KUVEMPU UNIVERSITY
DEPARTMENT OF BIOCHEMISTRY
SYLLABUS FOR M.Sc. BIOCHEMISTRY COURSE
REVISED (JANUARY 2017)

SEMESTER - I

BC 1.1: **PAPER I -** ANALYTICAL BIOCHEMISTRY **(HARD CORE)**
BC 1.2: **PAPER II -** BIOMOLECULES **(HARD CORE)**
BC 1.3: **PAPER III -** CELL BIOLOGY AND GENERAL MICROBIOLOGY **(SOFT CORE)**
BC 1.4: **PAPER IV -** FUNDAMENTALS OF BIOCHEMISTRY **(SOFT CORE)**
BC 1.5: **PRACTICAL I** - ANALYTICAL BIOCHEMISTRY
BC 1.6: **PRACTICAL II -**BIOMOLECULES
BC 1.7: **PRACTICAL III -** CELL BIOLOGY AND GENERAL MICROBIOLOGY

SEMESTER - II

BC 2.1: **PAPER V** - ENZYMOLOGY **(HARD CORE)**
BC 2.2: **PAPER VI** - METABOLISM OF FUEL MOLECULES AND BIOENERGITICS **(HARD CORE)**
BC 2.3: **PAPER VII -** HUMAN PHYSIOLOGY AND NUTRITIONAL BIOCHEMISTRY **(SOFT CORE)**
BC 2.4: **PAPER VIII -** ENZYME PURIFICATION TECHNIQUES **(ELECTIVE)**
BC 2.5: **PRACTICAL IV -** ENZYMOLOGY
BC 2.6: **PRACTICAL V -** METABOLISM OF FUEL MOLECULES AND BIOENERGITICS
BC 2.7: **PRACTICAL VI -** HUMAN PHYSIOLOGY AND NUTRITIONAL BIOCHEMISTRY

SEMESTER – III

BC 3.1: **PAPER IX -**MOLECULAR IMMUNOLOGY AND CLINICAL BIOCHEMISTRY **(HARD CORE)**
BC 3.2: **PAPER X -** BIOCHEMICAL GENETICS AND MOLECULAR BIOLOGY **(HARDCORE)**
BC 3.3: **PAPER XI -**METABOLISM OF NITROGENOUS COMPOUNDS WITH CLINICAL CORRELATIONS **(SOFT CORE)**
BC 3.4: **PAPER XII -** CLINICAL BIOCHEMISTRY **(ELECTIVE)**
BC 3.5: **PRACTICAL VII -** MOLECULAR IMMUNOLOGY AND CLINICAL BIOCHEMISTRY
BC 3.6: **PRACTICAL VIII --** BIOCHEMICAL GENETICS AND MOLECULAR BIOLOGY

BC 3.7: **PRACTICAL IX -** METABOLISM OF NITROGENOUS COMPOUNDS WITH CLINICAL CORRELATIONS

SEMESTER – IV

BC 4.1: **PAPER XIII** - CELL SIGNALLING **(HARD CORE)**
BC 4.2: **PAPER XIV** - GENETIC ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY **(HARD CORE)**
BC 4.3: **PAPER XV** - BIOSTATISTICS, BIOINFORMATICS & NANO BIOTECHNOLOGY **(SOFT CORE)**
BC 4.4: **PAPER XVI-** PROJECT WORK / DISSERTATION **(HARD CORE)**
BC 4.5: **PRACTICAL X** - CELL SIGNALLING
BC 4.6: **PRACTICAL XI** - GENETIC ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY

STRUCTURE OF M.Sc. (BIOCHEMISTRY) PROGRAM – REVISED

Paper code	Title	Semester	No. of Credits	Teaching h/week	IA marks/viva	Semend Exam Marks	Total Marks	Exam Duration (hr)
BC 1.1	**Paper I:** Analytical Biochemistry (Hard core)	I	5	5	25	75	100	3
BC 1.2	**Paper II:** Biomolecules (Hard core)	I	5	5	25	75	100	3
BC 1.3	**Paper III:** Cell Biology and General Microbiology (Soft core)	I	4	4	25	75	100	3
BC 1.4	**Paper IV:** Fundamentals of Biochemistry (Soft core)	I	4	4	25	75	100	3
BC 1.5	**Practical I:** Analytical Biochemistry	I	2	4	-	50	50	4
BC 1.6	**Practical II:** Biomolecules	I	2	4	-	50	50	4
BC 1.7	**Practical III:** Cell Biology & General Microbiology	I	2	4	-	50	50	4
BC 2.1	**Paper V:** Enzymology (Hard core)	II	5	5	25	75	100	3
BC 2.2	**Paper VI:** Metabolism of Fuel Molecules and Bioenergitics (Hard core)	II	5	5	25	75	100	3
BC 2.3	**Paper VII:** Human Physiology and Nutritional Biochemistry (Soft core)	II	4	4	25	75	100	3
BC 2.4	**Paper VIII:** Enzyme Purification Techniques (Elective)	II	2	2	10	40	50	1.5
BC 2.5	**Practical IV:** Enzymology	II	2	4	-	50	50	4
BC 2.6	**Practical V:**Metabolism of Fuel Molecules and Bioenergitics	II	2	4	-	50	50	4
BC 2.7	**Practical VI:** Human Physiology and Nutritional Biochemistry	II	2	4	-	50	50	4
BC 3.1	**Paper IX:** Molecular Immunology and Clinical Biochemistry (Hard core)	III	5	5	25	75	100	3
BC 3.2	**Paper X:** Biochemical Genetics and Molecular Biology (Hard Core)	III	5	5	25	75	100	3
BC 3.3	**Paper XI:** Metabolism of Nitrogenous Compounds With Clinical Correlations (Soft core)	III	4	4	25	75	100	3
BC 3.4	**Paper XII:** Clinical Biochemistry (Elective)	III	2	2	10	40	50	1.5
BC 3.5	**Practical VII:** Molecular Immunology and Clinical Biochemistry	III	2	4	-	50	50	4
BC 3.6	**Practical VIII:** Biochemical Genetics & Molecular Biology	III	2	4	-	50	50	4
BC 3.7	**Practical IX:**Metabolism of Nitrogenous Compounds With Clinical Correlations	III	2	4	-	50	50	4
BC 4.1	**Paper XIII:** Cell Signalling (Hard core)	IV	5	5	25	75	100	3
BC 4.2	**Paper XIV:** Genetic Engineering and Industrial Biotechnology (Hard Core)	IV	5	5	25	75	100	3
BC 4.3	**Paper XV:** Biostatistics, Bioinformatics & Nano Biotechnology (Soft Core)	IV	4	4	25	75	100	3
BC 4.4	**Paper XVI: Project work/Dissertation**	IV	6	6	50	100	150	-
BC 4.5	**Practical X:** Cell Signalling	IV	2	4	-	50	50	4
BC 4.6	**Practical XI:** Genetic Engineering and Industrial Biotechnology	IV	2	4	-	50	50	4
	Total		**94**	**112**			**2100**	

SYLLABUS FOR M.Sc. BIOCHEMISTRY COURSE
SEMESTER - I

Paper - I **80 hrs**

BC 1.1: ANALYTICAL BIOCHEMISTRY (Hard Core)

UNIT I

Chromatography - Introduction, principle, procedure and applications of – Adsorption chromatography, Paper, Thin Layer Chromatography (TLC), Gas Liquid Chromatography (GLC), Ion-exchange Chromatography, Molecular Sieve Chromatography, Affinity Chromatography, Reverse phase chromatography, High Performance Liquid Chromatography (HPLC) and Fast Performance Liquid Chromatography (FPLC). **16 hrs**

UNIT II

Electrophoresis - Theory of electrophoresis, factors affecting electrophoresis. Principle and applications of paper, starch, agarose, polyacrylamide, SDS-PAGE, Isoelectrofocussing, isotachophoresis, pulsed field electrophoresis, 2D-electrophoresis. Principles and applications of Southern, Northern and Western blotting techniques. **16 hrs**

UNIT III

Centrifugation - Basic Principles of centrifugation – Relative centrifugal force (RCF). Svedberg coefficient, sedimentation velocity and equilibrium. Classification of rotors. Types of centrifuges - Differential, continuous and density gradient centrifugation. Preparative and analytical ultracentrifugation.

Dialysis - Principle and applications of Dialysis, equilibrium Dialysis and Ultra filtration. Artificial membranes, semipermeable membranes, Donan membrane equilibrium. **16 hrs**

UNIT IV

Spectroscopy - Basic principles and electromagnetic spectrum. Beer-Lambert's Law. Principle and biochemical applications of UV-Vis spectrophotometry, colorimetry, fluorimetry, turbidometry, flame spectrophotometry, atomic absorption and fluorescence spectroscopy. Theory and applications of CD, ORD, IR, NMR, ESR in the study of macromolecular structures. **16 hrs**

UNIT V

Mass spectroscopy- Principle and applications, Ionization, fragmentation, m/e, Time of flight, MALDI and ESI-MS/MS.

Radioisotopes - Definition and types of radiation. Units of radioactivity, Specific activity, and half-life of radioisotopes. Basic principles and applications of GM, scintillation counters and Cerenekov counting. Autoradiography, preparation of labeled compounds. Application of ^{3}H,^{14}C, ^{32}P,^{131}I,^{35}S in biological sciences. Use of non-radioactive isotopes in biochemistry. **16 hrs**

References

1. Biochemical techniques- theory and practice, John F. Roybt and Bernard J. White, Waveland Press 1990.
2. Experimental biochemistry, Robert Switzer and Liam Garrity, 3rd edn. Freeman and Company.
3. Modern Experimental Biochemistry, Rodney Boyer, 3rd edition, Pearsons Education.
4. Experimental Biochemistry; J. Stenesh, Allyn and Bacon publishers
5. Biophysical chemistry-principles and techniques; Upadyaya and Upadyayanath,
6. Introduction to Biophysical Chemistry, Bruce Martin.
7. Physical biochemistry, David Freifelder, 2nd edition, W. H. Freeman and company.
8. Practical Biochemistry by Wilson and Walker.
9. Biochemical Calculations, Irwin H.Segel (1976) 2 nd Ed. Jhon Wiley and Sons.
10. Methods in Enzymology: Colowick, S.P. et al., [Eds.] (1987) Vol. 152, Academic Press.
11. Modern Experimental Biochemistry R.F.Boyer [Ed.] 3rd edn, (1999) Benzamin Cummings.
12. Analytical Biochemistry; D.J.Holme and H. Pick, (1983) Longman.
13. Practical Biochemistry: Principles and Techniques eds. K.Wilson and J. Waker, 5th edn, (1999) Cambridge University Press.
14. Biochemical Methods eds. Sadasivan and Manickan, 2nd edn, (1996), New Age International Pvt.Ltd.
15. Experimental Biochemistry, eds. Robert Switzer and Liam Garrity, (1999), W.H. Freeman.
16. Analytical Biochemistry; D.J. Holme and H. Pick, 3rd Ed. (1998) Longman.
17. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work (1969) Voil I & II, North Holland.
18. Biochemistry LabFax, Ed. J.A.A. Chambers and D. Rickwood, (1993), Blackwell Science.
19. Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
20. Practical Biochemistry; Principles and Techniques; K.Wilson and J. Walker (1995) 4 th Edn. Cambridge University Press.
21. Principles of Instrumental Analysis, (1980) 2 nd Edn.Holt- Saunders.
22. Principles and Techniques of Practical Biochemistry, Williams and Wilson (1981) 3 rd Edn. Edward Arnold.
23. Protein Purification Applications, S.L.V. Harris and Angal (1990) IRL Press.
24. Protein Purification, Robert, K. Scopes (1988) 2 nd Edn. Springer-Verlag.
25. Protein Purification Methods, S.L.V. Harris and Angal (1989) IRL Press.
26. Techniques in Molecular Biology, Walker and Gastra (1983) Croom Helm.
27. Protein purification protocols, P. Cutler, 2nd edn. Humana press.
28. Chromatography concepts and contrast, James M. Miller, Wiley, 2005
29. Radiochemical methods (analytical chemistry by open learning) W. Geary, Wiley-India publishing.
30. Quantitative bioassay-(analytical chemistry by open learning), D. Hawcroft, Wiley-India publishing.
31. Biological applications of IR spectroscopy, B. Stuan, Johan Wiley publishers.
32. Thin layer chromatography, Richard J. Hamilton (analytical chemistry by open learning), Wiley-India publishing.
33. High performance liquid chromatography – Sandie Lindsay and Johan Barnes, (analytical chemistry by open learning), Wiley-India publishing.
34. Mass spectroscopy, (analytical chemistry by open learning), James Barker, 2nd edn. John-Wiley.
35. Electrophoresis - analytical chemistry by open learning), M. Melvin, Wiley-India.
36. Basic Mathematics for Biochemists; Cornish Bowden, (1998), Oxford University Press.

