

Transposons

Microbiology VI

Transposons

- Transposons or transposable elements (TE) are DNA sequences that can change its position within a genome so that mutations are either created or reversed and cell's genome size is altered.
- These mobile segments of DNA are also called “**jumping genes**”.
- It is simply a piece of DNA that can move from one location to another in a cell's genome.
- **Barbara McClintock** was the one to find it first in **maize** (*Zea mays*) at the Cold Spring Harbor Laboratory in New York for which she earned Nobel Prize in 1983.
- It was named as dissociator (Ds) at first.
- More abundant in eukaryotic genomes than prokaryotes.

General characteristics of Transposable elements (TE):

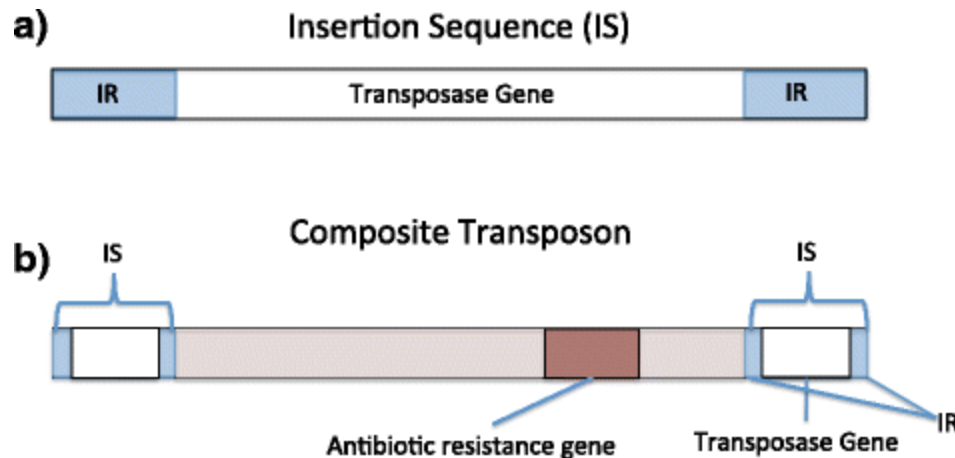
- They were found to be DNA sequences that code for **enzymes**, which bring about the **insertion** of an **identical copy** of themselves into a new DNA site.
- Transposition events involve both recombination and replication processes which frequently generate two daughter copies of the transposable elements.
- One copy remains at the **parent site** and another appears at the **target site**.
- A transposable element is not a replicon. Thus, it can not replicate apart from the host chromosome.
- There is no homology between the transposon and its target site for insertion. These elements can insert at almost any position in the host chromosome or a plasmid.

Types of transposable elements:

- Different type of transposable elements are present in both prokaryotes and eukaryotes.

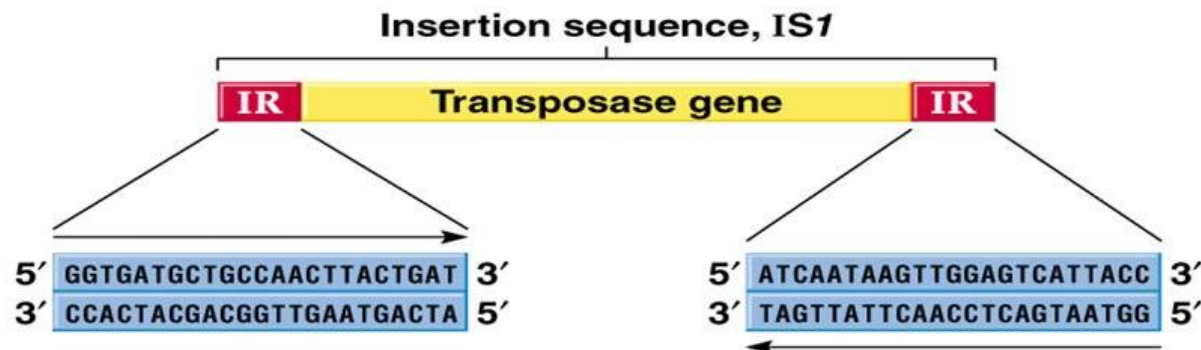
Transposable elements are of the following two types:

1. **Insertion sequences (IS)** or Simple Transposons
2. **Transposons (Tn)** or Complex Transposons



