

COURSE WORK
for
Ph.D. (Biotechnology)

Compulsory papers

(I) Research Methodology (AS601) – 3 credits

(II) Journal club (In the presence of all faculty, Ph.D. as well as interested M. Tech students)-2 credits

Elective Papers

Student will opt any two/three Courses from the following theory subjects (total 12 credits)

1. Structural Biology - 3 credits

Unit 1

Conformational analysis and forces stabilizing structure of bio molecules: Intra and inter molecular forces, electrostatic and Hydrogen bonding interactions, dipole moments, covalent bond distances, vander Waals and Hydrophobic interactions, Disulphide bridges, Role of water and weak interactions, conformational entropy.

Unit 2

Structure-function of Biomolecules: Classification and properties of amino acids and proteins, pH titration of amino acids and proteins, peptide bond, synthesis and sequencing of proteins, structural organization of proteins: primary, secondary, tertiary and quaternary structure of proteins. Conformational properties of polypeptides, folded conformation of globular proteins denaturation of proteins, Steric contour diagrams, stability of proteins. Helix-coil transition, isolation and purification of proteins: chromatographic techniques. *Protein-ligand kinetics:* Gel filtration, isothermal calorimetry, protein sequencing, homology search, particles in a field: mass spectroscopy, electrophoresis, and sedimentation.

Unit 3

Molecular Structure determination: From genes to structure to function. three dimensional structure determination of macromolecules, Spectroscopic and diffraction techniques, Crystallisation Methods, Molecular crystal symmetry, X ray diffraction by crystals, Bragg's Law, von Laue conditions and rotation methods, Data collection and interpretation, Structure solution methods, Neutron diffraction, Nuclear magnetic resonance spectroscopy. Drawing of protein structures and analysis.

2. Advances in Plant Biotechnology -3 credits

Unit 1.Plant Tissue Culture: The culture environment, cellular competence for *in vitro* regeneration, Plant growth regulators, Culture types, Protoplast Related Techniques, Plant regeneration, Production of Haploids and methods of diploidization, Importance of tissue culture into plant transformation

Unit 2. Techniques for Plant Transformation and genetic engineering: *Agrobacterium* Biology, Direct gene transfer methods, Vectors for plant transformation, heterologous promoters, chloroplast transformation and its uses, gene silencing and methods of overcoming it, RNA interference/silencing (role of small RNAs), VIGS, Non-antibiotics based selection, Crop plant genome sequencing. Transposon and T-DNA tagging, TILLING, Targeted mutagenesis in plants.

Unit 3. Application of Gene Transfer Technology: Identification of novel plant genes, Probe based screening, Genomic and proteomic approaches, map based cloning, Transgenic plants for abiotic and biotic stress tolerance, Use of plant transformation to study plant physiology and biochemistry, plants as bioreactors, transgenic plants as vaccine production systems, phytoremediation of contaminated soils, Functional characterization of gene/gene families in crop plants, Beyond genetically modified crops

3. Advances in Animal Biotechnology

-3 credits

Unit 1. Animal cell tissue culture: Historical Background (Advantage, limitation and types of Tissue Culture), Biology of Cultured Cells, Equipment and Media Preparation, Primary Culture, Subculture and Cell Lines, Gene Transfer or Transfection, Transformation and Immortalization, Contamination and its eradication, Cryopreservation, Cytotoxicity.

Unit 2. Genetic Engineering in Animals: In vitro Fertilization and Embryo Transfer in Humans and Livestock, Cloning Technology, Transgenic Technology, Gene targeting and Knock-out Models, Cloning Models, Human Cloning, Ethical issues and the Risks Associated with Human Cloning, Transgenic Animals and Applications.

Unit 3. Application of Animal Biotechnology: Stem Cells, Germ Cells, and Aminiocytes, Culturing of Native and Transformed Cells, Genomics and Animal improvement, Knockout mouse model, Preparation of Animal disease Models, Tissue Engineering, products of animal biotechnology.

4. Advanced Microbial Biotechnology

-3 credits

Unit 1.

Culture techniques of microorganisms, Strain Improvement by mutagenesis and Recombinant DNA Technology, Chromosome Engineering, Isolation of microbes.

Unit 2.

Understanding microbial world and their interaction: Metagenomics and its application and challenges. Molecular biology of microbial pathogenesis. Quorum sensing and biofilms, their role in pathogenesis, Microarrays for microbes, 16S library array of microbes.

Unit 3.

Production of enzymes, biofuels (bioethanol, biodiesel, biohydrogen, biomethane), Biopolymers, biodegradable plastics, antibodies and organic acids.

Fermentation, Designing and development of various biosensors and their applications and lab scale fermentation studies. Forensic microbial technology, bioterrorism.

Bioreactors (design and applications) and downstream processing (submerged, solid state and surface).

Various application areas with case studies, sustained agricultural productivity, health & environment, occupational health hazards and management, community health care programme.

8. Advances in Research techniques-4 credits

Basic Research Methodology: Documentation, literature review, manuscript writing, Laboratory safety, Standard operating procedures, Research ethics (in Animals, Plants, Stem cells and Human)

Experimental Methodology: Exploratory studies, Experiment Design, Computational analysis (excel, MS office) Various Statistics tools- Mean, Median, Mode and One way Annova, Two way Annova, Hypothesis testing (t-test, chi test), Correlation Regression, Data Analysis and presentation (powerpoint, Photoshop, Graph pad, Sigma plot)

Research Techniques: Macromolecule (DNA, RNA and protein) isolation, quantitation and purification Histochemistry (tissue sectioning, staining and analysis), Cytochemistry , Spectroscopy (UV-Vis, CD,NMR, Fluorescence, IR, ESR), Confocal Microscopy, FACS and MACS , Aseptic techniques and Cell Culture (Plant and Animal) techniques, Isolation and characterizations of Microbes , PCR (qualitative and quantitative analysis) , Cloning , ELISA, RIA , Sequencing and Next Generation sequencing, Microarrays, Heavy metal detection, Gas chromatography, Bioremediation, Basic tools of Bioinformatics (Pubmed, NCBI, Sequence alignment, Pattern search, 3D Structure visualization and Modeling) , Gel electrophoresis (AGE, 2D etc), ChIP, EMSA, Co-Immunoprecipitation, Mass Spectrometry (MALDI-TOF), Yeast library screening.