AP Biology
Notes: Recombinants

Thomas Hunt Morgan from Columbia University performed experiments in the early 1900s
which provided convincing evidence that Mendel's inheritable factors are located on chromosomesMorgan selected the fruit fly, *Drosophila melanogaster*, as the experimental
organism because these flies:

*Are easily cultured in the laboratory
* Are prolific breeders
*Have a short generation time
*Have only four pairs of chromosomes which are easily seen with a microscope

There are three pairs of autosomes (II, III and IV) and one pair of sex chromosomes. Females have two X chromosomes, and males have one X and one Y chromosome

Morgan and his colleagues used genetic symbols that are now convention.
For a particular character:

*A gene's symbol is based on the first mutant, non-wild type discovered
*If the mutant is recessive the first letter is lowercase (e.g. w = white eye allele in *Drosophila*)
*If the mutant is dominant, the first letter is capitalized (e.g Cy = curly allele in *Drosophila*
that causes abnormal curled wings)
*Wild type trait is designated by a superscript + (e.g. Cy^+ = allele for normal straight wings)

After a year of breeding *Drosophila* to find variant phenotypes , Morgan discovered a single
male fly with white eyes instead of the wild-type red. Morgan mated this mutant white-eyed
male with a red-eyed female. The cross is outlined below

w = white-eye allele
w^+ = red-eyed or wild type allele

P generation:
w^+w^+ (female) X w (male)

F_1 generation: w^+w X w^+

F_2 generation
w^+w^+ w^+

Morgan deduced that eye color is linked to sex and that the gene for eye color is located only on the X chromosome.

*If eye color is located only on the X chromosome, then females (XX) carry two copies of the gene, while males (XY) carry only one

*Since the mutant allele is recessive a white-eyed female must have the allele only X chromosomes which was impossible for F_2 females in Morgan's experiment.

*A white-eyed male has no wild-type allele to mask the recessive mutant allele, so a single copy of the mutant allele confers white eyes

Sex linked genes: Genes located on the sex chromosomes. The term is commonly applied only to genes on the X chromosome.

Linked genes: Genes that are located on the same chromosome and that tend to be inherited together

*Linked genes do not assort independently, because they are on the same chromosome and move together through meiosis and fertilization

*Since independent assortment does not occur a dihybrid cross following two linked genes will not produce a F_2 phenotypic ration of 9:3:3:1

T.H. Morgan and his students performed a dihybird testcross between flies with autosomal recessive mutant alleles for black bodies and vestigial wings and wild-type flies heterozygous for both traits.

b = black body **vg = vestigial wings**
b^+ = gray body **vg^+ = wild-type wings**

b^+bvg^+vg X bbvgvg
gray, normal wings **black, vestigial wings**

*Resulting phenotypes of the progeny did not occur in the expected 1:1:1:1 ratio for a dihybrid testcross

*A disproportionately large number of flies had the phenotypes of the parents:

*Morgan proposed that these unusual rations were due to linkage. The genes for body color and wing size are on the same chromosome and are usually thus inherited together.

Independent assortment of chromosomes and crossing over produce genetic recombinants:

Genetic recombination: The production of offspring with new combinations of traits different from those combination found in the parents; results from the events of meiosis and random fertilization

P generation

YyRr X yyrr

yellow round green wrinkled

Testcross progeny:

_	**YyRr**	**_yyrr**	***Parental type***
	yellow, round	**green, wrinkled**	***50%***

_	**yyRr**	**_Yyrr**	***Recombinant types***
	green, round	**yellow, wrinkled**	***50%***

Parental types: Progeny that have the same phenotype as one or the other of the parents
Recombinants: Progeny whose phenotypes differ from either parent. In hits cross, seed shape and seed color are unlinked.

If genes are totally linked, some possible phenotypic combinations should not appear. Sometimes, however the unexpected recombinant phenotypes do appear. As described earlier, T.H. Morgan and his students performed the following dihybird testcross between flies with autosomal recessive mutant alleles for black bodies and vestigial wings and wild-type flies heterozygous for both traits.

b = black body **vg = vestigial wings**
b^+ = gray body **vg^+ = wild-type wings**

b^+bvg^+vg X bbvgvg

gray, normal wings black, vestigial wings

Phenotypes	Genotypes	Expected Results if Genes are Unlinked	Expected Results if Genes are Totally Linked	Actual Results

Blakc, body, normal wings	**$\frac{b\ vg^+}{b\ vg}$**	**575**	**1150**	**206**
Gray body, normal wings	**$\frac{b^+\ vg^+}{b\ vg}$**	**575**		**956**
Blakc body vestigial wings	**$\frac{b\ vg}{b\ vg}$**	**575**	**1150**	**944**
Gray body,. vestigial wings	**$\frac{b^+\ vg}{b\ vg}$**	**575**		**185**

Recombination Frequency = 391 recombinants divided by 2300 total offspring X 100 = 17%

Gene mapping: