P.K.University
Shivpuri (M.P.)

SYLLABUS

M.Sc. Biochemistry

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BIOCHEMISTRY

Semester	Course Code	Title of the Paper	
First	BCH-101	Fundamentals of Cell Biology	100
	BCH-102	Biomolecules	100
	BCH-103	Microbial Biochemistry	100
	BCH-104	Bioinstrumentation	100
	BCH-105	Lab Course I	50
	BCH-106	Lab Course II	50
		Total	**500**
Second	BCH-201	Fundamentals of Molecular Biology	100
	BCH-202	Bioenergetics and Metabolism	100
	BCH-203	Immunochemistry	100
	BCH-204	Enzymology	100
	BCH-205	Lab Course III	50
	BCH-206	Lab Course IV	50
		Total	**500**
Third	BCH-301	Genetic Engineering	100
	BCH-302	Plant Biotechnology	100
	BCH-303	Clinical Biochemistry & Nutrition	100
	BCH-304	Physiology & Endocrinology	100
	BCH-305	Lab Course V	50
	BCH-306	Lab Course VI	50
		Total	**500**
Fourth	BCH-401	Frontiers in Biochemistry & Biostatistics	100
	BCH-402	Project Work	100
	BCH-403	Comprehensive Viva Voce	100
	BCH-404	Seminar	100
	BCH-405	Practical	100
		Total	**500**
		Total marks of all semester	**2000**

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BCH 101: Fundamentals of Cell Biology

UNIT I

1. Cellular and Chemical Foundations of Life
2. Prokaryotic and Eukaryotic Cells: Comparative Study; Cells as Experimental Models
3. Cell Membrane: Physicochemical Properties; Molecular Organization – asymmetrical organization of lipids, proteins and carbohydrates; and Functions
4. Molecular Models and Biogenesis of Cell Membrane

UNIT II

1. Transport of Small Molecules Across Cell Membranes: Types and Mechanism
2. Active Transport by ATP-Powered Pumps: Types, properties and mechanisms
3. Transport of proteins into mitochondria and chloroplast
4. Transport of proteins into and out of nucleus

UNIT III

1. Transport of proteins into endoplasmic reticulum
2. Processing of Proteins in Endoplasmic Reticulum and Golgi Apparatus
3. Transport by vesicle formation: Endocytosis and Exocytosis
4. Molecular Mechanism of vesicular transport

UNIT IV

1. Intracellular Digestion: Ultra structure and Functions of Lysosomes
2. Peroxisomes: Ultra structure, Functions and Biogenesis
3. Cell Motility and Shape I: Structure and Functions of Microfilaments
4. Cell Motility and Shape II: Structure and Functions of Microtubules and Intermediate Filaments

UNIT V

1. Intracellular communication through cell junctions: Molecular structure, organization and functions of Occluding Junctions, Anchoring Junctions and Communicating Junctions
2. Molecular Mechanism of Cell-Cell Adhesion: Ca^{++} dependent and Ca^{++} independent cell-cell adhesion
3. Extra-cellular Matrix of Animals: Molecular Composition, Organization and Functions
4. Extra-cellular Matrix Receptors on Animal Cells: Molecular Structure, Types and Distribution of Integrins

Practical Exercises

1. Sub cellular fractionation

2. Chromosome Preparation: Mitosis – Onion root tip, rat/mouse cornea, rat/mouse bone marrow, human lymphocytes
3. Chromosome Preparation: Meiosis – Rat/mouse testis, Grasshopper testis
4. Polytene chromosome preparation from Drosophila salivary gland
5. Identification of tissue typing: Histological preparation of tissue
6. Identification of different biomolecules in different tissues by histochemical techniques
7. Electron microscopy: Demonstration and good photographs for interpretation

Reference Books

1. Molecular Biology of the Cell, Alberts, *et al*
2. Molecular Cell Biology, Lodish, et al
3. Working with Molecular Cell Biology: A study Companion, Storrie *et al*

5. The Cell: A Molecular Approach, G.M. Cooper
6. The Word of the Cell, Becker *et al*
7. Cell Proliferation and Apoptosis, Hughes and Mehnet
8. Essential Cell Biology, Alberts *et al*
9. Biochemistry and Molecular Biology of Plants, Buchanan *et al*
10. Harpers Biochemistry Murray *et al*

Note: All text books are of latest editions.

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BCH 102: BIOMOLECULES

UNIT I

1 Carbohydrates : Structure, classification, properties and functions
2 Home and heterpolysaccharides : carbohydrate derivatives
3 Lipids : Classification, structure, properties and functions
4 Lipids with special biological functions

UNIT II

1 Amino acids : Structure, classification, abbreviations, properties and functions
2 Peptides and polypeptides
3 Synthesis of peptides and protein sequencing
4 Proteins : Properties, covalent structure, secondary, tertiary and quaternary structure

UNIT III

1 Enzymes : Classification, mechanism of action, allosteric enzymes,multienzyme complex
2 Enzyme kinetics : Basic concepts
3. Water soluble vitamins : Structure, distribution, interaction and biological functions (mechanism of action not included)
4. Fat soluble vitamins : Structure, distribution and functions

