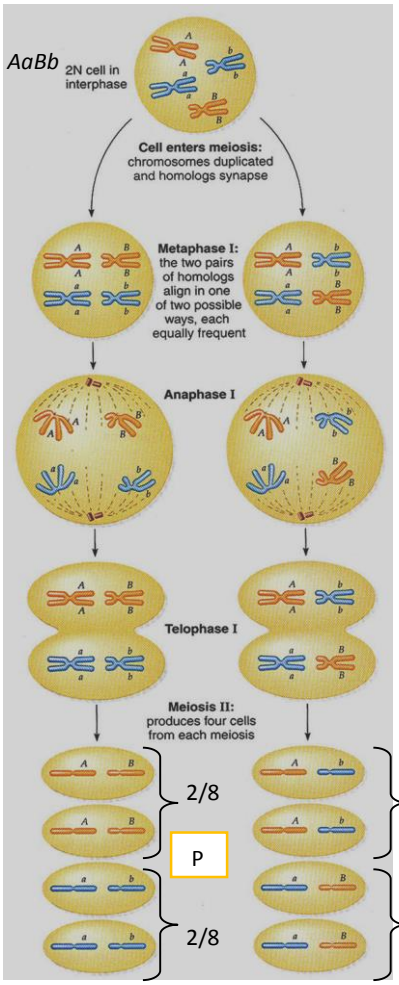
Chromosomal Theory of Inheritance

P = *AABB* x *aabb*



-Assume that parents are AABB and aabb → In F_1 random alignment of bivalents at metaphase I leads to different meiotic products with

- Either the parental (P) gametic genotypes (AB, ab)
- Or the recombinant (R) gametic genotypes (Ab, aB)

-Final genotypic ratio is 1:1:1:1

-Meiosis generates *recombinants*, which are haploid meiotic products with new combinations of the alleles carried by the haploid genotypes that united to form the meiocyte!

Recombinant frequency (%Rf): Proportion of recombinants in offspring genotypes

$$\%Rf = \frac{Number\ of\ recombinants}{Total\ number\ of\ genotypes} \times 100\%$$

For genes on different chromosomes,

$$\%Rf = \frac{2}{4} \times 100\% = 50\%$$

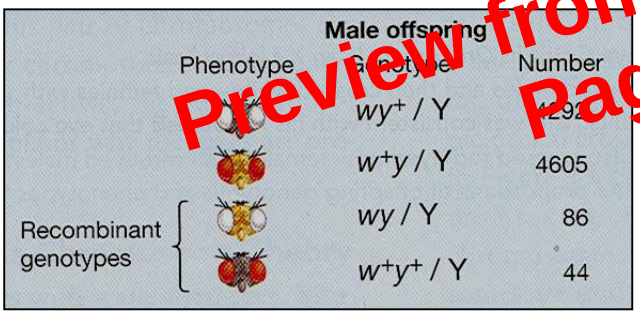
Half of the genotypes are recombinants!

But if genes are *linked (completely/partially)*, then %Rf will be different!

-Morgan (1911) discovered incomplete sex-linkage in eye colour and grey/yellow body are X-linked traits

$$\%Rf = \frac{86 + 44}{1292 + 4605 + 86 + 44} \times 100\% = 1.44\%$$

-It is not complete linkage/independent assortment because no 1:1:1:1 ratio. For every 100 progenies, there will be 1.44 progenies that are recombinant types; white-yellow or red-grey



Main ideas:

- Since there is no recombination in male Drosophila (one X and one Y), by looking at males' genotypes, we can investigate female's chromosomal activity
- Linked genes segregate TOGETHER unless 'crossing over' and genetic recombination occur
- Number of recombinants depends on the LINEAR DISTANCE between genes; The closer the genes, the more likely they are going to be inherited together
- Genes on the same chromosome are not necessarily linked; as long as the linear distance is long enough for crossing over to occur, then two genes AREN'T linked!
- Complete linkage → %Rf = 0%
- Maximum %Rf is 50% (No. of parental gamete = No. of recombinant gamete)
- For 0 < %Rf < 50%, there should be MORE parental gametes than recombinant → more common
- Genetic loci on same chromosome are *syntenic*; Genetic loci on different chromosomes are non-syntenic
- Mitochondrial/chloroplast genes are linked and they show maternal inheritance!