BT 301: BIOCHEMISTRY

Biochemistry of Carbohydrates and Lipids:

Introduction to Biochemistry and macromolecules.

Metabolic Pathways - Biosynthesis of Glucose, Glycogen and Starch, Carbohydrate Metabolism - Glycolysis, Citric Acid Cycle (TCA Cycle) and Oxidative Phosphorylation, Metabolic Pathways - Biosynthesis of Saturated and Unsaturated Fatty Acids, Cholesterol, Phospholipids and Sphingolipids, Lipid Metabolism - Catabolism of Fatty Acids, Metabolism of Triglycerol and Cholesterol, Metabolism of Glyco-conjugates - Proteoglycans, Glycoproteins and Glyco-Lipids.

Biochemistry of Proteins and Nucleic Acids:

Metabolic Pathways - Biosynthesis of Amino Acids, Peptides and Proteins, Protein Metabolism - Catabolism of Carbon skeletons of Amino Acids - Oxidative Deamination and Oxidative Decarboxylation, Nitrogen Excretion and Urea Cycle, Metabolic pathways - Biosynthesis of Purines, Pyrimidines, Nucleotides and Nucleic Acids (DNA and RNA), Nucleic Acid Metabolism - Degradation of Nucleotides and Nucleic Acids and Genetic Disorders.

Biochemistry of Photosynthesis:

Plant photosynthesis : Oxygenic and Anoxygenic Photosynthesis, Photosynthetic reaction Centers, Chlorophylls as trappers of Solar Energy Hill Reaction - Photosynthesis I and Photosynthesis II, Dark Reaction Cyclic and Non-cyclic Photo Phosphorylation, Bacterial photosynthesis.

References

- Lehninger Principles of Biochemistry By David. L. Nelson and Michael. M. Cox
- Outlines of Biochemistry by E.E Conn and P.K.Stumpf
- Biochemistry by Stryer.L
- Harper's review of Biochemistry by by Martin. D. W, Mayes. P. A and Rodwell. V. M
- Practical of Biochemistry by Wilson & Walker

BIOCHEMISTRY LABORATORY

- Buffer preparations with the help of pH meter.
- Centrifugation and isolation of protein fractions from mixture.
- Estimation of carbohydrates.
- Estimation of proteins.
- Extraction of Lipids.
- Estimation of nucleic acids.
- Molecular weight determination of protein through SDS-PAGE.
- Enzyme assays based on UV-VIS spectroscopy.

BT302: MICROBIOLOGY

Introduction to Microbiology:

Discovery of microorganisms, Theory of spontaneous generation, Germ theory of diseases, Major contribution and events in the field of microbiology, Scope and relevance of Microbiology.

Classification and Identification of microorganisms:

Three domain concept, Five and eight kingdom system of classification, classification systems (phylogenetic, phenetic), numerical taxonomy, polyphasic taxonomy, major characteristics used in taxonomy, morphological, physiological, ecological, biochemical, immunological, genetical and molecular. Identification of microorganisms - a general account. Fixation, principal dyes, simple staining, differential staining, staining of specific structures.

Morphology and Major Groups of Microorganisms:

Morphology and fine structure of bacteria: Cell wall, Structure external and internal to cell wall, Spore and Cysts. Characteristics of Archeabacteria and Eubacteria); Characteristics of important groups of microorganisms.

Nutrition of Microorganisms:

Nutritional Types; Uptake of nutrients by cells, Simple diffusion, Facilitated diffusion, Group translocation, Active transport, Chemiosmotic theory, Siderophores.

Growth and Cultivation of Microorganisms:

Growth of microorganisms: Growth curve, Measurement of microbial growth (cell numbers, cell mass and cell activity), Continuous growth, Chemostat, Turbidostat, Balanced and unbalanced growth. Culture media: synthetic, complex media, selective, differential, enrichment and enriched media. Factors influencing growth.

Control of Microorganisms and Microbiological Applications:

Principles of control of growth, Control of microorganisms by physical and chemical agents, Evaluation of antimicrobial chemical agents. Microbiology in production and QC of food and pharmaceuticals (HACCP and sterility testing).

References:

- Microbiology Pelczar M.J. Chan ECS and Krieg NR, Tala McGraw Hill.
- General Microbiology by Roger Y.Stanier, Macmillan.
- Bergeys Manual of Systematic Bacteriology II edition.
- General Microbiology by Prescott and Dunn.
- Microbiology by T. D. Brocks.

LABORATORY

- Examination of microorganisms by staining techniques
- Simple staining
- Negative staining
- Gram staining
- Capsule staining
- Spore staining
- Lacto phenol cotton blue mounting of fungi
- Hanging drop method-motility
- Preparation of media for cultivation of microorganisms
- Liquid Medium (Broth)
- Solid medium (Agar)
- Selective and Differential Medium
- Sterilization techniques
- Isolation and Enumeration of microorganisms by serial dilution agar plating method
- To obtain pure culture of microorganisms by following:
- Pour Plate method
- Spread plate method
- Streak plate method
- Preservation of bacterial culture
- To assess Biochemical activities of microorganisms
- To check the antibiotic sensitivity by Kirby Bauer method
- Environmental sample analysis

BT303: GENETICS

Physical Basis of Heredity:

Basic law of inheritance, mono-hybrid, dihybrid and tri-hybrid ratios. Modification of Mendel's ratios due o gene interaction, Multiple alleles, Multiple factors of inheritance. Genes and environment interaction. Probability and statistical testing.

Linkage, Recombination and Mapping:

Chromosomal inheritance, the concept of linkage, crossing over and recombinations. Molecular mechanism of recombination, Fine structure of gene at genetic level. Mapping to genes by three point test cross and tetrad analysis and mitotic crossing over.

Chromosome Structure, Organization, Aberrations and Extra Chromosomal Inheritance:

Organization of genetic material in prokaryotes, eukaryotes. Chromosome morphology, Classification, Karyotyping special chromosome, Chromosome aberrations, origins, types and cytogenetic effects. Euchromatin and Heterochromatin organizations,. The maternal inheritance.

Sex Determination:

Mechanism of sex determination in animals and plants, sex linked, sex influence and sex limited traits. Sex differentiation and developments in humans. Sex linked disorders in human beings.

Mutation:

Mutation at morphological level, biochemical level and molecular level and its applications

Molecular Genetics:

Chemistry of gene: Nucleic acid and their structure, DNA and RNA is genetic material. The genetic code, mitochondrial genetic code, transposable elements, gene expression, gene regulation and gene silencing.

Human Genetics: Organization of human genome; Pedigree analysis; Genetic disorders, Inborn errors of metabolism, Neurogenetic disorders, Muscle genetic disorders, Genetic disorders of Haematopoitic systems, Cancer Genetics and Genetic counseling

Population genetics:

The Hardy- Weinberg equilibrium, Change in gene frequencies and mating system. Genetics of the evolutionary process, behaviour and development and sociobiology.

References:

- Genetics, Goodenough U, Hold Saunders International 1985. Principles of Genetics,
- Gardner EJ, Simmons MJ,
- Genetics by Strickberger.
- Genetics by Gardener
- Gene X by B. Lewin

LABORATORY

- Genetic analysis of Monohybrid, dihybrid and three point test cross
- Probability and Pedigrees analysis
- Genetic mapping by conjugation.
- Study of chromosome morphology at different stages of cell division
- Study of gene expression by mRNA and protein expression.
- Induction of mutation and isolation of mutants.
- Study of genetic markers in bacteria.
- Study of genetic polymorphism in more than two populations
- Study of GxE interaction in given populations
- Study of different transposable elements in prokaryote or eukaryote

CE301: ENVIRONMENT AND ECOLOGY

Introduction and scope:

Conservation of natural resources i.e. forest resource, water resource, mineral resource, energy resource, land resource etc. Role of individual for resource conservation and sustainable development.

Ecosystem and its basic concept:

Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids. Examples of ecosystems.

Biodiversity and its conservation:

Introduction - Definition: genetic, species and ecosystem diversity, National and global scenario.

Environmental Pollution, Definition, Causes, effects and control measures of:

Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards.

Sustainable development:

Urban problems related to energy, Water conservation, rain water harvesting, watershed management.

Environmental ethics:

Issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust Case studies, Wasteland reclamation, Consumerism and waste products, Environmental Management through Acts.

Human Population and the Environment:

Environment and human health, Role of Information Technology in Environment and human health, Case studies.

AM301: MATERIAL SCIENCE AND ENGINEERING

Structure and properties relationship of Engineering Materials.

Structure of Crystalline Solids:

Crystal structures and Systems, Unit Cells, Metallic Crystal Structures, Crystallographic directions and Planes, Density Computations.

Characterization of Materials:

Crystallography, Reciprocal Lattice, Stereographic projections, Diffraction methods, Electron microscopy, Metallography, Thermal analysis.

Imperfections in Crystals:

Point defects, Dislocations, Interfacial Defects, Bulk defects.

