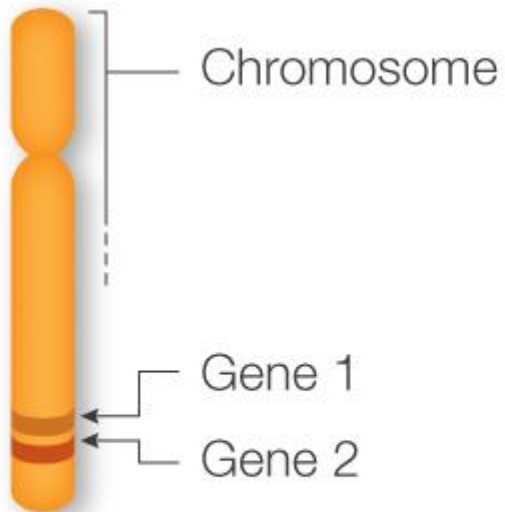
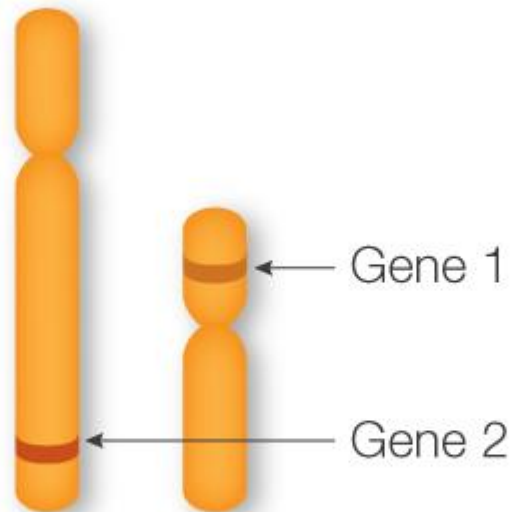


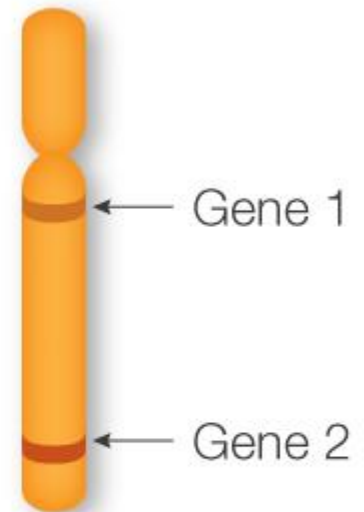
LINKAGE



Linked



Not Linked



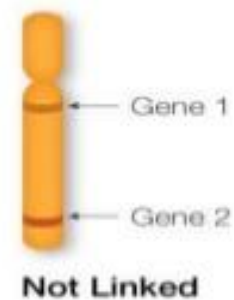
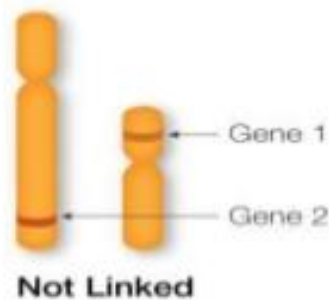
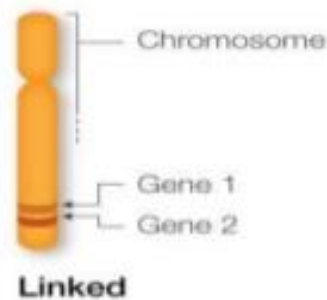
Not Linked

Linkage

A recombination frequency of 50% means that genes are unlinked. There are two ways in which genes may be unlinked:

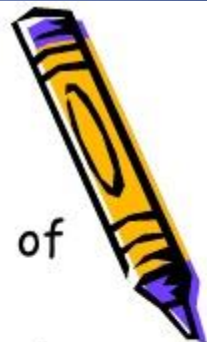
- They may be on separate chromosomes.

- They may be far apart on the same chromosome.



What is Linkage?

- Linkage is defined genetically as the failure of two genes to assort independently.
- Linkage occurs when two genes are close to each other on the same chromosome.
- Genes far apart on the same chromosome assort independently: they are not linked.
- Linkage is based on the frequency of crossing over between the two genes.
- Crossing over occurs in prophase of meiosis 1, where homologous chromosomes break at identical locations and rejoin with each other.



- The genes for different characters may be either situated in the same chromosomes or in different chromosomes.
- When the genes are situated in the different chromosomes, the characters they control appear in the next generation either together or apart, depending on the chance alone.
- If the genes are situated in the same chromosome and are fairly close to each other, they tend to be inherited together.
- This type of coexistence of two or more genes in the same chromosome is known as linkage.**

T. H. Morgan in 1911 put the hypothesis that linked genes tend to remain in their original combinations because of their location in the same chromosome.

SUTTON - BOVERI CHROMOSOME THEORY OF HEREDITY (1902)

- These investigators recognised independently that the behaviour of Mendel's genes during the production of gametes in pea, precisely parallel the behaviour of chromosomes at meiosis.
- So, they concluded that genes or Mendelian factors were located on chromosomes.
- This generalization is now known as "**Chromosome theory of inheritance**".

