

**Scheme of Examination for  
M.Sc. (Bio-Chemistry)  
A four-semester programme**

**SEMESTER-I -2008-09**

<b>Code</b>	<b>Paper</b>	<b>Max.Marks</b>
BCH.501	Biomolecules	100 (80+20) Internal Assessment
BCH.502	Cell Biology & Physiology	100 (80+20) Internal Assessment
BCH.503	Intermediary Metabolism	100 (80+20) Internal Assessment
BCH.504	Plant Biochemistry	100 (80+20) Internal Assessment
BCH.505	Lab Course-I	<u>100</u> (80+20) Internal Assessment
		<b><u>500</u></b>

**SEMESTER-II -2009-10**

<b>Code</b>	<b>Paper</b>	<b>Max.Marks</b>
BCH.506	Enzymology	100 (80+20) Internal Assessment
BCH.507	Advanced Molecular Biology	100 (80+20) Internal Assessment
BCH.508	Biophysical & Biochemical Techniques	100 (80+20) Internal Assessment
BCH.509	Immunology	100 (80+20) Internal Assessment
BCH.510	Lab Course-II	<u>100</u> (80+20) Internal Assessment
		<b><u>500</u></b>

**SEMESTER-III**

<b>Code</b>	<b>Paper</b>	<b>Max.Marks</b>
BCH.511	Methods in Molecular Biology	100 (80+20) Internal Assessment
BCH.512	Nutritional Biochemistry	100 (80+20) Internal Assessment

BCH.513	Clinical Biochemistry	100 (80+20) Internal Assessment
BCH.514	Microbial Biochemistry	100 (80+20) Internal Assessment
BCH.515	Lab Course III	<u>100</u>
		<b><u>500</u></b>
BCH.600	Dissertation (Exam. to be conducted at the end of IVth Semester)	

**SEMESTER-IV**

<b>Code</b>	<b>Paper</b>	<b>Max.Marks</b>
BCH.516	Research Methodology and Biostatistics	50 (40+10) Internal Assessment
BCH.517	Basic computers and Bioinformatics	50 (40+10) Internal Assessment
BCH.518	Seminar based on dissertation	50 (40+10) Internal Assessment
BCH.519	Seminar	50
BCH.600	Dissertation (Continued from IIIrd Semester)	<u>300</u>
		<b><u>500</u></b>

**Total Marks 2000**

4 periods of 60 minutes per paper	4 papers	=16 hr/week
Lab course/Practical (3 hr x 5 days)		=15 hr/week
Seminars		=1 hr/week
Dissertation		= 2 hr/week

**Semester-I****BCH 501 : 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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80

Time : 3 hrs.

**Unit-I**

- 1. Introduction :** Introduction to Biochemistry, water as biological solvent, weak acids and bases, pH, buffers, Handerson-Hasselbach equation, physiological buffers.
- 2. Carbohydrates :** Classification, structure, occurrence and biological functions. Bacterial cell wall polysaccharides, glycoproteins. Physicochemical properties of monosaccharides.

**Unit-2**

- 3. Lipids :** Classification, structure, occurrence and biological functions of lipids. No-menclature 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**

- 4. 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.
- 5. Proteins :** Classification, structure (primary, secondary, tertiary and quaternary; structure of peptide bond, Ramachandran Plot), properties and biological functions of proteins. Protein denaturation, renaturation. Methods to determine amino acid sequence-N-and C-terminal amino acid identification, amino acid sequencing of small peptides and

overlapping. Chemical synthesis of polypeptides, salting in and salting out of proteins.

**Unit-4**

- 6. Nucleic acids :** Nature of genetic material, properties of DNA insolution, evidence of DNA as genetic material and evidence for semi-conservative nature, Composition of RNA and DNA, generalized structure plan of nucleic acids, nomenclature in structure of nucleic acids, features of DNA double helix, denaturation and annealing of DNA. Structure and roles of different types of DNAs and RNAs. Genetic code, genome.
- 7. Porphyrins :** Porphyrin nucleus and classification of porphyrins, important metalloporphyrins occurring in nature, Chemical nature and significance of bile pigments.

