UNIVERSITY OF PUNE

Syllabus for M.Sc. Biochemistry (Credit System/Semester System) starting from June 2008

M.Sc. Biochemistry syllabus under credit system at the Department of Chemistry, University of Pune, Pune-411007 will be effective from the academic year 2008. The M.Sc. course in Biochemistry for two years will consist of 100 credits and will have 70 credits for theory and 30 credits for practical and project work. Each semester will run for 15 weeks. Each credit is equivalent to 15 clock hours of teaching.

		Semester I Theory Courses	**Credits**
B CH	170	Biomolecules	5
BCH	171	Enzymology and Physiological Biochemistry	5
BCH	172	Cell Biochemistry	5
		Semester II Theory Courses	
BCH	270	Bioenergetics and Metabolism	5
BCH	271	Biophysical Techniques	5
BCH	272	Biostatistics Bioinformatics and Computational techniques in Biochemistry	5
BCH	273	Membrane Biochemistry and Nucleic acid	5
		Practical Courses for Part I	
BCH	167	Analytical Biochemistry I + II	5
BCH	168	Biophysical Techniques and Computers	5
BCH	267	Microbiology and Enzymology	5

** The teacher can take liberty of introducing latest topics in the respective field. The teacher should also provide sufficient reading material to the student for such new topics/concepts being taught in the classroom*

M.Sc. Biochemistry Part I Syllabus

SEMESTER I

BCH –170 Biomolecules

Biomolecules I: Carbohydrates and Lipids

1 The molecular logic of life: The chemical unity of diverse living organisms, composition of living matter. Macromolecules and their monomeric subunits.
2 Properties of Water: With interactions in aqueous systems. Ionization of water, weak acids and weak base. The pH scale, measurement of pH, pH metry, acid base titration curves. Buffers, biological buffer systems.
3 Carbohydrates: Classification, basic chemical structure, monosaccharides, aldoses, and ketoses, cyclic structure of monosaccharides, steroisomerism, anomers and epimers. Sugar derivatives, deoxy sugars, amino sugars, and sugar acids. General reaction and properties.
4 Lipids: Classification, structure and function of major lipid subclasses-acylglycerols, circulating lipids, Separation techniques Lipoproteins, chylomicrons, LDL, HDL, and VLDL. Pathological changes in lipid levels. Formation of micelles, monolayers, bilayer, liposomes.
5 Vitamins and Co-enzymes: Classification, water-soluble and fat-soluble vitamins. Structure, dietary requirements, deficiency conditions, coenzyme forms.

Biomolecules II: Proteins

1. Amino acids: Classification, Properties, reactions, rare amino acids, and separation techniques.
2. Protein classification: Reactions, functions, properties peptide synthesis. Solid phase synthesis.
3. Structure:
   a) Peptide bond, end group analysis, sequencing.
   b) Secondary: X ray diffraction, alpha-helix bets- structure, β-helix, super secondary structure.
   c) Tertiary Structure: Forces stabilizing, unfolding/ refolding expt. Prediction of tertiary Structure.
   d) Quaternary structure – hemoglobin.
   e) Ramachandran plot.
   f) Helix coil transitions, Vander Walls, electrostatic, Hydrogen bonding, and hydrophobic interactions.
   g) Energy terms in Biopolymer conformational calculation.

Reference Books:

1 Principles of Biochemistry, Lehninger C Rs. Publ. (1982).
2 Biochemistry, L. Stryer, W.H. Freeman, San Francisco.
3 Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W. Kuchel and G.B. Ralston. Int. Ed., McGraw-Hill Book Co.
4 Problem Approaches in Biochemistry. Wood and Hood.

BCH 171 Enzymology and Physiological Biochemistry

Enzymology

1. Historical aspect: Remarkable properties cofactors Nomenclature and classification, isoenzymes, multienzyme.
2. Isolation, purification, criteria's of purity.
3. Enzymes kinetics: One substrate reactions, effect of pH, temperature and inhibitions. Two substrate reactions. Theory, order analysis, pre-steady state kinetics, stopped flow technique, Relaxation methods.
4. Mechanism of enzymes action: Theoretical background, Factors leading to rate enhancement of enzyme catalyzed reactions: Acid-base catalysis, proximity and orientation effects, covalent catalysis, strain or distortion and change in environment. Experimental approaches of determination of enzymes mechanism: Kinetics studies, detection of intermediates, X-ray crystallographic studies, Chemical modification of amino acid side chain and affinity labeling, site directed mutagenesis. Examples of chymotrypsin, triose phosphate isomerases, aldolase etc.
5. Control of enzyme activity: Control of activities of single enzyme: inhibitor molecules, availability of substrate or cofactor. Product inhibition. Control by changes in covalent structure of enzymes:
    a) Reversible Change
    b) Irreversible change
6. Zymogen activation and phosphorylation dephosphorylation ligand induced changes: Allosteric enzymes, Therotical models, Hill equation, Adair equation, M.W.C. and K.N.F. Models, usefulness of the models. Significance of allosteric and cooperative behavior in enzymes.
7. Control of metabolic pathways: Amplification of signals, substrate cycles and Inter-convertible enzyme cycles.
8. Multienzyme complex: Properties, pyruvate dehydrogenase system, (*E. coli* and mammalian), Tryptophan synthetase, multienzyme complex from E.coli, fatty acid synthetase, glycogen particle.
9. Enzyme turnover: Kinetics of enzyme turnover. Measurement of enzyme turnover, Ks and Kd. Correlation between the rates of enzyme turnover and structure and function of enzymes. Mechanism of enzyme degradation. Significance of enzyme turnover.
10. Clinical aspects of enzymology: LDH isozymes, SGOT, SGPT, creatine kinase, alpha amylase, phosphatase, inborn errors.
11. Ligand binding

Physiological Biochemistry:

1. Blood: Blood composition, plasma proteins and their diseases, blood counting and its significance, leucocyltes, thrombocytes and erythrocytes.
2. Chemistry of respiration: Gas transport and pH regulation, need for a carrier of oxygen in blood, transport of oxygen, carbon dioxide and H by Hb, buffer systems of plasma, interstitial fluid, carbon dioxide-bicarbonate buffer system, acid- base balance and it's maintenance, compensatory mechanisms, measures of acid base imbalance, significance of Anion gap.
3. The kidney: Formation and acidification of urine, abnormalities of acid- base balance regulation by kidney, mechanism of action of diuretics, tests of renal function, composition of urine and hormones of the kidney.

