Department of Biochemistry

Credit Matrix for M.Sc. Biochemistry programme w.e.f. session 2019-2020

Semester	Hard Core (HC)	Soft Core (SC)	Supportive (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*:**

- **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 Course (F)**:- The Foundation Course is based upon the content that leads to- Knowledge enhancement. It is mandatory as per course curriculum. Student has opt it from University pool.
- **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 2019-20.

Semester I (Dec-2019)

S. No	Course Code	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
1.	19BC-21-HC1	Biomolecules	HC	4-0-0	4	80	20
2.	19BC-21-HC2	Cell Structure and Signalling	HC	4-0-0	4	80	20
3.	19BC-21-HC3	Human Physiology	HC	4-0-0	4	80	20
4.	19BC-21-HC4	Metabolism and Regulation	HC	4-0-0	4	80	20
5.	19BC-21-HC5	Enzymology	HC	4-0-0	4	80	20
6.	19BC-21-HC6	Lab Course I	HC	0-0-4	8	100	
7.	19BC-21-HC7	Lab Course II	HC	0-0-4	8	100	
Sub Total				**28**	**38**	**700**	

Semester II (May-2020)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
Hardcore							
1.	19BC-22-HC1	Immunology	HC	4-0-0	4	80	20
2.	19BC-22-HC2	Biophysical Techniques	HC	4-0-0	4	80	20
3.	19BC-22-HC3	Molecular Biology	HC	4-0-0	4	80	20
Softcore 1*							
4.	19BC-22-SC1A	Proteomics	SC	4-0-0	4	80	20
5.	19BC-22-SC1B	Neurochemistry					
6.	19BC-22-SC1C	Nutritional Biochemistry					
Foundation Elective* *							
7.	Fundamental Elective		FC	2-0-0	2	80	20
Open Elective#							
8.	16BC-22-OE1	Basic Biochemistry	OE	3-0-0	3	80	20
Lab Course							
9.	19BC-22-HC4	Lab Course III	HC	0-0-4	8	100	
10.	19BC-22-HC5	Lab Course IV	HC	0-0-4	8	100	
Sub Total				**29**	**37**	**800**	

* Students have to opt one paper out of Softcore 1 i.e. 19BC-22-SC1A or 19BC-22-SC1B or 19BC-22-SC1C

* *M.Sc. Biochemistry students will have to opt Fundamental Elective paper out of University Pool

Open to all students from any discipline except Biochemistry

Semester III (Dec-2020)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Int Ass
Hardcore							
1.	19BC-23-HC1	Microbial Biochemistry	HC	4-0-0	4	80	20
2.	19BC-23-HC2	Clinical Biochemistry	HC	4-0-0	4	80	20
Softcore 2*							
3.	19BC-23-SC2A	Essentials of Genetics	SC	4-0-0	4	80	20
4.	19BC-23-SC2B	Biochemical Toxicology					
Softcore 3**							
5.	19BC-23-SC3A	Biostatistics	SC	4-0-0	4	80	20
6.	19BC-23-SC3B	Bioinformatics					
Open Elective#							
7.	16BC-23-OE2	Human Health and Nutritional Disorders	OE	3-0-0	3	80	20
Lab Course							
8.	19BC-23-HC3	Lab Course V	HC	0-0-4	8	100	
9.	19BC-23-SC4	Lab Course VI	SC	0-0-4	8	100	
Sub Total				**27**	**35**	**700**	

M.Sc. Biochemistry students will opt one paper from each Softcores 2* and 3** i.e. one from 19BC-22-SC2A and 19BC-22-SC2B and one from 19BC-23-SC3A and 19BC-23-SC3B.

Open to all students from any discipline except Biochemistry

Semester IV (May-2021)

S. No	Course No	Title of Paper	Type	L-T-P Credits	Hours	Marks	
						Theory	Marks
1.	19BC-24-HC1	Genetic Engineering	HC	4-0-0	4	80	20
2.	19BC-24-HC2	Plant Biochemistry	HC	4-0-0	4	80	20
3.	19BC-24-HC3	Dissertation	HC	0-0-20	40	300	
Sub Total				**28**	**48**	**500**	

M.Sc. Dissertation Rules (Session 2019-2020)

Distribution/allotment of students to be done at the Department level. Dissertation work will be based on a small piece of research work or completion of experimental techniques or compilation of thematic research studies. The dissertation will commence with third semester and will continue till the completion of the 4th Semester. The structure of the Dissertation could be any one of the given options:

Sr No	**Structure of the Dissertation**	
i	Acknowledgement	Acknowledgement
ii	Certificate of supervisor	Certificate of supervisor
i	Introduction	Introduction
iv	Review of Literature	Overview of the theme
v	Materials & Methods	Discussion
vi	Results and Discussion	Conclusion
vii	Summary	Future Prospectives
viii	Bibliography	Bibliography

Last date of dissertation submission, fee, plagiarism policy, etc. will be as per university guidelines. Evaluation of Project work will be performed jointly by an external examiner (From the panel approved by PGBOS) and internal examiner (Supervisor/Guide). Final marks will be the meanest of the score given by the Internal + External examiner. Written part of the dissertation shall account for 300 marks, including viva voce.