Diffusion:

Mechanisms, steady state and non steady state Diffusion, factors influencing diffusion

Multiphase Structures, Phase Transformations:

Unary, Binary, Equilibrium Phase Diagrams, Eutectic, Eutectoid, Peritectic and Peritectoid Reactions**,** Iron Carbon Diagram.

Mechanical Behaviour of Materials:

Elastic and Plastic properties, Creep, Fracture, Heat treatment of steels.

Ceramic Materials:

Ceramic Structures, Properties

Electric and Electronic materials:

Electrical Conduction, Classification of semiconductor materials, Materials and Technology for integrated circuits, Photonic materials, super conductivity and special super-conducting materials, Ferrites. Quartz crystal, Dielectric materials. Piezoelectric and Ferro-electric materials, Electromechanical materials, Mechanism of polarization, Its measurements

Magnetic Properties for Applications:

Diamagnetism, Paramagnetism, ferromagnetism, Antiferromagnetism, Ferrimagnetism, Soft and hard magnetic materials magnetic storage.

Optical properties:

Optical properties of Metals and Non metals, Luminescence, photoconductivity, Optical Fibers in communications

References:

- Callister J ,?Material science for Engineers
- Van Vlack, Material Science
- Raghavan V, Material Science
- Guy, Physical Metallurgy

BT 305: CELL AND SYSTEM BIOLOGY

The cell:

Definition and type of cell, cellular compartmentalization and different cell organelles (structure and functions). The Nucleus: global structure of chromosomes, chromosomal DNA and its packaging, organization and evolution of the nuclear genome. Plasma Membrane: organization and transport across the plasma membrane. Protein sorting and secretion.

Cell Cycle and Division:

General strategy of the cell cycle, mechanics of cell division, cell-cycle control.

Cytoskeleton:

Nature of the cytoskeleton, microfilaments, microtubule, intermediate filaments, cilia and centrioles.

Cell-cell interaction:

Cell Junctions, cell-cell adhesion, extracellular matrix of animals, integrins, plant cell wall.

Cancer:

Cancer as a microevolutionary process, tumour cells, proto-oncogenes and viral oncogenes, tumour suppressor genes.

Signal transduction:

Intracellular receptor and cell surface receptors, signalling via G-protein linked receptors and enzyme linked receptor signalling pathways.

Cell Death:

Necrosis and programmed cell death, ageing

Structure and function of various body systems in humans:

Epithelial system, Muscular system, Circulatory system, Endocrine system and nervous system.

BT401: BIOPHYSICS AND STRUCTURAL BIOLOGY

Principles of protein structures:

Hydrogen bonding, hydrophobic interactions, ionic interactions, disulphide bonds and their role in protein structure. Secondary structural elements and organisation of tertiary structure. Helix-coil transition and zipper model. Three dimensional conformations of proteins, Ramachandran plot, motifs, folds, mechanism of protein folding, fibrous proteins, membrane proteins and their structures.

Principles of Nucleic acid structures:

Nucleic acid structure and composition: A, B, and Z: forms of DNA, supercoiling of DNA, denaturation and renaturation kinetics, nucleotide sequence composition: unique, middle and highly repetitive DNA, Redundant DNA.

Methods of determination of biomolecular structures:

Macromolecular structure determination: Basic concepts and principles of X-ray diffraction, crystallography, spectroscopy : UV-Visible, fluorescence spectroscopy and NMR, circular dichroism, electron microscopy.

Biomolecular interactions:

Protein-Protein interactions, protein-carbohydrate interactions, Protein-DNA interactions, prediction and engineering of protein structures. General features and thermodynamic aspects of protein folding, Detection of folding intermediates, complex and folding kinetics. Ligand interactions, co-operative interactions.

Textbook:

1. Lehninger Principles of Biochemistry,
2. Kensal E van Holde, Principles of Physical Biochemistry.
3. R. Narayanan; Biophysics,
4. Kim Sneppen and Giovanni Zocchi; Physics in molecular Biology.
5. Computational Structural Biology; Methods and applications.

Reference books:

1. David Friefelder, Physical Biochemistry
2. Practical Biochemistry Principles and techniques: Wilson and Walker, Cambridge University Press.

Laboratory Experiments:

- Measurement of thermodynamic parameters of heat denaturation of proteins

- Study of re-naturation kinetics of DNA.
- Measurement of the conformational stability of a protein.
- Crystal development of a pure protein.
- Modelling biomolecule and biomolecular processes by Computer Simulations and Graphics.
- Calculation of number of particles /unit cells of a cubic crystal system

CS402: COMPUTER BASED NUMERICAL & STATISTICAL TECHNIQUES

Introduction: Errors in numerical computation, Mathematical preliminaries, Errors and their analysis, Machine Computations, Computer Software.

Algebraic and Transcendental Equations: Bisection method, Iteration method, Method of False Position, rate of convergence, Method for complex root, Muller's Method, Quotient Difference method, Newton-Raphson Method.

Interpolation: Introduction, Errors in Polynomial interpolation, Finite differences, Decision of errors, Newton's formula for interpolation, Gauss, Sterling, Bessel's, Everett's Formula, Interpolation by unevenly spaced points, Lagrange interpolation formula, Divided Difference, Newton's General interpolation Formula.

Curve Fitting, Cubic Spline & Approximation: Introduction, Method of Least Square curve fitting procedures, Fitting a straight line, Curve fitting by sum of exponential, Data fitting with cubic splines, Approximation of functions.

Numerical Integration and Differentiation: Introduction, Numerical differentiation, Numerical integration, Trapezoidal rule, Simpson 1/3 rule, Simpson 3/8 rule, Booles & Weddles rule, Euler-Maclariaun formula, Gaussian Formula, Numerical evaluation of singular integrals.

Statistical Computations: Frequency Chart, Regression Analysis, Least Square fit, Polynomial fit, Linear and Nonlinear Regression, Multiple Regression, Statistical Quality Control Methods.

Books and References:

- Balaguruswamy, "Numerical methods", TMH
- Shastri, " Introductory methods of numerical analysis", PHI
- V. Rajaraman, "Introduction to Numerical Methods", TMH

BT405: THERMODYNAMICS OF BIOLOGICAL SYSYTEM

Introduction and Basic Concepts of Thermodynamics:

Introduction**,** Temperature and Zeroth law, Review of first and second laws of thermodynamics,

Introductory biological thermodynamics:

Introduction and distribution of energy, systems and surroundings, First law of thermodynamics- Introduction, Internal energy, Work, The First Law in operation, Enthalpy, Heat capacity, Energy conservation in the living organism

The Second Law of Thermodynamics, Entropy, Heat engines, Entropy of the universe, Isothermal systems, Protein denaturation, The Third Law and biology

Thermodynamics and its Applications:

Bioenergetics, Energetics of Metabolic Pathways; Energy Coupling (ATP & NADH), Thermodynamics of oxidation-reduction reactions. Energetic of Protein folding, enzyme-ligand binding.

Gibbs free energy – applications, Photosynthesis, glycolysis, and the citric acid cycle, Oxidative phosphorylation and ATP hydrolysis

Phase Equilibria:

The Ideal Solution, Ideal and Non-ideal behaviour of systems in phase equilibrium, The Chemical Potential and Phase Equilibria, Fugacity and Fugacity Coefficient: for pure species and solution; Generalised correlations for Fugacity,

The Nature of Equilibrium, Vapour Liquid Equilibrium, Simple model for Vapour/Liquid Equilibrium, PVT behaviour of Pure Substances, virial equations.

Chemical Reaction Equilibria:

Equilibrium criteria for homogeneous chemical reactions, Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions. Basic equations of Fluid Flow, Hagen Poiseville equation, Bernoulli Equation, Fluid Friction. Friction in flow through packed beds, fundamentals of fluidisation.

Textbook:

1. Smith & Vanness, Thermodynamics for Chemical Engineers, MGH

2. Donald T Haynie, Biological Thermodynamics

Reference books:

1. Richardson, J.F., Peacock, D.G.Coulson & Richardson's Chemical Engineering- Volume 3 ed., First Indian ed. Asian Books Pvt. Ltd. 1998

2. Levenspiel.O., Chemical Reaction Engineering, Wiley Eastern Ltd.

3. Bailey & Olis,Biochemical Engg. Fudamentals, MGH, 1990

4. Physical Chemistry: Castellan, Narosa Publishing.

5. Physical Chemistry, ;Moore, PHI

BT 406: INSTRUMENTATION IN BIOTECHNOLOGY

Microscopy:

Principle, working, sample preparation and biological applications of different microscopes – light microscope (bright field and dark field, phase contrast, polarization, differential interference contrast), electron microscope (TEM, SEM), fluorescence microscope (simple and confocal) and Atomic force microscope.

Centrifugation:

Principle, construction, working of centrifugation and concept of RCF, Types of instruments & rotors used in centrifugation, Types of centrifugations- preparative, differential density gradient centrifugation and analytical ultracentrifuge.

