BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

M.Sc. Biochemistry - Course Structure under CBCS

(applicable to the candidates admitted from the academic year 2008-2009 onwards)

Semester	Course	Course Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Extn.	
I	Core Course – I (CC)	Chemistry of Biomolecules	6	5	3	25	75	100
	Core Course – II (CC)	Analytical Techniques	6	5	3	25	75	100
	Core Course – III (CC)	Enzymes and Enzyme Technology	6	5	3	25	75	100
	Core Course – IV (CC)	Cell Biology and Physiology	6	4	3	25	75	100
	Core Course – V (CC)	Practical - I	6	4	6	40	60	100
		Total	**30**	**23**				**500**
II	Core Course – VI (CC)	Metabolism and Regulation	5	5	3	25	75	100
	Core Course – VII (CC)	Molecular Biology	5	5	3	25	75	100
	Core Course – VIII (CC)	Microbiology	5	5	3	25	75	100
	Core Course – IX (CC)	Practical - II	5	3	6	40	60	100
	Elective – I (EC)	Biostatistics	5	5	3	25	75	100
	Elective – II (EC)	Endocrinology	5	5	3	25	75	100
		Total	**30**	**28**				**600**
III	Core Course – X (CC)	Immunology	7	6	3	25	75	100
	Core Course – XI (CC)	Clinical Biochemistry	6	5	3	25	75	100
	Core Course – XII (CC)	Practical – III	7	5	6	40	60	100
	Elective – III	Genetic Engineering	5	5	3	25	75	100
	Elective – IV	Biotechnology	5	5	3	25	75	100
		Total	**30**	**26**				**500**
IV	Core Course – XIII (CC)	Bioinformatics	6	5	3	25	75	100
	Project Work	Dissertation=80 Marks [2 reviews –20+20=40 marks Report Valuation = 40 marks] Viva = 20 Marks	24	8				100
		Total	**30**	**13**				**200**
		Grand Total	**120**	**90**				**1800**

Note:

Core Courses include Theory, Practicals & Project

No. of Courses	14 - 17
Credit per Course	4 - 5
Total Credits	70

Elective Courses

(Major based / Non Major / Internship)

No. of Courses	4 – 5
Credit per Course	4 – 6
Total Credits	20

	Internal	External
Theory	25	75
Practicals	40	60

Project

Dissertation	80 Marks	[2 reviews – 20+20	=	40 marks
		Report Valuation	=	40 marks]
Viva	20 Marks			20 marks

Passing Minimum in a Subject

CIA	40%	Aggregate 50%
UE	40%	

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SEMESTER – I

CORE COURSE I –Chemistry of Biomolecules

Unit 1

Classification of amino acids and general properties. The peptide bond– the Ramachandran plot. Chemical synthesis of peptides– Merrifield method. Proteins– classification, denaturation and renaturation. Orders of protein structure. Secondary structure– the α-helix, β- pleated sheet. Pauling and Corey model for fibrous proteins. Collagen triple helix. Protein sequencing.

Unit 2

Super secondary structure– helix– loop helix, the hairpin β -motif and the β-α-β-motif. Forces stabilizing tertiary and quaternary structure. Structure of haemoglobin– oxygen binding and changes in conformation. Structure of myoglobin- Methods of isolation, characterization and purification of proteins.

Unit 3

Polysaccharides: structure and biological functions of Homo polysaccharides structure and biological functions of chitin, fructans, mannans, xylans, and galactans. Hetero polysaccharides. Structure and biological importance of sugar derivatives- glycosaminoglycans, proteoglycans. Glycoprotein – Blood group and bacterial cell wall polysaccharides, O- linked and N- linked oligosaccharides and Lectins.

Unit 4

Definition and classification of lipids. Biological significance of fat. Types of Fatty acids-Essential, Non essential. Structure and biological functions of phospholipids, sphingolipids, glycolipids. Steroids–functions of cholesterol, bile acids, sex hormones, ergosterol. Fatty acids as inflammatory mediators. Structure and biological role of prostaglandins, thromboxanes and leukotrienes.

Unit 5

Structure of purines, pyrimidines, nucleosides and nucleotides. DNA double helical structure. A, B and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA: buoyant density, viscosity, hypochromicity, denaturation and renaturation– the cot curve. DNA sequencing– chemical and enzymatic methods. Chemical synthesis of DNA. RNA– types and biological role. Secondary, tertiary structures of RNA. Minerals in Biological systems and its importance –Iron, calcium, Phosphorous, Iodine, Copper, Zinc. Fat and water soluble Vitamins – properties and function. Role of Vitamin as Antioxidant.

Books recommended

1. Biochemistry Zubay 4th edition 1998 William C.Brown Publication.
2. Harper's Biochemistry 25th edition McGraw Hill.
3. Biochemistry Stryer 4th edition Freeman.
4. Principles of Biochemistry. Lehninger Nelson Cox Macmillan worth Publishers, 2000.
5. Biochemistry. Davidson and Sittmann, NMS 4th ed. Lippincott Williams and Wilkins, 1999
6. Biochemistry – Voet and Voet.
7. Biochemistry – David Rawn.

CORE COURSE II – ANALYTICAL TECHNIQUES

Unit 1 Spectroscopic techniques

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UVvisible spectrophotometry and spectrofluorimetry. Basic principles of turbidimetry and nephelometry. Principle, instrumentation and applications of luminometry. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy. - MALOF TOF.

Unit 2 Centrifugation and radioisotope techniques

Ultracentrifuges– Analytical ultracentrifuge– instrumentation and applications. Preparative ultracentrifuge– types, instrumentation and applications of preparative rotors. Analysis of subcellular fractions and determination of relative molecular mass– sedimentation velocity and sedimentation equilibrium.

