science generation

TRAITS AND HEREDITY

SCIENCE ACTIVITIES

Session 1 2–4
Reader's Theater

Session 2 5–8
Speaking Scientifically

Session 3 9–15
Strange but True

Session 4 16–20
Prepare for Debate
Writing

Session 5 21
Class Debate: Testing, Testing!

SUPPLEMENTARY ACTIVITIES FOR OTHER CONTENT AREAS

ELA 22
Fan-Fueled Pet Crazes

Math 23
What are the odds?

Social Studies 24
Testing Athletes for Sickle Cell Trait

FOCUS WORDS

Examining the Focus Words Closely 25

© 2015 SERP

Reader's Theater

Black plus black makes brown fur?

Setting: Klent, Jordan, and Alexis push through the gate into Keara's backyard.

Keara: Hey guys! How did the furry-friends sale go? Did you sell all of the rabbits to Ms. Tom, the principal at Dover Elementary?

Jordan: No, she only wanted the black ones.

Alexis: Three months ago Ms. Tom said she'd buy a rabbit for every class at Dover, but she didn't say they had to be 100% black!

Klent: We sold Midnight and Jet and six of their babies that were all black. But we had to bring back Ajax and Poseidon, the two with chocolate brown fur. What's with that? Everybody likes chocolate!

Jordan: What happened was all the kids read the book *Race Down the Rabbit Hole*.

Keara: Oh yeah, I read that when I was in elementary school. I remember the rabbit in that story was "black from the tips of his ears to the end of his tail."

Jordan: You got it. So now the kids only want all-black rabbits.

Alexis: *(sighing)* That's just great. Three months of work down the drain. We bought Jet and Midnight at the pet store; we fed them and cleaned the cages every day. We learned how to breed them. And then we took special care of Midnight and her eight kits.

Klent: I'd really like to know what's with the chocolate fur anyway. The parents were all black. Not a spot of brown! But some of their baby kits are chocolate brown! How did this happen?

Alexis: Hey, maybe it's like when the snowshoe rabbits turn white every winter to camouflage themselves against the white snow. Maybe a change in fur color is caused by the weather.

Jordan: No, I'm pretty **skeptical** about that explanation. If that were right they would all be the same color because they've all always lived in the same climate.

Klent: Maybe it's like mixing paint colors together. You take the parents' fur colors, blend them together, and—

Alexis. And you get six black kits and two brown kits? That can't be right…I think maybe the color of the fur is made by a chemical. The mother has a limited amount to make into a color. Maybe she ran out of black? So the last ones born are kind of faded out?

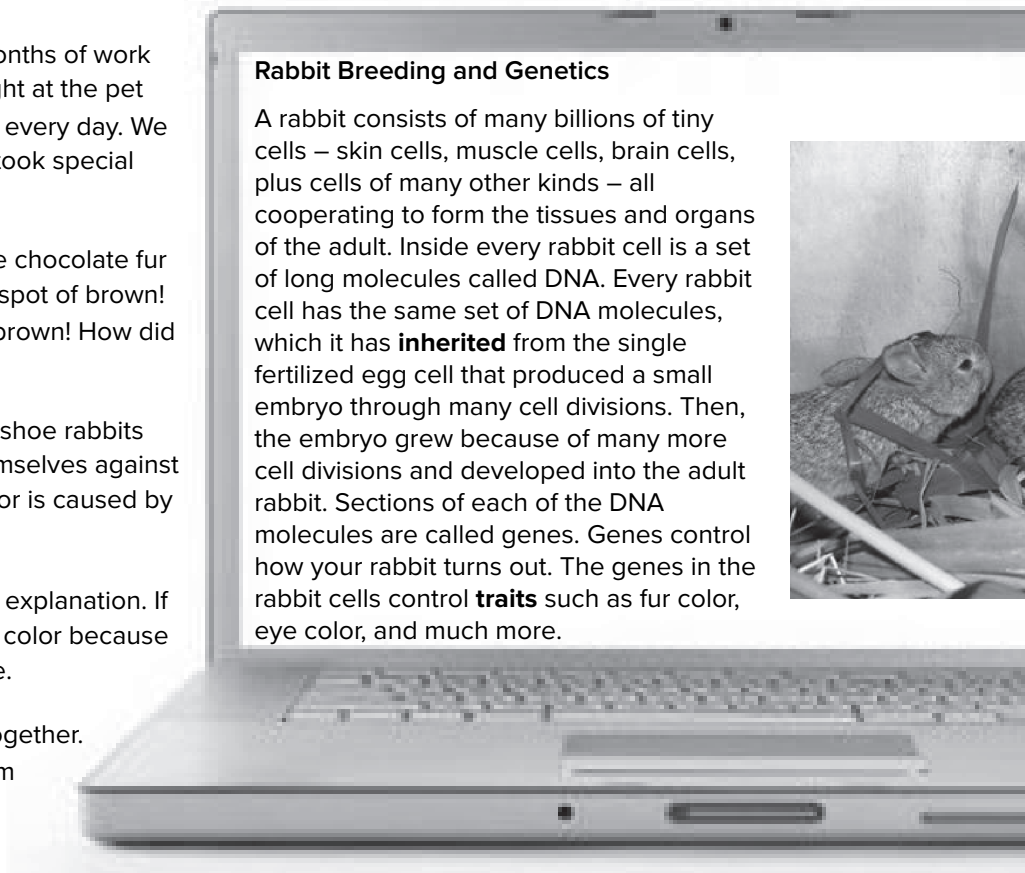
Klent: Wait! I know! The brown ones have got to be MUTANTS! They were zapped by aliens or something!

Jordan: *(rolled eyes)* More like YOU were zapped by aliens.

Alexis: *(changing the subject)* Anyway…Ms. Tom said she would buy more all-black bunnies. So if we're going to sell them, we've got to breed them. We better learn why an all-black dam and an all-black sire can have some kits that are chocolate.

Keara: Maybe that website the pet store told us about will have some info.

Jordan: Good idea. We should've read that before we first bought Jet and Midnight!



Rabbit Breeding and Genetics

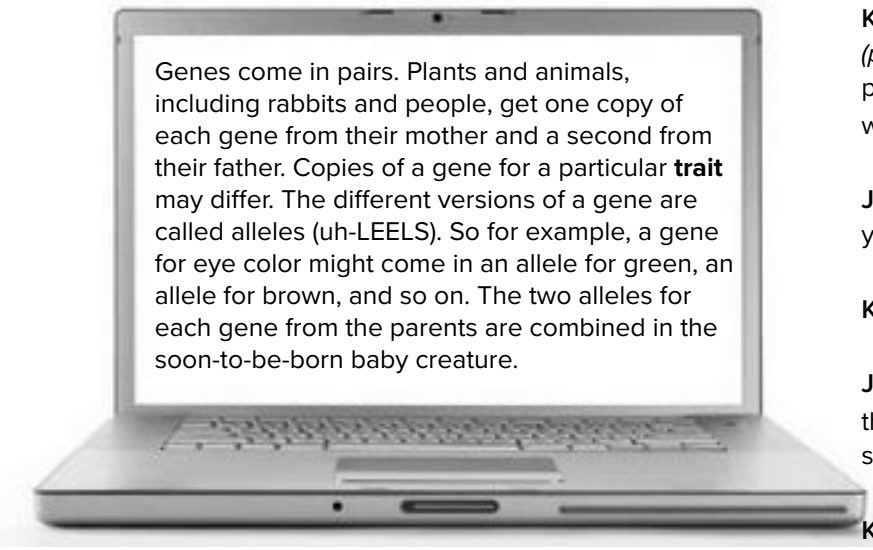
A rabbit consists of many billions of tiny cells – skin cells, muscle cells, brain cells, plus cells of many other kinds – all cooperating to form the tissues and organs of the adult. Inside every rabbit cell is a set of long molecules called DNA. Every rabbit cell has the same set of DNA molecules, which it has **inherited** from the single fertilized egg cell that produced a small embryo through many cell divisions. Then, the embryo grew because of many more cell divisions and developed into the adult rabbit. Sections of each of the DNA molecules are called genes. Genes control how your rabbit turns out. The genes in the rabbit cells control **traits** such as fur color, eye color, and much more.

Reader's Theater

Black plus black makes brown fur?

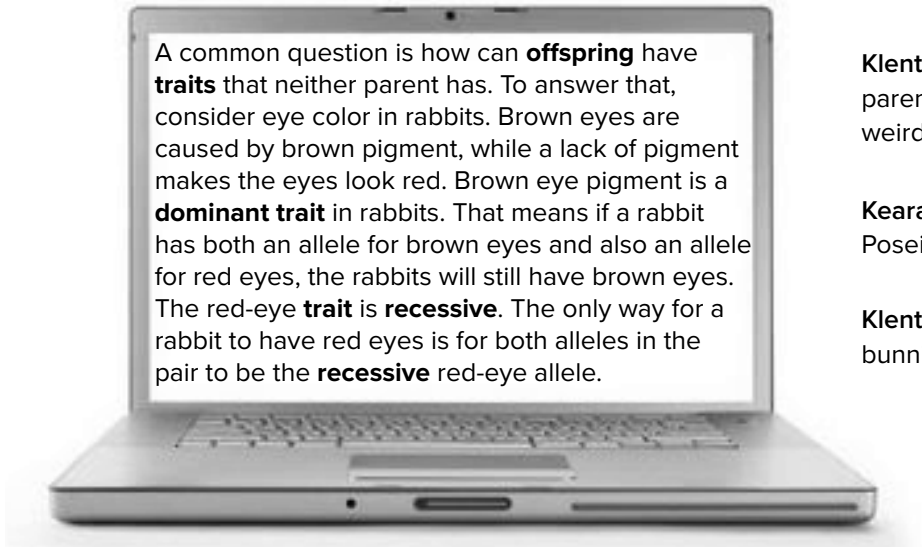
Jordan: Hey, now we're getting somewhere. Genes are formed by DNA. Because every rabbit cell has the same DNA, the same genes are present throughout the entire rabbit body! Awesome!