4. Water and mineral metabolism.
5. Liver function and its disorders.

Reference Books:

1. Text-book of Biochemistry with clinical correlations by Thomas M. Devlin, 2nd Edition, J. Wiley and Sons (1986).
2. Physiological chemistry by Harper.
3. Textbook of Medical Physiology by Guyton. A.C., H. Sanders Philadelphia. 1988.
4. Physiological basis of Medical practice, West J.B., Best and Taylor.
5. Introduction to Physiology by Davidson H and Segal M.B. Academic Press.
6. Fundamentals of Enzymology by Price and Stevens
7. Enzymology by Dixon and Webb
8. Enzymes by Palmer

BCH 172 Cell Biochemistry

Cell Biochemistry I

1. Characterization and classification of microorganisms.
2. Theory, phase contrast microscopy, fluorescence microscopy.
3. Electron microscopy: theory, specimen preparation, freeze etching, freeze fracture, shadow casting, electron microscopy of nucleic acids, TEM, SEM.
4. Cell wall: Structure of peptidoglycon and other cell wall components.
5. Cultivation of Bacteria, nutrition, physiology and growth of microbial cells.
6. Reproduction and growth, synchronous growth, continuous culture of microorganisms.
7. Pure cultures and cultural characteristics.
8. Fundamentals of control of microbial growth, control by physical agents, control by chemical agents.
9. Production of mutants by chemical and physical agents and their characterizations.
10. Host Microbe Interactions, endotoxins, exotoxins, capsular material. Enzymatic and other factors, tissue affinity, resistance and immunity.
11. Viruses of bacteria, plant and animal cells, structure classification life cycle, Mycoplasma and viriods, diseases
12. Chemical activities of bacteria leading to the accumulation of industrially important products.

Reference Books :

1. Microbiology, M.S. Pelczar, R.D. Reid, E.C.S. Chan, Mc Graw Hill, New York (1986).
2. General Microbiology (Vth Edition), R.Y. Stanier, Prentice Hall (1986)
3. Biochemical Engineering, S Aiba, A.E. Humphrey, Nancy F. Mills, University of Tokyo Press. (1978).
4. Introductory Microbiology, F.C. Ross, Charles Merril Publication (1983).

Cell Biochemistry II

Cell classification, cell variability, size, shape and complexity, function
Prokaryotes, cell structure and components
Eukaryotic cell : Structure, sub cellular components: Nucleus, chromosomes, plasma membrane, cell wall, endoplasmic reticulum, lysosomes, peroxisomes, Golgi apparatus,

mitochondria, chloroplast, cytoskeleton, pili, flagellum, sub cellular fractionation, different and density gradient centrifugation, specific staining of organelles or marker enzymes.

Cell division, mitosis and meiosis, cell cycle

Plant cells: Cell wall and its function, xylem, phloem and epidermal cells. The interaction and communication between the cells, cell-cell reorganization in plants, role of golgi vesicles in plasma membrane, cell growth and division.

Cell-cell adhesion and the extracellular matrix-species Intercellular recognization specific cell aggregation in sponges, cell junctions, extracellular matrix, collagen, elastic fibronectin

Germ cells and fertilization stem cells, cell differentiation, organogenesis, functional and biochemical maturation of tissues.

Molecular basis of biodiversity

Reference Books:

1. Molecular Biology of the cell – Bruce Alberts – J.D. Watson et al Garland publishing Inc., N.Y. (1983).
2. Cell and Molecular Biology – DeRobertis and Saunders (1980).
3. The cell – C.P. Swanson, Prentice Hall (1989)
4. Cell Biology – C.J. Avers, Addision Wesley Co. (1986).

SEMESTER II

BCH: 270 Bioenergetics and Metabolism

Bioenergetics and Metabolism I

1. Survey of metabolism: Carbon, oxygen, nitrogen cycle catabolism, use of mutants and isotopes in the study of metabolism, compartmentation, food chain and energy flow.
2. Cell bioenergetics: First and second law of thermodynamic, internal energy, enthalpy, entropy, concept of free energy, standard free energy change of a chemical reaction, redox potentials, ATP and high energy phosphate compounds.
3. Glycolysis: Anaerbic pathway of glucose metabolism, two phases of glycolysis. Detailed study of all the reactions, entry of other carbohydraes in Glycolytic pathway, energy balance sheet regulation of glycolytic sequence by enzymes and hormones, alcoholic fermentation.
4. Citric acid cycle: Aerobic pathway of glucose metabolism, historical background, details of the cycle, use of isotope for the study of citric acid cycle, interconversion of hexoses, Pasteur Effect.
5. Alternate pathways of carbohydrate metabolism: Pentose phosphate pathway, glyoxalate cycle, glucuronic acid cycle, inter conversion of hexoses, Pasteur effect.
6. Lipid metabolism: Fatty acid metabolism, Beta oxidation of saturated and unsaturated fatty acids, the phases of fatty acid oxidation, energetics of beta oxidation. Oxidation of fatty acids with odd number of carbon atoms, formation of ketone bodies, other types of fatty acid oxidation.
7. Integration of carbohydrate and lipid metabolism.
8. Biosynthesis of lipids: Requirements of carbon dioxide and citrate for biosynthesis, fatty acid synthase complex, regulation of biosynthesis. Biosynthesis of triglycerides, cholesterol and phospholipids.

9. Electron transport chain and oxidative phosphorylation.
10. Glycogen metabolism: Biosynthesis and degradation of glycogen and it's regulation. Starch and cellulose biosynthesis.
11. Gluconeogenesis
12. Photosynthesis : Intracellular organization of photosynthetic system, fundamental reactions of photosynthesis, light and dark reactions, photosynthetic pigments, role of light, Hill reaction and it's significance. Photophosphorylation, light reactions, cyclic and non-cyclic photoinduced electron flow, energetics of photosynthesis, photosynthetic phosphorylation photorespiration, dark phase of photosynthesis, Calvin cycle, C4 pathway, Bacterial photosynthesis.