Spectrophotometry:

Basic concepts of spectroscopy, beer lamberts law, principles, instrumentation and applications of UV-Visible spectroscopy, nephelometry, turbidometry, fluorescence spectroscopy, atomic absorption spectrophotometry. IR, NMR and Mass spectroscopy (ESI, MALDI-TOF), and circular dichorism.

Electrophoresis:

Principle & Working of zonal & continuous electrophoresis, Types of electrophoresis- paper, cellulose acetate, gel & capillary electrophoresis, native and denaturing gels, isoelectric focusing, two dimensional gel electrophoresis, pulse-field gel electrophoresis.

Chromatography:

Principle, instrumentation and biological applications of paper & thin layer (TLC) chromatography, Gel Permeation (GPC), ion exchange chromatography, affinity chromatography, gas liquid (GC) and High Pressure Liquid Chromatography.

Reference books:

- Wilson & Walker, Practical Biochemistry
- Vasantha Pattabhi and N. Gautham, Biophysics
- Helmut gunzler and Alex Williams, Handbook of analytical techniques
- Susan R Mikkeleson, E. Corton, Bioanalytical chemistry
- Alan Cooper, Biophysical chemistry
- Skoog & West, Fundamentals of Analytical Biochemistry

LABORATORY

1. Demonstration of dark field, bright field and fluorescent microscopy.
2. Spectrophotometric estimation of proteins by Lowry's method.
3. Isolation of chloroplast and quantitative estimation of different plant pigments.
4. Demonstration of paper, TLC, affinity and ion-exchange chromatography.
5. Agarose gel electrophoresis and SDS-PAGE electrophoresis.
6. Demonstration of instruments such as HPLC and AAS

BT 407: PLANT BIOTECHNOLOGY

Introduction to plant cell and tissue culture, Historical perspectives, Laboratory organization and tissue culture media- composition and preparation, Callus formation Organogenesis. Production of haploid and homozygous diploid lines through embryo culture and embryo rescue; anther, pollen and ovary culture.

Protoplast isolation, culture and fusion; selection of hybrid cells and production of somatic hybrid plant. Somatic embryogenesis; somaclonal variation, and application in crop improvement.

Plant regeneration and hardening Cell/callus line selection of herbicide, stress and diseases resistance plant. Production of "synthetic seeds. Cryopreservation for germplasm conservation , Clonal and Micropropogation. production of pathogen free pl

Genetic engineering in plants (transformation experiments with *Agrobacterium tumefaciens* and tobacco), Physical methods of transfer of genes to plant, Vectorless and vector mediated transformation. Transgene stability and gene silencing, selection and expression of cloned genes, Production of antibodies and pharmaceutically useful proteins in plants. Biosafety regulations relating to transgenic plants

Plant transformation for productivity and performance of herbicide resistance, insect resistance by Bt. and non Bt genes. virus resistance disease resistance , abiotic stress, post harvest losses, long shelf life of fruits , vegetables and flowers etc.

Chloroplast transformation: metabolic engineering and industrial products; Control mechanism and manipulation of different plant metabolic pathways for industrial applications, and production plant secondary metabolites

Molecular Breeding and its application: Marker assisted selection (MAS), Molecular markers, gene silencing by small RNA,

Topics in plant biotechnology (student presentations)

References:

- Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.

- Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan (1996) Elsevier, Amsterdam.
- An Introduction to Plant Biotechnology by H C Chawla Oxford and IBH 2002.
- Elements of Biotechnology. Gupta P.K. Rastogi Publications.
- Text Book of Biotechnology, Singh B.D. Kalyani Publishers

- Plant Genomics and Proteomics. 2004. C.A. Cullis. John Wiley & Sons, New York.
- Plant Functional Genomics. 2003. E. Grotewold. Humana Press, Totowa.
- The Handbook of Plant Genome Mapping. 2005. K. Maksem and G. Kahl. John Wiley –VCM, Weinheim.
- Molecular Plant Biology, Vol I & II. 2002. P.M. Gilmartin and C. Bowler. Oxford University Press, Oxford.
- From Genes to Genomes. 2002. J.W. Dale and M.V. Schantz. John Wiley & Sons, New York.
- Plant Functional Genomics. 2006. D. Lister. Haworth Press (Panima, New Delhi).

LABORATORY

- Basic design, lay out, requirement and safety guidelines of plant tissue culture
- laboratory
- Selection, preparation and sterilization of explant and laboratory wares

- Various media preparations for plant tissue culture (MS) and nutrient optimization

- Production Callus from different tissues of plant
- Plant regeneration by embryo, anther and pollen culture

- Performance of *Agrobacterium* mediated gene transformation in plant

- Performance of gene transfer by physical delivery method

- Chloroplast transformation in higher plant

- Producing plant cell lines and study of gene silencing

- Production of antibodies and pharmaceutically useful proteins in plants

BT408: MOLECULAR BIOLOGY

DNA Structure, Replication & Repair:

Structure of DNA-Watson & Crick's model, Types of DNA-A-DNA, B-DNA, Z-DNA, Replication of DNA-semi conservative replication, enzymology of replication, continuous and discontinuous DNA synthesis, unidirectional replication, bi-directional replication, rolling circle replication, denaturation and renaturation of DNA. DNA damage and repair. Genetic recombination.

RNA Synthesis and Structure:

Transcription apparatus and proteins involved in transcription in prokaryotes & eukaryotes. Types of RNA, processing of RNA and RNA Splicing. mRNA transport.

Protein Synthesis and Structure:

Ribosome- Structural features of prokaryotic and eukaryotic ribosome. Genetic code- triplet code, cracking of genetic code, features of genetic code, wobbles hypothesis. Translation in prokaryotes and eukaryotes- initiation, elongation and termination of polypeptide chain, post translation modification, protein folding.

Regulation of Gene Expression:

Regulation of Gene expression in bacteria- Operon concept, inducible and repressible operons (laca nd trp), catabolite repression of lac operon in *E.coli*. Control of gene expression by sigma factor. Enhancers, silencers and other upstream controlling elements. Regulation of gene expression by steroid hormones. DNA methylation. Chromatin remodelling.

BT 504: BIO-PROCESS AND PLANT DESIGN

Bioreactor configuration and control:

Definitions, Classification of bioreactors, Description of a conventional bioreactor with all aspects. Various types of bioreactors for microbial, animal , plant cell culture, fludized bed reactor, bubble column, air lift fermenter paked bed, trickle bed etc., Design and construction criteria of a bioreactor. Monitoring and process control of bioreactor.

Reactor engineering:

Ideal reactors, concept of ideality, space time and space velocity, batch, plug low reactor (PFR), continuous stirred rank reactors (CSTR), multiple reactor systems, equal sized mixed reactors in series. Mixed flow reactors of different size in series, Determination of the best system for a given conversion, Advantages and limitations of series combinations. Non ideal reactors, residence time distributions (RTD), Exit age distribution. Models of non ideal reactors

Recycle reactors, recycle ratio for auto catalytic reactions:

Optimum recycle ratio for plug flow and mixed flow for an autocatalytic reaction.

Design of multiple reactors:

Reactors in parallel, Contacting patterns, for reactions in parallel, Quantitative treatment of product distribution and of reactor size, best operating conditions for parallel and series reactions, Kinetics of series parallel reaction.

References:

- Doran, P.M., Bioprocess Engineering Principles, Academic Press, London.
- M.L. Shuler and F. Kargi, Bioprocess Engineering , Prentice Hall, NJ, USA.
- James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill.
- Lydersen, D. Eila, Nelson, Bioprocess Engineering, Systems and Equipments.
- Chemical Reaction Engineering- Octave Levenspiel

BT506: GENETIC ENGINEERING

Recombinant DNA and Gene Cloning:

Plasmids, Bacteriophages and high capacity vectors.

Plasmids: Definition, types of plasmids, identification and classification of plasmids, purification of plasmids, Plasmid transfer and its mechanism.

Construction of Genomic and cDNA libraries, and their strategies and advantages of cDNA libraries, BAC Library.

Restriction Enzymes and Restriction Mapping:

Enzymes used in cloning – polymerases, lipases, restriction modification – DNA methylation of enzyme and modification of restriction site. Types of restriction enzymes and nomenclature of restriction enzymes. Restriction mapping Different Blotting techniques: Southern, Northern, Western

Polymerase Chain Reaction (PCR) and its applications:

Principle of PCR, Design of primers, PCR methodology: RT-PCR, Multiplex PCR, Anchored PCR, Inverse PCR and PCR walking. Identification of PCR products, applications of PCR, Site directed mutagenesis, gene sequencing.

Molecular Markers:

Type of molecular markers, use of RFLP, RAPD, AFLP, STMS, DNA chips, SNPs and micro array, 16s r-ANA typing, gene chip and micro array; applications in disease profile Plant nuclear genes, plastid genes, plastid transformation, mitochondrial genes, RNA silencing micro RNA, siRNA, silencing suppressors

Transposable elements:

Definition, Type of transposable elements, Type of transposition and excision, detection of transposition in plant and bacteria, applications of transposons. Map-based cloning, T-DNA tagging, transposons tagging, TILLING

Applications of Genetic Engineering:

Gene cloning in medicine, agriculture, transgenic animals and plants, molecular farming. Trait modification by genetic engineering – over expression or under expression of heterologous genes

References:

- Genes to clone by T. A. Brown
- Genetic engineering by S. Mitra
- Principles of Gene Manipulation: An Introduction to Genetic Engineering Old RW, Primrose SB. Blackwell Science Publications.
- Genes by B. Lewin
- Molecular biology D. Freifielder.
- Molecular cloning by Sambrook et al.

