

**M. Sc. SEMESTER: I - IV**

# **SYLLABUS**

**Updated June 2006**

**M. Sc. BIOCHEMISTRY**

**SEMESTER: I -IV**

**Department of Chemistry**  
**(FIST-DST Funded and UGC (SAP) Sponsored)**  
**Saurashtra University**



# SAURASHTRA UNIVERSITY

## DEGREE OF MASTER OF SCIENCE (CHEMISTRY & BIOCHEMISTRY)

### **O. M. Sc. 1:**

Candidates for the Examination for the Degree of Master of Science must have

- (i) Obtained the degree of Bachelor of Science of this University or a Degree recognized as equivalent thereto, at least with second class.
- (ii) Passed in all papers including practicals, if any, prescribed by the relevant Board of Studies from time to time for each of the Semester examination held at the end of each term for the Degree of Master of Science after keeping required minimum attendance as laid down on that behalf.

### **O. M. Sc. 2:**

To pass the whole M. Sc. Examination, student should clear M. Sc. Semesters I to IV and examinations within a period of five years from the date of his/her registration. He/She will be required to register himself as a fresh candidate and keep the attendance and appear and pass all semester examinations afresh from first onwards in order to obtain the Degree of Master of Science.

### **O. M. Sc. 3:**

No candidate for the M. Sc. Degree examination can select a subject other than one offered by him/her as a special subject at the B.Sc. (Sp.) examination or as a principal subject at the B.Sc. Degree examination.

### **O. M. Sc. 4:**

Notwithstanding anything contained in any ordinances or regulations, a candidate passing the B.Sc. examination with the subject of Physics of this University can select Electronics subject at the M. Sc. examination as a special case, provided he/she completes the bridge for electronics during the first year of the M. Sc. Class.

### **O. M. Sc. 5:**

A candidate who has passed the M. Sc. Examination of this University in one specialization of the subject will be permitted on the submission of a few applications and payment of a fresh fee to appear in the other specialization of the same subject provided he/she keeps fresh terms in the specialization of the subject for the M. Sc. Examination.

Provided further that the marks obtained by the candidate in the previous Examination of M. Sc. Part-I/Semester I & II will be carried forward in the total marks in the subject and the class will be awarded accordingly but he/she will not be eligible for a Prize, Scholarship or any other Award at the Examination.

**O. M. Sc. 7:**

Subject to the provisions laid down in Ordinance M. Sc. 2, a candidate who has passed the M. Sc. semester I & II of this University and if there is a break in the studies for any reason and if there is a change in the courses from semester system to annual part Examination system, the candidate will be admitted to M. Sc. Part II and the marks obtained by the candidate in his previous examination of this University in M. Sc. semester I and II will be carried forward and the result of the M. Sc. Final Examination will be declared accordingly on the basis of  $1000 + 800 = 1800$  Marks.

**R. M. Sc. 1:**

The M. Sc. Degree may be taken by written examination and practicals (if any) or partly by papers including practicals (if any) and dissertation.

**R. M. Sc. 2:**

The examination will comprise the following subjects and a student will be required to select one of the following subjects namely:

(1) Mathematics, (2) Statistics, (3) Physics, (4) Chemistry, (5) Botany, (6) Zoology, (7) MCA, (8) MIT, (9) Experimental Biology, (10) Biosciences-AS,PS & MicroBio, (11) Electronics, (12) Biochemistry, (13) Wild Life Science, (14) Biotechnology and (15) Polymer Science

**R. M. Sc. 3:**

In the subject of Chemistry & Bio-Chemistry, there will be four theory papers each of 100 marks in each semester i.e. Semester I to IV and there will be 200 marks of practicals related to theory papers in each semester. There will be a viva voce examination of 50 marks at the end of each semester. Thus, there will be total 1600 marks of theory, 800 marks of practicals and 200 marks of viva voce based on the theory papers. The dissertation option will be given in the semester III and IV. The dissertation will be submitted before the commencement of the theory examination.

**R. M. Sc. 4:**

There will be theory and practical examinations at the end of each semester. The viva voce examination will be conducted at the end of each semester.

A candidate failing in more than three theory papers out of eight papers at the end of Semester-I and II will not be allowed to keep term. The candidate must have at least 80% presence in theory as well as practicals. In any circumstances if candidate fails in fulfilling the required presence, the term will not be granted for appearing in the examination.

**R. M. Sc. 5:**

The passing standard in theory, practicals and viva voce examination will be 40% in each head of passing.

The final class will be awarded as under:

- a) The candidate securing greater than equal to 70% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a distinction class.
- b) The candidate securing below 70% but less than equal to 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded first class.
- c) The candidate securing the aggregate percentage from 48 to less than 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a second class.

**R. M. Sc. 6:**

The eligibility for securing admission at M. Sc. Polymer Science, the candidate must have passed B.Sc. with Chemistry / Biochemistry, and P.G. Diploma in Polymer Science.

**M. Sc. Biochemistry**  
**(Effective from June 2006)**

<b>Semester - I</b>		Marks
BC-101	Chemistry of Biomolecules and Metabolism- I	100
BC-102	Protein Biochemistry and Basic Enzymology	100
BC-103	Biophysics	100
BC-104	Analytical Chemistry	100
BC-105 & 106	Practicals	200
C-107	Viva voce	50
<b>Semester – II</b>		
BC-201	Chemistry of Biomolecules and Metabolism – II	100
BC-202	Advances in Enzymology and Metabolic Regulations	100
BC-203	Cellular Biochemistry	100
BC-204	Spectroscopy	100
BC-205 & 206	Practicals	200
BC-207	Viva voce	50
<b>Semester - III</b>		
BC-301	Separation Techniques	100
BC-302	Genetics and Molecular Biochemistry	100
BC-303	Immunology	100
BC-304	Microbial Biochemistry	100
BC-305 & 306	Practicals	200
BC-307	Viva voce	50
<b>Semester – IV</b>		
BC-401	Genetic Engineering	100
BC-402	Cellular and Neuron Biochemistry	100
BC-403	Advances in Biochemistry	100
BC-404	Selected Topic in Biochemistry	100
BC-405 & 406	Practicals	200
BC-407	Viva voce	50

## M. Sc. SEMESTER- I

### BC- 101: CHEMISTRY OF BIOMOLECULES AND METABOLISM- I

- 1. Intermediary metabolism:** General feature of metabolism, experimental approaches to study metabolism. 6h
- 2. Carbohydrate:** Introduction and classification, properties of mono, oligo and polysaccharides and glycosidic bonds, interconversion of sugars such as epimerization and isomerisation, uptake of carbohydrate in animals for catabolism, reactions, energetic and regulation of glycolysis, glycogenolysis, TCA cycle, its function in energy generation, alcoholic and lactic acid fermentations, reactions and physiological significance of pentose phosphate pathway, glyoxylate cycle and its role in conversion of fats into carbohydrates, interconversions of sugars, conversion of non-carbohydrate to carbohydrate precursors, gluconeogenesis, biosynthesis of glycogen, starch, oligosaccharides, lactose, glucuronic acid and ascorbic acid, regulation of blood glucose homeostasis, hormonal regulation of carbohydrate metabolism, glycoproteins N and O linked glycosylation, blood group polysaccharides, in born error of carbohydrates metabolism: pentosuria, diabetes, galactosemia and glycogen storage disease. 24 h
- 3. Amino acids:** Introduction, classification of amino acids, common structural features, stereo-isomerism and RS system of designating optical isomers, classification and structures of standard amino acids as zwitterions in aqueous solutions, physical and chemical properties, titration of amino acids, separation of amino acids, unusual amino acids in biological system like selenocystein, desmosine etc., metabolism: general features of amino acid metabolism: transamination, oxidative deamination and decarboxylation, urea cycle, degradation and biosynthesis of amino acids and their regulation, glucogenic and ketogenic amino acids, biosynthesis of amino acids from precursors, in-born errors of amino acid metabolism: phenylketonurea, alkaptonurea, maple syrup disease, albinism and homocysteinurea. 18 h
- 4. Vitamins:** Introduction, classification and functions of vitamins, disease of vitamins deficiency, conversion of vitamins from precursor:  $\beta$ -carotenes to vitamin-A, ergosterol to D3. 08 h

