K L University
Dept. of Biotechnology

Course structure for M. Tech Biotechnology
(2 year regular programme)
CDC and Electives

First Year (First Semester) :

S.No.		Course Title	Periods			Credits
			L	T	P	
1	12BT501	Mathematics and Biostatistics	4	0	0	4
2	12BT502	Biochemical Engineering	3	1	2	5
3	12BT503	Molecular Biology and r-DNA Technology	3	0	2	4
4	12BT504	Applied Bioinformatics	3	1	2	5
5	12BTE530	Elective 1	3	0	0	3
6	12BTE531	Elective 2	3	0	0	3
7	KLUC 501	Seminar/Term Paper	0	0	4	2
		Total Credits	26			

II Semester with-holding

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	12BT505	Plant and Animal Biotechnology	3	1	2	5
2	12BT506	Immunotechnology	4	0	0	4
3	12BT507	Bioreactor modeling and Simulation	3	0	2	4
4	12BT508	Downstream Processing	3	0	2	4
5	12BTE532	Enzyme technology	3	0	0	3
6	12BTE533	Molecular Modeling and Drug Designing	3	0	0	3
7	KLUC 502	Thesis/Project	0	0	4	2
		Total Credits	25			

III Semester & IV Semester	
Course	Credits
Dissertation work	36

HOD-BT

MATHEMATICS & STATISTICS

Scope: This paper emphasizes the fundamentals of Mathematics and Biostatistics useful to apply analysis of experimental data. The main aim and objective of the paper is to train the students to understand the importance of Mathematics and biostatistics in Biotechnology field and their use in R&D.

Unit-I: Numerical Methods

Solutions of algebraic & transcendental equations - Bisection Method, New-Raphson Method, Solution of linear simultaneous equations, Simpson's rule, Trapezoidal rule.

Unit-II: Linear-Differential equation:

1st order differential equations, solutions of 1st order, variable separable, homogeneous equation linear and enact equations. Linear differential equations of higher order with constant co efficient. Rules for finding complementary function and particular integral.

UNIT – III: Presentation of data & Measures of central tendency

Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves. Mean, medium, mode, and their simple properties (without derivation), range, mean deviation, standard deviation and coefficient of variation.

UNIT – IV: Correlation, Regression and Tests of significance

Simple correlation and regression coefficients and their relations. Limits of correlation coefficient, effect of change of origin and scale on correlation coefficient, Linear regression and equations of line of regression, association and independence of attributes. Paired and unpaired t-test for correlation and regression coefficient. T- test for comparison of variances of two populations. Chi-square test- independence of attributes, goodness of fit, and homogeneity of sample.

UNIT – V: Experimental designs

Principles of experimental design, completely randomized design, randomized block design and Latin square design. Analysis of variance (ANOVA) and its use in the analysis of RBD. F-test.

Recommended Textbooks:

1. Norman T.J. Bailey, Statistical methods in biology (3rd edition), Cambridge University Press (1995).
2. Bernard Rosner, Fundamentals of Biostatistics, 5th edition, Thomson Brooks/ Cole, 2000.
3. Higher engineering mathematics by B.S Grawel

References Books:

1. S.C.Gupta and V.K. Kapoor – Fundamentals of Mathematical Statistics, 9th Extensively revised edition, Sultan Chand & Sons, 1999.
1. Advanced Engineering Mathematics, Michael D.Greenberg, Pearson Education.
2. Advanced Engineering Mathematics by Ervin Kreyszic.
3. Higher engineering mathematics by Bird john

BIOCHEMICAL ENGINEERING

Scope: This paper deals with studying various biochemical reactions in bioreactors, their design and operation. The paper also discusses the non-ideal behavior of different reactor designs.

UNIT – I: Introduction to Biochemical reactions

Types of reactions (Simple stepwise and Parallel) and their applications in fermentations, reaction rates, kinetics of homogenous reactions, molecularity and order of reaction and temperature dependency of reaction rate.

UNIT – II: Design and Operation of Bioreactors

Mass transfer aspect, Bioreactor types and design, Continuous stirred tank bioreactors, fed batch bioreactors, airlift bioreactors, Fluidised bed bioreactor, Bioreactors for plant and animal cell, scale up of bioreactor using constant p/v and constant KLa..

UNIT – III: Mass Transfer in Bioprocess Operation

Mass transfer by diffusion, Theories of Diffusional mass transfer film theory, Penetration theory, Surface renewal theory Mass transfer by convection, Gas-liquid mass transfer, correlation for mass transfer coefficient, measurement of KLa, O2 transfer, methodology in fermentors, specific oxygen uptake rate, critical oxygen concentration, maximum cell concentration.

UNIT – IV: Heterogeneous reactor systems

Classification of reaction systems, (homogenous, heterogeneous), mass transfer consideration in heterogeneous systems, Intra particle diffusion and reaction rates, Effectiveness factor and Thiele modules, observed Thiele modules, criterion for mass transfers limitations.

UNIT–V: Non-ideal flow in bioreactors

Reasons for non-ideality, RTD studies (F-Curve, C-Curve for ideal and non-ideal CSTR and plug flow reactors), mean and variance of residence time, conversion using tracer information, modeling of non-ideal flow behavior by dispersion model.

Recommended textbooks:

1. Introduction to Biochemical Engineering by D.G.Rao
2. Biochemical Engineering fundamentals by Bailey and Oliss

Reference Books:

1. Bioprocess Engineering Principles by Pauline and Doran

BIOCHEMICAL ENGINEERING LAB

(Perform minimum any 10 practicals)

1. Study of thermal death kinetics and estimation of delta factor for bacterial culture

2. Determination of Volumetric mass transfer coefficient in fermenters (sodium sulphite technique, Static method)

3. Determination of gas holdup in sparged reactor

4. Determination of mixing time in bioreactor

5. Determination of circulation time using flow follower method

6. Estimation of Reynolds number for a given flow in pipes

7. Residence time distribution experiment in CSTR

8. Estimation of power number for stirrer in fermenters

9. Estimation of conversion of a substrate in plug flow reactor

10. Kinetic studies in fluidized bed bioreactor

11. Design exercises on fermenters

Molecular Biology & r-DNA Technology

Scope: Recombinant DNA technology is fundamental to molecular biotechnology that encompasses many scientific disciplines i.e. molecular biology, microbiology, biochemistry, immunology etc and generates a wide range of consumer products (i.e. crops, drugs, vaccines, diagnostics, and livestock). Recombinant DNA technology uses prokaryotic and eukaryotic organisms and is the manipulation of DNA to generate clones, examine gene regulation, and express proteins. The course includes current technical procedures for recombinant DNA technology and its applications.

UNIT – I: DNA STRUCTURE & REPLICATION

Structure of DNA:-Watson & Crick's model, Types of DNA, Denaturation and renaturation Kinetics, Replication of DNA- Semi conservative, bi-directional replication. DNA damage and repair: Types of DNA damages- deamination, alkylation, pyrimidine dimmers; Repair mechanisms-Excision, mismatch and SOS repair, Recombination: Homologous and nonhomologous; **rec** gene and its role in DNA repair.

UNIT – II: TRANSCRIPTION AND TRANSLATION

Structure of Promoters-RNA Polymerases of Prokaryotic and Eukaryotic Organism; Transcription- Initiation, Elongation and Termination; Prokaryotic & Eukaryotic transcription; Post Transcriptional Processing of Eukaryotic RNA. Translation in prokaryotic and Eukaryotes: initiation of translation, elongation of polypeptide chain, termination of translation. Post-translational modifications.