Three soft bound copies and one soft copy of the dissertation will be prepared that will include one copy of department record, one copy for good record, one copy of the students and soft copy for the library. Any patent /IPR based on experimental work will be in the name of students and guide/supervisor as an inventor. A publication based on dissertation work should be in consent of guide only.

19BC-21-HC1: 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

Water and buffers: Physical properties and structure of water; hydrogen bonding and ionization of water; weak acids and bases, pH & its calculation; Handerson-Hasselbalch equation; ionization behavior of amino acids and proteins; titration curves; physiological buffers.

Carbohydrates: Structure and classification and biological functions. Physicochemical properties of monosaccharides including sterochemistry. Derivatives of monosaccharides. disaccharides and homopylysaccharides.

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. Steroids and carotenoids of biological origin, liposomes. Ether linked lipids. Classes and properties of apolipoproteins.

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.

UNIT 3

Proteins: Classification, structure (primary, secondary, tertiary and quaternary; structure of peptide bond), domains, motifs and folds. Ramachandran plot, properties and biological functions of proteins. Protein denaturation and renaturation. Methods to determine amino acid sequence- N- and C-terminal amino acid identification. protein sequencing methods, salting in and salting out of proteins. Forces stabilizing, unfolding/ refolding in the 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. Sangerôs dideoxynucleotide chain termination sequencing, strategies for genome sequencing, applications of DNA & RNA sequencing. Stability of nucelic acids.

Porphyrin Metabolism: Porphyrin nucleus and classification of prophyrins, important metal-loporphyrins occurring in nature. Biosynthesis and degradation of porphyrins, significance and production of bile pigments.

Suggested Readings for 19BC-21-HC1 (Biomolecules):

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.

19BC-21-HC2: Cell Structure and Signalling

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Membrane structure and models: Composition and dynamics, models, transport of ions and macromolecules, pumps (channel proteins, passive carrier proteins, coupled transporters and ATP-driven pumps), carriers and channels; endo and exocytosis, membrane carbohydrates and their significance in cellular recognition. Mechanism of sorting and regulation of intracellular transport,electrical properties of membranes.
Techniques to study membrane: Preparation of bilayers and vesicles, Scanning Calorimetry, FRAP & FRET, *Cellular junction and adhesion molecules:* Cadherins, integrins, IgSF, selectins, tight/gap junctions.

UNIT 2

Organelles: Cell wall, structure and function of nucleus, nuclear envelope, lamina and nucleolus mitochondria, Golgi apparatus, microbodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast. Secretary pathways in cell organization and role of microtubules and microfilaments, macromlecular trafficking, endo-membrane system and cellular motility, cell shape and motility, actin-binding proteins and their significance; intermediate filaments, molecular motors
The extracellular matrix: collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

UNIT 3
Chromatin organization and packaging: Structure of chromatin and chromosomes, histones and its modifications, repetitive DNA, heterochromatin and euchromation, operon system, interrupted genes, gene families, organelles DNA, transposons, retrotransposons.
Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.

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,
Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes. virus-induced cancer, metastasis, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth.

Suggested Readings for 19BC-21-HC2 (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-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

19BC-21-HC3: Human Physiology

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Blood- Composition including erythrocytes, leukocytes and thrombocytes. Hemoglobin- structure, types and functions. Roles of plasma proteins. Events and regulation of hemopoiesis and haemostasis. Blood coagulation and fibrinolysis ï molecular events and regulation. Blood groups and Rh factor.

Cardiovascular System: Heart structure, ECG ï its principle and significance, cardiac cycle, heart as a pump- rhythymical excitation, regulation of cardiac output, blood pressure, neural and chemical regulation of all above.

UNIT 2

Digestive system- Composition and regulation of salivary, gastric, pancreatic, intestinal and hepatobiliary secretions. Digestion and absorption of proteins, carbohydrates, proteins, vitamins and minerals.

Respiratory system: Transfers of blood gases ï oxygen and carbon dioxide (roles of 2,3-BPG, Bohr effect and chloride shift). Mechanics and neural/chemical regulation of respiration; pulmonary volumes.