### **Reference Books:**

1. Lehninger's Principle of Biochemistry: (3<sup>rd</sup> ed. 2002), Nelson, L. D. and M. M Cox, Macmillan, Worth Publication Inc.
2. Biochemistry: ( 4<sup>th</sup> ed. 1992) Stryer, L., W.H. Freeman & Co. NY
3. Biochemistry with Clinical Correlation: (5<sup>th</sup> ed., 2002) Thomas M. Devlin, Wiley- Liss Publication.
4. Biochemistry: (2<sup>nd</sup> ed.1995) Voet & Voet, John Wiley and Sons.
5. Biochemistry: (3<sup>rd</sup> ed. Vol.1, 2, 3, 1993) Jeoffrery Zubay, Wm C. Brown Publ.
6. Principles of Biochemistry: (1995) Jeoffrery Zubay, Wm C. Brown Publ.
7. Biochemistry: (1990) Mathews C.K. and K.E.van Holde, Benjamin/ Cumming Publ. Co.
8. Biochemistry: West, B. Todd, M. Mason, R. V. Bruggen and Macmillan.
9. Biochemistry: (3<sup>rd</sup> ed. 1994) Rawn J.D., Neil Patterson Publ.
10. Biochemistry: (2<sup>nd</sup> ed. Vol. I & II, 2001) Metzler D.E., A Harcourt. Sci. and Tech. Co.
11. Fundamental of Biochemistry: (1999) Voet & Voet, John Wiley and Sons.
12. Fundamental of Biochemistry :(1992) A.C. Deb, New Central Book Agency, Calcutta.
13. Biochemistry: ( 4<sup>th</sup> ed. 1999) Powar and Chatwal, Himalaya Publishing House
14. Biochemistry: (1<sup>st</sup> ed. 1985) Agarwal G., Goel Publishing House, Meerut.
15. Biochemistry: (1999) Satyanarayana U., Books and Allied Pvt. Ltd. Calcutta.

## M. Sc. SEMESTER- I

### BC – 102: PROTEIN BIOCHEMISTRY AND BASIC ENZYMOLOGY

- 1. Protein biochemistry:** Introduction, classification based on solubility, shape, composition and functions of proteins, peptides: structure of peptide bond, chemical synthesis of polypeptides – protection and deprotection of N-terminal and C-terminal ends and functional groups in the side-chains, formation of peptide bonds, condensing agents, strategy of chemical synthesis, Merrifield solid-phase peptide synthesis, determination of the amino acid sequence of a polypeptide chain; specific chemical and enzymatic cleavage of a polypeptide chains and separation of peptides, alignment, protein structure: levels of structure in protein architecture, primary and secondary structures of proteins: helix and pleated sheets, tertiary structure of proteins, forces stabilizing the tertiary structure and quaternary structure of proteins, denaturation and renaturation of proteins, behaviors of proteins in solutions, salting in and salting out of proteins, structure and biological functions of fibrous proteins (keratins, collagen and elastin), globular proteins (hemoglobin, myoglobin), lipoproteins, metalloproteins, glycoprotein and nucleoproteins. 16 h
- 2. Basic enzymology:** History, general characteristics, nomenclature, IUB enzyme classification, enzyme specificity, enzyme purification, methods for isolation, purification and characterization of enzymes, methods of examining enzyme-substrate complexes, vitamins as cofactors: role of vitamins as coenzymes precursors (general treatment), role of cofactors in enzyme catalysis: NAD/NADP<sup>+</sup>, MN/FAD, coenzyme A, biocytin, cobamide, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions. 14 h
- 3. Enzyme catalysis:** Transition and collision state theories, significance of activation energy, acid-base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory, reaction mechanism based on class of enzymes, mechanisms of catalysis action of : serine proteases chymotrypsin, pepsin carboxypeptidase-A, ribonucleases, lysozyme, sucrase , maltase, triose phosphate isomerases and ATPase, experimental approaches to determine enzyme mechanisms 10 h
- 4. Enzyme kinetics:** Significance and evaluation of energy of activation and free energy, factors affecting enzyme activity: enzyme concentration, substrate concentration, pH and temperature, derivation of Michaelis-Menten equation for uni-substrate reactions, Km and

its significance, Line-Weaver-Burk plot and its limitations, kinetics of zero and first order reactions, importance of  $k_{cat}/K_m$ , mechanisms of Bi-substrate reactions, sequential and ping-pong with examples, kinetics of multisubstrate reactions, derivation of the rate of expression for random order and ordered, ping pong reaction mechanism, use of initial velocity, inhibition and isotopes exchange studies to differentiate between multisubstrate reactions, enzyme inhibition: reversible and irreversible inhibition, competitive, non-competitive and uncompetitive inhibitions, determination of  $K_m$  &  $V_{max}$  in presence and absence of inhibitor and  $k_i$  determination.

10 h

### Reference Books:

1. Fundamentals of Enzymology: (1989) Nicholas C. Price and Lewis Stevens, Oxford Univ. Press.
2. Enzymes: (1979) M. Dixon, E. C. Webb, CJR Thorne and K. F. Tipton, Longmans, London.
3. Principles of Biochemistry: (1995) Jeoffrey Zubay, Wm C. Brown Publ.
4. Understanding Enzymes :( 5<sup>th</sup> ed. 2000) Trevor Palmer, Ellia Horwood Scientific Publisher.
5. The Proteins: (2<sup>nd</sup> ed. 4 volumes.), Hans.
6. The Chemical Kinetics of Enzyme Action: K. J. Laidler and P. S. Bunting, Oxford University Press, London.
7. Steady State Kinetics: R.F. Boyer.
8. Proteins; Structure and Molecular Properties: (1995) Creighton T.E.
9. Enzyme Structure and Functions: (2<sup>nd</sup> ed.1985), Fersht., W.H. Freeman & Co, NY.

**M. Sc. SEMESTER- I**  
**BC-103: BIOPHYSICS**

- 1. Concepts of bioenergetics:** Principles of thermodynamics and their applications in biochemistry: introduction, thermodynamic system, thermodynamic state functions, first and second laws of thermodynamics, concept of free energy, standard free energy, determination of G for a reaction, relation between equilibrium constant and standard free energy change, biological standard state and standard free energy change in coupled reactions, biological oxidation-reduction reactions: introduction, redox potentials, relation between standard reduction potentials and free energy change (derivations and numerical included), high-energy phosphate compounds: introduction, phosphate group transfers, free energy of hydrolysis of ATP and sugar phosphates along with reaction 10 h
- 2. Water and measurement of pH:** Water: physical properties, structure of water, hydrogen bonding, ionization of water, pH scale, acids-bases, principle of glass and reference electrodes, types of electrodes, standard electrode potential and its determination, its relationship with emf, electron transfer measures, complication of pH measurement (dependence of pH on ionic strength, electrode contamination and sodium error), use of pH, buffer: Handerson-Hasselbalch equation, ionization behavior of amino acids and proteins, titration curve, buffer solutions and their action buffering capacity and biological buffer system. 10 h
- 3. Centrifugation and Electrophoresis:** Sedimentation: sedimentation velocity, centrifugation force, RCF, RPM and its relationship, centrifugal techniques and application, differential centrifugation, density gradient, preparative and analytical ultracentrifugation techniques, subcellular fractionation, electrophoresis: basic principle of electrophoresis, agarose gel, PAGE, SDS PAGE, 2D electrophoresis, isoelectric focusing and capillary electrophoresis. 10 h
- 4. Radio isotopic techniques:** Types of radio isotopes used in biochemistry, unit of radioactivity measurements, techniques used to measure radioactivity (gas ionization and scintillation counting), nuclear emulsions used in biological studies (pre- mounted liquid and stripping, isotopes commonly used in biochemical studies  $^{32}\text{P}$ ,  $^{35}\text{S}$   $^{14}\text{C}$  and  $^3\text{H}$  etc.), autoradiography, biological hazards of radiation, safety measures in handling radioisotopes and biological application. 10 h

- 5. Microscopy:** Light, phase contrast, fluorescence microscopy, electron (scanning and transmission), specific staining of organelles or marker enzymes and methods of preparation to study cell structure, chemoluminescence. 08 h

**Reference Books:**

1. Lehninger's Principle of Biochemistry: (3<sup>rd</sup> ed. 2002), Nelson, L. D. and M. M Cox, Macmillan, Worth Publication Inc.
2. Biochemistry: (2<sup>nd</sup> ed.1995) Voet & Voet, John Wiley and Sons.
3. Biochemistry: (3<sup>rd</sup> ed. Vol.1, 2, 3, 1993) Jeoffrey Zubay, Wm C. Brown Publ.
4. Principles of Biochemistry: (1995) Jeoffrey Zubay, Wm C. Brown Publ.
5. Biochemistry: West, B. Todd, M. Mason, R. V. Bruggen and Macmillan.
6. Biochemistry: (3<sup>rd</sup> ed. 1994) Rawn J.D., Neil Patterson Publ.
7. Biochemistry: (2<sup>nd</sup> ed. Vol. I & II, 2001) Metzler D.E., A Harcourt. Sci. and Tech. Co
8. Principles and Techniques of Practical Biochemistry: (1995) Willson K., J. Walker, Cambridge University Press.
9. Physical Biochemistry: (2<sup>nd</sup> ed. 1982) David Freifelder, W.H. Feeman & Co.NY.
10. Spectroscopy : Chatwal and Anand.
11. Instrumental Methods of Chemical Analysis: Chatwal & Anand
12. Instrumental Methods of Analysis: Willard, Merrit, Dean and Settle.

