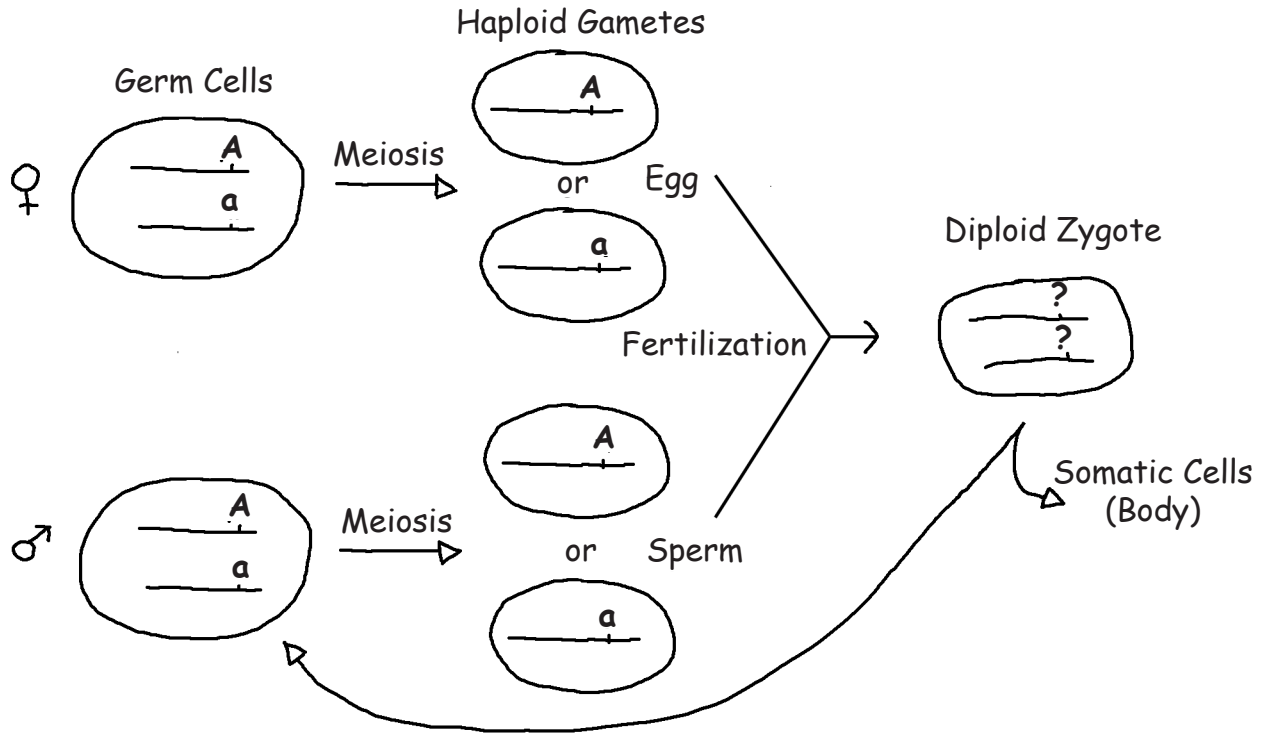
**Lecture 3**

Now let's consider diploid organisms:




The genotype of the zygote will depend on which alleles are carried in the gametes.

| Allele in gamete | | sperm **A** | sperm **a** |
|---|---|---|---|
| egg | **A** | **A/A** | **A/a** |
| | **a** | **a/A** | **a/a** |

When heterozygotes mate their offspring will have different phenotypes: If **A** is dominant to **a**, the two possible phenotypes will be the phenotype of **a/a** or the phenotype of ***A/A*** and ***A/a***.

When we do breeding experiments it is important to know the genotypes of the parents. But as you can see from the example above individuals with the dominant trait could be either ***A/A*** or ***A/a***. A method to control this type of variation is to start with populations that we know to be homozygous. One way to do this is to keep inbreeding individuals until all crosses among related individuals always produce identical offspring. This is known as a true-breeding population and all individuals can be assumed to be homozygous.

