BHARATHIAR UNIVERSITY, COIMBATORE.
M. Sc., BIOCHEMISTRY DEGREE COURSE WITH COMPULSORY DIPLOMA
(AFFILIATED COLLEGES)
(Effective from the academic Year 2010-2011)
SCHEME OF EXAMINATIONS – CBCS PATTERN

SEM	Subject and Paper	Inst. Hrs/ week	Examinations				Credit
			Dur.Hrs	CIA	Marks	Total Marks	
I	Paper-I Biopolymers	5	3	25	75	100	4
	Paper-II Analytical Biochemistry and Bioinformatics	5	3	25	75	100	4
	Paper-III Enzymes and Enzyme Technology	4	3	25	75	100	4
	Paper-IV Cellular Biochemistry	4	3	25	75	100	4
	Paper-V Plant Biochemistry and Biotechnology	4	3	25	75	100	4
	Practical-I Core Biochemistry Practical-I	5	-	-	-	-	-
	Elective – Paper I	3	3	25	75	100	4
II	Paper-VI Microbial Biochemistry	5	3	25	75	100	4
	Paper-VII Immunology	5	3	25	75	100	4
	Paper-VIII Advanced Clinical Biochemistry	5	3	25	75	100	4
	Paper-IX Molecular Biology	5	3	25	75	100	4
	Practical-I Core Biochemistry Practical-I	5	6	40	60	100	4
	Elective – Paper II	5	3	25	75	100	4
III	Paper-X Biostatistics	5	3	25	75	100	4
	Paper-XI Metabolism and Metabolic Regulation	5	3	25	75	100	4
	Paper-XII Genetic Engineering	5	3	25	75	100	4
	Paper-XIII Endocrinology	4	3	25	75	100	4
	Paper-XIV Pharmaceutical Chemistry and Neurochemistry	4	3	25	75	100	4
	Practical –II Core Biochemistry Practical-II	4	-	-	-	-	-
	Elective – Paper III	3	3	25	75	100	4
IV	Practical-II Core Biochemistry Practical-II	5	6	40	60	100	4
	Project Work	-	-	100	150	250*	10
	Elective – Practical/ Project	5	6	40	60	100*	4
	Total					2250	90

* For Project report - 80%; Viva-voce - 20% [Assessment of Internal marks should be based on Monthly assessment and report by the concerned guide and HOD]

* Includes 25 / 40% continuous internal assessment marks for theory and practical papers respectively.

List of Group Elective papers (Colleges can choose any one of the Group papers as electives)

Paper / Sem	GROUP A Elective - Cell Culture and Molecular Techniques	GROUP B Elective - Computational Molecular Biology	GROUP C Elective - Nanoscience
I	Plant Tissue Culture	Computational Molecular Biology	Fundamentals of Nanoscale Science
II	Animal Tissue Culture	Genomics	Nanomaterials Synthesis
III	Methods in Molecular Biology	Proteomics	Characterization and Application of Nano Materials
IV	Elective Practical	Elective Practical	Elective Project work

Semester – I Paper I

Subject Title : BIOPOLYMERS

Subject Description : This course provides an overview of the macromolecules that are key to all living system. Topics covered include structure, properties and functions of polysaccharides, proteins, lipids and nucleic acids.
Goals: This course is to develop sufficient knowledge about higher order structures i.e. Polysaccharides, proteins, lipids and nucleic acids.
Objectives: At the end of this course students will be able to obtain a keen knowledge on the characterization of biological macromolecules.

UNIT-I
Polysaccharides

Polysaccharides – occurrence, structure and biological functions of cellulose, chitin, starch and glycogen. A brief account on chitin, fructans, arabinans and galactans.
Occurrence, structure, isolation, purification, properties and biological functions of mucopolysaccharides, bacterial cell wall polysaccharides and blood group antigens. Glycosaminoglycans – structure and biological role of hyaluronic acid, chondroitin sulfate and heparin. Sialic acid – structure and significane, proteoglycans. A brief account on glycoproteins and their biological importance.

UNIT-II
Proteins

Orders of protein structure. Primary structure – determination of amino acid sequence of proteins. The peptide bond – The Ramachandran plot.
Secondary structures – α-helix, β-sheet and β-turns. Pauling and Corey model for fibrous proteins. Reverse turns and super secondary structures. Collagen triple helix
Tertiary structure – α and β domains. Conformational properties of silk fibroin.
Quarternary structure of proteins. The structure of haemoglobin. Models for haemoglobin allostery.

UNIT-III

Lipids

Lipids – Introduction, fate of dietary lipids, simple lipid, compound lipids and derived lipids – structure and functions.

Fatty acids – saturated, unsaturated and hydroxy fatty acids. Phospholipids and glycolipids – structure and functions.

Plant and animal sterols – structure and functions of cholesterol.

Lipid peroxidation and antioxidants. Lipoproteins – classification and composition.

UNIT-IV

Nucleic acids

DNA double helical structure – Watson and Crick model. A, B and Z forms of DNA. Triple and quadruple structures. DNA supercoiling and linking number. Properties of DNA – buoyant density, viscosity, denaturation and renaturation – The cot curve – Chemical synthesis of DNA. Major classes of RNA – mRNA, rRNA, tRNA, sn RNA, hn RNA – structure and biological functions.

UNIT-V

Nucleic acids in cells

Salient features of nucleic acid recognition by proteins. DNA binding motifs in proteins – the basic helix loop helix (bHLH) motif, zinc finger, the leucine zipper and helix-loop helix. RNA binding motifs in proteins. Molecular aspects of protein-nucleic acid binding – direct interactions. Techniques characterizing nucleic acid-protein complex – gel retardation assay, DNase I footprinting.

References:

1. Lehninger Principles of Biochemistry 4th edition Nelson and Cox, Freeman Publishers, 2005
2. Harper's Biochemistry 26th edition. McGraw Hill, 2003
3. Biochemistry 4th edition. Zubay, William C. Brown Publication, 1998
4. Biochemistry. Voet and Voet, John Wiley, 1995
5. Nucleic acid structure and recognition. Neidle, Oxford University Press, 2002
6. Nucleic acids in chemistry and biology. Blackburn and Gait, IRL Press, 1996

Semester-I Paper-II

Subject Title : ANALYTICAL BIOCHEMISTRY AND BIOINFORMATICS

Course Number : Number of Credit Hours: 5

Subject Description : This course focuses on instrumental techniques including spectrometry, electrophoresis, centrifugation, x-rays, radioactivity and also in bioinformatics database design, principles of programming languages, structure and sequence analysis.

Goals: Students will have the ability to critically understand many instrumental principle and analysis. They can use computer databases to store, retrieve and assist in understanding biological information and also get knowledge about use of the most commonly used online tools and resources

Objectives:
At the end of this course students will be able
To have a basic understanding of the theoretical principles involved in Bioinstrumentation
To have the practical skills and techniques required in biochemical analysis
To become competent in the basic experimental techniques of biochemistry
To gain knowledge in using software techniques and internet resources to handle and compare sequence and structure information, search databases and Interpret protein structure.

UNIT-I
Spectroscopic technique: Basic principles, instrumentation and applications of UV, visible and IR spectrophotometers. Electron spin resonance, Nuclear Magnetic Resonance, Mass Spectrometry, Flame Photometry – principles and applications. Centrifugation techniques: Principle and technique of preparative and analytical centrifugation, differential centrifugation, density gradient centrifugation, ultracentrifuge and its application.

UNIT-II
Chromatographic techniques: Principle, technique and applications of paper, TLC, ion-exchange, molecular sieve and adsorption chromatography. Principle, components, limitations and applications of GLC and HPLC.
Electrophoresis techniques: Principle and technique of paper, gels – SDS-PAGE. High voltage and discontinuous electrophoresis. Isoelectric focusing.

UNIT-III
X-rays, X-ray diffraction, crystals and detectors – quantitative analysis and applications. ORD and circular dichroism – principles and applications.
Nature and units of radioactivity. Radiochemical methods: basic concepts, counting methods and applications, autoradiography.

UNIT-IV
Introduction: objectives and scope of bioinformatics, internet and world wide web. Useful search engines. Scripting languages – perl and its applications to bioinformatics. Biological databases – sequence and structure. Data retrieval. Database search – FASTA and BLAST. CLUSTAL and PHYLIP.

UNIT-V
Biological databases. Sequence and structure database. Protein databases – sequence and structure data, Expasy, Swiss-port/PDB bases. Secondary and tertiary structure prediction of proteins. Introduction to proteomics. Fold recognition. Application of proteomics. Mining

proteomes, protein expression profiling, identifying protein-protein interactions and protein complex. Mapping protein modification.

References:

1. Analytical biochemistry – D.J. Homie and H. Peck. Longman group – Rastogic CBS publishers, 1st edition, 2003.
2. Modern experimental biochemistry 3rd edition – R. Boyer, Addison Weslery Longman Publishers, 2000
3. A biologist's guide to principles and techniques of practical biochemistry 5th edition – Wilson and Walker, Cambridge University Press, 2000
4. Bioinformatics – concepts, skills and applications 1st edition. S.C. Rastogi *et al.*, CBS publishers, 2003
5. Introduction to bioinformatics 1st edition – S. Sundararajan, R. Balaji, Himalya publishing house, 1st edition, 2002
6. Bioinformatics for beginners. 1st edition – K. Mani, N. Vijayara, Kalaikathir Achagam, Coimbatore, 2002
7. Discovering genomics, proteomics and bioinformatics – Campbell, Heyer, Cold Spring Harbor Laboratory Press, 2002
8. Introduction to bioinformatics – A. M. Lesk, Oxford University Press, 2002
9. Introduction to proteomics – D. C. Liebler, Humana press, 2002

Web sites:

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

Semester-I Paper-III

Subject Title : ENZYMES AND ENZYME TECHNOLOGY

Course Number : Number of Credit Hours: 4

Subject Description : Enzymes are proteins that catalyze (*i.e.* accelerate) chemical reactions. Enzymes make excellent analytical reagents due to their specificity, selectivity and efficiencyAlmost all processes in a biological cell need enzymes in order to occur at significant rates. a set of enzymes made in a cell determines which metabolic pathways occur in that cell. This course presents an detailed account of enzymes function in human and health-covering basic principles and applications of enzymes in industry;

Goals: To provide a body of knowledge relevant to the principles of enzymology and techniques employed in the utilization of enzymes.

To acquire an understanding of the principles by which enzymes catalyse reactions.

To provide a knowledge of the theory and applications of modern approaches to enzyme technology.

Objectives:
On successful completion of this unit ,Students should be able to complete a range of tasks exemplified by the following:
Demonstrate an understanding of the kinetics of enzyme-catalysed reactions.
Describe how enzymes can be used in the laboratory and industrially. Demonstrate an understanding of the mechanism of enzyme action.
Demonstrate a critical appreciation of the preparation and use of immobilised enzymes.

UNIT I
Enzymes- Introduction, Classification of enzymes, Factors affecting enzyme activity. Active site- Definition: investigations of active site structure, Trapping ES complex, use of substrate analogues. Modification by sing chemicals procedures, enzyme modification by treatment with proteases, enzyme modification by site directed mutagenesis. Isoenzymes, Multienzyme complex.

UNIT II
Enzyme catalysis: Acid base catalysis, covalent catalysis, Mechanisms of reaction catalyzed by enzyme lysozyme, chymotrypsim. Metal activated, enzymes & metalo Enzyme Role of metal ions in mechanism - carbonic anhydrase, superoxide dismutase, carboxy peptidase, Coenzymes and cofactors in enzyme catalysed reaction.

UNIT III
Enzyme kinetics: MM Kinetics, LB plot, Eadie - Hofstee plot and Hanes plot. Allosteric enzymes - Cooperavity, Hill plot, K & V serives of Enzyme. R & T states. Bisubstrate reaction. Concerted, Sequential Enzyme & enzyme inhibition - Types & kinetic differentiation. Of competitive, uncompetitive, non-competive inhibitions. Allosteric inhibition and regulation.

UNIT IV
Application of enzymes in industry; Industrial scale enzyme extraction, purification and stabilization.
Industrial application of carbohydrases, proteolytic enzyme, lignocellulose degrading enzyme, pectin and pectic enzyme. Enzyme in animal nutrition.
Non - catalytic industrial proteins,
Animal & microbial proteins. Sweet and taste modifying proteins. Application of enzymes in food Industry . Ribozyme, abzyme.

UNIT V
Immobilised enzymes- Techniques of immobilization and applications of immobilized enzyme. Enzymes as diagnostic reagents.
Biosensors: calorimetric biosensors: potentiometric biosensors: Amperometric biosensors: immunosensors.
Applications of Monoclonal antibodies.

References :
1. Enzymes – Dixon, Webb
2. Enzyme Kinetics – Bowden, Wharton

3. Immobilized enzymes - Trevan
4. Hand book of Enzyme technology 3rd edition – Weisman, Printice Hall .
5. Enzyme technology 1st edition – Chapline, Bucke, Cambridge University Press, 1990
6. Protein Biotechnology 1st edition – Chapline, Bucke, Cambridge University Press, 1990
7. Understanding Enzymes 3rd edition - Palmer, Printice Hall, 1991
8. Fundamentals of enzymology 2nd edition – Price, Stevens, Oxford University Press, 1995
9. Enzyme kinetics. A modern approach – Marangoni, John Wiley, 2002
10. Concepts in Biotechnology – Balasubramanian *et al.,* Universities Press India Ltd. 2004
11. Enzymes in food technology – Whitehurst, CRC Press

Semester- I-Paper-lV

Subject Title : **CELLULAR BIOCHEMISTRY**

Course Number : **Number of Credit Hours: 4 (Four)**

Subject Description :
This course is concerned with the structure and function of cells. "Structure" and "function" are two different ways of looking at the same thing; structures exist to accomplish certain functions and we account for biological function in this course.

Goals: This course of study aims:
To develop an understanding of the fundamentals of cell biology.
To gain an understanding of the structure and function of living organisms, their life processes and Biochemical basis of motility
To provide a strong basis for membrane and organelle biogenesis, cell-cell interaction, cell-cell signaling, Cancer and cell cycle.
Objectives: At the end of this Course of study students will be able to:
Demonstrate an understanding of the membrane models and membrane transport.
Demonstrate an understanding of the major types of living organisms and the characteristics of and fundamental differences in their body plans/organisation and functions.
Demonstrate an understanding of the various types of microfilaments and microtubules .
Demonstrate an understanding of the structures and functions of the major cell and tissue types of higher animals, particularly humans.
Demonstrate an understanding of the cell cycle, its control through apoptosis, and explosion of cancer and its mechanism

UNIT-I
Membrane bilayer - Models, Membrane lipids - fluidity, Asymmetry phase transition, Liposomes . Membrane proteins - Types, Orientation, Mobility - Experiments, flippases, proteins or RBC membrane, Bacteriorhodopsin, Porins-aquaporin. RBC ghosts, solubilisation of proteins, lipid anchored proteins carbohydrates - cell surface carbohydrates - Lectins,

UNIT II

Membrane transport - Overview, Passive diffusion, Facilitated diffusion in erythrocytes, Carriers and Ion - Channels. Ion cone. gradients. Uniporter Catalyzed transport. Active transport systems. Transport process driven by A TP - Ion Pumps :-Calcium, APT ase; Na^+K^+ATP ase; Mechanism, Gastric H^+K^+ATP ase; Mechanism, Gastric H^+K^+ ATP ase, ATP ases that transport peptides and drugs.
ABC superfamily - Bacterial PM permeases, Mammalian MDR proteins: Transport process driven by light and ion gradients.
Co-transport by Symporters and antiporters, Group translocation Osmosis and Receptor mediated endocytosis.

UNIT III
Mitochondria - Reduction potentials, electron transport chain Overview, Complexes, Q-cycle, Cyt.C oxidase complex, Translocation of Protons and the establishment of a proton, motive force Machinery for ATP formation. Chemi-osmotic mechanism, APT Synthase Experiments, inhibitions of OP. Uncouplers.
Microfilaments - Action – Structures, Assembly, Myosin.
Microtubules - Organisation and dynamics, Kinesin and dynem.
Cilia and Flagella - Structure and functions, Intermediary fi1aments.
Striated muscle - structure, excitation - contraction.

UNIT IV
Cell – Cell and Cell - matrix adhesion: - An overview.
Cell-Cell, interaction:- ECM; Collagen, hyaluronan & proteolycans, laminin, integrins and fibronectins.
Cell-Cell adhesion: Specialised junctions -- Desmosomes, Gap junctions, Adhesion molecules - Cadherins - Connexins.
Cell-Cel1 signaling - Signaling molecules and their receptors: functions of cell surface receptors, pathways', of intracellular signal transduction, second messengers. (G -protein coupled receptors, receptor tyrosine kinases. Ras. MAP kinases.

UNIT V
Cell cycle and cancer: - Cell Cycle: - Overview of cell cycle and its control. General studies; with yeasts. Cell cycle Control in mammalian cells, Checkpoints in cell -cycle regulation.
Apoptosis (Programmed cell death) -- Pathways, regulators & effectors in apoptosis.
Cancer: Properties of tumor cells & Genetic basis and onset of cancer.
Tumor viruses - DNA & RNA viruses as transforming agents - mechanism.
Tumor suppressor genes and functions of their products. Carcinogenic effect of chemicals and radiation. Molecular diagnosis of cancer.

References:
1. Molecular cell biology 5th edition- Locish, Berk *et al.*, Freeman and Co., 2004
2. Principles of biochemistry, Garrette, Grisham, Saunders College Publishing Co. 1994
3. Molecular Cell biology 3rd edition, Lodish *et a1.*, Scientific American Books. Freeman and Co.,1995
4. Molecular biology of the cell 4th edition – Alberts *et al.*, Garland Publishers, 2002
5. Harper's Biochemistry 26th edition – Murray *et al.*, McGraw Hill, 2003

SEMESTER- I Paper-V

Subject Title : **PLANT BIOCHEMISTRY AND BIOTECHNOLOGY**

Course Number : **Number of Credit Hours: 4 (Four)**

Subject Description :
The course deals with plant cells and its organelles, metabolism of carbon , nitrogen and sulphur compounds ,technical advantages in plant tissue culture and gene transfer technology

Goals:
It provides sufficient knowledge about the various metabolic pathways and its applications in plant productivity.

Objectives :
To obtain knowledge on production of transgenic plants.
To understand the functions and regulations of major biosynthetic pathways of plants.
To become familiar with the exciting topics in plant biology research

UNIT-I
Photosynthesis – photosynthetic apparatus; organistation of thylakoid; role of chlorphylls, carotenoids and other photosynthetic pigments; light absorption and energy conservation.
Light – properties of both particle and wave; light absorbed by pigment molecules; the reaction centre complex. The photo systems I and II.
Electron transport pathways in chloroplast membranes. ATP synthesis in chloroplasts; cyclic and noncyclic photophosphorylation

UNIT-II
Carbon reactions in C3, C4 and CAM plants - Calvin cycle; Hatch-Slack pathway.
Photorespiration: role of photorespiration in plants; biochemical basis of PR pathway – C2 cycle; pathways of glucose oxidation in plants; starch biosynthesis and degradation; metabolic transport between organelles;
Overview of lipid and protein metabolism in plants; bioluminescence in *Gonyaulax*

UNIT-III
Nitrogen fixation – symbiotic and non-symbiotic. Symbiotic nitrogen fixation in legumes by Rhizobia – biochemistry and molecular biology of nitrogen fixation – enzymology of nitrogen fixation; regulation of *nif* and *nod* genes of nitrogen fixation.
Interaction between nitrate assimilation and carbon metabolism.
Sulphur chemistry and functions; reductive sulfate assimilation pathway.
Synthesis and function of glutathione and its derivatives.

UNIT-IV
Structure of plant genes. Organisation of plant chromatin. The nuclear, chloroplast and mitochondrial genomes. Interaction between nuclear and organellar genome.
Biosynthesis of organelles – development of chloroplast and plastids.

Gene transfer to plants; *Agrobacterium* mediated transformation – Ti plasmids. Ri plasmids. Direct DNA transfer to plants – protoplast transformation. Plant viruses as vectors – CaMV, Gemini viruses, RNA viruses (TMV, potato virus X) as vectors. Advantages and uses of transgenic plants

UNIT-V

Plant cell and tissue cultute. Tissue culture media – composition and preparation. Micropropagation; somoclonal variation. Callus. Protoplast culture - isolation and purification of protoplasts. Protoplast fusion; genetic modification of protoplasts.

Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Uses of haploids in plant breeding. Selection of hybrid cells and regeneration of hybrid plants, cybrids. Uses of plant tissue culture.

References:

1. Metabolic activities of plant cells – Anderson, Beandall, Blackwell Scientific Publishers
2. Biochemistry and molecular biology of plants – Bob, Buchannan
3. Plant biochemistry 3rd edition – Bonner, Varner, Academic Press
4. Plants, genes and crop biotechnology 2nd edition – Chrispeels *et al.*, Jones and Bartlett, 2002
5. Cell and tissue culture: laboratory procedures – Doyle, Griffiths, John Wiley, 1998
6. Plant biochemistry and molecular biology – Hans, Walter-Heldt, Oxford University Press, 1997
7. Genetic engineering 2nd edition – Nicholls, Cambridge University Press, 2002
8. Principles of gene manipulation 6th edition – Primrose *et al.*, Blackwell Scientific Publishers, 2001
9. Plant biotechnology – Slater *et al.*, Oxford University Press

SEMESTER I AND II
CORE BIOCHEMISTRY PRACTICALS – I

Clinical biochemistry:

1. Determination of the activity of the following serum enzymes:

a) LDH b) Acid phosphatase c) Alkaline phosphatase d) Aspartate amino transferase e) Alanine amino transferase f) Creatine kinase g) Superoxide dismutase h) glutathione peroxidase

2. Determination of the following from urine/serum:
   a) Chloride b) Calcium c) Magnesium
3. Estimation of albumin
4. Estimation of thiobarbituric acid reactive substances (TBARS) in serum
5. Determination of Na^+ and K^+ using flame photometer
6. Estimation of glucose, protein and chloride in CSF

Genetic engineering and molecular biology:

7. Agarose gel electrophoresis of DNA
8. Preparation of competent *E. coli* – Transformation (demonstration)

9. Plasmid DNA isolation from *E. coli*

Immunology:

10. Immunodiffusion – single radial and double diffusion
11. Immunoelectrophoresis
12. Rocket immunoelectrophoresis
13. Agglutination antibodies
14. Identifying blood group and Rh typing

Separation techniques:

16. Separation of amino acids by paper chromatography – circular, ascending and descending
17. Separation of amino acids/lipids/sugars by TLC
18. Separation of plant pigments by column chromatography

Bioinformatics

19. Sequence and Structural Database
20. BLAST and Clustal W
21. Gene Prediction using GenMark and GenScan

SEMESTER – III and IV
CORE BIOCHEMISTRY PRACTICALS – II

Colorimetric experiments:

1. Isolation and estimation of starch from potato
2. Isolation and estimation of glycogen from liver
3. Isolation and estimation of ascorbic acid from fruit
4. Estimation of β-carotene from carrot
5. Estimation of thiamine from cereals/fruits
6. Estimation of riboflavin
7. Estimation of lactose from milk
8. Estimation of RNA – UV and visible methods
9. Isolation and estimation of DNA from spleen/liver – UV and visible methods
10. Estimation of fructose in fruits

Enzyme studies:

11. Isolation , purification (precipitation methods, dialysis and chromatography), properties, kinetics and inhibitor studies of any one of the following enzymes:
    a) peroxidase b) amylase c) cellulase d) protease

Clinical microbiology:

12. Isolation of pure culture – serial dilution, pour plate, spread plate, streak plate methods, and slab culture techniques for long term storage
13. Colony morphology – colony counting
14. Staining techniques – simple, differential, negative, acid fast, spore, capsule and fungal staining
15. Antibiotic sensitivity disc – phenol coefficient method
16. Estimation of bacteria – growth curve of bacteria and generation time
17. Biochemical test – IMVIC , Starch test and Catalase test.

Semester – II Paper–VI

Subject Title : MICROBIAL BIOCHEMISTRY

Course Number : Number of Credit Hours: 5 (Five)

Subject Description :

The course examines the biochemical ecology of diverse microbial groups with emphasis on growth, transport of sugar, microbial metabolism, bioprocess technology and applications of microbial products in diverse fields

Goals :

The unit of study aims to provide:

An understanding of the basic principles of metabolic processes within the cell and how these processes can be harnessed for biotechnology.

Basic knowledge regarding the structure and properties of micro-organisms, including those of clinical, environmental and industrial importance.

A variety of laboratory exercises where students can apply their theoretical knowledge to practical situations and demonstrations, in the above areas.

Objectives:

At the end of this course, students will be able to:

Demonstrate an understanding of the major mechanisms of metabolism, energy exchanges and homeostasis in cells.

Recognize the linkage between the structures, chemical properties and chemical processes of certain molecules and macromolecules, and their roles in cells and biological processes, and in certain diseases.

Gain an introduction to bioprocess technology.

Gain an understanding of the applications of biotechnology in diverse fields such as agriculture, medicine and the environment and the significance of these developments.

UNIT-I

Transport of sugars into bacterial cell – the bacterial phosphotransferase system. Growth – balanced and unbalanced; measurement of growth; continuous culture, fed batch culture; growth and environment; growth cycle of bacterial culture; growth of single cells – cell cycle.Energy yielding metabolism – carbohydrates – EMP, HMP, TCA – importance in bacteria. Phosphoketolase pathway, ED pathway, characteristics of electron transport in bacteria

UNIT-II

Fermentations: alcoholic fermentation, propionic acid, formic acid, butyric acid and lactic acid fermentation; oxidation of aliphatic and aromatic hydrocarbons; metabolism of one carbon and two carbon compounds.

Amino acid biosynthesis; biosynthesis of cell wall – peptidoglycan, teichoic acid, lipids; biosynthesis of straight and branched chain fatty acids, unsaturated fatty acids and cyclopropane fatty acids. Synthesis of triacylglycerols, phospholipids, glycolipids and polyisoprenoids.

Metabolism of purines and pyrimidines

UNIT-III

Bioprocess technology – screening for industrially important microbes, strain improvement for better yield; design of fermenter- parts of the fermenter and their functions; types of fermentation processes. Analysis of batch and continuous bioreactions; stability of microbial reactors; Tower fermenter; air lift fermenter; specialized bioreactors; solid substrate fermentation and media formulation. Inocula prepation; Recovery and purification of products; monitoring of downstream processing.

UNIT-IV

Microbial products – production of organic acids – source, production of microbial process, recovery and applications.

Production of organic acids – source, recovery and uses of citric acid and lactic acid.

Production of antibiotics – source, production, recovery and uses of penicillin, tetracycline, amoxicillin.

Production of bioinsecticides from bacteria and fungi; production of bacterial and fungal polysaccharides; commercial production of xanthan gum.

UNIT-V

Animal cell and tissue culture. History and scope – advantages and disadvantages, laboratory facilities, the substrate, culture media and culture procedures. Primary culture, cell lines, maintenance of cultures and cell lines; valuable products from animal cell lines. Tissue culture – slide, flask and test tube cultures.

Whole embryo culture, organ culture. Stem cells – isolation, identification, expansion, differentiation and uses.

