., Botany, Zoology, Chemistry, Microbiology, Genetics, Medical Biochemistry, Biotechnology, Biochemical Engineering (out of the three subjects, at least two should be related to Biology) with at least 50% marks in aggregate, or, any other examination recognized by M.D. University, Rohtak. (Relaxation will be given for Students belonging to SC/ST category as per state/University norms).

BCH 101: Biomolecules

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Introduction: Water as biological solvent, weak acids and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers.

Carbohydrates: Classification, structure, occurrence and biological functions. Glycoproteins. Physicochemical properties of monosaccharides.

UNIT 2

Lipids: Classification, structure, occurrence and biological functions of lipids. Nomenclature and properties of fatty acids and triglycerides, saponification number, acid number, Reichert-Meissel number, rancidity of fats. Composition and types of lipoproteins. Steroids and carotenoids of biological origin, liposomes.

UNIT 3

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

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

UNIT 4

Nucleic acids: Nature of genetic material, properties of DNA in solution, evidence of DNA as genetic material and evidence for semi-conservative nature, Composition of RNA and DNA, features of DNA double helix, denaturation and annealing of DNA. Structure and roles of different types of DNAs and RNAs.

Porphyryns: Porphyrin nucleus and classification of porphyryns, important metalloporphyryns occurring in nature, Chemical nature and significance of bile pigments.

Suggested Readings: _____.

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. Biochemistry and Molecular biology **By** William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3rd Ed. **By** Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
9. Fundamentals of Biochemistry: Life at the Molecular Level [Import] (Hardcover) **By** Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher: Wiley.
10. Principles of Biochemistry (Paperback) **By** Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
11. Biochemistry **By** U. S. Satyanarayana
12. Outlines of Biochemistry **By** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

BCH 102: Cell Biology

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Structure and function of cell organelles: comparison of prokaryotic and eukaryotic cell structure, detailed description of nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, ribosomes

The epithelial apices- glycocalyx and microvilli. Tissues, Classification and role of various type of tissues, organization of various tissues in organs;

Cellular communication: general principles of cell communication, Cell Cell Interaction-cell adhesion and roles of different adhesion molecules (cadherins, integrins, IgSF, selectins, tight/gap junctions).

UNIT 2

The extracellular matrix: collagen, elastin, fibrillin, fibro-nectin, laminin and proteoglycans.

Cell cycle: different phases and their regulation.

Biomembranes: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps (channel proteins, passive carrier proteins, coupled transporters and ATP-driven pumps), mechanism of sorting and regulation of intracellular transport

UNIT 3

Genes and chromosome structure: Chemical structure of gene and chromosome, Chromosomal organization of genes and non-coding DNA, structural organization of eukaryotic chromosomes, organelle DNA, Mobile DNA: transposons, retrotransposons, LINES and SINES.

Mutations: Definition, types, mutagenicity testing and DNA repair mechanisms

The cytoskeleton: microtubules and microfilaments, functions of motor proteins in microtubules. Secretary pathways in cell,

UNIT 4

Cell signaling: Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

Biochemistry of cancer – carcinogenesis, characteristics of cancer cell, Prognosis of cancer, Classification of carcinogens, agents promoting carcinogenesis, biochemical markers in cancer.

Suggested Readings: _____.

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 (Hardcover) **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-Heldin Heldin and Mary Purton. Bios Scientific Publishers Ltd.
8. Fundamental Neuroscience 2nd Edition **By** Larry Squire, James Roberts, Nicholas Spitzer, Michael Zigmond. Academic Press

BCH 103: Bioorganic Chemistry

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Structure of atoms, molecules and chemical bonds. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties). Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

UNIT 2

Isomerism, optical isomerism, optical activity, specific rotation, chirality, enantiomers, diastereoisomers, D/L/R/S notations, Fisher projection formula, stereoisomerism of cyclic molecules, separation of enantiomers, stereogenic centers other than carbon, and synthesis of chiral molecules. Conformational analysis of ethane, cyclohexane, n-butane and monosaccharides, boat & chair forms; eclipsed, gauche & staggered conformations. Anomers and mutarotation.

UNIT 3

Structures of triacylglycerols, terpenoids, steroids, amino acids, proteins, peptides and nucleic acids. Stabilization of peptide secondary structures, conformational restriction of sphingolipids, significance of aminomutases; carbohydrate recognition by artificial receptors, bioorganic receptors for amino acids and peptides. Metal ions in biological systems-metalloenzymes, cytochromes and iron-sulfur proteins.

UNIT 4

DNA intercalation and interactions in minor groove, Non-specific and specific DNA detection, peptide nucleic acids (PNA), charge transfer in DNA, reactions of nucleic acids with active carcinogens and photochemical modifications. Organic chemistry of monooxygenation, dioxygenation, substitutions, carboxylations, decarboxylations, isomerization, and additions in enzyme-catalyzed reactions, Protease catalyzed formation of C-N bonds, twin ribozymes, catalytic properties of RNA; acid-base and nucleophilic enzyme catalysis

Suggested readings:-

1. Highlights in Bioorganic Chemistry **By** Carsten Schmuck and Helma Wennemers. Pub: WileyInterscience
2. Bioorganic, Bioinorganic and Supramolecular Chemistry **By** PS Kalsi and JP Kalsi. New Age International Publishers
3. The Organic Chemistry Of Biological Pathways **By** John McMurry and Tadhg P. Begley. Roberts and Co Publishers.