UNIT-III: REGULATION OF GENE EXPRESSION

Regulation of Gene expression in bacteria- Operon concept, **lac, trp, ara** Operons. Control of gene expression by sigma factor and post transcriptional control. Absolute control by antisense RNA's; enhancers, upstream controlling elements, Structural Motifs of Transcription factors: helix turn, zinc finger motifs, leucine zippers and homeotic genes.

UNIT-IV ENZYMES AND VECTORS IN CLONING

Restriction Enzymes; DNA ligase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern, Colony hybridization & FISH, Plasmids; Phagemids; Cosmids; Shuttle vectors, Artificial chromosome vectors (YACs; BACs); Expression vectors: Baculovirus and pichia vectors system; Plant based vectors: Ti and Ri vectors, Construction of cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Yeast two hybrid system; Phage display.

UNIT-V PCR, SEQUENCING & RNA TECHNLOGIES

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR; PCR Applications Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Introduction to siRNA; siRNA technology; Micro RNA; Principle and application of gene silencing; Gene knockouts and Gene Therapy; knockout mice; Disease model; Transgenics; Differential gene expression and protein array.

Recommended Text Books:

1. Fundamentals of Molecular Biology by Avinash & Kakoli Upadhyay; Himalaya Publication.

I/II M. Tech Biotechnology 2nd semester

2. Essentials of Molecular Biology by George M. Malacinski and David Freifelder; Jones and Bartlett publishers.
3. Molecular Biology by Weaver; Academic International Publication.
4. Gene IX by Benjamin Lewin; Pearson Publishing

Reference Books:

1. Principles of gene manipulation by Sandy B Primrose, Richard M Twyman and Robert W old
2. Molecular biology of cell by Alberts.

MBTL22 – MOLECULAR BIOLOGY & r DNA TECHNOLOGY LAB

1. Isolation & Visualization of genomic DNA from whole blood.
2. Isolation of RNA from plant tissue.
3. Bacterial Transformation.
4. Isolation & Visualization of Plasmids.
5. Amplification of DNA fragments by PCR and analysis by gel electrophoresis.
6. Restriction mapping of plasmid vector (gel analysis).
7. Vector and insert ligation, transformation in E.coli.
8. Screening of recombinant clones (Blue/white screening and GFP).
9. SDS-PAGE and Staining Techniques – Silver Nitrate & Coomasie Blue
10. Western Blotting.

REFERENCE BOOKS:

1. Current protocols in Molecular biology; Wiley Publishers.

Applied Bioinformatics

Scope: The Course aims to prepare the students for understanding biological data at molecular level from both informational and biological perspective and impart conceptual, computational and practical skills to acquire, analyze, process or use the data to address significant problems in the field of Bioinformatics, of both pure and applied nature.

Unit – I: Comparative Genomics
Genetic mapping, Physical mapping, SNPs, ESTs, GSS, Gene prediction methods, Gene prediction tools, Gene annotation, Molecular Predictions with DNA sequence, Human Genome Project.

UNIT – II: Protein Structure Prediction and Evaluation methods
Structure of Protein – PDB, MMDB; Ramachandran Plots; Structure visualization – Rasmol; Methods of Structure prediction – Homology modeling - SPDBV, Threading, Ab-initio method; Structure Evaluation – DSSP, ProCheck, Verify 3D; Structure comparison.

UNIT – III: Protein Identification And Interactions
Proteomics approaches for protein analysis; Protein identification Programs – Mascot, GFS; Comparative Proteomics methods; Protein interactions; Protein Interaction dbs – GRID, MINT; Network Mapping; Biological Pathway dbs – EcoCyc, KEGG; Pathway prediction; Metabolic pathway reconstruction.

UNIT – IV: Gene Expression Analysis
Introduction; Serial Analysis of Gene Expression; Microarray, Types of Microarrays, Microarray Fabrication, Microarray hybridization and detection, Microarray Image Processing and analysis, Expression ratios, Transformations of the Expression ratio, Data Normalization.

UNIT – V: System Biology
Foundations of System Biology- Objectives of System Biology-Strategies relating to In Silico Modeling of biological processes- Metabolic Networks- Signal Transduction pathways, Gene Expression patterns – Applications of System Biology Markup Language (SBML), E-cell, V-cell simulations and Applications

Recommended Textbooks:
G. Gibson and SV Muse, A Primer of Genome Science, Second Edition - Sinauer Associates, Inc.
CW Sensen, Essentials of genomics and Bioinformatics, Wiley-VCH publication.
Reference textbooks:
Speed T. (ed.) Statistical analysis of gene expression microarray data (CRC, 2003)

Applied BIOINFORMATICS LABORATORY

1. Identification of genes from genomes using GeneMark.
2. Identification of biologically relevant protein using PSI – BLAST.
3. Database similarity search using WU – BLAST.
4. Identification of sequence motifs by writing patterns.
5. Genome annotation using ARTEMIS.
6. Protein homology modeling by Swiss Model.
7. Gene Expression Analysis
8. Programming basics and working with DNA sequences and strings
9. Regular Expressions and finding motifs in data.
10. Simulating gene mutation using random number generators.

Recommended laboratory manuals:

G. Gibson and SV Muse, A Primer of Genome Science, Second Edition – Sinauer Associates, Inc.

Plant and Animal Biotechnology

Scope: The course ensures critical understanding of fundamentals and the lab and will provide hands on laboratory exercise to learn and perform the essential techniques in Tissue culture.

UNIT –I: Introduction & Overview
Introduction & Historical Overview of Plant Tissue Culture, Totipotency, Growth & Cytodifferentiation of Cultured Plant Tissues Nutritional Media- Obligatory & Optional Constituents, Growth Regulators. Concept of sterilization and aseptic technique, Incubation Systems: Light & Dark, Static & Agitated, And Problems in Plant Tissue Culture: Contamination, Phenolics, Recalcitrance and Seasonal variation

UNIT – II: Micro Propagation and Secondary Metabolites
Homozygous Plant Production through Anther Culture. Callus & Suspension Culture Systems and Organogenesis: Direct & Indirect- Basic aspects, Somatic Embryogenesis, Somaclonal & Gametoclonal Variation. Plant Secondary Metabolites: Commercial Production using appropriate media supplements (Elicitors, Growth Factors, Stress Factors, Precursors, Anti-metabolites and Defense Proteins.

UNIT – III: Gene Transfer Techniques and Applications
Gene transfer methods (Direct and Indirect), current status and limitations. Agro bacterium mediated genetic transformation and application in crop improvement. Herbicide, stress and disease resistant plants and callus/cell line selection for resistance. Applications of Plant Tissue culture.

UNIT – IV: Animal cell culture
Basic requirements for animal cell culture; Cell culture media and reagents; Animal cell, tissue and organ cultures; Primary culture, secondary culture; Continuous cell lines; Suspension cultures; Somatic cell cloning and hybridization. Transfection and transformation of cells; Commercial scale production of animal cells; Stem cells and their application; Application of animal cell culture, for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture; Application of cell culture technology in production of human and animal vaccines and pharmaceutical proteins.

UNIT – V: Animal Reproductive Biotechnology
Culture of embryos; Micromanipulation of animal embryos; Cryopreservation of embryos; Embryo transfer; Embryo-splitting; Embryo sexing; Transgenic animal technology and its different applications; Animal viral vectors; Animal cloning- basic concepts; Cloning from embryonic cells and adult cells; Ethical, social and moral issues related to cloning. Introduction to animal genomics; Different methods for characterization of animal genomes, SNP, STR, QTLS, RFLP, RAPD, Genetic basis for disease resistance; Biocrimes and Bioterrorism.