References:

1. Microbial biotechnology – Alexander *et al.,* -W.H. Freeman Publishers, 1995
2. Biology of microorgansisms – Madigan *et al.,* - Printice Hall, 2002
3. Biochemistry of bacterial growth – Mandelstram, Blackwell Scientific Publishers
4. Principles of fermentation technology 2nd edition – Stanbury *et al.,* Pergamon Publishers, 1995
5. Basic biotechnology 2nd edition – Ratledge, Kristiansen Cambridge University Press, 2001
6. Elements of biotechnology – Gupta, Rastogi Publication, 1998
7. Bioprocess engineering – basic concepts 2nd editon – Schuler, Karg, Printice Hall, 2001
8. Concepts in biotechnology – Balasubramanian *et al.,* Universities Press (India) Ltd., 2004
9. Animal tissue culture – Freshney, IRL press
10. Culture of animal cells: a manual of basic techniques 4th edition – Freshney, Wiley Liss, 2000

Semester – II – Paper – VII

Subject Title : IMMUNOLOGY

Course Number : Number of Credit Hours: 4 (Four)

Subject Description :

Immunology is a broad branch of science that covers the study of all aspects of the immune system in all organisms. It deals with, among other things, the physiological functioning of the immune system in states of both health and disease; malfunctions of the immune system in immunological disorders (autoimmune diseases, hypersensitivities, immune deficiency, allograft rejection); the physical, chemical and physiological characteristics of the components of the immune system in vitro, in situ, and in vivo.

Goals: Students can attain knowledge about body's immune system ,its functions and disorders, identifying antibodies, investigating problems with the immune system such as autoimmune diseases, and immunodeficiency disorders. And determining organ compatibility for transplantation.

Objectives:

given students a key understanding of the molecular and cellular components that comprise the immune system, including their function and interaction.

Enable students to learn diseases caused by disorders of the immune system (failure, aberrant action, and malignant growth of the cellular elements of the system),

Given the students, the latest methods of detecting disease causing pathogens, its treatment using novel vaccines.

UNIT I

Experimental Animal Models: inbred strains, SCID mice, nude, knockout mice. hemolytic plaque assay. Cells of the immune system: haematopoiesis. haematopoietic growth factors. Regulation of haematorpoiesis, clinical uses of stem cells. Lymphoid cells – Lymphoblasts CD antigens, T cell membrane molecules. T-cell receptors. Null cells, granulocytes adhesion molecules.

UNIT II

Antigens : B cell epitopes, T cell epitopes, Haptens : viral and bacterial antigens. factor influencing immunogencity, adjuant technology; Immunogloblins: domains classes and biological active antigenic determinants on lmmunoglobins. Immunoglobulins superfamily, Monoclonal Antibodies, gene rearrangements in immunoglobulins. Antigen - antibody interactions invivo - cross reactivity Antigen - antibody interaction invivo -- precipitants, agglutinants, RIA, ELISA - techniques and applications. Immunoglobulin genes - Multigene family, antibody diversity, expression of immunoglobin genes. MHC: Organization, MHC molecules and genes, Cellular distribution, regulation of MHC and immune responsiveness. MHC and disease. Antigen processing and presentation.

UNIT III

Complement Activation: Pathways regulation of complement system, Biological consequence of complement activation, complement deficiencies. Cytokines: IL. IFN, TNF, CSF, Cytokine, receptors, Cytokine antagonists, Cytokines related diseases. B&T cell maturation, activation, proliferation & differentiation

Unit IV

Hypersensitivity reactions - Type I, II, III & IV. Hypersensitivity disease. Cell mediated immunity: CTL mediated cytotoxicity, NK cell mediated toxicity. delayed type hypersensitivity. Immunological tolerance. Vaccines: Active and passive immunization, whole organism vaccines, recombinant vector vaccines, DNA vaccines, Synthetic peptide vaccines, multivalant sub-units vaccines. Immunodeficiency diseases.

UNIT V

Autoimmunity: Autoimmune disease in human, animal models, mechanism for induction of autoimmunity, Therapy. Transplantation immunology: clinical manifestation, therapy and bone-marrow transplants. organ-transplants. Cancer immunology: Tumor antigens, immune response to tumors, tumor evasion, Cancer immuno therapy. AIDS: Structure of HIV, destruction of T cells, immunological symptoms of AIDS. AIDS vaccine, gene therapy for treatment.

References:

1. Kuby immunology 4th edition – Goldsby *et al.*, Freeman and Co. 2000
2. Immunology V-The immune system in health and disease. Janeway Jr.Paul Travels and Co., 2001
3. Immunology 3rd edition – Roitt *et al.,* Mosby publishers 1993
4. Immunology 4th edition - Zubay, W.M.C. Brown publishers, 1992
5. Cellular and molecular immunology 2nd edition Abbas *et al.,* W.S.saunders 1994
6. Immunology 3rd edition Kuby, W.H.Freeman and company
7. Introduction to Medical immunology 4th edition, Virella, Marcel Dekker Ltd., 1999

SEMESTER-II PAPER-VIII

Subject Title : ADVANCED CLINICAL BIOCHEMISTRY

Course Number : Number of Credit Hours: 5

Subject Description :

Clinical biochemistry is the area of pathology that is generally concerned with analysis of bodily fluids. Clinical Biochemistry is that discipline which applies basic biochemistry and analytical chemistry to medical diagnosis, treatment and management. It provides a sound, objective basis on which to gauge the extent of a clinical disorder, the biochemical consequences of a particular disease process, and the response to therapy..

Goals:

To enable the students to learn serum chemistry, Principle, assay, and clinical significance of diagnostic enzymes .Diseases associated with liver, kidney and pancreas. Cancer, types and role of free radicals

Objectives:

Given information Common chemical pathology tests include: AST,ALT,GTT, Alkaline phosphatases , Bilirubin, CSF etc.

Course emphasized human metabolism , students developed knowledge of metabolic changes during the fed, fasting and starved state.
A substantial no of medical cases were included to demonstrate the relevance of biochemistry to health and disease.
Topics discussed include: Biochemical markers of disease and clinical significance of steroid, protein and thyroid hormones

UNIT I

Serology and hematology :- C- reactive protein test, immunological test for pregnancy. Rhumatoid arthritis (RA) test. ESR.,Coagulation test, prothrombin test. Hemoglobin: Normal and abnormal Hb, Seperation of hemoglobin. Thalasemia, Hemoglobinopathies. Erythrocyte metabolic pathways, Disorder of erythrocyte metabolic pathways,. Porphyrins and porphyrias.

UNIT II

Specimen collection and processing:-
Collection of blood vein puncture, collection with syringe, collection with evacuated tube, skin puncture, arterial puncture and anticoagulants.
Collection of urine:-
Timed urine specimens, urine preservatives. Test for urinary compounds. Clinical significance of urinary components with reference to sugars,proteins,ketone bodies, bilirubin and porhyrins.
CSF:- Composition and collection ,chemical examination and infections, spinal cord infections.
Amniotic fluid:- Origin, collection,composition and analysis of amniotic fluid.

UNIT III

Clinical enzymology and endocrinology:-
Principles of diagnostic enzymology - Factors affecting enzyme levels in blood.
Principle, assay, and clinical significance of transaminases, creatine kinase, lactate
Dehydrogenase, phosphatases, isocitrate dehydrogenase, 5'nuclotidase, gamma –glutamyl transferase, amylase, lipase, trypsin, chymotrypsin, choline esterase, glutamate dehydrogenase, glucose -6-phosphate dehydrogenase and ceruloplasmin.
Enzyme pattern in diseases:- Myocardial infarction, hepatobiliary diseases. Overview of clinical significance of steroid, protein and thyroid hormones. (Experimental details not required).

UNIT IV

Liver function test and related disorders:-Jaundice ,cirrhosis, hepatitis, fatty liver and gall stones.
Renal function test and related disorder:- Acute renal failure.glomerular disease,tubular diseases, analysis of urinary calculi. Gastric and pancreatic function test. Hyper and hypo lipoproteinemias and diagnostic test for lipoprotein disorders.

UNIT V

Oncology:- Cancer markers for oral cancer. Prostate cancer,.Colorectal cancer.breast cancer and gastrointestinal tract cancer.
Alpha fetoproteins,carcino embryonic antigens, leukemia.
Free radicals in diseases:- Introduction , Types of free radicals. Free radical induced lipid peroxidation and antioxidants(Enzymic – SOD, Glutathione PEroxidase, Glutathione Reductase; Non Enzymic-Ascorbic acid, Tocopherol, Reduced Glutathione) .

References:

1. Fundamentals of clinical chemistry – Teitz, W.B.Saunders company, 1994
2. Clinical chemistry in diagnosis and treatment 6th edition – Mayne, ELBS Publications, 1994
3. Practical clinical biochemistry, volume I and II, 5th edition – Varley *et.al.*, CBS Publishers, 1980
4. Teitz text book of clinical biochemistry 3rd edition – Burtis *et al.*, William Heinmann medical books, Ltd., 1999
5. Clinical biochemistry – Metabolic and clinical aspects, Pearson Professional Ltd.1995
6. Clinical chemistry 5th edition – Mosby, Marshall, 2004
7. Harrison's Principles of internal medicine Vol. I and II. 14th edition, McGraw Hill
8. Clinical chemistry – principles, procedures and correlations, Bishop, Lipppincott, 2000

SEMESTER- II PAPER-IX

Subject Title : **MOLECULAR BIOLOGY**
Course Number : **Number of Credit Hours: 5 (Five)**

Subject Description :
Molecular biology is the study of biology at a molecular level. It chiefly concerns itself with understanding the interactions between the various systems of a cell, including the interrelationship of DNA, RNA and protein synthesis and learning how these interactions are regulated.

Goals:
To enable the students to learn molecular underpinnings of the process of replication, transcription and translation of the genetic material.

Objectives:
Given information on the cell, DNA, RNA, proteins, how cells read the genome,(from DNA to protein), and control of gene expression ,

UNIT-I
Molecular structure of genes and chromosomes; molecular definition of gene – pro and eukaryotic transcription units. Chromosomal organization of genes and noncoding DNA – protein coding genes. Tandemly repeated genes, single sequence DNA. Mobile DNA – mobile elements. Bacterial insertion sequence, bacterial transposons, viral retrotransposons, non-viral retrotransposons.