Paper - II **80 hrs**

BC 1.2: BIOMOLECULES (HARD CORE)

UNIT I

Carbohydrates

Monosaccharides - classification, stereochemistry, Sugar derivatives- structure and biological importance of deoxy-sugars, amino sugars (D-glactosamine, N-acetyl neuraminic acid glucosamine). General methods of structural elucidation of monosaccharides - glucose.

Disaccharides and Oligosaccharides - Structure and importance of sucrose, lactose, maltose, Trehalose, cellobiose, raffinose, stachyose.

Polysaccharides - Homo and heteropolysaccharides, structure and functions of storage polysaccharides - starch, glycogen, inulin, dextrins. Structural polysaccharides-cellulose, chitin, alginate, agarose. Bacterial polysaccharides (Peptidoglycan) and lipopolysaccharides.

Glycosaminoglycans and proteoglycans - Structure and biological importance of Hyaluronic acid, heparin, chondroitin-4-and 6-sulfate, Dermatan sulfate, Keratan sulfate.

Glycoproteins - structure and biological functions of *N*-and *O*-linked glycoproteins. Antifreeze glycoproteins. **16 hrs**

UNIT II

Amino acids: Structure and physicochemical properties of amino acids, non-protein and non-standard amino acids, classification, stereochemistry, reactions and titration curves of amino acids, pKa values.

Peptides: Peptide bond - structure and conformation. Peptide synthesis - reactive ester method and modified Merrifield solid phase synthesis. Naturally occurring peptides - structure and biological importance of oxytocin, vasopressin, somtostatin and glutathione.
Proteins: Introduction, classification based on source, composition, solubility, and functions. **16 hrs**

UNIT III

Structural organization of proteins: primary, secondary, tertiary and quaternary structures. Determination of primary structure of proteins. Determination of amino acid composition. End group analysis. Fragmentation of polypeptide chains by enzymatic, acid and chemical methods. Separation of cleaved fragments. Protein sequencing - Edman's and modern methods of micro sequencing including solid phase sequencing methods. Assignment of disulfide bonds. Interpretation and overlapping of sequence.

Secondary structure of proteins - alpha helix, Beta-pleated sheets and other secondary motifs, Supersecondary structures of proteins; Beta bend, helix-turn-helix, zinc finger and leucine zippers. Prediction of secondary structure, Ramachandran plots, Fibrous proteins, keratin, silk fibroin, triple helix structure of collagen.

Tertirary structure of proteins - protein folding and stability, forces involved in folding of protein, denaturation and renaturation (ribonuclease). Role of chaperons in protein folding.

Quaternary structure of proteins - Quaternary structure, Haemoglobin as an allosteric protein, oxygen binding mechanism, explanation of Bohr's effect, BPG binding. Differences between myoglobin and hemoglobin. Normal and abnormal hemoglobins with respect to primary structure.

Denaturation of Proteins – Definition, Methods of denaturation, Effect of denaturation on the physicochemical and biological properties of proteins, measurement of denaturation. **16 hrs**

UNIT IV

Lipids - Classification, structure and biological functions of major lipid sub classes: Fatty acids, Acyl glycerols, Phospholipids, Sphingolipids, Glycolipids, Steroids, bile salts, Prostaglandins, thromboxanes, and Leukotrienes. Properties of lipid aggregates-micelles, bilayers and liposomes. Lipoproteins and lipopolysaccharides. Blood group antigens. **16 hrs**

UNIT V

Nucleic acids- Chemistry of purine and pyrimidine bases, nucleosides and nucleotides. Physico - chemical properties of nucleic acids - melting of DNA, buoyant density and UV absorption. Hydrolysis of nucleic acids – acid, base and enzymatic (Nucleases and restriction endonucleases) Structure of DNA, m RNA and t-RNA. Conformational forms DNA- A, B and Z and recent models-supercoils, cruciform, single stranded and satellite DNA. Recent methods of sequencing of nucleic acids. **16 hrs**

References

1. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
2. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
3. Biochemistry, Christopher K. Mathews et al, 3rd edition, Pearson Education.
4. Biochemistry, Lubert Strayer, 5th edition, W.H. Freeman and company.
5. Biochemistry, Robert Roskoski, W.B. Saunders company, 1996
6. Principles of biochemistry, H. Rober Horton and Laurence A. Moran, 4th edition, Pearson Education.
7. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
8. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
9. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1999), Wiley -Liss.
10. Harper's Review of Biochemistry, Murray et.al., (1997) 24th Edn. Lange
11. Proteins structural and molecular properties, Thomas E. Creighton, 2nd Edition, Freeman publishers.
12. Complex Carbohydrates, Sharon, N. (1975) Addison Wisely.
13. Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
14. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., (1982) Blackwell Scientific.
15. Principles of Protein Structure, Function, & evolution, Dickerson & Geis (1983) 2nd Ed., Benjamin-Cummings.
16. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
17. Principles of Biochemistry; General Aspects, Smith et al., [Ed.] (1983) McGarw Hill.
18. Human Biochemistry, Orten and Neuhans (1983) 10th Edn. Mosbey International
19. Topics in bioelectrical chemistry and Bioenergetics, G. Millazo, Vol-5, Wiley publishers
20. General biochemistry, J.H. Weil, 6th Edition, New Age International.

Paper - III **64 Hrs**

BC 1.3: CELL BIOLOGY AND GENERAL MICROBIOLOGY (Soft core)

Cell Biology (32 hrs)

UNIT I

Structural Organization of a Cell: Brief review of Prokaryotic and Eukaryotic cell structure. Structure and functions of various cellular organelles.

Plasma membrane - Physicochemical properties of biological membranes - compositions, supra molecular organization – Models of Membrane, Evolution in concept of membrane models, Gorter and Grendel's experiment, bilayer structure, Danielle – Davson model of membrane, Singer and Nicolson's model. Newer models. Membrane asymmetry-lipids, proteins and carbohydrates. Membrane protein-protein and protein-lipid interactions lateral diffusion, biogenesis of lipids and proteins, polarized cells, Membrane domains- caveolae, rafts, Membrane lipid and protein turnover. Membrane lipid phases, bilayer phase, non bilayer phase, Cell fusion, use of liposomes and erythrocyte ghosts, membrane potential. Techniques used to study the membrane structure - FRET, FRAP, single particle tracking, EM of membranes, Spin labeled ESR, NMR, Fluorescence labels, confocal microscopy of membrane dynamics.

Membrane Transport - Laws of diffusion across membranes, simple diffusion, facilitated diffusion and active transport - glucose transporter, Na^+ K^+ ATPase, Ca^{2+} ATPase, K^+- H^+ ATPase) (Structure and mechanism of action), γ - glutamyl cycle, bacterial phosphotransferase system. Endocytosis, receptor mediated endocytosis, exocytosis. Ion channels and aquaporin channel, Disorders associated with membrane transport systems; Cystic fibrosis and Hartnup's disease. **16 hrs**

UNIT II

Nucleus - the nuclear envelope, nuclear pore complex, nucleolus- structure and composition, the structure of chromosome, chromatin, histones and non histone proteins.
Mitochondrion: structure of mitochondrion, inner and outer membrane. The mitochondrial matrix, respiratory chain carriers.
Chloroplast - structure and function, photosynthetic pigments, photosynthetic units and reaction centers. Organization of thylakoid membranes. Photophosphorylation-light and dark reactions, Calvin cycle, regulation of photosynthesis. C3 and C4 plants, Hatch-Slack's pathway, photorespiration, bacterial photosynthesis, bacterial electron transport chain.
Cellular Components: Endoplasmic reticulum, Golgi complex, lysosomes, vacuoles, peroxisomes, glyoxysomes, melanosomes, and flagella.
Cytoskeleton - structure, composition and functions of microtubules, intermediate filaments and microfilaments.
Cell cycle and cell-cell interaction - specific events in the cell cycle-G1, S, G2, and M phase, regulation of the cell cycle, mitosis, meiotic cell cycle – meiosis1 and meiosis2. Biochemistry of cancer - carcinogens, characteristics of cancer cells, oncogenes, tumor suppresser genes and

programmed cell death. Introduction to cell adhesion molecules, junction between the cells-desomsomes, hemidesmosomes and tight junctions, communication via gap junctions plasmadesmata. **16 hrs**

General Microbiology: (32 hrs)

UNIT III

Development of Microbiology and Microscopy - Different types of microscopic methods for observing microorganisms – light microscopy, florescence, dark field, phase contrast, interference, electron (SEM and TEM) and confocal microscopy.

Bacteriology - Eubacteria , Archaebacteria, Cynobacteria, Bergy's classification of bacteria. Detailed study of bacterial cell structures - genetic elements, ribosomes, membranes, cell envelope, capsule, flagella, pili and endospores. Staining techniques – Gram, Acid fast and flagellar. Endotoxins, Biosynthesis of peptidoglycan.

Cultivation of Bacteria - Nutritional requirements, different kinds of media, factors affecting growth. Isolation and maintenance of pure cultures. Modes of reproduction, enumeration, growth curve, generation time, synchronous growth, Chemostat. Physical and chemical methods of controlling bacterial growth. Antibiotics and their action. **16 hrs**

UNIT IV

Eukaryotic Microorganisms - Fungi - Classification, cultivation and morphology of yeasts and molds. Control of fungal growth. Brief study of algae and protozoa.

Viruses and other acellular microbes (viruses, viroids and prions) – Classification, structure, isolation and assay, viral replication (lytic and lysogenic). Classification of plant, animal and bacterial viruses.

Food, Diary and Soil Microbiology - Food spoilage, food preservation, fermented foods, exotoxins produced by bacteria and molds. Contamination of milk by microorganisms. Bacterial count, reactions occurring in milk, pasteurization and sterilization. Fermented milk products

Soil Microbiology- Soil bacteria, agrobacterium nitrogen fixation, extremophiles, sulphur cycle.