UNIT III

1 Nucleotides : Structure of purine and pyrimdine bases, nucleosides, nucleotides
2 DNA : Structure and Conformation
3 DNA : denaturation, degradation, modification, repair, recombination and rearrangement
4 RNA : Structure, types and functions

UNIT V

1 Animal hormones : Structure and biological roles
2 Plant hormones : Structure and biological functions
3 Plant phenolics: Classification and functions
4 Alkaloids : Classification and functions

Practical Exercises

1 Titration of amino acids
2 Colorimetric determination of pKa
3 Model building using space filling/ ball and stuck models
4 Reaction of amino acids, sugars and lipids
5 Quantitation of proteins and sugars

6 Analysis of oils : iodine number, saponification value, acid number

Reference Books

1 Principles of Biochemistry by Nelson, Cox and Lehninger
2 Biochemistry by G.Zubay
3 Biochemistry by Stryer
4 Biochemistry by Garrett and Grisham
5 Biochemical Calculations, Irwin H. Seigel, John Wiley and Sons Inc.
6 Biochemistry, DVoet and JG. Voet , J Wiley and Sons.
7 Biochemistry, D Freifilder, W.H. Freeman & Company.
8 Laboratory Techniques in Biochemistry and molecular Biology, Work and Work
9 A Biologist's guide to Principles and Techniques of Practical Biochemistry, Wilson & Goulding, ELBS Edition.

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BCH 103: MICROBIAL BIOCHEMISTRY

UNIT I

1 Classification of Microorganisms: Basis of microbial classification, Haekel three kingdom, Whittaker's five kingdom concept.
2 Morphology and fine structure of eubacteria and archeobacteria cell wall, cytoplasmic membrane and other organelles.
3 Pure culture techniques and preservation methods.
4 Preparation of Culture media, microbial staining.

UNIT II

1 Sterilization: Physical and chemical methods
2 Microbial Growth: Bacterial growth curve, Mathematical expression, measurement of Growth and factors affecting growth
3. Microbial Nutrition: Nutritional classification of Microorganisms, common nutritional requirements, mode of nutrition, transport of nutrients across the bacterial membrane
4. Oxygen toxicity: Study of catalase, peroxidase, superoxide dismutase, mechanism of oxygen toxicity.

UNIT III

1 Virus: Types, Isolation, cultivation, identification and viral replication.
2 Structure and morphology of Bacteriophage, Lytic and lysogenic cycle.
3 Life cycle of DNA Viruses: SV 40, RNA Viruses: Retroviruses
4 Cynobacteria : General account and their importance

UNIT IV

1 Infection and disease, types of Infection, Mechanism of pathogenicity
2 Bacterial Diseases: Staphylococcal and Clostridial food poisoning, Salmonellosis Shigellosis
3 Fungal diseases: Histoplasmosis , Aspergillosis
4 Viral diseases: Chicken pox, Hepatitis B, and Poliomyelitis

UNIT V

1 Mycoplasmas and diseases caused by them
2. Bacterial Recombination: Transformation, Conjugation, Transduction, Plasmids and transposons
3. Chemotherapeutic agents: Classification of antibiotics, Broad spectrum antibiotics, Antibiotics from prokaryotes
4. Anti-fungal and antiviral antibiotics, mode of action of antibiotics and resistance to antibiotics

Practical Exercises

1 Preparation of liquid and solid media for growth of microorganisms.
2. Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and

stab cultures. Storage of microorganisms

3. Isolation of pure cultures from soil and water.
4. Growth; Growth curve; Measurement of bacteria population by turbidometry and serial dilution methods. Effect of temperature, pH and carbon and nitrogen sources on growth.
5. Microscopic examination of bacteria, Yeast and molds and study of organisms by Gram stain, Acid fast stain and staining for spores.
6. Study of mutations by Ames test.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for portability and determination of MPN.
9. Bacterial transformation.
10. Biochemical characterization of selected microbes.
11. One step growth curve of coliphage.

Reference Books

1. General Microbiology, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The MacMillan Press Ltd.
2. Brock Biology of Microorganism, M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelzar, M.J., Chan , E.C.S. and Kreig, N.R., Tata McGraw Hill.
4. Microbial Genetics, Maloy , S.R., Cronan, J.E.Jr and Freifelder, D. Jones, Bartlett Publishers.
5. Microbiology-a Laboratory Manual,cappuccino, J.G. and Sherman, N. Addison Weseley.
6. Microbiological Applications, (A Laboratory Manual in General Microbiology) Benson, H.J. WCB: Wm C. Brown Publishers

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BCH 104 : BIOINSTRUMENTATION

UNIT I

1 Centrifugation: Basic principle, type, instrumentation and applications
2 Spectroscopy: Basic principles of colorimetry, and UV visible spectrophotometry, instrumentation and applications
3 Infra red spectroscopy
4 Fluorimetry: Principle, instrumentation and applications

UNIT II

1 Chromatography: Principle, types, instrumentation and applications
2 Affinity chromatography, HPLC and FPLC
3 Electrophoresis: Principle, types and applications
4 Isoelectricfocussing and isotachophoresis

UNIT III

1 Atomic absorption spectroscopy: Principle, instrumentation and applications
2 Flame emission spectroscopy: Principle, instrumentation and applications
3 Polarimetry: Principle, instrumentation and applications
4 ORD and CD