Units of radioactivity. Detection and measurement of radioactivity– solid and liquid scintillation counting, scintillation cocktails and sample preparation. Cerenkov counting. Autoradiography. Applications of radioisotopes in biology. Radiation hazards.

Unit 3 Electrophoresis and Electrochemical techniques

Electrophoresis: General principles. Support media. Electrophoresis of proteins– SDS-PAGE, native gels, gradient gels, isoelectric focusing, 2-DPAGE. Cellulose acetate electrophoresis. Detection, estimation and recovery of proteins in gels. Electrophoresis of nucleic acids– agarose gel electrophoresis, DNA sequencing gels, pulsed field gel electrophoresis. Membrane blotting and hybridization of

nucleic acids– Southern, Western, dot-blot and fluorescent in situ hybridization. RFLP- technique and applications.

Unit 4 Chromatography

Principle, instrumentation and applications of thin layer and gas chromatography. Column chromatography-packing, loading, eluting and detection. Ion-exchange chromatographypreparation of resins, procedure and applications. Chromatofocusing. Molecular exclusion chromatography-principle, gel preparation, operation and applications. Affinity chromatography– principle, materials, procedure and applications. Special forms of affinity chromatography– immunoaffinity, metal chelate, dye-ligand and covalent chromatography. HPLC– principle, materials, instrumentation and applications. Capillary electrochromatography.

Unit 5 PCR technique: PCR– basic principle, RT-PCR, quantitative PCR and in situ PCR. Diagnostic and laboratory applications of PCR. Comet assay. Monitoring of oncogenes and antioncogenes. Mutagenecity testing– Ame's test. DNA finger printing, DNA foot printing.

Books recommended

1. Wilson and Walker. A biologists guide to principles and techniques of practical biochemistry. 5th ed. Cambridge University Press 2000.
2. Boyer, R. Modern Experimental Biochemistry. 3rd ed. Addison Weslery Longman, 2000.
3. Upadhyay, Upadhyay and Nath. Biophysical Chemistry Principles and Techniques.
Himalaya Publ. 1997.
4. Simpson CFA & Whittacker, M. Electrophoretic techniques.
5. Sambrook. Molecular Cloning. Cold Spring Harbor Laboratory, 2001.
6. Friefelder and Friefelder. Physical Biochemistry – Applications to Biochemistry and
Molecular Biology. WH Freeman & Co. 1994.
7. Pavia et al. Introduction to Spectroscopy. 3rd ed. Brooks/Cole Pub Co., 2000.

CORE COURSE III – ENZYMES AND ENZYME TECHNOLOGY

Unit 1

Enzymes- Active site. Definition. Investigation of active site structure. Identification of intermediates– trapping, chemical inference, isotope exchange and rapid quenching methods. Photo oxidation. Enzyme modification using chemicals. Modification using proteases. Affinity labeling using active site directed reagents– TPCK, TLCK. Effect of changing pH, multienzyme complexes and multifunctional enzymes. A brief account of nonprotein enzymes- ribozymes and DNA enzymes.

Unit 2

Enzyme kinetics- pre-steady state and steady state kinetics. Fast kinetics to elucidate the intermediates and rate limiting steps (flow and relaxation methods) effect of pH, temperature, enzyme and substrate concentration. Michaelis-Menten plot, linear transformation Lineweaver- Burk plot, Eadie-Hofstee plot, and Hanes-Woolf equations. Significance of Km and Vmax. King- Altman procedure. Kinetics of allosteric enzymes- MWC and KNF models. Hill's equation and co-efficient. Sequential and non sequential bisubstrate reactions.

Unit 3

Enzyme inhibition- irreversible and reversible competitive, noncompetitive, uncompetitive, mixed, inhibitions. Kinetic differentiation and graphical methods. Examples. Determination of inhibitor constant, therapeutic, diagnostic and industrial applications of enzyme inhibitors. Mechanism of enzyme action- acid base catalysis, covalent catalysis, strain, proximity and orientation effects. Mechanism of action of lysozyme, chymotrypsin, DNA polymerases, RNase.

Unit 4

Coenzymes structure and function- mechanism of pyridine nucleotides, flavin nucleotides, coenzyme A pyridoxal phosphate, thiamine pyrophosphate, tetrahydrofolate and B_{12} coenzymes, multienzyme complexes. Metal dependent and metalloenzymes. Isoenzymes.

Enzyme regulation: General mechanism of enzyme regulation, feedback inhibition and feedforward stimulation. Enzyme repression, induction and degradation, control of enzymic activity by products and substrates. Zymogens. Immobilization of enzymes and their applications. Enzyme engineering. Creation of artificial enzymes.

Unit 5

Enzyme electrodes, enzyme biosensors and their applications, ELISA, EMIT.
Enzymes of industrial and clinical significance, sources of industrial enzymes, thermophilic nzymes, amylases, glucose isomerases, cellulose degrading enzymes, pectic enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Enzymes as thrombolytic agents, anti-inflammatory agents, debriding agents, digestive aids, therapeutic use of enzymes.

Books recommended

1. T.Palmer. Understanding enzymes. Prentice Hall.
2. Principles of Biochemistry – Zubay 4th ed. 1998, William C.Brown Publ.
3. Ratledge and Kristiansen. Basic Biotechnology. 2nd ed. Cambridge Univ. Press, 2001.
4. Dixon and Webb. Enzymes 3rd ed. Longmans, 1979.
5. Stryer. Biochemistry 5th ed. Freeman, 2002.
6. Whitehurst RJ. Enzymes in Food Technology. CRC Press, 2001.
7. Uhlig H. Industrial enzymes and their applications. John Wiley, 1998.
8. Marangoni AG. Enzyme Kinetics. A modern approach. John Wiley & Sons, 2002.
9. Balasubramanian et al. Concepts in Biotechnology Universities Press (India) Ltd., 1998.