16 hrs

References

1. Molecular Biology of the Cell, Bruce Alberts et al., (2002), Garland Publications
2. Nuclear Organization; Chromatin Structure and Gene Expression, Roen Van Driel and Arie P. Otte (1997) Oxford University Press.
3. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
4. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGraw-Hill.
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13. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
14. Principles of biochemistry, Zubey,
15. Cell and Molecular biology, E. D. P. De Robeties and E. M. F. De Robeties, 8th edn. Lea and Fabiger international edn.
16. Applied Cell and Molecular biology, Gabinindel Waite and Lee R. Waite, McGraw Hill publishers.
17. Recent Advances in Cell biology, Vineeta Singhal and C.K. Aorara, Vol-1, Anmol publications.
18. Molecular cell biology, Dornell, Lodish and Baltimore.
19. Cell biology, David E. Sadava.
20. Microbial Physiology, 2nd edn. I.W. Dawes and I.W. Sutherland, (1991) Blackwell Scientific.
21. Modern Food Microbiology; Jmes M.Jay (1996) th Ed. CBS Publishers.
22. A Modern Introduction to Food Microbiology; Board, R.G. [Ed.] (1983) Blackwell Scientific
23. Biology of Microorganisms, Brock (1996) Prentice Hall.
24. Industrial Microbiology; Miller and Litsky [Eds.] (1976) McGraw Hill Publishers.
25. Molecular Cell Biology Baltimore et al., (1995) Scientific American Publication.
26. Microbiology, Prescot, Hartley and Klein, (1993) WCB Publications.
27. Microbiology; Essentials and Applications, Larry Mckane and J.Kandel (19) McGraw Hill Publishers.
28. Milestones in Microbiology, Ed. T. Brock (1991), A.S.M. Press.
29. Microbes in Action, A Laboratory Manual of Microbiology Seley et al., (19) W.H. Freeman.
30. Introduction to Ecotoxicology, Ed. D.W. Connell, (2000) Blackwell Scientific
31. Molecular Pharmacology, ed. T. Kenakin, (1997), Blackwell Science Inc.
32. Applied Microbial Physiology ; A practical approach Rhodes and Stanbury (1997) IRL Press
33. Microbes in Action, A Laboratory Manual of Microbiology Seley et al., (19) W.H. Freeman.
34. Basic and Practical Microbiology, Ronald L. Atlas (1986) McMillan Publication Co.
35. General Microbiology, Stanier, et al., (1975) 4th Edn. McMillan.
36. Microbiology, Pelczer, Reid and Krieg (1996) Tata-McGrawHill.
Biology of Microorganisms, Brock (1996) Prentice Hall.

Paper - IV **64 Hrs**

BC 1.4: FUNDAMENTALS OF BIOCHEMISTRY (Soft core)

UNIT I

Chemical bonding: Types of bonding in biological molecules. Characteristics of chemical bonds-sigma and Pi bonds, properties of covalent, co-ordinate, hydrogen and ionic bonds, hydrophobic and Vander-Waals interactions and their importance in biological systems. Concept of Hybridization and aromaticity. Homo and heterolytic cleavage, structure and reactivity and C^+, C^- and $C^\cdot$, Nucleophile, electrophile, free radicals in biological systems.

Reaction mechanisms: Characteristics and mechanisms of substitution, addition, elimination and rearrangements. Energy profiles of reactions, transition state theory. Reactions SN1, SN2, SN1 neighbouring group participation. E2, E1, Curtin-Hammett principle. Electrophilic addition to C=0, aldol condensation and Michael addition. Esterification and hydrolysis. **16 hrs**

UNIT II

Stereochemistry - Optical isomerism, optical activity, specific rotation, chiarlity, enantiomers, diastereomers, DL, RS, threo and erythro notations. Conformation and configuration. Stereoisomerism and geometrical isomerism, cis-trans and EZ notations. Stereochemistry of glucose - anomers, epimers, stereoisomers. Mutarotation and racemization.

Heterocyclic compounds- Occurrence in biological systems, structure and properties of furan, pyrrole. Indole, thiazole, imidazole, pyridine, pyrimidine, purine, quinone, pteridine and isoalloxazine. **16 hrs**

UNIT III

Properties of water - Physical, chemical and anamalous properties of water, Importance of water in biological systems. Ionic product of water, Acids and bases, pH, pKa, Henderson–Hasselbalch equation, buffer action, buffer capacity. Preparation of buffers and their importance in biological systems, physiological buffer systems.

Bioinorganic Chemistry: Ligand field theory of complexes, stability of complex ions in solution, kinetics and mechanism of reactions of complexions. Ligand replacement reactions and electron transfer reactions of organometallic moieties of biological macromolecules (Specific examples will be discussed under appropriate sections). Role of metal ions in biological systems, metalloporphyrins, metalloenzymes, cytochromes, iron-sulfur proteins **16 hrs**

UNIT IV

Thermodynamics: Laws of thermodynamics, Concepts of entropy, free energy, free energy change and standard free energy change of reactions, significance of free energy changes, effect of temperature and pH on ΔG^o, methods for the determination of free energy changes, relation between K_{eq} and ΔG^o. Group transfer reactions and High energy compounds. Oxidation-reduction and hydrolytic reactions in biological systems, chemical potential, membrane potential, Redox potentials (electron transfer reactions), free energy changes of oxidation-reduction reactions and coupled reactions. **16 hrs**

References

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2. Chemistry – An Introduction to General, Organic and Biological Chemistry, VII Ed., (1999), Karen C. Timberlake, Benjamin/Cummings
3. Physical Chemistry of Macromolecules, C. Tanford
   Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill.
4. Organic Mechanisms, Peter Sykes (1977), Longman
5. Inorganic Biochemistry, G.L. Eichhorn (1973) Elsevier.
6. Guide Book to Mechanisms in Organic Chemistry, Peter Sykes, 6th Ed., (1986), Longman
7. Biochemistry-the chemical reactions of living cells, David E. Metzler, Vol-2, 2nd edition, Academic press
8. Lippinctott's illustrated reviews biochemistry, 4th edn., P.C. Champe , R.A. Harvey and D. R. Ferrier, Lippincot's Williams and Wilkins.
9. Organic chemistry of Natural products, Gurudeep Chatwal, Vol-1 and V0l-2, Himalya publishers,
10. Text book of organic chemistry, Bhal and Arun Bhal, Chand publishers.
11. Bioinorganic chemistry, Rosette M. Roatmalone, 2nd edition, Wiley Interscience.
12. Enclyopedia of biological Chemistry, William J. Lennarz and Daniel Lane, A-D, Volume 1, Elsevier Academic press.
13. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
14. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
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18. Principles of biochemistry, H. Rober Horton and Laurence A. Moran, 4th edition, Pearson Education.
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21. Proteins structural and molecular properties, Thomas E. Creighton, 2nd Edition, Freeman publishers.
22. Complex Carbohydrates, Sharon, N. (1975) Addison Wisely.
23. Principles of Protein Structure, Function, & evolution, Dickerson & Geis (1983) 2nd Ed., Benjamin-Cummings.
24. Bioinorganic chemistry, Ayodhya singh and Sanjay Kumar sing, Campus publications.
25. Principles of bioinorganic chemistry, Stephen J. Lippard and Jeremymberg, University Science books
26. Biophysical chemistry part-2, Cantor and Schmmel, Freeman publications.
27. Topics in bioelectrical chemistry and Bioenergetics, G. Millazo, Vol-5, Wiley publishers

SYLLABUS FOR M.Sc. BIOCHEMISTRY

SEMESTER - II

Paper - V **80 hrs**

BC 2.1: Enzymology (Hard core)

UNIT I

Introduction to Enzymes - Nomenclature and classification of enzymes. Specificity and active site. Investigation of enzymes in biological preparations. Fundamentals of enzyme assay - enzyme units, Definition of IU, ketal, enzyme turn over number and specific activity, coupled kinetic assay and radio-immuno assay. Enzyme localization, isolation, purification and criteria of purity of enzymes.Clinical and biotechnological application of enzymes. **16 hrs**

UNIT II

Kinetics of enzyme-catalyzed reactions - Chemical nature of enzyme catalysis - General acid-base catalysis, electrostatic catalysis, covalent catalysis, intramolecular catalysis and enzyme catalysis. Methods used in the investigation of the kinetics of enzyme-catalyzed reactions, initial velocity studies, ion-selective electrode techniques, rapid reaction techniques and immuno-assay techniques. Enzyme kinetics of single substrate reactions - Michaelis theory, steady state theory. Kinetic data evaluation - linear transformation of Michaelis-Menten equation. Pre-steady state kinetics. Integrated velocity equation, King-Altman procedure for deriving the rate equation. Factors affecting enzyme kinetics - Effect of enzyme concentration, substrate concentration, pH, temperature and activators and inhibitors. **16 hrs**

UNIT III

Enzyme Inhibition - Types of reversible inhibitors - competitive, non-competitive, uncompetetive and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible inhibition.

Kinetics of bi-substrate reactions - Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between different kinetic pathways using primary and secondary plots. Inhibition studies in the characterization of bisubstrate reactions. Investigations of reaction mechanisms using isotopic-exchange at equilibrium. **Molecular basis of enzyme catalysis -** general theories and hypothesis proposed to explain enzyme specificity, lock and key, induced-fit theory, contribution of structural flexibility to the specificity of the enzymes.

16 hrs

UNIT IV

The investigation of active site of an enzyme : The identification of binding sites and catalytic sites - trapping the E-S complex, the use of substrate analogs, chemical modification of amino acid side chains, photo-oxidation, enzyme modification by treatment with proteolytic enzymes, the 3-D structural features of active sites as revealed by X-ray, NMR and chemical studies. Mechanisms of reactions catalyzed by the following enzymes - chymotrypsin, trypsin, lysozyme and ribonuclease. Metal activated enzymes and metallo-enzymes - pyruvate kinase, creatine kinase, superoxide dismutase & carboxypeptidase-A.

Coenzymes - The mechanistic role of the following coenzymes in enzyme catalyzed reactions - nicotinamide nucleotides, flavin nucleotides, coenzyme A, lipoic acid, thiamine pyrophosphate, biotin, tetrahydrofolate and coenzyme B_{12}. **16 hrs**

UNIT V

Monomeric, oligomeric and other forms of enzymes - Monomeric enzymes - the serine proteases, zymogen activation. Sulphydryl enzymes - papain and alcohol dehydrogenase. Oligomeric enzymes - isoenzymes (LDH) and multi-enzyme complexes (Pyruvate dehydrogenase complex), ribozymes, metalloenzymes, abzymes

Allostery of enzyme action - Binding of ligands to proteins - Co-operativity, the Hill equation, the Adair equation, the Scatchard plot and equilibrium dialysis techniques.