UNIT IV

1 ESR: Principle, instrumentation and applications
2 NMR: Basic principle, instrumentation and applications
3 X ray crystallography: Principle, instrumentation and applications
4 Mass Spectrometry: Principal, Mass Analyzers and Applications

UNIT V

1 Microscopy: Light, phase contrast, interference, fluorescence and polarization microscopy
2 Electron microscopy: Principle and Applications
3. Radioactivity: Principle, Geiger Muller Counter, liquid scintillation counter, solid scintillation counter, gamma counter
4. Autoradiography & Radio immunoassay: Basic principle and applications

Practical Exercises

1 Verification of Beer's law
2 Determination of absorption maxima
3 Electrophoresis of Proteins-native and under denaturing conditions.

4 Amino acid and carbohydrate separations by paper & thin layer chromatography
5 Gas chromatography
6 Ion exchange and gel filtration chromatography
7 Separation of blood cells by density gradient centrifugation

Reference Books

1. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by Freifelder
1 Biochemical Techniques: Theory and Practice by Robyt and White
2 Principles of Instrumental Analysis by Skoog and West
3 Analytical Biochemistry by Holme and Peck
4 Biological Spectroscopy by Campbell and Dwek
5 Organic Spectroscopy by Kemp
6 A Biologist's Guide to Principles and Techniques of Practical Biochemistry by Wilson and Goulding
7 Principles of Instrumental Analysis by Skoog, Hollar and Nicman

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BCH 201: FUNDAMENTALS OF MOLECULAR BIOLOGY

UNIT I

1. DNA Replication : General features of Chromosomal Replication; DNA Replication Machinery in Prokaryotes
2. DNA Replication Machinery in Eukaryotes
3. Enzymology of DNA Replication : DNA Polymerases; Primases; Ligases; Helicases; Topoisomerases; Gyrases and Single Stranded Binding Proteins
4. Regulation of DNA Replication

UNIT II

1. Transcription in Prokaryotes : Initiation, elongation and termination
2. Structure and functions of prokaryotic promoter
3. Control of transcriptional initiation in prokaryotes : Structure and functions of RNA Polymerase; Sigma factors – Types and functions
4. Control of transcriptional termination in prokaryotes : Intrinsic termination and Rho factor dependent termination; attenuation and antitermination

UNIT III

1. Regulation of Gene Expression in Prokaryotes : Operon concept, induction and repression, Structure and regulation of lactose, arabinose and tryptophan operons
2. Initiation of Transcription in Eukaryotes : RNA Polymerases – Types and properties; Promoter – Types, structure and properties
3. Transcription factors – Types and properties; Enhancers – Structure and properties; Response Elements
4. Post-transcriptional Modification Eukaryotes – 5’ and 3’ modification of mRNA

UNIT IV

1. Post-transcriptional Processing of pre tRNA and pre tRNA transcripts
2. Post transcriptional Processing of pre rRNA and Catalytic RNA
3. Genetic Code : Evidence and properties; Wobble hypothesis
4. Translational adaptors and amino acyl tRNA synthetases
5.

UNIT V

1. Translation: Successive stages of protein synthesis in prokaryotes and its comparison with eukaryotes
2. Post-translational Modification: Types and Significance
3. Regulation of Gene Expression in Eukaryotes: *cis*-acting DNA Elements; Chromatin organization and regulation of gene expression; Regulation at the level of processing of transcripts

4. Regulation of Gene Expression in Eukaryotes: RNA Editing; Gene Alteration; DNA methylation and gene regulation; Regulation of gene expression by hormones; Regulation of gene expression at translational level

Practical Exercises

1. Isolation of genomic DNA and restriction digestion
2. Size fractionation of restricted DNA fragments by Agarose Gel Electrophoresis
3. Quantitation of DNA
4. Determination of Amax of purified DNA fragments
5. Determination of Tm of nucleic acid
6. Isolation of RNA
7. Fractionation of poly $(A)^+$ RNA
8. *In vitro* transcription
9. *In vitro* translation
10. Metabolic labeling of proteins and immunoprecipitation
11. Protein- DNA interaction

Reference Books

1. Genes VIII , by Benjamin Lewin
2. Molecular Biology, by Turner *et al*
3. Cell and Molecular Biology: Concepts and Experiments, by Gerald Karp
4. Transcriptional Regulation in Eukaryotes, by Carey and Smale
5. Translational control of gene Expression, by Sonenberg *et al*
6. Chromatin and Gene Regulation, by Turner
7. An Introduction to Genetic Analysis, by Griffiths *et al*
8. Genome, by Brown
9. Concepts of Genetics, by Klug and Cummings
10. Proteins, by Creighton
11. Molecular Cell Biology, by Lodhish *et al*
12. Biochemistry and Molecular Biology of Plants, by Buchanan
13. Plant Biochemistry and Molecular Biology, by Lea and Leegood
14. Plant Biochemistry, by Dey and Harborne

Note: All text books are of latest editions.