Recommended textbooks:
1. Experiments in Plant Tissue Culture (Dodds, J.H. and Roberts, L.W.) 1985.
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Ed. Martin, Clynes Animal Cell Culture Techniques, Springer, 1998.
4. Plant Tissue Culture methods and application in agriculture (Thorpe, T.A.) 1981;

Reference books:
1. An Introduction to Plant Tissue Culture.MK Razdan.2nd Ed.2003. Oxford and IBH.
2. Plant Biotechnology by C.Chawla.2004.Oxford and IBH.
3. Animal Cell Biotechnology. Portner, 2nd Edition, Humana Press, 2007.
4. Plant Biotechnology and its applications in Plant tissue culture by Ashwani Kumar and Shikha Roy

PLANT AND ANIMAL BIOTECHNOLOGY LAB

(Perform minimum any 10 practicals at least 5 from each Lab)

Plant Biotechnology LAB

1. Preparatory techniques: Washing of *glassware*, dry and steam sterilization. Maintenance of aseptic conditions. Sterilization techniques.
2. Preparation of Media MS, B5
3. Selection, sterilization and inoculation of explants
4. Embryo culture
5. Callus induction
6. Organ culture
7. Micropropagation of commercially important crops.
8. Androgenesis: Anther culture
9. Isolation and culture of protoplasts and demonstration of Polyethyleneglycol mediated protoplast fusion
10. Agrobacterium mediated gene transfer, selection of transformants and reporter gene (GUS) assays.
11. Cell synchronization (determination of mitotic index and cell cycle time).

Animal Biotechnology Lab

1. Cell culture lab practices
2. Sterilization techniques for performing different animal tissue culture
3. Media preparation and standardization
1. Preparation of Whole mounts of 24 and 48 hrs, Chick/Koel embryos.
2. Preparation of single cell suspension from spleen and thymus
3. Cell counting and cell culture
4. Role of serum in cell culture
5. Primary culture of chick embryo fibroblast
6. Maintenance of cell line
7. Cryopreservation, reviving frozen cultures
8. MTT assay for cell viability and growth

Reference

1. Culture of Animal Cells: A Manual of Basic Technique by R. Ian Freshney
2. General Techniques of Cell Culture Handbooks in Practical Animal Cell Biology by Maureen A Journal articles and reviews

Immunotechnology

Scope: Principle aim of this paper is to interpret how Immunotechnology is useful for the public and its importance in human immune system. It emphasizes different strategies of Immunity to fight against various pathogenic diseases and tools for diagnosis. Different remedies in the development of vaccine technology.

UNIT –I: Cells and Lymphoid organs
Immune system overview, innate and acquired immune system. Components of immune system. Phagocytosis; Inflammation, opsonization. Primary and secondary lymphoid organs. Complement. B cell, T cell ontogeny. Characteristics of antigen, T cell dependent and independent antigens and Super antigens. Types and applications of Hapten and Adjuvant.

UNIT – II: Immune response
Generation of immune response - Primary and Secondary immune responses. Structure, functions of antibody and BCR.. Generation of Antibody diversity. TCR structure, δγTCR. MHC I and II gene, polymorphism. T helper, T cytotoxic cells. MHC peptide interaction. Antigen presentation, secondary signaling.

UNIT – III: Immunological disorders
Immunological disorders; Hypersensitivity and autoimmune diseases. Immune response to viral and bacterial lymphatic infection. Kinetics of immune response. Techniques in humoral and cellular immunology.

UNIT – IV: Immunotechnology
Animal models and transgenic animals and their use in immunology. Experimental immunology. Hybridoma technology. Chimeric antibodies, phage display, antibody engineering. Large scale manufacture of antibodies. Manufacturing of immunodiagnostics.

UNIT – V: Disease diagnosis and Vaccines
Concept of vaccination & Vaccine development. Strategies for development of vaccines against dreadful diseases – malaria, tuberculosis, HIV. Diagnostic tools and Kit development technology

Recommended textbooks:
1. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.
2. Janeway et al., Immunobiology, 4th Edition, Current Biology publications., 1999.

Reference books:
1. Brostoff J, Seaddin JK, Male D, Roitt IM., Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
2. Paul.W.E, Fundamental of Immunology, 4th edition, Lippencott Raven

BIOREACTOR MODELING AND SIMULATION

Scope: This paper deals with various mathematical models and their simulation methodologies with reference to Bioprocess, Biochemical engineering and fermentation technology. A few case studies also are incorporated in the paper for understanding of the subject.

UNIT – 1: Fundamentals of Modeling
Different approaches towards modeling, (Empirical and Modeling approach), applications and advantages of modeling and simulations, general flow diagrams for model building, simulation tools (Berkeley-Madonna, Mat Lab- Simu Link)

UNIT – II: Enzymes and growth kinetic models
Michaelis-Menten equation, graphical determination of Km and Vmax, Double Michaelis Menten kinetic model, inhibition models (Competitive, Non-Competitive, Uncompetitive, Deactivation Kinetics models) Monad growth kinetics model, equation for inhibition of growth, Product inhibition, , Teisser equation for growth, Contoin equation, Moses equation for growth models.

UNIT – III: Modeling of batch cultures
Unstructured growth models, structural kinetic model, metabolic models for batch cultures.

UNIT – IV: Product formation Kinetics
Product formation kinetic models, unstructured models, chemically structured models, genetically structured models.

UNIT – V: Case studies of simulations
Programme for simulation of Batch fermentation, continuous fermentation, steady state and fed batch fermentation.

Recommended textbooks:
1. Biological reaction Engineering- J.J.Dunn, E.Heinzle, J.Ingham, J.E.Presnosil Organic modeling fundamentals with simulation examples.
2. Biochemical Engineering fundamentals- James.E.Bailey and David.F.Ollis, Mc-Graw- Hill international Edition
3. Franks.R.G.E (1973), Modeling and simulation in chemical Engineering, Wiley, New York

Reference Books
1. Modeling and simulation in Biochemical Engineering. Adv, Biochemical Engineering, 3, 127-165
2. Hanm, B, Ruth. B (1997) Modeling dynamic biological systems, Springer-Verlag, New York.

BIOREACTOR MODELING AND SIMULATION LAB

1. Batch fermentation simulation
2. Modeling of a Chemostat fermentation
3. LB Plot modeling
4. Predator-Prey Population dynamics
5. Steady state Chemostat modeling
6. Fed batch fermentation Modeling
7. Continuous enzymatic reactor modeling
8. Aeration of tank reactor for enzymatic oxidation
9. Continuous production of PHB in a two tank reactor process
10. Simulation of estimation for KLa by static method

DOWNSTREAM PROCESSING

Scope: The aim of this paper is to provide the scientific Knowledge for isolation, purification and characterization of bioproducts from their mixed state or from biological systems. It is also emphasizes the merits and demerits while operating different instruments during the separation of Biomolecules.

UNIT-I: Down Stream Processing In Biotechnology

Overview of bioseparations, Characterization of Biomolecules, characterization of Bioprocess, characterization of fermentation broth: Morphology of cells, structure of the cell wall, product concentrations, Biomass density, Rheological Behavior of fermentation broth.

UNIT– II: Primary Separation And Recovery Processes

Recovery of intracellular products: Cell disruption methods-physical methods(osmotic shock, grinding with abrasives, solid shear, liquid shear) – chemical methods (alkali, detergents)- enzymatic methods. Removal of suspended solids: Foam separation, filtration. Filtration equipment, centrifugation, tubular bowl centrifuge, disk. Bowl centrifuge, basket centrifuge, scale up of centrifuges.