Keara: Keep reading, Jordan.



Keara: Wait! This is weird. Both Midnight and Jet are all black and both gave a gene for fur color to Ajax. So how come Ajax is brown?

Jordan: Chill out! Read this next part.



Klent: **Recessive**? Is that like a recess? The gene doesn't have to go to class?

Keara: Uh, I don't think so. It's more like it's in the background, I think.

Klent: And what does eye color have to do with fur color? *(pauses)* Wait a sec! I have blue eyes and both my parents have brown. I've always wondered how that works...

Jordan: I think it's supposed to have something to do with your grandparents.

Klent: But I never even met my grandparents.

Jordan: No, what I mean is there's a good chance one of them had blue eyes! My brother is really tall, and my Mom says my granddad was tall, but it skipped a **generation**.

Keara: I think I get it: Somebody in a previous **generation** of Klent's family had to have blue eyes for Klent to have that **trait**. Maybe fur color on rabbits works the same way.

Klent: I still don't get how a grandparent's eye color...

Alexis: Or fur color!

Klent: Fine! Eye color *or fur color* can jump over my parents and get to me from my grandparents. Seems too weird to be true.

Keara: So what are we going to do with Ajax and Poseidon? They're too cute to be rejects.

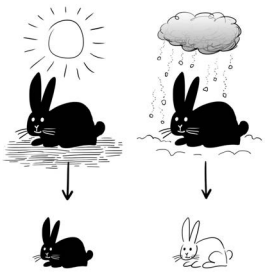
Klent: Let's go find a book about chocolate brown bunnies to read to those kids at Dover Elementary.

© 2015 SERP

Reader's Theater

Identifying Perspectives

With a partner, use the text in the Reader's Theater to complete the chart below: *male = ♂ female = ♀*



the weather theory

Who mentioned this idea? ☐ Keara ☐ Jordan ☐ Alexis ☐ Klent

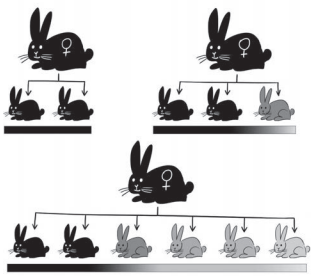
How did he or she think this "theory" worked?

_____

_____

On a scale from 1 to 5, how plausible do you think this theory is? (circle one)

1	**2**	**3**	**4**	**5**
not plausible at all	unlikely	neutral/unsure	somewhat plausible	highly plausible



the fade-out theory

Who mentioned this idea? ☐ Keara ☐ Jordan ☐ Alexis ☐ Klent

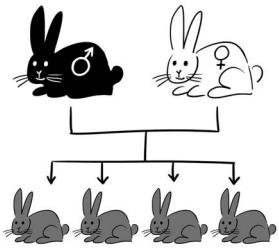
How did he or she think this "theory" worked?

_____

_____

On a scale from 1 to 5, how plausible do you think this theory is? (circle one)

1	**2**	**3**	**4**	**5**
not plausible at all	unlikely	neutral/unsure	somewhat plausible	highly plausible



the blending theory

Who mentioned this idea? ☐ Keara ☐ Jordan ☐ Alexis ☐ Klent

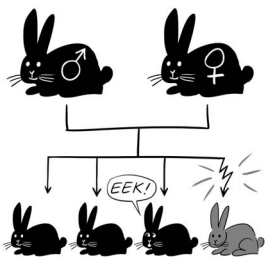
How did he or she think this "theory" worked?

_____

_____

On a scale from 1 to 5, how plausible do you think this theory is? (circle one)

1	**2**	**3**	**4**	**5**
not plausible at all	unlikely	neutral/unsure	somewhat plausible	highly plausible



the mutant theory

Who mentioned this idea? ☐ Keara ☐ Jordan ☐ Alexis ☐ Klent

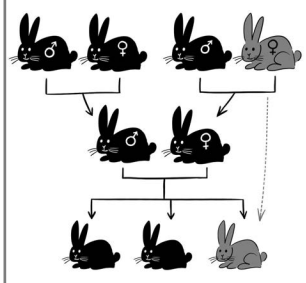
How did he or she think this "theory" worked?

_____

_____

On a scale from 1 to 5, how plausible do you think this theory is? (circle one)

1	**2**	**3**	**4**	**5**
not plausible at all	unlikely	neutral/unsure	somewhat plausible	highly plausible



the grandparent theory

Who mentioned this idea? ☐ Keara ☐ Jordan ☐ Alexis ☐ Klent

How did he or she think this "theory" worked?

_____

_____

On a scale from 1 to 5, how plausible do you think this theory is? (circle one)

1	**2**	**3**	**4**	**5**
not plausible at all	unlikely	neutral/unsure	somewhat plausible	highly plausible

Which character's idea do you think makes the most sense? Why?

© 2015 SERP

Speaking Scientifically

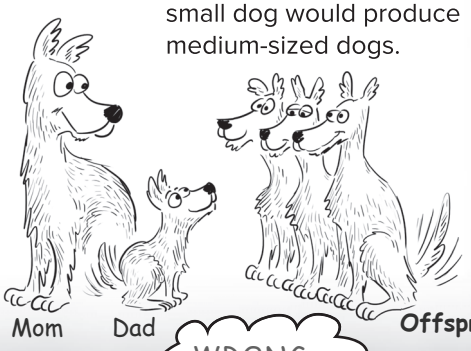
The Skeptical Monk

In the 1800s, an Austrian monk named Gregor Mendel spent many long hours working—and thinking—in his garden. He thought a lot about how **traits** are **inherited** from one **generation** to the next. He wondered why the **offspring** of people and other living things are like or unlike their parents.

Back in the 1800s, these misconceptions (wrong ideas) about **heredity** were popular:

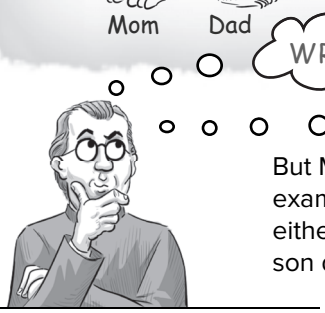
#1 BLENDING

Some people thought the **traits** of any two parents were blended in their young. For example, a big dog and a small dog would produce medium-sized dogs.

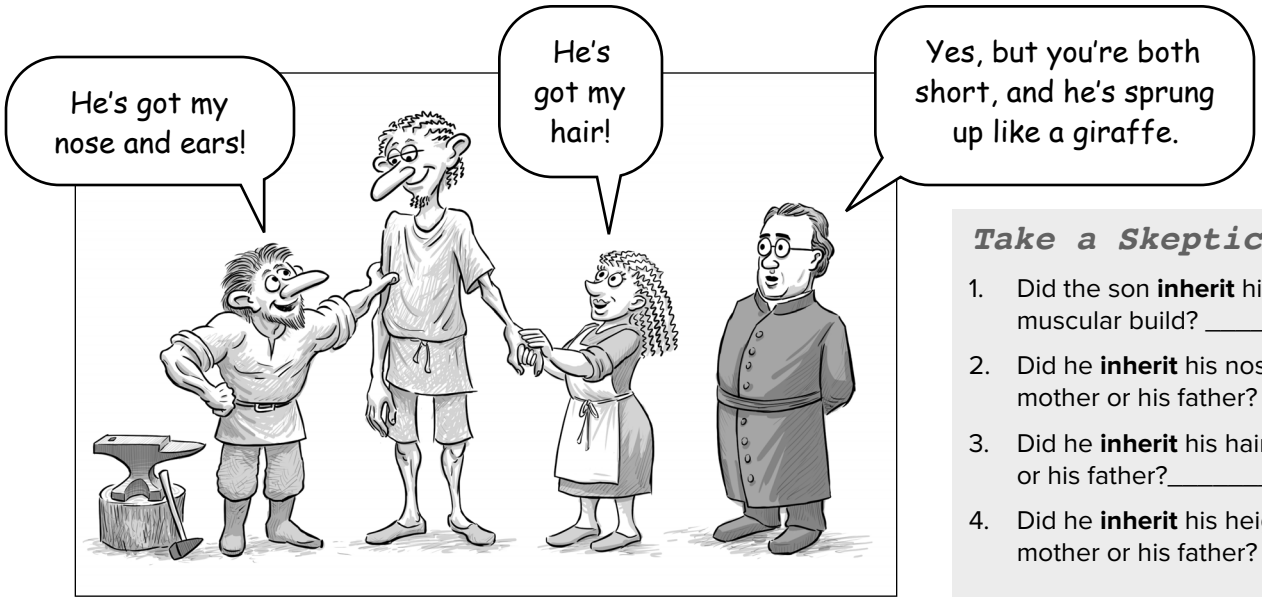


#2 ACQUIRED TRAITS

Some people thought parents passed **traits** on to their young that they acquired during their lifetimes. For example, if a giraffe stretched her neck reaching for leaves, the next **generation** (her **offspring**) would have slightly longer necks.



But Mendel didn't believe either of these ideas. He was **skeptical** because he saw too many examples that didn't fit either theory. Consider the family pictured below. The son is taller than either of his parents. And while the father has big muscles from working as a blacksmith, the son did not **inherit** the father's muscular body.



