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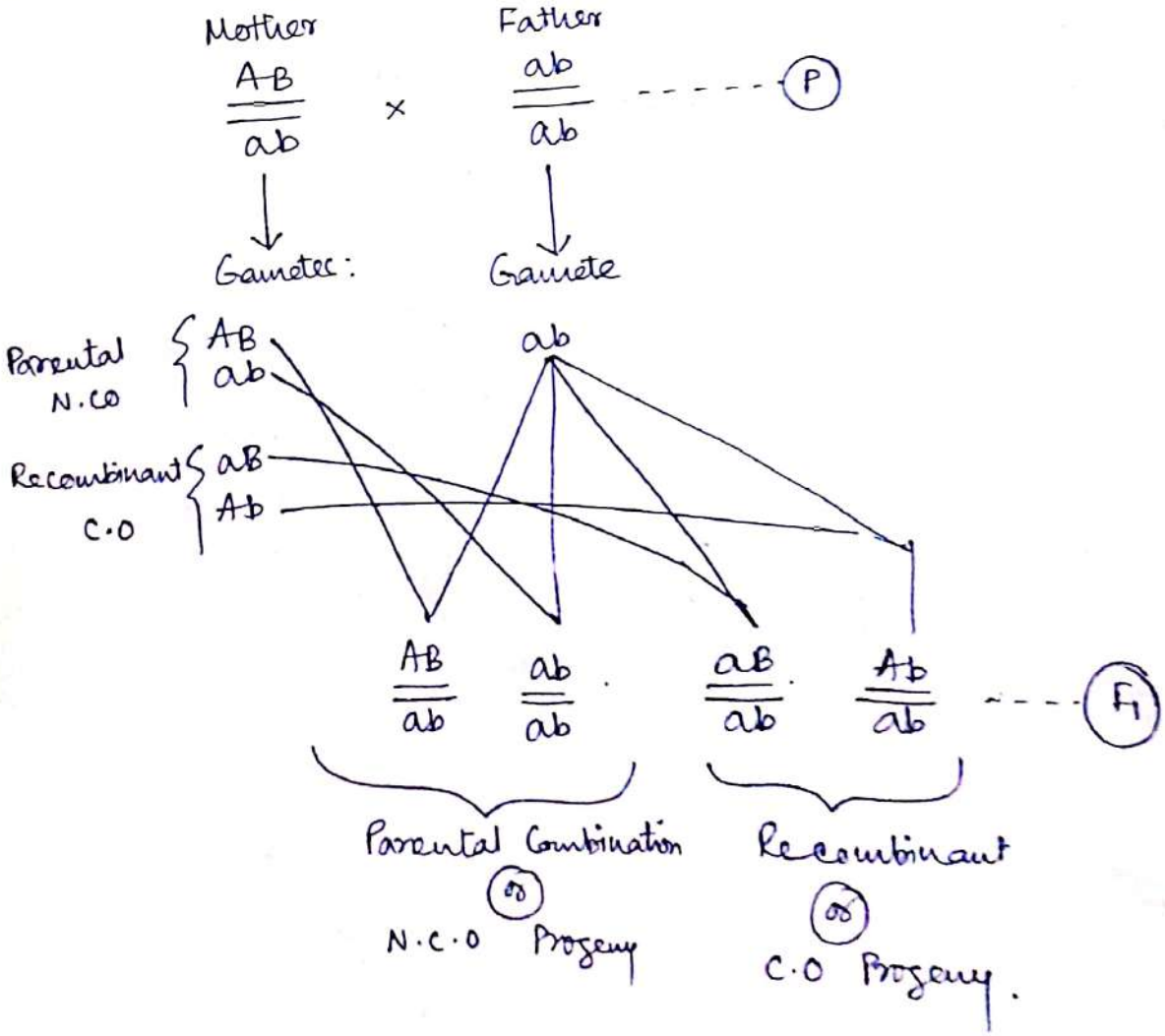
Basics of Linkage and Recombination

1. **Linkage**: When two or more genes reside in the same chromosome, they tend to stay together during the formation of gametes and transmit together to the next generation. These genes are termed as "**Linked Genes**" and the phenomenon is referred as "**Linkage**".