UNIT– III: Product Enrichment Operations

Membrane based separations – Classification & characteristics of membrane separation, merits of the process. Micro filtration, ultra filtration, Reverse osmosis, dialysis & electro dialysis. Selection of membrane, operational requirements of membrane. Retention coefficient, concentration factor, permeate yield & solid yield in membrane separation processes. Membrane modules: Plate & Frame, hollow fiber, spiral wound, shell & tube, cross flow micro filtration. Aqueous two-phase extraction process: Applications of aqueous two-phase extraction, reversed micelles extraction principle, micellar structures, critical micelle concentration. Protein solubilization, limitation of reversed micelles. Precipitations of proteins with salts and organic solvents, kinetics of protein aggregation.

UNIT– IV: Product Purification

Chromatographic Separations: Classification of chromatographic techniques, column chromatography, elusion frontal displacement techniques, partition coefficient, retention time and volume, capacity factor, column efficiency, design and scale up of chromatography. Principles & practices of Gel Filtration, Ion Exchange and Affinity chromatography.

UNIT – V: Alternative Separation Methods and Product Polishing

Super critical extraction: principles of SCE, Flow scheme of a simple SCE system. Formulation strategies: Importance of formulation, formulation of beakers yeast, Enzymes, formulation of pharmaceutical products. Polishing: Crystallization, Principles of crystallization and equipment. Principles of drying and lyophilization, Freeze dryer.

Recommended Textbooks

Butterworth and Heinmann. Product recovery in bioprocess Technology-Biotol series,
B.Siva Sankar Bioseperations

References Books:

Harvey Blanch. Biochemical Engineering
Christie J.Geankoplis., Transport processes and Unit operations

DOWN STREAM PROCESSING LAB

1. Extraction of proteins by Two-phase separation (PEG 3000 & Ammonium sulphate or Organic solvents)
2. Fractionation of proteins from Egg by Ammonium Sulphate Precipitation.
3. Desalting of Proteins by Dialysis ($CuSo_4$ + protein)
4. Isolation of Milk protein (Casein) by Iso-electric Precipitation.
5. Cell Disruption by Sonication and Enzymatic Reaction
6. Separation of proteins by Gel Filtration
7. Separation of Plant pigments by Adsorption Chromatography.
8. Separation of charged biomolecules by Ion Exchange Chromatography
9. Separation of proteins by Native/SDS Gel Electrophoresis (SDS PAGE)
10. Extraction and isolation of Enzymes from microbial cultures.
11. Separation of proteins by Affinity Chromatography
12. Separation of Biomolecules by High Pressure Liquid Chromatography
13. Separation of Volatile compounds by Gas Chromatography
14. Crystallization of pure protein.
15. Separation of proteins by Tube Gel Electrophoresis.

Recommended laboratory manuals:

1. Handbook of Downstream Processing By Goldberg, Elliott, Chapman & Hall publishers

PROTEIN ENGINEERING

Scope: Protein engineering is the process of developing useful or valuable proteins. It is a young discipline, with much research currently taking place into the understanding of protein folding and protein recognition for protein design principles.

UNIT-I: Protein Engineering

Methods of protein isolation, purification, detection, quantitation and characterization. Study of protein structure and organization. Solid phase peptide synthesis, use of peptides in biology, examples of engineered proteins, protein design with examples.

UNIT – II: Structure & Functional Relationship Of Proteins

Structural characteristics of DNA binding proteins, prokaryotic and Eukaryotic transcription factors. DNA polymerases, Bacteriorhodopsin, epidermal growth factors, insulin and PDGF receptors and their interaction effectors, protein phosphorylation, Immunoglobulins, nucleotide binding proteins, serine proteases, Ribonuclease, Lysozyme.

UNIT-III: Protein Folding

Chaperons in protein folding, types of chaperons. Non-covalent forces in protein folding, Structural Dynamics of proteins, Protein folding models, Denaturation of proteins, Protein degradation and turn over; ATP dependent proteolysis, intracellular digestion of proteins in Lysosomes.

UNIT-IV: Protein Targeting

Introduction, Methods in targeting, translocation and transport. Signal sequences, Signal Recognition Particle, Protein export in bacteria, Protein modification and targeting. Protein targeting in Bacterial system. Protein targeting in Endoplasmic Reticulum, Mitochondria and Chloroplast.

UNIT-V: Protein Techniques

Solution properties of proteins, Protein fragmentation, Peptide sequence determination, Protein hydration, Conformational stability of proteins, Recombinant protein, Fusion proteins, Modification of proteins, Protein labeling, Peptide mapping.

Recommended Textbooks:

1. L. Stryer by Biochemistry, 5th edition Freeman – Toppan publications.
2. TM Devlin, Textbook of Biochemistry with clinical correlations, 6th edition with human molecular genetics. John Wiley and Sons, Inc.

Reference textbooks:

1. Moody P C E and A J Wilkinson. Protein Engineering. IRL Press.
2. Creighton T E, Proteins. Freeman W H. Second edition 1993.

ENZYME TECHNOLOGY

Scope: The principle aim of this paper is to explain the importance of Enzyme in the daily life and various methods of large-scale production of enzymes in the industry. It also emphasizes the production and making of tailor-made enzymes for medical, agricultural, and industrial purpose.

UNIT–1: Introduction to enzyme technology

Source of enzymes; Production, isolation and purification of enzymes; Characterization in terms of pH, temperature, ionic strength, substrate and product tolerance, effects of metal ions etc.; Various production methods for commercial enzymes; Large scale production of enzymes. Production of recombinant proteins (Insulin, Interleukin, Interferon); Important commercial enzymes; Amylases; Proteases; Lipases; Cellulases.

UNIT–II: Enzyme Kinetics

Michaelis-Menten equation, alterations and significance. General mechanisms of enzyme regulation, Types of inhibition; Irreversible inhibition (proteases), Reversible (glutamine synthase & phosphorylase), competitive inhibition, Non & Un-competitive, mixed inhibition, and substrate & product.inhibition; Allosteric enzymes, qualitative description of concerted & sequential models for allosteric enzymes. Allo-steric regulation of enzymes; Deactivation kinetics. Feed back inhibition and feed forward stimulation. Half site reactivity, Flipflop mechanism, positive and negative co-operativity with special reference to aspartate transcarbamoylase. Protein-ligand binding measurement, analysis of binding isotherms, Hill and Scatchard plots.

UNIT–1II: Enzyme Engineering

Enzymes as biological catalysts; Active site, Functional group, Enzyme substrate complex, Cofactors; Acidbase
catalysis, covalent catalysis, proximity, orientation effect. Strain & distortion theory. Chemical modification of active site groups. Random and rational approach of protein engineering; Directed evolution and its applications in the field of biocatalysis; Various approaches of creating variant enzyme molecules; Site directed mutagenesis of enzymes. Mechanism of action of chymotrypsin, lysozyme, carboxypeptidase and alcohol dehydrogenase.

UNIT–1V: Enzyme immobilization and applications

Introduction to enzyme immobilization; various immobilization methods; physical and chemical techniques for enzyme immobilization – adsorption; Matrix entrapment, encapsulation; Cross-linking; Covalent binding; Medical and analytical applications of immobilized enzymes; Design of enzyme electrode & their application in clinical diagnostics. Role of enzymes in recombinant DNA technology; Enzymes for diagnostic and analytical purposes. Use of enzymes in analysis-types of sensing-gadgetry and methods. Case studies on application – chiral conversion, esterification.