Metabolism II: Nitrogen Metabolism

1. Oxidative degradation of amino acids : Proteolysis, Transamination, oxidative deamination, acetyl CoA, Alpha ketogutarate, acetoacetyl CoA, succinate, fumarate and oxaloaccetate pathway, decarboxylation, urea cycle, Ammonia excretion.
2. Biosynthesis of amino acids: Amino acid biosynthesis, Precursor functions of amino acids, Biosynthesis of aromatic amino acids, Histidine, One carbon atom transfer by folic acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine.)
3. Peptides, polyamines, Porphyrins, gamma glutamyl cycle, glutathione biosynthesis, Nonribosomal Protein Biosynthesis.
4. Purine pyrimidine degradation.
5. Biosynthesis of Purine and pyrimidine nucleotides, Regulation, Biosynthesis of nucleotide coenzymes.
6. Nitrogen fixation: historical background, nitrogen cycle in nature, symbiotic nitrogen fixation, nitrogenase system, nitrate reductase.

Reference Books

1. Biochemistry – Lehninger.
2. Metabolic Pathways - Greenberg.
3. Biochemistry – G. Zubay, Addision Wesley Publ. (1983).
4. Biochemistry – Stryer (1988) 3rd Edition W.H. Freeman and Co.

BCH – 271 Biophysical Techniques

Biophysical Techniques I

1. UV and visible Spectophotometry, IR and NMR Spectrophotometry.
2. Membrane filtration and dialysis: Nitrocellulose, fibre glass, Polycarbonate filters, Dialysis and Concentration, Reverse Dialysis, Freeze drying, lyophilization.
3. Chromatography: Partition and adsorption Chromatography- paper, TLC, GLC, GCMS, Gel filtration-theory, materials, advantages, molecular weight determination and other applications. Ion exchange chromatography – properties of ion exchangers, choice, technique and applications. Amino acid analyzer- HPLC, HPTLC, affinity chromatography Methods of ligand immobilization. Immuno-adsorption – Hydrophobic interaction chromatography, Metal chelate chromatography, covalent chromatography. Special chromatographic techniques for nucleic acids. DNA cellulose chromatography, MAK hydroxyl-apatite chromatography, Separation of DNA fragment according to their base composition.

4. Electrophoresis : Theory, types, moving boundary electrophoresis, zone electrophoresis, paper, cellulose acetate, gel Electrophoresis, Native PAGE, disc PAGE, Gradient PAGE, SDS PAGE, DNA agarose gel electrophoresis Southern, Northern, Western transfers, Isoelectric focusing finger printing, DNA sequencing Pulsed – field Electrophoresis, Capillary Electrophoresis.

Biophysical Techniques II

1. Sedimentation: Theory, Preparatory and analytical ultracentrifuges, factors affecting sedimentation velocity, sedimentation coefficient, measurement of S, Zonal centrifugation, DNA analysis, Determination of molecular weight by sedimentation, diffusion and sedimentation equilibrium methods. Specific example of application.
2. Partial specific volume and the diffusion coefficient, Measurement of partial specific volume and diffusion coefficients.
3. Viscosity: Theory, effect of macromolecules on the viscosity of a solution, measurement, molecular weight determination.
4. Isotope Tracer Technique: Types of radiations, measurement scintillation and gamma counters. Background noise quenching, Applications.
5. Interaction of radiation with matter, passage of neutrons through, matter, interaction of gamma rays with matter, units of measuring radiation absorption, Radiation dosimetry, Radiolysis of water, free radicals in water.
6. Autoradiography.

Reference Books:

1. Physical Biochemistry by D. Freifelder IInd Edition (1982)
2. Biochemical calculation by I.H. Segal IInd Edition (1976)

BCH-272 Biostatistics Bioinformatics and Computational techniques in Biochemistry

Biostatistics:

Principles and practice of statistical methods in biological research, samples and populations, Basic statistics-average, statistics of dispersion, coefficient of variation, confidence limits, Probability distribution, normal, binomial and Poisson distribution. Mean variants, standard deviations and standard error, correlation and regression, test of statistical significance, and analysis of variance.

Computational techniques in Biochemistry

Introduction to hardware and software, binary and decimal numbers, constants and variables, assignment statement, flow charts and their use. If and go to statements, Do loops. Input, output and format statements, Subroutines and function subprograms. Introduction to programming in BASIC/Fortran/C. The students will carry out programming in a related laboratory course.

1. Computer awareness
2. Basic programming
3. Writing of few basic programs related to Biochemistry
4. Prentice on packages
5. Writing a BASIC program to plot graphs of enzyme kinetic data by a variety of linear transforms and the Michalies Menten hyperbolic plots.
6. Write a BASIC program to calculate the pH of a dilute salt solution

7. Write a BASIC program for the analysis of amino acid sequences.
8. Use of packaged statistical computer program for the statistical analysis.
9. Use of computer program to analyze DNA sequences to find complementary sequences, search repeats, restriction sites, coding sequences, codon usage, etc

Reference Books:

1. Computers and Common Sense- *R. Hunt and Shelley*, Prentice Hall, New Delhi (1998).
2. Computer Programming in Fortran-90- *V. Rajaraman*, Prentice Hall, New Delhi (1990).
3. Computing for Biologists- *A. Fielding*, Addison Wesley Pub., UK (1985).
4. Microcomputers in Biochemical Education- *E. J. Wood (Ed)*, Taylor and Francis Ltd., UK (1984).
5. Computer Games and Simulation for Biochemical Engineering- *H. R. Bungay*, John Wiley and Sons Ltd., New York (1985).
6. Microcomputers in Biology- A practical approach- *C. R. Ireland and S.P. Lang*, IRL Press Ltd., (1985)

BCH 273 Membrane Biochemistry and Nucleic acid

Membrane Biochemistry

1) Biological membrane, structure, and assembly: constituents, bacterial cell envelope, asymmetry flip flop, protein lipid interaction, factors affecting physical properties of membranes.
2) Membrane models: biological and physical models: energetics and transduction phenomena, biochemical chemiosmotic hypothesis of Mitchell.
3) Membrane transport: diffusion, passive, active and facilitated, transport role of proteins in the process, exocytosis, receptor mediated endocytosis, osmoregulation.
4) Na, H dependent processes and phosphotranferase synthesis, specialized mechanism for transport of macromolecules, gap junctions, nuclear pores, toxins, control of transport processes, binding proteins, hormone effects and the role of lipids.
5) Role of Na, K ATPase and the passive permeability of the plasma membrane to Na, K and Cl, voltage and ligand gated ion channels, ATP-ADP exchanger.
6) Molecular mechanisms, ion translocating antibiotics, valinomycin, gramicidin, ouabain, group translocation, ionophores, electrical gradient, energy coupling mechanism.
7) Penetrating the defenses: how antimicrobial agents reach their targets, cellular permeability barrier to drug penetration, some examples of modes of penetration of antimicrobial agents, the exploitation of transport systems in the design of new antimicrobial agents.
8) Assembly of virus membrane receptor