Structural organization of eukaryotic chromosomes – histone proteins, chromatin. Functional elements of eukaryotic chromosomes. Mutations – types.

UNIT-II
DNA replication, repair and recombination. General features of chromosomal replication. DNA replication machinery – eukaryotes and prokaryotes. Role of topoisomerases in DNA replication. DNA damage and repair – all types. Recombination – Holliday model, Rec BCD enzyme, Rec A protein, Messelson model, site specific recombination

UNIT-III

Prokaryotic transcription – initiation, elongation and termination (rho dependent and rho independent). Lac operon and trp operon. Transcriptional control of gene expression. Overview of eukaryotic gene control and RNA polymerases. Regulatory sequences in protein coding genes – TATA box, initiators, proximal elements, distant enhancer sites.

Transcription initiation by RNA polymerase II, I and III. Regulation of transcription – factor control, lipid soluble hormones and polypeptide hormones
Transcription of HIV genome – antitermination mechanism. Mitochondrial and chloroplast DNA – transcription by organelle specific RNA polymerases

UNIT-IV

Post RNA transcriptional gene control. Processing of eukaryotic pre mRNA, hnRNA proteins, RNA binding motifs, splicing, snRNA, spliceosome. RNA editing, macromolecular transport across the nuclear envelope. Nuclear pore complex, cytoplasmic polyadenylation, degradation of mRNA, regulation of processing of rRNA and tRNA

UNIT-V

Genetic code – wobble hypothesis. Protein sorting and targeting of mitochondria and chloroplast proteins. Synthesis and targeting of peroxisomal proteins. Overview of secretory pathway. Translocation of secretory products across ER membrane.
Insertion of proteins into ER membrane. Posttranslational modification – protein glycosylation in ER and Golgi complex. Receptor mediated endocytosis.

References:

1. Advanced molecular biology – Twyman, Viva publication, 1998
2. Genes VIII – Lewin, Printice Hall, 2004
3. Molecular biology of the cell 4th edition – Alberts *et al.*, Garland Science Publications, 2002
4. Molecular biology of the gene 5th edition – Watson, Pearson Education, 2004
5. Molecular cell biology 5th edition – Freeman Publishers, 2003

SEMESTER- III PAPER –X

Subject Title : **BIOSTATISTICS**
Course Number : **Number of Credit Hours: 5 (Five)**

Subject Description :

The course emphasizes on various statistical methods and significance. In this paper the methods for which there are applications in life sciences are taught. The students are expected to understand the concepts and solve relevant problems pertaining to each topic. No derivations or proofs are expected of them. Emphasis is laid on learning to solve the problems

Goals:
To equip the students with basic statistical knowledge and its biological applications
Objectives:
To provide knowledge and skills sufficient to allow students to understand the role of statistics in research.
To develop skill in the basic methods of data gathering and analysis.
To provide sufficient background to be able to interpret statistical results in research papers.
To develop sufficient knowledge of probability and probability distributions to support further studies in statistics and operations research.

UNIT I
Organising a statistical survey - Planning and executing the survey. Source of data - Primary and secondary data, Collection -- observation; interview; enquiry forms, questionnaire schedule and check list. Classification and tabulation of data. Diagrammatic & graphic presentation of data.

UNIT II
Measures of central tendency; arithmetic mean, median, mode, quartiles, deciles and percentiles. Measures of variation: range, quartile, deviation, mean deviation, standard deviation. Correlation analysis: Scatter diagram, Karl Peason's coefficient of correlation and Spearman's rank method. Regression analysis.

UNIT III
Probability -- definition, concepts, theorems (proof of the theorems not necessary) and calculations of probability.
Theoretical, distributions.
Binomial - 'Poisonn and normal distribution.
Normal -importance, properties, conditions and constants of the distribution (proof not necessary).
Simple problems.

UNIT IV
Sampling distribution and test of significance:
Testing of hypothesis errors in hypothesis testing, standard error and sampling distribution. sampling of variables (large samples and small samples).
Student's 't' distribution and its applications.
Chi - square test & goodness of fit.

UNIT V
Analysis of variance one way and two-way classification, Duncans Multiple Range Test.
Design of experiment - completely randomized block design randomized clock design

References:
1. Statistical methods S.P. Gupta
2. Biostatistics – A foundation for analysis in health science Danien.
3.Biostatistical analysis - Jerrold H.Zar. Pearson Education, 4th Edition

SEMESTER-III PAPER-XI

Subject Title : **METABOLISM AND METABOLIC REGULATION**

Course Number : **Number of Credit Hours: 5 (Five)**

Subject Description :

This subject will give a more detailed overview of the major catabolic and anabolic pathways and their regulation. Particular emphasis is placed on bioenergetics and enzymes involved in it. A detailed examination of the metabolism of carbohydrates, lipids, amino acids, purine and pyrimidines are dealt with this course..

Goals:

. The goal is to provide students with a well-rounded understanding of Intermediary metabolism: principles of bioenergetics, catabolism and anabolism, the metabolic pathway. Central metabolic pathways: glycolysis, citric acid cycle, the pentose phosphate pathway, gluconeogenesis. Energy stores: glycogen and fatty acids.. Integration of metabolic pathways.

Objectives:

On successful completion of the course the students should have

Understood catabolic and anabolic pathways of carbohydrate, lipids, amino acids and porphyrin metabolism

Learnt the role of plant hormones and biosynthesis of secondary metabolites and its application.

UNIT I

Carbohydrate Metabolism:-

An overview & energitics of glycolysis and gluconcogensis - Regulation of glycolysis and gluconcogenesis - phosphofructokinase, hexokinase and pyruvate kinase as regulatory enzymes in glycolysis; hormine regulation. Anaphlerotic reactions 'filling up reactions

Gluconeogensis: Regulation by allosteric and substrate level control mechanisms.

TCA - cycle - steps: Regulation at branch points :-Pyruvate dehydrogenase. alpha - keto glutarate dehydrogenase, and citrate synthase.

Glycogen metabolism - Regulation of glycogen phosphorylase; glycogen synthase by effectors, covalent modification and hormones.

UNIT II

Lipid metabolism:

An overview of fatty acid anabolism and catabolism. Regulation of fatty acid synthesis - Control of acetyl CoA carboxylase line on fatty acid synthetase complex: Role of hormones; effect of diet on fatty acid synthesis.

Regulation of biosynthesis of triacylglycerols, cholesterol, phosphotidyl choline, phosphotidyl ethanolamine and sphingomyelin

Biosynthesis and regulation of prostaglandins, Eicosanoids, Thromboxanes leukotrienes.

UNIT III

Amino acid metabolism:

An overview on Gamma -glutamyl cycle.
An overview -Methionine as methyl donor (SAM pathway!
An overview & regulation of urea cycle.
Regulation of alpha-keto glutarate family, pyruvate family. 3-
Phosphoglycerate family, Aspartate family and Aromatic family of amino acids.
Allosteric regulation of glutamine synthase.

UNIT IV

An overview on porphyrin metabolism:

Regulation of biosynthesis & degration hemoglobin, chlorophyll & cytochrome.
Nucleic acid metabolism:
Pathways of purines and pyrimidines biosynthesis (both de novo and salvage pathways) & degradation. .
Regulation of purine biosynthesis:PRPP aminotransferases.
Regulation of pyrimidine biosynthesis: Aspartate carbamoyl transferase. Regulation of deoxyribonuclcotides by activators and inhibitors.

UNIT V

Elucidation of metabolic pathways-Analysis of single step pathway and Multistep pathway , Mutant study-Complementation for metabolic steps analysis.

Plant metabolism:

Hormones: Biosynthesis of – Indole acetic acid, Gibberellins, cytokinins, Ethylene, salicylic acid.
Pathways of synthesis of secondary metabolites and its application. Alkaloids,
Flavanoids and Terpenoids.

References:

1. Biochemistry 3rd edition - Zubay, John Wiley, 2002.
2. Regulation in metabolism - Newshome, Start John Wiley
3. Principles or Biochemistry with human focus – Garrette, Grisham. Brookes Cole l997
4. Biochemistry and molecular biology of plants – Buchanan.
5. Biochemistry 5th edition – Stryer, Freeman 2002
6. Lehninger's Principles of biochemistry, 4th edition – Nelson, Cox, McMillan Worth, 2005
7. Biochemistry 4th edition – Campbell, Farrell, Brooks Publishing Co.,

SEMESTER- III PAPER-XII

Subject Title : **GENETIC ENGINEERING**

Course Number : **Number of Credit Hours: 5 (Five)**

Subject Description :
Genetic engineering is a term that is applied to the manipulation of genes, generally implying that the process is outside the organism's natural reproductive process. It involves the isolation, manipulation and reintroduction of DNA into cells or model organisms, usually to express a protein.

Goals:
To equip the students to learn and apply the recent advances in the various techniques of GE to introduce a new characteristics to introduce a novel trait or enhancing existing ones, or produce a new protein or enzyme.

Objectives:
Learnt the advent of DNA research and the ability to change gene expressions, so as it is now possible to change human capacities, whether they be physical, cognitive, or emotional.
Learnt about the potentially momentous biotechnological applications of GM, for example, Cloning, Vectors, transgenic animals, treating diseases etc.

