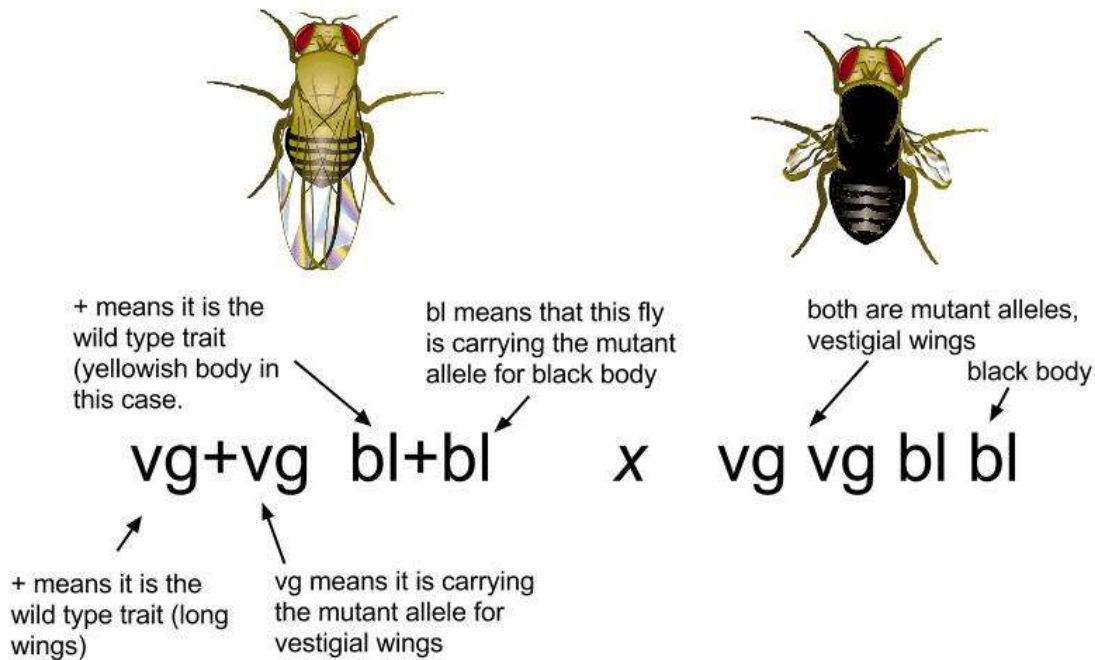


Gene Linkage & Chromosome Maps

Thomas Hunt Morgan studied fruit flies and found that in some crosses, expected outcomes weren't happening. Further experiments confirmed that alleles located on the same chromosome are inherited together.

*Mendel's dihybrid cross $AaBb \times AaBb$ would not have yielded a 9:3:3:1 ratio if he had chosen alleles located on the same chromosomes. A common cross used to demonstrate linkage groups is the cross of a heterozygote wild type vestigial wings/ black body with a recessive mutant.

The cross would look like this $vg^+ \ vg \ bl^+ \ bl \times \ vg \ vg \ bl \ bl$



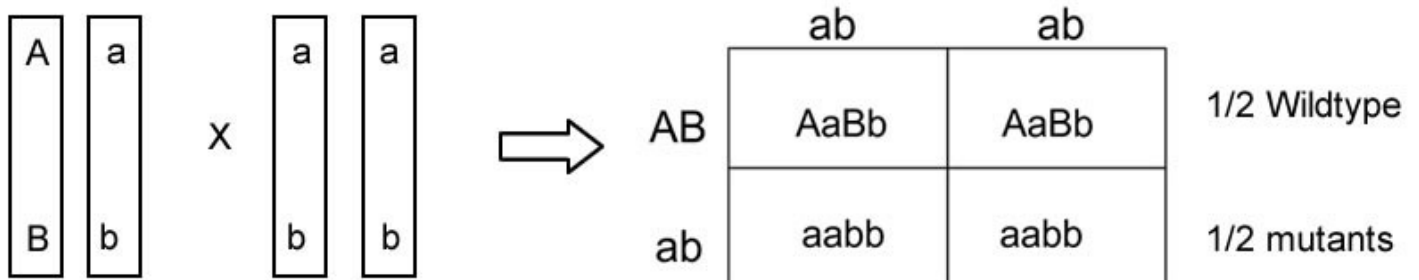
It may be easier at this point to use the older notation for letters, where the cross would look like

$AaBb \times aabb$

There are two possible arrangements for the heterozygote ($AaBb$) in the above cross.

If the dominant alleles are on different chromosomes (Ab) then it is called **TRANS**

If the dominant alleles AB are on the same chromosome, it is called a **CIS** arrangement



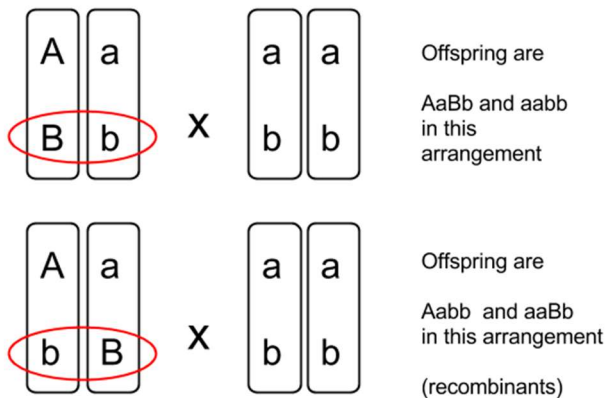
Cross produces: 50% wild type / 50 % mutant

If no crossing over has occurred, the outcome will always be 1:1, however this is not what Thomas Hunt Morgan observed.