UNIT 3

Endocrinology: Secretion, mechanisms of action and effects of hormones of hypothalamus, pituitary, thyroid, adrenal gland and pancreas. Synthesis and functions of testosterone and ovarian hormones.

Central Nervous system: 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 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 and volume.

Stress 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 19BC-21-HC3 (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 Wrightôs Applied Physiology 13th Ed. CA Keele, E Neil & N Joels. Oxforf 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 Hershal Strang. McGraw Hill Education.
10. Medical Physiology: Principles for Clinical Medicine 3rd Ed. ***By*** Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.

19BC-21-HC4: Metabolism and Regulation

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Metabolism: Characteristics, methods to study metabolism, types of metabolic reactions, rate of molecular process, rate constant and factor affecting rate constant.

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, Uronic acid pathway and glyoxylate cycle.

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.

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. 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.

Suggested Readings for 19BC-21-HC4 (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. Harperôs 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.

19BC-21-HC5: Enzymology

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Introduction: General characteristics, nomenclature and IUB classification of enzymes, Holoenzyme, apoenzyme, coenzymes, prosthetic groups, cofactors, types of activators & inhibitors. Units of enzyme activity (definition of IU, Katal, specific activity), Active sites and its salient features, isoenzymes and enzyme turnover number. Ribozymes and abzymes. Enzyme specificity.

Enzyme Catalysis: Theories of enzyme catalysis i.e. Fisher lock and key hypothesis, Koshland Induced fit hypothesis and substrate strain hypothesis. general mechanism of enzyme catalysis- proximity and orientation, strain and distortion, acid base catalysis and covalent catalysis.

UNIT 2

Enzyme kinetics of single and multiple substrate(s): Factors affecting enzyme activity- Substrate concen-tration, pH, temperature, time of incubation and enzyme 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.

Enzyme inhibition: Reversible and irreversible inhibition; competitive, non-competitive and uncompetitive inhibitions with determination of K_m and V_{max} in presence of complete and partial reversible inhibitors.

UNIT 3

Enzyme regulation and interactions: Different stages of enzyme regulation including allosteric regulation and feedback regulation. Adenylate energy charge, monocyclic and multicyclic cascade systems. Enzyme activation, induction and repression. Enzyme-enzyme interactions.

Mechanisms of important enzymatic reactions: Chymotrypsin, ribonuclease, carboxypeptidase, papain and lysozyme. Chemistry of monooxygenation, dioxygenation, substitutions, carboxylations, decarboxylations and isomerizations in enzyme-catalyzed reactions.

UNIT 4

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

Diagnostic enzymology: Clinical significance of aspartate aminotransferase, alanine aminotransferase, alkaline phosphatase, creatine kinase, lactate dehydrogenase, amylase, lipase and trypsin. Enzyme tests in determination of myocardial infarction and muscle diseases.

Suggested Readings for 19BC-21-HC5 (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. Publi-sher: Wiley VCH.
8. Enzymatic Reaction Mechanisms ***By*** Perry A. Frey and Adrian D. Hegeman. Oxford University Press.
9. Comprehensive Enzyme Kinetics ***By*** Vladimir Leskovac. Publisher: Kluwer Academic / Plenum Publishers.
10. Enzyme Kinetics: A Modern Approach ***By*** Alejandro G. Marangoni. Pub-lisher: 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 Uni-versity Press, London.

19BC-21-HC6: LAB Course I

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

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

19BC-21-HC7: LAB Course II

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 of inhibitors and activators on enzymatic activity. Separation of isoenzymes.

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

19BC-22-HC1: Immunology

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

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

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

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

UNIT 2

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

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

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, ELISA, flow cytometry, radioimmunoassay, hybridoma and production of monoclonal antibodies.

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

UNIT 4

Immune Responses and Host-viral Interaction in Diseases: Immune responses to infectious diseases: virus and interferons; bacterial infections and toxin neutralization; protozoan infection including malaria.

Disorders of immune responses: Autoimmunity, immunodeficiency disorders. congenital immunodeficiencies, acquired immunodeficiencies.

Immunization: Active immunization (immunoporphylaxis), Passive immunization (Immunotherapy). Role of Vaccines in prevention of disease.

Suggested Readings for 19BC-22-HC1: 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. Roittôs 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.

19BC-22-HC2: Biophysical 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

Bioenergetics: Structure of atoms and molecules. Types of stablizing 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; colligative properties, high energy compounds.

Viscocity: Measurement of viscosity using viscometer, relationship of viscosity with conformational changes.

Centrifugation: Basic principle of sedimentation, factors affecting sedimentation, types of centrifuges ï low speed, high speed centrifuges and ultracentrifuges, differential and density gradient centrifugation and their applications.

