2. Duplication :-

Duplication involves addition of one or more genes, as a result of which the organism carries the genes repeated in its haploid chromosome complement. In this the genes carrying segments are represented at least twice in a chromosome. Duplications are important for evolution. Evolution has proceeded from simple to more complex forms and has been accompanied by a progressive increase in the number of genes per cell.

Example ; Formation of Bar eye in Drosophila is a good example of tandem duplication.

A B C D E F G H → A B C D E **D E** F G H Tandem duplication
Duplication

→ A B C **D E E D** F G H Reverse Tandem duplication

3. Inversion :-

Inversion is the rotation of a block of genes by 180° / degrees within a chromosome. In this process, first chromosome breaks into segments containing groups of genes. The segment containing genes joins the same chromosome but in a reverse direction so that the genesequence now becomes completely opposite to the original sequence.

Inversion involves simply the rearrangement of genes within the chromosome and no change in the number of genes.

Types :-

1. Paracentric inversion —

If the inverted segment does not include the centromere, then it is known as paracentric. The paracentric inversions do not produce any visible change in the chromosome.

2. Pericentric inversion ——

If the inverted segment includes the centromere, then it is called pericentric inversion.
Pericentric inversions sometimes lead to the change in the appearance of chromosome.

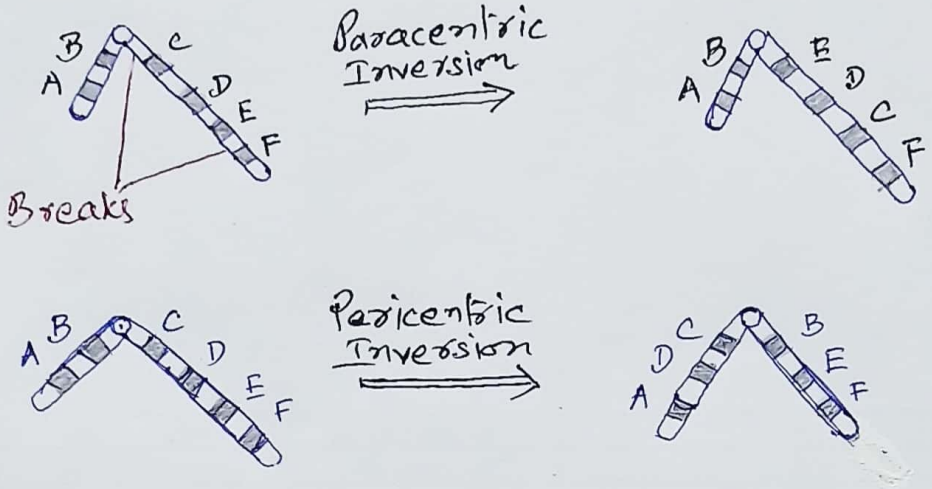


Fig: Change in the shape of chromosome due to pericentric inversion.

- If crossing over takes place in inverted segment in paracentric inversion then acentric and dicentric chromatids are formed. But if such crossing over takes place in pericentric inversion then duplication and deficiency gametes are formed.
- Inversions lower the recombination frequency within the inverted sequences. Inversions may also result in the change of chromosomal shape due to displacement of centromere.

4. Translocation :-

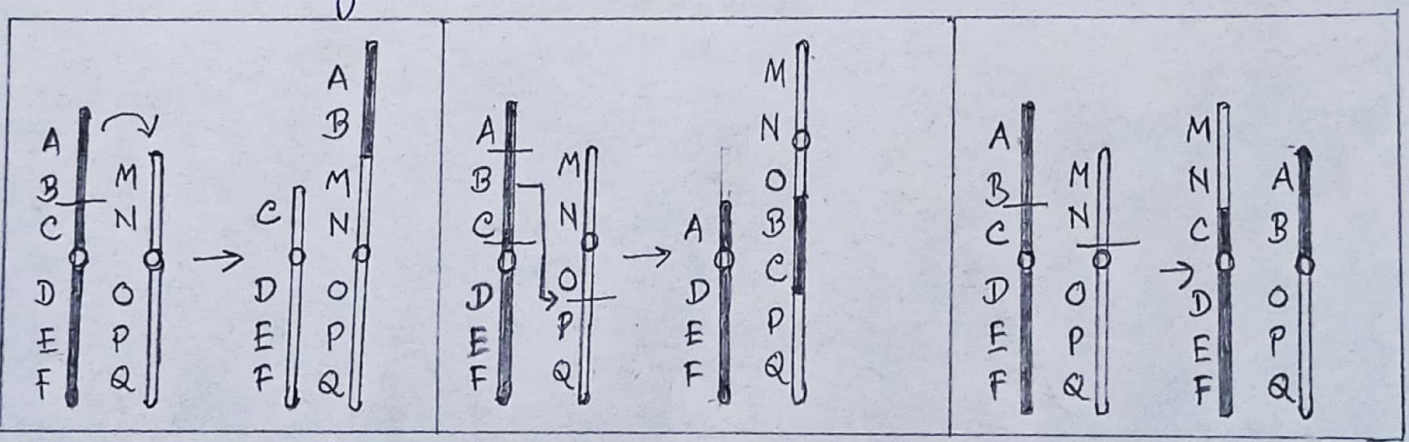
Translocation involves exchange of (parts between) genetic material between nonhomologous chromosomes. In other words, when a chromosome segment containing genes breaks and joins to another non-homologous chromosome, it is known as translocation. As a result two new chromosomes are formed. This leads to change in the arrangement of genes changing their relative position from one linkage group to other.

Types of Translocation –

1. Simple translocation:
occurs when segment from a chromosome is added to the end of some nonhomologous chromosome.

2. Shift translocation:
occurs when an interstitial segment of one chromosome is inserted within some nonhomologous chromosome.

3. Reciprocal translocation:
occurs when there is exchange of reciprocal segments between nonhomologous chromosomes.



Simple unidirectional translocation | Shift translocation | Reciprocal translocation

– Translocation has played important role in the origin of new species both in plants and animals.
– Researchers have traced the origin of karyotypes of different species of Drosophila from the karyotype of ancestral species, D. virilis.