Sigmoidal kinetics - The MWC and KNF models. Significance of sigmoidal behavior. Allosteric enzymes and metabolic regulation. Study of ATCase as typical allosteric enzyme. Other mechanisms of metabolic regulation. **16 hrs**

References

1. Basic Biochemical Laboratory Procedures and Computing, R. Cecil Jack (1995) Oxford University.
2. Biochemical Calculations, Irwin H.Segel (1976) 2 nd Ed. Jhon Wiley and Sons.
3. Methods in Enzymology; Colowick, S.P. et al., [Eds.] (1987) Vol. 152, Academic Press.
4. Methods of Enzymatic Analysis; Berg Meyer (1974) Vol. 1-X,
5. Protein Purification Methods; S.L.V. Harris and Angal (1989) IRL Press.
6. Understanding Enzymes; Palmer, T. (1981) Ellis Horwood Ltd.
7. Enzyme Kinetics; Roberts, D.V. (1977) Cambridge University Press.
8. The Enzymes; Boyer ( ) Academic Press.
9. Enzyme Kinetics; Irwin H.Segel ((1976) Interscience-Wiley.
10. Enzyme Kinetics;The Steady state approach; Engel, P.C.(1981) 2 nd Edn. Champman and Hall.
11. Nature of Enzymology; Foster, (1980) Croom Helm.
12. Principles of Enzymology for Food Sciences; Whitaker, Marcel Dekker (1972) Academic Press.
13. Fundamentals of Enzymology, N.C. Price and Lewis (1989) Oxford University Press.
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15. Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), Blackwell Science.
16. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
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18. Cell and Molecular biology, G.Karp , 4th edition, wiley publishers
19. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
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21. Biochemistry, Christopher K. Mathews et al, 3rd edition, Pearson Education.
22. Biochemistry, Lubert Strayer, 5th edition, W.H. Freeman and company.
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24. Principles of biochemistry, H. Rober Horton and Laurence A. Moran, 4th edition, Pearson education.
25. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
26. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
27. Principles of biochemistry, Zubey,

Paper - VI **80 Hrs**

BC 2.2: METABOLISM OF FUEL MOLECULES AND BIOENERGITICS (Hard core)

UINIT I

Carbohydrate Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. Carbohydrates - glycolytic pathway, energetics, regulation of glycolysis. Yeast fermentation – different forms. Alternative pathways of glucose oxidation: HMP– shunt pathway, Glucuronate pathway, Entneur-Dueodorf pathway, Transportation of cytosolic NADH by Aspartate-malate & glycerol phosphate shuttle systems. Interconversion of hexoses. Gluconeogenesis. Tri carboxylic acid cycle - energy yields and importance of the pathway. Anapleurosis, glyoxylate cycle. Glycogen Metabolism: synthesis, degradation and regulation. Hormonal regulation of carbohydrate metabolism. **16 hrs**

UINIT II

Lipid Metabolism - Degradation of triglycerols, phospholipids and glycolipids. Oxidation of even & odd numbered fatty acids (β oxidation), Knoop's experiment; energies of β-oxidation scheme, role of carnitine, ω-oxidation, α-oxidation, oxidation of unsaturated fatty acids. Alternate route for fatty acid oxidation, formation of ketone bodies and their oxidation. Biosynthesis of fatty acids, extra mitochondrial chain elongation and desaturation pathways. Biosynthesis of prostaglandins, leukotrienes and thromboxanes. Biosynthesis of triglycerols, phospholipids & sphingolipids, regulation of fatty acid metabolism. Biosynthesis and degradation of cholesterol and related steroids, regulation of cholesterol synthesis. Integration of lipid and carbohydrate metabolism. **16 hrs**

UNIT III

Disorders associated with Carbohydrate metabolism: Glycogen storage diseases, lactose intolerance, hyperglycemia and hypoglycemia, diabetes mellitus.

Disorders associated with Lipid metabolism: Ketosis and their clinical significance, hyper cholesterolemia, Atherosclerosis, Niemann pick's disease, Taysacch's disease, Gaucher's disease. **16 hrs**

UNIT IV

BIOENERGETICS

Introduction: Basic concepts of metabolic energy capture and transfer. Biochemical energetic - group transfer reactions of ATP, phosphate group transfer potential of ATP and other high energy phosphate donors. Stages in extraction of energy from fuel molecules.

Biological oxidation - Biological redox couplers, participation in oxidative metabolism. Free energy changes in electron transfer reactions. Mitochondrial electron transfer system- Chemical nature, topology and thermodynamic design of electron carriers. Sequence of electron carriers - isolation of mitochondrial complexes, reconstitution experiments and study of specific inhibitors of ETC.

16 hrs

UNIT V

Oxidative phosphorylation - Mechanism of proton pumping. Proton motive force and the Mitchell hypothesis. FoF1-ATPase structure and mechanism, O18 exchange. Coupling of electron transfer to ATP synthesis. Uncouplers, inhibitors and ionophores, partial reactions of OP, P/O ratios and their use in localization of sites of ATP synthesis along the chain. Mechanism of oxidative phosphorylation, mitochondrial specific transport systems and energy charge. Microsomal electron transport.

Oxygen Utilizing Enzymes - Generation of reactive oxygen species (R.O.S.), role of mixed function oxidase (hydroxiase & monooxygenase), catalase, peroxidase and super oxide dismutase. **16 hrs**

References:

1. Biochemistry: Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
2. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley -Liss.
4. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
5. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
6. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
7. Photosynthesis, D.O. Hall and K.K. Rao, (1999), 6 th Edn. Cambridge University Press.
8. Hawk's Physiological Chemistry, Oser (1976) 14 th Edn Tata-McGraHill.
9. Photosynthesis. Ed. A.S. Raghavendra, (2000), Cambridge University Press.
10. Recent Advances in Plant Biochemistry; S.L. Mehta, M.L. Lodha, and P.V. Sane, (1992) ICAR, New Delhi.

Paper - VII **64 hrs**

B.C. 2.3: HUMAN PHYSIOLOGY AND NUTRITIONAL BIOCHEMISTRY (Soft Core)

HUMAN PHYSIOLOGY (48 hrs)

UNIT I

Tissues - Formation of different kinds of tissues from primary germ layers. Types and functions of epithelial tissue, inter-cellular junctions. Connective tissue - extra cellular matrix, glycosaminoglycans and proteoglycans. Collagens - types, composition, structure and synthesis. Elastin, Fibronectins, Laminin and other proteins of the extra-cellular matrix. Basal lamina.

Nervous System - Divisions of the nervous system, receptors, neurons and other cells of nervous system. Types and structure of neuron. Resting membrane potential and action potential, neurotransmitters, post-synaptic potential. Myelin sheath; composition and function. NGF, N-CAM and other specialized proteins. Resting membrane potential of excitable cells; Nernst and Goldman equations. Mechanism of initiation and propagation of action potential; Voltage gated ion; channels (sodium, potassium and calcium). Design and use of Patch-Clamp in measuring membrane potential. Depolarization and hyper-polarization in postsynaptic cells. Use of ionophores and toxins to study membrane transport. Synaptic transmission, neurotransmitters; biogenic amines, amino acids and neuropeptides. storage and exocytosis of neurotransmitters. Termination of neurotransmitter action. Acetylcholine receptors; nicotinic and muscarinic adrenergic receptors, other neurotransmitter receptors. Mechanism of synaptic transmission; receptor-integrated ion-channels and G-protein mediated ion channels. Use of agonists and antagonists of neurotransmitters in Biochemistry and Medicine.

Biochemistry of Vision - Structure of rod and cone cells and other cells involved in vision. Photosensitive pigments. Biochemical events occurring in photosensitive cells leading to initiation of nerve impulse **16 hrs**

UNIT II

Endocrine system - Location and interrelationships of endocrine glands in humans. Classification and chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, gonads and GI tract. Concept of homeostasis, Regulation of hormone production and release: Paracrine action of hormones, Production and functions of the hormones secreted by pituitary, thyroid, parathyroid, pancreas, adrenals and gonads. Effect of Insulin, glucagon and catecholamines on carbohydrate and lipid metabolism. Chemistry and biology of prostaglandins, prostacyclins and thromoxanes. Pineal gland; Melatonin and circadian rhythm.

Muscular System - Smooth, skeletal and cardiac muscles. Contractile and other proteins of muscle. Fine structure of the muscle fibre, neuro-muscular junctions, Fast and slow muscle. Phosphagens. Muscle Biochemistry – excitation of striated muscle, changes occurring at sarcolemma, transverse-tubular system and sarcoplasmic reticulum mechanism of muscle contraction. Regulation of

contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies. **Cardio-vascular System -** Systemic and pulmonary circulation. Structure of blood vessels. Regulation of cardiac activity. Blood volume, blood pressure. Plasma composition and functions of plasma lipoproteins. Mechanism of blood clotting, role of vitamin K, clot dissolution, anti-clotting factors. Formation, counting and functions of erythrocytes, leukocytes and thrombocytes. Lymph, Cerebro Spinal Fluid (CSF) - composition and analysis in diagnosis. **16 hrs**

UNIT III

Respiratory System - Mechanics & regulation of respiration transport of respiratory gases.

Digestive System - Structure of the gastro-intestinal tract. Secretion, regulation of secretion, composition and functions of saliva, gastric, pancreatic and intestinal juices and bile. Gastro-intestinal hormones. Digestion, absorption and transport of carbohydrates, proteins, lipids, nucleic acids and vitamins. Liver - structure and functions. Detoxification mechanisms

Excretory System – Structure of functional units of Kidney. Formation and composition of urine, urine analysis for abnormal constituents, tubular function tests. Nephritis and nephrosis. Kidney hormones. Regulation of acid-base, electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis. **16 hrs**

Nutrition (16 hrs)

UNIT IV

Basics of Nutrition: Concepts of macro and micro nutrients, essential nutrients and their classification. Food groups, proximate analysis of foods, chemical and biological analysis for nutrients. Food as source of energy, methods of determining energy value of foods, calorimetry, physiological fuel value, daily requirement of energy, high and low calorie diets. Basal metabolic rate (BMR) factors affecting BMR, specific dynamic action of foods. Carbohydrates - dietary sources, dietary fibre essentiality of carbohydrates. Proteins **-** Evaluation of nutritive value of dietary protein PER, BV, essential amino acids nutritional classification of proteins, supplementary value of proteins, protein calorine malnutrition Kwashiorkar and Merasmus. Fats - Sources, invsisible fat, essential fatty acids, PUFA.

Vitamins and Minerals - Fat soluble and water soluble vitamins pro vitamins, antivitamins, dietary sources structure, daily requirements, function and deficiency symptoms of B and C vitamins and fat soluble vitamins, hypervitaminosis vitamin - like compounds. Macro micro micronutrients sources requirements, functions and deficiency symptoms, water metabolism. Distribution in body, function water balances, mid factors affecting water balance. Recommended dietary allowances - special nutrition for infants, children, during pregnancy, lactation and old age. Nutrition for diabetes and cardiovascular disease patients. Wellness diets, fitness diets, obesity and BMI,

16 hrs

References

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
2. Fundamentals of Biochemistry; Voet , Voet,and Pratt. [Eds.], (1999), Jhon Wiley & sons.
3. Human Physiology; Vander Sherman & Luciano (2001), McGraw-Hill.
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11. Harper's Review of Biochemistry, Murray et al., (1997) Lange.
12. The Cell; A molecular Approach; Cooper and Geoffrey, M. (2001), Oxford University Press.
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15. Protein Targeting; Hartley, (2001), Oxford University Press.
16. Foods-facts and principles, N.Shakunthala Manay and M.Shadakshra Swamy, Wilely International.
17. Text book of Medical Physiology, A.D. Guyton, 8th edition, Kul.
18. Human Physiology, Andrey Davies, Churchill and livingstone publishers.
19. Principles of Anatomy and Physilogy, 11th edn. Gerard J. Tartora,
20. Text Book of biochemistry and Human physiology, Talwar G. P.
21. Human Biochemistry, Orten and Neuhans, 10th edn.
22. Human phsiogy, chaterjee, vol-I and Vol-2.
23. Human Physiology, Chowdary.
24. Nutrition Science, V. Sreelakshmi, revised 2nd edn, New Age International Publishers.
25. Discovery nutrition, Paul Insen, R. Elaine Turner and Don Ross, Jones and Bartlett publishers.
26. Medical biochemistry, Miriam D. Rosenthal and Robert H. Glew, John-Wiley and sons.
27. Human biochemistry and disease, Gerald Litwack, Academic press.
28. Text of book of biochemistry for medical students, Vasudevan and Sreekumari, Jaypee publishers.