4. The Organic Chemistry of Enzyme-Catalyzed Reactions **By** Richard B. Silverman. Academic Press.
5. Introduction to Bioorganic Chemistry and Chemical Biology [Paperback] **By** David Van Vranken and Gregory A. Weiss. Pub: Garland Science
6. Principles of Bioorganic Chemistry **By** Stephen J. Lippard and Jeremy M. Berg.
7. Nucleic acids in Chemistry and Biology **By** G. Michael Blackburn. RSC Publishing.

BCH 104: Metabolism

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

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, generation of superoxides in mitochondria, biological oxidation and reduction reactions, energy rich compounds

UNIT 2

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.

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.

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 prostaglandins.

UNIT 4

Nucleic acid Metabolism: biosynthesis and degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide reductase.

Biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis. Porphyrin Metabolism: Biosynthesis and degradation of porphyrins, production of bile pigments.

Suggested Readings: _____.

1. Lehninger Principles of Biochemistry 4th Ed **By** David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Principles of Biochemistry (Hardcover) **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: 0 (Paperback) **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 (Hardcover) 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 (Hardcover) **By** D Voet. John Wiley and Sons.
12. Biochemistry **By** Lubert Stryer. WH Freeman and Co.
13. Principles of Biochemistry (Paperback) **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.

BCH 105: Bioanalytical Techniques

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Radioisotope techniques: Isotopes and nature of radioactivity, types of radioactive decay, half-life. Measurement of radioactivity, uses of radioisotopes in research; In vivo and in vitro labeling techniques- double labeling, quenching, internal standard ratio and external standard ratio; autoradiography.

Viscosity & Centrifugation: Viscosity of macromolecules, relationship with conformational changes. Basic principle of sedimentation, factors affecting sedimentation, Instrumentation of centrifugation – low speed and high speed centrifuges, Ultracentrifuges, differential and density gradient centrifugation and their applications.

UNIT 2

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

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

Basic principle of electromagnetic radiation: Laws of photometry. Beer-Lambert's law, Principles and applications of colorimetry, absorbance and transmittance, flame photometry
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 4

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

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:_____.

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 **6th Ed.** Keith Wilson & John Walker, Cambridge University Press
4. Encyclopedia of Spectroscopy and Spectrometry (3-Volume Set with Online Version) (Hardcover) **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 (Hardcover) **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 (Hardcover) **By** Terry D. Allen. Academic Press.
13. Enzyme and Microbial Biosensors: Techniques and Protocols (Methods in Biotechnology) (Hardcover) **By** Ashok Mulchandani. Humana Press Inc., U.S.

Lab Course I (based on BC 101 & 102)

1. Preparation of buffers and measurement of pH
2. Determination/calculation of normality and molarity of solutions
3. Determination of acid value of lipid samples
4. Determination of saponification of lipid samples
5. Determination of iodine number of lipid samples
6. Determination of protein in given sample by Lowry method
7. Determination of protein in given sample by Biuret method
8. Formal titration of Glycine
9. Qualitative and quantitative analysis of sugars

Lab Course II (based on BC 103, 104 & 105)

10. Separation of sugar mixture by paper chromatography and TLC
11. Separation of lipids by thin layer chromatography
12. Separation of amino acids by circular paper chromatography
13. Separation of proteins by gel filtration/ion exchange chromatography
14. To analyse the given protein sample by SDS-PAGE
15. To perform the Western Blotting for detection of proteins
16. To perform 2D gel electrophoresis
17. Native discontinuous polyacrylamide gel electrophoresis of BSA
18. Sub-cellular fractionation of rat liver cells
19. To isolate mitochondria from rat liver

BCH 201: Plant Biochemistry

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

Max. Marks: 80

Max. Time: 3 hrs

Unit 1

Structure and functions of plant cell (including cell wall, plasmodesmata, vacuoles & secretory systems). Isolation of cell organelles with assessment of chloroplast fraction purity. Absorption and transport of water and ions in plants. Evapotranspiration.

Biological nitrogen fixation and ammonia assimilation. Importance of Hup⁺ symbionts. Structure and properties of symbiotic nodules. Nitrate and sulfate reduction and their incorporation in amino acids. Electron allocation coefficient of nitrogen.

Unit 2

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

Photosystems I & II- their location. Mechanism of quantum capture and energy transfer in photosystems- roles of ferredoxin, plastocyanin, plastoquinone, carotenoids. The Hill reaction and photophosphorylation. Reduction of carbon dioxide: C₃, C₄ and CAM metabolism with regulation (light activation of enzymes in them). Starch and sucrose metabolism. Role of inhibitors (DCMU) in photosynthetic electron transport. Photorespiration and its efficiency.

