



**DEPARTMENT OF APPLIED BIOSCIENCES**  
**MAHATMA GANDHI UNIVERSITY, NALGONDA**

**PRE- PhD COURSE WORK SYLLABUS**  
**SUBJECT- BIOTECHNOLOGY**

**COMMON PAPER**  
**PAPER I – RESEARCH METHODOLOGY**

**Unit I: Tools and techniques in Research**

- 1.1. Centrifugation techniques- Principle, types & applications
- 1.2. Spectrophotometric techniques- Principle, types and applications
- 1.3. Chromatographic techniques-Principle, types and applications
- 1.4. Electrophoretic techniques- Principle, types& applications
- 1.5. Microscopy- Principle, types and applications
- 1.6. Real time PCR, DNA microarray, Next generation DNA sequencing

**Unit II: Recombinant DNA technology**

- 2.1. Restriction enzymes and types; Modifying enzymes- methylases, polymerases, ligases, kinases, phosphatases, nucleases
- 2.2. Vectors for cloning, expression (gateway cloning vectors) and library preparation (Lambda phage vectors, cosmids, BAC, YAC), prokaryotic (E.coli) and eukaryotic (Yeast) hosts
- 2.3. Strategies for construction of genomic (Chromosome walking and jumping for positional cloning of genes) and cDNA libraries (Subtractive and Normalized libraries)
- 2.4. Selection of recombinant clones - insertional inactivation, alpha-complementation, PCR screening, immunological screening for expressed genes, Screening using blotting techniques (Southern, Northern, Western blotting)
- 2.5. Protein expression and purification- expression vectors; Recombinant protein expression in bacteria, yeast, plant cells & mammalian cells; Post-translational modification of proteins
- 2.6. Advanced techniques in r-DNA technology- site directed mutagenesis, RNA interference, Knock-in and knock-out technology, Genome editing technologies- CRISPR-CAS system, TALENs & Zinc finger Nucleases

**Unit III: Bioinformatics**

- 3.1. Introduction: Aim and branches of Bioinformatics, Application of Bioinformatics, Role of internet, Forms of biological information.

- 3.2. Bioinformatics Resources: Sequence databases: Nucleic acid sequence databases: GenBank, EMBL, DDBJ; Protein sequence databases: Uniprot-KB: SWISS-PROT, TrEMBL; Plant genome data bases: Rice-PDB, NDB, PubChem, ChemBank.
- 3.3. Nucleic acid & Amino acid properties: Various tools at the ExPASy server, Sequence Analysis: Basic concepts of sequence similarity, identity and homology
- 3.4. Sequence alignment: Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments. BLAST and FASTA algorithms, Multiple sequence alignment and Phylogenetic analysis.
- 3.5. Genomic and Proteomic applications: Whole genome duplications, Segmental duplication, Single nucleotide variation, identification and its implications, Gene annotations-bacteria, plant and human.
- 3.6. Medical application of Bioinformatics: Identification of disease genes, drug targets, disease diagnostics, overview of drug discovery, pharmacogenomics

#### **Unit IV: Statistics and Research concepts**

- 4.1. Introduction to application of statistics in biology
- 4.2. Sample size- Basic data required for sample size determination; Collection of data, measures of dispersion, measures of central tendency
- 4.3. Tests of significance- Z-test, paired & unpaired t-test, F-test, Chi-square test and ANOVA; Correlation and Regression analysis; SPSS for statistical analysis
- 4.4. Introduction to research concepts
  - a) Philosophy & Meaning of Research, Basic research, applied research and need based research; Identification and defining of the problem
  - b) Literature survey: the search for facts; the verification of facts; the analysis of evidence; truth & causation; Sources of prejudice and bias.
  - c) Library reference schemes; Note making, Lab record, Internet.
- 4.5. Research proposal design & formulation; Hypothesis- Direct & alternate methods; Research methodology; Data collection, Data validation
- 4.6. Statistical approach, Validation of findings, Plagiarism, Research communications and Impact factor journals.
- 4.7. The structure of a thesis; Language & style in the thesis, Index, Foot notes, Diagrams, Bibliographies