UNIT–V: Mass transfer effects in immobilized systems

Analysis of Film and Pore Diffusion Effects on kinetics of Immobilized Enzyme Reactions; Calculations of diffusional resistances and Thiele's modulus; Multi step immobilized enzyme systems; Solutions of numerical problems; Application and future of immobilized enzyme technology. Concentration gradients and Reaction rates in solid catalysts; Internal mass transfer and reaction; Steady state Shell Mass balance; Formulation of dimensionless groups and calculation of Effectiveness factors

Recommended Textbooks;

1. Nelson and Cox, Principles of Biochemistry, 4th Edition, W. H. Freeman, 2004.
2. J. Rehm and G. Reed, Enzyme Technology, Vol. 7a, VCH-Verlag.
3. Trevor Palmer: ENZYMES – Biochemistry, Biotechnology, Clinical chemistry. Horwood Publishing Ltd. Affiliated East – West Press Pvt. Ltd. New Delhi.

Reference Text Books:

1. Biotol Series (This series has many volumes pertaining to different subjects including white, red, blue and green biotechnology).

ENVIRONMENTAL BIOTECHNOLOGY

Scope: The main objective of this paper to explain the role of Biotechnology in protection of environment from different natural calamities and pollutants. This paper in detail addresses the problems, the root causes and the biotechnological remedies to sustain the natural environment.

Unit – I: Environmental Pollution

Types, Environmental pollution (water, soil, air), Noise & Thermal pollution, sources, and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Biotechnology for hazardous waste management, persistent organic pollutants, Xenobiotics, biological detoxification of pH. Removal of oil spills. Environmental monitoring. Bioremediation – solid & liquid waste treatment.

Unit-II: Water Pollution

Water Quality modeling for streams. Water pollution and its control, wastewater treatment – Biological processes for Industrial and domestic effluents treatments, Aerobic and non-aerobic Biological treatment. Role of Biotechnology in water purification systems. (Primary, secondary and tertiary treatments)

Unit-1II: Air Pollution

Source of air, water and solid wastes. Micrometeorology and dispersion of pollutants in Environment. Centrifugal collectors, Electrostatics, precipitator, bag filters and wet scrubbers. Design and efficiencies. Combustion generated pollution mine drainages, vehicle emission control. Case studies – Bio techniques for Air pollution control.

Unit – IV: Microbe-Metal Interaction

Heavy metal pollution and impact on environment Bioleaching Microbial systems for heavy metal accumulation, Biosorption, molecular mechanism of heavy metal tolerance, role of microbes in synthesis of nanoparticles.

Unit – V: Environment & Energy

Renewable sources of energy – Biogas, waste material, energy crops, cellulose. Bio-fuels & Bio diesel using microorganisms. Global Environmental problems. Ozone depletion, UV-B, Green house effect. National policy on environment..

Recommended textbooks:

1. T. Srinivas, Environmental Biotechnology, New-Age Publications, New Delhi (2008)
2. Bru E. Rittmann and Perry L.Mc Carty, Environmental Biotechnology: Principles and Applications, Mc Graw Hill Company (2001)

Reference textbooks:

1. Howard S. Peavy, Donal R. Rowe and George Tchobanoglous, Environmental Engineering, Mc Graw Hill Company (1985)

BIOPROCESS VALIDATION & CGMP

Scope: The objective of the paper is to strengthen the concepts and requirements necessary for compliance with Good Manufacturing Practice (GMP) for professionals in the areas of pharmaceutical and biopharmaceutical subject. It emphasizes the quality assurance and standard operating procedures for various bioprocesses.

UNIT– I: Bioprocess Validations

Validations – Methods of validation. Prerequisites, process design & testing process characterization, Process optimization, Validation options, Prospective process validation, retrospective validations, Concurrent validations, Revalidation, Organizing Revalidation studies, Analytical method validations, Cleaning validation, Prevalidation verification, Documentation, Control of cleaning materials & ancillary tools, Frequency of cleaning, Development of validation protocol.

UNIT– II: Quality Assurance

Quality Assurance, Quality control, Quality management, Responsibilities of quality management in laboratories, Development of quality records, Deviations of quality product process, Good laboratory practices, Responsibilities in GLP, Computational processes in GLP.

UNIT– III: Standard Operating Procedures

Standard operating procedures, SOP of immunological industries, SOP of tissue culture, Deviations of SOP, Revision occurrence in SOP, Authorized control of SOP, Guidelines and regulation of FDA and ICH for GLP.

UNIT– IV: Good Manufacturing Practices

Quality control of a product, Good manufacturing practices, cGMP, GMP of industries, Sanitation & Hygiene, Control of finished products, Maintenance of materials in laboratories, Zero contamination, Documentation of GMP, Compliance of GMP.

UNIT–V: Clinical Practices Of GMP

Clinical practices in laboratories, Clinical practices in vaccine production, Clean room, Class A, B (USFDA), Bacterial counts in clean room, Waste disposal in laboratories, Health & hygiene of persons involved in clinical laboratories. ICH guidelines for clinical laboratories.

Recommended Textbooks:

1. P. P. Sharma,How to Practice GMP’s
2. ICH Guidelines – USFDA Hand book

Reference textbook:

1. J. Seiler,Good Laboratory Practices

TRANSPORT PHENOMENON IN BIOPROCESS

Unit-I: Introduction to transport phenomena

Three levels of transport process, conservation laws, Basic laws governing momentum, heat and mass transport, pressure and temperature dependence on viscosity, thermal conductivity and mass diffusivity, Molecular theories of viscosity, thermal conductivity and mass diffusivity under different condition, Introduction to convective transport process

Unit-II: Shell balances for momentum, mass and energy

Flow of a falling film, flow through a circular tube, flow through annulus, heat conduction with electrical, nuclear and chemical heat, heat conduction in a fin, diffusion through a stagnant gas film, diffusion with homogeneous and heterogeneous chemical reaction, diffusion and reaction in a porous catalyst, Forced convective momentum, heat and mass transport process

Unit-III: Transport process under turbulent conditions

Equations of change for isothermal and non-isothermal conditions, unsteady state momentum, heat and mass transport process, Velocity distribution in turbulent flow, time smoothed equation of change, turbulent flow in ducts, unsteady state heat conduction, temperature distribution for turbulent flow in tubes, jets and at large Prandtl number, concentration distribution in turbulent flow

Unit-IV: Interphase transport process

Definition of friction factors, friction factors for flow in tubes and pressure drop calculations, heat transfer coefficients, heat transfer coefficient for free and forced convection, analytical calculations of heat transfer, mass transfer coefficient, mass transfer coefficient in single and two phase system, mass transfer with chemical reactions

Unit-V: Macroscopic balances and other mechanisms of transport

Macroscopic balances for steady and unsteady state balances in momentum, heat and mass transport. Heat transfer by radiation, radiation between nonblack bodies at different temperatures, mass transport during centrifugation of proteins, diffusion of salts in aqueous solution, mass transport across permeable membranes, mass transport in porous media

Recommended Textbook:

1. R. B. Bird. W.E. Stewart and E.N. Lightfoor, Transport Phenomenoa Wiley II edition, India.

Reference books:

2. D.G.Rao, Introduction to Biochemical Engineering, Tata Mc Hill (2005)
3. Paul M. Doran, Bioprocess Engineering Principles Academic press (1995).
4. J E Bailey and D F Ollis, “Biochemical Engineering fundamentals “2nd edition Mc Graw-Hill (1986).
5. S Aiba, A E Humphrey and N Millis, “Biochemical Engineering” Prentice- Hall (1978).
6. Michaeln L shuler and F Kargi,Bio process Engineering : Basic concepts” 2nd ed., Prentice Hall of India (2003).