CORE COURSE IV – CELL BIOLOGY AND PHYSIOLOGY

Unit I Tissues

Types of tissue. Epithelium – organization and types. The basement membrane. Bone and cartilage. Major classes of cell junctions – anchoring, tight and gap junctions. Major families of cell adhesion molecules (CAMs) – the cadherins (classical and desmosomal). The integrins. The extracellular matrix of epithelial and nonepithelial tissues. ECM components – collagen, elastin, fibrilling, fibronectin, laminin and proteoglycans.

Unit II Biomembranes, cell cycle, cell death

Membrane assembly – importins and exportins. Membrane transport. Diffusion (passive and facilitated) active transport (symport, antiport, Na+ K+ ATPhase), ion gradients, ion selective channels, group translocations, porins, endocytosis and exocytosis. The cell cycle : phases, regulation by cyclins and cyclin – dependent kinases. Checkpoints in cell cycle regulation. Programmed cell death – Brief outline of apoptosis. Differences between apoptosis and necrosis.

Unit III Blood

Composition and functions of blood. Separation of plasma and serum. Plasma proteins in health and disease. Red blood cells – formation and destruction. Important aspects of RBC metabolism. The RBC membrane – principle proteins (spectrin, ankyrin, glycophorins). Anaemias. Composition and functions of WECs. Blood coagulation – mechanism and regulation. Fibrinolysis. Anticoagulants.

Unit IV Body Fluids

Lymph – composition and functions. CSF – composition and clinical significance. Formation of urine – structure of nephron, glomerular filtration, tubular reabsorption of glucose, water and electrolytes. Countercurrent multiplication, tubular secretion. Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions. Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids.

Unit V Neuromuscular System

Structure of neuron. Propagation of action potential: structure of voltage – gated ion channels. Neurotransmitters-examples, release and cycling of neurotransmitters. The neuromuscular junction – activation of gated ion channels. The acetylcholine receptor. Structure of skeletal muscle. Muscle proteins – myosin, actin, troponing and tropomyosin and other proteins. Sequence of events in contraction and relaxation of skeletal muscle. Pathophysiology of Duchenne muscular dystrophy. Cardiac muscle – $Ca2^{+}$ -Na^{+} exchanger, Ca2+ -ATPase. Brief outline of channelopathies. Cardiac myophathy. Smooth muscle – regulation by Ca2+ and nitric oxide. Source of energy for muscle contraction.

Books Recommended :

1. Lodish et.al. Molecular Cell Biology 5th ed. 2003, WH Freeman (for unit 1,2,5).
2. Murray et al. Harper's Biochemistry 26th ed. Mcgraw Hill 2003 (unit 2 Biomembranes, unit 3, unit 4, unit 5 muscle).
3. Smith et al. Principles of Biochemistry. Mammalian Biochemistry. McGraw Hill 7^{th} ed. (for unit 3, unit 4).

References:

1. De Robertis and De Robertis. Cell and Molecular Biology. Lea and Febiger 8^{th} ed.
2. Alberts et al. Molecular Biology of the Cell 4th ed. Garland Sci. 2002.

CORE COURSE – V - PRACTICAL – I

1. Estimation of proteins by Lowry et al/Brad ford method.
2. Estimation of phospholipids by phosphorous assay.
3. Separation of lipids by thin-layer chromatography.
4. Separation of serum proteins by paper electrophoresis.
5. Desalting of proteins by dialysis.

Enzyme kinetics

1. Determination of total and specific activity of salivary amylase.
2. Effect of pH on enzyme activity (Acid phosphatase/Alkaline phosphatase).
3. Effect of temperature on enzyme activity (Urease/ALP) and determination of activation energy.
4. Effect of substrate concentration on enzyme activity (Salivary Amylase) and determination of Km value.
5. Effect of inhibitor on activity of any one enzyme.
6. Effect of activator on activity of any one enzyme.
7. Purification of protein by gel filtration chromatography using saphadex

SEMESTER II
CORE COURSE - VI – METABOLISM AND REGULATION

Unit 1 Bioenergetics

Free energy and entropy. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain– organization and role in electron capture.Oxidative phosphorylation- electron transfer reactions in mitochondria. F_1F_0 ATPase- structure and mechanism of action. The chemiosmotic theory. Inhibitors of respiratory chain and oxidative phosphorylation- uncouplers, ionophores. Regulation of oxidative phosphorylation. Mitochondrial transport systems- ATP/ADP exchange, malate / glycerophosphate shuttle.

Unit 2 Carbohydrate metabolism

Glycolysis and gluconeogenesis– pathway, key enzymes and co-ordinate regulation. Mechanism of pyruvate dehydrogenase multienzyme complex and the regulation of this enzyme through reversible covalent modification. The citric

acid cycle and regulation. The pentose phosphate pathway. Metabolism of glycogen and regulation. Glycogen storage diseases. Blood glucose homeostasis– role of tissues and hormones.

Unit 3 Lipid metabolism

Lipogenesis. Control of acetyl CoA carboxylase. Role of hormones. Effect of diet on fatty acid biosynthesis. Regulation of biosynthesis of triacylglycerol, phospholipids and cholesterol. Metabolism of triacylglycerol during stress. α, β, γ, Oxidation of fatty acids– Role of carnitine cycle in the regulation of _-oxidation. Ketogenesis and its control. Lipoprotein metabolism exogenous and endogenus pathways.

