**Course Title:** Plant Genetic Engineering and Omics

| Assessment | |
|---|---|
| Maximum marks | 100 |
| Continuous Internal Assessment (CIA) | 25 |
| Mid Semester Exam (MSE) | 25 |
| End Semester Exam (ESE) | 50 |
| Passing Marks | 50 |

**Course objectives:** To acquaint the students to the versatile tools and techniques employed in genetic engineering and recombinant DNA technology. The student will achieve a sound knowledge on methodological repertoire which allows them to innovatively apply these techniques in basic and applied fields of life science research.

**Theory**

**Unit 1: Advanced tools in plant genetic engineering**

Introduction to plant genetic engineering –restriction enzymes –Protein engineering of restriction enzymes; Vectors - New-generation vectors for transgenic Plants - GATEWAY-Compatible binary Vectors; Destination vectors; GATEWAY-Compatible MicroRNA vectors; Tissue-Specific and Stress-Inducible Binary vectors; Vectors for virus-induced gene silencing; Gene-editing by expression of developmental regulators and *de novo* meristem induction in plants; RNA viruses and mobile guide RNAs for heritable plant gene-editing; Nanoparticles for delivering biomolecules to facilitate plant genome engineering; Cloning vectors for higher organisms; Commercially available plasmids; transcriptional terminators; Vectors for plants; expression vectors;

**Unit 2: Plant genetic transformation**

Plant transformation vectors - T-DNA and viral vectors; plant transformation by Agrobacterium sp; non-Agrobacterium sp; and *in planta* transformation; molecular mechanism of T-DNA transfer; direct gene transfer methods in plants - gene gun and other methods; chloroplast transformation; transgene analysis; silencing and targeting; marker-free and novel selection strategies; multigene engineering; gene knock-down by ribozymes; antisense RNA and RNA interference; Marker-Free Transgenic Plants; Plastid genome

engineering; Plastid bioreactors for molecular farming; Plastid as a biofactory for Industrially Important products

**Unit 3: Applications of plant transgenic technology**

Transgenic crops for resistance against biotic and abiotic stresses; engineering crops for male sterility and modification of flower colour/pattern; fruit ripening and senescence; GM crops for nutritional quality and quantity; RNAi-mediated crop improvement; molecular farming; metabolic engineering and hairy root culture for secondary plant products; global status and biosafety of transgenic plants. Transgenic Crops in Virus Management- Nucleic Acid-Mediated Resistance (NAMR); Artificial MicroRNA (amiR)-Mediated Resistance Key Challenges in Developing Products from Transgenic Plants- Plant Tissues Used for Expression of Recombinant Proteins; Expression Systems; Production of Therapeutic Proteins in Plants

**Unit 4: Computational and Machine learning in botany**

Computational botany-Introduction, morphometrics, morphometric analysis of leaves, flowers and other organs, feature extraction-Leaf shape, texture and margins, image recognition of plant- artificial intelligence, Machine Learning Techniques in Plant Biology machine-learning applications for studies in plants, machine learning methods and modelling techniques, machine learning for plant leaf analysis, limitations of machine learning.

**Unit 5: Plant Omics**

Omics- history and prospects omics; Omics of Model Plants; Next-Generation Sequencing and Assembly of Plant Genomes; Genome Assembly Algorithms; Biological Applications of Next-Generation Sequencing; Cytogenomic Techniques-Chromosome Biology, and Genome Analysis; miRNomics- Plant Gene Regulation by miRNAs; Role of miRNA in Plants; Phenomics: Applications in Plant and Agriculture; Plant Cytomics and applications; Chloroplast and Mitochondrial Omics; Micromorphomics; Microbiomics; Plant Pharmacogenomics Bioinformatics and Nanobiotechnology in agricultural development.

**Suggested readings:**

1. Genes VI: Benjamin Lewin. Oxford University Press, Oxford, 1997.
2. Genes VII: Benjamin Lewin. Oxford University Press, Oxford, 2000.

3. Knowler, J.T., Leader, D.P. and Adams, R.L., 1986. *The Biochemistry of the Nucleic Acids*. Chapman & Hall.

4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D., 1999. *Molecular Biology of the Cell*, 477–485.

5. DNA cloning 1: A Practical approach: Core techniques, 2nd Edition. IRL Press, 1995.

6. Shaw, C.H. ed., 1988. *Plant Molecular Biology: A Practical Approach*. IRL Press.

7. Barh, D., Khan, M. S., Davies, E., 2015. PlantOmics: The Omics of Plant Science. Springer India

8. Bánerjee, R., Kumar, G. V., Jeevan Kumar, S. P., 2019. OMICS-Based Approaches in Plant Biotechnology. Wiley publishers

9. Sathishkumar, R., Sarma, R. K., Jagadeesan, H., Venkidasamy, B., 2019 Advances in Plant Transgenics: Methods and Applications. Springer Nature Singapore Pvt. Ltd.

10. Santos, D. M., 2011. Genetic Engineering -Recent Developments in Applications. Apple Academic Press.

11. Rajagopal, K., 2012. Recombinant DNA Technology and Genetic Engineering. Tata McGraw Hill Education Private Limited

**Practical's** Plant Genetic Engineering and Omics Lab.

| Assessment | |
|---|---|
| Max; Mark | 50 |
| Continuous Internal Assessment (CIA) | 25 |
| End Semester Exam (ESE) | 25 |
| Passing Marks | 25 |

1. To isolate the nucleic acids from different sources.
2. To analyse the restriction enzyme digestion of DNA and calculation of molecular weight of the digested DNA.
3. To study the DNA amplification by PCR method.
4. To prepare the competent cells in *E. coli*.
5. To study bacteria transformation through $CaCl_2$ and PEG methods.
6. To study the methods of western and southern blotting.
7. To isolate and purify the plasmids DNA of bacteria and yeast.
8. To study the electrophoretic separation of plasmid DNA by agarose gel electrophoresis.
9. To Quantify and assess the quality of DNA by UV spectrophotometry and electrophoresis.
10. To analyse restriction and construction of restriction map of plasmid DNA.
11. To construct of recombinant plasmid.
12. To study the screening of transformed cells for the presence of recombinant plasmid and gene.
13. To study of transformation frequency and cloning efficiency.