UNIT 2

Basic principle of electromagnetic radiation: Laws of photometry. Principle and applications of colorimetry, absorbance and transmittance.

Spectroscopy: Principle and applications of UV-Visible, IR, NMR, ESR, mass spectrometry, x-ray diffraction, ORD and CD spectroscopy.

UNIT 3

Electrophoretic techniques: Theory of electrophoresis; SDS-PAGE; western blotting, isoelectric focusing and 2-dimensional gel electrophoresis, capillary electrophoresis; electrophoresis mobility shift assay (EMSA).

Chromatography Techniques: Principle and applications of paper, thin layer chromatography, ion exchange, gel filtration, affinity, HPLC and gas chromatographic techniques.

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; incorporation and imaging of radioisotopes in biological tissues and cells, safety guidelines.

Microscopy: Resolving powers of different microscopes, light, phase contrast and fluorescence microscopy. Electron Microscopy: Principle and application of scanning and transmission microscopy, speciement interactions in TEM and SEM, preparation of specimen for electron microscopy, freeze- fracture methods for EM.

Suggested Readings 19BC-22-HC2: Biophysical 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 **6th Ed**. 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 Cumm-ings 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 Biotech-nology) ***By*** Ashok Mulchandani. Humana Press Inc., U.S.

19BC-22-HC3: 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 1

*DNA replication***:** DNA supercoiling, 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 damage and repair mechamnisms. Extrachromosomal replicons.

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, Ribozymes.

UNIT III

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

UNIT IV

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

Suggested Readings for 19BC-22-HC3: 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) **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 ***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

19BC-22-SC1A: Proteomics

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

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

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

UNIT 2

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

UNIT 3

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

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

UNIT 4

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

General introduction on homology modelling, and protein target prediction.

Suggested Readings for 19BC-22-SC1A: Proteomics:

1. Introduction to Proteomics: Principles and Applications, Nawin Mishra, Print ISBN: 9780471754022; Book Series: Methods of Biochemical Analysis, Wiley Pblications.
2. Sample Preparation in Biological Mass Spectrometry; Alexander R. Ivanov and Alexander V. Lazarev (Eds.); Wiley Pblications.
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 Pubvlishers.

19BC-22-SC1B: Neurochemistry

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

General features of Neurons. Cellular organization of neurons, Classification and types of neurons, The Nissl and Golgi stains, *Glial cells*: Structure and function of glial cells, Different types of glial cells: astrocytes, oligodendrocytes and Schwann cells; ependymal cells

Thermoregulation: Comfort zone, body temperature ï physical, chemical, neural regulation, acclimatization.

UNIT 2

*Neurotransmitter and Neuropeptides***:** Chemistry, synthesis, storage and release of nervous neurotransmitters and regulation, transmitter action, synaptic modulation and mechanism of neuronal integration. Types, synthesis, release and functions of neuromodulators.

Classes of neuropeptides, mode of action, role of neuropeptides in obesity and pain. Neuropeptide receptors.

UNIT 3

Synaptic Transmission and Second Messenger Pathways: Axons structure and functional aspects, structure and types of the synapse, transmission across the synapse, pre and post synaptic events, membrane potential in the steady state action, action potential and propagation of nerve impulse

Blood Brain CSF Barriers: Characteristics of BBB ï morphology, diffusion, mediated transport, enzymatic barriers in capillary endothelium. Characteristics of blood CSF barrier, composition of CSF, formation of CSF, active transport from CSF to brain.

UNIT 4

Muscles and higher senses: Molecular mechanisms of contraction and control of skeletal, cardiac and smooth muscles, neural control of muscle tone and posture.

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

Suggested Readings for 19BC-22-SC1B: Neurochemistry:

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 Wrightôs Applied Physiology 13th Ed. CA Keele, E Neil & N Joels. Oxforf 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 Hershal Strang. McGraw Hill Education.
10. Medical Physiology: Principles for Clinical Medicine 3rd Ed. ***By*** Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.

19BC-22-SC1C: Nutritional Biochemistry

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

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

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

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

UNIT 2

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

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

UNIT 3

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

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

UNIT 4

Nutritional disorders: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor, Nutritional anemia - mechanism, etiology and clinical symptoms of vitamin $B_{12,}$ 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.

Free radicals & antioxidants: Formation of free radicals in biological Systems. Natural anti-oxidants and defense against free radicals. Role of free radicals and antioxidants in health and disease.

<u>Suggested Readings for 19BC-22-SC1C:</u> 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 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.

