GENERIC ELECTIVE (GE-7)

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Genetically Modified Plants ALS BOT GE 07	**4**	**2**	**0**	**2**	Class XII pass with Biology and Chemistry	NA

Learning Objectives

The Learning Outcomes of this course are as follows:

- to illustrate the use of modern techniques for genome analysis and manipulation
- to understand the strategies involved and the need for developing transgenic crops
- to gain knowledge about biosafety and ethical concerns associated with Genetically Modified DNA.

- to train in strategizing research topics employing genetic engineering techniques.

Learning outcomes

By studying this course, students will be able to:

- know about the commercial application of Genetically Modified Plants in research, agriculture and human health.
- learn aboutmodern techniques involved in the manipulation of nucleic acids and creation of genetically modified organisms (GMOs).
- appreciate the applications of PCR, hybridization techniques and sequencing.
- understand about the biosafety and ethical issues associated with Genetic engineering.
- design and conduct experiments involving genetic manipulation of plants.

Unit 1: Introduction to Transgenics (2 Hours)

First and Second-generation transgenic crops. Terminology: Transgenics, Transgene, Genetic transformation, recombinant DNA, Putative Transgenic, Stable gene integration. Gene Construct. Introduction to selectable marker (*npt II, hpt, spt*) and reporter (*GUS, GFP* and Luciferase) genes.

Unit 2: Gene Isolation and Genetic Transformation (10 Hours)

Methods for gene isolation - Direct selection, construction and screening of genomic and cDNA libraries (Replica plating, Complementation screening, heterologous gene probe-based hybridizations); Gene transfer methods - Direct (*Agrobacterium* mediated transformation, molecular basis of T-DNA transfer); Indirect methods (Electroporation, Microinjection and Particle Bombardment). Screening for putative transgenics through PCR and Southern blotting. Gene expression analyses at transcriptional level (Northern blotting, DNA microarrays) and translational level (Western blotting, ELISA). Generation of marker-free transgenics. Chloroplast transformation.

Unit 3: Transgenics for Resistance to Biotic and Abiotic Stress (9 Hours)

Biotic stress - Strategies for developing Insect resistant plants (Bt toxin, protease inhibitor, *α-amylase* inhibitor and other protein genes), Virus resistant plants (Coat protein mediated protection, Pokeweed antiviral protein, *RNaseIII*, micro-RNA and other viral genes), Fungal and Bacterial disease resistant plants (Genes for PR proteins like *Chitanase*, β-1,3 *Glucanase*, Thaumatin like, Osmotin; Antimicrobial proteins like Ribosome Inactivating Proteins, Lectins, Lysozyme; Phytoalexins etc.); Abiotic Stress - Strategies for overcoming Oxidative, Salt & Drought, Chilling stress through transgenics approach. Herbicide Resistance- Strategies, Roundup Ready Soybean.

Unit 4: Transgenics for Improved Quality and Other Traits (3 Hours)

Engineering for shelf-life (Antisense *Polygalacturanase* gene, *SAM hydrolase*) and nutritional quality (β-carotene production). Transgenics as bioreactor - plantibodies and edible vaccines. Biodegradable Plastics.

Unit 5: Safety and Ethical Issues (6 Hours)

Field testing and commercialization, Rules and Regulations for handling rDNA/ GMOs, Terminator technology, Ethics: Impact and safety, moral, social, regulatory & ethical issues.

PRACTICAL (60 hours)

1. Isolation of plasmid DNA from bacteria
2. Isolation of genomic DNA from plant (Cauliflower head/ *Brassica* seedlings)
3. Preparation of competent cells in *E. coli*.
4. Transformation of *E. coli* cell by $CaCl_2$ method and calculation of transformation efficiency.
5. Restricting Mapping of linear and circular DNA.
7. Study of direct and indirect gene transfer methods by photographs: Electroporation, Microinjection and Particle Bombardment, Ti-plasmid mediated gene transfer
8. Study of techniques using digital resources/ demonstration: PCR, Southern, Northern and Western blotting, ELISA, DNA Microarray.

9. Study of Sequencing techniques (Whole Genome Shot Gun Approach, Clone by Clone Sequencing, Sanger's Dideoxy Sequencing) through digital resources.
10. Study of Genetically Modified Plants using digital resources: Bt-Cotton, Golden rice, Flavr Savr tomato, Round-up Ready Soybean
11. Visit to a research laboratory/field.

Essential/recommended readings

1. Brown, T. A. (2016) *Gene Cloning and Analysis: An Introduction.* Wiley-BlackwellPublishing.
2. Chrispeels M.J., &Sadava D. E. (1994). *Plants, Genes and Agriculture.* Jones andBartlett Publishers.
3. Glick B.R., & Patten C.L. (2022). *Molecular Biotechnology: Principles & Applications of Recombinant DNA* (6th Ed.). ASM Press.
4. Green, M.R., & Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*(4th Ed.). ColdSpring Harbor.
5. Wink, M. (2011). *An Introduction to Molecular Biotechnology: MolecularFundamentals, Methodsand Applications in Modern Biotechnology* (2nd Ed.).Wiley.
6. Primrose, S. B., & Twyman, R. (2009). *Principles of gene manipulation and genomics.*Wiley.
7. Howe, C. J. (2007). *Gene cloning and manipulation.* Cambridge University Press.

Suggestive readings

1. Primrose, S. B., & Twyman, R. (2006) *Principles of Gene Manipulation and Genomics* (7th ed.). Wiley-Blackwell.
2. Dale J. W., Schantz M. V. and Plant N. (2011) *From Genes to Genomes: Concepts and Applications of DNA Technology.* John Wiley & Sons.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.