Sutton's view on Linkage

- The chromosomes move as units during meiosis to the gametes.
- All the genes which are situated in the same chromosome will be linked together.
- So, each sp. Would have a specific number of groups of linked genes which would corresponds with the number of chromosomes found in that species.
- Unfortunately, Sutton could not prove his predictions experimentally.

Bateson & Punnett's Coupling and Repulsion theory

- Bateson and Punnett in 1906, described a cross in sweet pea, where failure of gene pairs to assort independently was exhibited.
- Plants of a sweet pea variety having blue flower (BB) and long pollen (LL) were crossed with those of another variety having red flower (bb) and round pollen (ll).
- F₁ individuals (BbLl) had blue flower and long pollen.
- These were test crossed with plants having red flower and round pollen (bbll).
- The test cross ratio is 7:1:1:7.
- This test ratio clearly indicated that there was a tendency in the dominant allele (BL) to pass together to the same gamete.

- This tendency of inheritance was explained as “gametic coupling”.
- In the second cross, two dominant and recessive alleles repelled each other.
- This tendency is termed as Repulsion.
- In this cross the genotype ratio of the test cross is 1:7:7:1

Morgan's view on Linkage

- According to him, pairs of genes of homozygous parent tend to enter the same gametes and to remain together.
- Same genes from heterozygous parent tend to enter in the different gametes and remain apart from each other.
- The reason behind the linkage is their location in the same chromosome.
- The degree and strength of linkage depends upon the distance between the linked genes.

Chromosome Theory on Linkage

Morgan along with Castle formulated this theory. According to this :

- Linked genes are situated in the same chromosome.
- Linked genes remain bonded by the chromosomal material so that they cannot be separated during the process of inheritance.
- The distance between the linked genes determines the length of linkage.
- Genes are arranged in linear fashion in the chromosome.

Kinds of Linkage

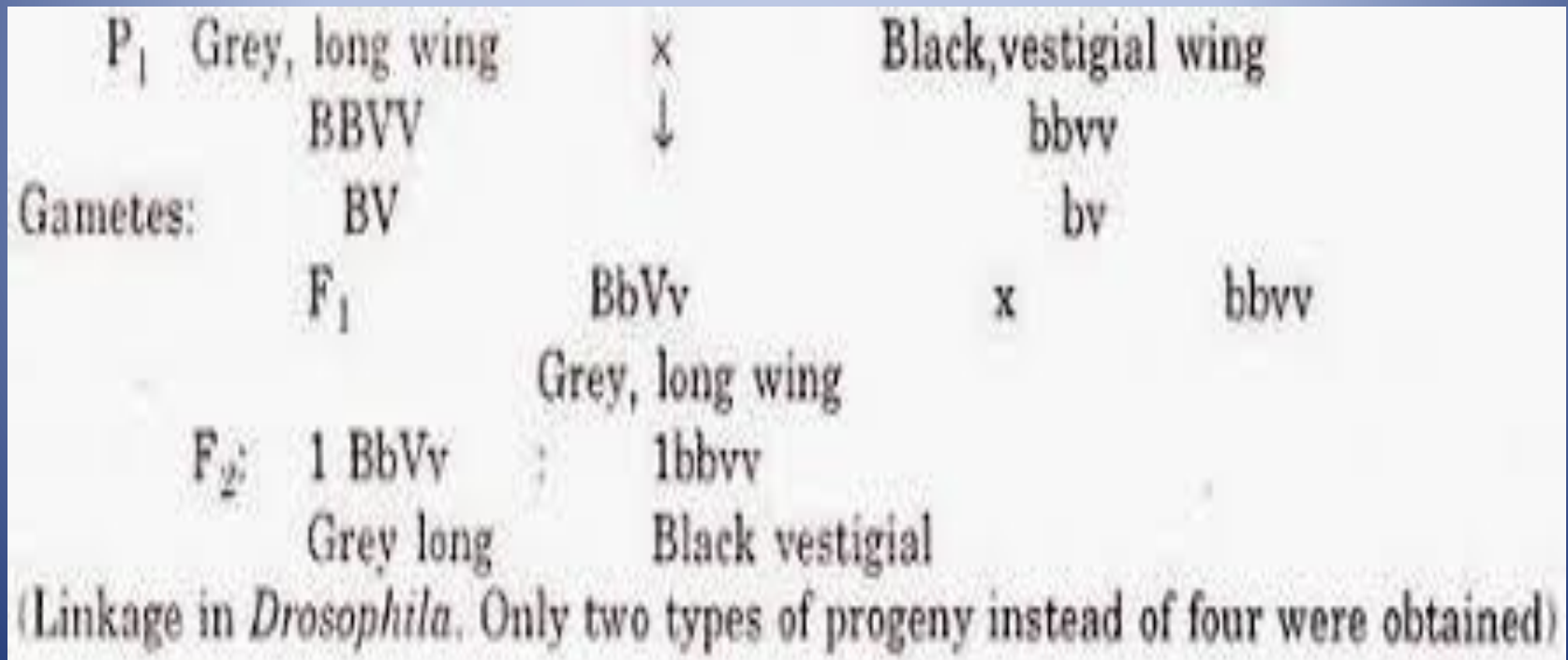
Two types of Linkage :

1. Incomplete linkage
2. Complete linkage

Complete Linkage

Genes are closely associated and tend to transmit together. Parental combinations of characters appear together for two or more generations in a continuous and regular fashion.