Take a Skeptical Look:

1. Did the son **inherit** his father's muscular build? _____
2. Did he **inherit** his nose from his mother or his father? _____
3. Did he **inherit** his hair from his mother or his father?_____
4. Did he **inherit** his height from his mother or his father? _____

Speaking Scientifically

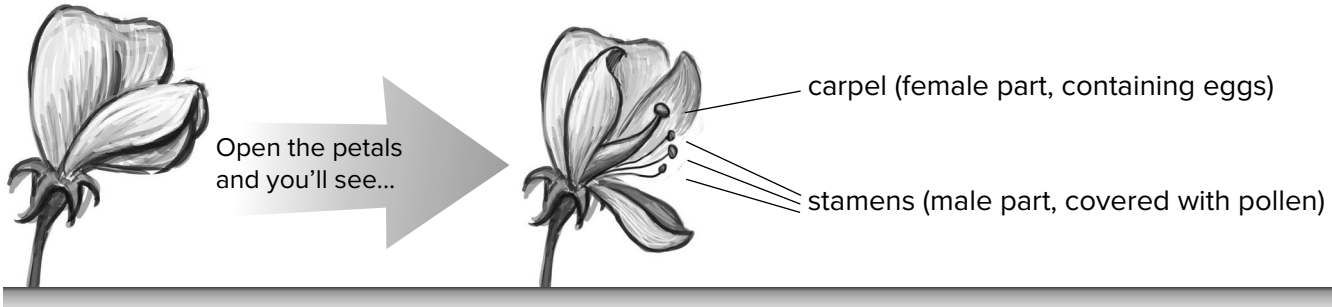
The Skeptical Monk

Mendel came from a family of farmers, and he knew a thing or two about plants. So he decided to study inheritance by doing experiments with the common pea plant. Here's what he already knew:

Fertilization **of the common pea plant**

Flowers contain the reproductive organs of plants. Like many flowering plants, pea plants combine their male and female parts in the same flower. For fertilization to occur and new plants to grow, pollen from the male parts must reach eggs in the female parts.

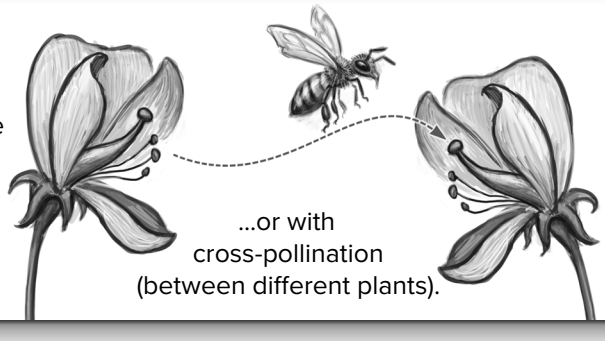
Flower Anatomy



Pollination by Bees

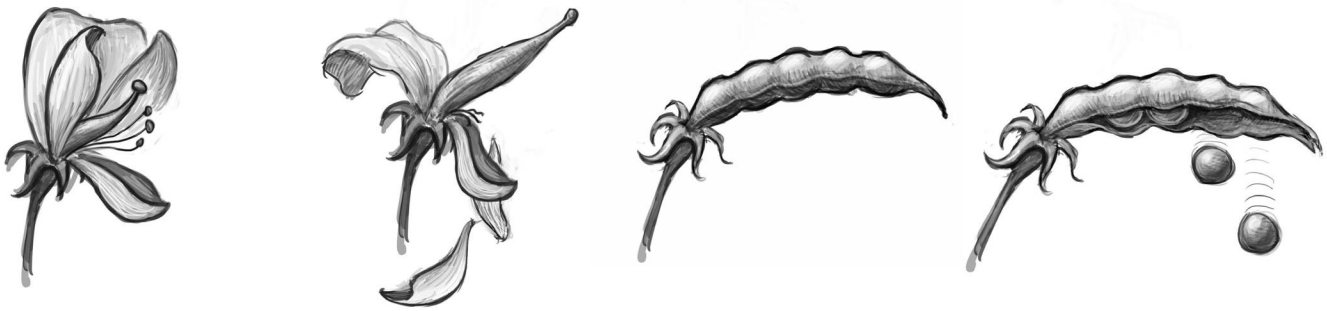
Bees get their food from flowers. While they do this, pollen from stamens clings to their legs, and the bees carry the pollen to the carpels. The bees get fed, and the flowers get fertilized.

Bees can help with self-pollination...



From Flower to Seedpod

After the pollen fertilizes the eggs, the carpal grows into a pea pod. The peas inside are the fertile seeds that can grow into new plants.



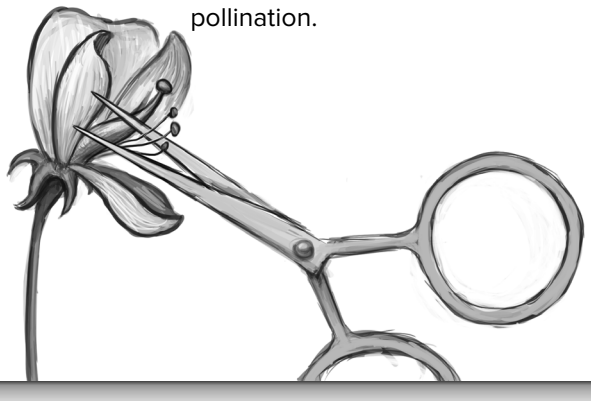
Speaking Scientifically

The **Skeptical Monk**

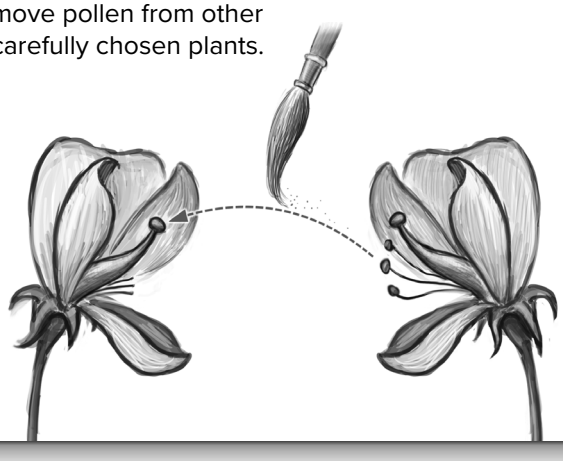
Mendel messes **with Mother Nature**

Starting with what he knew about pea plant fertilization, Mendel developed a clever strategy for studying **heredity** in the plants. Basically, he took over the job of the bees!

Mendel snipped off the stamens of plants he chose to fertilize, to prevent self-pollination.



Then he used a brush to move pollen from other carefully chosen plants.



Mendel controlled which of his pea plants bred with which. He kept records of what **traits** the starting parent plants had and what **traits** later **generations** had. He focused on certain features: flower color, stem length, and pea pod shape. Each of these features had two possible **traits**:

Flowers were either PURPLE or WHITE.

Stems were either LONG or SHORT.

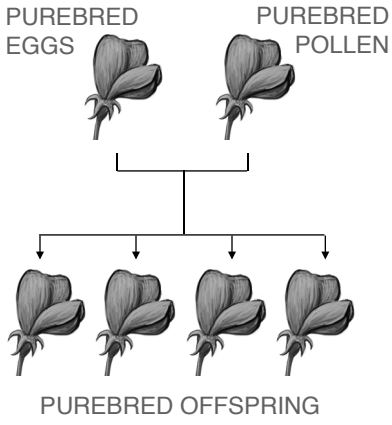
Pods were either SMOOTH or BUMPY.

Speaking Scientifically

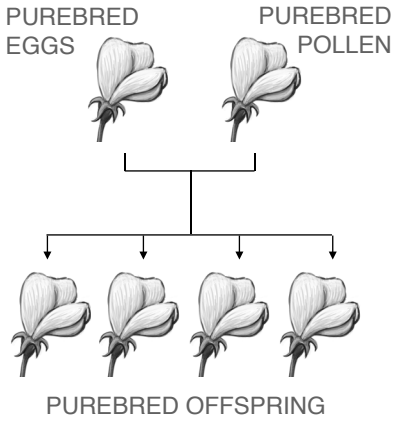
The **Skeptical Monk**

To begin with, Mendel carefully chose parent plants that were "purebred" for the **traits** he was focusing on. A purebred plant that self-pollinates (or two plants that are purebred for the same **trait**) will always produce **offspring** with the same **trait**.

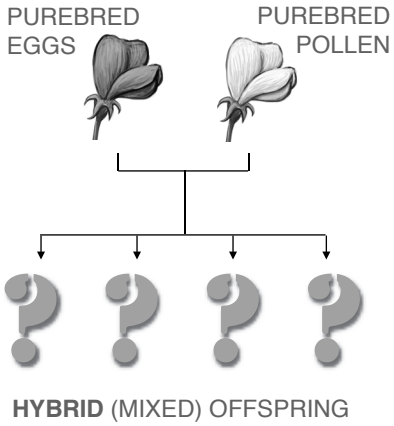
For example, a purebred purple-flowering pea plant that self-pollinates always produces purple-flowering **offspring**.



And a purebred white-flowering pea plant that self-pollinates always produces white-flowering **offspring**.



But Mendel decided to see what would happen if he cross-pollinated a purebred purple-flowering plant with a purebred white-flowering plant.



Discuss the following questions with a partner and write down your answers.

1. What is the difference between self-pollination and cross-pollination? Explain in your own words how Mendel prevented the self-pollination of his pea plants, and why.