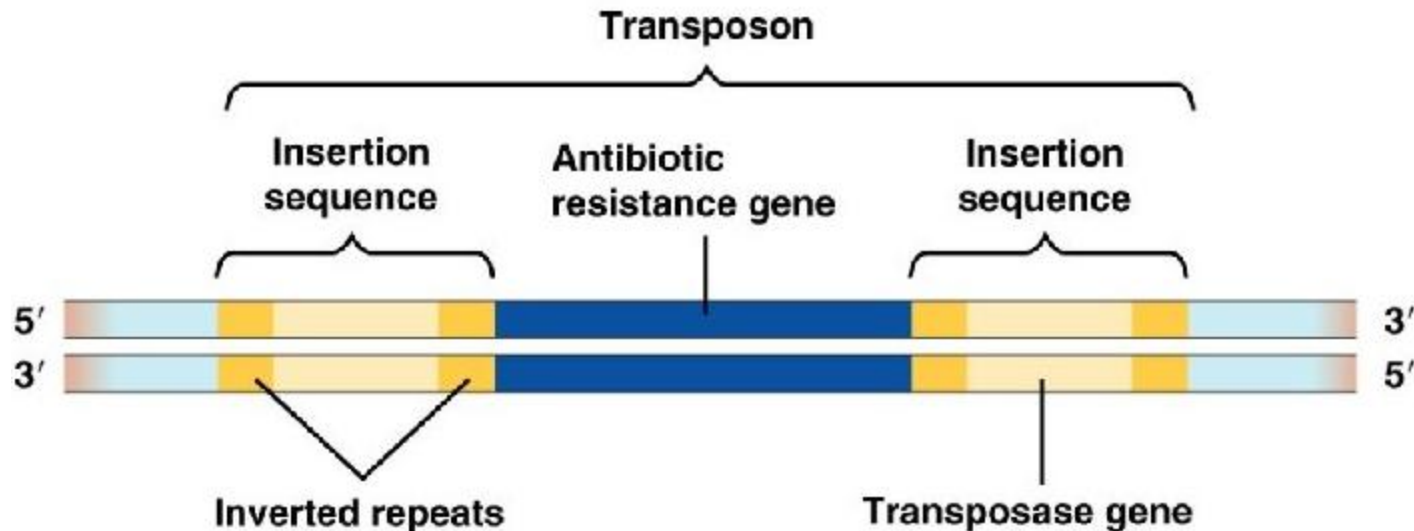
INSERTION SEQUENCE (IS):

- The simplest transposable elements are Insertion Sequences (IS).
- The insertion sequences (IS) or simple transposons are shorter sequences (800 to 1500 bp) and do not code for proteins.
- These sequences carry the genetic information necessary for their transposition (*e.*, the gene for the enzyme transposase)
- Insertion sequences have been identified in bacteriophages, in F factor plasmid and many bacteria.



Transposons (Tn) or Complex Transposons

- Transposons (Tn) or complex transposons are several thousand base pair long, and have genes that code for **one or more proteins** which might include resistance factors in bacteria acting against **antibiotics**.
- A distinguishing character of a transposon is the presence of identical, **inverted terminal repeat (IR)** sequences ranging from 8 to 38 base pairs (bp)
- These inverted repeats are unique to different types of transposons.



- A short sequence (less than ten bp) is present on either side of a transposon.
- The insertion of transposon causes duplication of a singular target sequence, which then appear as direct repeats flanking the inserted transposable element.
- The flanking direct repeats are not considered part of the transposon. These repeat sequences themselves act like IS or IS-like segments.

Composite Transposons vs IS Elements

More Information Online WWW.DIFFERENCEBETWEEN.COM

| | Composite Transposons | IS Elements |
|----------------------------|--|--|
| DEFINITION | Composite transposons are mobile genetic elements consisting of two insertion sequences (ISs) flanking often one or more antibiotic resistance genes | IS elements are a type of simple transposable element that contain genes coding for transposase enzyme to catalyze transposition |
| STRUCTURE | A coding sequence flanked by two IS elements | A coding sequence flanked by two inverted repeats |
| ANTIBIOTIC RESISTANT GENES | Carries antibiotic resistant genes | Does not carry antibiotic resistant genes |
| CODE FOR | Antibiotic resistance | Transposase enzymes |
| SAMPLE | Large | Small |

Examples of Transposable elements

- Tn 3 transposon of *E. coli*
- Bacteriophage Mu
- Yeast Ty elements

There are two distinct types of transposons:

1) DNA transposons:

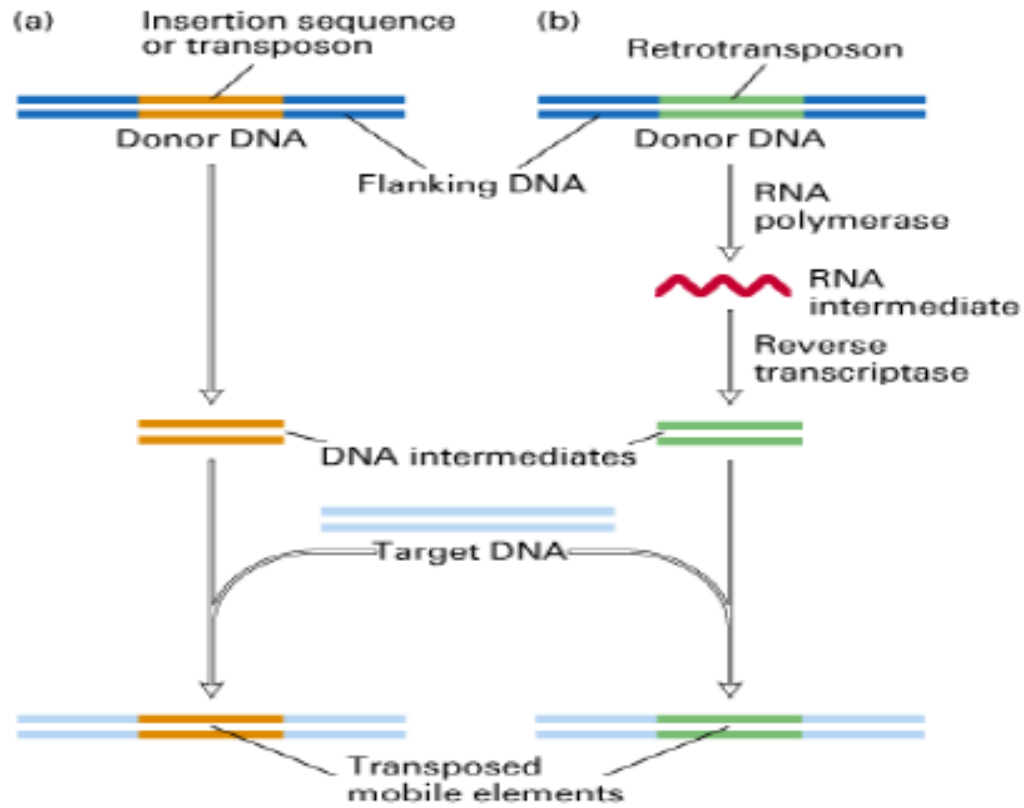
- These are transposons which consists only of DNA that moves directly from place to place.

2) Retrotransposons:

- Here the DNA is first transcribed into RNA and then uses reverse transcriptase to make a DNA copy of the RNA which inserts in a new location.

DNA Transposons

Retrotransposons



Transposition:

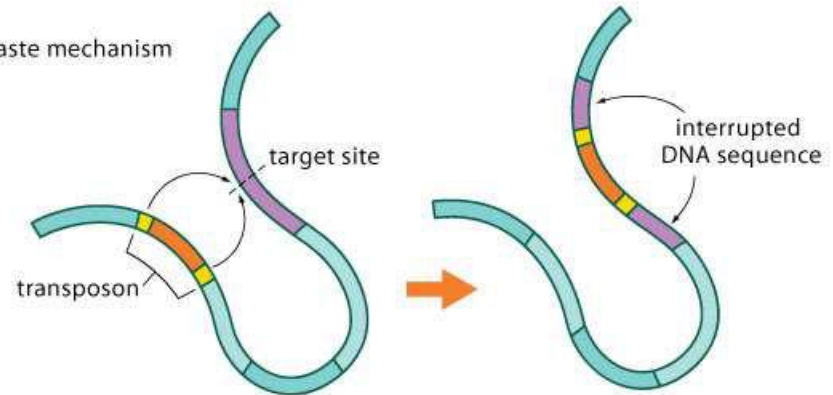
- It is a process in which a **transposable element** is removed from one site and inserted into a second site in the DNA.
- Genetic transposition was the first type of genetic instability to be discovered.