**Suggested Readings :**

1. Lehninger Principles of Biochemistry 5<sup>th</sup> Ed by David L. Nelson and Michael M. Cox, WH Freeman and Company.
2. Chemistry of Biomolecules : An Introduction (Paperback) by Richard J. Simmonds. Publisher : Royal Society of Chemistry.
3. Principles of Biochemistry (Hardcover) By Geoffrey Zubay. Publisher: McGraw Hill College.
4. Biochemistry By Lubert Stryer. WH Freeman and Co.
5. Biochemistry : The Molecular Basis of Life (Paperback) by Trudy McKee and James R McKee. Publisher : McGraw-Hill Higher education.
6. Biochemistry and Molecular biology By William H. Elliott and Daphne C. Elliott. Oxford University Press.
7. Biochemistry (Hardcover) 3<sup>rd</sup> Ed.By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Fundamentals of Biochemistry : Life at the Molecular Level [(Import] (Hardcover) by Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher : Wiley.
9. Principles of Biochemistry (Paperback) by Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
10. Biochemistry by U.S. Satyanarayana.
11. Outlines of Biochemistry by Eric C Conn, PK Stumpf, G Bruening and Ray H. Doi. John Wiley & Sons.

**BCH 502: Cell Biology and Physiology**

**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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80  
Time : 3 hrs.

**Unit-1**

1. Variations in structure and functions of eukaryotic cells, comparison of structure with prokaryotic cell.
2. The ultra structure and functions of nucleus, mitochondria ( organization of ETC ), endoplasmic reticulum, Golgi apparatus, lysosomes and peroxisomes. Processing of proteins in ER and Golgi. Ultrastructure of cell membrane with reference to RBC.
3. The epithelial apices- glycocalyx and microvilli. The basement membrane - structural features and characteristics. The extracellular matrix- collagen, elastin, fibrillin, fibronectin, laminin and proteoglycans.

**Unit-2**

4. **The cytoskeleton :** microtubules and microfilaments, functions of motor proteins in microtubules.
5. Signal transduction and secretory pathways in cell, cell-cell interactions, transport proteins in cell membrane.
6. Cell cycle- phases and regulation.
7. Biochemistry of cancer- carcinogenesis, characteristics of cancer cell, agents promoting carcinogenesis.

**Unit-3**

8. Blood-Composition and functions of plasma, hemopoiesis, erythrocytes including Hb, leukocytes and thrombocytes, plasma proteins and their role. Blood coagulation- mechanism and regulation, Fibrinolysis, Blood group and Rh factor.

9. Transfers of blood gases- oxygen and carbon dioxide. Role of 2, 3-BPG, Bohr effect and chloride shift. Regulation of respiration.
10. Digestive system-Composition, functions and regulation of salivary, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins, nucleic acids, minerals and vitamins. Role of peristalsis and large intestine in digestion.
11. Excretory system-Structure of nephron, formation of urine (glomerular filtration, tubular reabsorption of glucose, water and electrolytes), tubular secretion, role of kidneys regulation of blood pressure.

**Unit-4**

12. Membrane Physiology- membrane potential and action potential, contraction of skeletal, cardiac and smooth muscles.
13. **Neurophysiology :** Types of neurones and synapses and transmission of nerve impulse across the membrane, Neurochemistry of vision, gustation, olfaction and hearing. Sensory receptors in skin and muscles.
14. Endocrinology- Secretion, mechanisms of action and of hormones of hypothalamus, pituitary, thyroid, adrenal gland and pancreas.
15. Reproductive physiology- Synthesis and functions of testosterone and ovarian hormones. Menstrual cycle and physiology of pregnancy and lactation.

**Suggested Readings :**

1. Molecular Cell Biology 4<sup>th</sup> Ed By James E. Darnell, Harvey Lodish, Arnold Berk, and Lawrence Zipursky, W.H. Freeman and Co.
2. Molecular Biology of the Cell 4<sup>th</sup> Ed. By Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter. Garland Publishers.
3. Cell Biology (Hardcover) by Thomas D. Pollard and William C. Earnshaw. Publisher : Saunders.