Unit 3

Functions of important growth regulating substances- brassinosteroids, oxylipins, salicylic acid, oligosaccharines and polyamines. Functions and molecular mechanisms of auxins, gibberellins, abscisic acid and cytokinins. Role of ethylene in fruit ripening.

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 uses. Biochemistry of fruit ripening. 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 and effects of phytotoxins on plants. Biochemistry of herbicide action.

Biochemistry of plant 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:_____.

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.

BCH 202: Immunology

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Introduction to Immune System: Innate and acquired immunity, active and passive immunity, Immunological memory, self vs non-self discrimination, adjuvant in immune response.

Cells & organs Involved in Immune Responses: Phagocytic cells and their killing mechanisms; T and B lymphocytes; Differentiation of lymphoid cells. Structure and functions of primary and secondary lymphoid organs.

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.

Major Histocompatibility Complex (MHC) Genes and Products: Role of MHC antigens in immune responses. MHC antigens in transplantation.

UNIT 3

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.

Tolerance vs Activation of Immune System: Immunosuppression

UNIT 4

Hypersensitivity (Types I, II, III and IV) and allergy.

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

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

Suggested Readings: _____.

1. Fundamental Immunology (Hardcover) **By** William E. Paul. Publisher: Lippincott Williams and Wilkins.
2. Immunology: International Edition (Paperback) **By** Janis Kuby, Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. WH Freeman and Co. Ltd.
3. Immunology (Paperback) **By** Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne and Janis Kuby. WH Freeman and Co. Ltd.
4. Immunology (Paperback) **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) (Paperback) **By** Peter Wood. Publisher: Prentice hall.
8. Basic Immunology: The Functions of the Immune System (Paperback) **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 (Hardcover) **By** Robert M. Coleman and M.F. Lombard. Publisher: Brown (William C.) Co , U.S.
11. Atlas of Immunology (Hardcover) **By** J.M. Cruse (Author), Robert E. Lewis. CRC Press Inc.
12. Immunology **By** Edwards S Golub. Sinauer Associate, Sunderland.

BCH 203: Enzymology

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

Max. Marks: 80

Max. Time: 3 hrs

Unit 1

Introduction: History, general characteristics, nomenclature, IUB classification, definitions with examples of holoenzyme, apoenzyme, coenzymes, prosthetic groups, cofactors, activators, inhibitors, active site, metalloenzymes, isozymes, monomeric enzymes, oligomeric enzymes and multienzyme complexes. Ribozymes and abzymes. Units of enzyme activity, specific activity of enzyme, methods for isolation of enzymes,

Enzyme kinetics: Factors affecting enzyme activity- pH, temperature, time of incubation, enzyme concentration and substrate concentration. Allosteric enzymes: Sigmoidal kinetics and their physiological importance, symmetric and sequential modes for action of allosteric enzymes and their significance.

Unit 2

Derivation of Michaelis-Menten equation for unisubstrate reaction, K_{cat}/K_m and its significance, Lineweaver-Burk plot and its limitations; Eadie-Hofstee Plot, and Hanes plot.

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

Unit 3

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. Mechanism of action of chymotrypsin, carboxypeptidase and lysozyme.

Immobilization of enzymes: Introduction, classification, various methods of immobilization, applications of immobilized enzymes in analysis of biological materials, food industry and medicine.

Unit 4

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

Coenzymes: Structure and biological functions of NAD, NADP, FAD, FMN, TPP, THF, biotin, ascorbic acid, lipoic acid and PLP.

Suggested Readings:_____.

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 (Hardcover) **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 (Hardcover) **By** Geoffrey Zubay. Publisher: McGraw Hill College.
5. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 (Hardcover) **By** D Voet. John Wiley and Sons.
6. Basic Biochemical Laboratory Procedures and Computing **By** R. Cecil Jack, Oxford University Press.
6. Enzyme Kinetics: Principles and Methods (Hardcover) **By** Hans Bisswanger. Publisher: Wiley VCH.
7. Enzymatic Reaction Mechanisms (Hardcover) **By** Perry A. Frey and Adrian D. Hegeman. Oxford University Press.
8. Comprehensive Enzyme Kinetics (Hardcover) **By** Vladimir Leskovac. Publisher: Kluwer Academic / Plenum Publishers.
9. Enzyme Kinetics: A Modern Approach (Hardcover) **By** Alejandro G. Marangoni. Publisher: WileyBlackwell.
10. Enzyme Kinetics and Mechanisms (Hardcover) **By** Kenneth B. Taylor. Kluwer Academic Publishers.
11. Nature of Enzymology **By** RL Foster
12. A textbook of enzyme biotechnology **By** Alan Wiseman.
13. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry **By** Trevor Palmer.
14. Enzymes **By** M Dixon and EC Webb. EC Longmans, London.
15. The chemical kinetics of enzyme action **By** KJ Laidler and PS Bunting. Oxford University Press, London.