2. What would you guess happened when Mendel used pollen from a purebred purple-flowering pea plant to pollinate a purebred white-flowering pea plant? (Use the theories from the rabbit breeding discussion in the Reader's Theater to explain your guess.)

Strange but True

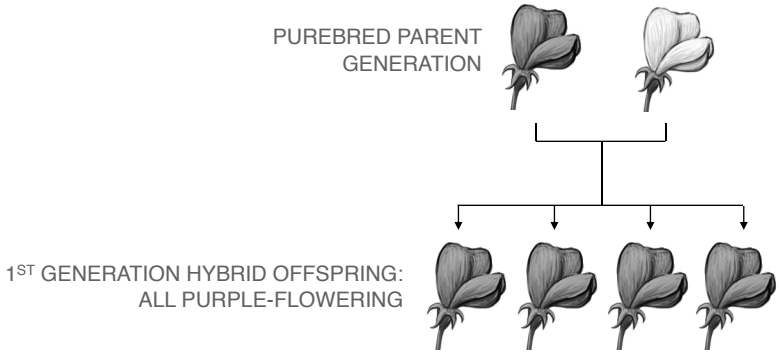
Making Hybrids

Dateline: 1866, Brünn, Austria-Hungary:

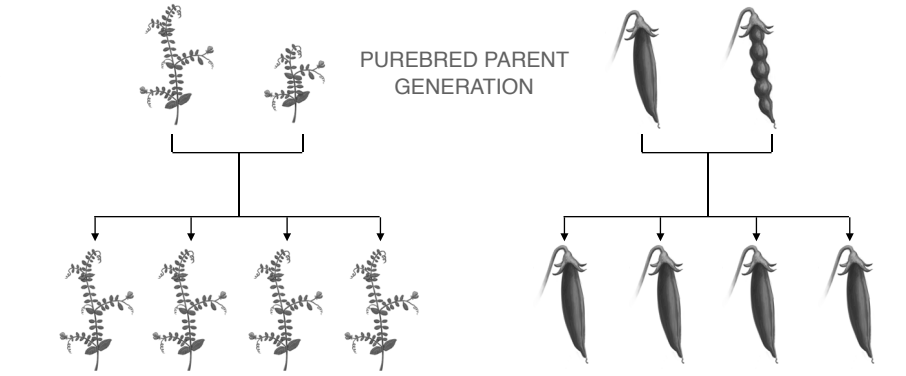
PEA PLANTS LEAD TO SCIENTIFIC BREAKTHROUGH

A monk named Gregor Mendel has just published a paper entitled "Experiments on Plant Hybridization," which he read last year at two meetings of the Natural History Society of Brünn. Despite a polite reception, no one seems to have the least idea what he is talking about, and it will probably be several decades before he receives his rightful recognition as the father of modern genetics. Said one reader, "Huh?" Mendel's unusual statistical

What would you guess happened when Mendel crossed purebred purple-flowering pea plants with purebred white-flowering pea plants? Well, in the first **generation** of **hybrids** (meaning **offspring** from different kinds of parents), all of the flowers were purple. The white flowers had completely disappeared!



A similar thing happened with stem length and with pod shape. In each case, the first **generation** of **hybrids** showed only one of the **traits**.



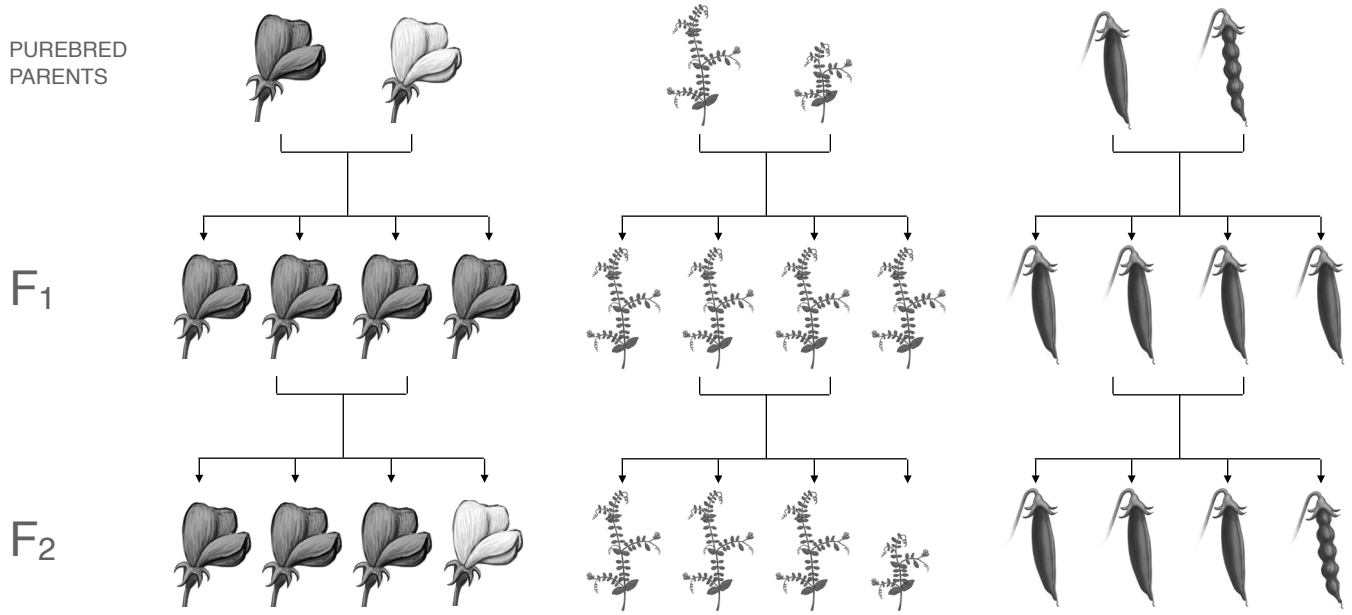
Strange but True

Making **Hybrids**

Mendel called the first **generation** of **hybrids** the F_1 **generation**, and he went on to call *their* **offspring** the F_2 **generation**. (He could have used G, X, or any other letter; but he chose F, so that's what we use.) The fact that certain **traits** disappeared completely in the F_1 **generation** may seem odd, but what happened next was even more surprising.

Combining **Hybrids**

The diagrams below show what happened when Mendel used his F_1 **generation** plants to breed an F_2 **generation**.



Describe what happened when the F_1 **hybrid** pea plants were bred with each other:

Strange but True

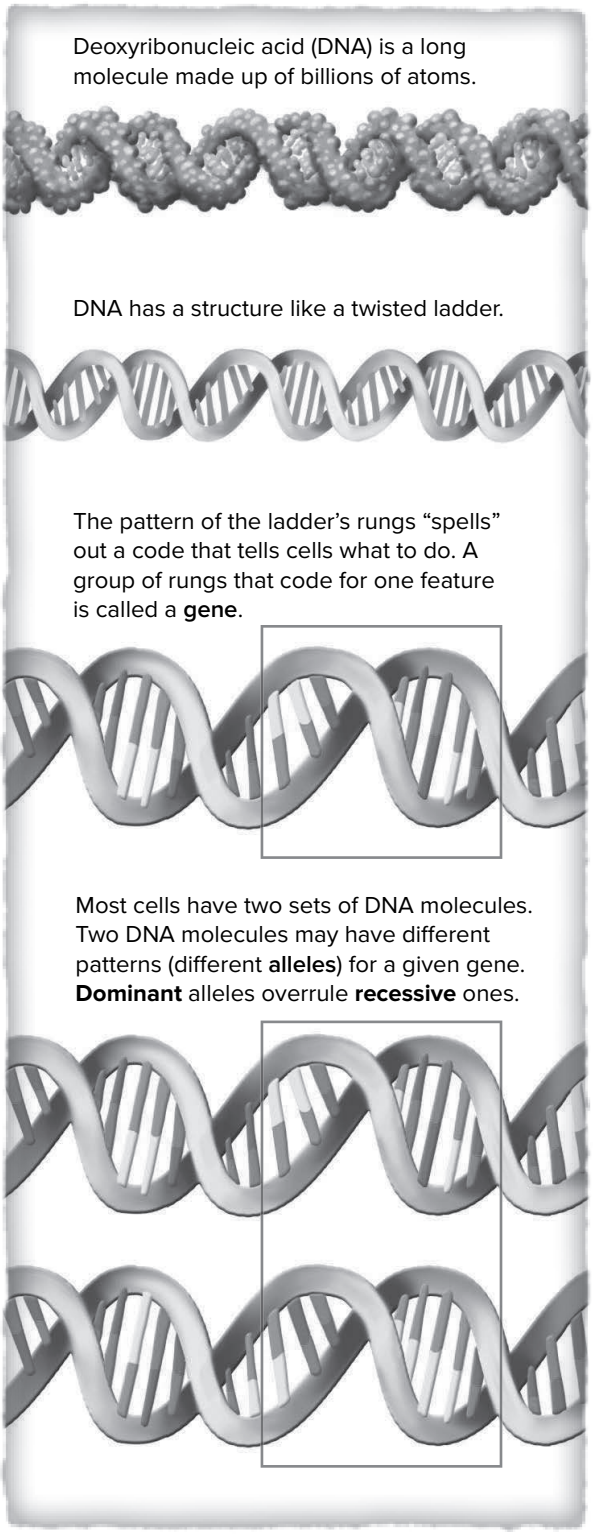
Just a Jot of Genetic Jargon

These days scientists know some interesting things about how and why **offspring inherit traits** from their parents. Today we talk about genes and alleles**,** and we say that alleles can be **dominant** or **recessive**. What do these words mean? Read on!