STEM CELL TECHNOLOGY

Unit – I: Introduction

What are stem cells, types, origin and nature of stem cells? Characteristic features, pluripotent stem cells and its types, Molecular basis of pluripotency. Cell surface markers of stem cells. Embryonic stem cells, factors requirements for maintain stem cells. Differences between human and mouse stem cells. Development of epithelial stem cell concept. Stem cell niches.

Unit – II: Stem cell characterization

Cell cycle regulation in stem cell. Mechanism of stem cell renewal, Changes of phenotypic characters, Characterization of human embryonic stem cells, Isolation and maintenance of Stem cell. Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells. Surface antigenic markers, lineage marking, Genomic reprogramming. Microarray analysis of stem cells & differentiation. Zebra fish and Stem cell research.

Unit – III: Tissue engineering

Neural stem cells and applications in neurodegenerative diseases, Treatment of heart diseases, diabetes, burns & skin ulcers, muscular dystrophy, regeneration of epidermis, orthopedic applications. Embryonic applications in tissue engineering. Novel sources of multipotent stem cells. Adult stem cells, Stem cell gene therapy.

Unit - IV: Biopharming

What is biopharming? Applications of stem cell technology in animal biotechnology. Production of artificial organs using stem cell technology. Artificial pancreas, kidney, heart, liver etc.

Unit – V: Regulations and Ethics

Ethics of human cell research-immortal cells and moral selves, Ethical considerations, stem cell based therapies. FDA products and preclinical regulatory considerations. Patent advocacy, Science policies, ethics in stem cell research, primordial germ cells and germ cell development epigenetics and reprogramming in stem cell biology, norms in clean room.

Books recommended:

1. Rober Lanza, Essentials of Stem cell biology, Elsevier academic press, 2009
2. Joseph D. Bronzino Tissue engineering and artificial organs, Biomedical engineering hand book. volume -2, 3rd edition, CRC press, Taylor & Francis publications, 2006

Reference book:

1. Daniel R. Marshak, Stem Cell Biology, *Johns Hopkins University and Cambrex Corp.;* Richard L. Gardner, *University of Oxford;* David Gottlieb, *Washington University, St. Louis*, 2001.

BIOMINING

(Data mining & Computing Techniques in Bioinformatics)

UNIT-I: Introduction to Data mining

Introduction to Data mining- methods- selection & sampling- Preprocessing and cleaning- Transformation & reduction- Data mining methods- Evaluation- visualization

Unit-II: Text mining

Overview on text mining- Natural Language Processing -Text summarization –tools- Applications of Data Mining

Unit-III: Introduction to Genetic Algorithms

Introduction to Genetic Algorithm, Genetic Operators and Parameters, Genetic Algorithmsin Problem Solving, Theoretical Foundations of Genetic Algorithms, Implementation issues

Unit-IV: Neural Network

Neural Model and Network Architectures, Perceptron Learning, Supervised HebbianLearning, Backpropagation, Associative Learning, Competitive Networks, Hopfield-Network, Computing with Neural Nets and Applications of Neural Network

Unit-V: Introduction to Fuzzy Sets

Introduction to Fuzzy Sets, Operations on Fuzzy sets, Fuzzy Relations, Fuzzy Measures,Applications of Fuzzy Set Theory to different branches of Science and Engineering

Recommended textbooks:

1. Mitchell, M., 1998 An Introduction to Genetic Algorithms, Prentice-Hall.
2. Lau C., (Ed), 1992, Neural Networks, IEEE Press.

Reference textbooks:

1. Freeman, J. and Skapura, D., 1991 Neural Networks: Algorithms, Applications, andProgramming Techniques, Addison-Wesley.
2. Klir, G.J. and Folger, T.A., 1988, Fuzzy Sets, Uncertainty, and Information, PHI.

MOLECULAR MODELLING AND DRUG DESIGN

Scope: The paper on molecular modeling and drug design imparts student technical information of computer simulations and molecular dynamics to evaluate the new drugs designed.

UNIT – I: Empirical Force Fields And Molecular Mechanisms

Models, Approximations and Reality, Force Field concepts and Mathematical Expressions, Molecular Mechanical and Quantum Mechanical Force Fields, Parameterization, Generation of Potential energy surfaces. Bond Stretching, Angle bending, Torsional I terms, Out of plane, Bonding Motions, Electrostatic interactions, Vander Walls interactions, Effective pair potentials, Hydrogen Bonding, Simulation of liquid water.

UNIT – II: Computer Simulation Methods

Time averages, Ensemble averages, Free energy methods, Thermo dynamic Perturbation Methods, Thermodynamic Integration Methods. Calculation of thermodynamics properties. Phase space; Practical aspects of computer simulation; Boundaries monitoring Equilibrium; Long range process; Analyzing results of simulation and estimation errors.

UNIT – III: Molecular Dynamics Simulation Methods

Molecular Dynamics using simple modules; Molecular Dynamics with continuous potentials; Running Molecular Dynamics Simulation; Constant Dynamics; Time dependent properties; Molecular Dynamics at constant temperature and pressure.

UNIT – IV: Monte Carlo Simulation Methods

Metropolis methods; Monte Carlo simulation of molecules; Monte Carlo simulation of Polymers; Calculating Chemical potentials; Monte Carlo simulation and molecular dynamics.

UNIT – V: Molecular Modeling In Drug Discovery

Molecular modeling in drug discovery-Deriving and using 3D Pharma cores, Molecular docking Structure Based methods to identify lead components-Denovo ligand design. QSARs and QSPRs, QSAR Methodology, Various Descriptors used in QSARs: Electronic; Topology; Quantum Chemical based Descriptors

Recommended textbooks:

1. Molecular Modeling Principles and Applications- AR Leach, Longman, 1996.
2. Molecular Dynamics Simulation-Elementary Methods- John Wiley and Sons, 1997.

Reference textbooks:

1. Current Protocols in Protein Science, Wiley Publishers, 2005; Deuflhard P., et al. Computational molecular dynamics - Challenges, methods, ideas.(Springer,1999)

PERL PROGRAMMING AND BIOPERL

(Principles of Bio-programming)

UNIT-I: An Introduction to Perl & Variables and Data Types

The Perl Interpreter - Perl Variables -Scalar Values-Variable Definition -Special Variables

UNIT-II: Arrays and Hashes

Arrays-Array Manipulation -Push and Pop, Shift and Unshift –Splice-Other Useful Array Functions-List and Scalar Context -Hashes -Maintaining a Hash

UNIT-III: Control Structures & String Manipulation

Comparisons Choices- If - Boolean Operators- Else-Loops-For Loops -Foreach Loops 52. Indeterminate Loops -While -Repeat Until -Loop Exits -Last - Next and Continue -Array-Based Character Manipulation -Regular Expressions –Match-Substitute - Translate

UNIT-IV: Input and Output

Program Parameters -File I/O -Filehandles- Working with Files -Built-in File Handles -File Safety - The Input Operator –Binary- Interprocess Communications – Processes- Process Pipes-Creating Processes - Monitoring Processes

UNIT-V: Bioperl

Sequences -SeqFeature – Annotation-Sequence - Example Bioperl Programs

Recommended text books:

1. Beginning Perl for Bioinformatics, James Tisdall, O'Reilly Publishers
2. Jamison D. ,Perl Programming for Biologists,Wiley publishers

Reference text books:

1. Introduction to computers, Peter Norton, Tata Mc Graw Hill publishers

BIOPROCESS TECHNOLOGY

Unit-1: Introduction

Isolation and screening of industrially important microbes. Strain improvement – mutation and recombination. Substrates for industrial fermentation.

Unit-II: Fermentation technology

Concepts of basic modes of fermentation - Batch, Fed batch and Continuous fermentation. Bioreactor designs, Media formulation. Air and media sterilization, Aeration & agitation in bioprocess.