16BC-22-OE1: Basic Biochemistry

Note: Question 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:

*Cell***:** definition, general structure and size of some important cells, general functions of cell organelles, basic difference in prokaryotic and eukaryotic cells

Carbohydrates: Definition, classifications and sources of carbohydrates, occurrence and biological functions of monosaccharides, disaccharides, and polysaccharides

UNIT 2:

*Lipids***:** Introduction, classification and functions of lipids. Saturated and unsaturated fatty acids. Essential fatty acids. Triacylglycerides and their properties,

*Amino acids***:** Nutritional classification of amino acids and physical properties of amino acids.
*Proteins***:** Definition, types, sources, properties and biological significance of proteins, Primary, secondary, tertiary and quaternary structure of proteins.

UNIT 3:
Nucleic acids: Nucleotides & nucleosides, types of DNA and RNA, evidence that DNA is the genetic material, feature of DNA double helix, Size of DNA in prokaryotic and eukaryotic cells.
*Vitamins***:** Sources, examples and classification, important functions of fat soluble and water soluble vitamins

UNIT 4:
Enzymes: History, general characteristics, nomenclature and IUB classification of enzymes, holoenzyme, apoenzyme, coenzymes, prosthetic groups, cofactors, activators, inhibitors, active site, metalloenzymes and isozymes, Units of enzyme activity, examples of some clinically important enzymes

Factors affecting enzyme activity: pH, temperature, time of incubation, enzyme concentration and substrate concentration. Properties of allosteric enzymes and their significance.

Suggested Readings for 19BC-22-OE1: Basic Biochemistry:

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. Biochemistry: The Molecular Basis of Life ***By*** Trudy McKee and James R McKee. Publisher: McGraw-Hill Higher education.
4. Biochemistry: Biomolecules, Mechanisms of Enzyme Action and Metabolism Vol 1 ***By*** D Voet. John Wiley and Sons.
5. Biochemistry ***By*** U. S. Satyanarayana
6. Outlines of Biochemistry ***By*** Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

19BC-22-HC4:Lab Course III

Lab Practicals for Bioanalytical Techniques: 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 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.

19BC-22-HC5: Lab Course IV

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

Lab Practicals for Nutritional Biochemistry: Estimation of copper, iron, calcium and vitamin C in foodstuffs. Chemical test for bio-constituents.

19BC-23-HC1: Microbial Biochemistry

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

General: Types of micro-organisms, Cell structure and function, General characteristics and classification of micro-organisms, criteria used in the classification of micro-organisms: cytology, genetics, serology, host specialization. Bacterial Flagella, Gram +ve and Gram ï ve organisms, Mycoplasma, Staining methods for bacteria. Quantitative measurement of bacterial growth. Culture collection and maintenance of microbial cultures.

Microbial growth and nutrition: Nutrition, physiology and different phases of microbial growth, strategies of cell division. Culture media, batch culture, types of media, isolation of pure bacterial cultures.

UNIT 2

Structure, functions and synthesis of peptidoglycan. Control of Microorganisms by physical and chemical Agents. Mechanism of action of antibiotics, Narrow and broad spectrum antibiotics, Antibiotic resistance mechanisms.

Microbial Genetics: Genetic recombination in bacteria including transformation (general and restrictive), sex types, transduction and conjugation; gene mapping by interrupted mating; application of bacterial genetics, molecular mechanism of recombination in bacteria, IS and Tn elements in bacteria.

UNIT 3

Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

Stress Response in bacteria: bacterial 2-Component system, Bacterial chemotaxis and quorum sensing,

UNIT 4

Microbial metabolism: oxidation-reduction vs fermentation, types of fermentations.

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

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

Suggested Readings for 19BC-23-HC1: Microbial Biochemistry:

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

19BC-23-HC2: Clinical Biochemistry

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

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

Disorders of lipid metabolism: Dyslipidosis and multiple sclerosis. Causes and diagnosis of the disorders of HDL-cholesterol, LDL-cholesterol and triglycerides. Hyperlipoprotein-emia, Tay-Sachs Disease (Gangliosidosis), Neimann Pick Disease, Gaucherôs Disease and Krabbôs Disease.

UNIT 2

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

Disorders of cardiovascular system: Disorders of erythrocyte metabolism. Porphyrias and thrombosis. Atherosclerosis, coronary artery disease.

UNIT 3

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

Hormonal disturbances: Protein hormones (anterior pituitary hormones, posterior pituitary hormones), thyroid and parathyroid functions, steroid hormones, adrenocorticosteroids.

UNIT 4

Disorders of pancreas, liver and muscles: Acute & chronic pancreatitis. liver cirrhosis, hepatitis and inherited liver diseases, differential diagnosis of jaundice and clinical importance of bilirubin, muscle dystrophy.

Programmed cell death: Caspases, apoptotic extrinsic andintrinsic pathway, regulation of apoptosis.