Genes: Genes are the basic units of inheritance. They tell living cells what to do. These genetic instructions are "written" not in words, but in the structural details of DNA molecules. DNA molecules get copied and passed down from parents to **offspring**. All living things, whether plants or animals, and whether huge or microscopically small, use DNA to encode their genetic inheritance.

Alleles: Going back to the example of Mendel's peas, the gene for the flower-color feature in pea plants comes in two versions, one for the purple **trait** and another for the white **trait**. Other genes also come in different versions (sometimes with more than two possible versions for a given feature). Each version of a gene is called an allele (pronounced uh-LEEL).

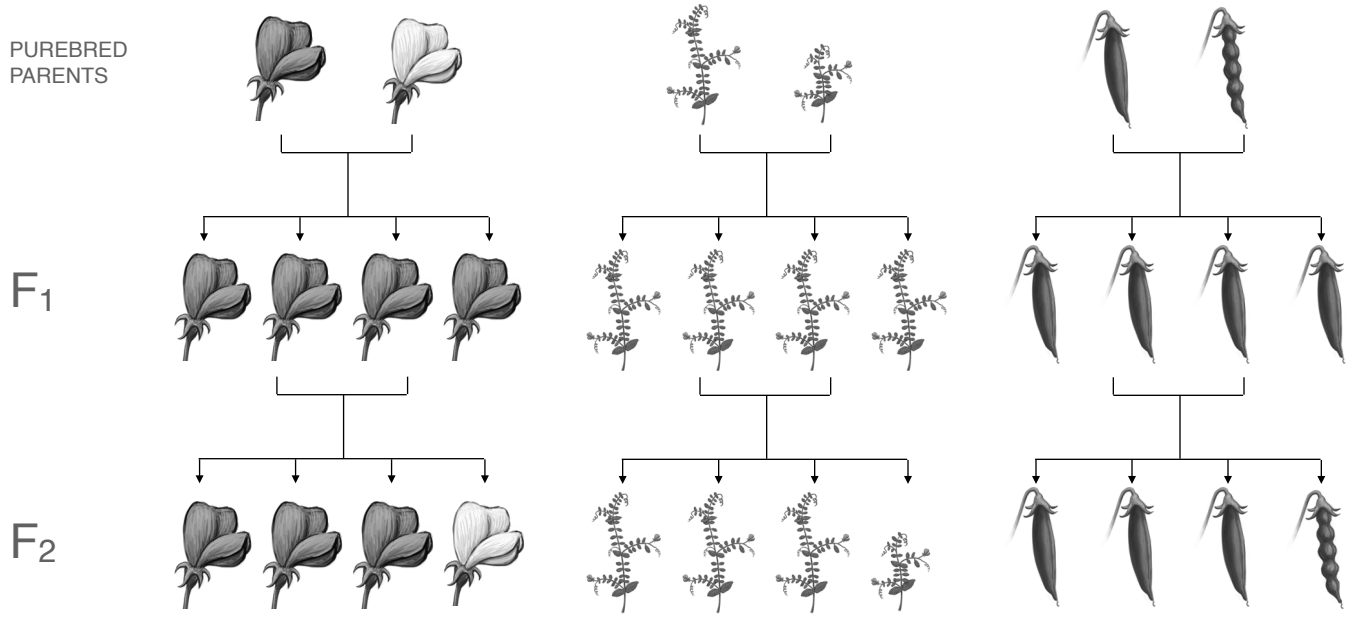
Dominant and recessive: Some alleles have more influence than others. For example, if a pea plant gets two purple-flower alleles from its parents, the plant will have purple flowers; if the plant gets two white-flower alleles from its parents, the plant will have white flowers; but if the plant gets one purple-flower allele and one white-flower allele from its parents, the purple-flower allele will ALWAYS overrule the white-flower allele, and the plant will have purple flowers.



Strange but True

Analyzing Results

Look again at the diagrams showing the results of Mendel's pea breeding experiments. As you now know, the purple-flower **trait** is **dominant** and the white-flower **trait** is **recessive**.



For stem length and pod shape, which alleles do you think are **dominant** and which do you think are **recessive**?

allele for...	(circle one)
long stems	**dominant** or **recessive**?
short stems	**dominant** or **recessive**?
smooth pod	**dominant** or **recessive**?
bumpy pod	**dominant** or **recessive**?

Strange but True

Track Those Traits

The first table below shows what happened when Mendel crossed purebred purple-flowering pea plants with purebred white-flowering pea plants. Each F_1 **hybrid inherits** one purple-flower allele and one white-flower allele. Because the purple-flower allele is **dominant**, the flowers on all the F_1 plants are purple.

FLOWER COLOR: Making the **F_1 generation**

All allele pairs **inherited** from the purebreds are the same	**purple** white	**purple** white	**purple** white	**purple** white
F_1 flower color will be:	purple	purple	purple	purple

But when the F_1 **hybrids** produce the next **generation** of **hybrids**, things are different. Each F_1 parent has an equal chance of giving a purple-flower or a white-flower allele to each of its F_2 **offspring**. The four possible outcomes shown below are all equally likely, and will tend to show up in equal numbers when two plants have a large number of **offspring**.

FLOWER COLOR: Making the **F_2 generation**

The 4 equally likely allele pairs **inherited** from the F_1 **generation**	**purple** **purple**	**purple** white	white **purple**	white white
F_2 flower color will be:	purple	purple	purple	white

The two tables above show why Mendel found that none of the F_1 plants showed **recessive traits**, but **recessive traits** showed again in about one quarter of the F_2 **generation** plants. Compare these tables to the F_1 and F_2 rows in the diagrams earlier in this section.

Complete the tables below by writing in the **traits** for the F_2 **generation** plants in the stem-length and pod-shape breeding experiments:

STEM LENGTH: Making the **F_2 generation**

The 4 equally likely allele pairs **inherited** from the F_1 **generation**	**long** **long**	**long** short	short **long**	short short
F_2 stem length will be:				

POD SHAPE: Making the **F_2 generation**

The 4 equally likely allele pairs **inherited** from the F_1 **generation**	**smooth** **smooth**	**smooth** bumpy	bumpy **smooth**	bumpy bumpy
F_2 pod shape will be:				

© 2015 SERP

Strange but True

Plant Portraits

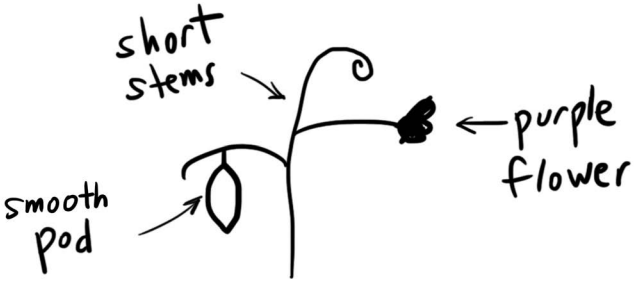
Mendel discovered one more important thing in his breeding experiments: The flower-color allele a parent plant passes on to a particular **offspring** has nothing to do with which stem-length allele it passes on. The same is true for pod shape. In other words, all of these **traits** are **inherited** independently of one another. So any combination of **traits** is possible in pea plants. Human **genetic inheritance** works basically the same way, which is why people come in such an amazing variety of appearances.

Here are the pairs that this pea plant **inherited**. The **dominant** alleles are circled.

purple	white
short	short
smooth	bumpy

TURN AND TALK

Why does this pea plant look the way it does?



Your turn!

First, circle the names of any **dominant** alleles in these pairs.

Then sketch and label what the plant would look like.

white	white
long	short
smooth	smooth

Your turn!

First, circle the names of any **dominant** alleles in these pairs.

Then sketch and label what the plant would look like.

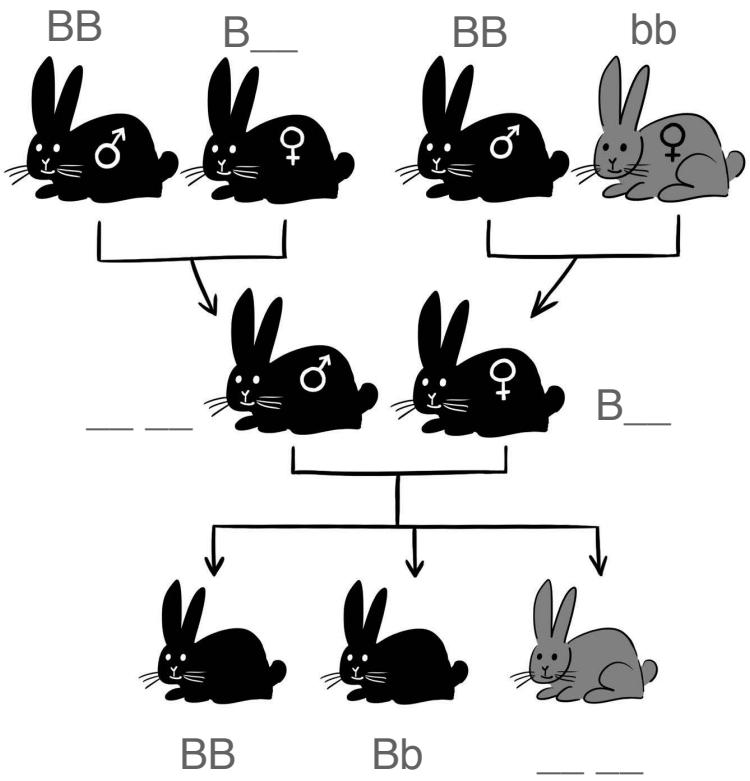
purple	white
long	long
bumpy	smooth

Strange but True

The Generation-Hopping Genetic Trait Challenge!