M.Sc. Biochem. 2nd Semester, From session 2015-16
BCS 204: Biochemical Toxicology

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Definition and Scope of Toxicology: Dose-response relationship, synergism and antagonism, determination of 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 alcohols, Phenol, Formaldehyde, Carboxylic acids, Ethers, Acid Anhydrides, Esters.

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

Suggested reading:-

1. General and applied toxicology, 1995 by Marrs and Turner Macmillan Press Ltd
2. Basic environmental toxicology 1994 by Lorris G. Corkerhem and Barbara SS Shane CRP Press Inc.
3. Introduction to food technology Takayurki Shibamoto & Leonard F. Bzeldanes
4. Molecular biotechnology 2nd Ed 1994 by Barnard R Glick & JJ Pasternak

BCS 205: Nutritional Biochemistry

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Basic concepts: Concept of balanced diet and energy content of foods; Measurement of energy expenditure (direct and indirect calorimetry); BMR, SDA and factors affecting them; Thermogenic effects of foods; Antinutrients: Protease inhibitors, Hemagglutinin

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

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, composition and metabolism of lipoproteins Essential fatty acids and their physiological functions.

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 3

Electrolytes and pH balance: Electrolyte concentrations of body fluids, acid-base regulation in human body. Concept of metabolic and respiratory acidosis and alkalosis.

Nutritional disorders: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor, Nutritional anemias;

Causes and role of nutrition in prevention & treatment of dental caries

UNIT 4

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

Food Preservation: Primary sources of microorganisms in foods, Sterilisation & Disinfection methods used in the destruction of microorganism in foods; Control of microorganism in foods using high and low temperature, dehydration, freezing, freeze-drying, irradiation and preservatives.

Suggested Readings: _____.

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 (Hardcover) **By** Tom Brody. Academic Press.
6. Nutritional Biochemistry (Paperback) **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 (Hardcover) **By** Maria C. Linder. Publisher: Appelton and Lange
9. Introduction to Nutrition and Metabolism (Paperback) **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 (Paperback) **By** Catherine Geissler and Hilary Pow-ers. Publisher: Churchill Livingstone.
12. Food Science: The Biochemistry of Food and Nutrition (Hardcover) **By** Kay Yockey Mehas 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.

BCS 206: Basics in Bioinformatics

Note: Que. 1 will be compulsory, of 12 marks and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit, each carrying 14 marks each and candidate will have to attempt one question from each unit. Overall, three questions to be attempted.

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Computer system design- essential components and working. Input/output and storage devices. Number Systems in computing language.

The Virtual Library: Tools and resources in NCBI. Searching 'Medline' on PubMed system from NCBI. Science Citation Index and Current contents. *Introduction of biological databases*- types (relational & object-oriented). Primary, secondary & specialized databases.

UNIT 2

Types of databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase (Swiss-prot & Tr embl and motif) and 3D structure databases (PDB, SCOP, Cath, Genecards, SRS & Entrez). Protein sequence databases.

Patents and searching of patent databases. Computational approaches for gene identification, ORF and Human Genome Project. Overview of sequence assembly.

UNIT 3

Basics of sequence analysis- Dot matrix method, Needleman–Wunsch Algorithm and Smith-Waterman algorithm, Alignments using BLAST and FASTA.

Multiple Sequence Alignment- CLUSTAL-X and CLUSTAL-W, Applications of multiple sequence alignment (PSSM and Markov/Hidden Markov models).

Analysis tools- Analysis by TreeView, Genedoc and Lasergene.

Phylogenetics- construction by distance based methods, character based methods

UNIT 4

Protein Structure Prediction in Bioinformatics- Ab initio based methods, Homology based methods, prediction with neural networks

Secondary structure prediction- Globular and transmembrane proteins. Coiled coil prediction, Gene and promoter prediction

Protein structure comparison- intermolecular and intramolecular methods

Standards and approaches for functional genomics

Suggested Readings:

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 Ban-sal. Publisher: Excel Books.
5. Discovering Computers: Fundamentals (Paperback) **By** Gary B. Shelly. Publisher: Cou-rse Technology.

6. Discovering Computers: Fundamentals, Fourth Edition (Shelly Cashman) (Paperback) **By** Gary B. Shelly Thomas J. Cashman and Misty E. Vermaat. Publishers: Course Technology
7. Computer Fundamentals: Architecture and Organization (Paperback) **By** B. Ram. Publisher: New Age Publications (Academic)
8. Essential Bioinformatics (Paperback) **By** Jin Xiong. Cambridge University Press.
9. Bioinformatics: Methods & Protocols **By** Stephen Misener and Stephen A. Krawetz, Humana Press.
10. Essentials of Bioinformatics **By** Irfan Ali khan and Atiya Khanum. Publisher: Ukaaz Publications.
11. Bioinformatics: Sequence and Genome Analysis (Hardcover) **By** David W. Mount. Cold Spring 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.