Ageing: Evolutionary theories, systemic theories, molecular and cellular theories. *Senescence*: Chromatin remodeling, metabolic reprogramming, increased autophagy and proinflammatory secretome.

Suggested Readings for 19BC-23-HC2: 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-Hilll 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.

19BC-23-SC2A: Essentials of Genetics

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1:

Introduction, history. Mendelôs Laws of inheritance and its applications, monohybrid and dihybrid crosses, types of dominance, test cross and back cross, interaction of genes with environment

Gene interactions: Incomplete dominance, codominance, duplicate genes, complementary genes, supplementary genes, lethal genes, pleotropic genes and multiple alleles; extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance

UNIT 2:

Abnormalities in genes and chromosomes: Types, causes and detection of gene mutations, mutant types ï lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
Structural and numerical alterations of chromosomes by deletion, duplication, inversion, translocation, ploidy and their genetic implications.

UNIT 3:

Chromosomal theory of inheritance: sex determination and sex differentiation in animals, multiple sex chromosomes; sex linkage and its characteristics. pedigree analysis; lod score for linkage testing; karyotypes.
Human genetics: Disorders of autosomes (albinism, cystic fibrosis, galactosemia, phenylketonuria, sickle cell diasese, Huntington disease and myotonic muscular dystrophy), sex chromosomes (Duchennes muscular dystrophy, colorblindness, hemophilia and fragile X disease) and nondysjunction (Down syndrome, Turner syndrome, Klinefelter syndrome).

UNIT 4:

Population genetics: Populations, gene pool, gene frequency; molecular clock and evolution; allele and genetic variations; sources of variations: Hardy-Weinberg principles and its applications.

Genome maps: Genetic maps (linkage maps, cytogenetic maps including FISH); genetic markers (naked eye polymorphism, protein based markers and DNA markers); linkage mapping of DNA markers (AFLP, and STSs); physical mapping of genomes.

Suggested Readings: 19BC-23-SC2A: Essentials 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. Evolutionary Quantitative Genetics ***By*** Derek A. Roff. Chapman & Hall.
6. Evolutionary Genetics- From Molecules to Morphology ***By*** R. S. Singh & C. Krimbas. Cambridge University Press.
7. Human genetics: The molecular evolution By Edwin H. Mcconkey. Jones and Barlett Publishers.
8. Human Molecular Genetics (2nd Edition) ***By*** Tom Strachan & Andrew P.Read John Wiley & Sons.
9. Human Genetics-Concepts & Applications (3rd Edition) ***By*** Ricki Lewis. McGraw-Hill.
10. Vogel and Motulskyós Human Genetics ***By*** MR Speicher, SE Antonarakis and AG Motulsky. Springer.
11. Human Genetics: From molecules to medicine ***By*** Christian P. Schaaf, Johannes Zschocke and Lorraine Potocki. Lippincott Williams & Wilkins.
12. Ecology- from individuals to ecosystems; M. Begon, CR Townsend and JL Harper. Blackwell publishing
13. Elements of Ecology By Thomas Michael Smith and Robert Leo Smith. Pearson Publishing.
14. Ecology: Principles and Applications ***By*** JL Chapman and MJ Reiss. Cambridge University Press.
15. Fundamentals of ecology ***By*** Eugene P. Odum. Cengage Learning India Private Limited.
16. Ecology, 4th Edition ***By*** RE Ricklefs and GL Miller. WH Freeman & Co. Ltd.

19BC-23-SC2B: 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, Biochemsitry of Carcinogenesis; Genetic Suspectibility 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 compunds; 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 19BC-23-SC2B: Biochemical Toxicology:

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

19BC-23-SC3A: Biostatistics

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Research Methodology: Meaning of research, Objectives of research, Types of Research, Research process, sample design and types of sampling, Criteria for good research, Research design- Meaning and need for research design, features of good design. Steps in sampling and sampling types. 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 and CV), random variables & probability distributions (discrete and continuous), Point and interval estimation, Statistical evaluation of results- Hypothesis testing and power analysis. Applications of Probability theory (Addition and multiplication theorems with binomial and Poisson distributions).

UNIT 3

Linear Regression and correlation. Calculation of percentiles, quartiles and deciles. Measurement of skewness and kurtosis. Relative and cumulative frequency distributions.
Parametric tests- Applications of ANOVA, F-test, t-test, z-test, Duncanôs multiple range and Dunnett tests in data analysis.

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, Spearmanôs & Kendall rank correlations, Tukey-Duckworth test and Friedman test.

Suggested Readings for 19BC-23-SC3A: Biostatistics:

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.

19BC-23-SC3B: Bioinformatics

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

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

UNIT 2

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

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 method0, disk covering methods],Computational approaches for gene identification, ORF and Human Genome Project.