Unit-III: Bioprocess control and monitoring

Bioprocess control and monitoring variables such as temperature, pH, agitation, pressure, online measurement, on / off control, PID control, computers in bioprocess control system.

Unit-IV: Downstream processing

Downstream processing – Filtration, Centrifugation, cell disruption, chromatography, Liquid – liquid extraction, membrane process, drying crystallization, broth processing. Effluent treatment – disposal, treatment process, by- products. Fermentation economics, Bioprocess for the production of amino acids, organic acids, nucleotides, nucleosides and related compounds,

Unit-V: Bioproducts

Bioprocess for the production of enzymes, vitamins, antibiotics and SCP. Immobilization of enzymes and microbial cells.

Recommended Textbooks:

1. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology & Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.

REFERENCE BOOKS:

3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker & S.J. Hall(1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York..
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.

FOOD TECHNOLOGY

Scope: The objective of the paper is to make the student to understand various aspects of Food processing and preservation. The role of various microorganisms and food storage techniques are discussed in detail.

Unit – I: Food associated Microbes

History of microorganisms in food, historical developments. Biotechnology in relation to the food industry, nutritive value of food, types of microorganism's associated with food, its sources, types and behavior in foods. Role and significance of microorganisms in food. Intrinsic and extrinsic parameters of foods that affect microbial growth.

Unit – II: Food processing

Bioprocessing of meat, fisheries, vegetables, diary product, enzymes and chemicals used in food processing, biochemical engineering for flavour and food productions. Emerging processing and preservation technologies for milk and dairy products.

Unit – III: Food preservation

Food preservation using irradiation, Characteristics of Radiations of interest in food preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation. Application of radiation, Radappertization, Radicidation, and Radurization of foods. Legal status of food irradiation. Effect of irradiation of food constituents.

Unit – IV: Storage of foods

Stability of food preservation with low temperatures, high temperatures, drying. Indicator and food borne pathogens. Food borne illness, quality control, HFCS (High Fructose Corn Syrup) and mycoproteins. Air sampling, metabolically injured organisms, enumeration and detection of foodborne
organisms.

Unit – V: Food microbiology

Utilization of microorganisms in food industries, genetic manipulations. Thermophiles and Radiation-resistant microorganisms, characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorganisms. Rheology of food production.

Recommended textbooks:

1. Lidsay, Willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science. 1988.
2. Food Science and Food Biotechnology by F.F.G. Lopez & G.V. B. Canovas (2003), CRC Press, Florida, USA.

Reference Books:

1. George J.B. Basic Food Microbilogy, CBS Publishers & Distributors, 1987.
2. Roger, A., Gordan B., and John T. Food Biotechnology, 1989.

NANOTECHNOLOGY

Unit–I: Introduction to nanotechnology

Definition of nanoscale with reference to physics and bio-systems. Crystal Structure, Unit Cells, Bravais Lattices, Crystallographic Directions, Crystallographic Planes, Miller Indices, Bragg's Law, Single Crystal and Powder X-ray Diffraction. **Types of Material -**Different types of materials: Metals, Semiconductors, Composite materials, Ceramics, Alloys, Polymers and Bio Polymer composites. **Imperfections in solids -** Imperfections of crystal structure: point defects, Grain boundaries, phase boundaries, Screw & Edge Dislocations.

Unit–II: Nano materials and synthesis

Nano material Synthesis: Top-Down Approach. **Physical methods** - Inert gas condensation, aerosol method, Arc discharge, RF-plasma technique, laser ablation, Spray Pyrolysis, Ball Milling. **Bottom-up approach - Chemical Methods -** Metal nanocrystals by reduction, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Sonochemical routes, Solvated metal atom dispersion, Sol- gel technique.

Unit –III: **Characterization of Nano materials by Spectroscopic techniques**

Introduction to microscope, optical microscope, Optical absorption spectrometer, UV-Vis-NIR spectrometer, x-ray Diffraction, Scanning electron microscopy, scanning probe microscopy, scanning tunneling microscope and transmission electron microscopy.

Unit–IV: **Mechanical & Optical properties**

Mechanical properties of nano materials, structural properties of nano materials, melting of nano materials, electrical conductivity, optical properties of nano structured metals and semiconductors.

Unit–V: CNT's

Introduction to carbon nano tubes, types of carbon nanotubes, synthesis, growth mechanism, Nano lithography, lithography using photons, lithography using paticle beams, scnaning probe lithography, soft lithography. Nano sensors, Carbon nano tube applications

Recommended text books:

1. Carl.C.Koch, "Nanostructured materials, processing, properties and applications, NFL publications, 2007.
2. Hari Singh Nalwa – Handbook of nanostructured materials and nanotechnology: Synthesis and processing, ASP,2004.
2. Stephen Elliott & S. R. Elliott The Physics and Chemistry of Solids, John Wiley & Sons, 1998.

Recommended Reference:

1. Charles Kittel, Introduction to Solid State Physics, John Wiley & Sons, 2004
2. Van Vlack, Elements materials science, Addison-Wesley, 1964
3. Zhong Lin Wang, *"Characterization of Nanophase Materials"*, Wiley-VCH, 2001
4. T.J.Chung, P.M. Anderson, M.K.Wu and S.Hsieh, "Nanomechanics of materials and structures, Springer, 2006.
5. Jackie Ying. Ed "*Nanostructured Materials",* Academic Press, 2001. A small edited volume with some good articles on some specialized topics such as adsorption in nanoporous materials
6. R. Haynes, "Optical Microscopy of Materials, International Textbook Company, Glascow, 1984.
7. John J. Bozzola and Lonnie D. Russel, "Electron Microscopy", Jones and Bartlett Publishers Inc., USA, 1999.
8. YIP-WAH-CHUNG, "Practical Guide to Surface Science & Spectroscopy", Academic Press, 2001.
9. Christopher Hammond, "The Basics of Crystallography, II edition, Oxford Univ. Press, (2001).
10. D. P. Woodruff and T. A. Delchar, "Modern Techniques of Surface Science", Cambridge Solid State Science Series, 1994.

MICROALGAL BIOTECHNOLOGY

To be compiled

Unit – I:

Unit –II:
Algal Biotechnology: Microalgae - indoor and mass culture methods, biotechnological approaches for production of important microalgae, single cell protein from Spirulina, raceway system of micro algae culture, vitamins, minerals and omega3 fatty acids from micro algae, enrichment of micro algae with micronutrients.

Unit – III:
The Algal Industry Survey, Prospective in Diatom Nanotechnology, Programmed Cell Death: An Integral Event in the Development of Algae and Higher Organisms, Spirulina: The Superfood and Medicine. Application of Seaweeds as Food: A Scenario, UV-B Radiation-Induced Stress and Protection Strategies in Cyanobacteria. Growth Response of Cyanobacteria from Sandy Soil and Mine Waste Burdened Soil to Different Environmental Variables.

Unit – IV:
Applications of microalgae: The Impact of Fungicides on Rice Field Cyanobacteria, Role of Blue Green Algae in Rice Production, Biotechnological Relevance of Microbes in Agriculture, Lipids and Fatty Acids from Marine Algae: A Potential Biofuel Resource, Algal Biodiesel: Procedures and Resources for Laboratory Study. Industrial Utilization of Algal Fatty Acids. Cyanobacterial Toxins, Algae and the Human Affairs in the 21$_{st}$ Century, Responses of Rice Field Cyanobacteria to Insecticides, Cyanobacterial Toxins and Public Health

Unit – V:
Biofertilizers and pesticides: Cyanobacteria for Biofertilizer, Bioremediation and Bioactive Compounds Production of Nutraceuticals and Antioxidant Enzymes in a Tropical Food Alga Nostochopsis lobatus Bioremediation of Heavy Metals.