What's that you say? You can't get enough of classical Mendelian **genetics**? Never fear, here's an extra challenge problem.

Mendel's ideas about **genetic** inheritance apply to rabbits (and people!) as well as to peas. In the diagram below, the symbol **B** stands for the **dominant** black-fur allele. The symbol **b** stands for the **recessive** brown-fur allele. With a partner, fill in the missing symbols in this rabbit family tree to show how the brown rabbit at the lower right **inherited** the phenotype of the grandma rabbit at the upper right. Remember, each rabbit gets a copy of one allele from its father (♂) and of another allele from its mother (♀):



If you figured it out, give yourself a carrot!

The genetics of rabbit coloring has been greatly simplified here.
Rabbits can come in hundreds of colors and patterns!

Prepare for Debate

On a more serious note...

Ms. Kahn is teaching her science class about genetic testing. Her students have a range of opinions about whether or not genetic screening should be regulated by the government.

“I don't think that pregnant women should have genetic tests for their babies,” says Shana. “It's wrong to make choices about a baby's future based on genes.”

"I agree with you, Shana,” Colleen replies. “But some people might want to be tested even before they decide to have a child. Some genetic tests can tell adults if they are *carriers* for a fatal genetic disease. If both parents carry the gene, their child might have the disease when it is born. The parents might choose to adopt instead.”

Shana asks, “What does it mean to be a ‘carrier’ of the gene?”

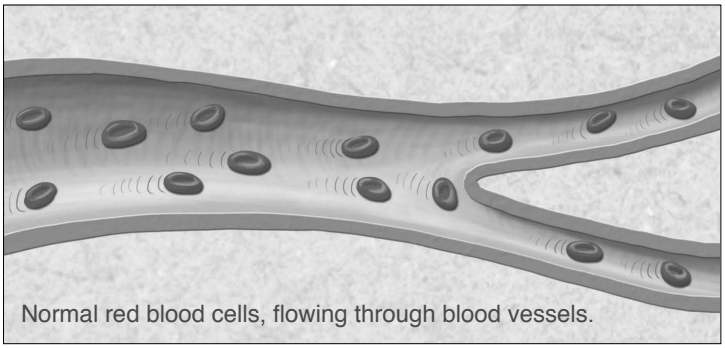
“That has to do with what we were learning before about **dominant** and **recessive alleles**,” Dylan says. “If you have one **dominant** and one **recessive** allele for a **trait**, you’re a carrier for the **recessive trait**. The **dominant trait** is what you see. But if your child **inherits** your **recessive** allele and gets a same **recessive** allele from the other parent, then the child will have the **trait**. It works the same way whether you’re talking about blue eyes or a genetic disease.”

“People don’t usually talk about being a carrier for blue eyes, though!” says Colleen. “Usually they use the word ‘carrier’ when they’re talking about a disease, like sickle cell anemia.”

“Sicka what?” says Shana.

“Sickle cell,” says Colleen. “I think it makes your blood cells a funny shape, and then they don’t work right.”

“That’s right,” says Ms. Kahn. “Normally, red blood cells have a circular shape. They have something called hemoglobin that carries oxygen to where it’s needed throughout the body. But when someone has two **recessive** sickle-cell-causing alleles, their body makes a slightly different form of hemoglobin. This form of hemoglobin causes the blood cells to have a sickle shape, kind of like a crescent moon. And the sickle cells don’t carry oxygen as well. Between the poor oxygen carrying capacity of the sickle cells and their tendency to catch on each other and block normal blood flow, sickle cell anemia is a serious health hazard. It can shorten life expectancy by a lot, although treatments have gotten better in recent years.”



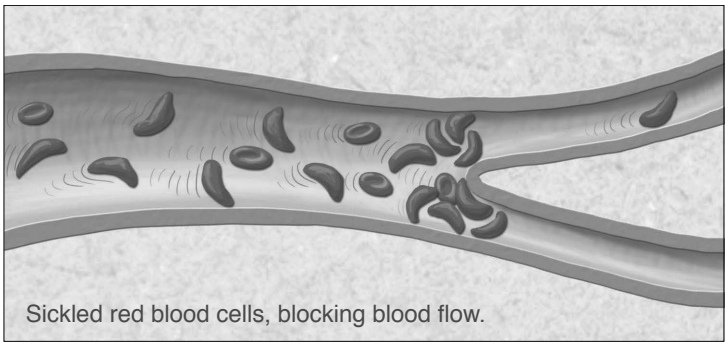
Normal red blood cells, flowing through blood vessels.

“How do you catch it?” asks Andrew.

“You don’t catch it, you have to **inherit** it,” says Dylan. “That’s why it’s called a genetic disease.”

“I heard,” says Colleen, “that sickle cell anemia is more common among people who are from certain tropical places, or who are descended from those people. Why is that?”

“Well,” says Ms. Kahn, “It turns out that although having the two **recessive** alleles that cause sickle cell anemia is bad for you, having just one of those **recessive** alleles can be an advantage in certain situations. The **dominant** allele in sickle cell carriers causes them to make enough normal hemoglobin that they generally don’t have the problems associated with sickle cell anemia. But the **recessive** allele is what’s called *incompletely **recessive***: it does cause the body to make some sickle shaped blood cells with abnormal hemoglobin. And it turns out that this blood condition creates a harsh environment for a microscopic parasite that can get into the human bloodstream and cause malaria.”



Sickled red blood cells, blocking blood flow.

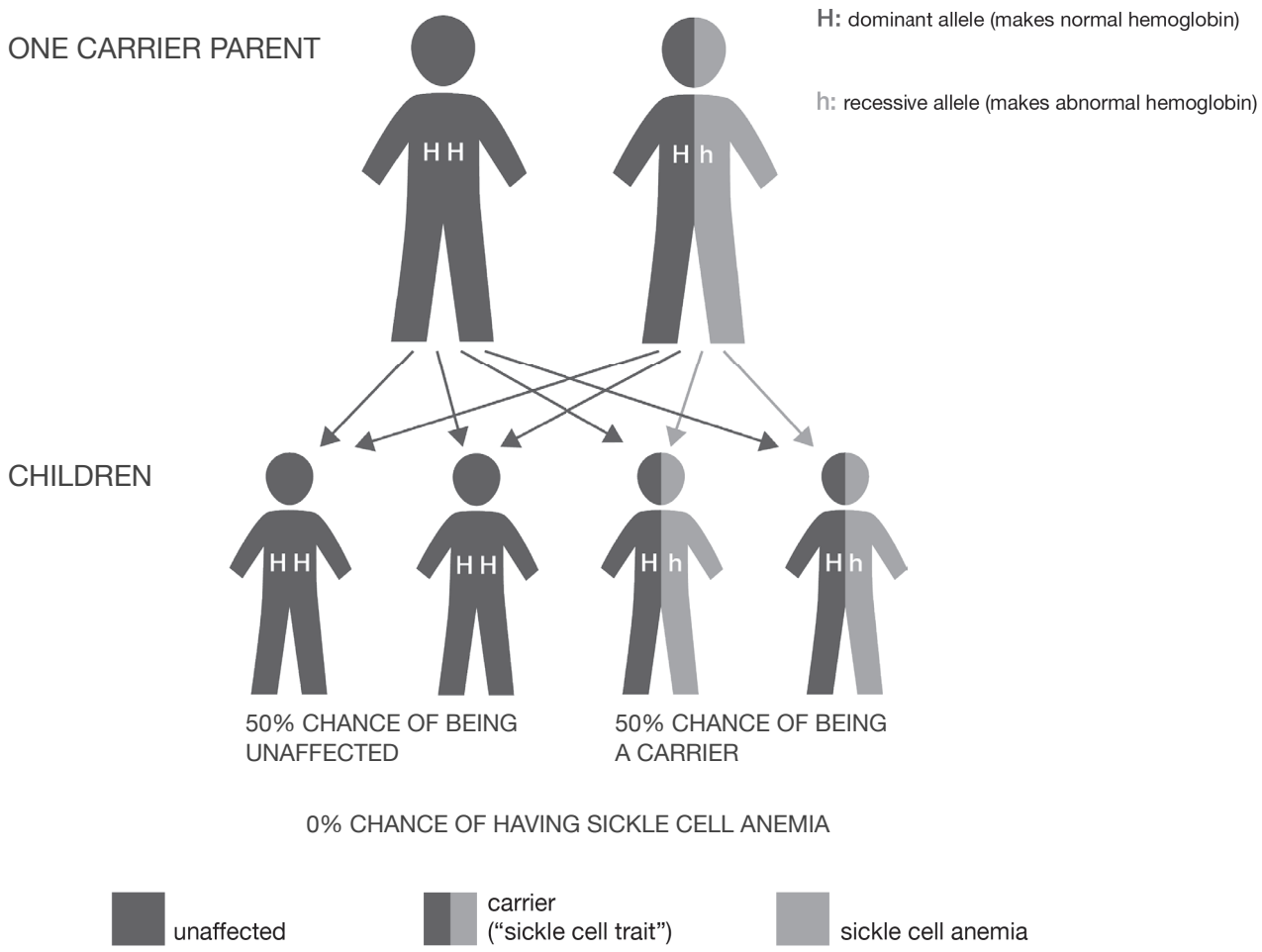
continued on next page

Prepare for Debate

Ms. Kahn continues, "Malaria is a disease that kills hundreds of thousands of people each year, and the parasite that causes it lives for part of its life cycle in humans, and the other part of its life cycle in mosquitoes that thrive in tropical areas. So malaria is much more common in the tropics, where so many of the mosquitoes are. People who are sickle cell carriers can still get malaria in the tropics, but they generally have less severe symptoms of the illness and have a lower risk of dying."

