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Linkage

- Tendency of two or more genes to remain together in the original combination in the same chromosome during the process of inheritance for a number of generations
- T. H. Morgan
- Principles
  - A chromosomes contains Many genes
  - Genes are arranged in linear fashion
  - The genes present in the chromosomes are Linked
  - Linked genes are Inherited together from parents to off springs.

- Bateson and Punnet studied linkage in sweet pea (*Lathyrus odoratus*). In sweet pea blue flower BB is Dominant over Red flower bb. Long pollen grain is dominant LL over Round pollen grain ll.

Linkage in sweat peas

	Blue long		Red Round
Parents	B B		b b
	L L	×	l l

F1 B b

L l Blue long

F1 Test crossed

Blue long B b × b b

L l × l l

B b

L l crossing over

B b	B b	b b	b b
L l	l l	L l	l l
Blue Long	Blue Round	Red long	Red round

7 : 1 : 1 : 7

- The strength of the linkage depends on the distance between the linked genes
- Closely located genes show strong linkage.
- Distantly located genes show weak linkage.
- Linkage arrangements- Two types

1. Cis arrangement : when dominant genes are located on one homologous chromosomes and the recessive genes on other homologous chromosome.
2. Trans arrangement : Dominant and recessive genes are arranged in one chromosome.

Linkage Groups

- All the linked genes of a homologous pair of chromosome constitute one group are called linkage groups.
- Example : Drosophila has 4 linkage groups and 4 pairs of chromosomes.

- Types of Groups : two types

1. Complete linkage: Chromosome do not break and linked genes inherited together for many generations.

   Eg. F1 Male Drosophilla

2. Incomplete linkage: chromosomes break occasionally and linked genes separate due to crossing over

   Eg. F1 Female Drosophilla

Complete Linkage

- These are closely associated and tend to inherit together.
- New characters do not appear.
- F1 Male hybrid

Complete Linkage in Drosophilla (Male)

Parents **Grey Long** × **Black Vestigial**

G G / L L × g g / l l

Gametes F1: G / L × g / l

G g / L l Grey long

F1: Male G g / Grey long L l × g g / l l Female Black Vestiginal

Gametes: G / L × g / l × g / l

F2: G g / L l × g g / l l

Grey long (50%) Black vestigial (50%)

Incomplete Linkage in Drosophilla (Female)

Parents — **Grey Long** × **Black Vestigial**

	G G / L L	×	g g / l l
Gametes F1	G / L		g / l
		G g / L l Grey long	
Test Cross	G g / L l		g g / l l
	G G g g / L l L l	Crossing over	
Gametes	G / L	G / l	g / L	g / l	g / l
F2	G g / L l Grey Long (41.5%)	G g / l l Grey Vestigial (8.5%)	g g / L l Black Long (8.5%)	g g / l l Black Vestigial (41.5%)

Coupling and Repulsion

- if dominant alleles or recessive alleles are present in the same plant, they tend to remain together resulting in increased parental forms.
- Thus, the two genes which inherit together are called linked genes. This aspect is called **coupling**.
- if dominant alleles or recessive alleles are present in the different plants, they tend to remain separate resulting in increased parental forms. This aspect is called **repulsion**.