Paper- VIII

BC 2.4: ENZYME PURIFICATION TECHNIQUES (Elective) 32 hrs

UNIT I

Introduction – Nomenclature and classification of enzymes, properties, kinetic parameters of single substrate reaction (Michaelis-Menten equation), Enzyme assays: Measurement and expression of enzyme activity. Definition of IU, ketal, enzyme turn over number and specific activity, cofactors, enzyme unit. Isolation of enzymes -objectives and strategy, choice of sources, methods of homogenization. Judging the purity of enzymes - catalytic activity, SDS PAGE, IEF, active site titrations. **16 hrs**

UNIT II

Separation & Purification of enzymes - Methods of separation, methods such as gel filtration, affinity, ion exchange, di-ligand chromatography, immune-absorption chromatography, covalent chromatography, HPLC/FPLC, hydrophobic interaction, solubility – change in pH, change in ionic strength, dielectric constant, dialysis and ultracentrifugation

Procedures adopted for purification of enzymes - Adenylate Kinase from pig muscle, Ribulose bisphosphate carboxylase from Spinach, Adenosine triphosphatase, RNA polymerase from E-coli. **16 hrs**

References:

1. Biochemistry; Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
2. Biochemistry, Christopher K. Mathews et al, 3rd edition, Pearson Education.
3. Biochemistry, Lubert Strayer, 5th edition, W.H. Freeman and company.
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9. Understanding of enzymes by Nicolas price, 2003.
10. Fundamental of enzymes, T. Palmer 2002.
11. Practical Biochemistry: Principles and Techniques eds. K.Wilson and J. Waker, 5th edn, (1999) Cambridge University Press.
12. Biophysical chemistry-principles and techniques; Upadyaya and Upadyaya,

SYLLABUS FOR M.Sc. BIOCHEMISTRY

SEMESTER: III

Paper - IX **80hrs**

BC 3.1. Molecular Immunology and Clinical Biochemistry (Hard Core)

Molecular Immunology **52 hrs**

UNIT I

Overview of the Immune System - Historical Perspective, Essential definitions, Innate and Adaptive Immunity, inflammation, Antigens **-** Immunogenicity versus Antigenicity, Factors that Influence Immunogenicity, Epitopes, Haptens, Pattern-Recognition Receptors.
Cells and Organs of the Immune System - Hematopoiesis, Cells of the Immune System, Organs of the Immune System, Systemic Function of the Immune System, Lymphoid Cells and Organs.
Antibodies: Structure and Function - Basic Structure of Antibodies, Obstacles to Antibody Sequencing, Immunoglobulin Fine Structure, Antibody-Mediated Effector Functions, Antibody Classes and Biological Activities, Antigenic Determinants on Immunoglobulins, The Immunoglobulin Superfamily, Monoclonal Antibodies.
Antigen-Antibody Interactions: Principles and Applications - Strength of Antigen-Antibody Interactions, Cross-Reactivity, Precipitation Reactions, Agglutination Reactions, Radioimmunoassay, Enzyme-Linked Immunosorbent Assay, Western Blotting, Immunoprecipitation, Immunofluorescence, Flow Cytometry and Fluorescence, Alternatives to Antigen-Antibody Reactions, Immunoelectron Microscopy. **16 hrs**

UNIT II

Organization and Expression of Immunoglobulin Genes - Genetic Model Compatible with Ig Structure, Multigene Organization of Ig Genes, Variable-Region Gene Rearrangements, Mechanism of Variable-Region DNA Rearrangements, Generation of Antibody Diversity, Class Switching among Constant-Region Genes, Expression of Ig Genes, Synthesis, Assembly, and Secretion of Immunoglobulins, Regulation of Ig-Gene Transcription, Antibody Genes and Antibody Engineering.
Major Histocompatibility Complex - General Organization and Inheritance of the MHC, MHC Molecules and Genes, Cellular Distribution of MHC Molecules, Regulation of MHC Expression, MHC and Immune Responsiveness, MHC and Disease Susceptibility.
Antigen Processing and Presentation - Self-MHC Restriction of T Cells, Role of Antigen-Presenting Cells, Evidence for Two Processing and Presentation Pathways, Endogenous Antigens: The Cytosolic Pathway, Exogenous Antigens: The Endocytic Pathway, Presentation of Nonpeptide Antigens.

T-Cell Receptor & T-Cell Maturation, Activation, and Differentiation - Early Studies of the T-Cell Receptor, αβ and γδ T-Cell Receptors: Structure and Roles, Organization and Rearrangement of TCR Genes, T-Cell Receptor Complex: TCR-CD3, T-Cell Accessory Membrane Molecules. T-Cell Maturation and the Thymus, Thymic Selection of the T-Cell Repertoire, T_H-Cell Activation, T-Cell Differentiation, Cell Death and T-Cell Populations, T_H Peripheral γδ T-Cells.

Cell-Mediated Effector Responses - Effector Responses, General Properties of Effector T Cells, Cytotoxic T Cells, Natural Killer Cells, Antibody-Dependent Cell-Mediated Cytotoxicity, Experimental Assessment of Cell-Mediated Cytotoxicity **.**

B-Cell Generation, Activation, and Differentiation - B-Cell Maturation, B-Cell Activation and Proliferation, The Humoral Response, In Vivo Sites for Induction of Humoral Responses, Germinal Centers and Antigen-Induced B Cell Differentiation, Regulation of B-Cell Development, Regulation of the Immune Effector Response **16 hrs**

UNIT III

Cytokines - Properties of Cytokines, Cytokine Receptors, Cytokine Antagonists, Cytokine Secretion by TH1 and TH2 Subsets, Cytokine-Related Diseases, Therapeutic Uses of Cytokines and Their Receptors, Cytokines in Hematopoiesis

The Complement System - The Functions of Complement, the Complement Components, Complement Activation, Regulation of the Complement System, Biological Consequences of Complement Activation, Complement Deficiencies.

Hypersensitive Reactions - Gell and Coombs Classification, IgE-Mediated (Type I) Hypersensitivity, Antibody-Mediated Cytotoxic (Type II) Hypersensitivity, Immune Complex–Mediated (Type III) Hypersensitivity, Type IV or Delayed-Type Hypersensitivity (DTH).

Autoimmunity - Organ-Specific Autoimmune Diseases, Systemic Autoimmune Diseases, Animal Models for Autoimmune Diseases, Evidence Implicating the CD4+ T Cell, MHC and TCR in Autoimmunity, Proposed Mechanisms for Induction of Autoimmunity, Treatment of Autoimmune Diseases. **16 hrs**

UNIT IV

Transplantation Immunology - Immunologic Basis of Graft Rejection, Clinical Manifestations of Graft Rejection, General Immunosuppressive Therapy, Specific Immunosuppressive Therapy, Immune Tolerance to Allografts, Clinical Transplantation.

Immune Response to Infectious Diseases - Viral Infections, Bacterial Infections, Protozoan Diseases, Diseases Caused by Parasitic Worms (Helminths), Emerging Infectious Diseases. **AIDS and other Immunodeficiencies -** Primary Immunodeficiencies, AIDS and Other Acquired or Secondary Immunodeficiencies

Vaccines - Active and Passive Immunization, Designing Vaccines for Active Immunization, Whole-Organism Vaccines, Purified Macromolecules as Vaccines, Recombinant-Vector Vaccines, DNA Vaccines, Multivalent Subunit Vaccines.

Cancer and the Immune System - Cancer: Origin and Terminology, Malignant Transformation of Cells, Oncogenes and Cancer Induction, Tumors of the Immune System, Tumor Antigens, Immune Response to Tumors, Tumor Evasion of the Immune System, Cancer Immunotherapy. **16 hrs**

UNIT V

CLINICAL BIOCHEMISTRY (16 hrs)

Introduction - Good clinical laboratory practices, Quality control-internal and external quality control. Types of laboratory tests, Collection of blood, Collection of urine and their composition in health and diseases

Cerebrospinal fluid (CSF) - Collection of CSF, function and their composition in health and diseases.

Blood and Human hereditary disease of blood coagulation - Introduction, plasma proteins and their variation in diseases. Hemoglobinopathies-Sickle cell anemia, hemoglobin C, D, E diseases. Thalassemias- molecular basis of thalassemias, alpha , beta thalassemias. Porphyrias-accute intermittent porphyria, congenital erythropoietin porphyria, porphyria cutaneatarda, hereditary coproporphyria, variegate porphyria, proto porphyria and acquired toxic porphyria

Clinical Enzymology - Enzymes in diagnosis of various disorders in Liver: Alkaline phosphatase (ALP), SGOT, SGPT, γ Glutamyltransferase, 5'Nucleotidase. In Myocordial infraction: CK, LDH

Hormonal aspects of endocrine diseases - Thyroid function tests, measurement of TSH, T_3 and T_4, Thyrotropin releasing hormone test, Abs to thyroid peroxidase, thyroglobulin and TSH, Corticotropin releasing hormone test, water deprivation test.

Liver - Functions, Liver function tests and significance, disorders of liver-jaundice

Kidney - Kidney function tests, abnormal constituents of urine and its clinical significance. Compensatory mechanisms

Gastrointestinal tract (GIT) - Diagnosis of helicobacter *pylori* infection, gastric acid secretion, disorders associated with gastrin, ghrelin and intrinsic factors. Pancreatric enzymes and their assays, duodenal contents. Malabsorption syndrome-steatorrhea laboratory test

Biochemical aspects of mental and neurological diseases - Wernicke-korsakoff syndrome, Dystonia, Down's syndrome, Fragile X syndrome. **16 hrs**

References:

1. Immunology- Kuby
2. Essential Immunology- Eds. Irvfin M Roitt. ELBS/ Blackwel Scientific Pub.
3. Cellular and Molecular Immunology- Abbas and Others
4. Atlas of Immunology- Julius M Cruse, Robert E Lewis, 3rd edition; CRC press
5. Clinical aspects of Immunology- Peter,Keith and Mark 5th edition; Black well scientific publication
6. Immunobiology- Kennel, Paul travers, 7th, edition Mark walport;Garland science publication.
7. Immunology- K R Joshi,Osama, 5th edition;Agrobios
8. An Introdution to Immunology- C V Rao 3rd edition; Nasaro publishing house
9. Immunology- Dr Bharath Singh; Pointer Publishers
10. Immunobiology M S Aslam; Campus books
11. Clinical biochemistry metabolic and clinical aspects- William J. Marshall and Stephen K. bangest, II edition, Churchill Livingstone Elsevier Publishers
12. Textbook of Biochemistry with Clinical correlations, Thomas M. Devlin, VI edition, Willey- LissPublishers
13. Text book of Medical Biochemistry, Chatterjea. M. N, RanashindeVI edition, JaypeePublishers, New Delhi
14. Biochemistry U. Satyanarayana and U ChakrapaniIII edition,
15. Biochemistry, III edition, Donald Voet and Judith G Voet, John Willey and Son, Inc.,
16. Biochemistry- Lubert Stryer; W H Freeman and Company
17. Biochemistry, Vasudevan Shree Kumari
18. Clinical Biochemistry Kaplon

Paper - X **80 hrs**

BC 3.2: BIOCHEMICAL GENETICS AND MOLECULAR BIOLOGY (Hard core)

BIOCHEMICAL GENETICS (28 hrs)

UNIT I: Mendelian Genetics - Principle of segregation, monohybrid crosses, dominance, recessiveness, codominance; Principle of independent assortment dihybrid ratios, gene interaction, epistasis, genetic versus environmental effects. Multiple Alleles - ABO Blood type alleles in humans, Rh factor alleles in humans.

