Semester - I

BT 611. Molecular Genetics and Cell Biology

The dynamic cell
Cell organization, sub-cellular structure of prokaryotic and eukaryotic cells
Organelle biogenesis
Synthesis and sorting of plasma membrane
Transport across cell membranes
Eukaryotic cell cycle
Signal transduction and regulation
Cancer/oncogenes

Immunity : Diversity

Prokaryotes as genetic systems
Sources of variation
Methods of genetic analysis
Prokaryotic chromosomes
Conjugation, transformation and transduction
Eukaryotic genome organisation
C-value paradox, cot-value
Chromatin structure
Chromosome replication
Structure and organisation of eukaryotic genes
rRNA gene
Histone gene
Immunoglobin gene
Molecular genetics of photosynthesis
Molecular genetics of nitrogen fixation
Molecular genetics of stress

BT 612. Techniques in Cell Biology

Microscopy

Principles of microscopy and optics
Cell size determination
Staining (Gram, fluorescence, geimsa)
Inverted microscopy
Root tip mitosis, meiosis and karyotyping, insitu hybridization, FISH and GISH
Microtomy and photography.

Cell fractionation : Mitochondria and Chloroplast isolation

Microbiological techniques

Sterilization
Media preparation
Culture maintenance
Single colony purification
Bacterial titre estimation
Growth curve
Replica plating
Culture characterization
Auxotroph isolation
Viruses and bacteriophages
Biochemical characterization
Antibiotic sensitivity
Conjugational genetic transformation
Generalised transduction
Fermentation

Immunological techniques

Agglutination and precipitation gel diffusion compliment fixation
Immuno-electrophoresis, ELISA, RIA

BT 613. Fundamentals of Molecular Biology

Introduction

Weak bonds
Thermodynamics
Equilibrium in molecular recognition and biological functions

Proteins

Structural organization
Conformation and biological function

Enzymes

Classification
Active site
Kinetics and regulation

Nucleic acids

Genetic material
Structures of DNA and RNA
Stereochemistry of bases and secondary structures
Organisation of the nucleic acids - chromatin structure

Genetic structure analysis of pro and eukaryotic genome

DNA replication

Evidence of basic targets
Enzymes
Models of DNA replication in pro and eukaryotes

Transcription

Enzymes
t,m,r and hn RNA structures and folding
Mechanisms in pro and eukaryotes
RNA splicing

Translation

Ribosomes
Genetic code
Steps in protein synthesis
Post-translational modifications
Protein targeting

Gene regulation

General control of DNA, RNA and protein synthesis
Gene regulation in prokaryotes
Gene clustering and operon concept
Mechanism of positive and negative control of gene expression

Eukaryotes

Translational and transcriptional control of regulatory mechanism of gene expression

Genomics

Structural genomics
Functional genomics and proteomics
Applications of genomics

Semester - II

BT 621. Techniques in Molecular Biology

Agarose gel electrophoresis of plasmid and genomic DNA
Electroelution
SDS - PAGE of protein from microbes, plants.
Mini and bulk preparation of plasmids from E.coli
Mini and bulk preparation of genomic DNA from microbes, plants :
Restriction mapping of plasmid DNA

Transformation of E.coli with plasmid DNA

Demonstration of

PCR amplification - RAPD
Southern , Northern and Western blotting and hybridization.
DNA sequencing
Protein sequencing
Molecular characterization of DNA T_m

BT 622. Principles of Genetic Engineering

Recombinant DNA Technology

Major events
Genomic and cDNA clones
Different methodologies and rationale of cloning a gene

The Tools of Genetic Engineering

Concept of restriction and modification
Restriction endonucleases
Modifying enzymes
Ligases
Host-vector system- E.coli as a host

Different Kinds of Vectors

Plasmids, phage vectors, M 13, cosmids, phagemids,
YACS, BACS, PACS and expression vectors.

The Means of Genetic Engineering

Different strategies of cloning
Ligation strategies
Genomic libraries
cDNA libraries
Gene tagging
Introduction to molecular marker technology

The Product

Subcloning
Nested deletions
Sequencing and sequence analysis
Site-directed mutagenesis
Expression of cloned genes
Isolation and purification of the expressed product

PCR Technology

Different types of PCR

Applications of PCR in cloning genes, promoters and flanking sequences.
Utilising PCR in the lab for preparation of probes
PCR on molecular marker technology, forensics and paternity decisions.

BT 623. Techniques in Genetic Engineering

-Cloning and Transformation in Prokaryotes

Vector preparations
Insert preparations
Ligation
Transformation
a) Methods of direct transformation
PEG mediated, microinjection, particle bombardment, electroporation
b) Methods of indirect transformation
Agrobacterium tumefaciens and A. rhizogenes
Screening for recombinant clones

-Cloning & Transformation in Eukaryotes

a) Methods of direct transformation
PEG mediated, microinjection, particle bombardment, electroporation
b) Methods of indirect transformation
Agrobacterium tumefaciens and A. rhizogenes

- Analysis of the recombinant DNA

Isolation of the recombinant plasmid
Restriction analysis
Excision of the insert
Restriction analysis of the excised insert
Sequence analysis of the insert
onstruction of Genomic and cDNA library
Gene isolation
Promoter analysis
Gene expression (reporter gene and immuno detection)

Semester - III

BT 631. Techniques in Plant Tissue Culture

- Basic techniques and tools:

Establishment of plant tissue culture lab: equipment, culture vessels, surface sterilization of various explants, pretreatment of explant, subculture and repeated transfer of explants and cultures.

- Composition of various tissue culture media and their preparation
- Establishment of callus, suspension cultures, organogenesis and embryogenesis,
- Meristem tip culture
- Hardening of plants
- Techniques of anther, embryo and ovule culture.
- Protoplast isolation, culture and fusion.
- Artificial seed (synthetic seed)
- Cell line selection using selection pressure
- Production of secondary metabolites
- Cryopreservation.

BT 632. Biotechnology for Crop Improvement

- Conventional methods for crop improvement
  - Pedegree breeding
  - Heterosis breeding
  - Mutation breeding
- Tissue culture in crop improvement
  - Micropropagation for virus-free plants
  - Somaclonal variation
  - Somatic hybridization
  - Haploids in plant breeding
- Genetic engineering for increasing crop productivity by manipulation of
  - Photosynthesis
  - Nitrogen fixation
  - Nutrient uptake efficiency
- Genetic engineering for biotic stress tolerance
  - Insects, fungi, bacteria, viruses, weeds
  - Genetic engineering for abiotic stress
  - drought, flooding, salt and temperature
- Genetic engineering for quality improvement
  - Protein, lipids, carbohydrates, vitamins & mineral nutrients
- Plants as bioreactor
- Molecular breeding
  - Constructing molecular maps
  - Molecular tagging of genes/traits
  - Marker-assisted selection of qualitative and quantitative traits

Physical maps of chromosomes
The concept of gene synteny
The concept of map-based cloning and their use in transgenics

BT 633. Biodiversity, IPR , Biosafety & Bioethics

Definition
Historical and geographical causes for diversity
Genetic diversity
Molecular diversity
Species and population biodiversity
Quantifying biodiversity
Maintenance of ecological biodiversity
Biodiversity and centres of origins of plants
Biodiversity hot spots in India
Collection and conservation of biodiversity
Assessing, analyzing and documenting biodiversity
Morphological and molecular characterization of biodiversity
Vulnerability and extinction of biodiversity
Introduction to biodiversity database: endangered plants, endemism and Red Data Books
Global biodiversity information system
Intellectual property rights (IPR), sovereignty rights, CBD, bioethics and patenting
General agreement on trade and tariffs
Indian sui-generis system for plant variety and farmer's rights protection act.

Biosafety

Definition
Requirement
Biosafety and biodiversity
Biosafety for human health and environment
Social and ethical issues
Biosafety in relation to transgenic research of applications.

BT 634. Plant Metabolic Engineering

- Introduction

The concept of secondary metabolites
Historical and current views
Importance of secondary metabolites in medicine and agriculture
Introduction to various pathways

- Flavanoid pathway

Chemistry : The basic structure
Stereochemistry

Chemical synthesis of different intermediates
Biochemistry : The biochemical pathway
Carbon flow
Different regulatory points
Intermediate pools and their significance in horticulture, agriculture and medicine.
Molecular genetics: Regulatory genes
Gene expression in response to environmental stimuli
Regulation of gene expression

- Terpenoid pathway

Chemistry : The basic structure
Stereochemistry
Chemical synthesis of different intermediates
Biochemistry : The biochemical pathway
Carbon flow
Different regulatory points
Intermediate pools and their significance in agriculture and medicine
Microgenetics
Molecular genetics: Regulatory genes
Gene expression in response to environmental stimuli
Regulation of gene expression

- Polyketoid pathway

Chemistry: The basic structure
Stereochemistry
Chemical synthesis of different intermediates
Biochemistry : The biochemical pathway
Carbon flow
Different regulatory points
Intermediate pools and their significance in horticulture, agriculture and medicine
Molecular genetics: Regulatory genes
Gene expression in response to environmental stimuli
Regulation of gene expression

- Biomolecules transformation pathways

- Networking of the secondary pathways

Concepts of common "global" regulation and response
Possible links between different pathways via intermediates
Implications of adding a new pathway
Resource restructuring

Minor Courses

Semester- I

Essentials in Biochemistry

Water pH and buffer, chemistry of living matter, protein structure, biomembranes, molecular weight, enzyme kinetics and mechanisms of action, coenzymes and their function, metabolic pathways of carbohydrates, lipids and amino acids, purines and pyrimidines, structure and role of nucleic acid, vitamins, minerals and harmones.

Molecular Biophysics

Laws of thermodynamics, heat, energy and work, chemical equilibrium, electron microscopy, sedimentation and viscosity, chromatography, electrophoresis, tracer techniques, light scattering and X-ray diffraction, absorption spectroscopy (UV, Visible, Infrared, Raman, NMR, ESR) and their uses, circular dichroism and optical rotatory dispersion principles and applications, microarray technology.

Semester-II

Bioinformatics & Statistics

Introduction
Computers in biology
Software and hardware requirements
Databases
Internet

Databases

Concept
Assessing a database on internet
Searching a database
Query and response
Developing a database
FTP and WWW

Biostatistics

Using different software packages like SYSTAT and SAAS. etc.

Enzyme kinetics

Using software like Leonara and Winzyme for enzyme kinetics analysis

Genomics

Structural genomics - sequencing and sequence analysis software like GCG etc.
Functional genomics - genefinder etc.

Proteomics

Three dimensional structural prediction swissprot, etc.

Computer graphics

Creation of recombinant molecules
Virtual analysis of biomolecules using vector NT, DNA star, etc.

Molecular modelling

Modelling of different macromolecules and
structural analysis using hyperchem, etc.

Semester-III

Microbiology

Nature of microbial world
The protists
The prokaryotes: an introductory survey
The effect of environment on microbial growth
The relations between structure and function in prokaryotic cells
The viruses
Classification of bacteria
The photosynthetic prokaryotes microorganisms as geochemical agents
Symbiosis
Microbial diseases of plants
The exploitation of micro-organisms by man
Industrial
Agricultural
Environmental

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