BCF 207: Communication skills in Science

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

Max. Marks: 40

Max. Time: 1.5 hrs

Unit 1

Report writing and communications- meaning of communications, process and importance of communications, written and oral communications and their barriers, source of communications noise, audience analysis and purpose analysis, Technical writing, proper use of verb, Nouns, pronouns, tense, use of powerpoints for preparing a scientific report.

Unit 2

Mechanical and stylistic aspects of scientific writing- Precision and clarity of language, writing style, writing process, presentation of numerical data and scientific figures. Constraints on scientific writing- audience, format and mechanics (grammar, word choice, punctuation, tenses), usage of line-,bar-graphs, charts to describe the results.

Unit 3

Scientific presentation: Types of presentation, preparation of presentation, Order of material, General gesture for presentations, Speed, loudness, clarity during presentations, use of appropriate vocabulary during presentation, General discussions, Different ways to make impressive presentations

Unit 4

Scientific paper writing: Preparation of Scientific report; correspondence with editors and reviewers, appropriate citations, copyright and Ethical issues in paper drafting, Acknowledgment, Keywords, Use of appropriate citations, usage of different softwares for manuscript preparation,

Suggested readings:.....

1. Rastogi, B.C., Bioinformatics, Concept, Skills & Applications, CBS Publications.
2. Richard Ellis, Communication Skills: Stepladders to success for professional, Gutenberg Press, Malta.
3. John W. Davis, Communication skills: a guide for engineering and applied science students, Prantics Hall, 2001.
4. Gupta S., Communication skills and Functional Grammer, University Science Press, New Delhi 110002.
5. Llyod M., Bor R., Communication skills for medicine, Elsevier press, Churchill Liverstone Elsevier.

M.Sc. Biochem. 2nd Semester, From session 2015-16

BCO 208: Basic Biochemistry

Lab Course III (based on BC 201 &202)

- Bioassay of kinetin
- Estimation of amylase activities in germinated seedlings
- Assay of nitrate reductase in given plant tissue
- Isolation of chloroplasts from given plant sample
- Enzymatic determination of oxaloacetic acid in plant sample (C₄ plant)
- Determination catalase activity in plant tissue
- Assay of glutamate dehydrogenase in given plant tissue
- Assay of PEP carboxylase in given plant tissue
- Estimation of proline content in plant sample
- Determination of aspartate aminotransferase activity in given plant tissue

To perform Antigen-Antibody assay

ELISA tests,

Immunoelectrophoresis,

immunoprecipitation

Lab Course IV (based on BC 203)

20. Study of effect of pH on the activity of alkaline phosphatase
21. Study of effect of time of incubation on the activity of alkaline phosphatase
22. Study of effect of temperature on the activity of alkaline phosphatase and estimation of E_a of its reaction
23. Study of effect of substrate conc. on the activity of alkaline phosphatase and determine K_m & V_{max} from various plots.
24. Study of effect of activator conc. on the activity of alkaline phosphatase
25. Study of effect of inhibitor conc. on the activity of alkaline phosphatase and determine K_i from various plots.

BCH 301: Molecular Physiology

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

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

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

UNIT 2

General mechanism of action of steroid and peptide hormones, role of receptors, cAMP, cGMP, phosphoinositides, calcium, diacylglycerol and nitric oxide.

Secretion, mechanisms and effects of hormones of: hypothalamus, pituitary, thyroid, adrenal gland, GIT and heart (Endothelins). Synthesis and functions of testosterone and ovarian hormones.

UNIT 3

Neurotransmitters: Types, storage and release; neurotransmitter receptors. Neurons and glia in nervous system; Types of synapses and transmission of nerve impulse across them, Neuronal synapses. Resting potentials and action potentials of excitable cells;

Molecular mechanisms of contraction and control of skeletal, cardiac and smooth muscles,

Neurochemistry of vision, gustation, olfaction and hearing. Sensory receptors in skin and muscles.

UNIT 4

Excretory system- Structure of nephron, formation of urine (glomerular filtration, tubular reabsorption of glucose, water and electrolytes), tubular secretion, role of kidneys in regulation of blood pressure.

Cardiovascular System: heart structure, myogenic heart, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of working of heart. Regulation of body temperature.

Suggested Readings:_____.

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 (Paperback) **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 (Paperback) **By** Arthur J. Vander, James Sherman, Dorothy S. Luciano, Eric P. Widmaier, Hershel Raff and Hershhal Strang. McGraw Hill Education.
10. Medical Physiology: Principles for Clinical Medicine 3rd Ed. **By** Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.

BCH 302: Clinical Biochemistry

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

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

Disorders of lipid metabolism: Lipidosis and multiple sclerosis. Causes and diagnosis of the disorders of HDL-cholesterol, LDL-cholesterol and triglycerides. Hyperlipoproteinemia, Hyperlipidemia, 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

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

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

UNIT 3

Hormonal disturbances: Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function.

