FUN WITH HEREDITY

Understanding heredity begins with genes, the segments of DNA that determine certain traits of an organism. Every organism passes along some of its traits to the next generation when it reproduces. This passing of traits by parents to offspring is called **heredity**.

Common traits that are passed along are eye, hair, and skin color, height, and some health traits. Examples of health traits that are inherited include color-blindness (when a person cannot distinguish certain colors), and hemophilia, (when a person's blood does not clot properly).

Traits such as height and weight are inherited, but are influenced greatly by a person's environment. If you do not have a diet with adequate nutrients, you may not grow as tall as you potentially could be. If you eat all fatty foods, you may be much heavier than your ideal weight. If you spend a lot of time in the sun, your skin color may darken. The genes you inherit give you potential, but your environment has a huge influence on how you turn out. The genes that determine the traits of each parent occur in pairs. Each gene in a pair is known as an allele. "If one of the alleles masks the effect of the other allele, it is called a **dominant** allele. The allele that is masked by the dominant allele is called a **recessive** allele." *

The father of the study of heredity is Gregor Mendel. He was an Austrian monk who began growing peas in his garden at his monastery in 1856.He noticed that pea plants differed on seven traits: height, (tall or short); pod color, (yellow or green); pod shape (inflated or constricted); seed shape (round or wrinkled); leaves (yellow or green); seed coats (clear or brown); and position of the pods, (axial or terminal: that is, on the sides or the end of the plants).

He began the experiment with true breeding plants--that is those that had shown a trait for many generations. When he placed the pollen from a tall plant on the pistils of the short plant, the resulting offspring were all tall. When he took those tall plants and allowed them to self pollinate, he found that out of every four, three were tall and one was short. (TT, Tt. Tt. tt) Then, when he allowed them to self pollinate again, one plant was shown to be pure for tallness; (TT); two were hybrids,(Tt, Tt); carrying the shortness gene, even though they were tall; and one was a pure short plant, (tt), always producing short offspring. Even though the gene for shortness was hidden in the first generation of offspring, it was still there, because it showed up in the next generation in one-fourth of the plants.

Mendel found similar patterns for all the other traits that he studied. One trait was three times more likely to show than another. Since it appears three times more often, it was called the **dominant** trait. The one that showed up in only one of four plants was the **recessive** trait.

One way to show this relationship is by constructing a Punnett Square.

The first generation of peas were pure for tallness: both gametes were tall (TT) and pure for shortness (tt). So, taking a pure tall and crossing it with a pure short, we can predict what will happen. TT x tt =

Generation P1 for tallness
TT= pure tallness
tt = pure for shortness

	T	T
t	Tt	Tt
t	Tt	Tt

The F1 (first) generation receives one factor for height (one allele) from each parent. Since the factor for tallness is dominant, all four of the plants will be tall.

In the next generation, shown below, one of the plants receives two alleles for the recessive trait of shortness. Therefore, it is short, and all of its offspring will be short if paired with other short plants. One plant receives two tall alleles, and will produce all tall plants. Two of the plants receive one tallness and one shortness allele, and will be tall, but could produce short plants in future generations.

Next, see a Punnett square for F1 generation crossing Tt x Tt

Generation P2

	T	t
T	TT	Tt
t	Tt	tt

A genotype is the actual set of genes that are inherited, (such as Tt for tallness). A phenotype is the appearance of the traits. Thus Tt would appear Tall, even though it carries the recessive short gene.

Sometimes scientists want to track more than one independent trait at a time. For instance, they may want to watch both the genes for tallness and color.

Let's try an example:
Let's take a pure breeding plant that always produces tall green peas, and cross it with a pure breeding plant that always produces short yellow peas.

We could represent that like this:

P1 generation
TTGG x ttgg

The gametes from this combination would take one of each of the traits:

TG tg

TtGg

F1 generation zygote

The gametes from one plant would carry the T and G factors; the gametes from the other would carry the t (shortness) and g (yellow pod) factors.

The F1 generation will consist of plants that are tall with green pods. (Phenotype)
However, they will be heterozygous for these traits, (TtGg) (Genotype)
(The phenotype is how the organism looks; the genotype reflects the actual gene combinations.)

What types of gametes will the F1 generation produce? (TtGg X TtGg)
Let's look at the possibilities:

The F1 male TtGg could have four possible combinations of these two traits:

TtGg = TG Tg tG tg

Similarly the F1 female could have four possible egg cell combinations

TtGg = TG Tg tG tg

Below is a Punnentt square to show all possible combinations of the gametes in the next generation F2

	TG	Tg	tG	tg
TG	TTGG	TTGg	TtGG	TtGg
Tg	TTGg	TTgg	TgGg	Ttgg
tG	TtGG	TtGg	ttGG	ttGg
tg	TtGg	Ttgg	ttGg	ttgg

The Punnett square shows that when the gametes above unite, they could form a total of 16 possible seed combinations.

1. How many of these seeds would produce tall plants with green pods?
2. How many would produce tall plants with yellow pods?
3. How many plants would be short with green pods?
4. How many would be short with yellow pods.

Use what you know to figure it out.

Do you think you could make a model when a third trait is added? Let's try the F1 and F2 generations for tallness or shortness Tt; Round or wrinkled pods Rr;
Green pods or yellow pods Gg.

Start with plants that are homozygous (pure) for tallness, round seeds, and green and cross them with plants that are homozygous for shortness wrinkled seeds and yellow pods. One can see that it gets complicated very quickly. Fortunately, we have computers to figure out all the possible combinations, so we don't have to, but it is fun to try.

Answers to questions above:

1. Tall green 9
2. Tall yellow 3
3. Short green 3
4. Short yellow 1

It is also fun to play the game called Geney.

In the game Geney, we have creatures from another planet. They differ in four ways. There are three possibilities for each trait. For instance, their hair may be punk, crew, or point; their heads may be round, pointed, or goat-shaped; their arms may be wings, hot, or stub. We are not told which characteristics are dominant, but we can figure it out by mating various individuals and then looking at their offspring (from 1-3offspring). The creatures automatically age, and can be mated when they reach 3 years old. The object of the game is to mate creatures until a creature with certain "target" features is created. It can be done alone, or by beaming creatures from one Palm to another. More directions are included with the game. Have fun with exploring heredity!

* some of the basic information was taken from ScienceSaurus: A Student Handbook published by Great Source Education Group, Inc. 2002, p. 122.