Nucleic Acids

1. Molecules of Heredity: Structure of DNA and RNA, DNA as genetic, material, Double helix. Semi conservative mechanism of replication. Nearest neighbor analysis. Denaturation and renaturation A, B, and Z forms of DNA.
2. Nearest neighbor analysis, Denaturation and renaturation, A, B and Z forms of DNA.
3. Laws of Haredity : Genotype, Phenotype Mendelian Laws of inheritance.
4. Basis of Biochemical genetics: One gene one cistron complementation tests, Co-linearity.

5. Auxotroph, prototroph, conditional mutants, Mutant isolation and selection. Transformation. Conjugation, Transposition.
6. Sex factors and Plasmids: Fertility factor, Hfr, Mapping of E, coli chromosome, other plasmids, cosmids, Introduction to Operon.
7. Genetic Code: Biochemical and genetic analysis of the genetic code.
8. Bacteriophages: Life cycle, use of bacterial viruses in genetic studies.
9. Genetic disorders, of chromosomal origin, gene origin –mutation.
10. Specialized genetic systems of fungi: Tetrad Analysis.

Reference Books:

1. Biochemistry of antimicrobial action- 4th edition, Chapman and Hall , TJ Franklin and GA Show (BCL)
2. Biochemistry-G Zubay , Addison Wesley, 1983
3. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989 , Freeman and Co. NY
4. Principles of Biochemistry –Lehninger
5. Biochemistry with clinical correlation- Thomas Devlin, 2nd ed, John Wiley and sons
6. Membranes and their cellular functions- IB Filnean, R.Coleman and RH Michell, 1984, Blackwell scientific publishers, Oxford, 3rd ed.
7. Genetics – Strickberger M.W., Macmillan Pub;. Inc. (1976).
8. 36 Lectures in Biology – S.E. Luria, M.I.T. Press, Cambridge (1975).
9. The Genetics of Bacterial viruses – William Hayes, PBS Publ. (1984).
10. Molecular Biology of the Gene- Watson Benjamin / Cummings Publ. Company (1987).
11. Genetics Analysis and Principles: R.J. Brooker Addison-Wesley.

BCH 167 Analytical Biochemistry I and II

1. Amino acid detections (Paper chromatography) and estimations.
2. Comparative evaluation of different methods of protein analysis: Lowry, Biuret, Kjeldahl, UV.
3. Specific reactions for Carbohydrate and estimations.
4. Isolation of amino acid and proteins: cystine, Egg albumin, globulin, milk casein .
5. Starch preparation and characterization.
6. Alpha and Beta amylolysis.
7. Cholesterol and lecithin from egg.
8. Vitamin C estimation.
9. Lipid isolation detection and estimations.
10. Estimation of DNA by diphenylamine method
11. Estimation of RNA by orcinol method

Reference Books

1. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker.
2. Practical Biochemistry by David Plummer
3. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh.

BCH 168 Biophysical Techniques and Computers

Biophysical Techniques

1. Concept of pH, preparation of buffers, measurement of pH.
2. pH metry: Acid base titration curves. Measurement of pKa of amino acids.

3. Ion exchange chromatography: Nature of exchanger, capacity of column, Separation of amino acids.
4. Gel filtration: Determination of void volume, Determination partition coefficient, Separation of two components in a sample.
5. Viscosity: Viscosity of hydrolyzed, partially hydrolyzed and unhydrolyzed starch. Determination of relative viscosity, Specific viscosity and intrinsic viscosity.
6. Electrophoresis: Paper electrophoresis, Agar electrophoresis for separation f low mol. Wt. Dyes. Separation serum proteins by Agarose gel electrophoresis. Polyacrylamide Gel electrophoresis (PAGE). Single cell electrophoresis
7. UV and Visible Spectrophotometry: Absorption spectra, Demonstration of Beer's Law, UV absorption of proteins and amino acids, Determination of Molar extinction coefficient. Absorption spectra of hemoglobin derivatives – oxyhemoglobin, carboxyhemoglobin and methemoglobin.
8. Dialysis, reverse dialysis and membrane filtration.
9. High performance Liquid Chromatography (HPLC)
10. Osmotic fragility.
11. Measurement of Refractive Index.

Reference Books:

1. An introduction to practical Biochemistry – David T. Plummer, Tata Mc Graw Hill Co. Ltd., Bombay.
2. Introductory Practical Biochemistry (2001). Ed. S.K. Sawhney and Randhir Singh.
3. Practical Biochemistry Sadasivam and Manickam.
4. Practical Biochemistry, Principles and Techniques (1995). Ed. Keith Wilson and John Walker.

Computer Programming

The student is expected to write and execute at least six of the following or similar computer programs in BASIC/Fortran/C

1. Linear regression
2. Quadratic equation
3. Simulation of pH titration
4. Michaelis Menten enzyme kinetics
5. Analysis of amino acid sequences
6. Analysis of DNA sequences, Complementary sequences, repeat frequencies, etc
7. Handling of atomic co-ordinates, files and distance statistics in large molecules
8. Determination of number of covalent or weak bonds from the given atomic co-ordinate files of a protein molecule.

These programs are only indicative. The instructor may choose other programs to illustrate the use of computers in chemistry.

Reference Books :

1. Computers and Common Sense- *R. Hunt and Shelley*, Prentice Hall, New Delhi (1998).
2. Computer Programming in FORTRAN-90- *V. Rajaraman*, Prentice Hall, New Delhi (1990).
3. Computing for Biologists- *A. Fielding*, Addison Wesley Pub., UK (1985).
4. Microcomputers in Biochemical Education- *E. J. Wood (Ed)*, Taylor and Francis Ltd., UK (1984).