UNIT-I
Introduction to genetics. Transmission genetics.
Mendelian genetics. Mendelian analysis of inheritance. Genes, chromosomes, alleles, homozygous, heterozygous and mechanism of Mendelian inheritance.
Mendel's laws. Linkage – definition, simple measurement and salient features.
Salient features of autosomal dominant, recessive, codominance; X-linked recessive, codominant and dominance; Y-linked characters.
Extranuclear inheritance.

UNIT-II
Restriction endonucleases – types and functions; restriction mapping
Nucleic acid probes and their applications – cloned probes, oligonucleotide probes; labeling of nucleid acid probes.
Nucleic acid hybridization techniques – liquid and dot blot technique; Southern and Northern hybridization; *in situ* hybridization; whole mount *in situ* hybridization. FISH.
Polymerase chain reaction – types and applications.
DNA fingerprinting, Chemical synthesis of genes, DNA sequencing.

UNIT-III
Cloning vectors – salient features. Plasmids as vectors – properties, natural plasmids, pBR 322, pSC 101, pUC, bluescript. Mechanism of cloning in plasmid vectors.
Bacteriophage vectors – λ phage, X-vector – packing of X-vector *in vitro*. Cosmid vectors, cosmid cloning.

DNA (single stranded) vectors – development of M13 vector, PEMBL vector, λ 2AP viral vectors. SV 40, retrovirus, adenovirus, recombinant vaccinia virus vectors. Baculo virus vector for insects. Transposons as vectors.
High capacity cloning vectors – bacterial artificial chromosomes, phage P1, yeast aritificial chromosomes and PACs.

UNIT-IV
Cloning strategies – genomic and cDNA cloning. cDNA library.
Expression vectors – vectors for maximizing protein synthesis, fusion proteins.
Expression vectors – expression of cloned genes in *E. coli*. Cloning and expression of cloned genes in *Bacillus subtilis*. Cloning in yeasts; yeast expression vectors, overexpression in yeast. Expression in baculovirus system.
Cultured insect cell expression systems; mammalian cell expression systems.
Recombination, selection and screening methods and processes.

UNIT-V
Gene transfer methods in animal cells – calcium phosphate copreceipitation, electroporation, microinjection, using viral vectors.
Transfer, cotransfer, selectable markers like TK, PSV, PRSV and reporters genes. Gene targeting in animal cells; transfer and expression of cloned genes in *Drosophila*. Gene knockout.
Methods for production of transgenic animals (mice, sheep, goat, fish, pig, cow *etc*.,) – retroviral, DNA microinjection and engineered stem cell methods. Applications of transgenic animals; transgenic animals as models/in the prevention of human diseases like cystic fibrosis, muscular dystrophy and anticancer therapy.

References:
1. Genomes – Brown, John Wiley, 1999
2. Genetics 4th edition – Elrod, Stansfield, 2002
3. Genes VIII – Lewin, Printice Hall, 2004
4. Molecular cell biology 5th edition – Lodish *et al.,* Freeman Publishers, 2004
5. Molecular biology of the gene 5th edition – Watson, Pearson Education, 2004
6. Molecular biotechnology 3rd edition – Glick, Paternak, Panima Publishers, 2003
7. Genetic engineering – Nicholls, Cambridge University Press, 2002
8. Recombinant DNA 2nd edition – Watson, Scientific American Publishers, 1998
9. Principles of gene manipulation 6th edition – Primrose *et al.,* Blackwell Scientific Publishers, 2001
10. Principles of genome analysis – Primrose, Blackwell Scientific Publishers, 2003

SEMESTER- III PAPER-XIII

Subject Title : **ENDOCRINOLOGY**

Course Number : **Number of Credit Hours: 5 (Five)**
Subject Description :
This course is a branch of medicine dealing with disorders of the endocrine system and its specific secretions called hormones.
Goals: To enable the students to learn about the chemical classes of hormones and its chemistry, Biosynthesis, control of secretion; physiological roles. Mechanism of action and pathophysiology.
Objectives: Provided much information related to Pitutary,Thyroid, Pancreatic ,adrenal and gonodal hormones and Various disorders related to each hormones.
Learnt about the mechanism of action of various hormones with its effect on human due to their hypo and hyper secretion .
Also learnt the biochemical changes occurring in pregnancy, parturition and lactation. ; Human infertility-reason and therapy

UNIT I
Hormones- Introduction, chemical structure. Hormones and homeostasis.Neuroendocrine integration in homeostasis. Classes of chemical messengers. Hormone secretion. Transport and clearance. Hormones and behavior. Feed back control of secretion .Mechanisim of hormone action –receptors .second messengers. Cytosolic hormone receptors: Eicosonoids and hormone action. calmodulin. Hormone bioassay-RIA, ELISA.

UNIT II
Pituitary hormones- Anatomy of pituitary gland, hormones of the pituitary, pathophysiology. Endocrine hypothalamus- structure, hypophysiotropic hormones, control of hypothalamic hormone secretion. Feed back mechanisms. mechanism of action. Neurohypophysis: Synthesis and chemistry of N.H. hormone, control of neurohypophyseal hormone secretion. Roles and mechanism of action of oxytocin, vasopressin. Pathophysiology . Growth hormones: somatotropins and somatomedins, pathophysiology. Growth factors: neurotropic growth factors, hematopoietic growth factors, epidermal growth factor.

UNIT III
Thyroid gland:- Synthesis and chemistry of hormones, control of thyroid hormone secretion, circulation and metabolism, physiological roles, mechanism of action. Pathophysiology. Parathyroid gland: synthesis, chemistry and metabolism of parathyroid gland hormones ,control of secretion. Physiological role and vitamin D. Mechanism of action of calcium homeostasis, pathophysiology. Melanotropic hormones- chemistry, role of MSH and mechanism of action. Pathophysiology.
Pineal gland - melatonin hypothesis, melatonin secretion and circulation, proposed role of pineal, mechanism of action.

UNIT IV

Pancreas:- Endocrine pancreas, insulin, glucagons, somatostatin. Pancreatic peptide – chemistry, physiological roles and mechanim of action. Catecholamines - synthesis, chemistry and metabolism. Neurohormones:- endorphins-source, chemistry, control of secretion; physiological roles. Mechanism of action and pathophysiology.

UNIT V

Reproductive endocrinology:-

Male reproductive system:- source, synthesis, chemistry and metabolism of androgens, Physiological roles and mechanism of action. Pathophysiology.

Female reproductive system:- Ovarian steroid hormone synthesis, physiological role.

Mechanism of action, Neuroendocrine controle of organ function. pathophysiology.

Endocrinology of pregnancy, parturition and lactation, sex differentiation and development, puberty and hormone control. Human infertility – reasons, therapy and treatment.

References:

1. Endocrinology 4th edition – Hadley, Prentice Hall
2. Text book of medical physiology 10th edition – Guyton, Hall, Saunders Publishing Co.,
3. Principles of biochemistry 7th edition – Smith *et al.*, McGraw Hill, 1983
4. William's Textbook of endocrinology 8th edition – Wilson, Foster

SEMESTER- III PAPER-XIV

Subject Title : **PHARMACEUTICAL CHEMISTRY AND NEUROCHEMISTRY**

Course Number : **Number of Credit Hours: 5 (Five)**

Subject Description :

This course. deals with the drug, drug metabolism, drug receptors,drug tolerance, dependance ,resistance. It also contains the effect of drugs on neuro system

Goals:

To enable the students to learn about various drugs with its effects and metabolism. Therapeutic monitoring of drugs.

Objectives:

After the completion of this course the student would have understood

Various routes of Drugs administration, its distribution, metabolism and excretion.

Genetically engineered drugs for AIDS and cancer and novel drug delivery systems

Effect of drugs on central nervous system and associated diseases

UNIT-I

Drugs – sources, dosage forms and routes of administration. Drugs – structural features and pharmacological activity, prodrug concept. Absorption, factors modifying drug absorption. Distribution, metabolism and excretion of drugs – phase I, II reactions, action of cytochrome P450.

Drug receptors – localization, types and subtypes, models and theories. G-protein coupled receptor and ion-channel linked receptors. Examples of drug-receptor interactions. Agonists and antagonists.

UNIT-II

Drug tolerance and drug dependence. Principles of basic pharmacokinetics. Adverse response to drugs, drug intolerance, pharmacogenetics, drug allergy, tachyphylaxis, drug abuse, vaccination against infection, factors modifying drug action and effect. Assay of drug potency: chemical, bioassay and immunoassay.

UNIT-III

Biotechnology and Pharmacy

Genetically engineered protein and peptide agents. Novel drug delivery systems – chronomodulated drug delivery systems; non-conventional routes of administration, anti-AIDS drug development, oncogenes as targets for drugs, multidrug resistance phenotypes, production of secondary metabolites by plant culture. Genome based medicine. The role of bioinformatics in genome based therapy. A very brief account of pharmacogenomics.

UNIT-IV

Mechanism of action of drugs used in therapy of

a) Respiratory system – cough, bronchial, asthma, pulmonary tuberculosis.

b) Antimicrobial drugs – sulfonamides, trimethoprim, penicillins, aminoglycosides and bacterial resistance.

c) Cancer chemotherapy

d) Thyroid and antithyroid drugs, insulin and oral antidiabetic drugs, antifertility and ovulation inducing drugs.

UNIT-V

Brain – neurotransmitters, encephalins and endorphins; general function of autonomic and somatic nervous system; cholinergic transmission and receptors; adrenergic transmission and receptors; muscarinic receptors.