**True Breeding:** homozygous for all genes

Say we have a true breeding line of shibire flies; these flies are paralyzed and have genotype **shi$^-$/shi$^-$**.

First, we can test to see whether the shibire allele is dominant or recessive.

♂ **shi$^-$/shi$^-$** **x** ♀ **shi$^+$/shi$^+$** (wild-type)

↓

all are **shi$^-$/shi$^+$**

(The offspring from a cross of two true breeding lines is known as the F1 or first filial generation). The F1 flies appear like wild type therefore **shi$^-$** is recessive (not expressed in heterozygote).

Say we have isolated a new paralyzed mutant that we call **par**.

We start with a true breeding **par$^-$** strain that we mate to wild type. We find that the mutation is not expressed in the $F_1$ heterozygotes and therefore is recessive.
To find out whether **par$^-$** is the same as **shi$^-$** we can do a complementation test since both mutations are recessive. For this test, we cross a true breeding **par$^-$** strain to a true breeding **shi$^-$** strain.

♂ **par$^-$/par$^-$** **x** ♀ **shi$^-$/shi$^-$**

↓

$F_1$ (these flies must inherit both **shi$^-$** and **par$^-$**)

| Possible outcome | Complementation? | Explanation | Inferred genotype |
|---|---|---|---|
| $F_1$ not paralyzed | **shi$^-$** and **par$^-$** complement | **par$^-$** genotype can supply function missing in **shi$^-$** and vice versa | **par$^-$/par$^+$**, **shi$^-$/shi$^+$** |
| $F_1$ paralyzed | **shi$^-$** and **par$^-$** do not complement | **par$^-$** has lost function needed to restore **shi$^-$** | **shi$^-$/shi$^-$** |

Now let's use complementation tests to evaluate different eye color traits in Drosophila. Wild type Drosophila have brick-red eyes. A mutant with white eyes has been isolated and you set up a cross between a female from a true-breeding white eyed strain and a wild type male. The outcome is different from that expected for either case of the white eyed trate caused by a recessive or a dominant mutation.

white ♀ x red ♂ (wild type)

↓

red ♀, white ♂

All of the male progeny have white eyes and the female have red eyes. This pattern is sometimes known as crisscross inheritance because the traits switch sexes from one generation to the next, and it is the hall mark of a trait on the X- chromosome. The eye color gene is on the sex determining chromosome X. Males only have one copy of the X chromosome and daughters always get one copy of the X from the mother and one copy from the father.

♀ (XX) x ♂ (XY)

XX XY

$X^w$ = white allele on X, $X^+$ = red allele on X

$X^wX^w$ x $X^+Y$

↓

$X^wX^+$ $X^wY$

red ♀ white ♂

Thus, the trait for red eyes is always inherited along with the X chromosome from the father. The absence of red (giving white eyes) always goes with the Y chromosome.

[Note that crisscross inheritance would not have been seen if we set up the reciprocal cross of a white eyed male crossed to a red eyed female:

white ♂ x red ♀ (wild type)

↓

all red (wild type)

For this cross, the white eyed mutant shows the same inheritance as for an autosomal recessive allele.]

Now suppose we isolated a new eye color mutation with apricot colored eyes which shows the same crisscross inheritance meaning that it is also X-linked recessive. To determine whether white and apricot are alleles of the same gene we can do a complementation test (since both the white and apricot alleles alleles are recessive). To do this we cross a white eyed female to a apricot eyed male. From this cross all of the female progeny have apricot eyes and the male progeny have white eyes. To interpret these results, we ignore the males since they only have a single X chromosome. However, the females have two copies of the X-chromosome, one with a white allele inherited from the mother and one with an apricot allele inherited from the father - thus the female progeny are double heterozygotes. Since these heterozygous females do not have normal eyes, the recessive white and apricot alleles don't complement one another and therefore they must be alleles of the same gene. [ The gene known as "White" is responsible for red pigment production the white eyed allele lacks all activity whereas the apricot allele has partial activity.]