5. Computer Games and Simulation for Biochemical Engineering- *H. R. Bungay*, John Wiley and Sons Ltd., New York (1985).
6. Microcomputers in Biology- A practical approach- *C. R. Ireland and S.P. Lang*, IRL Press Ltd., (1985)

BCH 267 Microbiology and Enzymology

Microbial Techniques

1. Media preparation, pour plate and streak plate techniques,
2. Microscopic examination (motility, monochrome staining and gram staining).
3. Sterilization: Steam, Dry heat and filter.
4. Detection of amylase, caseinase, catalase activity
5. Preservations of bacterial cultures.
6. Phosphatase test for the quality of milk
7. Methylene blue reduction test (MBRT) for quality of milk
8. Growth curve of *E. coli*.
9. Growth curve of yeast.
10. Total viable count determination (pour plate and spread plate).
11. Ultraviolet irradiation and survival curve.
12. Isolation of auxotrophic mutants.
13. Plaque assay for phage.
14. Immobilization of yeast cells
15. Alcohol production.
16. BOD
17. COD.
18. Microbial, assay of vitamin and antibiotic.

Reference Books :

1. Microbial methods – J.Collins.
2. Medical Microbiology, Vol. II – Cruickschank.

Enzymology

1. Detection of some common enzymes.
2. Effect of different parameters on enzyme activity
3. Enzyme Kinetics (Determination of Km and Vmax)
4. Purification and characterization of enzyme
5. Enzyme immobilization.

Reference Books:

1. Biochemical Techniques Theory and Practice: J.R. Robyt and B.J. White.
2. Practical Biochemistry: Principles and techniques: K. Wilson and J. Walker.
3. Practical Biochemistry by David Plummer
4. Introductory Practical Biochemistry by S.K. Sawhney and R.Singh

M.Sc. Biochemistry Part II- Syllabus

		Semester III Theory Courses	Credits
B CH	370	Molecular Biology	5
BCH	371	Medical Biochemistry and Immunology	5
BCH	372	Signal transduction pathways	4
Optional Courses (Any One)			
BCH	373	Recent trends in Biochemistry and Toxicology	5
BCH	374	Developmental Biology and Molecular Evolution	5
BCH	375	Nutrition and Clinical Nutrition	5
		Semester IV Theory Courses	
BCH	470	Biochemical Endocrinology and Tissue culture	4
BCH	471	Fermentation, Enzyme and Food Technology	4
BCH	472	Genetic Engineering	4
Optional Courses			
BCH	474	Genomics and Biotechnology	4
		Practical Courses for Part II	
BCH	367	Molecular Biology and Clinical Biochemistry	5
BCH	368	Special Experiments	3
BCH	467	Project	7

Semester III

BCH 370 Molecular Biology

1) DNA Replication: DNA polymerase I, II, III, origin locus, Okazaki fragments, replication fork.
2) DNA Repair: substitution, deletion and insertion mutations, pyrimidine dimer, uracil DNA glycosidase.
3) Gene rearrangements recombination, Holliday structures, rec A,B,C,D. SOS response, mobile genetic elements
4) Transcription and splicing :RNA polymerases, promoters, sigma and Rho factors, initiation, elongation and termination of transcription, post transcriptional modifications of tRNA and rRNA, inhibitors of transcription, RNA pol I,II,III, enhancers ,5' capping, 3' poly A tailing, splice site, mechanism of splicing, ribozyme.
5) Protein synthesis
6) Protein targeting: Intracellular protein targeting. Signal hypothesis, signal sequences, glycosylation, Targeting of protein to mitochondria, lysosomes, ER, plasma membrane, Peroxisomes, chloroplast, destruction of proteins, etc
7) Protein folding and protein motifs and control of gene expression
8) Eukaryotic chromosome and gene expression
9) Molecular virology

Reference Books

1) Biochemistry (3^{rd} /4^{th}/5^{th} edition) L. Stryer, WH Freeman and Co.
2) Molecular biology of the gene, Vol I and II (4^{TH} ed)J D Watson, Benjamin/Cummings publ. Co Inc.
3) Molecular cell biology (1988) J Darnell and D. Baltimore, W,H Freeman and Co.
4) Molecular biology of the cell (19830 B. Alberts, Garland Pub. In., NY
5) Genes (2^{nd} ed), B. Lewin, John Wiley and sons, NY.

BCH 371 Medical Biochemistry and Immunology

Medical Biochemistry

1) Mechanism of action at molecular level of selected antibiotics, anti metabolites, analgesics, hallucinogens and other drugs, mechanism of resistance to antibiotics and other drugs.
2) Lysosomes and their physiological role.
3) Cerebrospinal fluid, composition in health and disease.
4) Blood coagulation, clotting factors, mechanism of coagulation, fibrinolysis, abnormal hemoglobin's, fibronectins. Diseases of cardiovascular system.
5) Cancer causative agents and control theories of cancer and carcinogenesis, viral etiology, control of cancer and carcinogenesis, viral etiology, control of cancer –basic approaches.
6) Counseling for genetic diseases
7) Ageing and apoptosis

Reference Books

1) Biochemistry of antimicrobial action (4^{th} ed) TJ Franklin, Chapman hall (1989)
2) General Microbiology, Pelczar, Rard and Chan (1987)

3) Mechanism of microbial diseases, M Schaechter et al,Williams and Wilkino Int. Ed.(1989)
4) Biochemistry, L Stryer (3rd ed), Freeman and Co.
5) Textbook of Biochemistry with clinical correlations, Thomas Devlin,(2nd ed),John Wiley and sons
6) Biochemical aspects of human diseases (1983), RL E lkeles, Slackwell scientific publishers, Oxford
7) Analogues of nucleic acids, Ray Berman (1970), Springer Verlag.