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BCH 202 : BIOENERGETICS AND METABOLISM

UNIT I

1 First and second laws of thermodynamics
2 Concept of free energy
3 ATP Cycle, ATP as high energy compound, functions of ATP
4 Other high energy biological compounds

UNIT II

1 Basic Concepts of intermediary metabolism
2 Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, glyconeogenesis, glyoxalate pathway
3 Regulation of carbohydrate metabolism
4 Inborn errors of carbohydrate metabolism

UNIT III

1 Electron transport and oxidative phosphorylation
2 Biosynthesis and degradation of lipids
3 Regulation of lipid metabolism
4 Inborn errors of lipid metabolism

UNIT IV

1 Nitrogen assimilation
2 Biosynthesis of amino acids
3 Degradation of amino acids
4 Regulation of amino acid metabolism

UNIT V

1 Inborn errors of amino acid metabolism
2 Nucleic acid metabolism
3 Inborn errors of nucleic acid metabolism
4 Integration of metabolism and metabolomics

Practical Exercises

1 To observe the catabolism of carbohydrates by micro-organisms
2 To observe the production of gas by micro-organisms during fermentation
3 To demonstrate the production of pyruvate and acetaldehyde during fermentation of glucose by yeast
4 To demonstrate biological oxidation and electron transport in heart muscle tissue
5 To observe the effect of fasting on the metabolism of rats

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BCH 203 : IMMUNOCHEMISTRY

UNIT I

1 Immune response: Innate immune mechanisms and characteristics of adaptive immune response, Hematopoiesis

2 Anatomical organization of immune system: Primary lymphoid organs, Secondary lymphoid organs. Ontogeny and Phylogeny of lymphocytes, Lymphocyte traffic

3 Cell of the immune system: Mononuclear cells and granulocytes, Antigen presenting cells, Lymphocytes and their subsets. Antigens, Heptanes: Factors affecting immunogenicity, properties of T and B Cell epitopes, Super antigens

4. Inflammation; its mediators and the process, Cell adhesion molecules and their role in inflammation, lymphocyte homing, tissue injury and immune response leading to an inflammatory reaction, role of anaphylatoxins, granulocytes in inflammatory process

UNIT II

1 Major histocompatibility systems: Structure of MHC I and II molecules, polymorphism, distribution variation and function. Organization of MHC complex in Mouse and Humans. Association of MHC with disease

2 Recognition of antigens by T and B Cells: Antigen processing, Role of MHC molecules in antigen presentation and Costimulatory signals

3 T – cell receptor complex, T-cell accessory membrane molecules, activation of T cells, Organization and arrangement of T-receptor genes

4 B-cell receptor complex, Activation of B-cells, Immunoglobulins: Molecular structure, types and functions. Antigenic determinants on immunoglobulins

UNIT III

1 Molecular mechanism of antibody diversity: Organization of genes coding for constant and variable regions of heavy chains and light chains. Mechanisms of antibody diversity, Class switching

2 Antibody engineering, Antigen-Antibody interaction, avidity & affinity measurement

3 Monoclonal antibodies: Production, characterization and applications in diagnosis, therapy and basic research

4 Complement system, components, activation pathways, and regulation of activation pathways, Complement deficiencies, Role of complement system in immune responses

UNIT IV

1 Cytokines: Structure and functions, cytokine receptors, signal transduction mediated by cytokine receptors, cytokine regulation of immune responses, cytokine related diseases and therapeutic applications of cytokines

2 Cytotoxic T cells and their mechanism of action, NK cells and mechanism of target cell destruction. Antibody dependent cell mediated cytotoxicity, Delayed type hypersensitivity. Techniques of Cell mediated immunity

3 Immunoregulation mediated by antigens, antibodies, immune complexes, MHC and cytokines

4 Hypersensitivity: Definition, IgE mediated hypersensitivity, mechanism of mast cell

degranulation, mediators of type-I reactions and consequences. Type II reactions, Immune complex mediated hypersensitivity and Delayed type hypersensitivity

UNIT V

1 Autoimmunity: Organ specific diseases, Systemic diseases, Mechanisms of autoimmunity and therapeutic approaches
2 Immunodeficiency syndromes: Primary immunodeficiencies and Secondary immunodeficiencies and their diagnosis and therapeutic approaches
3 Vaccines: Active and passive immunization, Whole organism vaccines, Macromoleculesas vaccines, Recombinant-vector vaccines, DNA Vaccines, Synthetic peptide vaccines and sub-unit vaccines
4 Immunodiagnostics : Precipitation techniques, Agglutination, Fluorescence techniques, ELISA, RIA, Western blotting and Immno-histochemical techniques

Practical Exercises

1 Blood Film preparation and identification of cells.
2 Lymphoid organs and their microscopic organization.
3 Immunization and production of polyclonal antibodies
4 Double diffusion and Immuno-electrophoresis.
5 Radial Immunodiffusion.
6 Purification of IgG from serum.
7 Separation of mononuclear cells by Ficoll-Hypaque.
8 Con-A induced proliferation of thymocytes (by MTT method).
9 Western –blotting.
10 ELISA
11 Preparation of antibody-enzyme conjugates

Reference Books

1 Kubey, Immunology, R.A. Goldsby, Thomas J. Kindt, Barbara, A. Osbarne. (Freeman).
2 Immunology-Ashort Course, -Eli Benjamini, Richard Coico, Geoffrey Sunshine.
3 Immunology by Tizzard
4 Fundamentals of immunology by William Paul.
5 Immunology by Roitt *et al*
6 Immunology by Abbas

