LINKAGE

coexistence of two or more genes to remain together during inheritance is called as LINKAGE

ARRANGEMENT OF LINKED GENES

According to Bateson and Punnet the linkage may be either cis or trans type

CIS or COUPLING phase

When two dominant genes are linked on same chromosome and the recessive alleles on the homologous chromosomes then the genes are said to be in coupling or cis phase

TRANS OR REPULSION Phase –

When the dominant and recessive alleles are present on same chromosome then the arrangement of linked, genes is said to be in trans or repulsion phase

Types of linkage

T.H. Morgan with his investigations on Drosophila and other organisms have found two types of linkage.,

1. **COMPLETE LINKAGE,**
2. **INCOMPLETE LINKAGE**

1. **COMPLETE LINKAGE**

When the linked genes are so closely located in the same chromosome that they inherit in the same, linkage group for one or more generations in regular manner then they are called as completely linked, genes and the phenomenon of their inheritance is called as complete linkage.,

Eg. Complete linkage in male drosophila and other organisms like tomato,, maize, pea, rice, poultry, man etc., In Drosophila Grey body colour (G) is dominant over Black body colour (g) and Long wings (L) are, dominant over vestigial wings (l) . A grey bodied long winged Drosophila (GL/GL) is crossed with, Black bodied vestigial winged winged Drosophila (gl/gl). In F 1 generation grey bodied long winged, Drosophila (GL/gl) is observed. When this F1 generation is test crossed, in F 2 generation instead of 1: 1, :1:1 ratio we get 1:1 ratio i.e. 1 grey long and 1 black vestigial

2. **INCOMPLETE LINKAGE –**

In many cases the gene pairs in most linkage group assort independently, of each other. Therefore the linkage is not complete. Incomplete linkage occurs in female Drosophila as, shown below.

Eg. When a hybrid Grey Bodied long winged Drosophila (GL/gl) is crossed with black bodied vestigial, winged Drosophila, four kinds of flies were obtained these were Grey Vestigial (41.1%), Black Long (, 41.1%),Black Vestigial (8.5%) and Grey Long (8.5%) . Thus in addition to two parental Genotypes, two, new kinds of flies i.e. black vestigial and grey long were obtained. This indicates that recombination has, occurred as result of crossing over.

CROSSING OVER

Every character of an organism is determined by a pair of genes called as allelomorphs or alleles. Such a pair of, allele occupies same locus on homologous pair of chromosomes. The genes located on same chromosome are said to, be linked with each other and forms linkage groups. In complete linkage the linked genes are transferred together to, the next generation. And in incomplete linkage the genes are exchanged between nonsister chromatids of, corresponding homologous chromosomes by the act of " Crossing Over". Thus crossing over is defined as " The process in which interchange of corresponding segments of nonsister chromatids of homologous chromosomes takes, place resulting in new combinations of genes". It occurs in meiosis during gamete formation.

ENTRI

MECHANISM OF CROSSING OVER,

Crossing over occurs in prolonged prophase of first meiotic division of gametogenesis. The mechanism of crossing, over is completed through following steps

1.Pairing or synapsis,

2. Duplication of chromosomes,

3.Crossing over,

4.Terminalization,

1/Pairing or synapsis,

During zygotene stage of prophase I of meiosis occurring in developing cells, the homologous, chromosomes comes close to each other and pairing of them takes place and is called as synapsis., Synapsis provides mechanical basis of heredity and variation. It is started during zygotene stage when, homologous chromosomes are held to make contact with each other at one or more points from which, synapsis extends into adjacent regions and it ends or reaches maximum in pachytene stage after which, the homologus chromosomes fall apart except the regions of chiasmata. Thus synapsis is the phase of, prolonged and close contact of homologous chromosomes due to attraction between two exactly, identical or homologous regions. Thus resulting pairs of chromosomes are called as bivalents.

2.Duplication of Chromosomes

The synapsis is followed by duplication of chromosomes. During this stage each homologous, chromosome of a bivalent splits longitudinally and forms identical sister chromatids, so that each, bivalent is now composed of four chromatids. A bivalent chromosome having four chromatids is called, as tetrad.

3.crossing over

The crossing over occurs in homologous chromosomes only during tetrad stage. During the process of, crossing over two nonsister chromatids first break at corresponding points due to activity of nuclear, enzyme called as endonuclease. Then a chromatid segment on one side of each break connects with the, segment on the opposite side of the break, so that the two nonsister chromatids cross each other at the, point of break and exchange. The fusion of chromosomal segments with that of opposite one takes, place due to action of an enzyme called as ligase., The crossing of two chromatidsis called as chiasma or chiasmata formation and the resultant cross a, chiasma or chiasmata. The crossing over thus includes the breaking of chromatid segments, their, transposition and fusion.,

4.Terminalization

After the completion of crossing over the nonsister chromatids starts to repel each other because the, force of synpsis attraction between them decreases. The chromatids separates progressively from the, centromere towards the chiasma and the chiasma itself moves in a zipper fashion towards the end of tetrad. The movement of chiasma towards the end is called as terminalization. Due to terminalization, homologous chromosomes are separated