Immunology

1) Cellular basis of immunity: immunological memory, specificity, diversity, discrimination between self and non self, primary and secondary lymphoid organs, cell mediated and humoral immune responses, T and B lymphocytes, autoimmune reactions.
2) Antigen and antibody: antigen, antigenic determinant, immunopotency, structure of antibody, constant and variable regions, Fab, F(ab2) and Fc fragments, different classes of antibodies and their functions, fine structures of antibodies, X ray diffraction studies, isotypes, allotypes and idiotypes,
3) Measurement of antigen- antibody interaction, diffusion, immunodiffusion, immunoelectrophoresis, radioimmunoassay, immunoflorescence, ELISA, Western blotting
4) Clonal selection theory of antibody production, monoclonal and polyclonal antibodies, poly reactive antibodies, catalytic antibodies, abzymes.
5) Complement system: classical and alternate pathway
6) T lymphocytes and cell mediated immunity, T cell sub populations, immune response genes, MHC gene complex, polymorphism, graft rejection, graft versus host response
7) Hypersensitivity, immunodeficiency diseases
8) Vaccines, interferon, AIDS
9) Blood antigens: blood group substances and Rh factor

Reference books

1) Molecular biology of the cell –Garland publishing Inc., NY, London
2) Immunology 3rd ed Janis Kuby
3) Essentials of immunology (5th ed) Roit, Blackwell scientific publishing, London
4) Cellular and Molecular Immunology, 3rd ed, Abbas

BCH 372 Signal transduction pathways

Signal transduction pathways I

1) Muscle contraction and cell motility: skeletal muscle, structure of muscle cell, ultra structural organization, protein components of myofibrils, molecular organization of thick and thin filaments, mechanism of muscle contraction, metabolism of muscle, cardiac muscle contraction, regulation of contraction, contractile proteins in cells other than muscle filaments, microfilaments, microtubules, cilia and flagella of eukaryotic cells,
2) Nerve conduction: structure and composition of nervous tissue, creation and propagation of nerve impulses, action potential, sodium and potassium channels. Transmission of nerve impulse, colinergic receptors, acetyl choline receptors, electraplexus as a source of acetyl choline receptors, acetyl choline esterase, nerve poisons, other neurotransmitters.

3) Biochemistry of vision: Structure of eye, lens and retina, perception of light, rods and cones, rhodopsin, primary events in visual excitation, cyclic GMP and transduction in generation of nerve impulses, color vision.
4) Biochemistry of taste and smell.
5) Biochemistry of hearing and speech
6) Chemotaxis.

Reference Books

1) Biochemistry , L Stryer, Freeman and Co, NY
2) Biochemistry, Zubay, Addison Wesley and Co.
3) Textbook of Physiology, Guyton
4) Physiology, Berne and Levy

Signal transduction pathways II

1) Neuromorphology and neuroanatomy- Central nervous system, spinal cord and different regions of the brain, peripheral nervous system, afferent pathways and sense organs, afferent pathway
2) Nerve and synapse structure, structure-function correlation at the synapse, transmission across the synapse, membrane potential in the steady state, action potential generation and propagation
3) Sensory system: types of receptors, properties, sensory modalities and sensory circuits. Sensory perception
4) Chemical composition of the brain
5) Specific aspects of carbohydrate, protein, lipid and amino acid metabolism in the brain
6) Neurotransmitter metabolism
7) Neuropeptides –turnover and regulation
8) Cerebro-spinal fluid, blood brain barrier
9) Coordination between nervous and endocrine systems
10) Natural, genetic & environmental factors affecting the development of CNS
11) Neural plasticity learning
12) Localization of higher functions: EEP patterns
13) Calcium signaling, zinc fingers

Reference books

1) Text book of physiology- Guyton
2) Principles of neural science Kandel ER, Schwartz JH, Elsevier, N. Holland, NY
3) Neurobiology, Shepherd GM , Oxford Univ. Press
4) Nerve and muscle excitation Junge D, Sinauer assoc, Sanderland, mass

BCH 373 Recent Techniques in Biochemistry & Toxicology

Recent Trends in Biochemistry

1. Basic concepts of theoretical conformation analysis of proteins
2. Spectroscopic methods:
    a. NMR
    b. ESR,
    c. Fluorescence
    d. ORD, CD.

e. GCMS

3. Biosensors
4. Electron spray assisted ionization
5. LCMS, MALDI, MALDI-TOF
6. IPR: Patent and Patenting, Intellectual right protection (National & International), WTO regulations.

Reference books

1) Biochemistry L Stryer, 4th ed
2) Molecular biology of the gene, Watson
3) Fundamentals of Biochemistry, Donald Voet, Judith Voet, Charlotte W Prott.
4) Molecular Cell Biology, 4th ed, Lodish Berk, Zipursky Matsudaira, Ball.
5) Physical Biochemistry-Friefelder , 2nd ed, Freeman Pub.

Biochemical Toxicology

1) Environmental pollution
2) Evaluation of toxicity
3) Toxicity of pesticides, food additives, animal and plant toxins, industrial chemicals and heavy metals
4) Metabolism of toxic substance
5) Toxic responses of different tissues and organs
6) Occupational health and industrial toxicity
7) Regulation of safety and social aspects in relation to toxicants
8) Applications of toxicology: forensic, clinical
9) Control of environmental pollution

Reference books

1) Haye's principles and methods of Toxicology Ed. A Wallace Hayes, Pub. Raven press, NY
2) Casarett and Doull's toxicology ed. John Doull, Curtio D Kleassen and Mary D Aunder, McMillan publisher Co, NY
3) Appraisal of the safety of chemicals in foods , drugs and cosmetics. Ed.The Editorial Committee of Association of Food and Drug Officials of the United States
4) Toxicology- Mechanisms and analytical methods, Vol I and II, ed Stewart CP and Stolman A, Pub Academic press
5) Veterinary toxicology by RJ Garner ed Beilliere, tindall and Cox London
6) The chemistry and microbiology of pollution (1975) IJ Higgins and RG Burns Acad Press , NY
7) Introduction to ecological biochemistry JB Harbone Acad Press, NY (1977)

BCH 374 Developmental Biology and Molecular Evolution

1) Theories of Evolution.-the time scale and some evolutionary principles. Chemical evolution and origin of life. Prototypes of metabolic pathways.
2) Genesis of oxygen generating photosynthesis and aerobic respiration. Methanogens – evolution of prokaryotes.
3) Evolution of protists.
4) Origin of eukaryotes

5) Theories regarding origin of mitochondria and chloroplast, the five kingdom classification of living organisms, outline of eukaryote evolution- evolution of primates.
6) Construction of phylogenetic trees- molecular data set based on sequences.
7) Evolution of proteins and nucleic acid – elastic analysis.
8) Evolution of introns
9) Evolutionary view of exon domain relationships.
10) Developmental Biology—Cell differentiation, hierarchy of genes, measurement of time during development, nature of differentiation, DNA rearrangements& amplification, genetic control of morphogenesis, plant molecular genetics.