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BCH 204: ENZYMOLOGY

UNIT I

1 Enzyme: Historical aspects, classification and nomenclature, EC number.
2 Mechanism of enzyme catalysis and action
3 Sub cellular localization and organization of enzymes
Methods of enzyme assay: continuous and sampling techniques, coupled enzyme assay and methods and significance of enzyme turnover number; specific activity

UNIT II

1 Enzyme purification techniques: objectives and strategy; methods of homogenization; method of isolation; purification and crystallization
2 Criteria of purity and tabulation of purification data; stable storage of enzymes
3 Characterization of purified enzyme
4 Coenzymes, Cofactors and Isoenzymes

UNIT III

1 Enzyme Kinetics: Equilibrium and steady state theory, rate equationand determination of Km and Vmax
2 Factors affecting rate of enzyme reaction: pH, temperature and pressure
3 Enzyme inhibition: reversible and irreversible inhibition, their type, inhibitor constant and its significance
4 Rapid reaction techniques

UNIT IV

1 Protein-ligand binding: types, cooperativity, Hill and Scatchard plot, Allosteric enzymes : Models of allostery, types and kinetics
2 Regulation of enzymes
3 Mechanism of action of Chymotrypsin; Ribonuclease; Lysozyme; Metallo-enzymes
4 Degradation of enzymes

UNIT V

1 Enzyme immobilization; techniques; experimental procedures and effect of immobilization on kinetic parameters
2 Principle and Industrial application of immobilized systems
3 Enzymes in Medical diagnosis and enzyme therapy
4 Enzymes during aging

Practical Exercises:

1 Protein estimation methods: Lowry, Bradford and Spectrophotometeric.
2 Urease estimation in plant tissues
3 Assay of Acid phosphatase in plant seeds

4 Assay of Alkaline phosphatase in Kidney and Liver
5 Determination of optimum pH, temperature & time
6 Determination of Km value of alkaline phosphatase
7 Acetylcholinesterase estimation in Rat /Goat Brain
8 Enzyme purification: Ammonium sulphate precipitation, Ion exchangechromatography, molecular sieve chromatography.
9 Checking of purity of enzyme by PAGE
10 Molecular weight determination of enzyme by Gel Filtration
11 Immobilization of HRP (Horse reddish peroxidase).
12 Kinetic properties of Immobilised HRP
13 Sub-cellular fractionation of rat liver and marker enzyme assays.

Reference Books

1 The Nature of Enzymology by R.L. Foster
2 Enzymes by Dixon and Webb
3 Fundamentals of Enzymology by Price and Stevens
4 Enzyme Catalysis and Regulation by Hammes
5 Enzyme Reaction Mechanisms by Walsch
6 The Enzymes vol I and II by Boyer
7 Enzyme Structure and Mechanism by Alan Fersht
8 Enzyme Assays: A Practical Approach by Eisenthal and Danson
9 Enzyme Biotechnology by G. Tripathi
10 Practical Biochemistry by Plummer.
11 Practical Biochemistry by Sawhney and R. Singh

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BCH 301: GENETIC ENGINEERING

UNIT I

1. The recombinant DNA Technology : General concept and Principle of cloning
2. Enzymes: Nucleases and restriction endonucleases – properties and types; phosphomonoesterases; polynucleotide kinase; DNA ligase; DNA polymerase I; RNA Dependent DNA Polymerase; terminal deoxynucleotidyl transferase; poly A polymerase
3. Prokaryotic host-vector system: Characteristics of *E. coli* as host; vectors for cloning in *E. coli* (plasmid, bacteriophage and plasmid-phage)
4. Other Prokaryotic host vector systems: Characteristics of Gram positive and Gram negative organisms as host and suitable vectors for cloning; Shuttle Vectors

UNIT II

1. Design and characteristics of expression vectors for cloning in prokaryotes
2. Factors affecting expression of cloned genes in prokaryotes
3. Cloning in Yeast: Properties of yeast as host for cloning and different types of vectors designed for cloning in yeast
4. Cloning in animals system: Animal system as a model host, Methods of introduction of foreign DNA in animal system

UNIT III

1. Vectors for cloning in animal system – SV 40, bovine papilloma virus, adenovirus, vaccinia virus, baculovirus and retrovirus vectors
2. Methods for Constructing rDNA and cloning: Inserts; vector insert ligation; infection, transfection and cloning
3. Methods for screening and selection of recombinant clones
4. DNA Libraries: Types, advantages and disadvantages of different types of libraries; Different methods for constructing genomic and full length cDNA libraries

UNIT IV

1. Gross anatomy of cloned insert – size, restriction mapping and location
2. Fine anatomy of DNA segment – General principle of chemical and enzymatic methods of nucleotide sequence analysis
3. Localization of cloned segments in genomes – molecular and chromosomal location
4. Methods for determination of copy number of a cloned gene in genome

UNIT V

1. Mutant construction: Introduction, deletion, insertion and point mutation
2. Applications of Recombinant DNA Technology in Medicine
3. Biosafety Measures
4. Regulations for Genetically Engineered Products