4. **Cell and Molecular Biology** : Concepts and Experiments (Hardcover) 5<sup>th</sup> Ed by Gerald Karp. John Wiley and Sons.
5. Cell and Molecular Biology by EDP deRobertis and EMF deRobertis (Jr.). Lippincott Williams & Wildins, Philadelphia.
6. Signal Transduction (Modular Texts in Molecular and Cell Biology) (Paperback) by C.H. Heldin, Carl-Heldin Heldin and Mary Purton. Bios Scientific Publishers Ltd.
7. Textbook of Medical Physiology 10<sup>th</sup> Ed. By arthur C. Guyton and E. Hall, Harcourt Asia Pte Ltd.
8. Physiology 3<sup>rd</sup> Ed, by Linda Costanzo, Saunders Publishers.
9. Principles of Anatomy and Physiology 10<sup>th</sup> Edition By Gerard J. Tortora and Sandra Grabowski. Publisher : John Wiley and Sons.
10. Principles of Human Physiology (Paperback) by Cindy L. Stanfield and William J. Germann. Publisher : Pearson Education.
11. 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.

### BCH 503 : Intermediary Metabolism

**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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80  
Time : 3 hrs.

#### Unit-1

1. **Introduction** : Concept of metabolism, experimental approaches to study metabolism-use of intact organisms, bacterial mutants, tissue slices and radioisotopes.
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, uncouplers of oxidative phosphorylation, transport of reducing potential potential and ions across mitochondrial membrane, phosphorylation, potential, reversed and microsomal electron transfers, generation of superoxides in mitochondria.

#### Unit-2

3. **Carbohydrate Metabolism** : Reactions and energetics of glycolysis. Alcoholic and lactic fermentations, entry of fructose, mannose and galactose. 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, regulation of blood glucose. Uronic acid pathway and glyoxylate cycle.
4. **Lipid metabolism** : Transport and mobilization of lipids, oxidation of saturated fatty acids, ( $\beta$ -,  $\alpha$ -,  $\omega$ -) oxidation of unsaturated even and odd-chain fatty acids, role of carnitine in transport of fatty acid, energetics of  $\beta$ -oxidation scheme, metabolism of ketone bodies and its biological significance.

**Unit-3**

5. **Lipid metabolism (contd.)** : Biosynthesis of saturated and unsaturated fatty acids. Biosynthesis of triglycerides, phospholipids, sphingolipids and cholesterol. Regulation of cholesterol metabolism. Metabolism of lipoproteins. Biosynthesis of prostaglandins.
6. **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-4**

7. **Nucleic and Metabolism** : Sources of atoms in purine and pyrimidine molecules, biosynthesis and degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide reductase. Bio-synthesis of ribonucleotides, deoxyribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis.
8. **Porphyrin Metabolism** : Biosynthesis and degradation of porphyrins, production of bile pigments.

**Suggested Readings :**

1. Lehninger Principles of Biochemistry 5<sup>th</sup> 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. Bioenergetics By David G. Nicholls and Stuart J. Ferguson. Academic Press.
4. Bioenergetics at a Glance : An Illustrated Introduction (At a Glance) (Paperback) by D. A Harris. Publisher : Wiley Blackwell.
5. Bioenergetics : 0 (Paperback) by Lars Garby and Poul S. Larsen. Cambridge University Press.

6. Fundamentals of Biochemistry : Life at the Molecular Level [Import] (Hardcover) by Donald Voet, Judith G. Voet and Charlotte W. Pratt. Publisher : Wiley.
7. Biochemistry (Hardcover) 3<sup>rd</sup> Ed. By Donald J. Voet and Judith G. Voet. John Wiley and Sons.
8. Biochemistry By Lubert Stryer. WH Freeman and Co.
9. Principles of Biochemistry (Paperback) by Robert Horton, Laurence A Moran, Gray Scrimgeour, Marc Perry and David Rawn. Pearson Education.
10. Harper's Biochemistry by R. K. Murray and others. Appelton and Lange, Stanford.

**BCH 504 : Plat 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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80  
Time : 3 hrs.

