Biotechnology

Microbiology

History of Microbiology, Discovery of the microbial world

Isolation, pure culture techniques, Methods of sterilization and Enrichment culture techniques

Bacterial identification, nomenclature and classification, New approaches to bacterial taxonomy / classification including ribotyping and ribosomal RNA sequencing

General structure and features, Brief account of all group of bacteria and cyanobacteria, Rickettsia, Chlamydia and Mycoplasma

Archaea : Archaebacteria and extremophilic microbes – their biotechnological potentials

The definition of growth, growth curve, measurement of growth and growth yields, Culture collection and maintenance of cultures

Different modes of nutrition in bacteria, Sulfate reduction, Nitrogen metabolism – nitrate reduction, nitrifying and denitrifying bacteria, Nitrogen fixation and Microbes used as biofertilizer

Viruses : Classification, morphology and composition of viruses in general,

Bacteriophages : ϕX 174, cyanophages and retroviruses, Viroids and Prions

Genetics and Molecular Biology

Introduction to cell division, Mendelian Laws and physical basis of inheritance, dominance and its molecular basis

Basics of gene interaction, cis-trans-test and complementation test, lethal genes, polygenic traits, linkage and gene maps

Double helix: Physico-chemical considerations

Organization of prokaryotic and eukaryotic genomes, supercoiling, repetitive DNA

DNA replication: Mechanism of replication of Prokaryotic & Eukaryotic Chromosome

Mutation: Types and molecular mechanisms of mutations, mutagens, DNA Repair

Transposition: Mechanisms of transposition, role of transposons in mutation

Gene transfer in prokaryotes: Transformation, conjugation, transduction, construction of genetic maps in bacteria

Recombination: Homologous and site - specific recombination

Gene expression in bacteria: Transcription and its regulation; operons, attenuation, anti-termination and anti-sense controls

Prokaryotic translation machinery, mechanism and regulation of translation

Gene expression in eukaryotes: Transcription, general and specific transcription factors, regulatory elements and mechanism of regulation, processing of transcripts

Biochemistry & Biophysics

Carbohydrates; Glycolysis, Gluconeogenesis, Krebs' Cycle, Electron transport chain, Oxidative Phosphorylation.

Fatty acids; general properties and ß- oxidation

Nitrogen metabolism: Amino acids (general properties); Amino acid sequencing and composition; end group analysis

Proteins: Protein structure (primary, secondary, tertiary & quaternary), Globular, Fibrous proteins; Ramachandran plot, Circular Dichroism, Hydrophobic and hydrophilic interactions. PAGE, SDS-PAGE, Diagonal Electrophoresis

Protein folding (Introduction / Tools to study folding – unfolding phenomenon)

DNA - protein interactions; DNA-drug interactions

Cell Biology & Virology

Principles of Microscopy

Structure of Cell (Bacterial, Plant and Animal) - Cell membranes, Composition of Cell Wall

Structure and function of organelles (Mitochondria, Chloroplast, Nucleus, Golgi apparatus, Lysosomes, Ribosomes) and Cytoskeletal elements

Cell adhesion

Basic concepts of signal transduction

Transport across biomembranes: facilitated transport, group translocation, Active transport, Na+-K+ ATPase pump

Cell cycle and its control

Oncogenesis

Bacterial Viruses : Bacteriophage lambda and Single stranded DNA Phages (M13)

Plant Viruses : TMV, CaMV and Gemini Virus

Animal Viruses : Baculoviruses

Biology of the Immune System

Introduction

- Innate and acquired immunity

- Clonal nature of the immune response

Nature of antigens

Antibody structure and function

Antigen - antibody reactions

Major histocompatibility complex

Complement system

Hematopoiesis and differentiation

Regulation of the immune response: Activation of B and T-lymphocytes, Cytokines, T-cell regulation, MHC restriction, Immunological tolerance

Cell-mediated cytotoxicity : Mechanism of cytotoxic T cells and NK cells mediated target cell lysis, Antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity

Hypersensitivity

Autoimmunity

Transplantation

Immunity to infection and tumours

Enzymology & Enzyme Technology

Classification and nomenclature of enzymes

Isolation, purification and large-scale production of enzymes

Coenzymes and Cofactors

Steady state kinetics: Methods for estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-Menten equation. Effects of substrate, temperature, pH and inhibitors on enzyme activity and stability

Mechanism of enzyme action (active site, chemical modification) and regulation (Zymogens, Isozymes)

Enzyme engineering

Applications of enzymes

Immobilization of Enzymes

Genetic Engineering

Restriction endonucleases, Modification methylases and other enzymes needed in genetic engineering

Cloning vectors: Plasmids and plasmid vectors, Phages and Phage Vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC), Animal virus derived vectors - SV40 and retroviral vectors

Molecular cloning: Recombinant DNA techniques, construction of genomic DNA and cDNA libraries, screening of recombinants