UNIT 4

Genome characterization: Genome sequencing and assembly, Identification of origin of replication, rRNA, tRNA and protein coding genes, identification and annotation of COGs.
Protein Structure Prediction; Homology modeling, prediction of protein structure from sequences, functional sites, Protein folding problem, protein folding classes, protein identification and characterization, Predicting transmembrane helices, Methods of sequence based prediction of protein function

Suggested Readings for 19BC-23-SC3B: Bioinformatics:

1. Computer Fundamentals: Concepts, Systems and Applications ***By*** PK Sinha. BPB Publications.
2. Computer Fundamentals and Programming in C ***By*** JB Dixit. University Science Press.
3. Computer fundamentals and programming in C ***By*** Amiya Kumar Rath, Alok Kumar Jagadev and Santosh Kumar Swain. Scitech Publications.
4. Computer Fundamentals (Paperback) ***By*** Ashok Arora, Shefali Bansai and Shefali Bansal. Publisher: Excel Books.
5. Discovering Computers: Fundamentals (Paperback) ***By*** Gary B. Shelly. Publisher: Course Technology.
6. Discovering Computers: Fundamentals, Fourth Edition (Shelly Cashman) (Paperback) ***By*** Gary B. Shelly Thomas J. Cashman and Misty E. Vermaat. Publishers: Course Technology
7. Computer Fundamentals: Architecture and Organization (Paperback) ***By*** B. Ram. Publisher: New Age Publications (Academic)
8. Essential Bioinformatics (Paperback) ***By*** Jin Xiong. Cambridge University Press.
9. Bioinformatics: Methods & Protocols ***By*** Stephen Misener and Stephen A. Krawetz, Humana Press.
10. Essentials of Bioinformatics ***By*** Irfan Ali khan and Atiya Khanum. Publisher: Ukaaz Publications.
11. Bioinformatics: Sequence and Genome Analysis (Hardcover) ***By*** David W. Mount. 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.

16BC-23-OE2: Human Health and Nutritional Disorders

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

*Food Physiology***:** Concept of balanced diet and energy content of foods; Basal and resting metabolism- influencing factors, Absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins.

Antioxidants: Free radicals: definition, formation in biological Systems. Natural anti-oxidants, defense against free radicals. Role of free radicals and antioxidants in health and disease.

Unit II

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

Minerals: Dietary sources and deficiency disorders of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.

Unit III

Malnutrition and blood disorders: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkor, Nutritional anemia - vitamin $B_{12,}$ folate and iron deficiency anemia; hemoglobinopathies and thalassemias.

*Obesity***:** Definition, classification and biochemical basis; Genetic and environmental factors leading to obesity; Obesity related diseases and management of obesity.

Unit IV

*Cardiovascular disease***:** Diseases of Liver, Gall bladder & Pancreas-Hepatitis, (A, B, and C), alcoholic liver disease, Gall stones, pancreatitis, Prevention and dietary management.

Common metabolic disorders: Diabetes mellitus, disorders of HDL-cholesterol, LDL-cholesterol, triglycerides, phenylketonuria, albinism.

Clinical significance of aspartate aminotransferase, alanine aminotransferase, lactate dehydrogenase, amylase, lipase and trypsin. Diagnosis of jaundice and clinical importance of bilirubin.

Suggested Readings for 16BC-23-OE2: Human Health and Nutritional Disorders:

1. Textbook of Medical Biochemistry ***By*** MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Review of Medical Physiology (Lange Basic Science) (Paperback) ***By*** William F. Ganong. Publisher: McGraw-Hilll Medical
3. Clinical Biochemistry ***By*** Richard Luxton. Scion Publishing Ltd.
4. Principles of Medical Biochemistry: With STUDENT CONSULT Online Access (Paperback) ***By*** Gerhard Meisenberg and William H. Simmons. Publisher: Mosby.
5. Essentials of Food and Nutrition Vol I & II, ***By*** M. Swaminathan. Bangalore Printing and Publishing Co. Ltd.
6. Modern Nutrition in Health and Diseases, ***By*** Maurice E Shils and Vernon Robert Young, 7th Ed., Pub: Lea & Febiger.
7. Handbook of Nutrition and Food 2nd Ed., ***By*** Carolyn Berdanier, Johanna Dwyer and Elaine Feldman, CRC Press
8. Nutritional Biochemistry (Hardcover) ***By*** Tom Brody. Academic Press.
9. Nutritional Biochemistry (Paperback) ***By*** S Ramakrishnan and S. Venkat Rao. TR Publications
10. Nutritional Biochemistry and Metabolism: With Clinical Applications (Hardcover) ***By*** Maria C. Linder. Publisher: Appelton and Lange