**Unit-1**

1. Structure and functions of plant cell (including cell wall, plasmodesmata, meristematic cell, vacuoles, secretory system). Root quiescent zone. Isolation of cell organelles. Absorption and transport of water and ions in plants. Evapotranspiration.
2. **Photosynthesis :**
  - a) Structure of organelles involved in photosynthesis in plants and bacteria (including light receptors, chlorophyll, light harvesting complex). Proton gradients and electron transport in chloroplast and in purple bacteria. Bacteriorhodopsin as ion pump.
  - b) 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 : C<sub>3</sub>, C<sub>4</sub> and CAM metabolism with regulation (light activation of enzymes in them). Role of inhibitors (DCMU) in photosynthetic electron transport. Binding change hypothesis of ATP synthesis. Photorespiration and its efficiency.

**Unit-2**

3. 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.

4. Growth regulating substances and their modes of action. Molecular effects of auxins and gibberellins in regulation of cell extension. Abscisic acid and cytokinins in regulation of growth and development. Ethylene-role in fruit ripening.

**Unit-3**

5. Photoperiodism-phytochromes and their physiological significance. physiology of senescence.
6. Biochemistry of seed development (including starch synthesis). Dormancy-its mechanism and uses. Biochemistry of fruit ripening. Artificial seeds-preparation and uses.

**Unit-4**

7. Defense system (including phytotoxins) in plants. Biochemistry of herbicide action.
8. Biochemistry of plant under various stress conditions (abiotic).

**Suggested Readings :**

1. Biochemistry and molecular biology of plants By Bob Buchanan, Wilhelm Gruissem and Russel L. Jones, IK International Pvt. Ltd.
2. Integrative Plant Biochemistry : 40 (Recent Advances in Phytochemistry) (Hardcover) by John Romeo. Elsevier Science.
3. Plant Biochemistry (Paperback) By PM Dey and JB Harborne. Academic Press Inc., US.
4. Plant Physiology, Biochemistry and Molecular Biology (Hardcover) by David T. Dennis and David H. Turpin. Publisher : Longman.
5. Plant Biochemistry and Molecular Biology (Hardcover) by Hans-Walter Heldt. Oxford university Press.
6. 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.
7. Plant Biochemistry (Paperback) by Caroline Bowsher, Martin Steer and Alyson Tobin. Garland Publishing Inc., US.
  8. Plant Physiology and Biochemistry (Paperback) by H.S. Srivastava and N. Shankar. Rastogi Publications.
  9. Textbook of Plant Physiology, Biochemistry and Biotechnology (Paperback) by S. Verma and Mohit Verma. S. Chand and Co.
  10. Plant Biochemistry (Hardcover ) By Hans-Walter Heldt. Academic Press.
  11. Plant Physiology, 4th Ed., by Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc.

**M.Sc. Biochemistry****BCH 505 : Laboratory Course-I**

Maximum Marks : 100

Time : 6hrs.

**Note :** In all ten questions will be set. Students are required to attempt any five questions. The examiner should cover entire syllabus while setting questions paper.

Chemical tests for bioconstituents.

Assay of enzymes like salivary amylases and alkaline phosphatases. Biochemical estimation like cholesterol, sugars, free fatty acids, iodine value and saponification value in oils, Vitamin C in fruit juices, preparation of casein from milk and tests for proteins and amino acids.

Microscopic examination and chemical analyses of blood.

Electrophoretic separation of serum proteins.

Disc gel electrophoretic separation of enzymes.

Microscopic examination and chemical analyses of urine.

Histobiology of blood and urine. Chemical analyses of domestic and industrial effluents.

**Semester-II****BCH 506 :****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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80

Time : 3 hrs.

**Unit-1**

- 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. Units of enzyme activity (definition of IU, Katal), specific activity of enzyme, measurement of enzyme activity, enzyme turnover. Ribozymes and abzymes.
- 2. Enzyme Catalysis :** Role of enzymes in energy of activation, factors of affecting action of enzymes-proximity and orientation, strain and distortion, acid base catalysis and covalent catalysis. Determination of active site. Mechanism of action of chymotrypsin, ribonuclease, carboxypeptidase and lysozyme.

