Transposons

Introduction

- In addition to plasmids and chromosomal DNA, bacteria have **mobile genetic elements** called **transposons** (jumping genes).
- First discovered by **Barbara McClintock (1940s)** in maize; she won the **Nobel Prize in 1983**.
- Transposons can move **within the same DNA molecule** or between different DNA molecules (chromosome ↔ plasmid).
- They play an important role in **genetic variation, mutation, and antibiotic resistance spread**.

Definition

Transposons are DNA sequences that can change their position within the genome (jumping genes), thereby causing mutations, altering gene expression, and facilitating gene transfer.

General Features

- Found in both **prokaryotes and eukaryotes**.
- Encode enzymes called **transposases**, which mediate their movement.
- May carry additional genes (e.g., antibiotic resistance).
- Movement can be **cut-and-paste** (non-replicative) or **copy-and-paste** (replicative).

Types of Transposons

1. **Insertion Sequences (IS elements)**
    - Simplest form of transposons.
    - Contain only the gene for **transposase** and short inverted repeats.
2. **Composite Transposons**
    - Contain resistance or toxin genes flanked by two IS elements.
    - Example: Tn10 carries **tetracycline resistance**.
3. **Complex Transposons**
    - Carry additional genes besides transposase, often antibiotic resistance.
    - Example: Tn3 carries **β-lactamase (ampicillin resistance)**.
4. **Retrotransposons (in eukaryotes)**
    - Move via **RNA intermediate** using reverse transcriptase.

Mechanism of Transposition

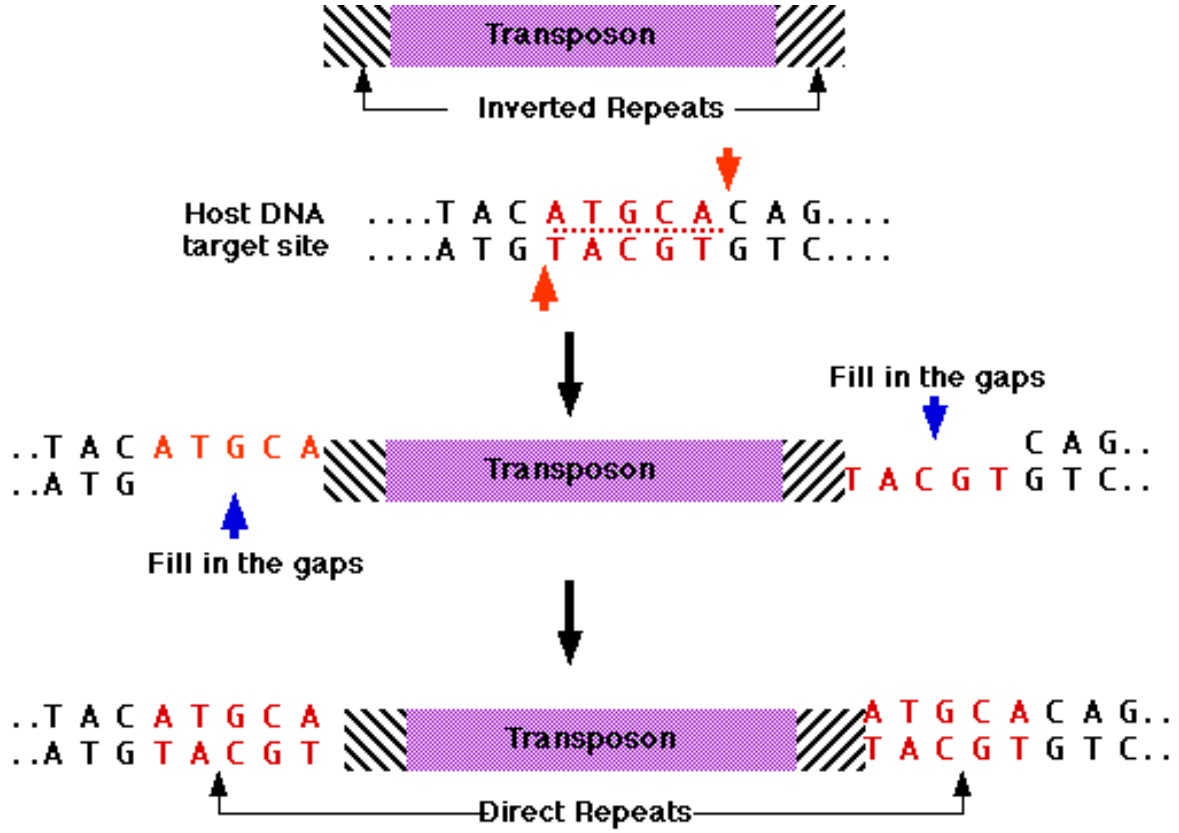
- **Cut and paste mechanism** (non-replicative): Transposon excises and inserts elsewhere.
- **Replicative mechanism:** Transposon is copied, and one copy inserts into new site.

Examples of Transposons

- Tn3 → β-lactamase (ampicillin resistance).
- Tn5 → Kanamycin resistance.
- Tn10 → Tetracycline resistance.
- Tn1546 → Vancomycin resistance (VRE).

Significance of Transposons

1. **In Nature**
   - Cause **mutations** and **genome rearrangements**.
   - Spread **antibiotic resistance genes**.
2. **In Medicine**
   - Responsible for the emergence of **multidrug-resistant bacteria**.
   - Important in understanding **pathogenesis**.
3. **In Biotechnology**
   - Used as **mutagenic tools** to study gene function.
   - Used as **vectors** for gene transfer.
   - Basis of **gene tagging and mapping**.



Conclusion

Transposons are powerful **mobile genetic elements** that contribute to bacterial evolution, resistance development, and genetic variability.
While they pose challenges in medicine due to drug resistance, they are also valuable tools in **molecular biology and genetic engineering**.