Expression strategies for heterologous genes

DNA analysis: labeling of DNA and RNA probes. Southern and fluorescence in situ hybridization, DNA fingerprinting, chromosome walking

Techniques for gene expression: Northern and Western blotting, gel retardation technique, DNA footprinting, Primer extension, Sl mapping, Reporter assays

Sequencing of DNA, chemical synthesis of oligonucleotides; techniques of in vitro mutagenesis, Site-directed mutagenesis, gene replacement and gene targeting

Polymerase chain reaction and its applications

Use of transposons in genetic analysis: Transposon tagging and its use in identification and isolation of genes

Applications of genetic engineering: Transgenic animals, production of recombinant pharmaceuticals, gene therapy, disease diagnosis

Biosafety regulation: Physical and Biological containment

Environmental Biotechnology

Environment : Basic concepts and issues

Environmental pollution: types of pollution, measurement of pollution; Methodology of environmental management - the problem solving approach, its limitations

Air Pollution and its control through Biotechnology

Water pollution and its Control : Water as a scarce natural resource; Need for water management; Measurement of water pollution; Sources of water pollution; Wastewater collection; Wastewater treatment-physical, chemical and biological treatment processes, Microbiology of waster water treatments; Aerobic processes: Activated sludge, Oxidation ditches, Trickling filter, Towers, Rotating discs, Rotating drums, Oxidation ponds; Anaerobic processes: Anaerobic processes; Anaerobic digestion, Anaerobic filters, Upflow anaerobic sludge blanket reactors; Treatment schemes for wastewaters of dairy, distillary, sugar, antibiotic industries

Degradation of Xenobiotic Compounds in Environment - Decay behaviour & degradative plasmids; Hydrocarbons, Substituted hydrocarbons, Oil pollution, Surfactants, Bioremediation of contaminated soils

Biopesticides; their roles in pest management

Solid wastes; Sources and management: composting, wormiculture and methane production, Food, feed and energy from solid waste (biomass and agrowastes)

Global Environmental Problems: Ozone depletion, UV-B and greenhouse effect, Acid rain, its impact and biotechnological approaches for management

Animal Cell Culture

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

Biology and characterization of the cultured cells

Measuring parameters of Growth

Basic techniques of mammalian cell cultures in vitro

Serum & protein free defined media and their applications

Measurement of viability and Cytotoxicity

Cell synchronization

Cell transformation

Applications of animal cell culture, Stem cells and their applications, Hybridoma Technology and Monoclonal antibodies

Organ Culture

Plant Biotechnology

Introduction and history. Tissue culture media, Initiation and maintenance of callus and suspension cultures; single cell clones

Biochemical production

Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil

Rapid clonal propagation and production of virus -free plants

In vitro pollination; embryo culture and embryo rescue

Protoplast fusion, selection of hybrid cells; symmetric and asymmetric hybrids, cybrids.

Nuclear cytology of cultured plant cells and somaclonal variations

Production of haploid plants and their utilization

Cryopreservation and slow growth for germ plasm conservation

Gene transfer in nuclear genome and chloroplasts; Agrobacterium-mediated gene transfer, direct gene transfer, gene silencing

Transgenic plants: insect resistance, virus resistance, resistance to fungal / bacterial diseases, longer shelf life, male sterility

Molecular markers: RFLP, RAPD, AFLP, applications of molecular markers

Bioprocess Engineering & Technology

Isolation, Preservation and Maintenance of Industrial Microorganisms

Microbial Growth and Death Kinetics

Media for Industrial Fermentation

Air and Media Sterilization

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.,)

Measurement and control of bioprocess parameters

Downstream Processing

Whole cell Immobilization and their Industrial Applications

Industrial Production of Chemicals - Ethanol, Acids (citric, acetic and gluconic), solvents (glycerol, acetone, butanol), Antibiotics (penicillin, streptomycin, tetracycline), Semisynthetic antibiotics, Aminoacids (lysine, glutamic acid), Single Cell Protein.

Use of microbes in mineral beneficiation and oil recovery

Introduction to Food Technology

- Elementary idea of canning and packing

- Sterilization and Pasteurization of Food Products

- Technology of Typical Food/Food products

Computer applications, Bioinformatics & Biostatistics

Introduction of digital computers : Organization ; low-level and high - level languages; binary number system, Concept of operating system

Flow charts and programming techniques

Introduction to programming in C

Introduction to data structures and database concepts, Overview of DBMS. Network topologies and protocols, Internet and its applications. Web-enabled services

Introduction to MS-OFFICE software, covering Word Processing, Spreadsheets and presentation software

Computer-oriented statistical techniques : Frequency table of single discrete variable, Bubble sort, computation of mean, variance and standard deviation; t-test, correlation coefficient

Introduction to Bio-informatics :

- Definition and Aims,

- Fundamentals of Database searching,

- Computational gene finding – multiple allignment and sequence search,

- Predicting structure and function,

- Molecular Evolution and phylogenetic trees