**M. Sc. SEMESTER-I**  
**C-104 ANALYTICAL CHEMISTRY**

- 1. Introduction:** The nature of analytical chemistry, The role of analytical chemistry, Classification of analytical methods (classical and instrumental) Quantitative analytical methods. An internal role for chemical analysis.
- 2. Selected topics on Environmental Chemistry:** Definitions of Air pollution, Energy Balance between Earth-Atmospheric system, Particulates Types Classifications, Organic Particulates, Particulate collection techniques, Importance of Particulates, Photolytic cycle, Photochemical smog chemistry.  
Water analysis parameters, Sampling and preservation techniques, Terminology and Preliminary exposures of Equalization, Proportioning, Volume reduction, Neutralization, Sedimentation, Chemical coagulation, Oxidation Ports, Aerators, Various other methods involving dissolved inorganic, Organic Colloidal solids. Activated chemical sludge, disperse growth aeration, Coagulation, Tricking Filter. Classification of primary secondary and tertiary treatments and definition.
- 3. Food analysis:** Moisture, Ash, Crude, Protein, Fat, Crude-fiber, Carbohydrate, Ca, K, Na, and PO<sub>4</sub>, Oil & fat, Food adulteration and their testing, Contamination of food.
- 4. Flamephotometry:** Principle, Theory, Instrumentation & Applications.
- 5. Flourimetry and Phosphorimetry:** Principles, Theory, Instrumentation & Applications.
- 6. Turbidimetry and Nephelometry:** Principles, Theory, Instrumentation & Applications.
- 7. Forensic Science:** General Introduction & Applications in various fields.

**Reference Books:**

1. Fundamentals of analytical chemistry - D. A. Skoog, D. M. West, F. J. Holler and Crouch.
2. Analytical Chemistry - G. D. Christian.
3. Quantitative Analysis – R. A. wDay Jr. And A. L. Underwood.
4. Analytical Chemistry - Principles – J. K. Kennedy and W. B. Saunders.
5. Instrumental Methods of Chemical Analysis – B. K. Sharma.
6. Food Analysis – S. N. Mahindru.

7. Instrumental Methods of Chemical Analysis – Willard, Merit and Dean.
8. Vogel's Textbook of quantitative Inorganic Analysis – L. Barrt et. al. ELBS.
9. Environmental Chemistry – A. K. De.
10. An Introduction to air pollution – R. K. Trivedi and P. K. Goel.
11. Principles of Environmental Chemistry – H. Kolhandaraman and Geetha Swaminathan.
12. Atmospheric Pollution – Black W. (McGrow Hill Company) New York.
13. A Textbook of Environmental Chemistry and Pollution Control – S. S. Dara (S. Chanda & Co.) New Eelhi.
14. Ecology of Polluted water and Toxicology – K. D. Mishra.
15. Environmental Guidelines and Standards in Indian - P. K. Goel & K. P. Sharma.
16. Enzyme Biotechnology – G. Tripathi.
17. Industry, Environment and Pollution – Arvind Kumar and P. K. Goel.
18. Manual on water & waste water analysis - Neeri
19. Water Pollution - Dr. V. P. Kudesia.
20. Basic concepts of Environmental Chemistry - Des W. Connel.
21. Manual on Water and Wastewater analysis - Dr. B. B. Sundarsan.
22. Liquid waste of Industry: Theories Practices and Treatment by Nelson L. Nemerow.

**M. Sc. SEMESTER- I**  
**BC 105 & 106: PRACTICALS**

**(200 marks)**

**I- Instrumental exercises:**

1. Conductometry: Mono and biprotic acids, mixtures of acids against strong/weak base, argentometric, complexometric, replacement titrations, verification of Onsagers's equation, dissociation constants of weak acids.
2. Potentiometry: acid- base, redox and argentometric titrations.
3. pH metry: acid - base titration, pKa of acids and  $E^{\circ}_{QH_2}$ .
5. Refracometry: Binary mixtures and solids.
6. Polarimetry: Optically active compounds.
7. Spectrophotometry: Lambert-Beers Law, binary mixture, kinetics of iodination, etc.

- II- Biomolecules estimations:**
- i) Spectroscopic exercises: Amino acids, protein, carbohydrate, urea, cholesterol, etc.
  - ii) Micro elemental exercises:  $PO_4$ ,  $NO_2$ , Fe, etc.
  - iii) Titration base qualitative estimations

**BC-107 : VIVA-VOCE EXAMINATION**

**M. Sc. SEMESTER- II**  
**BC-201: CHEMISTRY OF BIOMOLECULES AND METABOLISM – II**

- 1. Electron transport chain and oxidative phosphorylation:** Structure of mitochondria, the mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization, sequence of electron carriers, inhibitors of electron transport chain, hypothesis of mitochondrial oxidative phosphorylation (basic concepts), sites of ATP production, inhibitors and uncouplers of oxidative phosphorylation, transport of reducing potentials into mitochondria, the Q cycle and the stoichiometry of proton extrusion and uptake, P/O and H/P ratios, reversed electron transfer, respiratory controls, oxidative phosphorylation, uncouplers and inhibitors of energy transfer, fractionation and reconstitution of respiratory chain complexes, ATP synthetase complex, microsomal electron transport, partial reduction of oxygen and superoxides.  
12 h
- 2. Lipid:** Introduction and classification: a uptake of lipids in animals, transport and hydrolysis of triglycerides, transport of fatty acids into mitochondria, Fatty acid oxidation: oxidation, lipoxidation,  $\beta$ -oxidation of saturated, unsaturated and odd chain fatty acids, ketone bodies formation and utilization, biosynthesis of fatty acids: saturated and unsaturated fatty acids, biosynthesis of triglycerides, important phospholipids, glycolipids, sphingolipids and cholesterol, regulation of cholesterol metabolism, biosynthetic pathways for terpenes, steroids and prostaglandins, metabolism of circulating lipids: chylomicrons, LDL, HDL and VLDL, Free fatty acids, in born error of lipid metabolism: Taysachs, Nieman Pick and Gauchar diseases.  
10 h
- 3. Nucleotide:** Biosynthesis of purines and pyrimidines, sources of the atoms in the purine and pyrimidine molecules, regulation of purine and pyrimidine biosynthesis, inhibitors of nucleic acid biosynthesis, degradation of purine and pyrimidines nucleotides, structure and regulation of ribonucleotide reductase, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, porphyrin: nucleus, classification of porphyrins, metabolism, biosynthesis and degradation of porphyrins, production of bile pigments and in born error of nucleotide metabolism.  
08 h
- 4. Photosynthesis:** Structure of organelles involved in photosynthesis in plants and bacteria, proton gradients and electron transfer in chloroplasts of plants and in purple bacteria and differences from mitochondria, light receptors: chlorophyll, light harvesting complexes,

bacteriorhodopsin and rhodopsin as ion pump, photosystems I and II, their location, mechanism of quantum capture and energy transfer between photo systems, ferredoxin, plastocyanin, plastoquinone and carotenoids, the Hill reaction, photophosphorylation, reduction of CO<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> and CAM metabolism, light and dark reactions, light activation of enzymes, regulation of photosynthesis, photorespiration, synthesis of starch and sucrose , control of photosynthesis. 10 h

- 5. Plant hormones:** Growth regulating substances and their mode of action, role of auxins, gibberlic acid, abscisic acid and cytokinins in the regulation of cell extension, seed germination, embryogenesis growth and development,

