

BIO -TECHNOLOGY
[SPECILISATION CODE: 02]

PAPER I
(Choose Any ONE Subject)

S. NO	SUBJECT NAME	SUBJECTCODE
1.	ANIMAL CELL SCIENCE AND TECHNOLOGY	R50201
2.	BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES	R50202
3.	BIOLOGY OF THE IMMUNE SYSTEM	R50203
4.	ENVIRONMENTAL BIOTECHNOLOGY	R50204
5.	ENZYME TECHNOLOGY	R50205
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7.	GENETIC ENGINEERING	R50207
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10.	PROCESS ENGINEERING PRINCIPLES	R50210

BIO –TECHNOLOGY
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PAPER II
(Choose Any ONE Subject)

S. NO	SUBJECT NAME	SUBJECT CODE
1.	BIOCHEMISTRY AND METABOLIC REGULATION	R50252
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ANIMAL CELL SCIENCE AND TECHNOLOGY

Theory

1. Structure and organization of animal cell
2. Equipments and materials for animal cell culture technology
3. Primary and established cell line cultures
4. Introduction to the balanced salt solutions and simple growth medium, Brief discussion on the chemical, physical and metabolic functions of different constituents of culture medium. Role of carbon dioxide. Role of serum and supplements.
5. Serum & protein free defined media and their application.
6. Measurement of viability and cytotoxicity.
7. Biology and characterization of the cultured cells, measuring parameters of growth.
8. Basic techniques of mammalian cell culture *in vitro*; disaggregation of tissue and primary culture, maintenance of cell culture; cell separation.
9. Scaling-up of animal cell culture.
10. Cell synchronization.
11. Cell cloning and micromanipulation.
12. Cell transformation.
13. Application of animal cell culture.
14. Stem cell cultures, embryonic stem cells and their applications
15. Cell culture based vaccines
16. Somatic cell genetics.
17. Organ and histotypic cultures.
18. Measurement of cell death
19. Apoptosis
20. Three dimensional culture and tissue engineering

Books

1. Culture of Animal Cells, (3rd Edition), Fl. Ian Froshney. Wiley-Liss.
2. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD,
3. Cell Growth and Division: A Practical Approach. Ed. R. Basega, IRL Press.
4. Cell Culture Lab Fax. Eds. M Butler & M. Dawson, Bios Scientific Publications Ltd..Oxford.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods. Ed. Jenni P Mather and David Barnes. Academic Press.

Subject Code: R50202

BIOCHEMICAL AND BIOPHYSICAL TECHNIQUES

Chromatography - adsorption, affinity, partition (GLC, GC, HPLC, TLC, RPC etc.) Immobilized cells.

Electrophoresis - Colloidal solutions of biopolymers and their electrochemical properties. Different methods of electrophoresis for proteins, nucleic acids, small molecular weight compounds and immunoprecipitates.

Peptide mapping and combination of electrofocussing and SDS-PAGE.

Hydrodynamic properties: Viscosity, diffusion etc. of biopolymers; Molecular weight determination, Osmotic pressure, Reverse osmosis and Donnan effect.

Structure of Biomembranes and their electrochemical properties, membrane potential, action potential and propagation of impulses.

Introduction to principles and applications of (a) Spectroscopic methods (UV, Vis, IR, Fluorescence, ORD, CD, & PAS) (b) NMR, ESR and mass spectrometry.

Use of Radioactive and stable isotopes and their detection in biological systems.

Introduction to principles and working of light and Electron microscopes.

Automatic analyzer for Amino acids, protein sequenator, peptide synthesizer and N.A. synthesizer.

Theory of lyophilization and its applications to biological systems.

Cell sorter and their applications.

Theory of centrifugation and application to biological systems. Rotors angle / vertical, zonal / continuous flow buoyant density centrifugation. Ultra centrifuge – principle and application.

BIOLOGY OF THE IMMUNE SYSTEM

Theory:

1. Introduction -Phylogeny of Immune System - Innate and acquired immunity - Clonal nature of immune response.
2. Organization and structure of lymphoid organs.
3. Nature and Biology of antigens and super antigens.
4. Antibody structure and function.
5. Antigen- antibody interactions.
6. Major histocompatibility complex,
7. BCR & TCR, generation of diversity.
8. Complement system.
9. Cells of the immune system: Hematopoiesis and differentiation, Lymphocyte trafficking, B- Lymphocytes, T-lymphocytes, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells.
10. Regulation of immune response -Antigen processing and presentation,generation of humoral and cell mediated immune responses - Activation of B- and T- lymphocytes - Cytokines and their role in immune regulation - T-cell regulation, MHC restriction - Immunological tolerance.
11. Cell - mediated cytotoxicity: Mechanism of T cell and NK cell mediated lysis, Antibody dependent cell mediated.cytotoxicity, macrophage mediated cytotoxicity.
12. Hypersensitivity.
13. Autoimmunity.
14. Transplantation
15. Immunity to infectious agents (intracellular parasites, helminthes, Bacteria & Viruses).
16. Tumor Immunology.
17. AIDS and other Immunodeficiencies.
18. Hybridoma Technology and Monoclonal antibodies

Books

1. Kuby Immunology, 4th Edition, -R.A. Goldsby, Thomas J. Kindt, Barbara, A.Osbarne. (Freeman).
2. Immunology-A short Course, 4th Edition, - Eli Benjamini, Richard Coico, Geoffrey Sunshine.(Wiley-Liss)
3. Fundamentals of Immunology, William Paul.
4. Immunology, by Roitt and others.

