Linkage:

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The phenomenon of tendency of linked genes to inherit together in the same combination for more than two generation is called linkage.
When two or more characters of parents are transmitted to the offsprings of few generations such as F_1, F_2, F_3 etc. without any recombination, they are called as the linked characters and the phenomenon is called as linkage.
This is a deviation from the Mendelian principle of independent assortment.

Mendel's law of independent assortment is applicable to the genes that are situated in separate chromosomes. When genes for different characters are located in the same chromosome, they are tied to one another and are said to be linked. They are inherited together by the offspring and will not be assorted independently. Thus, the tendency of two or more genes of the same chromosome to remain together in the process of inheritance is called linkage. Bateson and Punnet (1906), while working with sweet pea (Lathyrus odoratus) observed that flower colour and pollen shape tend to remain together and do not assort independently as per Mendel's law of independent assortment.

History:

Term linkage was coined by Morgan (1910).it was first discovered by Bateson and Punnet in 1906 in sweat pea.

Morgan's View:

The degree of linkage between two genes depends on the distance between location of genes and they vary and form crossing over, if they are located at the distance. This phenomenon is explained by T.H. Morgan in 1911 in Drosophila melanogaster with grey body long wing and black body, vestigial wing. He stated that the pairs of genes of homozygous parents tried to enter the same gametes and to remain together, whereas same genes from heterozygous parents tend to enter different gametes and remain apart from each other.

Chromosomes Theory of linkage:

According to Morgan and Castle,

1.They concluded that chromosomes bear many genes.

2.The genes which show linkage are situated in the same chromosomes are bounded by the chromosomal material.

3.Gene are arranged in a linear fashion.

4.The strength of linkage depends upon the distance between the linked genes in the chromosomes.

5.Linked gene remained in their original combination during the course of inheritance.

Types of Linkages:

1.Complete linkage:

If the parental combination of characters appear together for two or more generation in a continuous manner and regular manner. Such linked is called complete linkage.

Example: Drosophila melanogaster

Here, gene are closely associated and tend to transmit together.

Parents: Grey, vestigial (BBvv) x Black long (bbVV)

Gametes: (BV) (bV)

F1 generation : All grey, long (BbVv)

Test cross: F1 male Grey, long (BbVv) x female-Blackvestigial (bbvv)

Gametes: (BV) (bv) (bv)

(Due to complete linkage only two types of gametes are formed).

Test cross ratio: Grey, vestigial: Black long (1:1)

(Bvbv) (bVbv)

The results shows complete linkage.

Incomplete linkage :

Incomplete linkage produces new combinations of the genes in the progeny due to the formation of chiasma or crossing over in between the linked genes present on homologous chromosomes. When in sweet peas a cross is made between blue flower and long pollen (BBLL) with red flower and heterozygous condition is got.

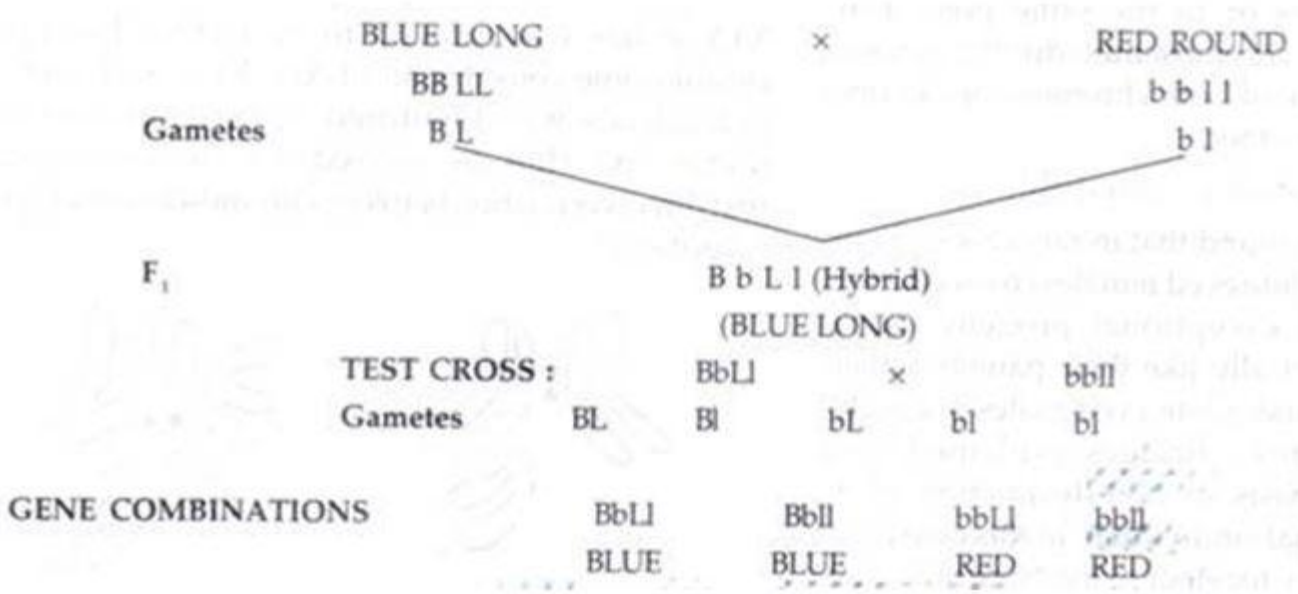

Fig. A case of incomplete linkage.

Fig: BbLl-blue long ;Bbll-Blue Round ; bbLl-Red long ; bbll-Red Round

However, test cross between blue and long (BbLl) and double recessive (bbll) gave blue long (43.7%), red round (43.7%), blue round (6.3%) and red long (6.3%). The parent combinations are 87.4% are due to linkage in genes on two homologous chromosomes, while in case of new combinations (12.6%) the genes get separated due to breaking of chromosomes at the time of crossing over in prophase-I of meiosis. New combinations in the progeny appeared due to incomplete linkage.

Significance of Linkage:

1. Linkage does not permit the breeders to bring the desirable characters in one variety.

2. Linked characters are maintained for generations because linkage prevents the incidence of recombination.

linkage group, in genetics, all of the genes on a single chromosome. They are inherited as a group; that is, during cell division they act and move as a unit rather than independently. The existence of linkage groups is the reason some traits do not comply with Mendel's law of independent assortment (recombination of genes and the traits they control); *i.e.,* the principle applies only if genes are located on different chromosomes. Variation in the gene composition of a chromosome can occur when a chromosome breaks, and the sections join with the partner chromosome if it has broken in the same places. This exchange of genes between chromosomes, called crossing over.