Unit 4 Metabolism of amino acids, purines and pyrimidines

Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid nitrogen– transamination, deamination, ammonia formation, the urea cycle and regulation of ureogenesis. Importance of glutamate dehydrogenase. Catabolism of carbon skeletons of amino acids– overview only. Disorders of amino acid metabolism– phenylketonuria, alkaptonuria and albinism only. Digestion and absorption of nucleoproteins, Metabolism of purines- de novo and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides. Purine catabolic pathway. Hyperuricemia. Metabolism of pyrimidines-biosynthesis and catabolism. Orotic aciduria.

Unit 5 Metabolic integration and hormonal regulation

Key junctions in metabolism– glucose-6-phosphate, pyruvate and acetyl CoA. Metabolic profiles of brain, muscle, liver, kidney and adipose tissue. Metabolic inter relationships in various nutritional and hormonal states– obesity, aerobic, anaerobic endurance, exercise, pregnancy, lactation, IDDM, NIDDM and starvation.

Books recommended

1. Stryer. Biochemistry. Freeman. 5th ed. 2002.
2. Murray et al. Harper's Biochemistry. 5th ed. Mc. GrawHill, 2000.
3. Nelson Cox. Lehninger's Principles of Biochemistry. 3rd ed. McMillan Worth, 2000.
4. Donald Voet, J.G. Voet, John Wiley, Biochemistry, 1995.
5. Kuchel and Ralston. Biochemistry. 2nd ed. Schaum's Outlines Mc Graw Hill, 1998.
6. Davidson and Sittman. Biochemistry NMS. 4th ed. Lippincott. Willams and Wilkins, 1999.
7. Campbell and Farrell. Biochemistry 4th ed. Brooks/Cole Pub Co. 2002.

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CORE COURSE - VII – MOLECULAR BIOLOGY

Unit 1 Prokaryotic transcription and regulation

Replication of DNA: DNA in prokaryotes and eukaryotes. Enzymes involved in replication, events on the replication fork and termination, mechanism of replication. Inhibitors of DNA replication and DNA repair. Type of damages, types of mutation – point mutation and frame shift mutation. Suppressor mutations – nonsense & missense suppression. Gene mutation and chromosomal aberration. Basic principles of transcription. Transcription- initiation, elongation and termination. . Inhibitors of transcription. Post-transcriptional processing of rRNA and tRNA. Regulation of transcription in prokaryotes– the lac, trp, Arab,Gal operon.

Unit 2 Eukaryotic transcription and regulation

Eukaryotic RNA polymerases- structure and functions. RNA pol I, II and III-promoters, transcription factors, transcription complex assembly and mechanism of transcription. Transcriptional regulation in eukaryotes- hormonal (steroid hormone receptors), phosphorylation (Stat proteins), activation of transcriptional elongation by HIV Tat protein, cell determination, homeodomain proteins. Post-transcriptional processing of mRNA, rRNA and t-RNA. Alternative splicing. Catalytic RNA (ribozymes), RNA editing, Antisense RNA and RNAi

Unit 3 Genetic code, translation

The genetic code- general features. Mitochondrial genetic code.

Components of protein synthesis– mRNA, ribosomes and tRNA. Mechanism of protein synthesis in bacteria and eukaryotes- amino acid activation, initiation, elongation and termination. Translational control in bacteria and eukaryotes. Regulation of protein synthesis- constitutive, and narrow domain regulation. Inhibition of protein synthesis. Co- and post-translational modifications. Protein targeting- the signal sequence hypothesis, targeting proteins to membranes, nucleus and intracellular organelles. Protein degradation: the ubiquitine pathway. Protein folding- models, molecular chaperones.

Unit 4 Gene expression and regulation

Levels of gene expression. Principles of gene regulation, Upregulation, downregulation, induction, repression, global and narrow domain mechanisms. Genetic and epigenetic gene regulation by DNA methylation. DNA methylation in prokaryotesrestriction- modification systems, Dam methylation, Dcm methylation. DNA methylation in eukaryotes- cytosine methylation, CpG islands. Methylation and gene regulation in mammals and plants. Epigenetic

gene regulation by DNA methylation in mammals- role of imprinting and X-chromosome inactivation.

Unit 5 Genomics

Genomics: an overview. Genome projects: HGP Genome sequencing approaches; Structural genomics; chromosome maps– RFLP, SSLP, RAPD Physical mapping. Positional cloning. Functional genomics– study of gene interactions; Proteomics. SNPs and implications; DNAmicro arrays. Developmental genetics: overview. Drosophila development maternal effect genes and zygotic genes.

Books recommended

1. Lewin. Genes VII. Oxford University Press 2000.
2. Twyman. Advanced Molecular Biology Viva Publ. 2nd ed 1998.
3. Alberts. Molecular Biology of the Cell. 4th ed. Garland Sci. 2002.
4. Lodish et al. Molecular Cell Biology. 4th ed. Freeman 2000
5. Pitot HC. Fundamentals of Oncology. Marcel Dekker, 2002.
6. Stansfield et al. Molecular Cell Biology. Schaum's Outlines. McGraw Hill, 1996.

CORE COURSE - VIII – MICROBIOLOGY

Unit 1 Morphology and Ultrastructure

Ultrastructure of bacteria, fungi, algae and protozoa. Classification of microbes, molecular taxonomy. Cell walls of eubacteria (peptidoglycan) and related molecules. Outer membrane of Gram– negative bacteria. Cell wall and cell membrane synthesis, flagella and motility, cell inclusions like endospores, gas vesicles.