Disorders of mineral metabolism: Hyper/Hypokalemia, Hyper/Hyponatremia, Hypercalcaemia, hypocalcaemia, hypophosphataemia and hyperphosphataemia.

UNIT 4

Biochemical aspects of hematology: Disorders of erythrocyte metabolism, hemoglobinopathies, thalassemias, thrombosis, porphyrias and anemias. Laboratory tests to measure coagulation and thrombolysis.

Evaluation of organ function tests: Hepatic: Tests based upon the metabolism of carbohydrates, lipids, protein and detoxification. Renal: GFR and its clinical importance, clearance tests (urea and creatinine) Intestinal: Malabsorption of fats, carbohydrates and proteins. Pancreas: amylase, lipase and trypsin

Suggested Readings: _____.

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.

BCH 303: Microbial Biochemistry

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Methods of classification of microorganisms, general characteristics of main groups of microorganisms. Mycoplasmas. Gram +ve and Gram -ve bacteria with structure and functions of peptidoglycan in them. Functions of polymeric components in outer membrane and acidic polymers in Gram -ve bacteria.

Different phases of microbial growth and physical conditions required. Staining methods for bacteria. Quantitative measurement of bacterial growth. Synthesis of peptidoglycan. Mechanism of action of anti-bacterial antibiotics.

UNIT 2

Genetic recombination in bacteria (Transformation, transduction and conjugation). Replication, transcription and translation in bacteria.

Biosynthesis of aspartate family amino acids, aromatic amino acids and histidine. Stickland reaction. Synthesis pathways of coenzyme A, folate, riboflavin, NAD(P) and cobalamins in bacteria. Microbial fermentation and production of small and macro molecules.

UNIT 3

Protein export pathways, generation of energy (ETC in aerobic/sulfur bacteria, autotrophic CO₂ fixation pathways), Oxidative reactions in methylotrophs. Microbial stress responses (genetic response to osmolality, modifications by facultative microbes, formate nitrate regulation, oxidative/pH/thermal stresses).

Specific alternative carbohydrate pathways (Entner Duodoroff Pathway, phosphoketolase pathway and anaerobic TCA). Fermentation pathways, Utilization of galactose, maltose, sorbose & mannitol. Metabolism of aromatic hydrocarbons.

UNIT 4

Virus structure including viral proteins, virus classification and lytic/lysogenic life cycles in viruses. Virus-induced changes in cells, methods of assay of viruses.

Replication of RNA viruses- negative strand (VSV), positive strand (polio) and retroviruses (HIV). Replication of DNA viruses (Adenovirus or SV40).

Suggested Readings:_____

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 (Hardcover) **By** Jerome Perry, James Staley and Stephen Lory. Pub: Sinauer Associates Inc.
4. Microbiology: Concepts and Applications (Hardcover) **By** MJ Pelczar, ECS Chan and NR Krieg, McGraw-Hill.
5. Microbiology (Hardcover) **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 (Hardcover) **By** ML Srivastava, Alpha Science Intl Ltd.
9. Microbial Biochemistry (Hardcover) **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) (Hardcover) **By** Gerald Litwack, Tadgh Begley. Publisher: Academic Press.
12. Principles of Virology: Molecular Biology, Pathogenesis and Control. **By** SJ Flint, LW Enquist, RM Krug, VR Racaniello and AM Skalka. ASM Press.
13. Fundamentals of Molecular Virology **By** Nicholas H. Acheson. John Wiley & Sons.
14. Basic Virology (Paperback) **By** Edward K. Wagner (Author), Martinez J. Hewlett, David C. Bloom and David Camerini. Publisher: WileyBlackwell

BCH 304: Molecular Biology

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT I

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

DNA Sequencing: Sanger's dideoxynucleotide chain termination sequencing, Pyrosequencing, Single molecule sequencing (Nanopore sequencing; PacBio sequencing), RNASeq, Applications of DNA & RNA Sequencing.

UNIT II

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

UNIT III

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

UNIT IV

Regulation of Transcription and Translation - Positive and negative control, Repressor & Inducer, regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing. Gene regulation in eukaryotes and prokaryotes- Operon concept, *Lac* operon, *Arab* operon and *Trp* operon, DNA binding motifs in pro- & eukaryotes, helix-turn-helix, zinc fingers, leucine zippers/b zip, helix-loop-helix motifs.

Suggested Readings: _____.

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.
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. 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 (Paperback) **By** Terence. A. Brown. WileyBlackwell.
8. Gene Cloning: An Introduction (Paperback) **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

BCS 305: Genetics

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1:

Mendelian laws, Applications of probability tests and chi-square test. Gene interactions, Chromosomal basis of inheritance. Multiple alleles, lethal alleles and penetrance & expressivity. Interaction of genes with environment.

Pleiotropy, Sex determination, Multiple sex chromosomes. Sex linked, sex- limited and sex influenced traits. Extra chromosomal inheritance.

UNIT 2:

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Recombination: Homologous and non-homologous recombination including transposition

UNIT 3:

Population genetics – Populations, Gene pool, Gene frequency. Molecular clock and evolution, Allele and genetic variations, Sources of variations: Hardy-Weinberg principles and its applications. Measurement and modulation of genetic variations.

Single nucleotide polymorphism (SNP), Physical and genetic mapping, Gene mapping by in-situ hybridization, Linkage analysis and genetic maps, Lod score, karyotypes. Linkage equilibrium and disequilibrium.

UNIT 4:

Human genome sequence and variations, Disorders of autosomes, Disorders of sex chromosomes, Disorders of sexual differentiation, Chromosome breakage syndromes. Human gene mutations. Human gene therapy. Cloning in treatment of human genetic disorders. Neural basis of learning, memory, cognition, sleep and arousal.

Suggested Readings: _____.

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.

BCS 306: Basics in Bioinformatics

Note: Que. 1 will be compulsory, of 12 marks and will cover the entire syllabus in the form of short questions. Que. 2 to 9 will include two questions from each unit, each carrying 14 marks each and candidate will have to attempt one question from each unit. Overall, three questions to be attempted.

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Computer system design- essential components and working. Input/output and storage devices. Number Systems in computing language.

The Virtual Library: Tools and resources in NCBI. Searching 'Medline' on PubMed system from NCBI. Science Citation Index and Current contents. *Introduction of biological databases*- types (relational & object-oriented). Primary, secondary & specialized databases.

UNIT 2

Types of databases- Nucleotide sequence database, EMBL, Genebank, Unigene, Genome biology, Protein dBase (Swiss-prot & Trembl and motif) and 3D structure databases (PDB, SCOP, Cath, Genecards, SRS & Entrez). Protein sequence databases.

Patents and searching of patent databases. Computational approaches for gene identification, ORF and Human Genome Project. Overview of sequence assembly.

UNIT 3

Basics of sequence analysis- Dot matrix method, Needleman–Wunsch Algorithm and Smith-Waterman algorithm, Alignments using BLAST and FASTA.

Multiple Sequence Alignment- CLUSTAL-X and CLUSTAL-W, Applications of multiple sequence alignment (PSSM and Markov/Hidden Markov models).

Analysis tools- Analysis by TreeView, Genedoc and Lasergene.

Phylogenetics- construction by distance based methods, character based methods

UNIT 4

Protein Structure Prediction in Bioinformatics- Ab initio based methods, Homology based methods, prediction with neural networks

Secondary structure prediction- Globular and transmembrane proteins. Coiled coil prediction, Gene and promoter prediction

Protein structure comparison- intermolecular and intramolecular methods

Standards and approaches for functional genomics

Suggested Readings:

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 Ban-sal. Publisher: Excel Books.

5. Discovering Computers: Fundamentals (Paperback) **By** Gary B. Shelly. Publisher: Course Technology.
6. Discovering Computers: Fundamentals, Fourth Edition (Shelly Cashman) (Paperback) **By** Gary B. Shelly Thomas J. Cashman and Misty E. Vermaat. Publishers: Course Technology
7. Computer Fundamentals: Architecture and Organization (Paperback) **By** B. Ram. Publisher: New Age Publications (Academic)
8. Essential Bioinformatics (Paperback) **By** Jin Xiong. Cambridge University Press.
9. Bioinformatics: Methods & Protocols **By** Stephen Misener and Stephen A. Krawetz, Humana Press.
10. Essentials of Bioinformatics **By** Irfan Ali khan and Atiya Khanum. Publisher: Ukaaz Publications.
11. Bioinformatics: Sequence and Genome Analysis (Hardcover) **By** David W. Mount. Cold Spring 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.

Lab Course V (based on BC 301 & 302)

1. To perform qualitative tests for urinary proteins
2. Qualitative and quantitative tests for reducing sugars in urine
3. Estimation of total proteins and albumin in serum and to calculate A/G ratio
4. Estimation of Total protein by Biuret method in the given urine sample
5. Estimation of Glucose and GTT in the given sample
6. Estimation of cholesterol in given sample
7. Estimation of ALP in serum
8. Estimation of urea in serum and urine
9. Estimation of creatinine in serum sample
10. Estimation of calcium in serum sample
11. To find urea and creatinine clearance
12. Estimation of uric acid serum and urine
13. Estimation of serum and urine bilirubin
14. Estimation of AST and ALT in serum sample

Lab Course VI (based on BC 303 & 304)

Isolation of blood/bacterial/plant tissue DNA. Quantitative determination of DNA by diphenylamine method, Quantitative determination of RNA by orcinol method,

Qualitative and quantitative determination of RNA and DNA, Standard curve preparation of DNA & RNA, Agarose gel electrophoresis of isolated DNA
Polymerase chain reaction. RFLP

Culture media; preparing & dispensing culture media establishing pure cultures. Preparation of wet mount, mobility test –Simple stain-Gram's stain-Acid Fast stain-Capsule stain.