Reference Books

1) Evolution and Diversity of life, E. Mayer Belknap Press Pub, 1976
2) Population species and evolution (1973), E Mayer Press Pub.
3) Biochemistry , Lehninger (1975) Worth pub
4) Origin of Eukaryotic cells, Margulis L.(1977)

BCH 375 Nutrition and Clinical Nutrition

Nutrition:

1. Basic Concepts: Composition of Human body. Nutritional value of foods and effect of processing. Energy content and its measurement in foods. Thermogenic effect of foods.
2. Role of food proteins: Requirements and allowances. Proteins as building material, amino acid inter relationships. Protein quality and methods of determination. Factors affecting protein metabolism, Nitrogen balance studies and factors affecting it. Protein and amino acid requirement at different stages of development.
3. Carbohydrates and Energy metabolism: Dietary requirements and source of carbohydrates, Classification – Available and Unavailable. Physico-chemical properties and the physiological role. Energy requirement and measurement of energy requirement: Direct and Indirect calorimetry. Factors affecting requirements; BMR, SDA and activity. BMR and relation of temperature regulation to basal metabolism.
4. Lipids: Nutritional classification of dietary lipids, sources and their physiological functions.
5. Minerals: Nutritional significance. Dietary Macro elements, Calcium, Phosphorus, Magnesium. Trace Elements, Iron, Iodine, Zinc, Copper etc.
6. Food utilization: Ingestion, digestion, absorption transport, storage and disposal of food nutrients (proteins, carbohydrates, fats, vitamins and minerals).
7. Primary Nutritional Diseases: Protein energy malnutrition, starvation, obesity, vitamin deficiency disorders and biochemical basis of causation and diagnosis of nutritional anaemias.
8. Conditional Nutritional Disorders: Disorders of Gastrointestinal tract, Liver, Biliary tract and Pancreas and Heart, Diabetes.
9. Food toxins and Allergy:

Clinical Nutrition

1) Diet and nutrition in India: Assessment of nutritional status
2) Factors affecting digestion and absorption of food
3) Effects of irradiation , cooking, refining, sprouting and fermentation on nutritional quality of food

4) Food toxins, adverse effects of alcohol, tobacco, tea
5) Interrelationship between dietary lipids and cholesterol metabolism
6) Malnutrition and infection
7) Malnutrition and mental development
8) Infant and geriatric nutrition
9) Nutritional basis of behavior, neutral tranquilizers
10) Amino acid therapy
11) Acidic and alkaline foods
12) Dietary fiber- chemical composition and importance
13) Physiological effects and metabolic adaptation during exercise
14) Nutritional management of inborn errors of metabolism

Reference books:

1. Essentials of food and nutrition M Swaminathan Vol. II, Applied aspects (1974) , Ganesh Pub, Madras
2. Human biochemistry – James Orten and Otto Neuhaus, 10th ed , CV Mosby co London
3. Human nutrition and dietetics-Davidson and Passmore
4. Amino acids in therapy – Leon Chaitwo, Thorsons publishers Inc. NY
5. Physiological chemistry- Hawk

SEMESTER IV

BCH 470 Biochemical Endocrinology and Tissue culture

Biochemical Endocrinology

1) General characteristics of hormones: chemistry , structure, synthesis, secretion, transport, metabolism & mechanism of action of hormones of the thyroid, hypothalamus, pituitary, pancreas, adrenals, glands, prostaglandins and gastro intestinal hormones, calcium signaling, zinc fingers
2) Secondary messengers and their mode of action
3) Cell membranes and intracellular receptors for hormones
4) Hormonal inter relationship
5) Biosynthesis of steroid hormones, cholera toxin, adenylate cyclase and TP, hormone overproduction and target cell insensitivity
6) EGF, NGF, PDGF, Enkephalin

Reference books:

1) Vertebrate endocrinology- Noris DO (1985) 2nd ed
2) Endocrine physiology- Martin, CR (1985(O xford Univ press (NY)
3) Physiological chemistry –Harper 17ed Lange medical
4) Biochemistry- Zubay (1983) Addison, Wesley publ. Co.
5) Text book of biochemistry –Williams, 6thed Saundes Co (1981)
6) Biochemical endocrinology E Frieden (1983)

Tissue culture

Plant tissue culture

Media requirements, sterilization and role of growth regulators, Requirements of a plant tissue culture laboratory, Micropropogation, Somatic cell hybridization, Haploid

(anther) culture, Embryo culture, Protoplast fusion, Somatic embryogenesis Somaclonal variations, Cybrides and Allopheny, Cell suspension and callus culture, Agrobacterium mediated hairy root culture, Conditioning of tissue culture plants (weaning and hardening), Active principles in medicinal plants and phytochemistry of the metabolites of medicinal importance.

Animal tissue culture

Media requirements, preparation of medium and sterilization techniques, Advantages and disadvantages of natural and synthetic media, Culture methods – hanging drop, suspension and monolayer culture, Behaviour and characteristics of cells in culture, Primary and established cell lines, characteristics of transformed cells. Methods of cell preservation, Organ culture – clot grid, chorioallantonic and ocular culture, Animal cell culture techniques: Cell strains and cell lines, primary cultures and secondary cultures, media for tissue culture, cloning, heterocaryons, variant cells, contact inhibitions, cell and tissue banking.