#### **REFERENCE BOOKS**

1. Biophysical chemistry by Upadhyay, Upadhyay and Nath 4th edition, Himalaya publishing House, Mumbai.
2. Practical Biochemistry by Keith Wilson and John Walker., 5th edition, Cambridge University press, U.K.
3. Molecular Biology of the gene by J. Watson
4. Genes Vol VI, VII and VIII by Benjamin Lewin
5. Molecular Biotechnology Principles and application of recombinant DNA
6. Principles of Gene manipulation by R.W. Old and S.B. Primrose
7. Recombinant DNA: A short course by J. Watson, Tooze and Kurtz

8. Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press
9. Biological Sequence Analysis : Probabilistic Models of Proteins and Nucleic Acids by Richard Durbin, Sean R. Eddy, Anders Krogh, Graeme Mitchison, Cambridge University Press.
10. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Second Edition by Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Interscience.
11. Introduction to Biostatistics by Robert Sokal and James Rohlf, Dover publications

## **PAPER II: PLANT BIOTECHNOLOGY (RESEARCH SPECIALIZATION)**

### **Unit I: Plant cell and tissue culture and its applications**

- 1.1. Callus and cell suspension cultures and plant regeneration
- 1.2. Organogenesis and somatic embryogenesis
- 1.3. Anther culture, production of haploids, double haploids (isogenic lines)
- 1.4. Production of Somatic hybrids and Cybrids
- 1.5. Cryopreservation of plant germplasm
- 1.6. *In vitro* production of secondary metabolites, Biotransformation and production of novel compounds

### **Unit II: Genetic modification of plants**

- 2.1. Methods of direct gene transfer in plants – particle bombardment, electroporation, PEG mediated
- 2.2. *Agrobacterium* mediated transformation - Features of Ti and Ri Plasmids and their use as vectors for plant transformation (binary and co-integrate vectors)
- 2.3. Selection (Reporter genes – scorable and selectable marker genes) and molecular characterization of transformants , Transgene stability and gene silencing
- 2.4. Antisense and RNAi technology
- 2.5. Chloroplast transformation and applications
- 2.6. Genome editing techniques – TALENs, Zinc finger nuclease, CRISPR/CAS system

### **Unit III: Genetically modified plants: improvement of productivity and performance**

- 3.1. Genetic modification of plants for Insect/Pest resistance
- 3.2. Production of transgenic plants for bacterial, fungal and viral resistance
- 3.3. Development of genetically modified plants for abiotic stress (drought, salt, low and high temperature, flooding and heavy metal) tolerance
- 3.4. Pathway engineering for production of secondary metabolites
- 3.5. Molecular Farming for production of biopharmaceuticals (plantibodies, plantigens, therapeutic proteins and edible vaccines) and industrial products (industrial enzymes, lysozyme)
- 3.6. Genetic modification of plants for improvement of shelf life of fruits, Oil quality and nutritional quality (amino acids, vitamins, micronutrients)

### **Unit IV: Molecular breeding for crop improvement**

- 4.1. Limitations of conventional breeding; Aspects of molecular breeding

- 4.2. Development of sequence based molecular markers - SSRs and SNPs
- 4.3. QTL mapping using structured populations, Map based gene/QTL isolation and development of gene based markers
- 4.4. Allele mining by TILLING and Eco-TILLING
- 4.5. Marker assisted selection (MAS) in backcross, heterosis breeding and gene pyramiding
- 4.6. Genomics assisted breeding

#### **REFERENCE BOOKS**

1. Bhojwani SS. 1983. *Plant Tissue Culture: Theory and Practice*. Elsevier.
2. Christou P & Klee H. 2004. *Handbook of Plant Biotechnology*. John Wiley & Sons
3. Dixon RA. 2003. *Plant Cell Culture*. IRL Press.
4. Gupta PK. 2004. *Biotechnology and Genomics*. Rastogi Publ.
5. Pena L. 2004. *Transgenic Plants: Methods and Protocols*. Humana Press.
6. Pierik RLM. 1997. *In vitro Culture of Higher Plants*. Kluwer.
7. Singh BD. 2007. *Biotechnology: Expanding Horizon*. Kalyani
8. Buchanan B, Gruissen W & Jones R. 2000. *Biochemistry and Molecular*
9. *Biology of Plants*. American Society of Plant Physiologists, USA.
10. Chittaranjan K. 2006-07. *Genome Mapping and Molecular Breeding in Plants*. Vols. I-VII. Springer.16
11. Newbury HJ. 2003. *Plant Molecular Breeding*. Blackwell Publ.