**Reference Books:**

1. Lehninger's Principle of Biochemistry: (3<sup>rd</sup> ed. 2002), Nelson, L.D. and M.M Cox, Macmillan, Worth Publication Inc.
2. Biochemistry: ( 4<sup>th</sup> ed. 1992) Stryer, L., W.H. Freeman & Co, NY.
3. Biochemistry with Clinical Correlation: (5<sup>th</sup> ed., 2002) Thomas M. Devlen- Wiley- Liss Publication.
4. Biochemistry: (2<sup>nd</sup> ed.1995) Voet & Voet, John Wiley and Sons.
5. Principles of Biochemistry: (1995) Jeoffrey Zubay, Wm C. Brown Publ.
6. Biochemistry: (1990) Mathews and Holde, The Benjamin / Cumming Publ. Co.
7. Biochemistry: (3<sup>rd</sup> ed. 1994) Rawn, J.D., Neil Patterson Publ.
8. The Proteins: (4 volumes, 2<sup>nd</sup> ed.) Hans.
9. Biochemistry: (2<sup>nd</sup> ed. Vol. I & II, 2001) Metzler, D.E., Harcourt Sci. and Tech. Co..
10. Fundamental of Biochemistry: (1999) Voet & Voet, John Wiley and Sons.
11. Fundamental of Biochemistry: (1992) A.C.Deb, New Central Book Agency, Calcutta.
12. Biochemistry: (4<sup>th</sup> ed., 1999) Powar and Chatwal, Himaliya Publishing House.
13. Biochemistry: Agarwal, Goel Publishing House.
14. Introduction to Plant biotechnology: (2000) Chawla, Oxford & BH Publishing Co.Ltd.
15. Plant Biochemistry: Dey P. M. and J. B. Harborne, Harcourt Aria PTE Ltd. Singapore.
16. Plant physiology: (4<sup>th</sup> ed.1992) Frank B. Salisbury and C. W. Ross, Wadsworth publ. Co.
17. Plant Physiology: (4<sup>th</sup> ed. 2000) Davlin. R. & Withman F., CBS Publishhers & distributors.

**M. Sc. SEMESTER- II**  
**BC- 202: ADVANCES IN ENZYMOLOGY AND METABOLIC REGULATIONS**

1. **Enzyme regulation:** General mechanisms of enzyme regulation: feed back inhibition, feed forward stimulation, enzyme repression, induction and irreversible covalent modifications of enzymes, reversible covalent modifications and regulation cascades, allosteric enzymes: sigmoidal kinetics , their physiological significance, symmetric and sequential modes for action of allosteric enzymes and their significance, protein-ligand binding including measurement, analysis of binding isotherms, co-operativity phenomenon, Hill and Scatchard plots, enzyme in metabolic regulation: mono-cyclic and multi-cyclic cascade systems with specific examples, multiplicity, sequential and cumulative, concept of convergent and divergent of enzymes, isoenzymes, oligomeric enzymes and multi-enzyme complexes.  
18 h
2. **Non Conventional Enzymes:** Abzymes, ribozymes, extremozymes, isozymes: evolutionary aspect and significance. 04 h
3. **Multienzyme system:** Occurrence, isolation and their properties, polygenic nature of multienzyme systems, mechanism of action and regulation of pyruvate dehydrogenase, fatty acid synthetase complexes, flexibility and conformational mobility of enzymes. 06 h
4. **Enzymes turnover:** Enzymes turnover and methods employed to measure turnover of enzymes, significance of enzymes turnover. 04 h
5. **Enzyme technology and applications:** Immobilization of enzymes, enzyme technology for industrial, medicine and clinical applications, use of enzymes electrodes and biosensor, biotransformation. 10 h
6. **Enzyme engineering:** Chemical modification and site directed mutagenesis to study structure and functional relationship, asymmetric reactions through enzyme and non-aqueous enzyme technology. 08 h

**Reference Book:**

1. **Fundamentals of Enzymology:** (1989) Nicholas C. Price and Lewis Stevens, Oxford Univ. Press.
2. **Enzymes:** (1979) M. Dixon, E. C. Webb, CJR Thorne and K. F. Tipton, Longmans, London.

3. Understanding Enzymes: (1999) Trevor Palmer.
4. The Chemical Kinetics of Enzyme Action: K. J. Laider and P. S. Bunting, Oxford University Press, London.
5. Steady state Kinetics: Boyer.
6. The Enzymology: (student ed. Vol.1 & 2) Boyer, A. P. Publication.
7. Proteins; Structure and Molecular Properties: (1995) Creighton T.E.
8. Enzyme Structure and Functions (2<sup>nd</sup> ed.1985) Fersht A.R., W.H. Freeman & Co, NY.
9. Fundamental of Biochemistry: (1999) Voet & Voet, John Wiley and Sons.
10. Immobilized Enzymes: Trehan.
11. Fundamental of Enzyme Kinetics: (1995, Reviews ed.) Cornish-Bowder, Portland Press London.

**M. Sc. SEMESTER- II**  
**BC-203: CELLULAR BIOCHEMISTRY**

- 1. Structure and function of cells and cell organelles:** Evolution of cell, introduction to cell, comparative aspects of prokaryotic and eukaryotic cell, cell variability (size, shape, complexity, functions), cell types including cellular specialization and differentiation, differences in plant and animal cells, structural organization of prokaryotic and eukaryotic cells, eukaryotic cell organelle's structure and functions: endoplasmic reticulum, nucleus, mitochondria, lysosomes, peroxisomes, golgi apparatus, ribosomes and polysomes, plant cell organization: Structure and biochemical aspects of specialized plant cell organelles, cell plate, primary and secondary cell walls, plasmodesmata, importance of vacuoles, characteristics of meristematic cells. 10 h
- 2. Membrane biochemistry:** Types and sub cellular location, chemical composition of biomembranes, model of lipid membranes: preparation and properties, similarities and differences between biomembranes and artificial phospholipids membranes, physical and biochemical methods to study membrane structure and properties, membrane asymmetry, lipid protein distribution and interactions, membrane lipid mobility: transverse & flip-flop movement, functions of biomembranes: energy transduction, signal recognition, specialized forms of membranes-brush border, flagella and pancreatic activity. 08 h
- 3. Tissue organization and cytoskeleton:** Cell differentiation, organogenesis, morphological, functional and biochemical maturation of tissues, cytoskeleton: microtubules polymerization, dynamic, and functions, microtubules as drugs target site for anticancer, antifungal, antiparasitic and herbicides, microfilaments: polymerization, role of actins in crawling, contractile and muscle contraction. 06 h
- 4. Intracellular compartmentation and protein sorting:** Intracellular compartmentation and phenomenon of exocytosis, endocytosis, receptor mediated endocytosis and their mechanisms, vesicular protein trafficking, protein glycosylation, sorting and translocation, intercellular junctions: Gap, tight junctions, intermediate junctions, adherent's junction, plasmodesmata, cell adhesion: cell-cell adhesion and cell matrix adhesion, extra cellular matrix. 08 h

- 5. Paracrine and endocrine system:** Nature, synthesis, secretion and functions of hormones from endocrine glands: Hypothalamus, thyroids, pituitary, adrenals, sex and reproduction, calcium homeostasis. 10 h
- 6. Cell biology technique:** Freeze fracture technique in the study of cells and cell organelles, Flow Cytometric Cells Fractionation, photo bleaching and membrane fluidity measurement, Patch Clamp Techniques, FRAPs, Fluorescence Activated Cell Sorter (FACS) technique. 08 h

**Reference Books:**

1. Molecular Biology of the Cells: (4<sup>th</sup> ed. 2002) Alberts B. et al. Garland Publ. Inc. NY.
2. Molecular Cell Biology: (4<sup>th</sup> ed. 2000) Harvey Lodish, Berk, Zippursky L. et al, W. H. Freeman & Company.
3. The World of Cell: (3<sup>ed</sup> ed.1996) Becker R., Poinei M., The Benjamin/Cumming Publishing Co.
4. Cell Biology: E. D. P. de Robertis and E. M. F. de Robertis.
5. Harpers Biochemistry : ( 26<sup>th</sup> ed. 1997).
6. Biochemistry with Clinical Correlation: (5<sup>th</sup> ed., 2002) Thomas M. Devlen- Wiley- Liss Publication.
7. Text book of Medical Physiology: (1998.) A. C. Guyton and J. E. Harcourt.
8. Text book of Medical Physiology: (18<sup>th</sup> ed. 1997) Ganong W., Prentic Hall International Inc.
9. Text book of Biochemistry and Human Biology: Talwar.