Sex-Determination and Sex linkage - Mechanism of sex determination, Identification of sex chromosomes, xx-xy mechanism of sex-determination, the Y-chromosome the Y-chromosome and sex determination in mammals, the balance concept of sex determination in drosophila, environmental factors and sex determination, dosage compensation.

Sex-Linked Inheritance - Morgan's discovery of sex linked inheritance, pattern of inheritance of sex-linked genes, X-linked- traits in humans, deleterious recessive sex-linked genes in humans. Sex-influenced dominance, sex-linked gene expression. Pedigree analysis - family tree, Symbols, identification of disorders using pedigree.

Organization of Eukaryotic Chromosome - Histones and non-histones, nucleosomes and higher order of organization, chromosomal banding, Gene Structure in eukaryotes, pseudogenes, gene clusters, spacers, single copy genes, repetitive sequences, tandem gene clusters, RNA genes, histone genes. **16 hrs**

UNIT II

Recombination in Bacteria - Transformation, conjugation, F x F crosses, Hfr strains, transduction – generalized, abortive, and specialized transduction, recombination and crossing over, site-specific recombination, holiday model.

Elements of gene mapping - Chromosome and gene linkage, mapping by recombination analysis, mapping by conjugation, mapping by transformation and transduction, tetrad analysis, somatic cell genetics, transposable elements, chromosomal abnormalities**.**

Mutation - Nature of mutation and mutagens, different kinds of mutation, detection and isolation of mutants, temperature sensitive mutants, mechanism of mutation, utility of mutants, benzer's fine structure of II locus. **16 hrs**

MOLECULAR BIOLOGY (48 hrs)

UNIT III

DNA Replication - The basic rule (s) for replication of all nucleic acids, semi conservative replication. The geometry and topological constraints of DNA replication, DNA super coiling, linking number, role of DNA topoisomerases, events on replication fork. Enzymology of DNA replication. Okazaki experiments; Messelson and Stahl experiment. Fidelity of DNA replication & nearest-neighbour-base frequency analysis. Types of replication initiation. Inhibitors of E.coli DNA replication. Replication of eukaryotic chromosomal DNA, Telomerase and telomeric sequences

16 hrs

UNIT IV

Transcription - DNA-protein interactions, protein-protein interactions, the organization of transcriptional units-structural genes and regulatory sequences, basic features of RNA, polynucleotide phosophorylase.

Prokaryotic Transcription - RNA polymerase, Transcription and transcription factors. Regulation of transcription and inhibitors. Deferent modes of transcription termination. Post- transcriptional modifications, Processing and generation of r RNAs and tRNA.

Eukaryotic Transcription - Eukaryotic RNA polymerases, regulatory sequences, exons and introns. Transcription and transcription factors, Regulation of transcription and inhibitors. Post-transcriptional modification, Mechanism of splicing. **16 hrs**

UNIT V

Translation - Outlines of translation, Genetic code, Properties of genetic code, deciphering the genetic code, Nirenberg and Khorana's work. The genetic code of mitochondrian and exceptions to the universal code. t- RNA structure, Prokaryotic and Eukaryotic Translation factors, Codon-anti codon interaction, Wobble hypothesis, amino acyl t-RNA synthetase, suppressor mutations. Ribosomes chemical composition, Regulatory sequences of Prokaryotes and Eukaryotes, Regulation of translation and inhibitors.

Post-translational Modifications: An overview protein sorting and targeting. Cell organelles and proteins in protein docking. Protein turnover and role of ubiquitin system.

Regulation of gene expression - General aspects of regulation of gene expression. Regulation of gene expression in prokaryotes, The operon concept, the fine structure of 'lac' operon and its regulation. The dual promoter -'gal' operon model. Dual functions of the repressor- 'Ara' operon. Transcriptional control by attenuation and mechanism of attenuation - 'Trp' (Biosynthesis) operon. Regulation of gene expression in eukaryotes. A brief account on DNA methylation and heterochromation. **16 hrs**

References:

01. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
02. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
03. Genetics, Strick Berger, M.W. (1990) 3 rdedn. McMillan.
04. Human Molecular Genetics; Peter Sudbery , (2002) Printice Hall.
05. Introduction to Modern Virology, Primrose and Dimmock (1988), Blackwell Sc.
06. Molecular Biology of the Cell, Alberts et al., (1989) 2nd Edn.Garland Publications
07. Molecular Biology; Current Innovations and Future Trends; Griffin and Griffin, (1995), Horizon Scientific Press.
08. Molecular Biotechnology; Glick and Pasternak, (1998), ASM Press.
09. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
10. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley- Liss.
11. The Science of Genetics, George W. Burns and Paul J. Bottino (1989), Maxwell-McMillan.
12. Molecular Biology - David Freifelder
13. Essential of Molecular Biology-David Freifelder
14. Microbial Genetics-David Freifelder
15. Genes - Benjamin & Lewin
16. Molecular Biology of the Gene-Watson et al
17. Lehninger's Principles of Biochemistry-Nelson & Cox
18. Principles of Biochemistry- Geoffrey Zubay
19. Molecular Biology of the Cell-Davidson, Lodish, Darnell and Baltimore
20. Genetics-Goodenougy

Paper - XI **64 hrs**

BC 3.3: METABOLISM OF NITROGENOUS COMPOUNDS WITH CLINICAL CORRELATIONS (Soft Core)

UINIT I

Nitrogen Metabolism

Proteins - General mechanisms of degradation in cells (Ubiquitin-proteosome pathway, lysosomal pathway), Degradation and biosynthesis of glycoproteins, proteoglycans.

Amino acids - General metabolic reactions of amino acids; oxidative deamination, transamination, decarboxylation racemisation reactions and their mechanism, role of PLP, degradation of individual amino acids. Biosynthesis of individual amino acids. Regulation of amino acid metabolism – Try, aromatic amino acids family, ASP family metabolism, Urea cycle, and its regulation. In born errors of amino acid degradation - Phenyl Ketonuria, alkaptonuria, maple syrup urine. Nitrogen cycle.

16 hrs

UNIT II

Heme Metabolism - Biosynthesis and degradation of porphyrin, porphyrias, jaundice and Hemoglobinopathies.

Disorders associated with nitrogen metabolism: Inborn errors of amino acid metabolism: Phenyl ketone urea, Maple syrup urine, Albinism, Histidnaemia, homocysteinuria, Alkaptanuria, Gout and Lesch-Nyhan syndrome **16 hrs**

UNIT III: Nucleotide Metabolism - Biosynthesis of purine and pyrimidine nucleotides and their inter conversion, regulation of biosynthesis. Other pathways of purine nucleotide formation (salvage pathway). Biosynthesis of deoxyribonucleotides and coenzymes nucleotides. Chemical inhibition of the biosynthesis of nucleic acid precursors. **16 hrs**

UNIT IV: Disorders associated with nucleotide metabolism: Degradation of purine and pyrimidines, and disorders associated with their metabolism, gout, Lesch-Nyhan syndrome, oroticaciduria, and xanthinuria. Non-ribosomal peptide synthesis: Glutathione and cyclic antibiotics. **16 hrs**

References:

11. Biochemistry: Voet, D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
12. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
13. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley -Liss.
14. Principles of Biochemistry; Lehninger et al., [Eds.] (1997) 2nd Edn. Worth Publishers.
15. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.
16. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.
17. Photosynthesis, D.O. Hall and K.K. Rao, (1999), 6 th Edn. Cambridge University Press.
18. Hawk's Physiological Chemistry, Oser (1976) 14 th Edn Tata-McGraHill.
19. Photosynthesis. Ed. A.S. Raghavendra, (2000), Cambridge University Press.
20. Recent Advances in Plant Biochemistry; S.L. Mehta, M.L. Lodha, and P.V. Sane, (1992) ICAR, New Delhi.

Paper - XII **32 hrs**

BC 3.4: CLINICAL BIOCHEMISTRY (Elective)

UNIT I

Introduction - Good clinical laboratory practices, Quality control-internal and external quality control. Types of laboratory tests, Collection of blood, Collection of urine and their composition in health and diseases.

Cerebrospinal fluid (CSF) - Collection of CSF, function and their composition in health and diseases.

Blood and Human hereditary disease of blood coagulation - Introduction, plasma proteins and their variation in diseases. Hemoglobinopathies-Sickle cell anemia, hemoglobin C, D, E diseases. Porphyrias-accute intermittent porphyria, congenital erythropoietin porphyria, porphyria cutaneatarda, hereditary coproporphyria, variegate porphyria, proto porphyria and acquired toxic porphyria

Clinical Enzymology - Enzymes in diagnosis of various disorders in Liver: Alkaline phosphatase (ALP), SGOT, SGPT, γ Glutamyltransferase, 5'Nucleotidase. In Myocordial infraction: CK, LDH **16 hrs**

UNIT II

Liver - Functions, Liver function tests and significance, disorders of liver-jaundice
Kidney - Kidney function tests, abnormal constituents of urine and its clinical significance.
Pancreatic enzymes - Pancreatic enzymes and their assays, duodenal contents. Malabsorption syndrome-steatorrhea laboratory test

Unit III

Disorders of carbohydrate metabolism - Glycogen storage diseases, lactose intolerance, hyperglycemia and hypoglycemia, diabetes mellitus

Abnormalities of lipid metabolism - Ketosis and their clinical significance, hyper cholesterolemia, Atherosclerosis, Niemann pick's disease, Taysacch's disease, Gaucher's disease
Abnormalities of Nitrogen metabolism - Inborn errors of amino acid metabolism: Phenyl ketone urea, Maple syrup urine, Albinism, Histidnaemia, homocysteinuria, Alkaptanuria, Gout and Lesch-Nyhan syndrome **16 hrs**

References:

1. Clinical biochemistry metabolic and clinical aspects- William J. Marshall and Stephen K. bangest, II edition, Churchill Livingstone Elsevier Publishers
2. Textbook of Biochemistry with Clinical correlations, Thomas M. Devlin, VI edition, Willey- Liss Publishers
3. Text book of Medical Biochemistry, Chatterjea. M. N, RanashindeVI edition, JaypeePublishers, New Delhi
4. Biochemistry U. Satyanarayana and U Chakrapani III edition,
5. Biochemistry, III edition, Donald Voet and Judith G Voet, John Willey and Son, Inc.,
6. Biochemistry- Lubert Stryer; W H Freeman and Company
7. Biochemistry, Vasudevan Shree Kumari
8. Clinical Biochemistry Kaplon

SYLLABUS FOR M.Sc. BIOCHEMISTRY

SEMESTER: IV

Paper XIII **80 hrs**

B.C-4.1: CELL SIGNALLING (Hard core)

UNIT I

Introduction and components of biosignaling: Definition of Cell Signaling, general principles of cell signaling and communication; various forms of communication between cells; signaling process and its stages – Signal recognition, transduction and cellular effect; Types of cell signaling – Autocrine signaling, Direct contact signaling, Paracrine signaling, Synaptic signaling, Endocrine (Distance) signaling. First messengers, glands and types of secretions, Ligands, Agonists, Antagonists, Receptors for first messengers, Second messengers, soluble second messengers, Membrane bound second messengers. Receptor down regulation, Receptor up regulation.