LABORATORY

- Isolation & visualization of Genomic DNA on agarose gels.
- Isolation & visualization of RNA.
- Isolation & visualization of plasmids on agarose gels.
- Restriction mapping of DNA fragments.
- Transformation, screening for recombinants.
- Blotting techniques – southern blotting.
- Protein expression in *E. coli* vectors, western blotting
- Amplification of DNA fragments by Polymerase chain reaction (PCR).

BT507: BIOCHEMICAL ENGINEERING

Kinetics of Microbial Growth and Product formation:

Growth curve in batch cultures. Simple unstructured Kinetic models for microbial growth, Monad model. Growth of filamentous organisms. Growth associated (primary) and non-growth associated (secondary) product formation kinetics. Leudcking-Piret models, substrate and product inhibition on cell growth and product formation. Introduction to structured models for growth and product formation.

Metabolic Stoichiometry and Energetic:

Mass and energy balance in biological system, Stoichiometry of cell growth and product formation, elemental balances, Degrees of reduction of substrate and biomass, available electron balances, Yield coefficients of biomass and product formation, Maintenance coefficients. Kinetic Models for growth, substrate utilization and product formation; Oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

Fermentation Process:

Batch, Fed-batch and continuous Fermentation. Fermentation systems, dual and multiple fermentations. Comparison between batch and continuous fermentations.

Steady state, unsteady state continuous fermentation theories, examples of continuous fermentation.

Aeration and Agitation in Fermentations:

Fluid flow and mixing in fermentation broths, Newtonian and non Newtonian fluids, Oxygen requirements of industrial fermentations. The balance between oxygen supply and demand. Determination of oxygen transfer rates, K_{La} values. Factors affecting K_{La} values in fermentation vessels. Mass transfer theories, bubble aeration and mechanical agitation. Correlations between mass transfer coefficients and operating variables. Other factors affecting the mass transfer coefficients.

Sterilization:

Sterilization methods, thermal death kinetics, design criterion, batch and continuous sterilization, and air sterilization

References:

- Fundamentals of Biochemical Engineering Bailey & Ollis, McGraw Hill (2nd Ed.,) 1986.
- Biochemical Engineering-F.C. Webb
- Chemical Engineering Vol-3 Coulson & Richardson
- Biotechnology and Biochemical Eng.- Atkinson & Mautiva

- Chemical Reaction Engineering-Octave Levenspiel
- Bioreaction Engineering-Kari Schugeri.

LABORATORY:

1. Demonstration of a Conventional Stirred tank reactor (CSTR).

2. To determine the coefficient of correlation between densitometric and total count (haemocytometer) analysis in the cell.
3. To determine maintenance energy of a microbial culture.
4. To follow the growth kinetic and verify the Monod's model of a microbial culture.
5. Determination of volumetric oxygen mass transfer coefficient (KLa) and respiratory parameter of yeast in a fermenter by DDGO (Dynamic Differential Gasing Out) method
6. To determine the washout condition and maximum out put in a chemostat culture
7. To classify the kinetic response patterns in a cheamostat
8. Determination of mixing time in a bioreactor

BT508: IMMUNOLOGY

The Immune system:

History and evolution of immune system; Innate and acquired immunity; Humoral and cell-mediated immunity; Hematopoiesis, cells and organs of immune system; Concept of immunogenicity, antigens, superantigens, epitopes, and haptens; Antibodies-structure, classes, functions, Monoclonal and polyclonal antibodies, Primary and secondary immune response.

Molecular basis of Immunology:

Molecular basis of antibody diversity: DNA rearrangements; variations arising out of V,D,J joining; somatic hypermutation, class switching; B and T cell generation, maturation, and their receptors; Antigen-antibody interactions- agglutination, precipitation, immunodiffusion, immunoassay (competitive, sandwich and indirect).

Molecules involved in immune response:

MHC: gene organization, types of MHC molecules and their structure, basis and significance of MHC polymorphism; Antigen processing and presentation; Cytokines and their role in immune response; Complement system.

Immune response and tolerance:

Hypersensitivity; Inflammatory response; Immune tolerance; T cell anergy and T cell elimination; Autoimmunity-organ specific and systemic.

Clinical pathologies and vaccines:

Infectous diseases: influenza, tuberculosis, malaria; Imunnodeficiencies: AIDS; Tumour immunology; transplantation immunology: imuunologic basis of graft rejection, immune tolerance to grafts; vaccines: active and passive immunization and their types.

Reference books:

1. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK

2. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H,Oxford,UK

3. Weir, Immunology, 8th ed, W.B. Saunders& Co.

4. K.A. Abbas, Immunology, 4th ed, W.B. Saunders& Co.

LABORATORY:

1. Purification of lymphocytes from peripheral blood.

2. Blood typing and count.
3. Haemmaglutination test
4. Isolation of antibody from blood and their quantification using spectrophotometer.
5. Enzyme linked immunosorbent assay (ELISA)-competitive and sandwich
6. Immunodiffusion test.
7. Rocket electrophoresis.
8. Purification of antibodies using ammonium sulphate and size exclusion chromatography
9. Protein A based affinity chromatography purification of antibodies
10. Immunoblotting and immunodetection

BT509: GENOMICS AND PROTEOMICS

Genomics:

Introduction, Gene prediction and counting, genome similarity- different kinds of databases. Functional annotations of genes by sequence comparison. Bioinformatics tools. Human genome project, functional relationship among genes.

Molecular Markers, Hybridization and PCR based. DNA polymorphism, gene mapping and tagging

High-throughput analysis techniques for studying gene expression, DNA microarrays and expression profiling, fluorescence in situ hybridization (FISH).

Comparative genomics, application of pharmaco-genomics

Proteomics:

Proteomics and the Proteome

Protein separation: Two-dimensional polyacrylamide gel electrophoresis, mass-spectrometry based method for protein identification, structure determination.

Protein-protein interaction, affinity chromatography, immunoprecipitation, yeast two hybrid system, phage display method.

Application of Proteomics: In drug development and toxicology

Bridging genomics and proteomics.

Recommended Books:

- Introduction to Proteomics: Tools for the new biology by Daniel C. Liebler, Published by Humana Press. (2002).
- Mount (2003). Bioinformatics: Sequence and Genome Analysis. CBS
- Sandor and Suhai. Genomics and Proteomics: Functional and Computational Aspect. Kluwar Academic Publisher.
- Stephen R. Pennington, Michael J. Dunn Proteomics: From Protein sequence to Function. BIOS Scientific Publisher LTD 2001.
- Anthony J. F. Griffiths: Introduction to genetic analysis. W.H. Freeman and Co., 2008
- S. B. Primrose, Richard M. Twyman. Principles of gene manipulation and genomics. Blackwell Publishing.

HS 501: PRINCIPLES OF MANAGEMENT

Introduction:

Definition of management, evolution of management thought, systems approach, process of decision making.

Functions of Management:

Planning, types of plans, Major steps in managerial planning, organizing, nature and purpose, process of organization, basic departmentation. Coordination ? nature, purpose and process of coordination. Supervision, Leadership -purpose, functions, types. Communication - process of communication, effective communication, barriers to communication. Motivation- what is motivation, factors involved, theories, motives in organization. Controlling -nature and purpose. Management of change- forces of change, strategies of changes, resistance to change.

Human elements in management:

Factors in individual behaviour, Perception, Learning, Personalty development, Interpersonal relationship & group behaviour, Conflict management, Stress management: sources of stress, consequences, strategies of stress management.

References:

- Koontz, H & Weihrich, H. Management : A Global Perspective 10^{th} ed.
- Robbins, S.P. Organizational Behaviour.
- Prasad, L.M. Principles of Management.

BT 601: BIOINFORMATICS

Introduction to Bioinformatics:

Scope of Bioinformatics: elementary commands and protocols. Introduction: strings, Edit distance strings, string similarity.

Sequence Databases and Their Use:

Introduction to databases, database search, algorithms issues in database search, sequence database search.

Parametric sequence alignments, sub optimal alignments, Dynamic programming global and local alignment gaps, multiple alignment, common multiple alignment methods. FASTA and BLAST. Amino acid substitution matrices PAM and BLOSSOM.

Evolutionary Trees and Phylogeny:

Ultrasonic trees, Parsimony , ultrametric problem, perfect phylogeny, phylogenetic alignment, connection between multiple alignment and tree constructions.

Special Topics in Bioinformatics:

DNA mapping and sequencing, map alignment, large scale sequencing and alignment, shotgun DNA sequencing method, sequence assembly, gene predictions, molecular predictions with DNA strings.