INTELLECTUAL PROPERTY RIGHTS AND PATENT LAWS

Scope: This paper deals with various intellectual property rights and patenting laws. It emphasizes the need for understanding these legal rights and laws very clearly.

UNIT-I: Intellectual Property Rights

Patents and intellectual property rights (IPR): Definition, History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures.

Unit-II: Priciples, Scope And Functions Of GATT&WTO

GATT- Historical perspective, objectives and fundamental principles, impact on developing countries. WTO-Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India-tasks and challenges.

Unit-III: Regulatory Affairs

Indian contest-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M,U & Y. Related quality systems-objectives and guidelines of USFDA,WHO & ICH; Introduction to ISO series.

UNIT-IV: Documentation And Protocols

Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation.

UNIT-V: Case Studies On Patents

Case Studies on - Patents (Basumati rice, turmeric, Neem, etc.)

Recommended Textbooks:

1. S. H. Willing, Good manufacturing practices for Pharmaceuticals

Reference textbooks:

1. P. Das & Gokul Das, Protection of Industrial property Rights.

REGULATORY AFFAIRS AND CLINICAL TRIALS

Scope: The objective of this paper is to impart students, knowledge of clinical trails - the methodology of checking the efficacy of the products developed. It also deals with the regulatory affairs and the ethical principles involved in doing drug & vaccine clinical trails.

UNIT-I: Basics And Features Of Clinical Trails

What is clinical trail - Need, Types and phases of clinical trails, Benefits and Risks in clinical trails: Team involved in a clinical trail: Features and essential components of clinical trails: Good clinical trail practices:

UNIT-II: Patent Requirement And Clinical Trail Statistic

Stages in patent recruitment: Recruitment evidence. Challenges in patent recruitment, Research methodology, Primary and secondary outcomes: Subgroup analysis, Checklists

UNIT –III: Design Of Experiments And Role Of It In Clinical Trails

Design configuration, Multicenter trails, Types of comparison: Group sequential designs, Sample size, Data capture and processing: Role of IT in clinical trails: Clinical trail team

UNIT- IV: Clinical Trail Regulatory Affairs

The history of clinical testing and its regulation, Clinical trail regulation, Good clinical trail guidance-The Indian scenario, Essential standards for performing clinical trails, Good clinical practice, Institutional ethics committee, General ethical principles, Specific ethical principles, The guidelines for drug trails, Phase wise guidelines for clinical trails, Guidelines for vaccine trails, Essential documents.

UNIT-V: Clinical Trail Business Environment

Basic components of clinical trails budgets, Clinical trail Industry, Economic challenges faced by Pharmaceutical companies, India as a place for conducting clinical trails. Indian/USA/EU ethics approval system.

Recommended Textbooks:

1. Good Clinical practices,Central Drugs Standard Control organization,Govt.of India
2. Drugs and cosmetics Act,1940.

Reference Books:

1. International Clinical Trail, Volume 1 & 2 Dominique P.brunier and Nahler, Interpham press, Denver, Colorado.
2. Code of Federal Regulation by USFDA-Download.

BIOPROCESS ECONOMICS AND PLANT DESIGN

Scope: The objective of this paper is to study, the design of bioreactors involved in biotechnological
applications and also stress upon the principless of chemical engineering in bioprocesses. The paper also discusses the economic aspects associated with the construction and design of a bioreactor.

UNIT – I: Economic evaluation

Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis.

UNIT – II: Bioprocess Economics

Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates – Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein.

UNIT – III: Introduction to process design

Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out.

UNIT – IV: Basic considerations in equipment design

General design procedure, equipment classification, materials of construction-Mechanical propertiesstrength,
elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals,
types of iron & steels, Nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials. Design conventions.

UNIT-V: Basic Design Problems

Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermentor construction. Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Design exercise on trickle flow fermenter. Problems associated with design equations.

Recommended Text Books:

1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers –
2. M V Joshi & V V Mahajani, Process equipment design
3. Robin smith, Chemical process design and integration

Reference books:

1. Harvey W Blanch, Biochemical Engineering
2. S.K. Hazra and choudary, Material Science & Processes

GENOMICS AND PROTEOMICS

Scope: The primary aim of this course is to impart student's basic principles of genomics and proteomics. Emphasizes will be placed on a theoretical and experimental approaches to learning the basics of genome structure and function through the use and application of mathematics and bioinformatics tools developed from advances in the human genome project. It also discusses the human genome and proteome projects and their ramifications in health and disease.

UNIT–I: Organization of genome and its mapping

Organization and structure of genomes, Genome Mapping - Construction of genomic libraries, mapping strategies and techniques. Human Genome Project, Genomes of other organisms. Principles of gene expression; Global analysis of gene expression.

UNIT–II: Structural and Functional genomics

Comparative genomics: protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison. Functional Genomics, Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development.

UNIT–III: Microarrays and gene therapy

Whole genome analysis of mRNA and protein expression, micro array analysis, types of micro arrays and applications. Gene Therapy: New Targets for drug discovery. Knockout mice, Role of animal models in identification of genes for disorders.

UNIT –IV: Proteomics

Principles of separation of Bio-molecules, Anfinsen's experiments, diagonal electrophoresis, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks – Topology, Network motifs, Protein Expression profiling, Protein Biochips, Applications of Proteomics and Protein arrays.

UNIT –V: Yeast two hybrid systems

Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighborhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Recommended Text Books:

1. S.Sahai, Genomics and Proteomics, " Functional an Computational Aspects ", Pienum Publications, 1999.
2. Moody P C E and A J Wilkinson. Protein Engineering. IRL Press.

Reference Books:

1. Molecular Biology by Watson *et al*
2. Creighton T E, Proteins. Freeman W H. Second edition 1993.

MEDICAL BIOTECHNOLOGY

Unit – I: Introduction to medical technology

Introduction and applications of medical Biotechnology. Artificial organs – methods and production principles. Artificial pancreas, Liver and Heart. Therapeutic proteins: Production of interferons, cytokinins, insulin etc.

Unit – II: Medical diagnosis

Immunodiagnostic techniques: monoclonal antibodies production as diagnostic reagents; Diagnosis by ELISA and Western blot. DNA sequencing and diagnosis. PCR and Array based techniques in diagnosis; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; ethics in Molecular Diagnosis

Unit: III – Gene transfer technology

Gene therapy; Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy , Retro and adeno virus mediated gene transfer. Liposome and nanoparticles mediated gene delivery Cellular therapy.

Unit: IV – Stem cell technology

Stem cells; definition, properties and potency of stem cells; Sources; embryonic and adult stem cells; Concept of tissue engineering; Role of scaffolds; Role of growth factors; Role of adult and embryonic stem cells. Clinical applications; Ethical issues.

Unit – V: Hybridoma technology

Hybridoma techniques and monoclonal antibody production. Production, purification, characterization and applications of monoclonal antibodies. Antibody engineering – chimeric antibody, diabody.

Recommended text books (Latest Edition);

1. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002

2. Pratibha Nallari, V. Venugopal Rao; Medical Biotechnology, oxford University press, 2010.

Reference text books:

1. James W. Goding , Monoclonal antibodies; Principles and Practice , 3rd Edition , Academic Press 1996

2. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition , Academic Press, 2005

3. Lela Buchingham and Maribeth L Flawsm , Molecular Diagnostics; Fundamentals, Methods and Clinical Application , 1st Edition F.A. Davis Company Philadelphia USA, 2007.