Purple and green bacteria, cyanobacteria, homoacetogenic bacteria, Acetic acid bacteria, Budding and appendaged bacteria, spirilla, spirochaetes, Gliding and sheathed bacteria, Pseudomonads, Lactic and propionic acid bacteria. Endospore forming rods and cocci, Mycobacteria, Rickettsia and Mycoplasma. Archaebacteria.

Unit 2 Microbial growth and metabolism

Microbial growth– definition. Mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth. Microbial metabolism– overview. Photosynthesis in microbes. Role of chlorophylls, carotenoids and phycobilins, Calvin cycle. Chemolithotrophy; Hydrogen– iron– nitrite oxidising bacteria; nitrate and sulfate reduction; methanogenesis and acetogenesis, fermentations–

diversity, syntrophy-role of anoxic decompositions. Nitrogen metabolism, nitrogen fixation, hydrocarbon transformation.

Unit 3 Microbiological Techniques

Methods in microbiology. Currents methods in microbial identification. Pure culture techniques. Theory and practice of sterilization. Principles of microbial nutrition, construction of culture media, Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microbes.

Unit 4 Viruses

Bacterial, plant, animal and tumor viruses. Classification and structure of viruses. Lytic cycle and lysogeny. DNA viruses; positive and negative strand, Double stranded RNA viruses. Replication; example of Herpes, pox, adenoviruses, Retroviruses. Viroids and prions.

Unit 5 Medical Microbiology

Disease reservoirs; Epidemiological terminologies. Infectious disease transmissions. Respiratory infections caused by bacteria and viruses; Tuberculosis, sexually transmitted diseases including AIDS; Vector borne diseases, water borne diseases. Public health and water quality. Pathogenic fungi. Antimicrobial agents, Antibiotics. Penicillins and cephalosporins, Broad spectrum antibiotics. Antibiotics from Prokaryotes, Antifungal antibiotics– Mode of action, Resistance to antibiotics. Lantibiotics.

Books recommended

1. Madigan et al. Brock Biology of microorganisms 10th ed. Prentice Hall, 2002.
2. Davis et al Microbiology 4th ed. Lippincott Williams and Wilkins, 1989.
3. Joklik et al. Zinsser's Microbiology Mc Graw-Hill Professional, 1995.
4. Pelczar et al. Microbiology 5th ed. Mc Graw Hill, 2000.
5. Stainer Ry et al. General Microbiology 5th ed. Prentice Hall 1986.
6. Brooks et al. Jawetz, Melnick and Adelberg's Medical Microbiology. Lange Med. 1998.
7. Prescott et al. Microbiology. Mc Graw Hill, 1999.
8.Encylopedia Microbiology– 2nd ed. Lederberg Vol. 1 to 4. Acad. Press 2000

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CORE COURSE – IX - PRACTICAL – II

1. Fractionating of Sub cellular organelles by differential and gradient centrifugation.
2. Separation of protein by SDS-PAGE
3. Estimation of DNA by diphenylamine method.
4. Estimation of RNA by orcinol method.
5. Isolation of plasmid DNA
6. Agarose gel electrophoresis of plasmid and genomic DNA.'

MICROBIAL TECHNIQUES-

7. Media preparation, culturing and plating techniques.
8. Determination of bacterial growth curve.
9. Assessment of antimicrobial activity by tube dilution, phenol coefficient test, disc diffusion method.
10. Preparation of competent cell.
11. Transformation

DEMONSATRACTION:

PCR amplification

Western blotting southern hybridization

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CORE COURSE–X - IMMUNOLOGY

Unit 1

Elements of Immunology. Types of immunity- innate and acquired. Humoral and cell mediated immunity. Central and peripheral lymphoid organs- Thymus, bone marrow, spleen, lymph nodes and other peripheral lymphoid tissues- GALT. Cells of the immune system- lymphocytes, mononuclear phagocytes- dendritic cells, granulocytes, NK cells and mast cells, cytokines.

Antigens vs immunogens, Haptens. Factors influencing immunogenicity. Immunoglobulinsstructure, classification and functions. Isotypes, allotypes and idiotypes.

Unit 2

Complement activation and its biological consequences. Clonal selection theory. Organization and expression of immunoglobulin genes generation of antibody diversity. Class switching.

T-cell, B-cell receptors, Antigen recognition- processing and presentation to T-cells. Interaction of T and B cells. Immunological memory. Effector mechanisms-macrophage activation. Cell mediated cytotoxicity, immunotolerance, immunosuppression.

Unit 3

MHC genes and products. Polymorphism of MHC genes, role of MHC antigens in immune response, MHC antigens in transplantation. Transplantation types. Immune responses to infectious diseases- Viral, bacterial and protozoal. Cancer and immune system. AIDS and other immunodeficiency disorders. Autoimmunity. Hypersensitivity- types.

Unit 4

Immunization practices- active and passive immunization. Vaccines- killed, attenuated- toxoids. Recombinant vector vaccines- DNA vaccines, synthetic peptide vaccines- antiidiotype vaccines production of polyclonal and monoclonal antibodies. Principles, techniques and application. Genetically engineered antibodies.

Fractionation of leucocytes by density gradient centrifugation. Identification of lymphocytes and their subsets in blood. Leukocyte migration inhibition technique. Delayed type hypersensitivity technique

Unit 5

Agglutination and precipitation techniques. Immuno-electrophoresis, RIA, immunoblotting, Avidin- biotin mediated immuno assay. Immunohistochemistry- immunofluorescence, immunoferritin technique. Fluorescent immunoassay. Cytokines assay: ELISA and ELISPOT. Production of cytokines in vitro. Interferon production. Abzymes.