ENVIRONMENTAL BIOTECHNOLOGY

Theory

1. Environment: Basic concepts and issues
2. Environmental Pollution: types of pollution, Methods for the measurement of pollution; - Methodology of environmental management - the problem solving approach, its limitations.
3. Air pollution and its control through Biotechnology.
4. Water Pollution and Its Control: Water as a scarce natural resource, Need for water management, Measurement of water pollution, sources of water pollution, Waste water collection, Waste water treatment -physical, chemical and biological treatment processes.
5. Microbiology of Waste Water Treatments, Aerobic Process: Activated sludge, Oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds.
6. Anaerobic Processes: Anaerobic digestion, anaerobic filters. Upflow anaerobic sludge blanket reactors.
7. Treatment schemes for waste waters of dairy, distillery, tannery, Sugar, antibiotic industries,
8. Microbiology of degradation of Xenobiotics in Environment . Ecological considerations, decay behaviour & degradative plasmids; Hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides.
9. Bioremediation of contaminated soils and waste land.
10. Biopesticides in integrated pest management.
11. Solid wastes: sources and management (composting, wormiculture and methane production).
12. Global Environmental Problems: Ozone depletion, UV-B, green -house effect and acid rain, their impact and biotechnological approaches for management.

Books

1. Wastewater Engineering - Treatment, Disposal and Reuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-Young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry. A.K. De, Wiley Eastern Ltd., New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal. ELBS/Edward Arnold.

ENZYME TECHNOLOGY

Theory

1. Discovery, classifications and nomenclature of enzymes. Techniques of enzyme isolation Techniques of enzyme assay
2. Intracellular localization of enzymes Techniques used in the purification of enzymes. Criteria of enzyme homogeneity Techniques used for determination of native and sub-unit molecular weight of enzymes
3. Isoenzymes Multienzyme complexes and multifunctional enzymes
4. Physico-chemical characterization of enzymes Enzyme kinetics : Enzyme catalysis in solution - kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences. Kinetics of enzyme inhibition
5. Allosterism including half of the site activity phenomena Enzyme memory and pnenomical enzymes
6. Structure and activity of the enzymes Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc.
7. Various techniques used for the immobilization of enzymes Applications of immobilized enzyme in Biotechnology
8. Riboenzyme and catalytic antibodies- Functional proteins- structure and drug targets (enzymes and receptors)

GENERAL AND INDUSTRIAL MICROBIOLOGY

The Beginning of Microbiology:

Discovery of the microbial world by Antony van Leeuwenhoek, Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases, Development of pure culture methods; Enrichment culture methods, developments of microbiology in the twentieth century.

Methods in Microbiology :

Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial Growth :

The definition of growth, mathematical expression of growth, growth curve, availability and oxygen; Culture collection and maintenance of cultures.

Media formulation: Principles of microbial nutrition, formulation of culture media, selective media, factors influencing the choice of various carbon and nitrogen sources, vitamins, minerals, precursors & antifoam agents. Importance of pH. History and development of fermentation industry. Shake flask, batch and continuous operations. Solid state fermentation. Primary and secondary metabolites.

Antibiotics: penicillin, streptomycin, tetracycline and other antibiotics; biological production considerations; large scale production.

Organic acids: Lactic, citric, acetic, gluconic, fumaric and itaconic acids; process variables and large scale production.

Alcohols and alcoholic beverages: Ethanol production and purification, production of beer, wine and related beverages.

Industrial Enzymes, Vitamins: Their importance and role as coenzymes; production of B, C and A.

Food industry: Bakers yeast and bread making, rennet and other proteolytic enzymes in cheese making, production of different cheeses; other products from dairy industry, sweeteners, single cell protein. Biofertilizers. Fuels: Methane generation, biological production of hydrogen. r-DNA proteins.