Genes on different chromosomes are distributed into gametes independently of one another (following Mendel's law of Independent assortment). These genes are referred as "**non-linked genes**".

2. **Recombination**: Linked genes do not always stay together. Rather, non-sister chromatids of homologous chromosomes may pair with one another in a process called "**Synapsis**" and then they may exchange segments of varying length with one another through **crossing over**. As a consequence **recombinant gametes** are produced and the phenomenon is referred as – "Recombination".

Example: Parental Genotypes:-



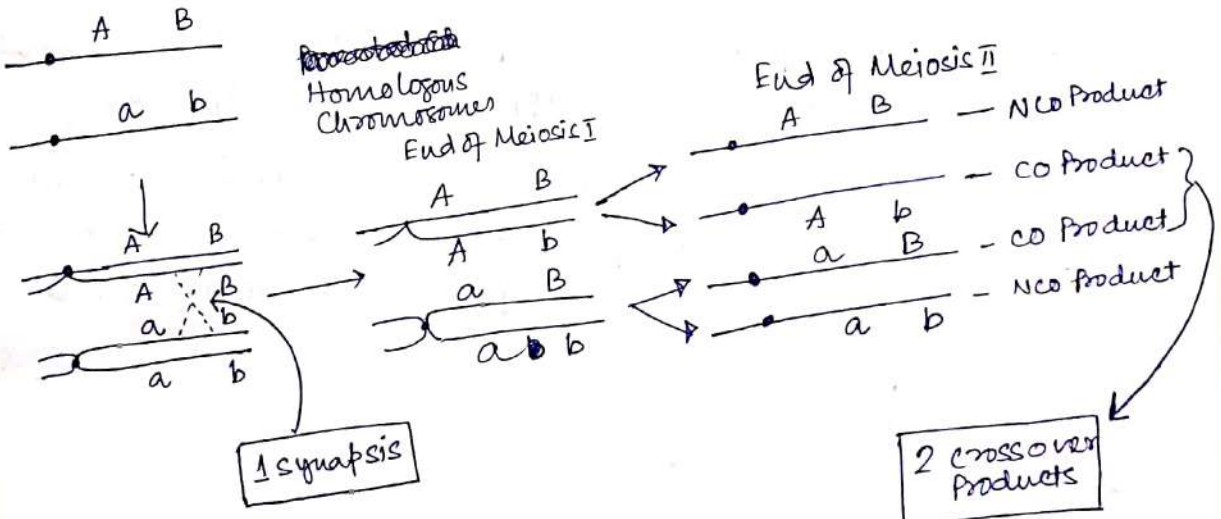
Calculation of Recombination %. :-

Recombination % between genes a & b = (No. of Recombinant progeny betn. genes a & b / Total no. of progeny) × 100

3. Chiasma frequency :- When a chiasma forms between two gene loci, only half of the meiotic products will be of cross-over type. Therefore, chiasma frequency is twice the frequency of cross-over products.

chiasma % = 2 (Crossing over %)