	Expected	Observed
Wild Type	50	33
Mutant	50	33
Vestigial Wings, Wild	0	17
Wild, Black Body	0	17

Question: How would you explain these results?

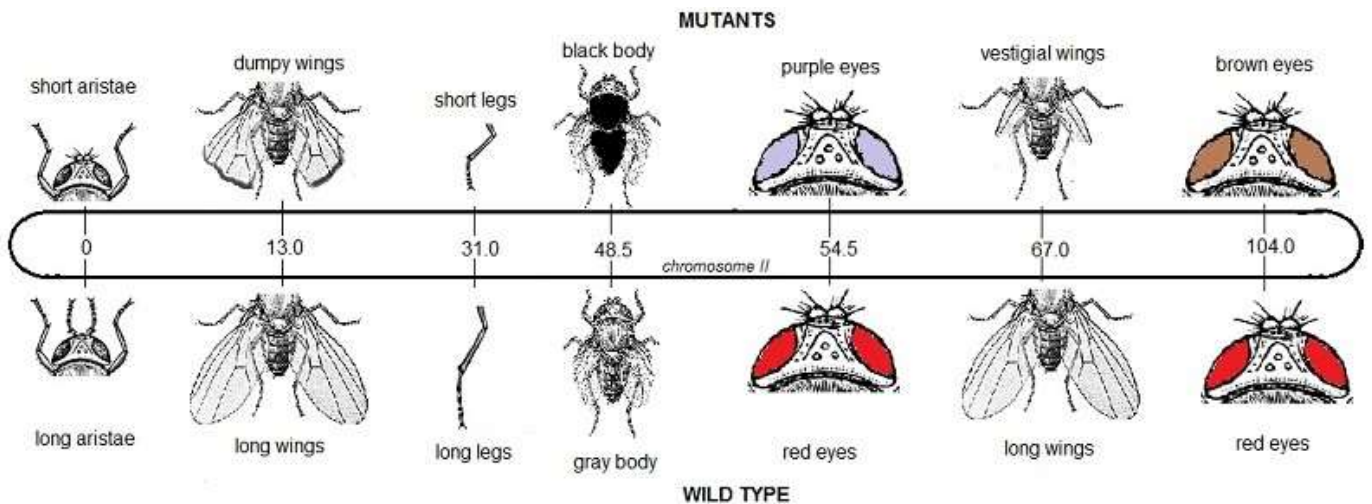
Answer: The two offspring that did not look like either parent are called **recombinants**. They are a result of **CROSS-OVER** which occurred during meiosis, the alleles switch position.



Using this methodology, the chromosomes of the fruit fly were mapped. Each MAP UNIT represents how far apart the alleles are on the chromosome, the number is based on how often crossing over occurs.

Chromosome 2 on *Drosophila Melanogaster* (fruit fly)

17 % of the time, these alleles switched



Practice Questions for Gene Linkage & Chromosome Maps

1. A dumpy winged (dd) fruit fly with long aristae (AA) is crossed with a long winged (Dd) short aristae (aa). Show the cross and the phenotypic proportions.

2. A fruit fly with short legs (ll) and vestigial wings (ww) is crossed with one that is heterozygous for both traits. Assuming the dominant alleles are on separate chromosomes, show the cross and the expected phenotypic proportions.

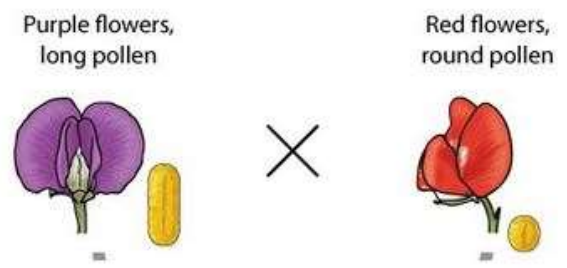
3. In fruit flies, red eyes is a dominant allele located on the X chromosome. The recessive condition results in white eyes. The tan body trait is also X-linked and is dominant to yellow bodies. A female who is heterozygous both traits with the dominant alleles located on the same chromosome is crossed with a white eyed, yellow bodied male. Show the cross and the phenotypic proportions (Don't forget these traits are X-linked!)

4. Chromosome Map Problem

In pea plants, flower color and pollen shape are located on the same chromosome. A plant with purple flowers and long pollen ($AaBb$) is crossed with one that is recessive for both traits ($aabb$).

The results are as follows:

	Results
Purple, long	47
Red, round	47
Purple, round	3
Red, Long	3



a) Are the chromosomes of the $AaBb$ parent in the cis or trans position? Sketch a punnett square showing the expected offspring.

b) How far apart are the two alleles?