References:

- Bioinformatics basics, applications in biological science and medicine by Hooman H. & Co.
- Bioinformatics: A machine learning approach P. Baladi, S. Brunak, and MIT Press 1988.
- Algorithms on strings trees and sequences Dan Gusfield, Cambridge University Press 1977.

BIOINFORMATICS LABORATORY

- Retrieval and analysis of sequences(nucleotides/amino acids) from biological databases.
- Use of FASTA searching. Comparison of same search with BLAST.
- Implementation of a selected sequence alignment algorithm.
- Prediction secondary and tertiary structure of protein from primary structure using homology moduling.
- Multiple sequence alignment using ClustalW
- Calculation of physio-chemical properties of proteins.

BT 602: ENZYMOLOGY

Applications of Enzymes:

Classification of Enzymes, Commercial applications of enzymes in food, pharmaceutical and other industries, Enzymes for analytical and diagnostic applications, Purification and characterization of enzymes from natural sources, Methods of characterization of enzymes.

Mechanisms and Kinetics of Enzyme Action:

Mechanisms of enzyme action, concept of active site and energetics of enzyme substrate complex formation, specificity of enzyme action, kinetics of single substrate reactions, turn over number, estimation of Michaelis-Menten parameters, Multi substrate reaction mechanisms and kinetics, Types of inhibition, Allosteric regulation of enzymes, Deactivation of kinetics.

Enzyme Immobilistion & Enzyme Biosensors:

Physical and chemical techniques for enzyme immobilization, adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding etc., Examples advantages and disadvantages of different immobilization techniques. Overview of applications of immobilized enzyme systems. Applications of enzymes in analysis, Design of enzyme electrodes and their application as biosensors in industry health care and environment.

References:

- Trevor Palmer and Philip Bonner; Enzymes: Biochemistry Biotechnology,Clinical chemistry.
- Colin J. Suckling & Colin L. Gibson ;Enzyme Chemistry: Impact & Application; Blackie Academic &Professional
- Biochemical Engineering by James M. Lee, Prentice Hall (1992).
- Principles of Biochemistry BY A. Lehninger (1987)
- Enzymes in Food Processing by Gerald Reed, Academic presses.

LABORATORY

- Production of an enzyme under solid state fermentation.
- Extraction of an enzyme by salting out.
- Purifiction of an enzyme by size exclusion chromatography.
- Analysis of the isolated microbes for enzymes mainly protease/cellulose production.
- Enzyme immobilisation either by alginate, agar-agar or cellulose strips.
- Determination of K_m of an enzyme.
- Determination of V_{max} of an enzyme.
- Determination of K_i for metal inhibitors for amylase.

BT 603: MOLECULAR AND CELLULAR DIAGNOSTICS

Specimen Collection & Processing:

Specimen collection (Blood, urine, spinal fluid, saliva, synovial fluid and amniotic fluid), Preservation, transportation.

Clinical Enzymology:

Principle of diagnostic enzymology: Liver, cardiac, skeletal enzyme and digestive enzyme.

General Function Tests:

Liver function test, cardiac function test, renal function test, thyroid function test, reproductive endocrine function test.

DNA based diagnostics:

DNA amplification and quantification: Methodology of detection of mutation in DNA, Diagnosis of genetic diseases. Molecular markers and DNA polymorphism. Case studies related to bacterial, viral and parasitic infections. DNA fingerprinting.

Cell based diagnostics:

Antibody markers, CD Markers, HLA typing. Molecular beacons.

Biosensors:

Concepts and applications. Biosensors for personal diabetes management, non invasive biosensors in clinical analysis, Introduction to biochips and their application.

Recommended Books:

- William B. Coleman, Gregory J. Tsongalis. Molecular diagnostics: for the clinical laboratorian, Human Press.
- Molecular diagnostics By George P. Patrinos, Wilhelm Ansorge . Elsevier Academic Press.
- Commercial Biosensors: Graham Ramsay, John Wiley & Son, INC. (1998).

BT 604: ANIMAL BIOTECHNOLOGY

Animal cell culture:

Basic principles, advantages and limitations; media for culturing cells and tissues; natural and defined media, serum free and serum based media, primary and secondary cell cultures, scaling-up, development and maintenance of cell lines.

Cryopreservation and Cytotoxicity:

Need of cryopreservation, cell banks, transporting cells, in vitro limitations and nature of assay of cytotoxicity studies, viability assay and survival.

Micromanipulation of embryos:

Introduction, basics and methodology. Composition of IVF media, Steps involved in IVF, Fertilization by micro-insemination, PZD, ICSI, SUZI, MESA

Transgenic animals:

Introduction, Embryonic Stem Cell method, Microinjection method, Retroviral vector method, importance and applications of transgenic animals.

References:

- Animal Cell Culture by John R.W. Masters Oxford University Press.
- Introduction to Cell and Tissue Culture by Jennie P. Matcher and Penelope E. Roberts, Plenum Press, New York and London.
- Molecular Biotechnology: Primrose.
- Animal Cell Biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.
- Ranga M.M. Animal Biotechnology, Agrobios India Limited.
- Ramadass P, Meera Rani S. Text Book of Animal Biotechnology, Akshara Printers.
- Pinkart C.A. Animal Transgenic Technology, Academic Press.

LABORATORY

- Parameters/standards for cell culture laboratory setup.
- Trypan blue dye exclusion assay for cell viability.
- Different steps in the development of primary cell culture.
- Transfection of plasmid DNA to cell lines.
- Cell proliferation assay.
- Expression of recombinant proteins in cell lines.

MS 601: PATENTING, IPR, BIO-SAFETY & BIO-ETHICS

Patenting:

Patents, copyrights, Trademarks, Patent Act (1970), Patent (Amendment) Act (2002) Salient features, Different types of patents and patent specifications, Filling and processing of applications for patents.

Intellectual Property Rights:

Intellectual property rights, and intellectual property protection, trade secret, farmers rights, plant breeder?s rights, Biopiracy and Biocolonialism.

Bio-Safety:

Bio-safety regulation and national and international guidelines, r-DNA guidelines. Experimental protocol approvals, levels of containment, Environmental aspects of biotech applications, Use of genetically modified organisms and their release in environment, Special procedures for r-DNA based product production (GMP).

Bioethics:

Public education of the processes of biotechnology involved ingenerating new forms of life for informed decision making.

References:

- Patents by N.R. Subbaram, Pharma Book Syndicate, Hyderabad, 2003.
- Sasson A, Biotechnology and Development, UNESCO Publications, 1988.
- Sasson A, Biotechnology in Developing Countries, Present and Future, UNESCO Publications, 1993.
- Singh K, Intellectual Property Rights on Biotechnology, BCIL, New Delhi.
- Biotechnology Emerging trends by J. Selvin, A.S. Ninawe, V.S. Sugunan, N.Sukumaran, A.P. Lipton Biotech Books, Delhi.
- Basic Biotechnology by S. Ignacimuthu Tata Mc Graw-Hill, Delhi.
- Genetically Yours by Hwa A Lim, World Scientific, USA.
- Biotechnology by J.E. Smith, Cambridge Univ. Press, UK.

BT 606: MICROBIAL TECHNOLOGY

Introduction to Industrial Bioprocess:

An overview of Industrial fermentation process and products. Process Flow Sheeting - a brief survey of microorganisms, processes, products and market economics relating to modern industrial biotechnology.

Production of Primary & Secondary Metabolites:

A brief outline of processes for the production of some commercially important organic acids (e.g. citric acid, lactic acid), amino acids (glutamic acid, lysin); alcohols, steroids, vitamin B12.

Study of production process for various classes of low molecular weight secondary metabolites:

Antibiotics-beta-lactams (Penicillins), aminoglycosides (streptomycin), macrolids (erythromycin), quinines.

Production of commercially important enzymes and recombinant proteins, specially bioproducts for agricultural, food and pharmaceutical industries:

Proteases, Amylases Lipases, Cellulases, Pectinases, Isomerases and other commercially important enzymes for the food, pharmaceutical and detergent industries, Production of recombinant proteins (Insulin, Interleukin) having therapeutic and diagnostic applications, Production of vaccines.

Strain improvement through physical and chemical mutation and molecular tools.

Production of Natural Biopreservatives (Nisin), and Biopolymers (Xanthan Gum and PHB), single cell protein, interferons, vaccines, High – Fructose com syrup; Bioconversion of Vegetable Oils.

LABORATORY

- Isolation of antibiotic producer from soil sample.
- Isolation and screening of industrially important microorganism.
- Production of organic acid in submerged fermentation.
- Study of Batch and Fed batch culture system and growth profile.
- Analysis of critical parameters for metabolite production in a fermentor.
- Study of product recovery processes.

BT703: DRUG DESIGN AND DRUG DISCOVERY

Introduction to The Drug Discovery and Development, Source of Drugs: Plant, Animal and microorganism. Structural effects on drug action: Sequence of events after drug administration, Physico-chemical properties that are related to drug action, Role and types of chemical bonding involved in drug-target interactions.