Modules and motifs in transduction: Src homology domains, Src homology-1 (SH1)- tyrosine kinase domain, Src-homelogy-2 (SH2)-phosphotyrosine binding domains, Src- homelogy-3 (SH3) phosphotyrosine binding domains, Src- homelogy-4 (SH4) motif and Src' 'unique domain', The C-terminal Src Regulatory motif and Src family auto inhibition. PH Super fold modules: PH domains-Phosphoinositide lipid-binding modules, PTB domains-Phosphotyrosine binding modules, PTZ domains - C terminal and C terminal -like peptide binding modules, Bcr-homology (BcrH) Domains, Dbl homology (DH) domains- partners of PH domains, Bcl-2 homology (BH) domains, Ras binding domains, Phosphoserine /phosphothreonine - binding domains, Forkhead-associated domains, EF-hands- Calcium sensing modules, C1 and C2 domain - a $Ca2^{+}$- activated, lipid -binding, module.

16 Hrs

UNIT II

Protein kinase enzymes - activation and auto – inhibition, The Protein Kinase fold, Invariant residues, The Phosphate- binding loop or 'p-loop', Critical differences between Serine/threonine kinases and tyrosine kinases, Closed and open conformations, The catalytic loop or 'C-loop', The activation segment / loop or Á-loop, auto inhibition. The insulin receptor kinase (IRK), Cyclin dependent kinases, Monomeric Cdk2 Structures, Cyclin - bound unphosphorylated Cdk, Cyclin - bound Phosphorylated Cdk.

7-pass receptors and the catabolic response: 7-pass receptor phylogeny, Functional mechanisms of 7-pass receptors, Gαs-coupling receptors- glucagon- and β-adrenergic receptors - Stimulation of cAMP Production. Gαq- coupling receptors-bombesin and α1- adrenergic receptors - stimulation of calcium release from the endoplasmic reticulum. Gαi-coupling receptors - somatosatin and α2-adrenergic receptors - inhibition of adenylyl cyclase, activation of K^{+} ion channels, inhibition of Ca^{2+} Channels, and activation of phospholipase Cβ2. Glucagon and β - adrenergic - receptors - the catabolic cAMP- dependent protein kinase (PKA) pathway leading to glycogenolysis.

16 Hrs

UNIT III

Adenylyl cyclase - PDE isoforrms, Transmembrane isoforms, Signal termination, crosstalk and negative feedback. G proteins and the adenylyl cyclase effector isoforms. Gs-coupling catabolic receptors.B-Adrenergic/glucagon- receptor stimulation of glycogenolysis. B- Adrenergic/ glucagon-receptor inhibition of glycogen synthesis. α1-adrenergic receptor stimulation of glycogenolysis. Diffusible cascade or scaffolded pathway. Regulatory subunits of PKA and A-Kinase Anchoring Proteins, PKA and its inhibitors.

Phospharylase kinase, Glycogen phosphorylase, Protein kinase C and Glycogen synthase: Phospharylase kinase- the catalytic γ-subunit, Regulatory subunits, substrates and autophosphorylation. Glycogen phosphorylase- isoforms, allosteris Sites, hormonal and metabolic control, functional differences between muscle and liver isoforms. Glycogen synthase GSK-3-a multi-tasking enzyme, hormonal control. Protein kinase C, Lipid activation of PKC-DAG-binding isoforms and their activation by phorbol esters, Alternative DAG/phorbol ester receptors, PKC scaffolds.

Single pass growth factor receptors: Receptors tyrosine kinases-ligands and signal transduction, RTK ligands and receptors. The PGDFR family -signal transduction, MAP kinases and MAPK kinases. PDGFR kinases insert tyrosines-PI-3- kinase, and Ras *versus* Rac, PDGFR, PI-3Kinase-Ras and mitosis. PDGFR, PI-3 Kinase, Rac and motility. PDGFR insert phospotyrosines and Ras regulators. Sos-1-a bi-functional guanine nucleotide exchange factor (GEF), Sos-the switch from RasGEF to RacGEF. PDGFR C-terminal tail tyrosine. Alternative Grb-2 docking sites: SHP-2 and Shc. Shc-PTB-SH2 domain adoptor. PLC γ. PDGFR Juxtamembrane tyrosines, PDGFR family autoinhibition. The ErbB family, EGFR family members and ligands, EGbB-Type receptor signal transducton particles. The epidermal growth factor receptor kinase- a pre- assembled active site. Autoinbibition of EGFR and activation. **16 Hrs**

UNIT IV

G Proteins (I) - monomeric G proteins, Classification, On and OFF stated of Ras-like proteins, Raf-f multi-domain serine/threonine kinase family of Ras effectors, Raf-Ras binding- translocaion of Raf from cytosol to membrane, cAMP inhibition of cell division via sequestration of Raf, Raf activation by translocation, Homologous or heterologous trans autophorylation, Eak-1/2-type MAPK pathway activation , MAPK scaffolds, Signal scaffolds. Ras protein structure and function, The GTPase site of Ras: G-boxes and switch regions, The P-loop (G-1), Switch I (G-2), Switch II (G-3), The switch mechanism :hydrolysis-driven conformational change in Ras, GTP hydrolysis, Structual effects of loss of γ -phosphate, Effector and regulator binding surfaces of Ras, Ras GAP, Ras GEFs, The Ras effect region and Ras binding, Rap1 and cAMP effects.

G Proteins (II) - heterotrimeric G protein-Classification and structural relationship with Ras. Gα-subunit: the Ras-like core, G-boxes and switch regions. GTP exchange, hydrolysis and switch movements. β/γ- and receptor binding surface of α-subunits. Modulator of G protein activity-the 'RGS' protein family, RGS proteins and GTPase activation, RGS proteins: inhibition of nucleotide exchange; crosstalk with other pathways. Gαi/o/q GEP proteins-unrelated to RGS. GRKs-RGS domain-containing S/T-kinases. Signal transduction by β/γ subunits. **16 Hrs**

UNIT V

The insulin receptor and the anabolic response The insulin receptor- a pre-dimerised RTK with a unique substrate, Cluster of autophosphorylated tyrosine in the InsR intracellular region. InsR an IGF-IR: differentiation leads differential tissue effects. Features of metabolic control in key tissues. InsR downstream signalling pathways. MAPK/p90Rsk pathway mediated growth effects, PI-3-kinase -prime anabolic effector. IRS protein targeting, IRS-interacting proteins- Class 1A PI-3-kinases, IRS-1/2 phosphorylation and PI-3-kinase activation. Protein phosphatise-1 (PP-1), Glycogen granule targeting of PP-1, P70Rsk-inducer of GS dephorylation. Insulin reverses effects of adrenaline and/ or glucagon, Insulin's reversal of adrenaline-induced glycogenolysis in muscle, Insulin's reversal of adrenaline- and glucagon-induced glycogenolysis in liver, Insulin's reversal of adrenaline/glucagon- induced lipolysis in adipose tissue, PIP3 downstream effects- glycogen synthesis, PKB and GSK-3 inactivation, PKC-C- negative feedback control, PIP3 downstream effects- GLUT4 mobilization**.** **16 Hrs**

References:

1. Text Book of Biochemistry with Clinical Correlations – Thomas H. Devlin
2. Clinical Biochemistry-Controw and Trumper, W.B. Saunders Pub.
3. Harper's Review of Biochemistry with Clinical Correlations Ed. Martin et al, 25nd edn.,
4. Outlines of Biochemistry – White, Handler and Smith
5. Lehninger Principles of Biochemistry – 5thEdition. David L. Nelson and Michael M. Cox
6. Molecular Cell Biology – Eds. – Darnell, Lodish and BaltimoreW.H. Freeman & Co..
7. Molecular Biology of the Cell – Bruce Albertset al., Garland Science.
8. Aggarwal, B.. Human Cytokines. Blackwell Scientific, Oxford.
9. Estrov, Z.. Interferons, Basic Principles and Clinical Applications. R. G. Landes, Florence, KY.
10. Fitzgerald, K.). The Cytokine Facts Book. Academic Press, London.
11. Mantovani, A. Pharmacology of Cytokines. Oxford University Press, Oxford.
12. Mire-Sluis, A.. Cytokines. Academic Press, London.
13. Abbas, A.. Cellular and Molecular Immunology. W. B. Saunders, London.
14. Gary Walsh. Biopharmaceuticals Biochemistry and Biotechnology.2nd Edition. John Wiley & Sons, Ltd, England
15. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3 Ed. Jhon Wiley and sons.
16. Fundamentals of Biochemistry; Voet , Voet,and Pratt. [Eds.], Jhon Wiley and sons.
17. Biochemistry; David Rawn, J. Neil Patterson Publishers.
18. Principles of Biochemistry; Smith et al., [Ed.], McGarw Hill.
19. The Biochemistry of Cell Signalling; Ernst Helmreich, OUP.
20. Basic Neurochemistry; George Siegel et al., Wippincott, Williams and Wilkins.
21. Cell biology; David E. Sadava; Jones and Bartlett Publishers
22. Biochemistry of Signal Transduction and Regulation; 3rd Edn. Gerhard Krauss, Wiley-VCH.
23. Introduction to Ecological Biochemistry, J. Harborne, Gulf Professional Publishing.