Bacterial Genetic System: Transformation, Conjugation, Transduction

TEXT BOOKS:

1. "General Microbiology" 5th Edition Stanier et al.
2. "Enzymes in food processing" by Gerald Reed, Academic press.
3. "Comprehensive Biotechnology" Vols III & IV, Editor M.Moo young.
4. "Industrial Microbiology" by Prescott
5. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
6. "Industrial Microbiology" by Casida

GENETIC ENGINEERING

1. Scope of Genetic Engineering
2. Milestones In Genetic Engineering - Isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation, cloning, gene expression. Cloning and patenting of life forms. Genetic engineering guidelines.
3. Molecular Tools and Their Applications Restriction enzymes, modification enzymes, DNA, and RNA markers.
4. Nucleic Acid Purification, Yield Analysis
5. Nucleic Acid Amplification and Its Applications
6. Gene Cloning Vectors –Plasmids, bacteriophages, phagemids, cosmids, Artificial chromosomes.
7. Restriction Mapping of DNA Fragments and Map Construction. Nucleic Acid Sequencing.
8. cDNA Synthesis and Cloning mRNA enrichment, reverse transcription, DNA primers, Linkers, adaptors and their chemical synthesis, Library construction and screening.
9. Alternative Strategies of Gene Cloning Cloning interacting genes- Two-and three hybrid systems, cloning differentially expressed genes. Nucleic acid microarray arrays.
10. Site-directed Mutagenesis and Protein Engineering
11. How to Study Gene Regulation? DNA transfection, Northern blot, Primer extension, S1 mapping, Rnase protection assay, Reporter assays.
12. Expression Strategies for Heterologous Genes Vector engineering and codon optimization, host engineering, In vitro transcription and translation, expression in bacteria, expression in Yeast, expression in insects and insect cells, expression in mammalian cells, expression in plants.
13. Processing of Recombinant Proteins Purification and refolding, characterization of recombinant proteins, stabilization of proteins.
14. Phage Display
15. T-DNA and Transposon Tagging Role of gene tagging in gene analysis, T-DNA and transposon tagging, Identification and isolation of genes through T-DNA or transposon.
16. Transgenic and Gene Knockout Technologies Targeted gene replacement, Chromosome engineering.
17. Gene Therapy Vector engineering. Strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Books

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.
3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J; Cseke, CRC Press, Florida, 1995.
4. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
5. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
6. DNA Science. A First Course in Recombinant Technology, D.A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New York, 1990.
7. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
8. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
9. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.
10. Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998

IMMUNOLOGY

Types of immunity: innate and acquired, acute phase reactants. Acquired immunity: humoral and cell mediated immune response.

Immunochemistry: Immunogens, immunogenicity, haptens, adjuvants. Immunoglobulin (antibody) structure and function. Monoclonal antibodies, recombinant and chimeric antibodies. Abzymes. Antigen-antibody interaction. Immunological techniques.

Cellular immunology: Lymphocytes- T and B, Macrophages- identification using CD markers. Lymphoid tissues, lymphocyte development.

Antigen receptors on B and T cells. Antigen recognition, Role of MHC antigens. Lymphocyte activation.

T-cell cloning and its applications in vaccine development

Antibody secretion and cell mediated immune responses. Cytokines: Monokines, lymphokines and interleukins.

Immunological tolerance, Immunosuppressive drugs and transplantation.

Vaccines. conventional, subunit and recombinant. Antiidiotypic vaccines.

Tumor immunology: Immunotoxins.

TEXT BOOKS :

1. "Essential Immunology" by Ivan M.Roitt(1980). (Blackwell Scientific Publications, Oxford, London) fourth edition.
2. "Immunology" by Ivan M. Roitt, Jonathan Brostoff and David K. Male (1985) (Glower Medical Publishing, London) first edition.
3. "Immunology Today".
4. Current topics in Microbiology & Immunology.

IMMUNO TECHNOLOGY

Hybridoma techniques and monoclonal antibody production - myeloma cell lines- fusion of myeloma cells with antibody producing B- cells- fusion methods- selection and screening methods for positive hybrids- cloning methods -production, purification and characterization of monoclonal antibodies. Application of monoclonals in biomedical research, in clinical diagnosis and treatment. Production of human monoclonal antibodies and their applications.

T-cell cloning- mechanism of antigen recognition by T and B- lymphocytes. Structure, function and synthesis of lymphokines- Importance of antigen presentation and MHC class II molecules in T- cell cloning -antigen specific and alloreactive T-cell cloning- use of T-cell cloning in understanding the immunologically relevant antigens and T-cell epitopes - application of T-cell cloning in vaccine development.

Immunity to virus, bacteria and parasites- Genetic control of immune response - MHC associated predisposition to diseases- infectious diseases, leprosy, tuberculosis, malaria, filariasis, amoebiasis, rabies, typhoid, hepatitis, AIDS.

Principles and strategy for developing vaccines- newer methods of vaccine preparation

Immunodiagnosis of infectious diseases.

Recent advances in immunotechnology.

