DEPARTMENT OF BIO-ENGINEERING

AREAS OF RESEARCH

1. Bioprocess Technology
2. Biochemistry, Molecular Biology & Genetic Engineering
3. Microbiology & Enzyme Technology
4. Biomedical Instrumentation
1. Bioprocess Technology


Mass balance and yield concepts: Yield and maintenance coefficients, calculation based on elemental balances, degree of reduction, theoretical predictions of yield coefficients.

Enzyme kinetics: Introduction to enzymes, mechanistic models for simple enzymekinetics, rate parameters, models for more complex enzyme kinetics, effect of pH and temperature, methods of immobilization, diffusional limitations in immobilized enzyme systems, brief introduction to large scale enzyme production.

Media and air sterilization: introduction and the kinetics of death, batch and continuous sterilization of media, air sterilization, various type of sterilization equipments, sterilization of media by membrane filters.

Agitation and aeration: types of impellors and sparger, oxygen transfer rate, oxygen uptake rate, volumetric oxygen transfer rate \(k_La\), measurement of \(k_La\), power requirement for agitation in gaseous and non gaseous systems.

Operating considerations for bioreactors: Choosing the cultivation methods, Batch, fed-batch and continuous bioreactors:

Analysis of ideal bioreactors: Fed-batch reactors, Enzyme catalysed reactions in CSTRs, CSTR reactors with recycle and wall growth, ideal Plug-flow tubular reactor.
2. Biochemistry, Molecular Biology and Genetic Engineering

Introduction to The Cell: Evolution of cell, prokaryotic and eukaryotic cell,

DNA structure & Chromosomes::DNA as genetic material, structure of DNA, DNA replication, repetitive DNA, Chromosomal DNA and its packaging,

Genetic organization: Discovery and salient features of genetic code, overlapping genes, organellar genetic code, colinearity of genes and protein, organelle and extranuclear inheritance.

Regulation of gene activity: Central dogma, difference in genetic organization of prokaryote and eukaryote, lac operon, regulation of bacteriophage λ life cycle, nucleic acid binding motifs in regulatory proteins.

Mutation:General properties and types of mutation, DNA damage and repair, reverse and suppressor mutations, duplications, deletions, inversions and translocations, polyploidy, transposable elements, inborn errors of metabolism.

RNA & Protein synthesis, RNA processing, Protein synthesis, Posttranslational modifications.

Creation Of Recombinant Molecules: Characteristics of plasmid and other cloning vectors, artificial chromosomes, prokaryotic and eukaryotic expression vectors, Recombinant Protein purification by IMAC method.

Genomic evolution: The world of RNA, ribozyme, Genetics to genomics to functional genomics. Forward and Reverse genetics

Methods In Genetic Engineering: Restriction and modifying enzymes, Restriction mapping, Southern blot, Northern blot, Western blot, Polymerase Chain Reaction: Thermostable DNA Polymerases, PCR technique, Inverse PCR, Nested PCR, RACE PCR, RealTime PCR, Site directed mutagenesis,

DNA sequencing: Sanger, Pyrosequencing and other NGS Whole Genome Sequencing: Strategies used,

Post-Transcriptional Gene silencing: RNA interference, antisense RNA, siRNA, MiRNA,

Applications Of Recombinant DNA Technology: Transgenic plants and animals, DNA vaccine, Gene therapy, PCR based diagnosis.
3. Microbiology & ENZYME TECHNOLOGY

Introduction: History of Microbiology, Methods in Microbiology-Microscopy, Methods of sterilization; culture media, Pure culture methods, Staining of Bacteria, Micrometry, culturing cells and spores, Classification of microorganisms into different groups: Bacteria, Viruses, Fungi, Actinomycetes, Outline of classification of bacteria and fungi

Structure of Microorganisms and Microbial Metabolism: Fine structure of bacteria, Archaeabacteria, Mycoplasmas, Mycobacteria, Myxobacteria, Rickettisae and chlamydiae, structure and classification of Viruses (Bacteriophage, Oncogenic viruses), Growth of Microorganisms, Cell cycles, Population growth, Batch culture, Continuous culture, Synchronous growth, Fed-batch culture.