∴ Crossing over % = $\frac{1}{2}$ × chiasma %

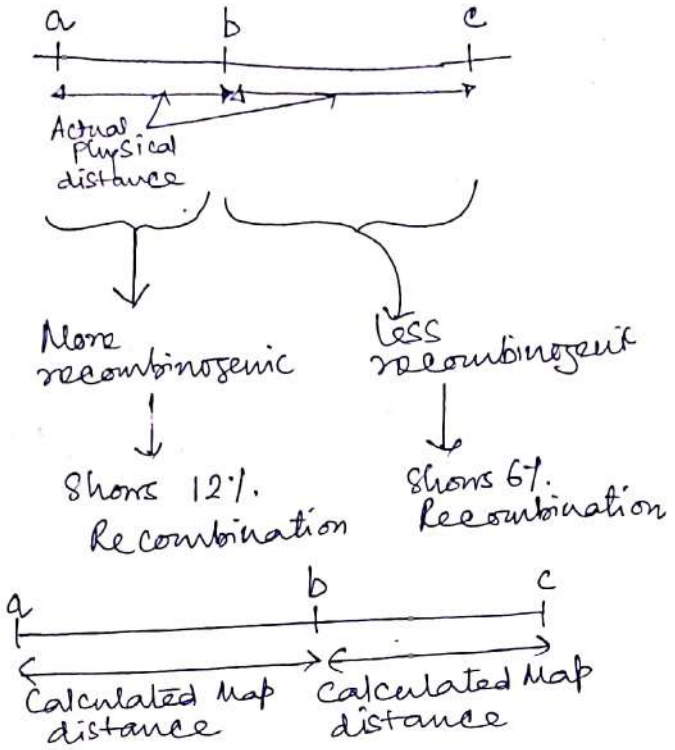


4. Map distance : Map distance is an apparent distance between two genes located on the same chromosome, completely based on the recombination percentage observed between them. This method, recombination mapping was desired by Morgan ( ). Hence, 1 map unit is referred as 1 cM (centi Morgan)

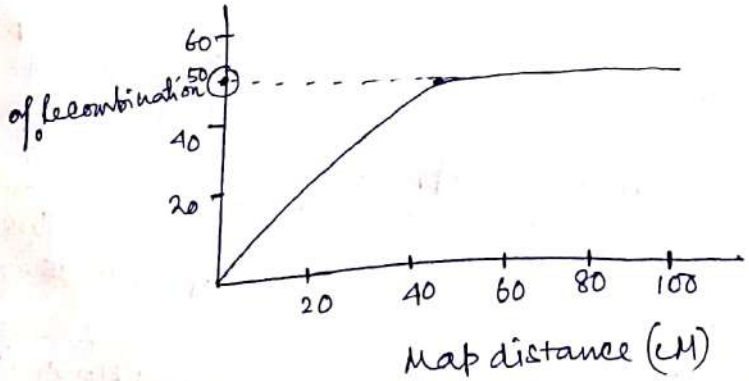
1% Recombination = 1 map unit (m.u) or 1 centiMorgan (cM)

5. Drawbacks of Recombination mapping :-

a) The frequency of crossing over usually varies in different segments of the chromosome, since all regions of a chromosome are not equally recombinogenic. Therefore, the actual physical distances between linked genes bears no direct relationship to the map distances calculated on the basis of crossover percentages.

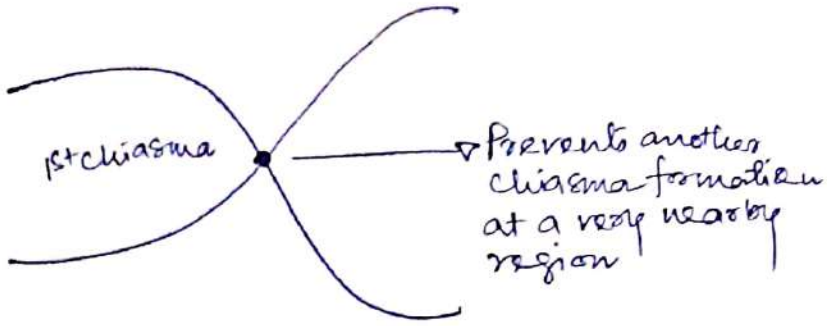


b) The relationship between map distance and recombination% becomes non-linear as it approaches 50 cM, since maximum percentage of recombination can be 50%. Hence, to calculate ~~map~~ the mapdistance between two genes that are more than 50 cM apart, combined result from test-cross experiments involving overlapping genes are required.



6. Interference: The formation of one chiasma actually reduces the probability of another chiasma formation in an immediately adjacent region of the chromosome. This reduction in chiasma formation occurs due to a physical inability of the chromatids to bend back upon themselves within certain minimum distances.

The net result of this interference is occurrence of fewer double cross over events than would be expected according to map distance.



7. Co-incidence :- In spite of interference, double crossing-over events do occur at adjacent regions. This phenomenon is referred as Co-incidence. The extent of this phenomenon is measured by :- Coefficient of Co-incidence or C.O.C.

$$C.O.C = \frac{\text{Observed DCO\%}}{\text{Expected DCO\%}}$$

$$\text{Interference (I)} = 1 - C.O.C$$