**M. Sc. SEMESTER- II**  
**BC-204: SPECTROSCOPY**

- 1. Ultraviolet Spectroscopy:** Electromagnetic spectrum & its absorption by organic molecules, electronic transitions & selection rules, Beer-Lambert law, designation of UV bands, instrumentation, UV absorption of organic compounds carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polymers, applications. 6 h
- 2. Infrared Spectroscopy:** Introduction basic theory instrumentation, combination, overtones, Fermi resonance & mechanical coupling, spectral features of major functional groups & factors affecting, detailed study of vibrational frequency of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams, & conjugated, interpretation of IR spectra of some representative compounds, application. 14 h
- 3. Nuclear Magnetic Resonance Spectroscopy:** Introduction, nuclear spin, energy absorption & relaxation. Basic ideas about instrument, chemical shift & factors affecting it, magnetic anisotropy, spin-spin coupling, coupling constant, pulse notation, first order & non first order splitting for two, three & four interacting nuclei., long range coupling, interpretation of PMR spectra of some representative compounds, simplification of spectra, shift reagents, NOE, FT NMR, applications. 15 h
- 4. Mass Spectrometry:** Principle & theory, instrumentation, different ionization techniques, (EI, CI, FAB and FD), general modes of fragmentation, fragmentation patterns of various classes of compound, McLafferty rearrangement, with representative compounds, applications. 10 h
- 5. Carbon- 13 NMR Spectroscopy:** General considerations, chemical shift, aliphatic, olefinic, alkyne, aromatic, heteroaromatic & carbonyl carbon, coupling constants, 2D NMR. 4 h
- 6. Problems based on Spectroscopy:** 5 h

**Reference Books**

1. Practical NMR Spectroscopy: M.L. Martin, J.J. Delpuech and G.J. Martin, Heyden.
2. Spectrometric identification of Organic Compounds: R. M. Silverstein, G. C. Bassler and T. C. Morrill, John Wiley.
3. Introduction to NMR Spectroscopy: R. J. Abraham, J. Fisher and P. Loftus, Wiley.
4. Application of Spectroscopy of Organic Compounds: J. R. Dyer, Prentice Hall.
5. Spectroscopy Methods in Org. Chem.: D. H. Williams, I. Fleming, Tata McGraw-Hill.
6. Spectroscopy of Organic Compounds: P. S. Kalsi, New Age International Ltd.

**M. Sc. SEMESTER- II**  
**BC-205 & 206: PRACTICALS**

**(200 marks)**

**I- Biochemical Exercises:**

Isolation and estimation of biomolecules from natural sources: Protein lipid and nucleic acids,

Basic enzymatic exercise: Measurements of units and specific activity

Determination of Factors affecting on enzymatic reactions

**II- Analytical Chemistry:**

1. Practicals based on food analysis.
2. Drug analysis: Aspirin, benzyl benzoate, etc.
3. Volumetric and gravimetric exercises.
4. Industrial products: Estimation for purity

**BC-207 : VIVA-VOCE EXAMINATION**

**M. Sc. SEMESTER- III**  
**BC-301: SEPARATION TECHNIQUES**

1. **Adsorption and partition chromatography:** History, classification, and definition of terms, principles and basic theory, column adsorption chromatography, techniques and applications. 6 h
2. **Partition chromatography:** (i) Column (ii) paper (iii) TLC techniques and applications. 12 h
3. **Band broadening and column efficiency:** Factors affecting band broadening and column efficiency, plate and rate theories of chromatography and their limitations. 6 h
4. **HPLC:** Principles, instrumentation and applications. 6 h
5. **GLC:** Principle, instrumentation, types of stationary phases and applications. 8 h
6. **Ion Exchange chromatography:** Principle, theory and applications. 4 h
7. **Affinity chromatography:** Principle, theory and applications. 2 h
8. **Hyphanated techniques:** Principles and applications of GC-MS, GC-TLC, LC-MS etc. 6 h

**Reference Books:**

1. Thin Layer Chromatography: W. Stahl.
2. Laboratory Handbook: (2<sup>nd</sup> Student ed., 1969) Egon, Springer International, New Delhi.
3. Chromatography: Heftmann.
4. High Performance Thin Layer Chromatography, HPTLC: (1<sup>st</sup> ed. 1996), Dr. P. D. Sethi, CBS Publishers and Distributors.
5. Principles of Instrumental Analysis: D.A. Skoog and J.L. Loary, W.B. Saunders.
6. Fundamentals of Analytical Chemistry: (8<sup>th</sup> low price ed., 2004), D.A. Skoog, D.M. West and F.J. Holler, W.B. Saunders, Thomson.
7. High Performance Liquid Chromatography: (1<sup>st</sup> ed., 2001).P. D. Sethi, CBS Publishers and distributors, New Delhi.

**M. Sc. SEMESTER- III**  
**BC-302: GENETICS AND MOLECULAR BIOCHEMISTRY**

1. **Basic genetics:** Basic principle of Mendelian inheritance, linkages and sex link inheritance. 04 h
2. **Packaging of eukaryotic genome:** Chromatin: Histone and non- histone proteins, general properties of histones, packaging density, nucleosomes, size variable linker, role of H1, transcriptionally active chromatin, various models to explain the structure of nucleus and chromosomes, nucleosome to chromosome organization, special types of chromosomes: lamp brush, salivary and  $\beta$  chromosomes, structural changes in chromosome: deficiency, duplication, inversion, and translocation of chromosomes (chromosome aberrations), genes and genomes organization within subcellular organelles, structures of DNA: primary, secondary and tertiary, type and conformations of DNA: A, B and Z DNA etc., single stranded DNA, chirality's of the helix, syn/antiparallel complementary stands. 04 h
3. **Organization of genes in eukaryotes:** Concept of genes, unit of genetic structure and functions, gene-citron relationship, gene structure and architectures, chromosomal DNA content, satellite DNA and its possible functions, repetitive and unique sequences, C-value paradox, centromeric and telomeric DNA, denaturation and re-association kinetics: cot values,  $T_m$  values, experimental procedure and qualitative significance. 04 h
4. **Replication of DNA in prokaryotes and eukaryotes:** DNA replication: general principles, various modes of replication, properties of DNA polymerases: proof reading, continuous and discontinuous synthesis, asymmetric & dimeric nature of DNA polymerase III and simultaneous synthesis of leading and lagging strands, DNA polymerase activity in eukaryotes, superhelicity in DNA, linking number, topological properties, mechanism of action of topoisomerases, initiation of replication of single stranded DNA, construction of replication fork in test tube, retroviruses and their unique mode of DNA synthesis, inhibitors of DNA replication (blocking precursor synthesis, nucleotide polymerization, altering DNA structure). 08 h
5. **Movable genetic elements:** Transposons and associated inverted repeats: mechanisms of transposition, consequence of transposition, retrotransposons, and virus and retro- virus life cycle. 04 h
6. **Gene as unit of mutation and recombination:** Types and molecular mechanism of recombination: homologous recombination, site-specific recombination and its

consequence, molecular basis of recombination, mutation: types of mutations, suppression of mutation, molecular nature of mutations: mitogens, spontaneous mutations: origin consequence of mutation, mutant alleles and phenotypes. 06 h

- 7. DNA damage and repair:** Types of DNA damages: deamination, oxidative damage, alkylation, pyrimidine dimers, DNA repair: repair pathways, methyl directed mismatch repair, very short patch repair, nucleotide excision repair, base excision repair, recombination repair, SOS system etc. 04 h
- 8. Transcription of DNA:** Transcription: general principles, basic apparatus, types of RNA polymerases, reactions: initiation, elongation and termination, inhibitors of RNA synthesis, polycistronic and monocistronic RNAs, mechanism of transcription, control of transcription: interaction between RNA polymerases and promoter regions, use of alternate sigma factors, controlled termination: attenuation and antitermination, maturation and processing of RNA: methylation, cutting and trimming of rRNA, capping, polyadenylation and splicing of mRNA, cutting, modification of tRNA and degradation systems, catalytic RNA, group I and II introns splicing, RNase- P. 10 h
- 9. RNA world:** Structural features of RNAs: rRNA, tRNA, mRNA and HnRNA, iRNA and relation to function, methods of isolation and fractionation of RNAs, initiator and elongation classes of tRNA, ribosome binding site on mRNA and corresponding site on rRNA and peptidyl transferase activity of 23S rRNA. 04 h
- 10. Control of gene expression:** Controlling elements, promoter, enhancer sequences and control of transcription, identification of protein binding sites on DNA, global regulatory responses: heat shock response, stringent response and regulation by small molecules such as ppGpp and cAMP, regulation of rRNA and tRNA synthesis. 04 h
- 11. Protein synthesis:** Basic features of the genetic code, translation of RNA: initiation, elongation and termination, factors involved in translation, inhibitors of protein synthesis, synthesis of export proteins on membrane-bound ribosomes, signal hypothesis, in vitro transcription and translation systems. 06 h