Paper - XIV **80 hrs**

BC 4.2: GENETIC ENGINEERING AND INDUSTRIAL BIOTECHNOLOGY (Hard core)
GENETIC ENGINEERING (52 hrs)

UNIT I

Introduction - Introduction to genetic engineering. Isolation, separation and purification of nucleic acids. Determination of fragment size, detection of radioactive nucleic acids, Elution/Recovery of Nucleic acids from the gels. Enzymes used in Genetic Engineering: Restriction endonuleases. Nucleases, Exonuclease, DNA polymerases, Reverse transcriptase, Terminal transferases. **Vectors -** Vectors used in molecular cloning – plasmids, phages as vectors, lambda phage as vectors, cosmids, and M13 vectors. Construction of recombinant vectors, Gene transfer methods for bacteria, plants and animals. Detection of transformants. Vectors for cloning in plant cells: Agro bacterium mediated, co- integrated vectors, binary vectors. Yeast artificial chromosome based vectors (YAC vectors). Vector system for expression of lac Z fusion genes. **16 hrs**

UNIT II

Selection markers - Histochemical selection, genetic selection. Selection of positive transfectants, Thymidine kinase gene, Dihydrofolate reductase, Aminoglycoside phosphotransferase, Xanthine-guanine phosphoribosyl transferase, CAD, Adenosine deaminase Asparagine synthetase. **Detection and analysis -** Analysis of proteins expressed from cloned genes. cDNA synthesis, construction of cDNA and genomic library. Polymerase chain reaction, Inverse PCR, RT PCR, Antisense RNA technology, RAPD, RFLP, Gene therapy. Analysis of DNA/RNA: Southern, Northern, *in situ* hybridizations, chromosome walking. **16 hrs**

UNIT III

Nucleic acid labeling techniques: Radioactive probes, DNA probes, RNA probes, end labeling, internal labeling, Random priming labeling (DNA probes), syntheses of cDNA probes, Non-radioactive labeling.

Techniques to study DNA-Protein interactions: Electrophoretic mobility shift assay, alkylation interference assay, hydroxyl radical foot printing, DNse I foot printing.
Mutagenesis: Site directed mutagenesis, oligonucleotide–directed mutagenesis, mutagenesis through misincorporation of nucleotides.

RNA silencing: siRNA and anti sense RNA their design and applications, Applications of genetic engineering in medicine, agriculture, limitation and negative aspects of genetic engineering. **16 hrs**

INDUSTRIAL BIOTECHNOLOGY (32 Hrs)

UNIT IV: Large scale cultivation of microbes – fermentation as a unit process, aqueous and solid state fermentations. Design and operation of fermenters, surface, submerged and continuous culture methods. Conditions of fermentation. Downstream process, selection of organisms, choice of raw materials, and fermentation media, foam control, origin of industrial strain, growth and product formation in industrial process. Recovery of products, methods of fermentation – primary and secondary metabolism. **16 hrs**

UNIT V

Microbial productions of:

Acids – Acetic acid, lactic acid and citric acid
Antibiotics – Penicillin, streptomycin, tetracycline, and chloroamphenicol
Alcohol and alcoholic beverages – production of ethanol from molasses and starch
Vitamins and Cheese – Vit B12, Riboflavin and Vit A, cheese
Biomass - microbial insecticides, biofertilizer, and single cell proteins
Water and Sewage microbiology: Pollution of water by microorganisms, bacteriological analysis of water, BOD, effluent treatment (activated sludge, trickling filters, and oxidation ponds), Production of Biogas. **16 hrs**

References

1. Molecular Cloning; A Laboratory Manual; Sambrook and Russel [Eds.] (2001) 3rd Ed. Cold spring Harbor
2. Virology; Heinz Fraenkel-Conrat et al., [Ed.] (1988) Prentice Hall
3. Molecular Biology - David Freifelder
4. Essential of Molecular Biology-David Freifelder
5. Molecular Biology of the Gene-Watson et al
6. Recombinant DNA-Watson et al.
7. Lehninger's Principles of Biochemistry-Nelson & Cox
8. Molecular Biology of the Cell-Davidson, Lodish, Darnell and Baltimore
9. Principles of gene Manipulation-Old & Primerose
10. Biotechnology; Principles and Application I.J. Higgins et al., [eds.] (1985) Blackwell Scientific Publications.
11. Molecular Biology; Current Innovations and Future Trends; Griffin and Griffin, (1995), Horizon Scientific Press.
12. Immobilized Enzymes; Treven M.D. [Ed.] (1980) Jhon Wiley.
13. Industrial Microbiology; Casida, L. [Ed.] (1989) Wiley Eastern.
14. Industrial Microbiology; Miller and Litsky [Eds.] (1976) McGraw Hill Publishers.
15. Industrial Microbiology; Presscott and Dunn [Eds.] (1989) 4th Ed. CBS Publishers.
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19. Plant Protoplast and Genetic Engineering; Y.P.S. Bajaj [Ed.] Vol. 1 and 2 (1989) Springer Verlag.
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21. Recombinant DNA; Watson J D et al., Second edition, Scientific American Books (1992) W H freeman and Company.
22. Biopharmaceuticals – biochemistry and biotechnology, Gary Walsh, 2nd edn. John Wiley publications.
23. Proteins-biochemistry and biotechnology, Gary Walsh, Wiley intersicence.
24. Fermentation technology, H. A. Modi, Vol-1, Pointer Publishers.
25. Text Book of biotechnology, C. R. Chatwal, Anmol Publications.

Paper - XV **64 Hrs**

BC 4.3: BIOSTATISTICS, BIOINFORMATICS AND NANOBIOTECHNOLOGY (Soft core)

Biostatistics (16 hrs)

UNIT I

Introduction to Biostatistics - Population, sample, sampling techniques and errors, Mean, median, mode, range, variance, coefficient of variation, frequency, standard deviation, standard error. Representation of statistical data line graph, histogram, bar diagram, pie chart, scatter diagram. Probability- rules of probability, binomial distribution, Normal distribution, area under the curve, Z value, choosing sample size, hypothesis testing, Student's t test. One way and two way ANOVA, correlation and regression. Chi-square test, goodness of fit, test of independence. **16 hrs**

Bioinformatics (16 hrs)

UNIT II

Biological databases, Sequence Comparison and Database Search - Introduction, Classification of Biological databases, Biological database Retrieval systems. Molecular Modeling Database at NCBI, Molecular visualization software (RASMOL) Phylogenetics- Clustal. Prediction of genes (Gene finder, ORF finder). Pair wise alignment, global alignment, local alignment, multiple sequence alignment, scoring a multiple alignment, multiple sequence alignment methods-Dynamic programming approach, Progressive alignment, iterative refinement methods, pattern matching in DNA and protein sequences, PAM matrices, BLAST, and FASTA.

Protein - structure prediction and modeling - Introduction, secondary structure prediction methods, softwares for secondary structure prediction, Protein families and classification, prediction of transmembrane regions. CATH and SCOP. Methods of protein modeling, homology or comparative modeling model refinement, Evaluation of the model.

Nucleotide sequence analysis and Molecular phylogenetics - Introduction, tools and methods single nucleotide polymorphism. Application of phylogenetic trees, basic terminology- taxa, taxanomy, root, leaf, node, tree, branch, clade, dendogram, cladogram, rooted tree, unrooted tree, scaled tree. Phylip, Clustal. **16 hrs**

Nano Biotechnology (32hrs)

Unit III

Nanobiotechnology and drug delivery– History, definition and scope, unique properties and applications of nanoparticles, nanobiotechnology to Nanomedicine, various types of nanoparticles in biology. Principles of drug delivery, targeted, non-targeted delivery; controlled drug release; exploiting novel delivery routes using nanoparticles.

Synthesis and properties of nanomaterials: Brief introduction to synthesis of nanoparticles - physical, chemical and biological methods. Synthesis and applications of gold and silver nanoparticles, micelles, quantum dots, liposomes, niosomes, dendrimers, nanopores, carbon nanotubes and other polymeric nanoparticles. Biological synthesis of nanoparticles **-** natural and artificial synthesis of nanoparticles by microorganisms and plants, magnetic nanoparticles. **16 hrs**

UNIT IV

Biomedical applications of nanoparticles and nanodevices – Gene therapy using nanoparticles; nanoparticles in cancer diagnosis, imaging, passive and active targeting strategies for cancer treatment. Tissue engineering and applications of nanotechnology in biology.

Biosensors – Introduction to biochips and biosensors, immobilization, characteristics, applications, conducting Polymer based sensors, Principles of microarray technology (DNA, protein, antibody and cytokines) and clinical applications, DNA microarray in detail. **16 hrs**

References

1. Reaction Mechanisms at a glance, ed. M. Moloney, Blackwell Science (2000).
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3. VII Ed., (1999), Karen C. Timberlake, Benjamin/Cummings
4. Physical Chemistry of Macromolecules, C. Tanford
5. Stereochemistry of Carbon Compounds, Eliel (1977) Tata-McGrawHill.
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7. Inorganic Biochemistry, G.L. Eichhorn (1973) Elsevier.
8. Guide Book to Mechanisms in Organic Chemistry, Peter Sykes, 6th Ed., (1986), Longman
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11. Organic chemistry of Natural products, Gurudeep Chatwal, Vol-1 and V0l-2, Himalya publishers,
12. Text book of organic chemistry, Bhal and Arun Bhal, Chand publishers.
13. Bioinorganic chemistry, Rosette M. Roatmalone, 2nd edition, Wiley Interscience.
14. Enclyopedia of biological Chemistry, William J. Lennarz and Daniel Lane, A-D, Volume 1, Elsevier Academic press.
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25. Principles of Protein Structure, Function, & evolution, Dickerson & Geis (1983) 2nd Ed., Benjamin-Cummings.
26. Bioinorganic chemistry, Ayodhya singh and Sanjay Kumar sing, Campus publications.
27. Principles of bioinorganic chemistry, Stephen J. Lippard and Jeremymberg, University Science books
28. Biophysical chemistry part-2, Cantor and Schmmel, Freeman publications.
29. Topics in bioelectrical chemistry and Bioenergetics, G. Millazo, Vol-5, Wiley publishers
30. Biostatistics, P. Ramakrishanan, Saras publications, Kanyakumari.
31. Fundamentals of biostatistics, Khan and Khanum.
32. Basic biostatistics-Suresh Kumar and Satyaveri, Campus books
33. Bioinformatics – sequence and genome analysis; David W. Mount, Cold spring Harber laboratory.
34. Structural bioinformatics-Philip E. Bourne and Helgeweissing, John Wiley and Sons.
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36. Basic Mathematics for Biochemists; Cornish Bowden, (1998), Oxford University Press.
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39. Data analysis for Bimolecular Science, Jhon Maber, (1999), Longman.
40. Developing Bioinformatics Computer Skills; Cynthia Gibas et al., (2001) Shroff Publishers.
41. Introduction to Bioinformatics; Lesk, A.M. (2002)
42. Introduction to Computational Biology, Michael S. Waterman (1995) Champman -Hall.
43. Introduction to Proteomics; Daniel C. Liebler, (2002), Humana Press.
44. Introduction to Bioinformatics; T K Attwood & D J Parry-Smith, (2002), Pearson Education.
45. Bionanotechnology: Lessons from Nature by David S. Goodsell
46. Nanomedicine, Vol. IIA: Biocompatibility by Robert A. Freitas
47. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology - Hari Singh Nalwa
48. Nanobiotechnology; ed. C.M.Niemeyer, C.A. Mirkin.
49. Nanofabrication towards biomedical application: Techniques, tools, Application and impact – Ed. Challa S., S. R. Kumar, J. H. Carola.
50. Nanomedicine, Vol. IIA: Biocompatibility - Robert A. Freitas
51. Dendrimers I, II, III, Ed. F. Vogtle
52. Tissue Engineering-Bernhard O. Palsson , Sangeeta N. Bhatia
53. Principles of Tissue Engineering - Robert Lanza, Robert Langer, and Joseph P
54. Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by H. Meixner.
55. Nanoscience & Technology: Novel structure and phenomea by Ping Sheng (Editor)

Paper - XV

BC 4.4: PROJECT WORK / DISSERTATION (Hard Core)