

Course Contents of Ph.D. (Biotechnology) Course Work

(Batch 2019 Onwards)

COURSE WORK FOR Ph.D.

A. Compulsory Courses

1. BT801 Research Methodology (4 credits)

Unit 1: Basics of Research: Understanding research, Research in biological sciences, Selection of research areas, criteria for selection of research problem, literature review, tools available for literature review, research article vs research review, identification of Gaps in research, feasibility of addressing research problem, generation of proposal/synopsis

Unit 2: Experimental methodology: Search of various experimental strategies, understanding their advantages and limitations, Design of optimal experimental strategy, work flow, protocols, selection of experimental controls, sample size, strategies for validation and interpretation/analysis of data, Importance of technical and experimental replicates, Reproducibility of data, Documentation of all experiments

Unit 3: Data Analysis: Importance of stats in data analysis, various statistical tools: Mean, Median, Mode and One way Anova, Two way Anova, Hypothesis testing (t-test, chi test), Correlation Regression, Data Analysis and presentation (powerpoint, Photoshop, Graph pad, Sigma plot, origin), Computational analysis (excel, MS office), chem draw

Unit 4: Ethics and biosafety in biological research: Biosafety guidelines, Biosafety levels, SOPs, Bioethics, GMO, IBSC, Human and animal biosafety committee, Human ethics, Animal ethics committee, concerns and approval, safety practices, disposal of biowaste material (animal origin, pathogen/non pathogens, chemical waste)

Unit 5: Scientific writing and presentation: Research papers, research article, report, short communication, research review, views, comments, Thesis writing, Organization of research data (abstract, introduction, methodology, results, discussion), Preparation of figs and tables, Management of references, Bibliography tools Endnote, Selection of Journal: UGC-CARE, Sci Indexed, Impact factor, author contribution, acknowledgement, Plagiarism, Tools to check plagiarism, Copyright violation. Patent, writing application, data protection, requirements. Skills scientific presentation, preparation and arrangement of presentation slides, acknowledgement

2. BT802 Journal Club (02 Credits)

3. BT803 Advances in Research Techniques (03 Credits)

Unit 1: Culture techniques: Aseptic culture techniques, Culture of pure and mixed species of microbes (bacteria, fungus and virus), Plant tissue culture, development of transgenics, Animal tissue culture techniques, ex vivo, in vivo, in vitro culture, techniques for development of animal models

Unit 2: Genetic engineering tools: basics of cloning, cloning vectors, expression vectors, chromosome engineering, MAGE, Molecular bar codes, High throughput screening approaches, Microarray, transcriptomics, epigenomics, NGS and analysis, Genome editing tools ZFN, TALEN and CRISPR, Anti CRISPR

Unit 3: Analytical tools: Spectroscopy (UV-Vis, CD, NMR, Fluorescence, IR, ESR), Confocal Microscopy, FACS and MACS, ELISA, RIA, metal detection, Gas chromatography, Bioremediation, Gel electrophoresis (AGE, 2D etc), ChIP, EMSA, Co-Immunoprecipitation, Mass Spectrometry (MALDI-TOF),

Unit 4: Computational biology Techniques and Tools: Techniques and tools for sequence alignment, phylogeny, gene prediction, ORF finding. Specialized biological databases like microarray databases, SNP databases, genomic databases.

B. Elective Courses (03 Credits each)

1. BT804 Structural Biology

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. BT805 Advances in Plant Biotechnology

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. BT806 Advances in Animal Biotechnology

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. BT807 Advanced Microbial Biotechnology

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).

5. BT808 Advances in Immunology and Immunotechnology

Unit 1. Innate Immunity, Adaptive Immunity, antibodies, molecular basis of antibody diversity, Immune responses: endogenous and exogenous pathway of T-cell activation.

Unit 2. Host-pathogen interactions and immune response of the host to bacteria, fungi and viruses, Tumorigenesis and Immune Response, Design and Development of vaccines.

Unit 3. Antibody production, engineered antibody, Hybridoma Technology, polyclonal antibodies, Immunodiffusion, Immunoelectrophoresis, ELISA, RIA, Cell proliferation and Cytotoxicity assays, FACS, Immunohistochemistry.

6. BT809 Bioinformatics Tools for Research

Unit 1: Sequences Alignment (Pairwise and multiple alignment), Phylogenetic analysis- Methods and Tools.

Unit 2: Genome Analysis: Introduction to Next Generation Sequencing technologies, Whole Genome Assembly and challenges, Sequencing and analysis of large genomes, Gene prediction, Functional annotation, Recent advances (databases, methods & approaches, tools, genome web browsers) in Comparative Genomics. Human genome project, Genomics and crop improvement, Functional genomics case studies.

Unit 3: Proteome Analysis: Protein arrays: computational tools for analysis of proteomics data, protein-protein interactions. Retrieving and drawing structures, visualization tools, Structure prediction, validation and correction, Identification of binding sites.

Unit 4: Computational approaches for drug design Approaches to Drug Design & Development; Concepts of Molecular modeling and simulations- Macro-molecular force fields, Molecular mechanics, conformational searches, Simulations. Recent advances in Computational approaches for structure based and ligand based drug design

7. BT810 Advanced Environmental biotechnology

Unit1: Overview of environmental biotechnology, Environmental pollutants, Microbial strains (engineered and natural) for bioremediation, Phytoremediation, Approaches and technologies for bioremediation, Biotechnology in pollution abatement, bioconversion of agricultural and industrial wastes into biofuels and biomanures. Bioharvesting of biofuels.

Unit 2: Concept and methods for application of biomonitoring in soil quality, water quality and air quality assessment, biosensor technology.

Unit 3:

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