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Programme : M.Sc Biotechnology
Course Title : Plant Biotechnology
Course code :22BICC12

Unit -3
Transformation Strategies
Transposons in Transgenic Plants

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Transposons in Transgenic Plants

Transposons, also known as "jumping genes," are DNA sequences that have the ability to change their position within a genome.

They can move from one location to another, potentially causing mutations, influencing gene expression, or affecting chromosomal structure.

Transposons are found in the genomes of a wide variety of organisms, including plants.

In the context of genetic engineering, transposons have become an important tool in the creation of transgenic plants, which are plants with altered genetic material designed for a specific purpose.

Transposons in Transgenic Plants

Mechanism of Transposition

Transposons are mobile genetic elements that move within the genome through a process called transposition. There are two main types of transposons: *Class I* transposons, also known as retrotransposons, and *Class II* transposons, known as DNA transposons.

- 1. Retrotransposons (Class I):** These elements transpose via an RNA intermediate. The transposon is first transcribed into RNA, which is then reverse transcribed into DNA and integrated into a new site in the genome. Retrotransposons typically move by a "copy-and-paste" mechanism, meaning that a copy of the transposon is made and inserted elsewhere in the genome, leaving the original transposon behind.
- 2. DNA Transposons (Class II):** These transposons move directly from one location to another in the genome without the need for an RNA intermediate. The transposon is excised from one location and inserted into a new location through a process that involves the activity of a transposase enzyme, which recognizes the terminal repeats of the transposon and catalyzes its movement. DNA transposons typically use a "cut-and-paste" mechanism, where the transposon is physically cut from its original site and inserted into a new one.

Transposons in Transgenic Plants

Transposons in Plant Genomes

In plants, transposons play a crucial role in shaping genetic diversity. While they are often regarded as selfish genetic elements, capable of causing mutations or rearrangements that may disrupt normal gene function, transposons can also contribute to the evolution of genomes by generating new gene variations or regulatory patterns.

Plant genomes are particularly rich in transposons, and some estimates suggest that up to 80% of the maize genome and around 45% of the Arabidopsis genome may be composed of transposable elements.

The majority of plant transposons are relatively inactive, but under certain conditions (such as stress or damage), they can become active and contribute to genetic variability. This can have both beneficial and harmful effects.

For example, transposons can be involved in the regulation of gene expression, helping plants adapt to environmental changes. Conversely, they may also cause mutations that lead to diseases or other undesirable traits.

Transposons in Transgenic Plants

Transposons in Transgenic Plant Technology

Transposons have emerged as powerful tools in the field of transgenic plant biotechnology. The ability to integrate foreign DNA into plant genomes efficiently is central to the development of genetically modified (GM) plants.

Transposons offer several advantages over traditional methods of genetic transformation, such as *Agrobacterium*-mediated transformation or particle bombardment.

- 1. Gene Delivery:** One of the most important applications of transposons in transgenic plants is their use for efficient gene delivery. In some transgenic systems, a modified transposon can be used to introduce new genes into a plant's genome. The transposon's mobility allows it to insert the foreign gene at random locations, which can increase the likelihood of stable integration. This random integration can sometimes be an advantage because it may bypass the need for specific targeting of genes, which can be difficult to achieve with other techniques.

Transposons in Transgenic Plants

2. Gene Stacking: Transposons can also be used to create "gene stacks" in plants. Gene stacking refers to the process of introducing multiple traits into a single plant. By using transposons to insert multiple genes at different loci, researchers can combine multiple beneficial traits, such as resistance to pests and diseases, improved nutritional content, or tolerance to abiotic stress. Transposons help ensure that these genes are integrated in a way that maintains their functionality and stability over time.

3. Gene Silencing and Activation: In addition to introducing new genes, transposons can be used to regulate the expression of existing genes. Transposons can carry regulatory sequences, such as promoters or silencers, that can influence the activity of nearby genes. This ability has been harnessed to improve traits such as flowering time, stress tolerance, or the production of secondary metabolites in plants.

4. Site-Specific Integration: One of the challenges of traditional transformation methods is the unpredictable integration of foreign DNA, which may lead to unwanted side effects. Transposons can be engineered to insert at specific genomic locations, allowing for more controlled and predictable integration. By using engineered transposons with specific recognition sites or promoters, scientists can target specific regions of the plant genome, reducing the risk of disrupting important genes or regulatory networks.

Transposons in Transgenic Plants

Advantages and Challenges

The use of transposons in transgenic plants presents several advantages. First, transposons are capable of efficient and stable gene integration, which is crucial for the success of transgenic plants. They also offer the flexibility of gene stacking, which can be used to combine multiple traits into a single plant. Additionally, the potential for site-specific integration makes them a promising tool for improving the precision of genetic modification.

However, there are also challenges associated with using transposons in plant biotechnology. The random insertion of transposons can sometimes result in insertional mutagenesis, where the transposon disrupts the function of essential genes or regulatory regions. This can lead to unintended effects, such as reduced plant fitness or undesirable traits. Moreover, the regulation of transposon activity must be carefully controlled, as uncontrolled transposition can cause genomic instability.



Thank you