19BC-23-HC3: Lab Course V

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

16BC-23-SC4: Lab Course V

Lab Practicals for Microbial Biochemistry: Autoclaving, Preparing & dispensing culture media, streaking. Culture of Bacteria, yeast and Filamentous Fungi; Pure and Mixed Culture. Preparation of wet mount, Trypan Blue exclusion assay, Mobility test (Hanging Drop) ï Simple stain-Negative Stain-Gramôs stain -Capsule stain. Physiological reactions of bacteria ï Catalase test ï Coagulase test ï Oxidase Test- Nitrate test ï Carbohydrate Fermentation test ï IMVIC test ï TSI test, Antibiotic sensitivity test- Qualitative: Kirby Bauerôs 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.

19BC-24-HC1: Genetic Engineering

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

Max. Marks: 80 Max. Time: 3 hrs

UNIT 1

Isolation and purification of RNA, genomic and plasmid DNA and proteins.Separation methods and analysis of DNA and RNA. Enzymes used in molecular cloning (restriction enzymes, DNA-Polymerases, ligases, kinases, phosphatases, and nucleases). Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors.

UNIT 2

Isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors, *in vitro* mutagenesis and detection.Southern and Northern blotting.

Gene knock out in bacterial and eukaryotic organisms; detection of post-translation modification of proteins; methods for analysis of gene expression at RNA and protein level, micro array based techniques; RFLP, RAPD and AFLP techniques

UNIT 3*:*

Gene transfer methods in animals, gene cloning vectors, techniques for genetic engineering, microinjection, embryonic-stem cells transfer, xenografting.

Transgenesis for animal improvement and production of animals as bioreactors for pharmaceutical proteins, use of transgenic animals. Applications of recombinant DNA technology in health, gene therapy and recombinant vaccines.

UNIT 4*:*

Cloning of plant cells and manipulation of plant genes, biology and molecular basis of Agrobacterium mediated plant transformation and its application, direct gene transfer methods, post-transcriptional and transcriptional gene silencing, clean gene technology.

Application of genetic engineering: Crop improvement, herbicide resistance, insect resistance, virus resistance, breeding in plants, marker assisted selection.

Suggested Readings for 19BC-24-HC1: Genetic Engineering:

1. Basic Biotechnology (Paperback) ***By*** Colin Ratledge and Bjorn Kristiansen. Cambridge University Press.
2. Introduction to Biotechnology (Paperback) ***By*** William J. Thieman and Michael A. Palladino. Benjamin Cummings; US Ed edition.
1. 3.Recombinant DNA Principles and Methodologies ***By*** James Joseph Greene, CRC Press.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (Paperback) ***By*** Bernard J Glick and Jack J Pasternak. Publisher: American Society for Microbiology.
4. Molecular Cloning: a laboratory manual (Vol 1, 2 & 3) **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*** Wulf Crueger 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.

19BC-24-HC2: Plant Biochemistry

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

Max. Marks: 80 Max. Time: 3 hrs

Unit 1

Structure and functions of plant cell (including membrane, secretory systems, plastids, vacuoles, cell wall and plasmodesmata).

Solute transport and photoassimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, membranes, xylem and phloem; transpiration process; mechanisms of loading and unloading of photoassimilates.

Nitrogen and sulfur assimilation- Structure and working of nitrogenase. Absorption and assimilation of nitrate; ammonium and sulfate- enzymatic mechanisms and regulation methods.

Unit 2

Photosynthesis: Overview of organelles involved in photosynthesis in plants (including light receptors, chlorophyll, light harvesting complex). Photosystems I & II- their location and composition; molecular change in chlorophyll by light; photoprotective mechanisms; Method of quantum capture and energy transfer in chloroplast ETS. CO_2 fixation (C3, C4 and CAM) pathways. Mechanism of action of photosynthetic inhibitors. Starch and sucrose metabolism in leaves.

Respiration and photorespiration: Citric acid cycle; Unique features of plant glycolysis and citric acid cycle. plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Unit 3

Plant hormones: Biosynthesis, storage, breakdown, transport, physiological effects and mechanisms of action of auxins, gibberellins, abscisic acid, ethylene and cytokinins. Growth regulation by brassinosteroids, jasmonic acid and salicylic acid.

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

Unit 4

Physiology of senescence; biochemistry of seed development (including starch synthesis) and seed germination. Seed dormancy- its mechanism, types and protein regulators.

Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress

Suggested Readings for 19BC-24-HC2: Plant Biochemistry:

1. Biochemistry and molecular biology of plants ***By*** Bob B. Buchanan, Wilhelm Gruis-sem 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. Oxf-ord 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.