Preclinical development. Clinical trials, Patenting, and clearance for application.

Approaches and Principles to Drug Design: Enzyme Inhibition, Molecular Recognition, Receptor Based Molecular Modelling, molecular docking, QSAR, Agonist and Antagonist.

Computer-Aided Drug Design: Lead Optimization and Computer-Aided Drug Design, Overview of Ligand-Based and Structure-Based Design, Review of Protein Structures, Primary Structure, Secondary Structure. Tertiary Structure, Quaternary Structure. Viewing Tools and Graphics Tools.

Examples of Designed Drugs: Antihypertensive, Antiviral, Anticancer and Antibiotic. Combinatorial Library and Highthrouput Screening.

- DeepView (http://ca.expasy.org/spdbv/)
- VMD (http://www.ks.uiuc.edu/Research/vmd/)
- Molscript (http://www.avatar.se/molscript/)
- Raster3D (http://skuld.bmsc.washington.edu/raster3d/)

BT 801: BIOPROCESS CONTROL AND ECONOMICS

Process plants:

continuous and batch plants. Procedure for systematic study of plants. Plant and equipment start up and shut downs, operations at steady state. Emergency response strategy for plants and equipment. Plant test runs and rating calculations for various equipment. Plant systems for utilities and auxiliary services. Handling of plant effluent. Safe commissioning of plants

Estimation of total product cost:

Manufacturing costs general expenses, direct production cost, fixed cost, plant over head cost, administration expenses, Distribution and marketing expenses.

Financial statements:

Balance sheet and profit and loss account, ratios used for comparing the balance sheet and profit and loss account.

Break even and minimum cost analysis:

Types of costs, cost analysis, Types of costs- valuable and fixed costs, economic production charts, differential analysis of economic production charts, critique in the use of break even and minimum cost analysis.

Profitability:

Investment evaluation, Mathematical methods for profitability evaluation, pay out time, pay out time with interest return on original investment, Return on average investment, investment, discounted cash flow, venture worth.

References:

- Coughanowr , "Process Systems Analysis and Control", McGraw Hill
- Peters and Timmerhaus, "Plant Design and Economics for Chemical Engineers"
- Aries and Newton, "Chemical Engineering Cost Estimation "

- Schweyer, "Process Engineering Economics"
- Happel, "Chemical Process Economics"
- Vilbrandt and Dryden, "Chemical Engineering Plant Design"

BT751: BIOTECHNOLOGY IN FOOD PROCESSING

Introduction:

Factors affecting the growth and survival of microorganisms in food.

Food spoilage:

Microbial spoilage of food, Common food borne diseases, Bacterial agents of food borne illness, Non-bacterial agents of food borne illness.

Microbiological examination of food:

Direct examination, culture techniques, MPN count, Dye reduction assay, Immunological methods and Advance techniques.

Fermented foods:

Fermented milk, cheese, sauerkraut, fermented meat, beer, vinegar, fish products, related products of baking, oriental foods.

Microbiology of Food Preservation:

Principles of food preservation, Methods of food preservation: Asepsis, anaerobic conditions, removal of microorganisms, Low temperature, High temperature, Radiation, Drying, Chemical preservatives and miscellaneous methods, canning.

Quality Control using Microbiological Criteria:

Cleaning and disinfection code for good manufacturing practices, Hazard analysis and critical control points, Sterility testing.

References

- James M. J., Modern Food Microbiology, CBS Publishers & Publishers, 1987.
- Freiser Food Microbiology.
- Lidsay, Willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science, 1988.
- Roger A., Gordan B., and John T., Food Biotechnology, 1989.
- George J. B., Basic Food Microbiology, CBS Publishers & Distributors, 1987.

BT752: PHARMACEUTICAL BIOTECHNOLOGY

Introduction:

Development of Drug and Pharmaceutical Industry, Therapeutic agents, their use and economics, Regulatory aspects.

Drug Metabolism and Pharmacokinetics:

Drug metabolism-physico chemical principles, Radio activity-pharmacokinetic action of drugs on human bodies.

Important Unit Processes and their Applications:

Bulk drug manufacturers, Types of reaction in bulk drug manufacture and processes, Special requirement for bulk drug manufacture.

Manufacturing Principles:

Compressed table, wet granulation, dry granulation or slugging, direct compression, tablet presses, coating of tablets, capsules, sustained action dosage forms, parental solution, oral liquids, injections, ointment-topical applications, Preservation, analytical methods and test for various drug and pharmaceuticals, Packing-Packing techniques, Quality management, GMP.

Pharmaceutical Product and their Control:

Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, biologicals, hormones.

References:

- Leon Lachman *et* al Theory and Practice of Industrial Pharmacy, 3rd Edition, Lea and Febiger, 1986
- Remington?s Pharmaceutical Science, Mark Publishing and Co.

BT753: BIODIVERSITY, BIOPROSPECTING AND ORGANIC FARMING

Ecosystems:

Major ecosystems and their flora and fauna. Co-evolution, symbiosis and interaction among organisms.

Taxonomy:

Nomenclature and classification of flora and fauna.

Biodiversity:

Analysis of biodiversity, On farm, *ex situ*, *in situ* and gene bank conservation, Geological and human activities endangering biodiversity, Domestication and utilization of biodiversity.

Bioprospecting:

Bioprospecting biodiversity for food, feed, health care and other products. Ethnobiology

Organic Farming:

Organic farming and sustainable use of natural and bioresources, Organic standards and certification of organic produce and products, Biological control, Global initiatives on future prospects.

References:

- Biodiversity: New leads for the pharmaceutical and agrochemical industries. Wrigley S.K., Hayes M.A., Thomas R, Chrystal E.J.T. and Nicholson L. Royal Society of Chemists, 2000.
- Biological and Biotechnological Resources (Eds) Tripathi G and Tripathi Y.C. Campus Books International, 2002.

BT754: DATA ANALYSIS FOR DNA MICROARRAYS

Micrarray Technology.

Basic digital imaging and image processing.

Probabilities, Common distributions, Bayes theorem.

Analyzing microarray data with classical hypothesis testing.

Analysis of variance, Experimental design, Analysis and Visualization tools- Box plots, Scatter plots, Histograms.

Cluster Analysis:

One-way, two-way, Graphic, Methods for selection of differentiated regulated genes, Hypothesis driven experiments using focussed microarrays.

Biological interpretation, Commercial software available.

References:

- DNA Microarrays and Gene Expression, From Proteomics to Data Analysis and Modelling by Pierre Baldi, G. Wesley Hatfield and Wesley G. Hatfield.
- Hidden Markov Models for Bioinformatics by Timo Koski, Timo Koskinen.
- Computational analysis of Biochemical Systems: A Practical Guide for Biochemists and Molecular biologists by Eberhard O. Voit.

BT781: BIOENERGY ENGINEERING

Introduction:

Bioenergy, Classification and sources of energy, Problems relating demand and supply of various energy sources.

Coal:

Origin and formation, composition and classification, resources and production, exploration and mining, analysis and testing storage and handling; coal carbonisation, briquette, coal hydrogenation. Wood and wood products.

Petroleum:

Origin, occurrence, Chemical composition, world reserve, production, refining operations, storage and conveying, testing and analysis different products from petroleum like naphtha, aviation gasoline, kerosene, diesel oil, gas oil, lubricating oil, asphalts etc., petroleum coke, oil shale and oil sand. Combusting methods; and systems, pulverised coal furnaces; cyclone furnaces, oil fired systems, gas fired systems, waste heat boilers.

Biogas plant and its design:

KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes. Development in energy routes.

Conversion of heat to power:

Thermoelectric converters, thermo-electric refrigerators, magneto-hydrodynamics, fuel cells, conversion of chemical energy into electricity, fuel cell performance, co-generation, efficiency improvement, energy conversion in petrochemical industries, polymer industries, natural organic industries, fertilizer industries etc.

Energy conservation:

Process modifications, Preventing energy loss, Waste utilisation, Energy audit.

References:

- S.B Pandya, "Conventional Energy Technology - Fuels and chemical Energy - TMH (1987)
- S.P. Sharma and Chander Mohan, Fuels and Combustion, "TMH, 1984
- Kash Kori, C., Energy resources, demand and conservation with special reference to India, TMH, 1975.
- Gulp Jr., "Principles of Energy Conservation, "MGK (1979)

- Chemtech I - Manual of Chemical Technology, "Vol.I. S. Chand and Co., New Delhi (1985)
- Pryde P.R., "Non Conventional energy resources" JW (1983)
- Gray T.J. and Gashos G.K., Tidel Power," Plenum Press (1972)
- Sarkar S. "Fuels and Combustion, "Orient Longmans (1974)

BT782 : STEM CELLS IN HEALTH CARE

Introduction:

Stem Cell Biology, Fate Mapping of Stem Cells.

Stem Cell Pattern:

Differentiated parental DNA Chain causes stem cell pattern of cell-type switching in *Schizosaccharomyces pombe on* equivalence groups and the Notch/LIN-12 communication System.