Practical Exercises

1. Bacterial Culture and antibiotic selection media. Preparation of competent cells
2. Isolation of plasmid DNA
3. Isolation of phage DNA
4. Quantitation of nucleic acids
5. Restriction mapping of plasmid DNA
6. Cloning in plasmid/phagemid vectors
7. Preparation of helper phage and its titration
8. Preparation of single stranded DNA template
9. Gene expression in *E .coli* and analysis of gene product
10. Polymerase Chain Reaction

Reference Books

1. Recombinant DNA – By Watson et al
2. Principles of Gene Manipulation, by Old and Primrose
3. Gene Cloning: An introduction, by Brown
4. Biotechnology: Theory and Techniques (Vol I & II), by Chirikjian
5. Molecular Genetics of Bacteria , Dale
6. Molecular Cloning (Vol I, II & III), by Sambrook & Russell
7. Applied Molecular Genetics, by Miesfeld
8. Genes and Genome, by Singer & Berg
9. Molecular Biotechnology, by Glick & Pasternak
10. Plant Molecular Biology (Vol I & II), by Gilmartin & Bowler

Note: All text books are of latest editions:

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BCH -302A PLANT BIOCHEMISTRY

UNIT I

1. Specialized plant organelles : Cell plate, Cell wall- Chemical and physical composition, biosynthesis, primary and secondary cell walls, Plasmadesmata, Plasids- Types and functions, Importance of vacuoles and microbodies, Meristematic cells an root quiescent zone
2. Absorption, adsorption and transport of water and ions in plants
3. Translocation of inorganic and organic substances
4. Structure and biogenesis of organelles involved in photosynthesis in plants

UNIT II

1. Chloroplast membrane and molecular organization of thylakoids, proton gradient and electron transfer in chloroplasts of plants and in purple bacteria-difference from mitochondria
2. Light receptors- Chlorophyll, light harvesting complexes, bacteriorhodopsin as ion pump
3. Photosystem I and II- Location, mechanism of energy transfer between pghotosystems, ferrodoxin, plastocyanin, plastoquinones and carotenoids
4. Hill reaction and photophosphorylation

UNIT III

1. The Calvin Cycle- Evidence, mechanism and stoichiometry, role of light in activation of dark phase enzymes
2. Photorespiration: Mechanism and regulation
3. The C4 mode of photosynthesis: Mechanism, stoichiometry and purpose, difference from C3 in relation to plant productivity

1. Crassulacean Acid Metabolism: Mechanism and regulation

UNIT IV

1. Biological Nitrogen Fixation: Formation of ammonia, conversion of nitrate to ammonia, assimilation and secondary assimilation of ammonia, inhibitors
2. Molecular properties of nitrogenase system, *nif* genes and their regulation, applications of biological nitrogen fixation
3. Molecular effects and mechanism of action of Auxin and Gibberellic Acid
4. Molecular effects and mechanism of action of Auxin and Gibberellic Acid

UNIT V

1. Secondary metabolites: Plant alkaloids- Distribution, localization and biosynthesis of true proto and pseudoalkaloids, biological functions
2. Plant phenolics : nature, distribution, biosynthesis and regulation of phenolics, phenolic acids, hydroxycinnamic acid, phenylpropenes, quinines, xanthones, stilbenes, flavanoids, bioflavanoids, lignins and tannins, biological functions
3. Biochemistry of seed development and fruit ripening
4. Defense system in plants

Practical Exercises

1. Estimation of plant proteins
2. Estimation of plant lipids and carbohydrates
3. Isolation of plant pigments, their analysis and determination of absorption Maxima
4. Chloroplast isolation
5. Hill Reaction
6. Estimation of nitrogenase
7. Estimation of nitrate reductase- *in vivo* method
8. Fruit ripening
9. Estimation of total phenolic compounds
10. Estimation of anthrocyanin pigments

Reference Books

1. Handbook of Photosynthesis by Mohammad Pe Sarakle
2. Plant Physiology by Salisburry and Ross
3. Introduction to Plant Biochemistry by Goodwin and Mercer
4. Seed: Physiology of Development and Germination by Bewley and Balck
5. Biochemistry of Energy Utilization in Plants by Blakie
6. Plant Biochemistry by Dey and Harbome

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BCH 305B : BIOCHEMICAL TOXICOLOGY

Unit I

1. Introduction to Toxicology
2. Basic Concepts
3. Toxicants of public health hazards and toxic compounds
4. Epidemiology and biostatistics in Toxicology
5. Absorption, translocation and excretion of toxicants

Unit II

1. Toxicological testing methods
2. Systemic toxicity testing
3. Exposure assessment and analytical methods in toxicology
4. Toxicological pathology
5. Biomagnification and bioaccumulation

Unit III

1. Toxic metals in environment
2. Petroleum and solvent toxicity
3. Pesticide toxicity
4. Toxicity of ionizing radiations
5. Toxicology of gaseous pollutants

Unit IV

1. Biotransformation and degradation of toxicants
2. Toxicokinetics
3. Organ toxicology
4. Genetic and reproductive toxicology
5. Toxicogenomics