TEXT BOOKS :

1. "Monoclonal antibodies: Principles and practice" by J.W. Goding. Academic Press.
2. "Hybridoma Technology in the Biosciences and Medicine" T.A.Sringer (Editor) Plenum Press, N.Y.
3. "Hybridoma Techniques: A Laboratory Course" by VR. Muthukkaruppan, S. Baskar and F. Sinigaglia, Macmillan India Ltd.
4. "Basic and Clinical Immunology" by D.P. Stites, J.D.Stobo, H.H.Fudenberg J.V. Wells. 5th Edition Large medical publications.
5. "Isolation, Characterization and Utilization of T-lymphocyte clones" by C.Garrison Fathman , F.W. Fitch academic Press.

PROCESS ENGINEERING PRINCIPLES

Role of process engineering principles in biotechnological industries, Brief overview of fundamentals of chemical engineering - concepts of unit operation & unit processes

Introduction to engineering calculations; variables, their dimensions and units; Dimensionally homogenous and Non-homogenous equations; standard conditions and ideal gases; Physical and chemical property data; Basics of Material and energy balances in a macroscopic view point.

Fluid mechanics:

Fluids vs solids, Fluid statics and applications including manometer; Mass and energy balances in fluid flow, Newton's law of viscosity, Measurement of viscosity of fermentation broths, flow curves for Non-Newtonian fluids, and examples from bioprocess fluids.

Pressure drop due to skin friction by Rayleigh's method of Dimensional Analysis - significance of friction factor and Reynold's number. Boundary layer theory and form friction, Pressure drop due to form friction.

Flow past immersed bodies and drag coefficients. Pressure drop in flow through packed beds. Fluidization and Pressure drop across fluidized beds. Flow machinery and control: overview of valves and pumps.

Heat transfer:

Models of heat transfer and examples. Fourier's law of heat conduction and analogy with momentum transfer, heat transfer through a cylindrical pipe wall.

Convection and concept of heat transfer coefficient, application of dimensional analysis to heat transfer from pipe to a flowing fluid. Thermal boundary layer and Prandtl number. Overall heat transfer coefficient. Correlations for heat transfer coefficients in natural and forced convection, significance of dimensionless numbers. Overview of heat exchangers and concept of LMTD.

Diffusion and mass transfer:

Fick's law of diffusion, analogy with momentum and energy transport, diffusivities of gases and liquids; Fundamentals of mass transfer: Theories of mass transfer, concept of mass transfer coefficient, Dimensional analysis of some mass transfer operations, dimensionless numbers and significance, correlation for mass transfer coefficients.

TEXT BOOKS :

1. Bioprocess Engineering Principles" by Pauline M.Doran, Academic Press
2. "Unit operations of Chemical Engineering" 5th ed. by W L McCabe, J C Smith and P. Harriot Mc Graw-Hill (1993).

Subject Code: R50252

BIOCHEMISTRY AND METABOLIC REGULATION

Structure of Biomolecules, Metabolism of Carbohydrates, Lipids, Proteins, Amino acids and Nucleic acids.

Photosynthesis.

Introduction to Enzymes, specificity, catalysis, kinetics, inhibition and allosteric enzymes.

Metabolic Organization and Regulation of metabolism.

Signal Transduction.

Regulation of Metabolism for the production of Primary and Secondary Metabolites with Case studies.

Plasma Membrane: Structure and Transport.

Protein Targeting.

TEXT BOOKS

1. Biochemistry L.Stryer Third Edition
2. Biochemistry White, Handler and R.B.Smith 7th Ed. 1983
3. Principles of Biochemistry A.Lehninger 1987.

BIOINFORMATICS

- Introduction to Bioinformatics -History & Overview and applications
 - Emerging areas of Bioinformatics
 - Primer on: Biology/Genetics/Mol. Genetics
 - Genomes and their Importance, genome sequencing, Physical Maps
 - Biological Databases: Definition, Purpose, Formats, Content, Access - PDB, Genbank, Swissprot, NRL3D, PIR
 - Nucleic Acids, gene families, and DNA motifs
 - Protein Motifs and Patterns, Protein families
 - Nucleotide Sequence Analysis
 - DNA Analysis- Strategies for sequencing genomes- Systematic approach, random approach, EST based approach
 - Introduction to Whole Genomic analysis, Elements of DNA Sequences, ORF finding, DNA Motifs and Patterns, Micro-satellite Repeat patterns, Gene Structure (promoter elements, splicing, termination, etc) Gene Identification: Gene identification methods: grail, genscan etc
 - Primer on: Proteins- Types, Functions and applications
 - Protein Sequence Analysis -Physico-chemical properties of Amino acids, Protein sequence motifs, Signal and membrane Proteins
 - Sequence Alignments and Statistics- Introduction to identity, similarity, Homology, Sequence Alignment methods, Alignment programs, Pairwise sequence alignment, Heuristic alignment concept and tools (BLAST- all flavors), mutation matrix, global vs local alignment, Dot plots, PAM and BLOSUM matrices
 - Multiple sequence Alignment- algorithms, Phylogenetic studies, dendrograms, phylograms, cladograms
 - Overview of Protein structure - Principles & characterization
 - Secondary structure elements, Domains, Folds, Motifs
 - Overview of Protein Secondary Structure Prediction Methods
 - Introduction to Molecular Modeling concepts and Applications
- Overview of Bioinformatics applications -Automated gel reading, Primer Design, Restriction Endonuclease mapping