**Unit-2**

- 3. Enzyme kinetics :** Factors affecting enzyme activity-pH, temperature, time of incubation, enzyme concentration and substrate concentration. Derivation of Menten equation for unisubstrate reaction,  $K_{cat}/K_m$  and its significance, Lineweaver-Burk plot and its limitation; Eadie-Hofstee Plot, Eadie Plot, Hanes plot and Eisenthal-Cornish-Bowden plot. Significance and calculation of energy of activation from Arrhenius plot. Reversible and irreversible inhibition; competitive, non-competitive and uncompetitive inhibitions with determination

of  $K_m$  and  $V_{max}$  in presence of reversible inhibitor. Derivation of  $K_i$  and Dixon plot.

- 4. Kinetics of Multisubstrate reactions,** introduction to sequential and ping-pong mechanisms and their classifications & double reciprocal plots with examples.

**Unit-3**

- 5. Protein-ligand binding,** cooperativity phenomenon, Hill and Scatchard plots. Allosteric enzymes : Sigmoidal kinetics and their physiological importance, symmetric and sequential modes for action of allosteric enzymes and their significance.
- 6. Immobilization of enzymes :** Introduction, classification, various methods of immobilization, kinetics of immobilized enzymes and its significance, applications of immobilized enzymes in analysis of biological materials, food industry and medicine.

**Unit-4**

- 7. Enzyme Regulation :** Reversible and irreversible covalent modification, feedback inhibition, control of enzyme by products, substrates and adenylate energy charge, monocyclic and multicyclic cascade systems, Enzyme activation, induction and repression.
- 8. Coenzymes :** Structure and biological function of NAD, NADP, FAD, FMN, TPP, THF, biotin, Coenzyme Q, 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 Altron Meister. John Wiley and Sons Inc.
- 3. Lehninger Principles of Biochemistry 5<sup>th</sup> 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. Enzymatic Reaction Mechanisms (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 :
9. Enzyme Kinetics and Mechanisms (Hardcover) by Alejandro G. Marangoni. Publisher : Wiley Blackwell.
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.

### **BCH 507: Advanced 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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80  
Time : 3 hrs.

#### **Unit-1**

##### **Basic Concepts :**

Chemical structure of gene and chromosome. Replication, transcription and translation in eukaryotes. Post-transcriptional modification of mRNA. Inhibitors of replication, transcription and translation. Reverse transcription. Genetic code/codon and Wobble hypothesis. Britten and Davidson model of gene regulation in eukaryotes. Gene regulation in prokaryotes (Operon concept, *Lac* operon, *Arab* operon and *Trp* operon).

Mutations in DNA, mutagenicity testing and DNA repair mechanisms.

#### **Unit-2**

##### **Recombinant DNA Technology and Hybridoma Technology :**

Methods of creating recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, construction of cDNA library, genomic vs. cDNA library, chemical synthesis of gene, cloning vectors ( $\lambda$ -phage, plasmid, M-13 phage, cosmid), shuttle vectors, yeast and viral vectors, expression vectors, uses of cloned gene, subcloning, sequencing by Sanger's method, proteins production in bacteria, site directed mutagenesis, RFLP, PCR, DNA finger printing, antisense-RNA technology, chromosomal walking.

Monoclonal antibodies, selection of hybrids, hybridomas, protoplast fusion and HAT-medium, screening assays, purification and applications of monoclonal antibodies.

### Unit-3

#### Plant and Animal Cell Culture

Micropropagation, somatic cell culture, somaclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and vectorless methods), production of transgenic plants and animals.

### Unit-4

#### Fermentation Technology

Primary and secondary metabolites in biotechnology, continuous and batch type culture techniques, principle types of fermentors, general design of fermentor, fermentation processes-brewing, manufacture of penicillin, production of single cell proteins, production strategies for other antibiotics and other compounds.

#### 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 (Paperback) by Bernard J Glick and Jack J Pasternak. Publisher : American Society for Microbiology.
4. Gene Cloning and DNA Analysis : An Introduction (Paperback) by T.A. Brown. Wiley Blackwell.
5. Gene Cloning : An Introduction (Paperback) by T.A. Brown. Nelson Thornes Ltd.