Experimental animal models: inbred strains, SCID mice, nude mice, knock out mice cell culture system: Primary lymphoid culture, cloned lymphoid cell lines.

Books recommended

1. Roitt et al. Roitt's. Essential Immunology. 10th ed. Blackwell Sci. 2001.
2. Richard A. Goldsby et al. Kuby Immunology. 4th ed. WH Freeman & Co. 2003.
3. Abbas et al. Cellular and Molecular Immunology. W.B. Saunders Company, 2000.

4. Janeway, C. (Ed), Paul Travers. Immunobiology. 5th ed. Garland Publ. 2001.
5. Eli Benjamini AU et al. Immunology: A short course. 4th ed. Wiley-Liss, 2000.
6. NMS Series in Immunology. 3rd ed. Lippincott Willams & Wilkins.
7. Bier et al. **Fundamentals** of immunology Springer Verlag, 1986.

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CORE COURSE - XI – CLINICAL BIOCHEMISTRY

Unit 1

Patterns of inheritance– autosomal and sex – linked disorders.

Disorders of amino acid metabolism– amino aciduria, Phenylketonuria, Hartnup disease, alkaptonuria, albinism, cystinuria, cystinosis, homocystinuria and maple syrup urine disease. Disorders of carbohydrate metabolism– glycogen storage diseases, galactosemia, fructose intolerance and fructosuria. Disorders of purine pyrimidine metabolism: Hyperuricemia and gout. Hypouricemia. Orotic aciduria. Serology: C reactive protein test, Rheumatoid arthritis (RA) test, immunologic test for pregnancy. Amniotic fluid: Origin, composition and analysis of amniotic fluid.

Unit 2

Blood sugar homeostasis: Role of tissues and hormones in the maintenance of blood sugar. Hypoglycemia, hyperglycemia, glycosuria. Diabetes mellitus – classification, metabolic abnormalities, diagnosis and management. Acute complications – diabetic ketoacidosis hyperosmolal non-ketotic coma. Long-term complications – retinopathy, neuropathy and nephropathy, glycosylation.

Disorders of lipid metabolism – lipoproteinaemias. Lipid storage diseases – Gaucher's, TaySach's Niemann Pick and Sandhoff's disease. Fatty liver. Atherosclerosis.

Unit 3

Jaundice: Retention and regurgitation jaundice. Causes, consequences and biochemical findings in hepatitis and cirrhosis. Tests related to excretory (bile pigments) synthetic (plasma proteins, prothrombin time) detoxifying (hippuric acid, NH3, aminopyrine) and metabolic (galactose) functions. Gallstones. Gastric function tests: Stimulation tests – insulin and pentagastrin. Peptic ulcer, gastritis and Zollinger Ellison syndrome. Porphyrias. Free radicals and disease: Formation of free radicals, lipid peroxidation and consequences. Antioxidant defence mechanisms.

Unit 4

Kidney function: Biochemical findings in glomerulonephritis, renal failure and nephritic syndrome. Nephrolithiasis. Glomerular function tests – inulin, urea and creatinine clearance tests, renal plasma flow, plasma _2–microglobulin, urea and creatinine. Tubular function tests – water load, concentration and acid excretion tests. Abnormal constituents of urine.

Clinical enzymology: Serum enzymes and isoenzymes in health and disease – Transaminases (AST, ALT) acid and alkaline phosphatases, amylase, LD and CK. Enzyme patterns in disease – Liver and muscle disease, myocardial infarction.

Unit 5

Oncology: Cancer cell – morphology and growth characteristics. Biochemical changes in tumor cells. Differences between benign and malignant tumors. Tumor markers – AFP, CEA and Hcg only. Agents causing cancer – radiation, viruses, chemicals (brief account only). Multistep carcinogenesis – initiation, promotion, progression. Oncogenes and proto-oncogenes – mechanisms of proto-oncogene activation. Tumor suppressor genes – p53.

Books recommended

1. Clinical Chemistry in diagnosis and treatment Mayne ELBS.
2. Clinical Chemistry Marshall 3rd edition Mosby.
3. TietZ textbook of Clinical Chemistry – 1998 3rd edition Saunders.
4. Principles of Internal Medicine. Harrison's Vol 1 & 2, 14th edition Mc Graw Hill.
5. Biochemistry and disease. Cohn and Roth. 1996, Williams and Wilkins.
6. Harper's Biochemistry McGraw Hill, 2000.
7. Biochemistry – A case oriented approach. Montgomery et al. Mosby.
8. Clinical Chemistry – Principles, procedures, correlations – Bishop, Lippincott, 2000.

CORE COURSE– XII - PRACTICAL – III

Clinical Biochemistry

1. Urine qualitative analysis – Normal and abnormal constituents
2. Blood – ESR, Examination of RBCs and WBC Hb levels, osmotic fragility.

Estimation of the following constituents in blood and urine

1. Blood grouping
2. Determination/Estimation of RBC, WBC and Hb.
3. Determination of Catalase(CAT)
4. Determination of Glutathione (GSH)
5. Determination of Glutathione Peroxidase (GPx)

6. Estimation of Blood sugar
7. Estimation of Cholesterol.
8. Estimation of Serum creatinine.
9. Estimation of Total protein, A/G ratio.
10. Estimation of Serum calcium.
11. Estimation of urine urea.
12. Estimation of urine bilirubin
13. Estimation of urine Calcium
14. Estimation of urine Urea
15. Estimation of urine Uric acid
16. Estimation of urine Ammonia

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CORE COURSE XIII – BIOINFORMATICS

Unit 1 Introduction

Introduction to bioinformatics, scope of bioinformatics, role of computers in biology. The internet, the world wide web, useful search engines- Boolean searching, search engine algorithms. Finding scientific articles- Pubmed.
Running computer software, computer operating systems. Software downloading and installation.