BIOMOLECULES

Theory

1. Chemical foundations of Biology - pH, pK, acids, bases, buffers, weak bonds, covalent bonds.
2. Principles of thermodynamics.
3. Classes of organic compounds and functional groups - atomic and molecular dimensions, space filling and ball and stick models.
4. Amino acids and peptides - classification, chemical reactions and physical properties.
5. Sugars - classification and reactions.
6. Heterocyclic compounds and secondary metabolites in living systems - nucleotides, pigments, isoprenoids.
7. Separation techniques for different biomolecules.
8. Lipids - classification, structure and functions.
9. Proteins - classification and separation, purification and criteria of homogeneity, end group analysis, hierarchy in structure, Ramachandran map.
10. Polysaccharides - types, structural features. methods for compositional analysis.
11. Analytical techniques in biochemistry and biophysics for small molecules and macromolecules for quantitation.

Practicals

1. Titration of amino acids
2. Colorimetric determination of pK
3. Reactions of amino acids, sugars and lipids- quantitative reactions
4. Analysis of oils-iodine number, saponification value, acid number.
5. UV, Visible, Absorption spectra.
6. Separation techniques- Centrifugation, Chromatography (Gel permeation, Ion exchange, TLC etc.) and Electrophoresis.
7. Estimation of inorganic phosphorus by Fiske Subbarow Method
8. Estimation of protein content by Lowry's method.
9. Isolation and estimation of protein using various colorimetric and spectrophotometric methods.

Books

1. Biochemical Calculations, Irwin H. Segel, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauling, W.H. Freeman & Company.
3. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry. D Voet and JG Voet, J Wiley and Sons.
5. Physical Biochemistry, D Freifelder, W.H. Freeman & Company.
6. Laboratory Techniques in Biochemistry and Molecular Biology, Work and Work.
7. Understanding Chemistry, CNR Rao, Universities Press. Hyderabad 1999.
8. A Biologist's Guide to Principles and Techniques of Practical Biochemistry, K Wilson & KH Goulding, ELBS Edition, 1986.
9. Tools of Biochemistry by T.G. Cooper.

BIOPROCESS ENGINEERING AND TECHNOLOGY

Theory

1. Introduction to Bioprocess Engineering.
2. Bioreactors.
3. Isolation, Preservation and Maintenance of Industrial Microorganisms.
4. Kinetics of microbial growth and death.
5. Media for Industrial Fermentation.
6. Air and Media Sterilization.
7. Types of fermentation processes: Analysis of batch, Fed-batch and continuous bioreactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.)
8. Measurement and control of bioprocess parameters.
9. Downstream Processing: Introduction, Removal of microbial cells and solid matter, foam based separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization, Effluent treatment: D.O.C. and C.O.D. treatment and disposal of effluents.
10. Whole cell Immobilization and their Industrial Applications.
11. Industrial Production of Chemicals: Alcohol (ethanol), Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Aminoacids (lysine, glutamic acid), Single Cell Protein.
12. Use of microbes in mineral beneficiation and oil recovery.
13. Introduction to Food Technology - Elementary idea of canning and packing. - Sterilization and Pasteurization of food Products. - Technology of Typical Food/Food products (bread, cheese, idli) - Food Preservation.

Books

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ. of Tokyo Press, Tokyo.
2. Biochemical Reactors, Atkinson, B., Pion Ltd. London.
3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F., McGraw- Hill Book Co. New York.
4. Bioprocess Technology.. Fundamentals and Applications, KTH, Stockholm.
5. BioProcess Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.
6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.
7. Principles of Fermentation Technology, Stanbury, RF, and Whitaker, A., Pergamon Press, Oxford.
8. Bioreaction Engineering Principles, Nielson, J. and Villadsen, J., Plenum Press.
9. Chemical Engineering Problems in Biotechnology, Shuler, M.L. (Ed.), AICHE.
10. Biochemical Engineering, Lee, J.M., Prentice Hall Inc.
11. Bioprocess Engineering-Kinetics, Mass Transport, Reactors and Gene Expression, Vieth, W.F., John Wiley & Sons, Inc.

