Unit 3 : Mutation

I. Introduction : Variations may also arise in chromosome structure : individual chromosomes may lose or gain parts & the order of genes within a chromosome may become altered. These variations in the number & structure of chromosomes are termed chromosome mutation.

II. Types of chromosome Mutations : Chromosome mutations can be grouped into three basic categories : Chromosome rearrangements, aneuploids & Polyploids. Chromosome rearrangements alter the structure of chromosomes ; for example, a piece of a chromosome might be duplicated, deleted or inverted. In aneuploidy, the number of chromosomes is altered. ; one or more individual chromosomes are added or deleted.

(A) Duplication : A chromosome duplication is a mutation in which part of the chromosome has been doubled. Consider a chromosome with segments ABoCDEFG, in which o represents the centromere. A duplication might include the EF segment giving rise to a chromosome with segments ABoCDEFEFG. This type of duplication, in which the duplicated region is immediately adjacent to the original segment, is called a Tandem duplication.

If the duplicated segment is located some distance from the origin segment, either on the same chromosome or on a different one, the chromosome rearrangement is called a Displaced Duplication. An example of a displaced duplication would be ABoCDEFGEF. A duplication can be either in the same orientation as that of the original sequence, as in the two preceding examples, or inverted ABoCDEFFEG. When the duplication is inverted, it is called a Reverse Duplication.

example: The Bar phenotype in Drosophila melanogaster results from an X-linked duplication. (a) Wild-type fruit flies have normal-size eyes. (b) Flies heterozygous for, (c) homozygous for the Bar-mutation have smaller, bar-shaped eyes. (d) Flies with double Bar have three copies of the duplication & much smaller bar-shaped eyes.

(a) Wild type female (B^+B^+)

(b) Heterozygous Bar female (B^+B)

(c) Homozygous Bar female (BB)

(d) Heterozygous double Bar female (B^+B^D).

(3) Deletions: A second type of chromosome rearrangement is a chromosome deletion, a loss of a chromosome segment. A chromosome with segments ABCDEFG that undergoes a deletion of segment EF would generate the mutated chromosome ABCDG.

A large deletion can be detected because the chromosome is noticeably shortened.

□ Effects of Deletion: First, the heterozygous condition may produce imbalances in the amounts of gene products, similar to the imbalances produced by extra gene copies.

The expression of a normally recessive Mutation is referred to as Pseudodominance.

Some genes must be present in two copies for normal function. When a single copy of a gene is not sufficient to produce a wild-type phenotype, it is said to be a haploinsufficient gene.

eg. Notch is a series of X-linked wing mutations in Drosophila that often result from chromosome deletions.

(4) Chromosome deletions in humans: In humans, a deletion on the short arm of chromosome 5 is responsible for Cri-du-chat syndrome. The name derives from the peculiar, catlike cry of infants with this syndrome. A child who is heterozygous for this deletion has a small head, widely spaced eyes & a round face & mentally retarded.

(c) Inversions : A third type of chromosome rearrangement is a chromosome inversion, in which a chromosome segment is inverted — turned 180°.

If a chromosome originally had segments ABo CDEFG, then chromosome ABo CFEDG represents an inversion that includes segment DEF.

For an inversion to take place, the chromosome must breaks in two places.

Inversions that do not include the centromere, such as ABoCFEDG, are termed Paracentric inversions. whereas, inversions that include the centromere, such as ADCoBEFG are termed Pericentric inversion.

□ Effects of inversion : Individual organisms with inversion have neither lost nor gained any genetic material. Many genes are regulated in a position-dependent manner, if their positions are altered by an inversion, they may be expressed at inappropriate times or in inappropriate tissues, an outcome referred to as a position effect.

Recombination is also reduced within Pericentric inversion No dicentric bridges or acentric fragments are produced, but the recombinant chromosomes have too many copies of some genes &

pies of others; so gametes that receive the recombinant chromosomes can not produce viable progeny.

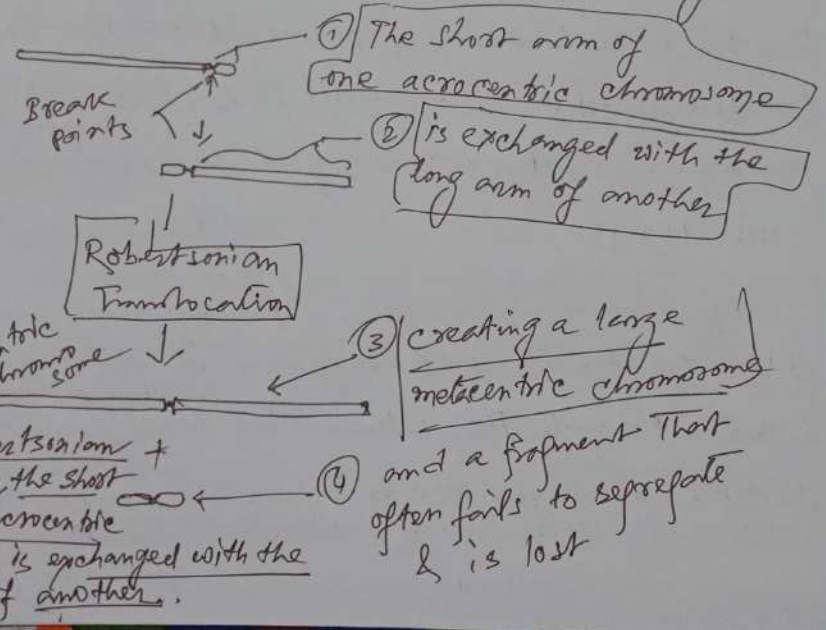
(D) Translocation: A Translocation entails the movement of genetic material between non-homologous chromosomes or within the same chromosome. Translocation should not be confused with crossing over, in which there is an exchange of genetic material b/w homologous chromosome.

In a Reciprocal Translocation, genetic material moves from one chromosome to another without any reciprocal exchange. Consider the following two non-homologous chromosomes: ABoCDEFG & MNoOPQRS. If chromosome segment EF moves from the first chromosome to the second any transfer of segments from the second chromosome to the first, a non-reciprocal translocation has taken place, producing chromosomes, ABoCDG & MNOOPEFQRS.

More commonly, there is a two-way exchange of segments between the chromosomes, resulting in a Reciprocal translocation. A Reciprocal translocation, between chromosomes ABoCDEFG & MNoOPQRS might give rise to chromosomes ABoCDQRG & MNoOPEFB

II. Effects of translocations: Translocation can affect a phenotype in several ways. First, they can physically link genes that were formerly located on different chromosomes. These new linkage relations may affect gene expression (a Position effect): genes translocated to new location may come under the control of different regulatory sequences or other genes that affect their expression.

Deletions frequently accompany translocations. In a Robertsonian translocation, for example, the long arms of two acrocentric chromosomes become joined to a common centromere through a translocation, generating a metacentric chromosome with two long arms & another chromosome with two very short arms.



Ex: In a Robertsonian Translocation, the short arm of one acrocentric chromosome is exchanged with the long arm of another.