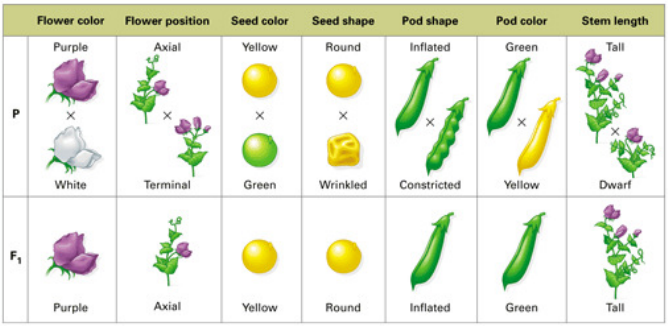
Non-Mendelian Genetics

Standard: Students will analyze how biological traits are passed on to successive generations.

Element: Using Mendel's laws, explain the role of meiosis in reproductive variability.

EQ: What are some exceptions to Mendelian genetics?

Gregor Mendel was fortunate to have studied pea plants because of their simple patterns of heredity.



Sometimes an organism's traits don't follow the rules that Mendel came up with, and today we will learn about some of these cases, called **codominance**, **incomplete dominance**, and **sex-linked traits**.

Codominance occurs when two alleles are *fully expressed* at the same time.

In other words, both alleles are **dominant**.

How to make a Punnett square with codominant alleles:

Since both alleles are dominant, each needs to be represented by a **capital letter**. Since they are both capital, we need two **different** letters to tell the two alleles apart.

In the roan cow example, we can use the letter **R** for the red allele and the letter **W** for the white allele.

A cow with a **heterozygous** genotype would be **RW** which would result in the roan coloration.

That means we have three possible genotypes for coat color, each with a different phenotype:

<u>Genotype: Phenotype:</u>
WW white
RR red
RW roan

Make a Punnett square for a cross between a white cow and a roan bull:

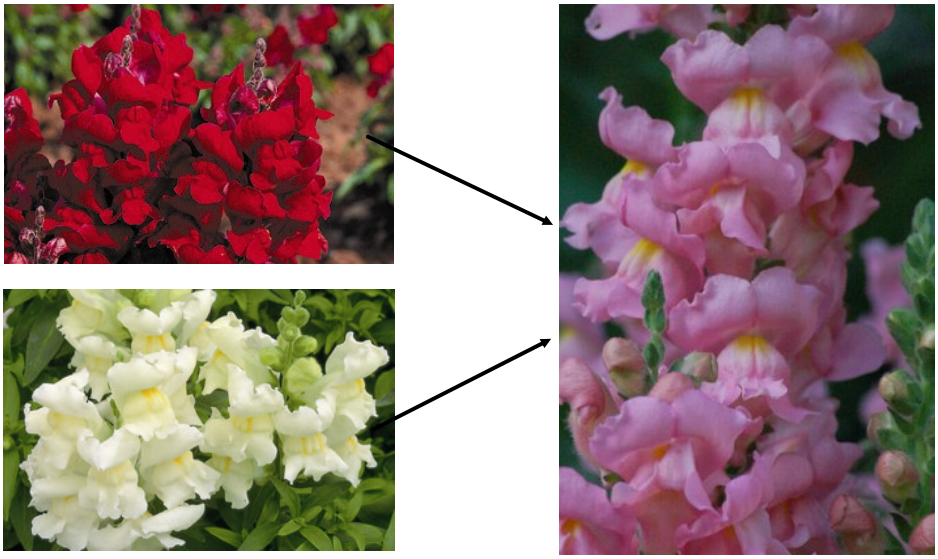
	R	W
W	RW	WW
W	RW	WW

What are the possible phenotypes of the offspring?

50% roan 50% white

<u>Incomplete dominance</u> occurs when the offspring's trait is a *combination* of the two parents' traits.

In this case, **<u>neither allele</u>** is fully dominant.



How to make a Punnett square with incompletely dominant alleles:

Again, the alleles are represented by **two different capital letters**.