Unit V

1. Nutrition toxicology and Immunotoxicology
2. Neurotoxicology and Occupational toxicology
3. Environmental Toxicology
4. Risk assessment and chemical safety evaluation
5. Legislation and International regulation

Practical

1. Determination of LD_{50} /LC_{50}
2. Determination of metal content in samples
3. Determination of Biological Oxygen Demand
4. Determination of Chemical Oxygen Demand
5. Biomarkers of neurotoxicity of organophosphate compounds

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BCH 303-A: CLINICAL BIOCHEMISTRY & NUTRITION

UNIT I

1. Basic Concepts: Composition of human body, Energy contents of foods, Measurement of energy expenditure, Direct and indirect calorimetry, Definition of BMR and SDA and factors affecting these, Thermogenic affects of foods, Energy requirements of man and woman and factors affecting energy requirements
2. Dietary requirements, sources of available and unavailable carbohydrates, physiological action of unavailable carbohydrates, Protein reserves of human body, Essential amino acids and concept of protein quality, Protein requirement at different stages of growth.
3. Nutritional and clinical significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper.
4. Vitamins: Dietary sources, biochemical functions, specific deficiency diseases associated with fat and water soluble vitamins, Hypervitaminosis, Nutritional requirements during pregnancy, lactation and of infants and children

UNIT II

1. Protein energy malnutrition: Etiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkar diseases
2. Obesity: Definition and classification, Genetic and environmental factors leading to obesity, Obesity related diseases and management of obesity, Role of leptin in regulation of body mass
3. Clinical nutrition: Role of diet and nutrition in the prevention and treatment of diseases, Dental caries, Fluorosis, renal failure, hyperlipidemia, atherosclerosis and rheumatic disorders
4. Food allergy: Definition, role of antigen, host and environment, Types of hypersensitivities, diagnosis and management of allergy

UNIT III

1. Basic concept: Concept of accuracy, precision, normal and reference value determination, collection, processing and preservation of specimen, analysis, laboratory management, automation and quality control
2. Clinical significance of specific plasma/ CSF proteins, Clinical applications of serum protein eletrophoresis, Hemoglobinopathies
3. Carbohydrate metabolism : Carbohydrate intolerance, Diabetes mellitus, types, etiology and pathogenicity, Hypoglycemia, ketone bodies
4. Lipid metabolism :Diagnostic significance of analysis of serum lipids, chlolesteol and heart disease, Lipoprotein metabolism and disorders

UNIT IV

1. Kidney; Role of kidney in biochemical processes, Renal clearance, renal diseases and kidney function tests
2. Liver: Role of liver in biochemical processes, Bilirubin metabolism, ammonia metabolism, liver diseases and liver function test
3. Gastrointestinal tract: Disorders and diagnosis

4. Clinical enzymology Use of enzymes in diagnosis, Tissue distribution of enzymes, Diagnostic significance

   of acid phosphates, alkaline phosphatase, amylase, cholinesterase, creatine kinase, gamma glutamyl transfearse, lactate dehydrogenase, lipase

UNIT V

1. Hemoglobin, porphyrin and related compounds: Disorders and diagnosis
2. Thyroid : Disorders and diagnosis
3. Hypothalamic-pituitary-adrenocortical system: Functions, disorders and diagnosis
4. Adrenal and gonads ; Disorder and biochemical assessment

Practical Exercises:

1. Electrophoretic separation of serum proteins on agarose gel
2. Estimation of serum albumin and determination of albumin : globulin ration
3. Estimation of blood glucose by glucose-oxidase method
4. Estimation of serum triglycerides
5. Estimation of serum total cholesterol, HDL cholesterol, LDL cholesterol
6. Estimation of serum bilirubin
7. Electrophoretic separation of sickle hemoglobin
8. Estimation of serum acid phosphatase
9. Estimation of serum alkaline phosphatase
10. Estimation of serum aspartate transaminase
11. Estimation of serum creatinine

Reference Books

1. Tietz Text book of Clinical Chemistry
2. Clinical Chemistry by DF Calbreath
3. Clinical Biochemistry by Varley

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BCH-303B: GENOMICS & PROTEOMICS

Unit I

1. Introduction Structural organization of genome in Prokaryotes and Eukaryotes;
2. Organelle DNA-mitochondrial, chloroplast;
3. DNA sequencing-principles and translation to large scale projects;
4. Recognition of coding and non-coding sequences and gene annotation;
5. Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II

1. Genome sequencing projects Microbes, plants and animals;
2. Accessing and retrieving genome project information from web;
3. Comparative genomics,
4. Identification and classification using molecular markers-16S rRNA typing/sequencing, ESTs and SNPs.