"That's kind of cool," says Dylan. "The costs and benefits of having certain genes can vary depending on what you're up against in your environment."

"Right," says Colleen. "But here in North America, being a sickle cell carrier is pretty much all bad, because you probably won't get malaria here, so all it means is that you might pass a dangerous allele on to your kids. I for one think the responsible thing to do would be to get a genetic test to find out whether or not I'm a sickle cell carrier before I decide whether or not to have a baby."



Prepare for Debate

"But even if you found out you were a carrier," says Dylan, "that wouldn't mean that your baby would have a risk of having sickle cell anemia unless the father was also a carrier. If the father just had two **dominant** normal alleles for hemoglobin, there's no way your baby could be born with sickle cell anemia."

"Well then," says Colleen, "I would want to know whether my husband was a carrier before we decided to have kids."

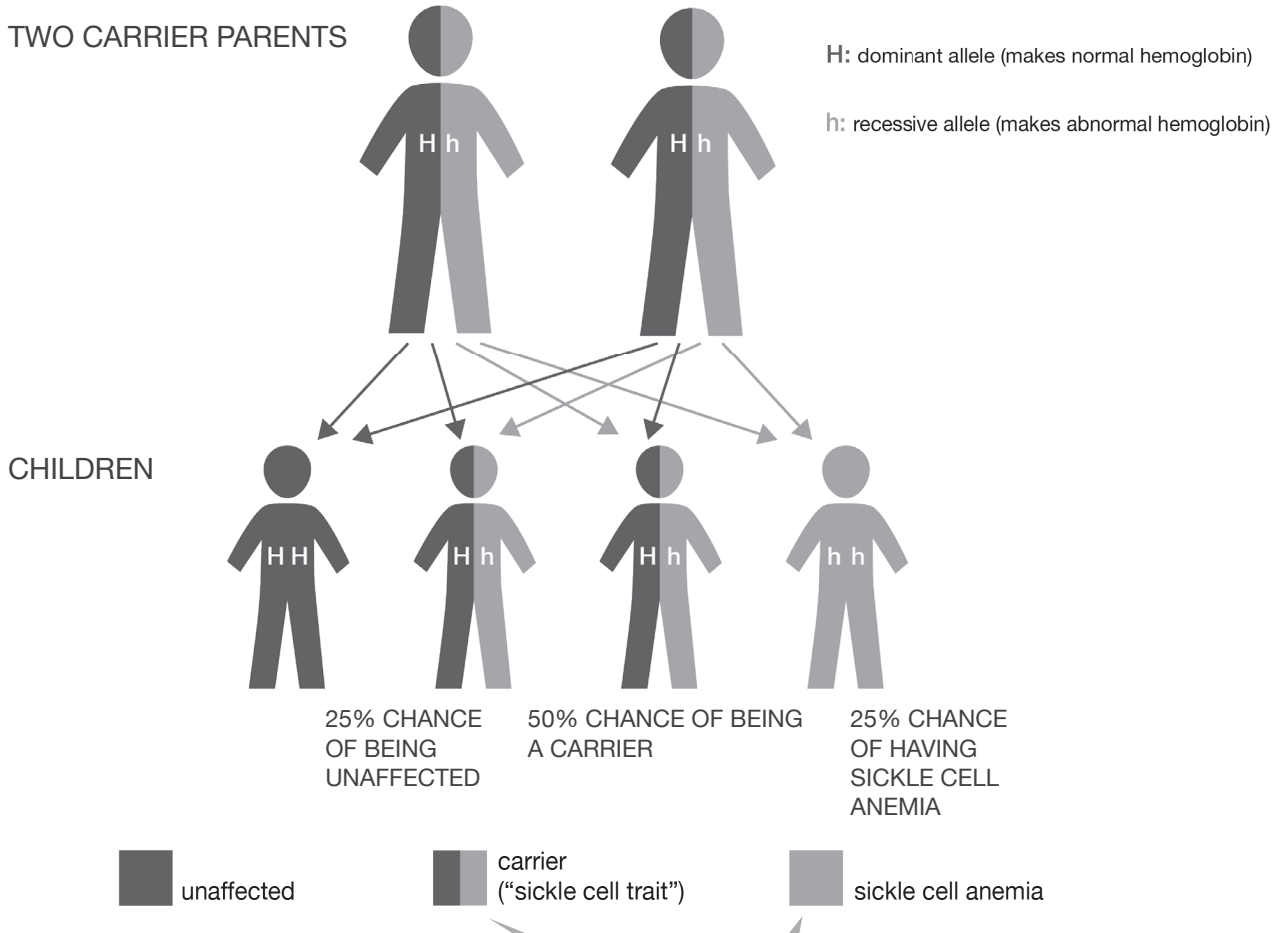
"You have a husband?" says Andrew. "But we're in middle school!"

"Ha ha, very funny. I mean if I were deciding whether or not to have children with somebody," says Colleen.

"Look, maybe you have a right to get a test if you want to, but I don't agree that you have a responsibility to get a test," says Shana. "And I'm very **skeptical** about the idea that anyone has a right to demand that somebody else get genetic testing. It's one thing if you want to test yourself. But everyone should have the right to keep their genetic information as private as they want, or even not get tested at all."

"I'm not so sure about that," says Colleen. "My husband's genes – uh, I mean my imaginary husband's genes – could have a big effect on me and my child. I'm responsible for that child, right? I think I would have a right to know about my husband's genetic information if I wanted to."

The class continues to debate who has a right to what genetic information.



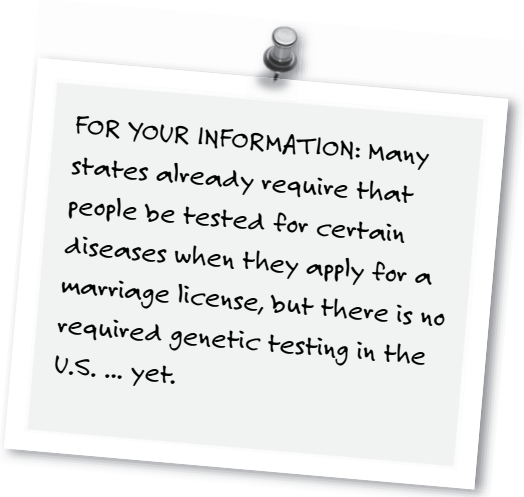
Debate Success Tip:
Make sure you understand the difference between carrier ("sickle cell trait") and sickle cell anemia.

Writing

What do you think?

Tomorrow, the class will have a debate about testing for genetic diseases. To prepare for the group debate, answer the following questions.

1. Do you think people ought to find out whether or not they are carriers for genetic diseases before deciding to have children?
2. Do you think people have a right to find out whether or not their partners are carriers for such diseases?



Writing

I used _____ of the week's focus words in this writing assignment.

Class Debate: Testing, Testing!

Should people be tested to see if they carry genetic diseases?

Today you are going to have a debate about testing for sickle cell **trait** and other **recessive** genetic diseases. Your class will debate the same two questions you wrote responses to yesterday:

1. Do you think people ought to find out whether or not they are carriers for genetic diseases before deciding to have children?
2. Do you think people have a right to find out whether or not their partners are carriers for such diseases?

Half of the class will participate in each debate. During each debate, the students who are not participating will observe and listen for good points and for this week's focus words.

Get ready...

Pick one of these positions (or create your own).

A. Genetic testing should be required before people have children. Everyone should have as much genetic information about themselves and their partners as possible. The effect our genes could have on our children outweighs other concerns.

B. Genetic testing is a bad idea. It's not worth the risk that other people might find out things about us that they don't have a right to know. And anyway, we shouldn't be making important life choices, like whether to have children, based on lab results.

C. People should be able to find out as much as they want to about their own genetic makeup. But no one has the right to anyone else's genetic information.

D. It's a good idea to get tested for genetic diseases, and partners ought to be willing to provide each other with genetic information, even if it isn't required.

E. _____

_____

_____

_____

_____

Get set...