Unit 2 Workstation

The bioinformatics workstation, Unix system, files and directories in Unix, working on a Unix system. Scripting languages- Perl and Python, markup languages- HTML, XML.

Unit 3 Databases

Database concepts- Database, database system, database management systems- Hierarchical, Rational and Network, Database security. Biological databases, Types- sequence and structure databases. Genome and organism specific databases. Miscellaneous databases. Data submission, data retrieval with Entrez, DBGET / Link DB and SRS.

Unit 4 Database searches and sequence alignment

Searching sequence database sequence similarity searches, amino acid substitution matrices, Database searches: FASTA and BLAST, sequence filters, Iterative database searches and PSIBLAST. Multiple sequence alignment- gene and protein families. Phylogenetics- building phylogenetic trees, Evolution of macromolecular sequences, Sequence annotation.

Unit 5 Applications

Prediction and visualization of protein structure. Drug discovery and development, combinatorial chemistry and docking. Pharmacogenomics. Pharmacogenetics. Toxicogenomics. Functional genomics, metabolomics. E-cell.
Metabolic pathways- Kegg and Wit, primer design, Microfluidics. Nanotechnology.

Books recommended

1. Lesk, A.M. Introduction to Bioinformatics. Oxford, 2002.

2. Campbell and Heyer. Discovering Genomics, Proteomics and Bioinformatics. Cold Spring Harbour Laboratory. Press & Benjamin Cummings, 2002.
3. Gibas and Per Jambeck. Developing Bioinformatics Computer Skills. O'Reilly & Associates, 2001.
4. Krane et al. Fundamental concepts of bioinformatics. Benjamin Cummings, 2002.
5. Bioinformatics computing Bergeron BP. 1st ed. Printice Hall, 2002.
6. Baxevanis & Ouellette. Bioinformatics: A practical guide to analysis of genes and proteins.2nd ed. Wiley-Inter Sci. 2001.

Web sites

http: //www.ensembl.org
http://www.ncbi.nlm.nih.gov/genbank
http://www.123genomics.com
http://www.expasy.ch

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ELECTIVE COURSE – I – BIOSTATISTICS

Unit I

Matrices : Matrix Algebra, Types of Matrices, Determinant of a matrix, Rank of a matrix, Singular and Non-Singular matrices. Inverse of matrix. Solving system of Linear equations using matrix method.

Unit II

Nature of biological and clinical experiments – collection of data in experiments – primary and Secondary data. Methods of Data collection. Classification and Tabulation. Diagrams and graphs of data.

Unit III

Measure of Averages – Mean, Median and mode. Use of these measures in biological studies. Measures of Dispersion for biological characters – Quartile Deviation, Mean Deviation and Standard deviation and coefficient of variation. Measures of skewness and Kurtosis. Corrletion and Regression – Rank Correlation – Regression equations. Simple problems based on biochemical data.

Unit IV

Basic concepts of sampling – Simple random sample, stratified sample and systematic sampling. Sample statistics. Sampling distribution and standard error. Tests of significance based large samples. Test for mean, difference of means, proportions and equality of proportions.

Unit V

Small sample Tests – Student 't' test for mean, difference of two means, test for correlation and regression coefficients. Chi-square test for goodness of an nonindependence of attributes. F test for equality of variances.

Books recommended :

1. Sundar Rao, Jesudian Richard – An Introduction to Bio-Statistics
2. Alwi E.Lewis. Bio-statistics, East West Press.
3. S.P.Gupta – Fundamentals of Statistics, Sultan Chand.

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ELECTIVE II – ENDOCRINOLOGY

Unit I Hypothalamic and pituitary hormones

Hormones – classification, biosynthesis, circulation in blood, modification and degradation. Hormone receptors – structure and regulation. Mechanism of hormone action. Hypothalamic and pituitary hormones. Hypothalamic releasing factors. Anterior pituitary hormones : biological actions, regulation and disorders of growth hormones, ACTH, gonadotrophins and prolactin. Leptin. Posterior pituitary hormones – biological actions and regulation of vasopressin. Diabetes insipdus and SIADH secretion. Oxytocin. Hypopituitarism.

Unit II Thyroid and parathyroid hormones

Thyroid hormones – synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Thyroid functions tests. Hyper and hypothyroidism. Hormonal regulation of calcium and phosphate metabolism. Secretion and biological actions of PTH, calcitonin and calcitriol. Hypercalcemia and hypocalcemia Rickets and osteomalacia.

Unit III Adrenal hormones

Adrenal cortical hormones. Synthesis, regulation, transport, metabolism and biological effects. Adrenal function tests. Cushing's syndrome, aldosteronism, congenial adrenal hyperplasia, adrenal cortical insufficiency. Adrenal medullary hormones – synthesis, secretion, metabolism, regulation and biological effects of catecholamines. Phaeochromocytoma.

Unit IV Gonadol, G.I. and pancreatic hormones

Gonadal hormones : Biosynthesis, regulation, transport, metabolism and biological actions of androgens. Hypogonadism and gynecomastia. Biosynthesis,

regulation, transport, metabolism and biological effects of oestrogen and progesterone. The menstrual cycle. Pregnancy – diagnostic tests and biochemical changes. Foetal monitoring. Amenorrhoea. Pancreatic hormones – synthesis, regulation, biological effects and mechanism of action of glucagons, somatostatin and insulin. Insuling receptor. Brief account of gastrointestinal hormones.