Non-steroidal and anti-inflammatory drugs; adrenergic blocking drugs; cholinergic blocking drugs; muscarinic blocking drugs; Parkinson's disease; Alzhemier's disease.

Neurodegenerative disorders – amylotropic, lateral sclerosis, senile dementia, Schizophrenia,Huntington's disease,

References:

1. The pharmacology, Volumes I and II – Goodman, Gilman
2. Basic and clinical pharmacology 7th edition – Katzung, Printice Hall, New Delhi
3. Pharmacology 3rd edition – Rang, Tale
4. Pharmacology and pharmacotherapeutics – Satoskar *et al.*, Popular Prakashar, Mumbai
5. Principles of medicinal chemistry – Foye, Waverks Pvt. Ltd. New Delhi
6. Burger's medicinal chemistry and drug discovery: principles and practice – Wolf, John Wiley
7. Molecular basis of inherited diseases – Davies, Read, IRL Press
8. Molecular biotechnology 2nd edition – Glick, Pasternak, Panima Publishers, 2002

ELECTIVE GROUP A : PAPER I - PLANT TISSUE CULTURE
Number of Credit Hours: 3 (Three)

UNIT -I

Genome organization in plants. Cell and Tissue culture in plants: Tissue culture media (composition and preparation)
Primary culture: cell line, cell clone, callus and suspension culture, Somoclonal variation, Micropropagation, Organogenesis.

UNIT- II

Embryo culture and Embryo rescue, somatic embryogenesis, Haploidy, Protoplast fusion and somatic hybridization, Cybrids, Allopheny, Artificial seeds.

UNIT -III

Anther, Pollen and ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth and DNA banking for germ plasm conservation.

UNIT- IV

Application of Plant Transformation for productivity and performance: Herbicide resistance, Insect resistance, virus resistance, Nematode resistance, and Bt genes.

UNIT- V

Plant secondary metabolites, Edible vaccines, and Biodegradable plastics.

ELECTIVE GROUP A : PAPER II - ANIMAL TISSUE CULTURE
Number of Credit Hours: 3 (Three)

UNIT-I

Animal cells; Culture media: Balanced salt solution and simple growth medium, Physical, Chemical and metabolic functions of different constituents of culture medium.

UNIT-II

Types of cell culture: primary and established culture, organ culture, tissue culture, three dimentional culture and tissue engineering.

UNIT-III

Biology and charecterization of cultured cells : tissue typing, cell-cell interaction, measuring parameters of growth, measurement of cell death, apoptosis and its determination, Cytotoxicity assay.

UNIT-IV

Embryology: collection and preservation of embryo, culturing of embryos, gametogenesis and fertilization in animals. Stem cell – isolation, identification, expantion, differentiation and uses.

UNIT-V

Transgenic animal production and application, transgenic animals as models for human diseases, transgenic animals in live stock improvement, transgenesis in industry.

ELECTIVE GROUP A :PAPER III - METHODS IN MOLECULAR BIOLOGY

Number of Credit Hours: 5 (Five)

UNIT-I

Rapid DNA sequencing techniques and strategies details of a range of methodologies, e.g. plus and minus, dideoxynucleotide, partial ribose substitution, Maxims and Gibert. Use of thin gels, resolution etc. interpretation of DNA sequences.

Role of counter ions , deep and narrow grooves ,single standard DNA,A,B and Z DNA etc. Chirality of the helix, syn / antiparallel complementary strands.

UNIT II

Physical properties of RNA: Classes of RNA, rRNA, tRNA, mRNA, HnRNA etc. Structure and methods of isolation and fractionation, gel electrophoresis and Dnases, Rnases , Phosphodiesterases.

Rapid RNA sequencing techniques: plus and minus.interpretation of RNA sequence.

Methods of distinguishing double and single standard DNA.

UNIT –III

Reassociation kinetics: cot values, experimental procedure, qualitative signifigance, use of Ag + cesium sulphate.

Satellite DNA : C-value paradox, possible functions of satellite DNA, mechanical strenth, gene library, suppressor mutation, centromeric DNA, spilt genes.

Chromatin: Histone and non-histone proteins, general properties of histones, packing density. Nucleosomes , size variable linker, role of H1.Solenoid structure. Transcriptionally active chromatin.

UNIT –IV

Movable genes: Transposons and associated inverted repeats. The cassette model, transforming DNA and plant genes. Retrovirus life cycle.

Strategies for cloning in plasmid vectors, features of commonly used vectors, their purification and characterization. Identification of bacterial colonies that contain recombinant plasmids . Bacteriophage λ vectors, growth, purification. Cloning in Bacteriophage λ vectors.

UNIT –V

Agarose gel and polyacrylamide gel electrophoresis, detection and extraction of DNA from gels. Construction and analysis of c-DNA: Protocols and strategies for c-DNA cloning. Analysis of genomic DNA by southern hybridization. Amplification of DNA by the Polymerase Chain Reaction. Preparation of radiolabled DNA and RNA probes. Synthetic oligonucleotide probes. Expression of cloned genes in cultured cells. Screening expression with antibodies and oligonucleotides.

ELECTIVE GROUP A : PAPER IV
CELL CULTURE AND MOLECULAR TECHNIQUES
PRACTICALS

PLANT TISSUE CULTURE

1) PTC laboratory organization
2) Sterilization procedures
3) Preparation of PTC medium
4) Callus induction
6) Micro propagation
7) Artificial seed production
8) Mitotic Preparation –Onion root tip

ANIMAL TISSUE CULTURE

1) Preparation of ATC medium and membrane filteration
2) Preparation of primary culture from chick embryo
3) Isolation of DNA from animal cell
4) Quantification of DNA- Spectrophotometric method

METHODS IN MOLECULAR BIOLOGY

1) Isolation of genomic DNA and RNA
2) Isolation of plasmid DNA and estimations by DNP method
3) Polymerase chain reaction

References

1) Molecular Cloning : a laboratory Manual, J. Sambrook, Fritsch and Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2) Applied Molecular Genetics, Roger, L.Miesfield, John Wiley and Sons Inc Publications, 1999.
3) Recombinant DNA Principles and Methodologies, James .J. greene, Vengalla B.Rao, Marcel Dekker Publications, 1998.
4) DNA Cloning, a pratical approach, D.M. Glover and B.D. Hames, IPL press, Oxford, 1995
5) Molecular and Cellular methods in Biology and Medicine, P.B. Kaufman, W.Wu, D.Kim and L.J.Cseke, CEC press, Florida, 1995.

ELECTIVE GROUP B
PAPER I - COMPUTATIONAL MOLECULAR BIOLOGY

Preamble:

Scope: To provide molecular biologists the modern molecular databases and tools including literature, sequence, structure and expression databases.

Objective: To provide information an understanding of the major computational problems in the field of molecular biology.

Goal: To gain knowledge on molecular databases, comparative genomics, pattern search, classification of sequence and structure, alignment of sequences, rapid similarity searching, phylogenies, automated pattern learning, representing and searching protein structure, gene expression profiling, clustering expressed genes, discovering transcription factor binding sites, discovering common functions of co-expressed genes, metabolic pathways, signal transduction pathways.

Contents:

Unit – I

Computational Molecular Biology: Bioinformatics - Bibliographic and Full Text Journal Access - Genome Databases - Molecular Biology Databases on the Web - DNA and protein forensics analysis - Probability and statistics - Prior probability - Linkage analysis

Unit - II

Pattern Matching with Consensus Sequences - Quantitative & Probabilistic Pattern Matching - Sequence Alignment - Rapid Sequence Similarity Search - Near-Optimal Sequence Alignments - Multiple Sequence Alignment.

Unit III

Distance Based Phylogenies - Sequence Blocks & Profiles - Protein Sequence Motifs Protein Structural Motifs.

Unit IV

Clustering and Functional Analysis of Coordinately Regulated Genes - Discovering Transcriptional Regulatory Signals - Ultra conservation in the Human Genome - Pathway Bioinformatics.

Unit V

Intro to the GCG SeqWeb Interface - Sequence Comparision - GCG SeqWeb - BestFit and Gap - Description of Progressive Pairwise Algorithm - Phylogenetic Analysis.

References:

1. Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley- Dream Tech India Pvt. Ltd.
2. Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reilly publications.

3. Introduction to bioinformatics by T.K. Attwood and D.J. Parry –smith, Pearson Education Asia.
4. Bioinformatics by David.W.Mount, CBS publishers and distributers.
5. Instant notes in bioinformatics by D.R. Westhead, J.H.Parish and R.M.Twyman.
6. Biostatistical analysis. Zar.J.H
7. Peuzner, P.A., Computational molecular Biology, An algorithmic approach.

ELECTIVE GROUP B
ELECTIVE PAPER - PAPER II - GENOMICS

Preamble:

Scope: T o provide students a detailed through background various wet lab techniques and data generation tools related to DNA sequences.
Objective: To handle the data in analyzing and interepretaion including annotation.
Goal: To educate students on stand alone and online software for genetic studies.
Contents:

Unit I
Genome structure: Genome sizes and the C-value paradox, introns and exons, microbial and organelle genomes - Centromeres and telomeres, tandem repeats- dispersed repeats (transposons), gene density, intergenic DNA.

Unit II
Genome physical mapping and sequencing: Fragmenting the genome, the need for markers - marker sequences (RFLPs, AFLPs, SNPs, etc) - hybridization mapping -mapping without cloning - Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – resequencing.

Unit III
Genome project and bioinformatics - www databases for genomes - DNA dynamics - Recombination – Evolution - Gene diversity - Consensus and pattern recognition - Sequence diversity – Polymorphism.

Unit IV
Phylogenetic Genome mapping - DNA sequence database analysis - Random-shearing
GenBank - Web-based ORF finding, sequence alignment and 3-D matrix tools – Genotator - DNA modeling.

Unit V
Orthologues and paralogues, RNA transactions, comparative genomics of viruses, bacteria, organelles and eukaryotes, lateral gene transfer.

Reference:

1.The Human Genome Project; Deciphering the blueprint of heredity ; Edited by Necia Grant Cooper; University Science books, CA, USA, 1994.
2. Bioinformatics-A beginner's guide by Jean – Michel Claverie and Cedric Notredame, Wiley-Dream Tech India Pvt. Ltd.
3. Developing bioinformatics computer skills by Cynthia Gibas and Per Jambeck, O' Reilly publications.

GROUP B
ELECTIVE PAPER - PAPER III - PROTEOMICS

Scope: T o provide students a detailed through background various wet lab techniques and data generation tools related to protein sequences.
Objective: To eable students to know warious wet lab and insilico tools for handling proteomic studies.
Goal: To educate students on stand alone and online software for proteomic studies.
Contents:

Unit I

Introduction to 2D gel electrophoresis, multidimensional chromatography, mass spectrometry, and analytical protein chips. Identifying proteins in complex mixtures.
Protein profiling, quantitative 2DGE, quantitative mass spectrometry.

Unit II

The analysis of phosphoproteins and glycoproteins. Protein interaction analysis, Y2H, mass spec complex analysis, functional protein chips, protein localization, high throughput functional annotation.

Unit III

Protein domains and folds, using sequences and structures to predict gene function, high throughout structural analysis of protein, structural proteomics and what it can achieve.

Unit III

Phamacogenomics and new drug design. Need for developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR; Active site determination of enzymes; Design of enzyme inhibitors.

Unit V

Significance of metabolomics, methodologies, technical problems, data handling, data Interpretation. Computational protein-protein interactions RasMol – Swiss PDB viewer

References

1. Branden, C and J.Troze, 1999. Introduction to protein structure. Second edition.
2. Baxevanis, A.D and Ouellette, B.F.F (Eds), 2001. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley interscience. New York.

3. Higgins, D and Taylor, W (Eds), 2000. Bioinformatics: Sequence, structure and databnks.Oxford University Press, Oxford.
4. Misener, S and Krawetz, S.A (Eds), 2001.Bioinformatics: methods and protocols. Replica press private limited, New Delhi.

ELECTIVE GROUP B
COMPUTATIONAL BIOLOGY PRACTICALS

Preamble:

Scope: To become familiar with the bioinformatic tools and resources accessible via the World Wide Web for database storage, retrieval, integration and interpretation.

Objective: Bioinformatics tools will be used for aligning DNA sequences for pairwise and multiple sequence comparisons, structural and functional predictions, phylogenetic construction and polymorphic characteristics that contribute to distinct metabolic responses to pharmaceuticals

Goal: To gain hands on experience on molecular databases, comparative genomics, pattern search, classification of sequence and structure, alignment of sequences, rapid similarity searching, phylogenies, automated pattern learning, representing and searching protein structure, gene expression profiling, clustering expressed genes, discovering transcription factor binding sites, discovering common functions of co-expressed genes, metabolic pathways, signal transduction pathways.

Contents

1. Expasy –Proteomic tools.
2. Molecular Modeling and drug design
3. Other data bases Small molecules, Fatty acids etc.

ELECTIVE GROUP C
PAPER I FUNDAMENTALS OF NANOSCALE SCIENCE

Unit I: Basics of Nanotechnology I

Background to Nanotechnology – scientific revolutions – types of nanotechnology and nanomachines – atomic structure molecules & phases – molecular and atomic size – surfaces and dimensional space – top down and bottom up Nanoscale formation

Unit II: Forces between atoms and molecules

Strong intermolecular forces – covalent and coulomb interactions – interactions involving polar molecules and polarization – weak intermolecular forces and total intermolecular pair potentials – Van der Waals forces – repulsive forces; special interactions such as hydrogen – bonding, hydrophobic and hydrophilic interactions

Unit III: Nanostructures and their properties

Definition of nano systems – dimensionality and size dependent phenomena in Quantum dots, and Quantum wires – size dependent variation in magnetic, electronic transport properties

Unit IV: High vacuum technology

Evaporation theory – different sources for evaporation – working principles of rotary and diffusion pumps – cryogenic pumps – cryo sorption and getter pumps – vacuum materials

References:

1. Nanotechnology: basic science and emerging technologies – Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhard Raguse, Overseas Press (2005)
2. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000)
3. Understanding Nanotechnology, Scientific American, editors at Scientific American, Warner Books (2002)
4. Introduction to Nanotechnology, Charles P. Poole, Frank J. Owens, Wiley-Interscience (2003)
5. Nanotechnology: A Gentle introduction to the Next Big Idea, Mark A. Ratner, Daniel Ratner, Mark Ratne, Prentice Hall PTR; 1st edition (2002)
6. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W. Mayer
7. Hand book of thin film technology, L.I. Maissel and R. Glang (McGraw – Hill Book Company)

ELECTIVE GROUP C

PAPER II NANOMATERIALS SYNTHESIS

Unit I: Sol-gel processing

Fundamentals of sol-gel process – sol-gel synthetic methods for oxides – other inorganics and nano composites – the Pecheni method – silica gel – Zirconia and Yttrium gel – aluminosilicate gel – polymer nano composites

Unit II: Film deposition methods

Introduction – fundamentals of film deposition – thermal evaporation – molecular beam epitaxy – pulsed laser deposition – sputter deposition – chemical vapour deposition – layer by layer growth and ultra thin films – chemical solution deposition – Langmuir Blodgelt films.

Unit III: Synthesis of nanostructures

Surface Chemistry and its role to prepare quantum dots – Polymer as quantum dot size stabilizer – One-dimensional (1D) by Spontaneous Growth – 1D structure by VLS and SLS Growth – Template Assisted Growth – Electrochemical growth of 1D structures

Unit IV: New forms of carbon

Types of nanotubes – formation of nanotubes – methods and reactants – arcing in the presence of cobalt – laser methods – ball milling – chemical vapour deposition methods –

properties of nano tubes – plasma arcing – electro deposition – pyrolytic synthesis – Zeolites and templated powders layered silicates.

References:

1. Nanoelectronics and Information technology: Advanced electronic materials and novel devices (2nd edition), Rainer Waser (Ed.), Wiley – VCH Verlag, Weiheim (2005)
2. Nanocomposite science and technology, Pulickel M. Ajayan, Linda S. Schadler, Paul V. Braun, Wiley – VCH Verag, Weiheim (2003)
3. Amorphous and Nanocrystalline Materials: Preparation, Properties, and Applications, A.Inoue, K.Hashimoto (Eds.,) (2000)
4. Quantum Heterostructures: Microelectronics and Optoelectronics, Vladimir Mitin
5. Theory of Modern electronic semiconductor devices, K.F. Brennan and A.S. Brown
6. Semiconductor Nanostructures for Optoelectronic applications, Todd D. Steiner
7. Smart Electronic Materials (Fundamentals and applications), Jasprit Singh
8. The Physics of Low dimensional semiconductors, John H. Davies

ELECTIVE GROUP C PAPER III
CHARACTERIZATION AND APPLICATION OF NANO MATERIALS

Unit I: Nano characterizing tool 1

Working of Atomic Force Microscopy – Mode of operations (qualitative) and its application – X-Ray diffraction basics and its application to Size Analysis of nanomaterials – NMR Basics and application to Nanomaterials

Unit II: Nano characterizing tool 2

Scanning Electron Microscope: Theory- Instrumental setup and its application – Low KV SEM and its application – Low temperature SEM and its application – working of electron probe micro analysis and its application in elemental analysis – EDX spectra

Important material systems – optical process in semiconductors – optical process in quantum wells – semiconducting optoelectronic devices – organic optoelectronic devices (qualitative)

Unit III: Applications of nanomaterials

Quantum dot IR photo detectors- Quantum dot lasers – Synthesis of Zinc oxide nanomaterials and its application – Synthesis of group three nitride nanostructures and their applications - SK growth of germanium dots on silicon and its application.

Unit IV: Cell Biology (quantitatively)

Amino acids, Protein structure: Primary, Secondary, teritary, structure of Nucleic acids – Nucleosides and Nucleotides – physical properties of nucleosides & nucleotides – base pair – mismatch base pair – stacking – Backbone of Nucleic acids

Antibodies and their use in nano based drug delivery and imaging – Tumor targeted drum delivery.

References:

1. Nanoscale calibration and Standards and Methods Edited by C.Wilkening and Koenders
2. Fundamentals of Surface and Thin Film Analysis, Leonard C.Feldman and James W. Mayer
3. Scanning Electron Microscopy for Nanotechnology Edited by W.Zhou and Z. Lin Wang
4. Nanosystem characterizationtools in the life sciences Edited by Challa Kumar
5. Nanostructures and Nanomaterials (Synthesis, Properties and Applications), Guozhong Cao
6. Nanoelectronics and Information technology Edited by Rainer Waser
7. Cell and Molecular Biology, Gerald Karp
8. Nucleic Acids in Chemistry and Biology, G. Michael Blackburn and Michal J. Gait
9. Principles of Nucleic Acid structure, Worfram Saenger