Gene Linkage

CELL BIOLOGY, GENETICS AND EVOLUTION

Definition of Gene Linkage

- Gene linkage refers to the tendency of certain genes to be inherited together because they are located close to each other on the same chromosome.
- This phenomenon challenges the law of independent assortment, which states that genes located on same or different chromosomes assort independently of one another.
- When genes are linked, they do not independently assort during meiosis, and instead, they tend to be transmitted as a group.

Discovery of Gene Linkage

- Gene linkage was first discovered by Thomas Hunt Morgan in the early 20th century through his experiments with fruit flies (Drosophila melanogaster). Morgan observed that certain traits, like body color and wing shape, were inherited together more often than expected. This led him to conclude that these genes were physically linked on the same chromosome.

Chromosomes and Gene Linkage

- Chromosomes are long strands of DNA that contain many genes. Each gene is located at a specific point on the chromosome called a locus.
- Genes that are located close to each other on the same chromosome are said to be linked. The closer they are, the less likely they are to be separated during recombination (crossing over).
- Crossing over (which happens during prophase I of meiosis) can sometimes break the linkage between genes. The farther apart two genes are on a chromosome, the more likely crossing over will separate them, allowing for independent assortment. However, genes that are very close together tend to be inherited together because the likelihood of crossing over between them is low.

Types of Gene Linkage

- 1. Complete Linkage
- 2. Incomplete Linkage (Partial Linkage)

Complete Linkage

- Complete linkage occurs when two genes are so close together on a chromosome that no crossing over occurs between them during meiosis. As a result, these genes are always inherited together.
- **Example:** If genes A and B are completely linked, and an organism inherits both genes from one parent, the offspring will inherit both genes together in every case, with no recombination between them.
- The offspring will always have the parental combination of alleles (the combination of traits inherited from the parents), without variation due to recombination.

Incomplete Linkage (Partial Linkage)

- Incomplete linkage happens when genes are located close to each other on the chromosome, but crossing over occurs between them some of the time. This leads to a mixture of parental and recombined genetic material.
- **Example:** If genes A and B are linked but not completely, some offspring will inherit a parental combination of alleles (from the same chromosome), while others will inherit recombinant alleles (due to crossing over between the two genes).
- The offspring will have a higher proportion of the parental combination of traits but some will show new combinations of traits due to recombination.

Linkage Groups

- A linkage group is a set of genes located on the same chromosome that are inherited together. The number of linkage groups corresponds to the number of chromosome pairs in an organism.
- In the case of humans, females have 23 linkage groups (22 pairs of autosomes and one pair of homologous sex chromosomes - XX). But in the case of males, it deviates. In males, other than 22 autosomes, there are two different types of sex chromosomes that are not homologous i.e. X and Y. So, 22+1+1 = 24 linkage groups.

THANK YOU