6. Principles of Fermentation Technology (Paperback) by P.F. Stanbury, A. Whitaker and S Hall. Publisher : Butterworth-Heinemann.
7. Molecular Biology of the gene By J Watson, NH Hopkin, JW Roberts, JP Stertz and AM Weiner. WH Freeman and Co., San Fransisco.
8. Gene By Benjamin Lewin. Oxford University Press.
9. Biotechnology: Expanding Horizons by B.D. Singh, Kalyani Publishers.
10. Textbook of Biotechnology by PK Gupta.
11. DNA Repair and Mutagenesis, By Errol C. Friedberg, Graham C. C Walker, Wolfrom Siede. ASM Press.
12. Principles of Gene Manipulation and Genomics, By SB Primrose and Richard M. Twyman. Blackwell Publishing.
13. Biotechnology : A textbook of Industiral Microbiology, By Wulf Crueger and Thomas D. Brock. Sinauer Assoc.

**BCH 508: Biophysical and Biochemical 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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80  
Time : 3 hrs.

**Unit-1**

- Bioenergetics :** Laws of thermodynamics, concept of free energy, determination of  $\Delta G$ , relation between equilibrium constant and standard free energy change, biological oxidation and reduction reactions, energy rich compounds, thermodynamics of ion gradients.
- Radioisotope techniques :** Nature of radioactivity, properties of  $\alpha$ ,  $\beta$  and  $\gamma$  rays. Measurement of radioactivity, uses of radioisotopes in research. In vivo and in vitro labeling techniques-double labeling, quenching, internal standard, standard, channel ratio, external standard ratio and emulsion counting. Isotope dilution techniques. Radioactive decay. Autoradiography.

**Unit-2**

- Viscosity & Centrifugation :** Measurement of viscosity (Ostwald's viscometer, Reynolds number), viscosity and sedimentation of macromolecules. Centrifugation techniques and their applications-differential and density gradient centrifugation. Subcellular fractionation.
- Electrophoretic and photometric techniques :** Moving boundary and zonal electrophoresis, paper & gel electrophoresis, isoelectric focusing. colorimetry, spectrophotometry and flame photometry.

**Unit-3**

- Chromatography :** Paper, TLC, adsorption, partition, ion exchange, reverse phase, gel filtration, affinity, HPLC and gas chromatographic techniques.
- Spectroscopy :** Basic concepts and applications of x-ray diffraction, NMR, ESR, UV, IR, fluorescence, Raman, CD and ORD spectroscopic techniques. Mass spectrometry in structure determination of organic and biomolecules.

**Unit -4**

- Microscopy :** Light, electron (scanning and transmission), phase contrast and fluorescence microscopies. Freeze-fracture techniques, specific staining of organelles by marker enzymes.
- Biosensor Technology :** Concept and design of biosensor, types and uses of biosensors. Principle and applications of biosensors for glucose, triglyceride, uric acid, cholesterol, lactic acid, lactose and oxalate.

**Suggested Readings:**

- Biophysics, 5th Edition, by R. Glaser, Springer, Netherlands
- Principles and Techniques of Biochemistry and Molecular Biology 6th Ed. Keith Wilson & John Walker, Cambridge University press
- Encyclopedia of Spectroscopy and Spectrometry (3-Volume Set with Online version) (Hardcover) by George E. Trainer, John I. Holmes and John C. Lindon, Academic Press
- Methods in Modern Biophysics, 2nd Edition, Bengt Nolting, Springer Netherlands
- Chromatography :** Concepts and Contrasts (Hardcover) by James M. Miller, Wiley, Interscience
- Modern Experimental Biochemistry 3rd Edition, by Rodney Boyer, Benjamin Cummings Press.

7. **Biochemical Techniques:** Theory and Practice By John F Roby. Publisher: SOS free stock.
8. Introduction to Electron Microscopy for Biologists: Methods in cell Biology (Hardcover) by Terry D. Allen. Academic press.
9. **Enzyme and Microbial Biosensors :** Techniques and Protocols (Methods in Biotechnology) (Hardcover) by Ashok Mulchandani. Humana Press Inc., U.S.
10. Microbiology (Hardcover) by Lansing M. Prescott, John P Harley and Donald A. Klein. Publisher : McGraw Hill Higher Education.

