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

## (Batch: January 2020 Onwards)

# COURSE WORK FOR Ph.D.

## A. Compulsory Courses

### 1. AS601 Research Methodology (4 credits)

**Unit-I: Basics of Research**

Research: Definition, Objectives, Type and Characteristics, Hypothesis: Meaning and types; Research methods vs Methodology. Positivism and post-positivistic approaches to research

**Unit-II Research Formulation**

Research Formulation – Defining and formulating the research problem; Characteristics of a good research problem; Selecting the problem; Literature review: Primary and secondary sources; Research proposal or synopsis Web as a literature source, searching the web; Organizing the literature and identifying gap areas from literature review

**Unit-III Research Design and Methods**

Research design: Basic principles, Need of research design, Features of a good research design; Important concepts relating to research design; Observations and facts; Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models; Developing a research plan-Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs

**Unit-IV Data Collection and Analysis**

Observations and collection of data; Sample and sampling methods; Data processing and analysis, Statistical packages of data analysis; Hypothesis testing, Generalization and interpretation; Role of ICT in research

**Unit-V Research Report**

Types of report-Technical reports and thesis; Structure and components of a scientific report, Steps in report preparation: Layout, structure and language of typical reports, illustrations and tables; Bibliographic entries, referencing and footnotes; Oral presentation: Planning and practice, use of visible aids, Importance of effective communication

Commercialization of knowledge and technologies and academic ethics; Intellectual property rights; Plagiarisms paraphrasing and copywriter violation, consequences of plagiarism; Reproducibiloty and accountability; Citation counting and impact factor, Scientific citation index (SCI), Scientific citation index-expanded (SCI-E), H-index

### 2. RE-001 Research and Publication Ethics (2 credits)

**Philosophy and Ethics**
1. Introduction to philosophy: Definition, nature and scope, concept, branches
2. Ethics: Definition, moral philosophy, nature of moral judgements and reactions

**Scientific Misconduct**
1. Ethics with respect to science and research
2. Intellectual honesty and research integrity

3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

**Publication Ethics**
1. Publication ethics: Definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: Definition, concept, problems that lead to unethical behaviour and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

**Open Access Publishing**
1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications development by SPPU
4. Journal finder/ journal duggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

**Publication Misconduct**
**A. Groups Discussions**
1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad
**B. Software Tools**
Use of plagiarism software like Turnitin, Urkund and other open source software tools

**Databases and Research Metrics**
**A. Databases**
1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.
**B. Research Metrics**
1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g-index, i10 index, altmetrics

**3. BT801 Journal Club (02 Credits)**

## B. Elective Courses

**BT802 Advances in Research Techniques (2 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.

**BT803 Advances in Plant Biotechnology (2 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 diplodization, Importance of tissue culture into plant transformation

**Unit 2.Techniquesfor 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

**BT804 Advances in Animal Biotechnology (2 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, Genomicsand Animal improvement, Knockout mouse model, Preparation of Animal disease Models, Tissue Engineering, products of animal biotechnology.

**BT805 Advanced Microbial Biotechnology (2 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).

**BT806 Advances in Immunology and Immunotechnology (2 Credits)**

**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.

**BT807 Bioinformatics Tools for Research (2 Credits)**

**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

**BT808 Advanced Environmental biotechnology (2 Credits)**

**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.

**BT809 Structural Biology (2 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 filteration, 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.