Environmental Microbiology: Distribution of Microbes in Air and water, Allergic disorders by air microflora, air sampling, Microbial components of water, Water treatment, Bacteriological analysis of water. Microbiology of Extreme environments

Agricultural Microbiology: Parasitism, Commensalism, Symbiosis and related microbial interactions, Rhizosphere and Rhizoplane, Bioinoculants.

Aquatic microbiology: microbiology of sewage, aquatic microorganisms & their interactions.

Microbial Biotechnology: Microbes in metal recovery, microbes in paper industries, Microbes as a source in vitamin production. Industrially important micro-organisms, secondary metabolites from micro-organisms.

Medical Microbiology: Diseases caused bacteria, virus, fungi, and protozoans; Fungal diseases (Mycoses), Microbial flora of healthy human host, host – microbe interactions, natural resistance and nonspecific defense mechanisms.

Discovery, classifications (IUB enzyme classification) and nomenclature of enzymes. Isozymes, Multienzyme complex, and multifunctional enzymes, Lock and key model and induced fit model apoenzyme, holoenzyme, Mechanism of enzyme action and activation energy, concept of active site, enzyme turnover number Specific activity, factors contributing catalytic efficiency of enzymes, Enzyme assay, Intracellular localization of enzymes.


Techniques used in the purification of the enzymes. Criteria of enzyme homogeneity, Techniques used for determination of native and sub-unit molecular weight of enzymes. Enzyme immobilization, various immobilization techniques, production and application of free and immobilized enzymes Enzyme bioreactors, bioreactors for immobilized enzymes, mass transfer limitation in bioreactors. Optimization of process parameters in enzyme bioreactors.
4. Biomedical Instrumentation

**Cell structure and Organization:** Structure and Functions of Organelles, Cytoskeleton, Cell Membrane, Cell Division and Cycle.

**Fundamental of Genetics:** Transcription and Translation; Biochemical Regulation of Gene Expression; Recombinant DNA Technology and Applications: PCR, DNA-Microarray; Principles of Mendelian Inheritance, Linkage, Recombination; Extrachromosomal Inheritance; Prokaryotic and Eukaryotic Genome Organization; Gene Mutation and Repair.


**Human Systems:** Structure and Function of Human Circulatory, Respiratory, Digestive, Excretory, and Nervous Systems.

**Computer Language:** Assembly Language and High-level Languages, Multiprogramming and Time-sharing Operating Systems, Computer Programming in C.

**Introduction to Microprocessor:** Organization & Simple Microcomputer System, Memory Units, Tri-state Switch; Architecture of 8085, Instruction Set, Addressing Modes and Addressing Format, Timing Diagram; Simple Assembly Language Programming, Data Transfer, Logic Operation; Interrupts & Peripheral Chips.

**Semiconductors:** p-n Junction; Simple Rectifiers; Transistors, Characteristics of CB, CE, CC Amplifiers, Frequency Response; Introduction to Feedback Amplifiers; FET, Op-Amp and its Special Features.

**Definitions in Instrumentation:** Accuracy, Sensitivity, Types of Error. Introduction to Galvanometer, PMMC Meter, D.C. Meter, Electronic Multimeter, Digital Voltmeter; AC & DC Bridges; Basics of CRO; Transducers & its Types: Resistive, strain gauge, capacitive, inductive, LVDT, photoelectric.

**Number systems:** Binary Arithmetic, Boolean Algebra of Logic Gates. Simple Combinational Logic Circuits, Counters.

**Biosignal Recording Devices:** Sensors and Transducers in Biosignals Recording, Different Biosignals and their Acquisition System, EKG (ECG, EMG, EEG, EOG etc), Plethysmography, Blood Pressure, Spirometry and Pulmonary Function Test.

**Biomedical Imaging Devices:** X-ray, Ultrasound, CT-Scan and MRI.

**Assistive and Therapeutic Devices:** Pacemakers, Defibrillator, Diathermy, Nerve and Muscle Stimulator, Ventilators and Anesthesia Machine.