Unit V Signal transduction

Fundamentals concepts and definitions of signals, ligands and receptors, endocrine, paracrine and autocrine signaling. Receptors and signaling pathways – cell surface receptors, ion channels, G-protein coupled receptors, receptor kineses (tyr, ser/thr).

Signal transduction through cytoplasmic and nuclear receptors. The Ras-raf MAP kinase cascade, second messengers – cyclic nucleotides, lipids and calcium ions. Crosstalk in signaling pathways.

Books recommended :

1. Williams Textbook of Endocrinology – Wilson and Foster 8th ed.
2. Mechanisms of hormone action – Autind and Short.
3. Harper's Biochemistry – Murray et al. 26th ed. McGraw Hill, 2003.
4. Principles of Biochemistry – Mammalian Biochemistry – Smith et al. McGraw Hill 7th ed.

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ELECTIVE COURSE – III: GENETIC ENGINEERING

Unit1

Introduction to gene cloning: Early development of genetics – gene cloning – specialized tools and techniques – importance of gene cloning.

Intellectual Property Rights and types, patening. Isolation and purification of DNA: Preparation of total cell DNA, plasmid DNA, bacteriophage DNA, plant cell DNA

Unit 2

Cloning and expression vectors: Plasmids – bacteriophages (M_{13} and λ) pUC vectors yeast vectors, agrobacterium, medicated Gene transfer, YAC, BAC, Human artifical chromosomes, Ti plasmid, SV40, baculoviruses, adenoviruses, papilloma viruses and retroviruses.

Unit 3

Multipulatin of purified DNA: DNA manipulative enzymes – necleases, ligases, polymerases, topoisomerases, restriction enzymes – performing restriction digests, ligation – joining DNA molecules together – random labeling nick translatin and end filling.

Unit 4

Introduction of DNA into living cells: Biolistics, electroporation, microinjection, liposome-mediated method and calcium phosphate method.

Unit 5

Construction of libraries – studying gene and genome structure – blotting techniques, PCR, in situ hybridization, DNA sequencing, chromosome walking and jumping, DNA foot printing, HR and HART, Restriction analysis of DNA RELP, RADD – Principles, procedures and applications

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ELECTIVE COURSE IV – BIOTECHNOLOGY

Unit 1

Bioprocess– Basic principles of microbial growth. Types, design and operation of fermenters. Fermentation culture medium– carbon, nitrogen and vitamin sources. Antifoaming devices. Downstream processing– separation, concentration, purification, modification and drying. Production of vitamin B12, penicillin, streptomycin and methane.

Unit 2

Waste treatment– aerobic and anaerobic. Composting. Utilization of cellulose. Bioremediation. Microbial degradation of xenobiotics. Biodegradable plastics. Single cell protein. Immobilized enzymes, methods and applications. Industrial applications of enzymes in food, diary and leather industry.

Unit 3

Basic principles. Use of restriction enzymes for production of DNA fragments. Cloning vectors– plasmids (pBR 322, pUC 18), phages (_ and M13) and cosmids. YACs, BACs, PACs, HAECs and HACs. Splicing of DNA– cohesive end method, blunt end ligation, linkers and adaptors. Gene transfer methods– calcium phosphate coprecipitation, electroporation, lipofection, microinjection. Choice of host organisms for cloning. Recombinant selection and screening–marker

inactivation, colony hybridization and in vitro translation. Cloning strategies– genomic and cDNA libraries. Chromosome walking. Cloning of insulin in E. coli.

Unit 4

Plant cell and tissue culture– culture media and cell culture. Tissue culture, micropropagation and somaclonal variation. Protoplast culture– isolation and purification of protoplasts, protoplast fusion, genetic modification of protoplasts. Methods of gene transfer in plants– Agrobacterium mediated transformation, viral vectors and particle gun method. Use of reporter genes in transformed plant cells. Transgenic plant technology– genetic engineering of plants for pest resistance, virus resistance, herbicide tolerance, stress tolerance and delay of fruit ripening. Use of plants to produce commercially important proteins, antibodies, viral antigens and peptide hormones.

Unit 5

In vitro fertilization and embryo transfer. Animal vaccines– production of vaccine for foot and mouth disease of cattle.Development of transgenic animals– retroviral, microinjection and embryonic stem cell methods. Applications of transgenic animals. Techniques in Human genome mapping–FISH, PCR, RFLP, DNA fingerprinting. Gene therapy–ex vivo and in vivo. Antisense RNA technology and applications. Hazards and safety aspects of genetic engineering.

Books recommended

1. Fermentation Biotechnology O.P. Ward. 1989 Prentice Hall.
2. Biotechnology J.E. Smith Cambridge University Press 1996.
3. Introduction to Biotechnology Brown, Campbell and Priest Blackwell Science 1987.
4. A Textbook on Biotechnology H.D. Kumar 2nd edition East West Press 1998.
5. Molecular Biotechnology Glick and Pasternak, Panima Publ.
6. From Genes to clones Winnaecker VCH Publication.
7. Elements of Biotechnology P.K. Gupta, Rastogi Publication, 1998.
8. Molecular Biology and Biotechnology. Walker and Gingold. 3rd ed. Panima Publ. 1999.
9. Plant Biotechnology. Ignacimuthu, Oxford, IBH.
10. Recombinant DNA Technology, Watson, Scientific American Publ.
11. Principles of Genome analysis, Primrose, Oxford University Press, 1998.

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