#### Reference books:

1. Basic Genetics: (2<sup>nd</sup> ed.1995) Weaver R., & Hedrick P. WM.C. Publishers.

2. Principle of Genetics (3<sup>rd</sup> international ed.2003), Snustad D and Simmons M., John Wiley & Sons.
3. Molecular Biology of the Gene: (4<sup>th</sup> ed. 1998) Watson et al. The Benjamin /Cumming Publishing Co.
4. Gene VII: (7<sup>th</sup> ed. 2000) Benjamin Lewin, Oxford University Press.
5. Advance in Molecular Biology: (1999) Twyman R., Viva books/Bioscience Publisher.
6. Cell and Molecular Biology-concepts and experiments: (1996) Gerald Karp, John Wiley & Sons.
7. Biochemistry of Nucleic acids: Adams et al.
8. Human cytogenetic techniques and clinical application: H. Purandare and A. Chakrabarty.
9. An Introduction to Genetic Engineering: (2<sup>nd</sup> ed. 2002) Desmond S.T., Nicoll, Cambridge University Press.
10. Molecular Biotechnology: (3<sup>rd</sup> ed. 2003) Glick and Pasternak, ASM press.
11. Biotechnology: (2004) Singh B.D, Kalyan Publishers.

## M. Sc. SEMESTER-III

### BC-303: IMMUNOLOGY

- 1. Introduction to immune system:** Types and classifications of immune response, structure and functions of primary and secondary lymphoid organs, differentiation of stem cells, cells involved in immune responses, phagocytic cells and their killing mechanisms, T and B lymphocytes properties, idiotypic variations. 06 h
- 2. Molecular mechanism of diversity in immune system:** Concept of antigen specific receptor, organization and expression of immunoglobulin genes, generation of antibody diversity, organization, expression and generation of T cell receptor diversity. 08 h
- 3. Molecular component of immune system:** Antigen vs. immunogen, haptens, antigen processing and presentation, structure and functions of immunoglobulin, isotypic, allotypic and idiotypic variations, humoral and cell mediated immune responses, kinetics of primary and secondary immune responses, cytokines and co stimulatory molecule's role in immune responses. 08 h
- 4. Major Histocompatibility Complex (MHC):** Organization and arrangement of genes, genes products and polymorphism of MHC, role of MHC antigens in immune responses, MHC antigens in transplantation. 06 h
- 5. Tolerance vs Activation of Immune System:** Clonal selection theory, concept of antigen specific receptor, memory, specificity, diversity, innate and acquired immunity, self vs non-self discrimination, T cells maturation activation and differentiation, B cells maturation activation and differentiation and T - B cells interactions, immune tolerances and immunosuppression. 06 h
- 6. Complement activation and its biological consequences.** 02 h
- 7. Cell Mediated Effectors Response.** 04 h
- 8. Hypersensitivity:** Type I, II, III, IV reactions, autoimmune diseases. 04 h
- 9. Measurement of Antigen – Antibody Interaction:** Agglutination and precipitation techniques, radioimmunoassay, ELISA, immunofluorescence assay. 04 h
- 10. Hybridoma technology:** Production of polyclonal and monoclonal antibodies: Principles, techniques and applications, mycelium cell fusion, selection of hybridomas, protoplast fusion and HAT-medium, screening assays, purification and application of monoclonal antibodies. 04 h

**Reference Books:**

1. Immunology: (4<sup>th</sup> ed.1998) Ivan Roitt, Brostoff and Male, D., Mosby Times Mirror Int. Publ. Ltd.
2. Essential immunology: ( 9<sup>th</sup> ed., 1997) Roitt, Blackwell Scientific Publishing,
3. Immunology: (5<sup>th</sup> ed. 2003) Kubey J., Goldsby R., et al., W.H. Freeman and Company, NY.
4. Introduction to Immunology: J.W. Kimball, Macmillan Publishing Company, NY.
5. Introduction to Molecular Immunology: A. Nisonoff Sineuer Assoc. Sunderland.
6. A hand book of Practical and Clinical Immunology: (2<sup>nd</sup> ed. vol-I & II 2002) G.P.Talwar & S.K.Gupta, CBS Publishers & Disbritures.
7. Immunochemical methods in Cell and Molecular Biology By: R.J. Mayer and J.H. Walker, Acaemic Press.
8. Immunology – An introduction: Tizard, I. R. Sanders College Publishing, NY.
9. Introductory Immunology: Davies, H., Chapman & Hall, London.
10. Immunology (instant notes): (2002) Lydyard P.M., Viva Books Private Ltd.

**M. Sc. SEMESTER- III**  
**BC-304: MICROBIAL BIOCHEMISTRY**

- 1. Introduction to bacterial cell:** Identification & classification of microorganisms, morphological, biochemical & molecular phylogeny, concepts of progeny, structure of bacterial cell and biosynthesis of cell wall, structure and functions of peptidoglycan in gram positive and gram negative organisms, functions of polymeric components in outer membrane and acidic polymers in gram negative organisms, internal & external cell structure of bacterial cell: capsule, flagella, cilia, pilli, endospore. 10 h
- 2. Bacterial growth:** Growth characteristic, growth curve & mass yield, stationary phase metabolism, synchronize growth, growth in fermentor & chemostate. 06 h
- 3. Special features of microbial metabolism:** Nutrition physiology: Classification of bacteria with respect to energy and nutrition, pathways and regulation of sugar metabolism in bacteria: PTS system, glycolysis, ED pathway, keto-gluconate pathway, fermentation and anaerobic respiration, growth on aromatic hydrocarbons, methane, cellulose, lectins, lignins, & pectins. 08 h
- 4. Regulation of genes in bacteria:** Nucleic acids as carriers of genetics information, arrangement and organization of gene in prokaryotes: operon concept, catabolite repression, instability of bacterial RNA, inducers and corepressors, *E.coli* lac operon: negative regulation and positive regulation, *E.coli* arabinose operon: regulation by attenuation, his and trp operons: antitermination, genetic transfer: conjugation, transformation and transduction. 10 h
- 5. Virology:** Introduction to virus, classification, assay method, properties and characteristic of bacterial, plant and animal viruses, virus host interaction, acute virus infections, persistent of virus infection, influenza, Herpes, Hepatitis A & B and HIV, RNA & DNA tumor viruses, viroids and prions. 08 h
- 6. Biological nitrogen fixation:** Nitrogen metabolism: mechanism and regulation of utilization of ammonia, nitrate and other nitrogen source, nitrogen fixation: mechanism and regulation of nitrogen fixation, symbiotic and asymbiotic nitrogen fixation and biochemistry of nitrogenase. 04 h
- 7. Phosphorus:** phosphate starvation, pho-regulation, solubilization of mineral phosphate. 02 h

- 8. Antimicrobial agents:** Antimicrobial agents and mode of action, resistance to antimicrobial agents. 02 h

**Reference Books:**

1. Principle of Microbiology: (2<sup>nd</sup> ed.1997) R.M. Atlas, Wm.C Brown., IOWA.
2. Microbial Physiology: (3<sup>rd</sup> ed.) Albert G. Moat and John W. Foster A. John Wiley & Sons. Inc. Publication.
3. Microbiology: (5<sup>th</sup> ed. 2003) Pelczar & Chan, Tata McGraw Hill Publishing Co. Ltd.
4. General Microbiology: (2<sup>nd</sup> ed. vol-1, 2, 1989) Power & Dagainawala, Himalaya Publishing House.
5. Biochemistry of Bacterial Growth: (4<sup>th</sup> ed.) Joet Mandelstam, Kenneth McQuillen, Ian Dawed. Blackwell Scientific Publication.
6. The Physiology and Biochemistry of Prokaryotes: (2<sup>nd</sup> ed. 2003) David white, Oxford University press.
7. Microbial Genetics: (1994) Maloy et. al., Jones & Barlett Publishers.
8. Molecular genetics of bacteria: (1994) J. W. Dale, John Wiley & Sons.
9. Modern microbial genetics: (1991) Streips & Yasbin. Niley. Ltd.