Two methods of transposition:

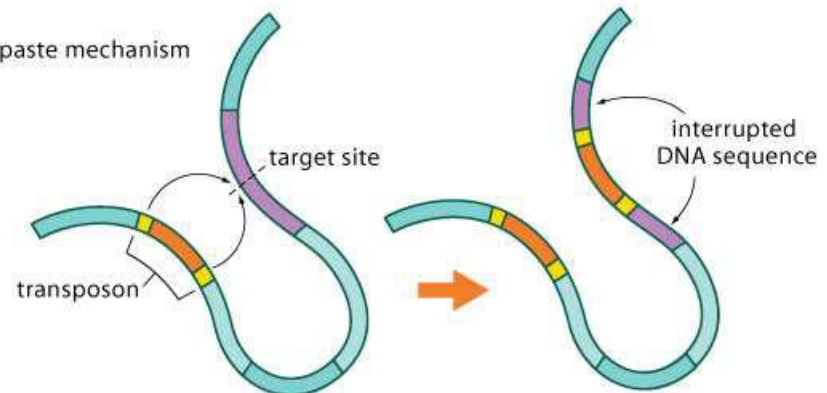
1. Cut and paste mechanism (**Conservative transposition**)
2. Copy and paste mechanism (**Replicative transposition**)

Two methods of transposition:

1. Cut-and-paste mechanism



2. Copy-and-paste mechanism



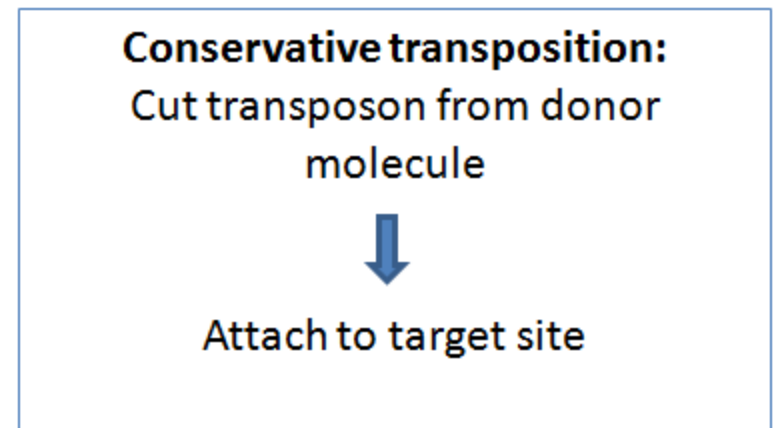
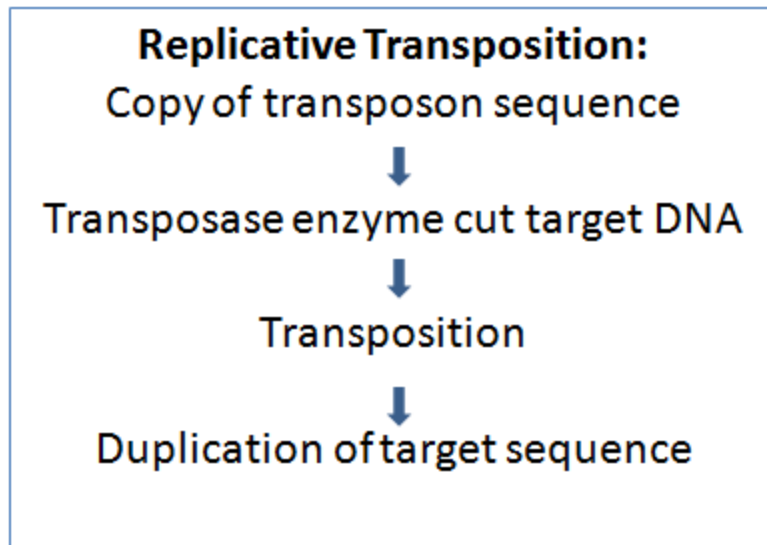
Transposition methods:

1. Cut and paste mechanism (**Conservative transposition**)
2. Copy and paste mechanism (**Replicative transposition**)

Mechanism of Transposition:

Two distinct mechanisms of transposition:

1. **Replicative transposition** – direct interaction between the donor transposon and the target site, resulting in **copying** of the donor element.
2. **Conservative transposition** – involving **excision** of the element and reintegration at a new site.
 - Here it cannot copy transposon sequence.
 - Transposition by cut and paste model is used.
 - Transposon sequence is cut from donor molecule and attached to target site.



Applications:

- As cloning vehicle.
- Researchers use transposons as a means of **mutagenesis**.
- To identifying the **mutant allele**.
- To study the chemical mutagenesis methods.
- To study **gene expression**.
- Transposons are also a widely used tool for mutagenesis of most experimentally tractable organisms.
- Genetic mutation creates **genetic diversity** which keeps the population healthy.

Negative effects of transposable elements

- A transposable gene, when inserted into a functional gene, might **disable the gene**.
- Multiple copies of the same sequence **hinder the chromosome pairing** during cell division resulting in chromosome duplication.
- **Expression** of harmful **disease-causing proteins** in the transposons affects the normal cellular function.