Ex. In male *Drosophila*



INCOMPLETE LINKAGE

The linked genes which are widely located in chromosomes and have chance of separation by crossing over are called incomplete linkage.

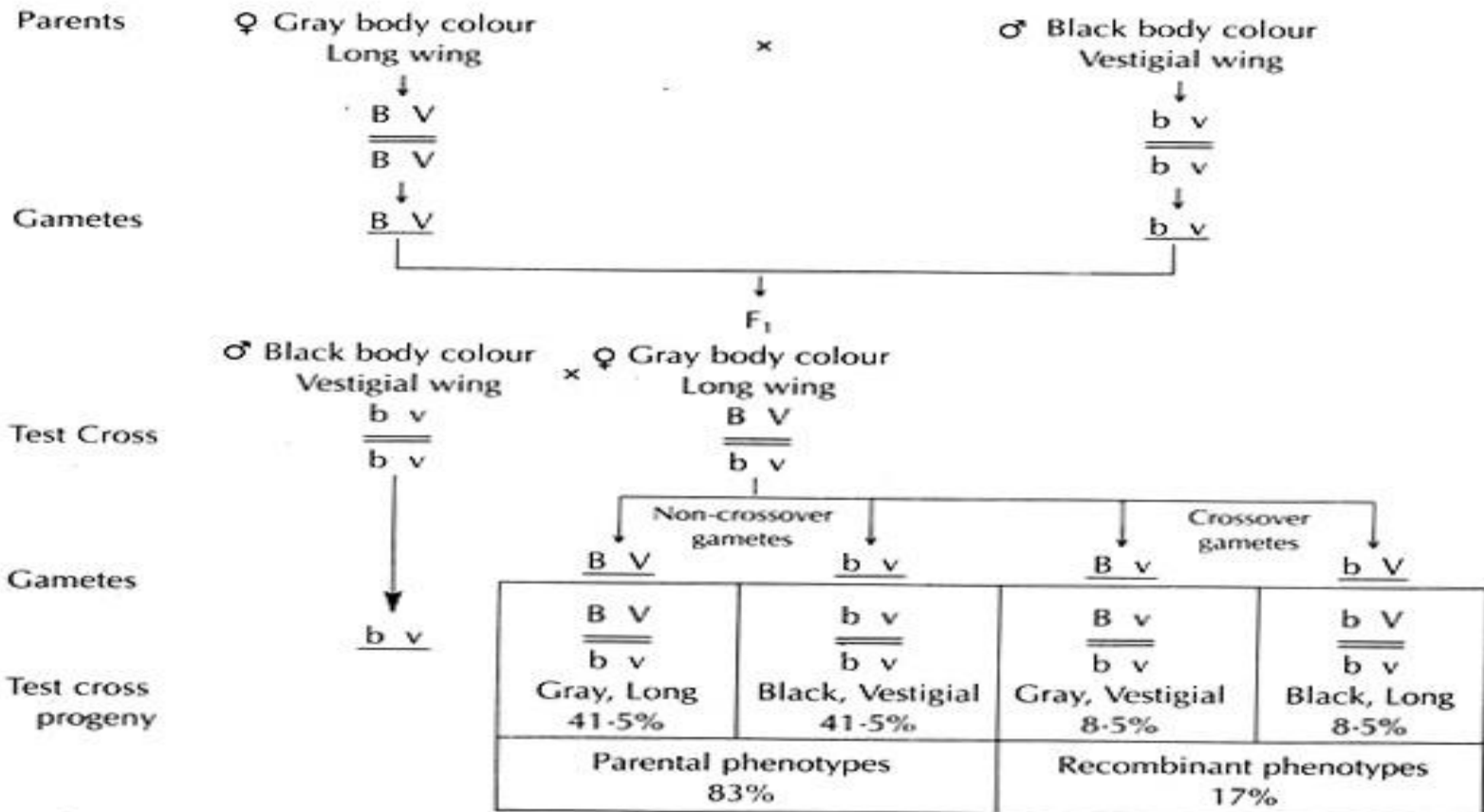


Fig. 8.2: Diagram illustrating linkage (incomplete) in *Drosophila*

LINKAGE GROUPS

- All the linked genes of a chromosome form a linkage group.
- The number of linkage group of a species, thus corresponds with the haploid number of chromosomes of that species.