**M. Sc. SEMESTER- III**

**BC-305& 306: PRACTICALS / DESSERTATION**

**(200 marks)**

Chromatography Separation of Biomolecules: Amino acids, sugars, plant pigments.

Microbiology practicals: Isolations, characterization and specific biochemical properties of bacteria.

**BC-307: VIVA-VOCE EXAMINATION**

**M. Sc. SEMESTER-IV**  
**BC-401: GENETIC ENGINEERING**

- 1. Basic techniques for genetic engineering:** Purification of nucleic acids, Electrophoresis and analysis of hybridization techniques, construction and labeling of probes and primers for RDT, DNA sequencing techniques: Maxam–Gilberts, Dideoxy (Sanger's enzymatic), automated with fluorescence tag and rapid sequencing methods (shot gun approach), Polymerase Chain Reaction (PCR): components of PCR, template DNA, primers and enzymes, types of PCR: RACE and RT-PCR, applications of PCR in biology and medicine, changing genes by mutagenesis: Non specific and site-directed mutagenesis, primer extension, PCR based and unidirectional deletion methods. 10 h
- 2. Tools used in Recombinant DNA Technology (RDT):** Selections and identification of strains and species for gene manipulation, properties of enzymes used for manipulation of DNA, specificity, properties and functions, vectors, biology, specificity and properties of plasmid, phasmid, cosmid, viruses, shuttle vectors, p1, artificial chromosomes: YAC, BAC and HAC, construction and screening of genomic and c-DNA libraries and probes for library screening, isolation of specific genes. 10 h
- 3. Strategies of gene cloning and expression:** Construction of recombinant construct in cloning vectors for expression in prokaryotes and eukaryotes, methods for the introduction of recombinant DNA construct into host cells: bacteria, animals and plant cells, selection of recombinant specific clones: reporter genes, elimination of non transfer cells, hybridization techniques based on complementation, antibodies mediated, etc. problems in gene transfer and manipulation and screening. 10 h
- 4. Analysis of clone genes:** DNA–protein interaction, identification of protein binding sites on DNA: Gel mobility shift assay, DNA protein cross linking assay, DNase-I, foot printing, SI nuclease mapping, protein-protein interactions: Chemical cross-linking, yeast-2 hybrid, yeast-3 hybrid and principle and application, mutation of clone genes and its applications, expression and over expression of proteins: problem and solution findings, *in vitro* transcription and translation systems. 10 h
- 5. Application of molecular biotechnology:** DNA finger printing techniques: RFLP, AFLP and RAPD and SNPS, micro array techniques and application, biochips, antisense RNA technology, polyamide nucleic acid (PNA) and DNA their uses, gene therapy, vaccines

(whole organism, recombinant vector and DNA vaccines), liposome as drug delivery system. 10 h

**Reference Books:**

1. Principal of gene manipulation: (6<sup>th</sup> ed. 2001) Old R., Primrose S., Twyman R., Blackwell Science Ltd.
2. Molecular Biology of the Gene: (4<sup>th</sup> ed. 1998) Watson et al., The Benjamin / Cumming Publishing Co.
3. Gene VII: (7<sup>th</sup> ed. 2000) Benjamin Lewin, Oxford University Press.
4. Advance in Molecular Biology: (1999) Twyman R., Viva Books / Bioscience Publisher.
5. Human cytogenetic techniques and clinical application: H. Purandare and A. chakrabarty.
6. Cell and Molecular Biology-Concepts and Experiments: (1996) Gerald Karp, John Wiley & Sons.
7. An Introduction to Genetic Engineering: (2<sup>nd</sup> ed. 2002) Desmond S.T., Nicoll, Cambridge University Press.
8. Molecular Biotechnology –Principle and Applications of Recombinant DNA: (3<sup>rd</sup> ed. 2003) Glick and Parturnek, ASM press.
9. Biotechnology- B.D Singh: Himaliya Publishing House.
10. Genetics Engineering: Sandhya Mitra.
11. Recombination DNA: Watson et al.
12. Molecular cloning (A Laboratory Manual) Part-1, 2, 3: (3<sup>rd</sup> ed. 2001): Sambrook & Russell (Maniatis), Cold Spring Harbor Laboratory Press, NY.
13. The Chemical Foundation of Molecular Biology of the Genes: (2<sup>nd</sup> edition), James D Watson.

## M. Sc. SEMESTER-IV

### BC- 402: CELLULAR AND NEURON BIOCHEMISTRY

- 1. Membrane transport:** Nutrient transport across biomembranes: simple diffusion, facilitated diffusion and Fick's law, transporter molecules: Porins, kinetics of facilitated transport: Symport, antiport and uniport, red cell membrane proteins, anion porter and glucose porter, active transport,  $\text{Na}^+$ -  $\text{K}^+$  pumps: examples and metabolic significance.  
06 h
- 2. Cell communication and signal transduction:** General principle of cell communication, cell signaling, receptors, signal transduction cascades and secondary messenger system.  
10 h
- 3. Cell division and programmed cell death:** Cell cycle and cell growth, control system of cell division and mechanism of mitosis and meiosis, apoptosis and cell death, culture-techniques to study cell division, properties of cell in culture, biochemistry of cancer: carcinogenesis, characteristics of cancer cell, agents promoting carcinogenesis, genetic and metabolic disorder, drug metabolism and detoxification, genetic load and genetic counseling.  
10 h
- 4. Nervous system:** Role of nervous system, basic organization of nervous system, neurophysiology: types of neuronal cell and their functions, typical structure and function of neurons and unique features, electrical properties of membrane, excitability: resting and action potential, conduction of electrical impulse, molecular properties of voltage gated and ligand gated ionic channels and their studies.  
10 h
- 5. Nerves and synapse ultra structure:** Synapse, synaptic junctions, synaptic transmission, transport and storage of molecules and vesicle, migration and docking of vesicle, release of neurotransmitters and regulation biology.  
08 h
- 6. Neurotransmitters and neuron receptors:** Neurotransmitters: synthesis, storage, release, binding, action and removal, neuron receptors: Classification and properties of neuron receptors, structure and functions, purification and characterization of adrenergic and cholinergic receptors, pre and postsynaptic events at neuromuscular junctions, neurotoxins and neuromodulators, antagonist and agonistic effectors.  
08 h

**Reference Books:**

1. Molecular Biology of the Cells: (4<sup>th</sup> ed. 2002) Alberts B. et al., Garland Publications Inc. NY.
2. Molecular Cell Biology: (4<sup>th</sup> ed. 2000) Harvey Lodish, Berk, Zippursky L. et al, W. H. Freeman & Company.
3. The World of Cell: (3<sup>ed</sup> ed.1996) Becker R., Poinei M., The Benjamin/Cumming Publishing Co.
4. Essentials of Neural Science and Behavior: Kandal and Schwartz.
5. Principle of Neural Science: (3<sup>rd</sup> ed.1991) Kandal and Schwartz.
6. Cell and Molecular Biology: E D P de Robertis and E M F de Robertis.
7. Harpers Biochemistry: (26<sup>th</sup> ed.).
8. Text book of Medical Physiology: A. C. Guyton and J. E. Harcourt.
9. Review on Medical Physiology: (18<sup>th</sup> ed. 1997) Ganong W., Prentic Hall International Inc.
10. Text book of Biochemistry and Human Biology: Talwar.

**M. Sc. SEMESTER-IV**  
**BC- 403: ADVANCES IN BIOCHEMISTRY**

**1. Computers and Bioinformatics:**

Computer application: General awareness, use of popular software package for word processing, DBMS, spreadsheets, graphics, and statistical packages: SPSS, SAS, MINITAB and MATLAB.

Introduction to bioinformatics, organization of biological data, use of nucleic acid and protein data banks : NCBI, EMBL, DDBJ, SWISSPORT, primer design and analysis, combinational problem in biology, gene finding, motif finding, multiple sequences alignment gene prediction, genome analysis, phylogenetic prediction, protein sequence analysis and image analysis. 10 h

- 2. Plant tissue culture:** Introduction to plant tissue culture, principle and methodology of plant tissue culture, plant protoplast: introduction, protoplast isolation, protoplast fusion, protoplast culture, function and morphogenesis, cell line: callus culture, micropropagation, somatic embryogenesis, haploidy, somoclonal variations, somatic, cell hybridization: application to medicine, industry and agriculture, transgenic biology: allopheny, artificial seeds, hybridoma technology, transgenic plants: application of transgenic plant, transgenic for insect resistance, viral resistance, modification of seed protein quality, male sterility, biochemical production, plant derived vaccines. 10 h

- 3. Animal cell culture:** Animal cell cultures as s tools for genetic engineering, primary and transferred cell culture, differentiation of cell in culture, application of artificial cells, organs, application of transgenic animals, tissue specific and developmental specific gene knocks out. 06 h

- 4. Fermentation technology:** Isolation, cultivation, preservation and improvement of industrially important organisms, principle of fermentation, primary and secondary metabolites for fermentation, batch, feed batch, and continuous process, scale up of bioprocess, product recovery, substrates and its processes for fermentation application, industrial fermentation production of enzymes, organic liquor, antibiotics, organic acids, vitamins, amino acids, alcohol, exopolysaccharides, steroid transformation, biopolymers and bioplastics.