Reference Books:

1. Neurochemistry by Ferdinand Hucho, VCH Publication, 1986
2. Molecular cell Biology by Lodish, Baltimore, et al W.H. Freeman & Co.1996
3. Tissue Culture by John Paul
4. Plant cell tissue and Organ culture by Gamborg Phillips
5. Culture of Animal Cells by Ian Freshney
6. Molecular Biotechnology by S. B. Primrose

BCH 471 Fermentation and Enzyme Technology and Food Technology

Fermentation and Enzyme Technology

1. Characteristics of industrial microorganisms
2. Strain improvement , use of auxotrophic mutants
3. Methods and parameters of cultivation of microorganisms , media for industrial fermentation
4. Fermenters, design of fermenters, fermentation process, and maintenance of aseptic conditions, aeration and agitation.
5. Downstream processing, recovery and purification of fermentation products, effluent treatment
6. Applications of fermentation technology
7. Enzymes as industrial catalysts
8. Rationale for immobilizing enzymes
9. Methods for enzyme immobilization, supports and their selection
10. Properties of immobilized enzymes, whole cell immobilization rationale, methods and applications, industrial stabilization of enzymes
11. Industrial applications of immobilized enzymes

Reference Books

1. Principles of Fermentation technology, PF Stanbury, A Whitaker, SJ Hall (1997)
2. Molecular biology and biotechnology- edited by JM Walker and FB Gingold, Royal society of chemistry (1988)
3. Immobilized enzymes- An introduction and application in biotechnology- Michael Trevan, John Wiley sons (1980)
4. Fundamentals of enzymology-NC Price and L Stevens.
5. Methods in Enzymology Ed by K.Mosbach Vol 44 (1976),Vol 135,135a (1987)

Food Technology

1) Foods of animal and plant origin
2) Monitoring food quality
3) Primary feedstock
4) Proteins from unconventional sources- OCP, SCP etc
5) Starch production, manufacture of natural and synthetic sweeteners and syrups
6) Enzymes in food analysis , toxins, alcohol, amino acids, glucose
7) Enzymes in food processing, meat tenderization and fruit juice technology
8) Biochemistry of food spoilage, principles of food preservations
9) Food additives, starches, sugars, syrups and sweeteners, flavoring agents, colors
10) Genetically modified foods

Reference books

1) Enzymes and food processing- GG Birch, N Blackbrough (1981)
2) Nutrition and food processing- MG Miller , G Tobin, AVI publishing Co, Creem Holm (1980)
3) Introduction to food sciences and technology –GF Stewart and MA Amerine (1973) Academic Press

BCH 472 Genetic Engineering

1) Genetic engineering concepts
2) Enzymes in genetic engineering
3) Plasmids, bacteriophages, shuttle vectors,
4) Cloning in yeast, bacillus and streptomyces
5) Animal, virus and derived vectors- Phages , cosmid, M13, 2µcircles
6) Ti plasmids and plant genetic engineering
7) Genomic and C-DNA library construction
8) Selection of recombinant DNA clones, Southern and Northern blotting
9) Hybridization and immunological techniques
10) Characterization of recombinant gene-S1 mapping, sequencing
11) Restriction mapping, chromosome walking
12) In vitro mutagenesis
13) RFLP, PCR, DDRT PCR
14) Transgenic plant and animals
15) Application of genetic engineering in medicine, agriculture and industry.
16) Protein Engineering
17) Evolution
18) Developmental Biology
19) DGGE
20) Metagenomics
21) Microarray

Reference Books

1. Recombinant DNA- Short courses, JD Watson, John Tooze, David T. Kurtz, Scientific American books, WH Freeman &Co.
2. Principles of gene manipulation, SB Primrose (6^{th} ed).
3. Gene cloning- An introduction, T.A Brown, 2^{nd} &3^{rd} ed, Chapman &Hall.

BCH 474 Genomics and Biotechnology

Genomics

DNA structure , replication, recombination, repair, RNA structure, different types of transcription, post transcriptional modification, protein synthesis, activation of amino acids and RNA adapter role, ribosomes, initiation, elongation, termination, regulation of gene expression, viruses-replication, life cycle

Recombinant DNA technology, basic cloning steps, restriction endonucleases, vectors, ligation, transformation, identification of recombinants, hybridization, immunological tech, sequencing of DNA, site directed mutagenesis, cloning in bacteria, yeast plants, mammalian cell lines.

Biotechnology

1. Application of recombinant DNA technology in production of therapeutic proteins
2. Application of recombinant DNA technology in drug development
3. Application of recombinant DNA technology in forensic science
4. Application of DNA technology in production of recombinant diagnosis, enzyme engineering
5. Application of recombinant DNA technology in monoclonal antibodies
6. Immobilized biocatalysts and biosensors

Reference Books

1. Molecular biology and Biotechnology (3rd ed) JM Walker, EB Gingold, Panima publishing Corp., New Delhi/Bangalore
2. Introduction to the principle of drug design and action .(3rd ed) edited by H.John Smith, Horwood academic press

Practical for M.Sc. Part II Biochemistry

BCH-367 Molecular Biology and Clinical Biochemistry (5 Credits)

Molecular Biology

1. Isolation of DNA from E. coli/ liver/ plant/ plasmid
2. Determination of base composition (spectrophotometry)
3. Agarose gel electrophoresis of DNA
4. Restriction digests of DNA.
5. Isolation of plasmid
6. Transduction
7. Transformation
8. Expression analysis
9. Ligation
10. PCR
11. Plasmid mapping
12. Mutation
13. Induction of lac operon

Clinical Biochemistry

1. Estimation of Lipoproteins.
2. Glucose tolerance test

3. Estimation of bilirubin
4. Estimation of blood urea
5. Blood sugar determination by Folin-Wu method
6. Estimation of creatine phosphokinase
7. Normal and abnormal constituents of urine
8. Determination of blood cholesterol
9. Determination of glucose by glucose oxidase method
10. Estimation of glycosylated hemoglobin
11. Estimation of LDH and its isozymes
12. Estimation of alkaline phosphatase from serum
13. Estimation of total protein and albumin from serum
14. Determination of SGPT and SGOT
15. Estimation of serum amylase

BCH- 368 Special experiments (3 Credits)

Special experiments

1. Affinity chromatography
2. Immobilization of enzymes
3. Sub cellular fractionation
4. Biosensors
5. Spectroflourimetry
6. HPLC
7. Immunochemical techniques
8. Immuno-electrophoresis
9. Ouchterlony double diffusion
10. Complement fixation test.
11. ELISA
12. Production of Monoclonal antibodies

Reference Books:

1. Practical Biochemistry- David Plummer
2. Practical Biochemistry – J. Jayaraman
3. Biochemical methods – Sadasivam and Manickam
4. Biochemistry –Practical Approach – Kieth Wilson and J. Walker
5. Introductory Practical Biochemistry- Randhir Singh and Sawhney

BCH 467 PROJECT **7 Credits**

Industrial Study Tour

Summer Training