In the snapdragon example, we can use the letter **R** for the red allele and the letter **W** for the white allele.

A flower with a **heterozygous** genotype would be **RW** which would result in pink petals.

That means we have three possible genotypes for flower color, each with a different phenotype:

Genotype: Phenotype:
WW white
RR red
RW pink

Make a Punnett square for a cross between a pink snapdragon and a red snapdragon:

	R	R
R	RR	RR
W	RW	RW

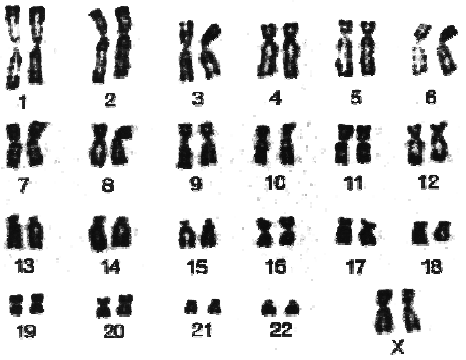
What are the possible phenotypes of the offspring?

50% red 50% pink

Sometimes the inheritance of a trait depends on the **sex** of the individual.

This is called a **sex-linked trait**.

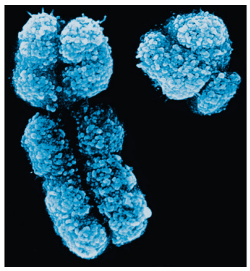
Before we talk about how to make a Punnett square for sex-linked traits, we must discuss the **two** different types of chromosomes, **autosomes** and **sex chromosomes**.



The chromosomes in an organism that determine its sex are called **sex chromosomes**.

The rest of the chromosomes do not affect the sex of the organism. These are called **autosomes**.

Humans have 22 pairs of autosomes and a single pair of sex chromosomes. The sex chromosomes are called **X** and **Y**.



Females have the genotype **XX** and males have the genotype **XY**.

A gene is sex-linked if it is found **on a sex chromosome**.

This usually means it will be on the **X chromosome** because the Y chromosome is very small and doesn't contain many **genes**.

So when we use Punnett Squares for sex-linked traits, we always use X and Y as the alleles, but we add a **superscript** to show the different traits.

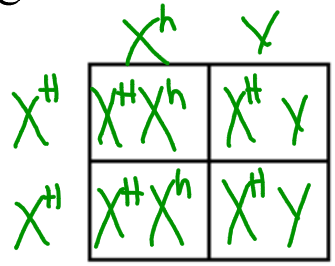
$\mathbf{X^A}$: sex-linked, dominant
$\mathbf{X^a}$: sex-linked, recessive

For example, hemophilia is a recessive sex-linked disorder so X^H would be the **normal** allele and X^h would be the allele that **causes the disease**.

The **Y chromosome** doesn't carry the gene so we just write Y.

Draw a Punnett Square for a man who has hemophilia and a woman who is homozygous dominant.

Genotypes:
man: X^hY
woman: X^HX^H



Remember, females have **two** X chromosomes. Males only have **one** X (and one Y).

If one X chromosome is defective, a female will have **another copy**, which is most likely normal. That means sex-linked traits affect **males** more than females.

A female with one normal X and one defective X (for example: X^HX^h) is said to be a **carrier** of the trait.

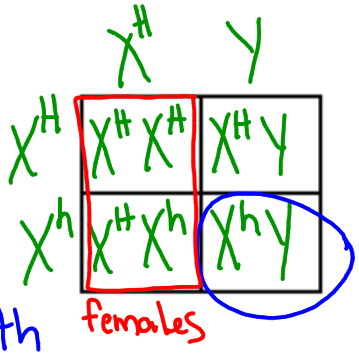
A carrier might pass the defective allele to her offspring even though she **does not have the disease**.

Suppose a normal man and a woman who is a carrier for hemophilia have a child. What is the chance of this child having hemophilia?

Genotypes:

man: $X^H Y$

woman: $X^H X^h$



25% chance of having a child with hemophilia.

0% chance of having a female child with hemophilia