Cell Cycle Control:

Checkpoints, and stem cell biology, senescence of dividing somatic cells.

The Drosophila Ovary:

An In Vivo Stem Cell System.

Male Germ-line Stem Cells:

Primordial germ cells as stem cells, embryonic stem cells, embryonal carcinoma cells as embryonic stem cells, trophoblast stem cells.

Hematopoietic Stem Cells:

Repopulating patterns of primitive hematopoietic stem cells, molecular diversification and developmental interrelationships, lymphopoiesis and the problem of commitment versus plasticity, hemangioblast, Mesenchymal Stem Cells of Human Adult Bone Marrow, Stem Cells and Neurogenesis.

Epidermal Stem Cells:

Liver Stem Cells, Pancreatic Stem Cells, Stem Cells in the Epithelium of the Small Intestine and Colon.

References:

- Developmental Biology, 6th Edition, Scott F. Gilbert.
- Hematology, William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman.
- Molecular Biology of the Cell, 3rd Edition, Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson.

Stem Cell Biology by Marshak, 2001, Cold Spring Harbour Symposium Publication.

BT 783: BIOTECHNOLOGY FOR SUSTAINABLE ENVIRONMENT

Concept of ecology and ecosystem, various types of environmental pollution, their sources and effects.

Microbial flora of soil, growth, ecological adaptations, interactions among soil micro-organisms, bio-geochemical role of soil microorganisms, Extremophilic microorganisms. Organisms involved in degradation of chlorinated hydrocarbons, substituted simple aromatic compounds, polyaromatic hydrocarbons, pesticides, surfactants and microbial treatment of oil pollution.

Sewage and waste water treatments, Solid waste management: landfills, composting, recycling and processing of organic residues.

Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal.

Biofertilizers and microbial inoculants, biopesticide, bioinsecticides, bioherbicides

Energy crops, Biogas, Bioethanol, biohydrogen

Sustainable Development: Concept and issues in Sustainable Development, Environmental laws and policies, Release of genetically engineered microbes and plant in environment.

Text / Reference Books:

1. Environmental Biotechnology by Alan Scragg (1999); Longman.

2. An Introduction to Environmental Biotechnology by Milton Wainwright (1999): Kluwer Academic Press.

3. Microbial Ecology: Fundamentals and Applications by Ronald M. Atlas and Richard Bartha. Pearson Education.

BT784: BIOSTATISTICS

Presentation of Data:

Data type, classification and summarization of data, diagrams and graphs, Measures of dispersion, Skewness and kurtosis.

Probability and Distribution:

Introduction to probability, Laws of probability, Bayes? theorem, Binomial distribution, Poisson distribution, Normal distribution and Gaussian distribution.

Correlation and Regression:

Positive and Negative correlation, Pearson and Mathew correlation coefficient, Non parametric tests, Receiver operating characteristics (ROC) curve, Linear and Non linear regression, Multiple regression.

Sampling:

Concept of population and sample, Random sample, Methods of taking a random sample.

Tests of Significance:

Sampling distribution of mean and standard error, Large sample tests (test for an assumed means and equality of two population means with known S.D.), Small sample tests (t-test for an assumed mean and equality of means of two populations when sample observations are independent, Paired and unpaired t-test for correlation and regression coefficients, T-test for comparison of variances of two populations, Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples.

Experimental Designs:

Principles of experimental designs, Completely randomized, Randomized block and latin square designs, Simple factorial experiments of 22, 23, 24 and 32 types? Confounding in factorial experiments (mathematical derivations not required, Analysis of variance (ANOVA) and its use in the analysis of RBD.

References:

- Statistical methods in Biology by Norman T.J. Bailey (3rd Edition), Cambridge University Press (1995).
- George W. and William G, Statistical methods, IBH Publication.
- Ipsen J *et al*, Introduction to Biostatistics, Harper and Row Publication.
- N.T.J. Bailey, Statistical methods in Biology, English University Press.
- R. Rangaswami, A Text Book of Agricultural Statistics, New Age Intl. Pub.

BT851: CHROMATOGRAPHIC SEPARATIONS

Introduction:

Classification of techniques, distribution coefficients, retention chromatography, sorption mechanisms, retention parameters, factors affecting retention, qualitative and quantitative aspects of chromatography, peak shape sorption isotherms, column efficiency, band broadening processes, selectivity and resolution.

Classical Chromatography:

Stationary phases, applications of ion exchange size exclusion, TLC-HPTLC.

High performance liquid chromatography:

Introduction, design of a typical HPLC machine, types of columns and their applications.

Gas chromatography:

Introduction, Instrumentation, Columns, Qualitative and quantitative aspects of gas chromatography , Quantitative analysis of GC.

Chiral Chromatography:

Principles, Types of chromatography, Scopes and limitations, Applications, Capillary electrophoresis.

References:

- Sewell P.A. Clarke B, Chromatographic separations. John Wiley & Sons, 1991.
- Lindsay B., High performance Liquid Chromatography, John Wiley & Sons.
- Lecture Notes on short course on Enantiomeric separations, April 28-29,1995.

BT852: BIOMOLECULAR SPECTROSCOPY

Electromagnetic and quantum theory of radiation:

Visible spectra, UV, X-ray radiation, Wave-particle duality, Photons, Interaction of light with matter.

UV-visible absorption spectroscopy:

Beer-Lambert's law; applications of uv-visible Spectroscopy.

Fluorescence Spectroscopy of Biomolecules:

Quantum yield, static and dynamic quenching of fluorescence, energy transfer, polarization, anisotropy, time-resolved fluorescence.

Optical Rotary Dispersion and Circular dichroism:

Spectra of alpha helix, beta sheet, beta turn in polypeptides/A, B and Z DNA.

Vibrational Spectroscopy:

IR, FT-IR , Raman spectroscopy, Moss Bauer and Pico Second Spectroscopy.

Nuclear Magnetic Resonance Spectroscopy:

Chemical shifts, coupling constants, ring currents, paramagnetic shifts, spin-spin and spin-lattice relaxation times, NOE, chemical exchange, application to biomolecular structure and dynamics, 2D NMR methods-COSY, NOESY, Magnetic Resonance Imaging(MRI).

Electron spin resonance spectroscopy:

Hyperfine splitting, zero field splitting, spin labels.Electron paramagnetic resonance (EPR) spectroscopy, Mass spectrometry of biomolecules.

X-ray diffraction:

Crystal systems and space groups, Miller indices and space lattices, Diffraction of x-rays and Braggs law, Compton effect, Structure determination of biomolecules, Refinement and accuracy of the x-ray crystallographic structures. Scanning Tunneling Microscopy; Atomic Force Microscopy; Electron Microscopy of Biomolecules.

References:

- Biological Spectroscopy ID Campbell and R.A. Dwek, Benjamin, Curmmings Pub co. Inc.

- Introduction to Biophysical Methods for Protein and Nucleic acid research, J.A. Glasel and M.B. Deutscher, Academic Press.
- Biophysical Chemistry Part-I and Part-III C.R. Cantor and Schimmel W.H,.Freeman and Co.
- Principles of Physical Biochemistry K.E. van Holde, W. Johnson, PS Ho , Prentice Hall. New Jersey Pub.
- Nuclear Magnetic Spectroscopy, H. Gunther, John Wiley and Sons.

BT853:BIO-NANOTECHNOLOGY

Introduction:

An Account and biological problems.

Cellular Architecture:

Structure and mechanics of cytoskeleton, Self assembly of cryoskeletal polymers, Force generation by polymerization.

Motor proteins and nanotechnology:

Types of Motor proteins: Linear and Rotary motors, Structure of Motor proteins, Motility properties of motors, ATP hydrolysis mechanism of various motor proteins, comparison of kinetics, steps and force production by motors, chemo-mechanical coupling of motors - single molecule approaches.

Nanocrystals in biological detection:

Protein based nanocrstals, microbial nanoparticle production.

DNA based nanostructures and gold nanoparticle conjugates:

DNA as a polymer and DNA based motors basics of DNA structure, Hairpin loops and helices: reciprocal exchange and stability of DNA structure, Base pairing, motifs used in DNA nanotechnology. RNA polymerase and DNA helicase as motors, Single molecule mechanics and DNA dynamics.

Luminescent quantum dots for biological imaging:

Emerging Nano Technologies-nano-labels, biosensors, medicine.

References:

- Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer, Chad A. Mirkin, First edition, Wiley-VCH.
- Nanotechnology: A gentle introduction to the next big idea, Ratner, M.Ratener, D.

- Bionanotechnology: Lessons from Nature by David S. Goodsell, First Edition, John Wiley and Sons.
- Introduction to Nanotechnology by Charles P. Poole, Frank J. Owens, John Wiley and Sons, Inc.

BT854: CELL AND TISSUE ENGINEERING

Introduction to Tissue Engineering.