CELL BIOLOGY

Theory

1. Diversity of cell size and shape.
2. Cell theory.
3. Structure of Prokaryotic and Eukaryotic cells - Isolation and growth of cells, Cell walls-of eubacteria (peptidoglycan) and related molecules; Outer-membrane of Gram- negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility, Cell inclusions like endospores, gas vesicles.
4. Microscopic techniques for study of cells.
5. Sub-cellular fractionation and criteria of functional integrity.
6. Cellular organelles- Plasma membrane, cell wall, their structural organization; Mitochondria, Chloroplast; Nucleus and other organelles and their organization.
7. Transport of nutrients, ions and macromolecules across membranes.
8. Cellular energy transactions - role of mitochondria and chloroplast.
9. Cell cycle - molecular events and model systems.
10. Cellular responses to environmental signals in plants and animals- mechanisms of signal transduction.
11. Cell motility- cilia, flagella of eukaryotes and prokaryotes.
12. Biology of cancer.
13. Metabolite pathways and their regulation.
14. Biosynthesis of proteins in Eukaryotic cell, Co- and post-translational modification intracellular protein traffic.
15. Cellular basis of differentiation and development - mitosis, gametogenesis and fertilization, Development in Drosophila and Arabidopsis; Spatial and temporal regulation of Gene Expression.
16. Brief introduction to the Life Cycle and Molecular Biology of some important pathogen of AIDS, Malaria, Hepatitis, Tuberculosis, Filariasis, Kala-azar.

Books

1. *Molecular Biology of cell*, Alberts. B et al.
2. *Molecular Cell Biology*, Lodish et al.
3. *Reproduction in Eukaryotic cells*, DM Prescott, Academic press.
4. *Developmental Biology*, SF Gilbert, Sinauer Associates Inc.
5. *Cell in Development and inheritance*, EB Wilson, MacMilan, New York.
6. *The Coiled Spring*, Ethan Bier, Cold Spring Harbor Press.

Fertilization, FT Longo, Chapman and Hall

DOWNSTREAM PROCESSING

Characteristics of biotechnology products.

Overview of a bioprocess including upstream and downstream processing.

Principles, operation, design and scale-up of the following:

Mechanical methods:, separation of particulate by filtration, centrifugation, cell disintegration, flocculation and sedimentation.

Primary isolation methods -solvent extraction, precipitation.

Membrane-based separations -micro filtration , ultra filtration and Reverse osmosis.

Purification methods: electrophoretic separations (all electrophoresis techniques including capillary electrophoresis) and various kinds of chromatography and adsorption

Product polishing- dialysis, crystallization

Product recovery trains - a few examples.

New and Emerging techniques: Pervaporation , Super critical extraction , Foam based separation.

TEXT BOOKS:

1. "Biochemical Engineering fundamentals" 2nd ed. by J E Bailey and D F Ollis, McGraw-Hill (1986)
2. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
3. "Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)

ENZYME ENGINEERING

Enzymes: Introduction, Free, immobilized and allosteric enzymes: Applications in Industrial, Medical, Analytical, Chemical, Pharmaceutical and Food sectors.

Enzyme isolation, purification, immobilization and assay methods.

Enzyme kinetics in free, immobilized and allosteric enzymes: Michaelis-Menten kinetics, kinetics for reversible reactions.

Effect of various types of inhibition, Evaluation of kinetic parameters.

Micro environmental effects on enzyme kinetics, Enzyme deactivation.

Structure and activity of the enzymes Mechanism of action of chymotrypsin, glyceraldehyde 3 Phosphate dehydrogenase, lysoenzyme, carboxy peptidase, ribonuclease, aldolase etc.

Applications of various types of reactors in enzymatic reactions: Immobilized bioreactors, fluidized bed reactors, Air lift reactors and recycle reactors.

Internal and external mass transfer effects in immobilized-enzyme reactors. Intra-particle diffusion and reaction, interaction between mass transfer and biochemical reaction. Concept of Thiele modulus and effectiveness factor, operational stability and optimization, general design considerations.

Enzyme reactions in organic media.

TEXT BOOKS :

1. "Biochemical Engineering" by James M. Lee , Prentice Hall (1992).
2. "Principles of Biochemistry" by A.Lehninger (1987).
3. "Design and Analysis of immobilised Enzyme Flow Reactors" by W.R.Vieth et al.

MACROMOLECULES & ANALYTICAL TECHNIQUES

Theory

1. Macromolecules and supra molecular assemblies - Types of macromolecules in biological systems, molecular assemblies like membranes, ribosomes, extracellular matrix.
2. Physical techniques in protein, nucleic acids and polysaccharide structural analysis (UV, IRNMR, LASER Raman Spectroscopy MASS Spectroscopy, Florescence Spectroscopy). Differential colorimetry, X-ray Crystallography, Ultra centrifugation, Electron Cryomicroscopy; Scanning Tunneling microcopy.
3. Radiochemical methods:radioactivity, measurement of radioactivity, photographic emulsion,ionisation chamber,Gieger Muller counter, autoradiography.
4. Sequencing of proteins and nucleic acids.
5. Protein-protein and protein-ligand interactions, physical and chemical, methods for study.
6. Conformational properties of polynucleotides and polysaccharides - secondary and tertiary structural features and their analysis- theoretical and experimental; protein folding - biophysical and cellular aspects.
7. Protein and nucleic acid data bases: structural comparison at secondary and tertiary levels.
8. Enzyme catalysis in solution - kinetics and thermodynamic analysis, effects of organic solvents on enzyme catalysis and structural consequences.
9. Glyco and lipoproteins - structure and function.
10. Organization of macromolecular complexes - chromatin and ribosomes., Protein denaturation.
11. Nucleic acid hybridization ~ Structural analysis and biological studies.
12. Computer aided drug designing, Computational techniques in structural analysis; Nanoparticles.