## BCH 509                      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 unit and candidate will have to attempt one question from each unit. Overall, five questions to be attempted. All questions to carry equal marks.

Maximum Marks : 80

Time : 3 hrs.

### Unit-1

1. **Introduction to Immune System:** Memory, specificity, diversity, innate and acquired immunity, self vs non - self discrimination. Structure and functions of primary and secondary lymphoid organs.
2. **Cell Involved in Immune Responses:** Phagocytic cells and their killing mechanisms; T and B lymphocytes; Differentiation of stem cells and idiotypic variations.
3. **Nature of Antigen and Antibody :** Antigen vs Immunogen, Haptens; Structure and functions of immunoglobulins; Isotypic, and idiotypic variations.

### Unit-2

4. **Generation of Diversity in Immune System :** Clonal Selection theory - concept of antigen specific receptor. Organization and expression of immunoglobulin genes: generation of antibody diversity. T cell receptor diversity.
5. **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.
6. **Major Histocompatibility Complex (MHC) Genes and Products:** Role of MHC antigens in immune responses. MHC antigens in transplantation.

**Unit-3**

- 7. Development , regulation and Evolution of the Immune System** : Measurement of Antigen-Antibody Interaction. Production of polyclonal and monoclonal antibodies : Principles, techniques and applications, Agglutination and precipitation techniques. Radio immunoassay, ELISA, immunofluorescence assays : Fluorescence activated cell sorter (FACS) technique.
- 8. Tolerance vs Activation of Immune System** : Immunotolerance, Immunosuppression, Hypersensitivity (Types I, II, III and IV).

**Unit-4**

- 9. Immune Responses in Diseases** : Immune responses to infectious diseases : viral, bacterial and protozoal. Cancer and immune system. Immunodeficiency disorders. Autoimmunity.
- 10. Immunization** : Active immunization (immunoprophylaxis), Passive immunization (Immunotherapy) and role of vaccines in the prevention of diseases.

**Suggested Readings :**

- 1. Immunology** : International Edition (Paperback) by Jains Kuby, Thomas J. Kindt, Barbara A. Osborne and Richard A. Goldsby. WH Freeman and Co. Ltd.
- Immunology (Paperback) by Richard A. Goldsby, Thomas, J. Kindt, Barbara A. Osborne and Jains Kuby. WH Freeman and Co. Ltd.
- Immunology (Paperback) by Ivan M. Roitt, Jonathan Brostoff and David Male. Publisher : Mosby.
- Understanding Immunology (Cell and Molecular Biology in Action) (Paperback) by Peter Wood. Publisher: Prentice hall.
- 5. Basic Immunology** : The Functions of the Immune System

(Paperback) by Abul K. Abbas and Andrew H. Lichtman  
Publisher : Saunders.

6. Fundamental Immunology (Hardcover) by William E. Paul  
Publisher: Lippincott Williams and Wilkins.
7. Fundamental Immunology (Hardcover) by Robert M. Coleman and M.F. Lombard. Publisher : Brown (William C.) Co., U.S.
8. Atlas of Immunology (Hardcover) by J.M. Cruse (Author), Robert E. Lewis CRC Press Inc.
9. Immunology By Edwards S Golub. Sinauer Associate, Sunderland.

**M.Sc. Biochemistry****BCH 510 :****Laboratory Course**

Maximum Marks : 100

Time : 6hrs.

**Note :** In all ten questions will be set. Students are required to attempt any five questions. The examiner should cover entire syllabus while setting questions paper.

Subcellular fractionation of organelles from liver cells and identification by the use of marker enzymes.

Purification of an enzyme using ion-exchange columns, gel filtration, affinity chromatography.

Molecular weight determination and kinetic studies on purified enzymes.

Plot graphs of enzyme kinetic data by a variety of linear transforms and the Michaelis-Menten hyperbolic plot.

Extraction of lipids from tissues, separation and estimation using thin layer chromatography.