Cells and cell injury, Tissue, Extracellular matrix and Cell Biomaterial interactions

Bioresorbable materials, Introduction to testing of biomaterials, Tissue compatibility and prosthetic devices

The concept of Biofilms and infections

Transplantation biology

Principles and practice of gene therapy. Compter aided Tissue Engineeing.

Implant and Device failure, Ethical Issues in Biomaterial Science.

Legal Aspects of Biomaterials

References:

- Patrick, Mikos and McIntire. Frontiers in Tissue Engineering, Pergamon Press.
- Lanza, Labnger and Vacanti. Principles of Tissue Engineering, Academic Press.
- Morgan and Yarmush, Tissue Engineering Methods and Protocols, Humana Press.
- Buddy D. Ratner, AS Hoffman, FJ Schoen and Jack E Lemons, Biomaterials Science. Academic Press.

BT881: MARKETING & MANAGEMENT OF BIOTECHNOLOGY

Why there is a need to commercialize Biotechnology:

Discovery, market needs development process, success rates and costs etc.

From Laboratory to Land:

Extension services of Biotechnology, Providing Process and Product Know-how to the Layman.

Creating and Marketing the image of the biotechnology Company:

Art of negotiation & effective communication.

Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up.

How to portray management and role of a biotechnology manager, technology decision-making, and resource decision-making etc., Product marketing decision.

Role of Research & development University-industry technology transfer arrangements, how and why a biotech company can benefit.

Positioning, power and importance of positioning of a company name and product, Workable marketing and the strength of distribution.

Effective advertising and marketing. Opportunities international, marketing and lessons to be learned.

Indian and foreign prospective of biotechnology, and current challenges for the biotechnology based products.

References:

- Positioning by All Rise and Jack Trout (1986), Warner Books.
- Biotechnology: The science and the business by V. Moser & R.E. Cape (1999) Harwood.

Latest review articles and papers on the subject.

BT882: BIOREMEDIATION, PRINCIPLES AND APPLICATIONS

An overview of the current bioremediation practice and its applications:

Microbial systems of bioremediation, Factors influencing bioremediation, environmental factors, physical factors and chemical factors.

Microbial transformation reactions:

Aerobic and anaerobic biotransformations, Microbial detoxification of specialty chemicals like insecticides, herbicides, fungicides, polychlorinated biphenyls, heavy metals.

Responses of microorganisms to the presence of pollutants:

Inducible degradative enzymes and mechanisms, Application of genetically engineered microorganisms for hazardous waste management.

Bioremediation systems and processes:

Solid and slurry phase bioremediation (land farming, composting, slurry bioreactors and lagoons Microbial cleaning of gases (biofiltration and bioscrubbing). Liquid phase bioremediation.

In situ bioremediation:

Assessment for in situ bioremediation, microbial activity, subsurface delivery systems, in situ oxygenation.

BT883: MOLECULAR ONCOLOGY

Introduction to Cancer biology, Immortalization, Transformation, Metastasis.

Genetic instability, mutation, deletion, insertion, aneuploidy, chromosome translocation and gene amplification.

Causes of cancer, Genetic alterations in cancer, Molecular mechanism of carcinogenesis, cell cycle checkpoints ? G1 and S checkpoint, G2 and M checkpoint, cyclin and cyclin dependent kinases.

CDK inhibitors-p16, p21 and p27, Oncogenes, growth factors, growth factor receptors, G protein/signal transduction, tyrosine and serine/threonine kinases and transcription factors.

Tumor suppressor genes- p53, RB, BRCA1, BRCA2, APC and WT1.

Mismatch repair, Telomerase, DNA methylation, Protein phosphorylation/dephosphorylation and degradation events.

Transformation by RNA and DNA tumor viruses(Adenovirus, Simian Virus 40 and Human papilloma virus), Oncogene-tumor suppressor interactions, Apoptosis and cancer, Cancer prevention, diagnosis and treatment, Cancer-gene therapy.

References:

- Metal Carcinogenesis Testing, Costa M.
- In Vitro Toxicity Testing Protocols, O?Hare S, Humana Press.
- Recombination Variability and Evolution, Koral, A.B., Chopma Hall.
- DNA Repair Protocols, 2nd Edition, Henderson D.S, Humana Press.
- Cellular and Molecular Biology of NO. Laskin J.D., Dekker.
- Human Retrovirus Protocols, ZHU. T., Humana Press.
- Immune Modulating Agents, Kresina T.E, Dekker.

Human Cytogenetics Cancer Markers, Wolman, Humana Press.

BT 884: MEMBRANE: STRUCTURE AND DYNAMICS

Membrane structure:

The lipid bilayer and membrane proteins, Membrane dynamics, Membrane pumps, channels and transporters. Interaction of small molecules with membranes - partitioning and permeability. Pore and channel forming proteins. The cell surface receptor. Membrane recycling and. Membrane biogenesis.

Molecular Cell Signalling:

Over view of Cell-Cell and intracellular signalling mechanisms, endocrine, paracrine, autocrine and synaptic transmissions. Cell-Cell recognition. Concepts of receptors, receptor-ligand interaction (concepts of agonist and antagonist), receptor characterizations, receptor functions.

Extracellular receptors:

Coupling of receptors to different signal transducing machinery; G-proteins, Ion channels, and catalytic proteins.

Mechanism(s) of signal transduction:

Gene regulation. Regulation of receptor function, receptor modifications, adaptation of cells. Signal transduction pathways in development and disease. Relationship of receptor tyrosine kinases with proto-oncogenes.

References:

- Cell signalling; John Hancock; Oxport University press.
- RB Gennis; Biomembranes - Molecular structure and function. Springer Verlag, 1988.
- Ernst. J.M. Helmreich ;The Biochemistry of cell signalling; Oxford University
- A. W. Norman and G. Litwack; Hormones. Academic Press, 1987.
- G. G. Gilman, L. S. Goodman, T. W. Rall and F. C. Murad (Eds.); The Pharmacological Basis of Therapeutics (7th ed). Macmillan, 1985.
- G. Posli and S. T. Crooke (Eds.); Mechanisms of Receptor Regulation. Plenum Press, 1985.
- Hille, Bertil; Ion channel of excitable membrane 3rd ed, Sinauer associates, 2001
- Selected reading from current articles in Science and Nature.

- G. G. Gilman, L. S. Goodman, T. W. Rall and F. C. Murad (Eds.); The Pharmacological Basis of Therapeutics (7th ed). Macmillan, 1985.
- G. Posli and S. T. Crooke (Eds.); Mechanisms of Receptor Regulation. Plenum Press, 1985.

LIST OF OPEN ELECTIVES

1. Introduction to Nano-technology, MED, AMD

2. Introduction to Bio-informatics, CH

3. Introduction to Bio-Engineering

4. Powder Metallurgy, MED. AMD

5. Optimisation Techniques, MED, EED

6. Engineering Materials and their Applications, AMD

7. Reliability Engineering, MED, CE, AMD

8. Digital Electronics and Microprocessors, EC

9. Electrical and Electronic Measurements , EE, EC

10. Data Communication and Networking, EC

11. Optical & Mobile Communication, EC

12. Fuzzy Logic and Neural Network, MED, EE

13. Modern Architectural Practices, CE

14. Artificial Intelligence and Expert Systems, CSE

15. Web Technology, CSE

16. Introduction to Robotics, MED, CS, AMD

17. Non-conventional Energy Sources ME, EE

18. Statistical Methods in Engineering, MA

19. Differential Geometry, MA

20. Graph Theory , MA

21. Industrial Psychology, HS,

22. Power Plant Engineering, ME

23. Knowledge Management, ME, CS

24. Technology Management, ME, CS,

25. Total Quality Management, ME

26. Safety Engineering, ME, EE

27. Value Engineering, ME

28. Solid State Physics, PH, EC, AM

29. Condensed Matter Physics, PH

30. X-ray Spectroscopy, PH, AM

31. Spectroscopy for Engineers , PH, AM

32. Introduction to Biotechnology, CH

33. Biomaterials Science & Technology, AM

34. Bio-medical Instrumentation , EE, EC

35. Introduction to GIS, CE

36. Micro-electronics and VLSI Technology, EC

37. Power Plant Engineering, ME, EE

38. Product Development and design, ME

39. Ethics in Engineering Education, ME

40. Entrepreneurship , ME, EE, HS

41. Accounting & Financial Management, ME, SM

42. Industrial Organisation, HS, SM

43. Waste Material Management , CE

44. Advanced System Engineering, EE

45. Accoustics & Noise Engg. , AM, ME

46. Systems Engg.

47. Engg. Systems Design, AM, ME

48. Linear & Non Linear Vibration, AM, ME

49. Environmental Impact Assessment , CE

50. Human Resource Management., HS, SM

51. Elements of Remote Sensing, CE

52. Fundamentals of GIS and GPS, CE

53. Research Methodology, HS

54. Communication Skills and Personality Development HS

55. Workshop in Creative Thinking HS

56. Modern English Drama HS

57. Modern Poetry HS

58. Modern Fiction HS

59. Science and Humanism HS

60. Water Resources Management CE

61. Operations Research CE

62. Regional and Urban Planning CE