Books

1. Essentials of Molecular Biology, David Friefilder, Jones and Barlett Publications.
2. Proteins-Structure and Molecular Properties. TE Creighton, WH Freeman and company.
3. Genes VII, B. Lewin, Oxford University Press.
4. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
5. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
6. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons.
7. Introduction to Biophysical Chemistry, RB Martin, McGraw Hill, New York.
8. Biophysical Chemistry, Cantoz, WH Freeman.
9. Protein Structure, by Max Perutz.

MICROBIAL PHYSIOLOGY AND GENETICS

Theory

1. **The Beginning of Microbiology**

Discovery of the microbial world by Antony van Leeuwenhoek, Controversy over spontaneous generation, Role of microorganisms in transformation of organic matter and in the causation of diseases, developments of microbiology in the twentieth century.

2. **Methods in Microbiology**

Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms, Enrichment culture methods.

3. **Microbial Evolution, Systematics and Taxonomy**

Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies and molecular coding; New approaches to bacterial taxonomy classification Taxonomy, Nomenclature and Bergey's Manual.

4. **Microbial Growth**

The definition of growth, mathematical expression of growth, growth curve, availability and oxygen; Culture collection and maintenance of cultures.

5. **Overview of Basic Metabolism & Microbial Nutrition**

6. **Prokaryotic diversity Bacteria**

Purple and green bacteria; Cyanobacteria; Homoacetogenic acid bacteria; Budding and appendaged bacteria; Spirilla; Spirochaetes; Gliding and sheathed bacteria.; Pseudomonads: Lactic and propionic acid bacteria; Endospore forming rods and cocci; Mycobacteria; Rickettsias, Chlamydias and Mycoplasmas. **Archaea:** archaea; Thermoplasma **Eukarya:** Algae, Fungi, Slime molds and Protozoa.

Viruses: structure of viruses; Lysogeny; DNA viruses; Positive strand, Negative strand. and double stranded RNA viruses; Replication; Examples of Herpes, Pox, Adenoviruses, Retroviruses, Viroids and Prions, Virus and Their Genetic System, Phage I and its life cycle; RNA phages; RNA Viruses; Retroviruses.

7. **Microbial Diseases & Chemotherapy/Antibiotics**

Disease reservoirs; Epidemiological terminologies; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (rabies, plague), insects and ticks (rickettsias, lyme disease, malaria), Food and water borne diseases; Public health and water quality; Pathogenic fungi; Emerging and resurgent infectious diseases. Antimicrobial agents, Sulfa drugs; Antibiotics: Pencillins 'and Cephalosporins; Broad- spectrum antibiotics; Antibiotics from prokaryotes, Antifungal antibiotics; Mode of action; Resistance to antibiotics.

8. **Host-Parasite relationships**

Normal microflora of Skin, Oral cavity. Gastrointestinal tract; Entry of pathogens into the host: Colonization and factors predisposing to infections: Types of toxins (Exo-, Endo-Entero-) and their structure; Mode of actions; Virulence and Pathogenesis.

MOLECULAR BIOLOGY**Theory**

1. Introduction to Molecular Biology and Genetics
2. **DNA Structure , Replication:** Prokaryotic and eukaryotic **DNA** replication, Mechanics of **DNA** replication, Enzymes and accessory proteins involved in **DNA** replication.
3. **DNA Repair and Recombination**
4. **Transcription** Prokaryotic transcription, Eukaryotic transcription, RNA polymerase, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, Transcriptional and post-transcriptional gene silencing.
5. **Modifications in RNA:** 5'-Cap formation, Transcription termination, 3'-end processing and polyadenylation, Splicing, Editing, Nuclear export of mRNA, mRNA stability.
6. **Translation:** Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co- and post-translational modifications of proteins.
7. **Protein Localization:** Synthesis of secretory and membrane proteins, Import into nucleus, mitochondria, chloroplast and peroxisomes, Receptor mediated endocytosis.
8. **Oncogenes and Tumor Suppressor Genes :** Viral and cellular oncogenes, tumor suppressor genes from humans, Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.
9. **Antisense and Ribozyme Technology:** Molecular mechanism of antisense molecules, inhibition of splicing, polyadenylation and translation, disruption of RNA structure and capping, Biochemistry of ribozyme; hammer- head, hairpin and other ribozymes, strategies for designing ribozymes, Applications of antisense and ribozyme technologies.
10. **Homologous Recombination:** Holliday junction, gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases.
11. **Molecular Mapping of Genome:** Genetic and physical maps, physical mapping and map-based cloning, choice of mapping population, Simple sequence repeat loci, Southern and fluorescence *in situ* hybridization for genome analysis, Chromosome microdissection and microcloning, Molecular markers in genome analysis: RFLP, RAPD and AFLP analysis, Molecular markers linked to disease resistance genes, Application of RFLP in forensic, disease prognosis, genetic counseling, Pedigree, varietal etc. Animal trafficking and poaching; Germplasm maintenance, taxonomy and Bio-diversity.
12. **Genes, Mutation and Mutagenesis and Bacterial Genetic System:** UV and chemical mutagens; Types of mutation; Ames test for mutagenesis; Methods of genetic analysis, Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons. Bacterial genetics map with reference to *E.Coli*.