5. **Protein and metabolic engineering:** Gene shuffling, mutagenesis and selections, gene modification at specific site, gene fusion, chimeric and synthetic genes for interested protein engineering, metabolic engineering: over production of metabolites, creating new products, alternative nutrients, redirecting metabolic flow from branch pathway. 08 h
6. **Nano technology:** Introduction of nano materials and their size, the fundamental science behind nanotechnology.

### Reference Books:

1. Computers Today: D. H. Sander, McGraw-Hill Book Company.
2. Developing bioinformatics computer skills: C. Gibas and P. Jamback, O'Reilly Associates.
3. Bioinformatics- A Machine learning Approach: Baldi, P. & S. Brunak, M. I. T. Press.
4. Bioinformatics- A Practical guide to the Analysis of Genes and Proteins: A. D. Bzxevanis and B. F. F. Onellette.
5. Methods in Molecular Biology (Vol. 132). Bioinformatics Methods and Protocols: S. Misenes and S. A. Krawetz (Eds.)
6. Principles of fermentation technology (2<sup>nd</sup> ed. 1997), Stanbury, P.F., A. Whitaker & S.J.Hall, Aditya Books Privete Ltd.
7. Fundamental of fermentation: (1968) Caseda L., Wiley Eastern Ltd.
8. Introduction to Plant biotechnology: (2000) Chawla, Oxford & BH Publishing Co.Ltd.
9. Plant Biochemistry: Dey P. M. and J. B. Harborne, Harcourt Aria PTE Ltd. Singapore.
10. Plant physiology: (4<sup>th</sup> ed.1992) Frank B. Salisbury and C. W. Ross, Wadsworth publishing Co.
11. Plant Physiology: (4<sup>th</sup> ed. 2000) Davlin. R. & Withman F., CBS Publishhers & distributors.
12. Biotechnology: B.D Singh, Himaliya Publishing house, India.
13. Introduction to Medicinal Chemistry: A Gringuage, Wiley-VCH.
14. An introduction to drug design: Panday, S.S & J.R. Dimmock, New age international.
15. Pharmacological Basis of Therapeutics: Goodman and Gilman, McGraw Hill.
16. Principles of Medicinal Chemistry: (4<sup>th</sup> ed.) William Foye, Lippincott.
17. Analytical Profile of Drug Substances (series): Florey.
18. Biopharmaceuticals and pharmacokinetics: Bramanker, Nirali Publication, New Delhi.

## M. Sc. SEMESTER-IV

### BC- 404: SELECTED TOPIC IN BIOCHEMISTRY

#### I Biostatistics

**Statistical data analysis:** Classification and definitions of errors. Accuracy, precision, standard and pooled precision deviations. The t-test when an accepted value is known, paired t-test, t-test with multiple samples. Rejection of data (Q-test), control charts and linear least squares. Statistical consideration in radio- activity. Use of computer chemical data analysis 20 h

#### II MEDICINAL BIOCHEMISTRY

1. **Introduction to medicinal chemistry:** Important terminology, drug design:

i) development of new drugs, procedures followed in drug design, concepts of lead identification and lead modification, structure-activity relationship (SAR), factor affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism and spatial considerations, ii) history and development of QSAR, physicochemical parameters: lipophilicity, electronic parameters, steric parameters, sheldon and surface activity parameters and redox potentials, Free Wilson analysis, Hansch analysis, relationship between Free-Wilson and Hansch analysis, and other statistical methods. 08 h

2. **Pharmacokinetics:** Introduction to drug absorption, deposition, drug metabolism and elimination, important pharmacokinetics parameters in defining drug disposition and in therapeutics, uses of pharmacokinetics in drug development process, concept of prodrug and soft drug.

3. **Pharmacodynamics:** Introduction, concept of drug receptors interactions, theories of drug activity relationship, treatment of diseases by enzyme stimulation and enzyme inhibition, elementary treatment of drug receptor interaction, LD<sub>50</sub>, ED<sub>50</sub>, MIC and MEC etc. (mathematical derivations of equation excluded), membrane active drugs (sulphonamides), xenobiotics and significance of drug metabolism in medicinal chemistry.

4. **Pro-drugs, drug delivery systems, polymorphism:**

#### III PHARMA REGULATORY AFFAIRS:

**Legal issue related to biotechnology:** Safety of recombinant DNA technology, restriction and regulation for the release of GMOs, patenting and regulatory affairs, ethical and legal issues associated with transgenic organisms: IPP and IPR etc.

Pharmaceutical products-their manufacturing.

Analytical aspect.

Documentation required for filing patent.

Product registration and their requirement looking to WHO-GMP.

European DMF.

US-FDA regulations.

ICH guidelines.

Pharmacopaeal and extra Pharmacopaeal entry.

Chemical physical biological (Clinical), data documentation.

Patent writing art and introduction of concept of non-infringing patent ability looking to GATT-WTO scenario.

Computer based data mining in drug research.

Pharmaceutical product management aspect.

**Reference Book:**

1. Fundamentals of Statistics: Gupta, C., Himalaya Publishing House.
2. Statistical Methods- an introductory text: Medhi, J., New Age International (P) Ltd. Publishers.
3. An Introduction to Biostatistics: Sudar Rao, P. S. S., J. Richard; Prentice Hall of India. N. Delhi.
4. Computers Today: D. H. Sanders. Mc. Graw-Hill. Book Company.
5. Developing Bioinformatics Computer Skills: C. Gibas and P. Jamback, O'Reilly Associates.
6. Statistical methods: (29<sup>th</sup> ed. 2000), S. P.Gupta, Sultan chand & Sons.
7. Statistics (Theory, Methods & Application): (7<sup>th</sup> ed. 2000) D. C. Sancheti & V.K.Kapoor, Sultan Chand & Sons.

**M. Sc. SEMESTER- IV**

**BC-405& 406: PRACTICALS / DESSERTATION**

**(200 marks)**

1. Molecular biology: Isolation and screening of plasmid and genomic DNA, RNA etc.
2. Protein Purifications: Enzyme purification, PAGE, SDS PAGE, etc.
3. Immunology: Ab- Ag Interactions reactions and Application.

**Practicals reference books:**

1. Practical Biochemistry: J Jayaramman
2. An Introduction to Practical Biochemistry: (3<sup>rd</sup> ed. 2003) Devid P. Plummer, Tata McGraw Hill Publishing Co. Ltd.
3. Fundamental laboratory approaches for Biochemistry and Biotechnology: Alexander J Ninfa, Fitzgerald Science Press, INC, Meriland.
4. Modern Experimental Biochemistry: (3<sup>rd</sup> ed 2003) R.F Boyer, Pearson Education
5. Laboratory manual in microbiology: (1995) Gunashakhren P., New Age International Publishers (P) Ltd. New Delhi.
6. Introductory Practical biochemistry: (2002) Sawhney S. K., R.Singh, Narosa Publishing House, New Delhi.
7. Microbiology A Laboratory Manual: (6<sup>th</sup> ed. 2002) Cappuccino, Pearson Education.
8. Experiment in Physical Chemistry: (2004) P.H. Parsania, F.Karia, Neminath Printers, Rajkot.
9. Method of Enzymatic Analysis: Bergmeyer, Verlag Chemie, Florida.
10. Cell Biology, Laboratory Handbook: (2<sup>nd</sup> ed. 3 vols. 1998) Edited by Julio E Celis, Academic Press.
11. Methods in Enzymology: Series, Academic Press, Inc.
12. Essential Molecular Biology: (2<sup>nd</sup> ed.) T.A. Brown, Oxford University Press.
13. Molecular cloning: (3<sup>rd</sup> ed. vol 1, 2, 3, 2001) Sambrook and Russell, Cold Spring Harbor Lab. Press, NY.

**BC-407: VIVA-VOCE EXAMINATION**