Be ready to provide evidence to back up your position during your class discussion or debate. Jot down a few quick notes:

_____

_____

_____

_____

_____

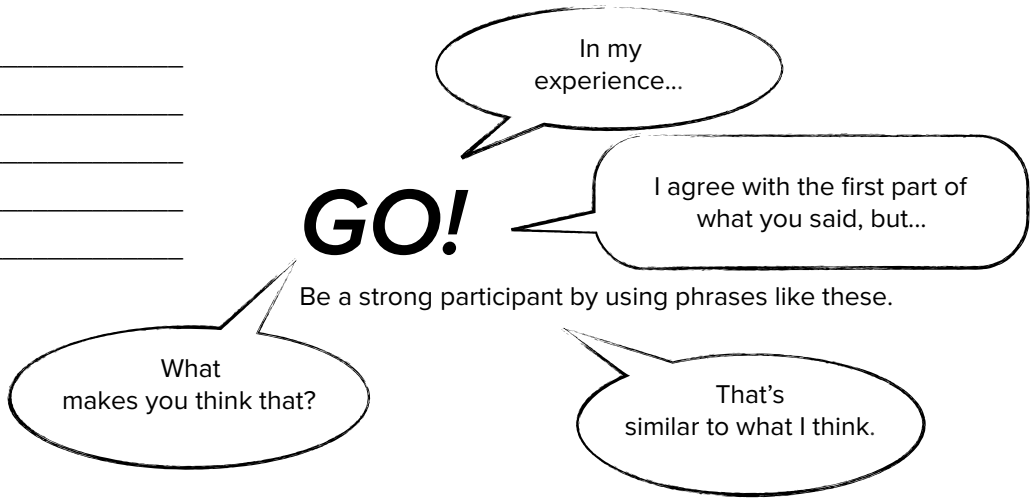
_____

_____

_____

_____

_____



Fan-Fueled Pet Crazes

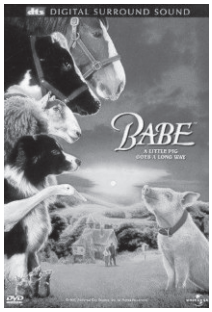
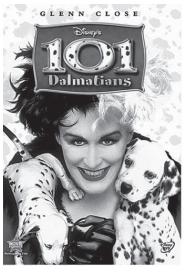
Trendy Critters

In the 1990s, Taco Bell launched an advertising campaign featuring a talking Chihuahua that said, "Yo quiero Taco Bell!" which translates to "I want Taco Bell!" These dogs are commonly associated with Mexico, partly because Chihuahua is one of Mexico's 31 states. It is the place of origin for this breed. The Chihuahua in the commercial was small and cute, and these **traits** made this breed a popular choice for a household pet. Chihuahuas also became popular when socialite Paris Hilton began carrying her pet Chihuahua, Tinkerbell, around Hollywood and New York City. The movie *Beverly Hills Chihuahua* also increased their popularity.

But people find that Chihuahuas don't make perfect pets. They are hard to train and can be very active. Chihuahuas are popular because they are small, but their size makes them prone to health issues. Because of these problems, many families who adopt Chihuahuas find that they are not the kind of pet that they had expected and give them up. This creates a problem for animal shelters which **inherit** thousands of abandoned Chihuahuas. For example, in 2009, one-third of all the rescue dogs in San Francisco's shelters were Chihuahuas. These shelters have a problem finding enough people to adopt these dogs, especially once they learn about how difficult they can be for owners.

Do you think corporations like Taco Bell, movie stars, and Hollywood studios have a responsibility to educate the public about the animals they help make popular? Or do you think people need to be **skeptical** and conduct their own research on problems associated with these "fan-fueled" pets?

More Fan-Fueled Pet Crazes

Animal:	**Turtles**	**Pigs**	**Dalmatians**	**Owls**
Popular Media:	 ***Teenage Mutant Ninja Turtles*** **1980s**	 ***Babe*** ***1991***	 ***101 Dalmations*** **1961 and 1996**	 ***Harry Potter*** **2001–2011**
Impact:	Many children wanted pet turtles because of the popular TV series. Because turtles outlive children's interest, many were released into ponds and streams where they caused problems for indigenous species.	After the film *Babe*, many people thought that a pig would make a good pet. However, when the pigs grew, their owners realized that they couldn't care for them.	In 1997, animal shelters were filling up with thousands of no-longer-wanted Dalmatians that had been taken in by owners who watched a live-action version of this Disney classic.	Animal shelters in England have found abandoned owls throughout the country.

What are the odds?

Probability and Genetics

Let's a do a probability experiment to simulate an important aspect of genetics. Get two poker chips (or something similar) and label one side of each of them with a capital letter to represent a **dominant trait**. Label the other side of each with the lower case of the same letter to represent a **recessive trait**.

To simulate two organisms having **offspring**, toss both poker chips in the air and see how they land on a table. Did they land with two capital letters facing up, simulating that the **offspring inherited** two **dominant** alleles? Or did they land with two lower case letters facing up (meaning two **recessive** alleles)? Or were they mixed (one of each)?

Try your experiment 12 times and record your results.

Label two chips, each with a capital letter on one side and the same letter in lowercase on the other side.

Trial	Result
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Questions:

1. What fraction of the new **generation** (the 12 trials) had two matching **dominant** alleles?

2. What fraction had two **recessive** alleles?

3. What fraction was mixed?

4. Using what you know about **dominant** and **recessive traits**, what fraction of the new **generation** should SHOW the **dominant trait**?

5. What percentage should SHOW the **recessive trait**?

How would you alter this experiment to predict the offspring from a father carrying two **recessive** alleles of gene A and a mother carrying one **dominant** allele and one **recessive** allele of gene A?

© 2015 SERP

Testing Athletes for Sickle Cell Trait

Sickle Cell Testing: What's the Score?

Generally speaking, people who have only one **recessive** sickle cell allele are healthy, although they may pass the allele to their **offspring**. They have what's called "sickle cell **trait**." This special use of the word **trait** in the medical name of a particular genetic condition may be a little confusing: Although sickle cell anemia is one genetic **trait**, people with “sickle cell **trait**” do not have sickle cell anemia.

However, sickle cell **trait** is not always harmless. Intense physical exertion can sometimes cause sickle cell carriers to suffer pain or even death from heat-related illness. During intense exercise, more of their blood cells may become sickle shaped, temporarily limiting the delivery of oxygen to where it’s needed in their bodies. The risk can be greater at high altitudes, where there is less oxygen in the atmosphere.

In response to the deaths of several student athletes who had sickle cell **trait**, U.S. colleges and universities have started testing many athletes for this **trait** in recent years. In 2010, the National Collegiate Athletic Association (NCAA) started a policy of testing all Division I athletes. The NCAA later extended the policy to include Division II athletes, and eventually Division III athletes as well.

The NCAA’s sickle cell testing policy is controversial. People who favor the policy say that it’s better to know if a student might be at risk. Under the policy, sickle cell carriers are still allowed to participate in athletics. The idea is just to make sure that those students and their coaches know that they need to be especially alert for symptoms of overexertion, take precautions such as good hydration, and rest if they experience cramping or extreme shortness of breath. Students can refuse to be tested.

However, this testing policy has its critics, including the Sickle Cell Disease Association of America, and the U.S. Health and Human Services Department’s Advisory Committee on Heritable Disorders in Newborns and Children. Critics of the policy point out that not all sickle cell carriers experience heat-related illness from exertion, and not all athletes who experience heat-related illness from exertion are sickle cell carriers. In other words, athletes with sickle cell **trait** and athletes who have life-threatening responses to exertion may be overlapping groups, but they are not the same group. Therefore, these critics argue, the smart thing to do would be to follow precautions that protect the health of all athletes, rather than testing a **generation** of athletes for an allele that doesn’t accurately identify who will or won’t experience problems training and competing.

Even though the NCAA’s policy says that both sickle cell carriers and those who refuse to be tested will be allowed to participate in sports, critics of the policy are **skeptical** about whether all athletes will really be treated equally. Concerns about discrimination based on genetic testing are all the greater because the sickle cell allele is distributed differently in different ethnic populations: It is estimated that 8% of African Americans, 0.5% of Latinos, and 0.2% of Caucasians carry alleles for sickle cell. The high occurrence of sickle cell **trait** in African Americans results from the protection that sickle cell **trait** provides against malaria, a disease that is common in Sub-Saharan Africa and other tropical parts of the world. Therefore, if there were any discrimination against athletes with sickle cell **trait**, it might affect African American athletes disproportionately.

On the other hand, one could argue that the medical dangers of sickle cell **trait** also affect African American athletes disproportionately, and that the potential positive results from genetic screening outweigh concerns about possible discrimination.

How should the danger of discrimination be weighed against the danger of a known risk factor for illness and death? Is it common sense to check for such a risk factor, or common sense for everyone to follow the same precautions, while keeping their medical information private? What do you think?

Examining the Focus Words Closely

SciGen Unit 7.5

→ **Scientific** or ✱ **Everyday Use**		**Definition**	**Try using the word...**
→	**trait** *noun*	an observable characteristic based on genetic background	*What are some **traits** of a pea plant?*
✱	**trait** *noun*	a particular quality in someone's character	*What is a **trait** that you wish you had?*
→	**dominant** *adjective*	always observable, even when paired with a different trait	*What is a **dominant** trait for the stem of a pea plant?*
✱	**dominant** *adjective*	strongest, most important, or most noticeable	*What professional team is **dominant** in a sport or other competition that you enjoy watching?*
→	**recessive** *adjective*	only visible when no dominant trait is present	*What is the **recessive** trait for the flower color of a pea plant?*
→	**inherit** *verb*	to receive a trait from a parent or previous generation	*What happens when an offspring **inherits** one dominant and one recessive trait from its parents?*
✱	**heredity** *noun*	the passing on of mental or physical qualities from parent to child	*Do you think **heredity** affects the way a person responds to problems? What evidence do you have?*
→	**offspring** *noun*	a person's children or an animal's young	*Describe the **offspring** of the black rabbits Jet and Midnight.*
→	**generation** *noun*	a single step of the ancestry of a living thing (i.e., a mother and daughter are one **generation** apart)	*Explain how a recessive trait can skip a **generation**.*
✱	**generation** *noun*	all of the people in a family or society that are around the same age	*Some people say that children today are part of the iGeneration. What do you think that means?*
→	**skeptical** *adjective*	questioning common beliefs	*What theories of heredity made Mendel **skeptical**?*
✱	**skeptic** *noun*	a person who doesn't easily believe others or ideas	*Do you think good scientists are also **skeptics**? Explain.*
→	**hybrid** *noun*	an offspring of two different varieties of plant or animal	*Describe how pea plants produce a generation of **hybrids**.*
✱	**hybrid** *noun*	something that is a mixture of two or more things	*Why are some cars called **hybrids**?*

© 2015 SERP