Physiological reaction of bacteria –Catalase test –Coagulates test –Oxidase Test- Nitrate test –Carbohydrate Fermentation test – IMVIC test –TSI test, Antibiotic sensitivity test-
Qualitative: Kirby Bauer's methods, Quantitative, MIC

BCH 401: Research Methodology and Biostatistics

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

Max. Marks: 80

Max. Time: 3 hrs

UNIT 1

Research Methodology- Meaning of research, Objectives of research, Types of Research, significance 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.

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; 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:_____.

1. Essentials of Bioinformatics **By** Irfan Ali khan and Atiya Khanum. Publisher: Ukaaz Publications.
2. Bioinformatics: Sequence and Genome Analysis (Hardcover) **By** David W. Mount. Cold Spring 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

BCH 402: Methods in Molecular Biology

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

Max. Marks: 80

Max. Time: 3 hrs

Unit 1:

Nucleic acid characterization: Methods of distinguishing double and single stranded DNA-SSB protein binding, S₁ nuclease digestion and ethidium bromide staining. Analysis of chromatin by micrococcal nuclease, chromatin immunoprecipitation, STAGE, chromosome conformation capture and triton/acetic/urea PAGE.

Protein characterization: Analysis of protein phosphorylation by phosphoamino acid analysis, unlabeled proteins, enzymatic techniques, exogenous substrates, phosphopeptide mapping and permeabilization strategies. Identification of sugars in glycoproteins by metabolic radiolabeling, chemical labeling and lectin analysis.

Unit 2:

Gene identification: Identification of gene by nucleic acid hybridization, immunoscreening, screening by function, screening by interaction, phage display and two hybrid screening. High density gene arrays and phenotypic microarray.

Mutagenesis: Creation of mutation by primer extension mutagenesis, strand selection methods, cassette mutagenesis, PCR based mutagenesis, QuickChange mutagenesis and random mutations in specific genes

Unit 3:

Recombinant DNA technology: Cloning tools; (restriction enzymes, DNA-Polymerases, ligases, kinases, phosphatases, and nucleases); cloning vectors (pUC19, pCC1FOS, Cosmid, M13, pBlueScript, BAC, YAC, Binary vectors, shuttle vectors pHB201; pSUM36; pRS vectors); Cloning hosts (*E. coli*; *Agrobacterium sp.*, *Mycobacterium smegmatis*; *Bacillus subtilis*; Yeast);

Types of cloning (Blunt end; sticky end and TA cloning); Methods of production of recombinant DNA; construction of DNA libraries- Genomic library, cDNA library; Screening methods for genomics/cDNA libraries.

Applications of recombinant DNA technology-production of insulin, drug, vaccines, diagnostic probe of genetic diseases. Gene therapy..

Unit 4:

Construction c-DNA and genomic libraries: Protocols and strategies for c-DNA cloning, preparation of radio-labeled DNA and RNA probes, synthetic oligonucleotide probes, Introduction and expression of cloned Genes in cultured cells. Screening expression with antibodies and oligonucleotides.

Qualitative and quantitative techniques in Genomics: RAPD, RFLP, DNA finger printing, Southern hybridization, Northern Hybridization, amplification of DNA by the polymerase chain reaction.

Suggested Readings:

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.
3. DNA Repair and Mutagenesis, **By** Errol C. Friedberg, Graham C. Walker, Wolfram Siede. ASM Press.
4. Recombinant DNA Principles and Methodologies **By** James Joseph Greene, CRC Press.
5. Molecular Biotechnology: Principles and Applications of Recombinant DNA (Paper-back) **By** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
6. Molecular Cloning: a laboratory manual (Vol 1, 2 & 3) **3rd Ed. By** J. Sambrook and DW Russel. Cold Spring Harbor Laboratory Publications, NY
7. Laboratory Techniques in Biochemistry and Molecular Biology; DNA sequencing (Vol 10). **By** J Hindley. Elsevier Biomedical.
8. Methods of DNA and RNA sequencing. **By** Sherman M. Weissman. Pub: Praeger
9. RNA isolation and analysis **By** P. Jones, J Qiu and D. Rickwood. Bios Scientific Publishers.
10. Advanced Organic Chemistry of Nucleic Acids (Paperback) **By** Zoe A. Shabarova and Alexey A. Bogdanov. Pub: VCH Publishers, Inc., New York, NY (USA).
11. Analytical Techniques in DNA sequencing **By** Brian Nunnally. Pub: Taylor and Francis.
12. Gene Cloning and DNA Analysis: An Introduction (Paperback) **By** Terence. A. Brown. WileyBlackwell.
13. Gene Cloning: An Introduction (Paperback) **By** Terence A. Brown. Nelson Thornes Ltd.
14. Principles of Gene Manipulation and Genomics, **By** S.B. Primrose & Richard M. Twyman, Blackwell Publishing.
15. Biochemical Engineering and Biotechnology **By** Ghasem D. Najafpour. Publisher: Elsevier Science
- 16 Molecular Cloning: A laboratory manual, Sambrook and Russel, Cold Spring Harbor Laboratory press, New York