Unit III

1. Microarray chips: Types of DNA chips and their production.
2. Gene Therapy for Human Diseases.
3. Protein Crystallization; Theory and methods: API Electrospray and MALDI-TOF.
4. SNP's and GMS (Genome mismatch Signals)

Unit IV

1. Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins;
2. Microscale solution isoelectricfocusing; Peptide fingerprinting;
3. LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics,
4. Protein-protein interactions, Yeast two hybrid system.
5. Functional Proteomics: Significance of Proteome research

Unit V

1. Overview of Bioinformatics; Introduction to MEDLINE on PubMed systems for accessing Biological Information Entrez, Swissport, PIR, NCBI.
2. Sequence Databases: Contents, Structure, and annonation for Human Genome Databases, Plant Genome Databases, Retrieving and installing a programme (Tree Tool)
3. Multiple sequence alignment programmes; Genome mapping applications: EST and functional genomics, EST cluster gene discovery, ORF prediction
4. Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

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BCH-304: PHYSIOLOGY AND ENDOCRINOLOGY

UNIT I

1. Composition of Blood: Structure, functions and biogenesis of RBC
2. Functions of hemoglobins, plasma proteins
3. Circulatory System (Open and closed circular, lymphatic systems)
4. Mechanism of blood coagulation : extrinsic and intrinsic pathways, inhibitors of coagulation

UNIT II

1. Urine formation: Formation of dilute and concentrated urine
2. Regulation of water electrolyte balance and role of kidney and hormones
3. Acid-base balance and its regulation by kidney and hormones
4. Digestive system

UNIT III

1. Nerve impulse transmission: structure of neuron, mechanism of conduction of nerve impulse along axon, neurotransmitters
2. Presynaptic and post-synaptic events of neuromuscular junctions
3. Ultra structure and molecular mechanisms of contraction of skeletal muscles and its regulation, energetics of muscle contraction, relaxation
4. Contraction of smooth muscles

UNIT IV

1. General characters and classification of hormones, receptors and mechanism of actin of hormones
2. Structure, synthesis, secretion, transport, metabolism and function of the hormones secreted by the pituitary
3. Structure, synthesis, secretion, transport, metabolism and function of the hormones secreted by parathyroid
4. Hormones of the thyroid structure, synthesis, secretion, transport, metabolism and functions

UNIT V

1. Hormones of the adrenal medulla; structure, synthesis, secretion, transport, metabolism and functions
2. Hormones of the adrenal cortex: structure, synthesis, secretion, transport, metabolism and functions
3. Hormones of the pancreas: structure, synthesis, secretion, transport, metabolism and functions

4. Hormones of the testis and ovary: structure, synthesis, secretion, transport, metabolism and functions

Practical Exercises :

1. To determine Hb% by Sahli's hemometer in blood samples
2. To determine the hematocrit
3. To determine the concentration of heparin in blood samples
4. To determine the PTT in blood samples
5. To demonstrate the effect of diet and hormones on the glycogen content of rat liver

Reference Books

1. Physiology by Guyton
2. Medical Physiology by Best and Taylor
3. Physiology by Garrett
4. Harper's Reviews of Biochemistry

BCH-305 : Lab Course V

Consists of practical exercises listed out under 301 & 302

BCH-306 : Lab Course VI

Consists of practical exercises listed out under 303 & 304

BCH-307: Seminar

Bch-308: Assignment

Bchh-309: Comprehensive viva


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BCH-401 FRONTIERS IN BIOCHEMISTRY & BIOSTATISTICS

UNIT I

1. Introduction and organization of animal cell and tissue culture laboratory, Contamination, Primary and established cell line culture
2. Serum and protein free defined media and their applications, measurement of viability and cytotoxicity
3. Introduction to balanced salt solutions and simple growth medium: Brief introduction of the chemical, physical and metabolic functions of different constituents of culture medium, Role of carbon dioxide and supplements
4. Biology and characterization of the cultured cells, measurement of parameters of growth

UNIT II

1. Basic techniques of mammalian cell culture: Disaggregation of tissues, Primary and established cell line cultures and mass culture techniques
2. Stem cell technology: Types of stem cell, manipulations of stem cells
3. Factors governing manipulation of stem cell, Therapeutic cloning for embryoinic stem cell (ESC's)
4. Applications of stem cell cultures

UNIT III

1. Introduction of plant tissue culture and laboratory organization
2. Tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture, single cell clones
3. Organogenesis : Somatic embryogenesis, transfer and establishment of whole plants in soil
4. Protoplast isolation, culture, regeneration and somatic hybridization and applications of plant tissue culture

UNIT IV

1. Nanobiotechnology: Introduction to nanoscinece, Tools for measuring nano structures
2. Biosensor development and its applications
3. Microarray chips: Types of DNA chips and their production
4. SNP's and GMS (Genome mismatch repair)

UNIT V

1. Functional proteomics: Methods of proteome analysis
2. Human Genome Project (HGP): The human genome/ Social implications
3. Forensic applications of DNA analysis
4. Patents and intellectual property: Intellectual property areas: Trademarks, copyrights. The process of obtaining a patent, Why obtain a patent, Recent changes in IPR and Patent policies

Reference Books:

1. DNA Microarrays and Gene Expression by P.Baldi and G.W.Hatfield
2. Protein-Protein Interactions by Erica Golemis
3. A passion for DNA (Genesm Genomes and Society) by J.D.Watson
4. Modern Genetic Analysis by Anthny J.F. Griffiths et al.
5. Nanobiotechnology- Next Big Idea by Mark, Ratner, Daniel Ratner
6. Gene Cloning by T.A.Brown
7. Latest information on academic Websites

BCH-402: Project work

BCH-403: Comprehensive viva voice

BCH-404: Seminar

BCH-405: Lab course based on 401