Books

1. Molecular Cloning:A Laboratory Manual, J. Sambrook, E.F. Fritsch and T Maniatis, ColdSpring Harbor laboratory Press, New York, 2000
2. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York, 1988
3. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
4. Molecular Biology of the Gene (4th Edition), J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A.Steitz and A.M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientific American Books, Inc., USA, 1994
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis,M. Raff, K.
7. Roberts, and J. D. Watson. Garland publishing, Inc., New York, 1994
8. Gene VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998, VCH Publishers, Inc., New York, 1995
9. Genomes, T.S. Brown

PLANT BIOTECHNOLOGY

Theory

1. Conventional Plant Breeding
2. Introduction to cell and Tissue Culture, tissue culture as a technique to produce novel plants and hybrids.
3. Tissue culture media (composition and preparation).
4. Initiation and maintenance of callus and suspension culture; single cell clones.
5. Organogenesis: somatic embryogenesis: transfer and establishment of whole plants in soil.
6. Shoot-tip culture: rapid clonal propagation and production of virus-free plants.
7. Embryo culture and embryo rescue.
8. Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
9. Anther, pollen and ovary culture for production of haploid plants and homozygous lines.
10. Cryopreservation, slow growth and DNA banking for germ plasm conservation.
11. Basic Techniques in rDNA Technology.
12. Plant Transformation technology: basis of tumor formation, hairy root, features of TI and RI plasmids, mechanisms of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes, reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their applications, multiple gene transfers, Vectors- less or direct DNA transfer, particle bombardment, (electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing.
13. Application of Plant Transformation for productivity and performance: herbicide resistance, phosphinothricin, glyphosate, sulfonamide, atrazine, insect resistance, Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated, nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, nematode resistance, abiotic stress, post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase.
14. Chloroplast Transformation: advantages, vectors. success with tobacco and potato.
15. Metabolic Engineering and Industrial Products: plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway; alkaloids, industrial enzymes, biodegradable plastics, polyhydroxybutyrate. therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.
16. Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.
17. Arid and semi-arid plant biotechnology.
18. Green House and Green-Home technology.

Books

1. J. Hammond, R McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer Verlag, 2000
2. T-J. Fu, G.Singh, and W.R. Curtis (Eds.): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999
3. H.S. Chawla: Biotechnology in Crop Improvement. International Book Distributing Company, 1998.
4. R.J. Henry: Practical Application of Plant Molecular Biology. Chapman and Hall. 1997
5. P.K. Gupta.. Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

PLANT TISSUE CULTURE

Different areas and applications of plant tissue culture. Totipotency.

Nutritional components of tissue culture media.

Establishment of aseptic cultures, Initiation of callus and suspension cultures, Regeneration of plants, Organogenesis, Micropropagation with shoot apex cultures (Clonal Propagation), Somatic Embryogenesis.

Regulation of cell differentiation, biochemical and molecular events in vitro.

Isolation and culture of protoplasts, protoplast fusion and somatic hybridization, Selection systems for somatic hybrids / Cybrids and their characterization . Anther Pollen culture, Production of haploids and their application.

Induction of mutation, Somoclonal variation.

Storage of plant genetic resources (Cryopreservation)

Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites Technology for yield enhancement and bioreactor system and models for mass cultivation of plant cells.

Biotransformations using plant cell cultures.

Genetic Transformation methods for production of transgenic plants (Direct, Indirect)

Production of genetically modified (GM) plants for Agronomic traits.

Application of Plant Biotechnology for the production of quality oil, Industrial enzymes, theraputic proteins (plantibodies, plantigens, edible vaccines etc.,)

TEXT BOOKS :

1. "Plant Cell, Tissue, and Organ culture" by J Reinert and Y P S Bajaj.
2. "Plant Cell and Tissue Culture" by S.Narayanaswamy.
3. "Hormones at Cellular Level" Ed. by Scott, T.K.
4. "Plant Tissue Culture" Thorpe, T.A. (Ed.).
5. "Handbook of Plant Cell Culture" Eds. Sharp et al.
6. "Plant Biotechnology" Eds. Mantell & Smith