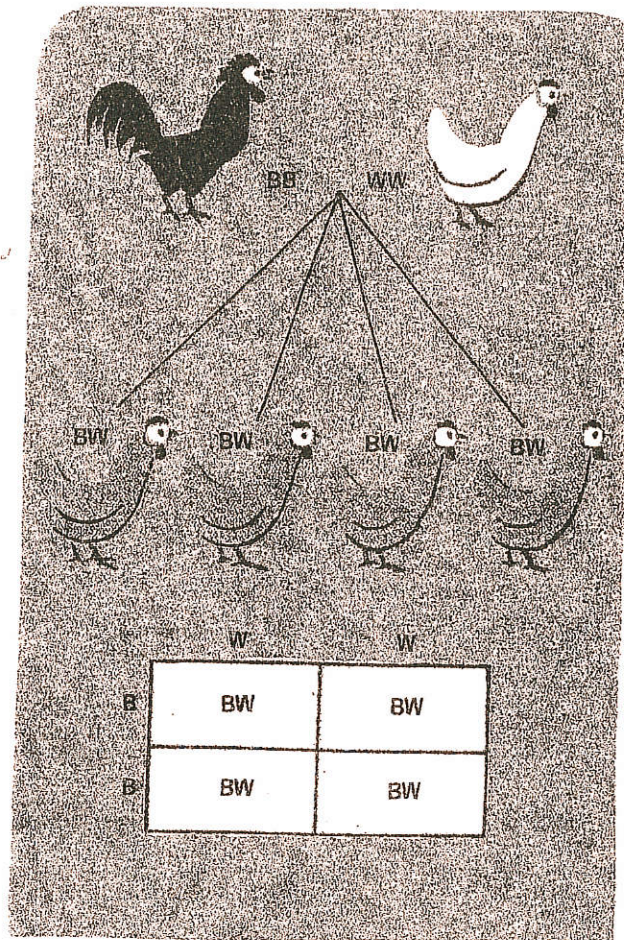


HEREDITY



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HEREDITY

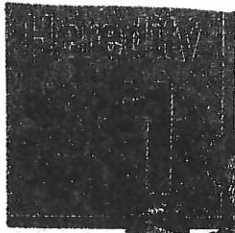


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TABLET

NO. 1000

What are inherited characteristics?



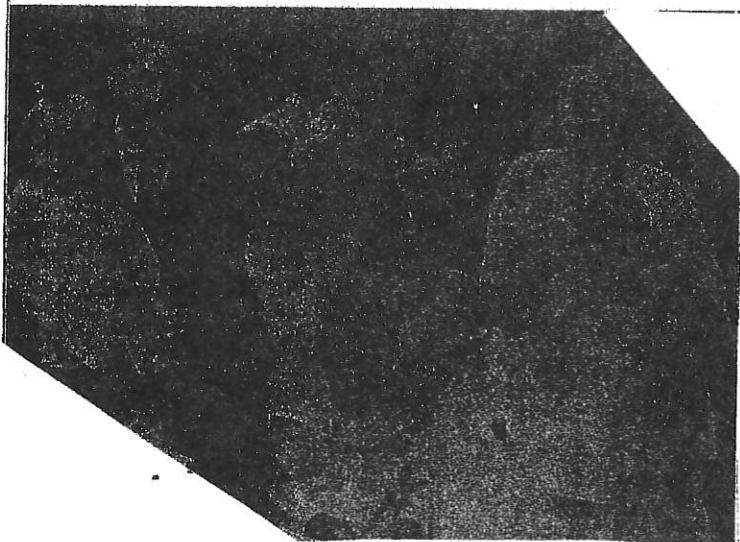
What do you look like? How do you describe your appearance? Short or tall, black hair or blond hair, blue eyes or brown eyes, and so on. Your hair, your eyes, and your height all help to identify you. They are your characteristics. Nobody else has exactly the same characteristics that you do. These characteristics that help to identify you are called traits (TRATES).

► What are traits?

How many inherited traits can you see in this family portrait?

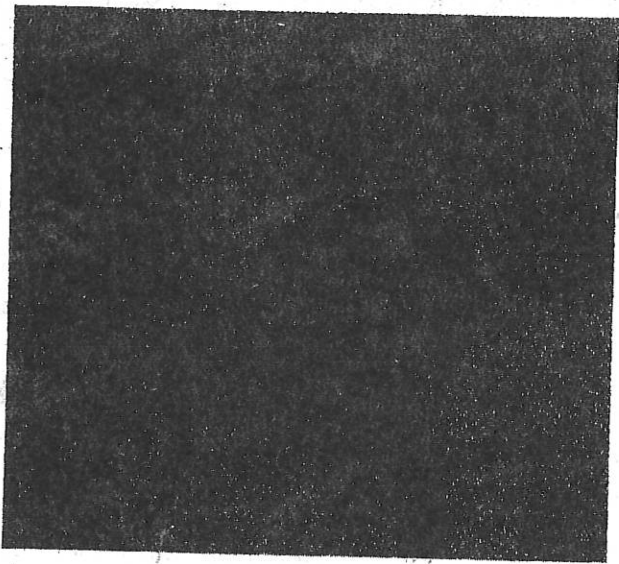
Whom do you look like? Do you look like your mother, or your father, or a mixture of both? Children often look like their parents or grandparents in some way. There is a reason for this. You learned that during fertilization, male and female sex cells join. These sex cells contain materials that control the development of the embryo. These materials also control the traits that are passed on from parents to offspring. Traits that are passed on from parents to offspring are called inherited (in-HEHR-it-ed) traits.

► What are inherited traits?



Heredity. The passing on of traits from parents to offspring is called heredity (huh-RED-uh-tee). The first scientist to study inherited traits was Gregor Mendel, an Austrian monk. Mendel studied how inherited traits are passed on from parent to offspring. He also studied differences in inherited traits. The modern science of heredity is called genetics (juh-NET-iks).

► What modern science deals with the study of heredity?



Gregor Mendel experimenting with pea plants.

WHAT YOU LEARNED

1. Traits are inherited.
2. Inherited traits are passed on from parents to offspring.
3. The way inherited traits are passed on is called heredity.
4. The modern science of heredity is called genetics.

SCIENCE WORDS

traits (TRATES)

characteristics of living organisms

inherited (in-HER-uh-ted) traits

traits that are passed on from parents to offspring

heredity (huh-RED-uh-tee)

the passing on of traits from parents to offspring

genetics (juh-NET-iks)

the modern science of heredity

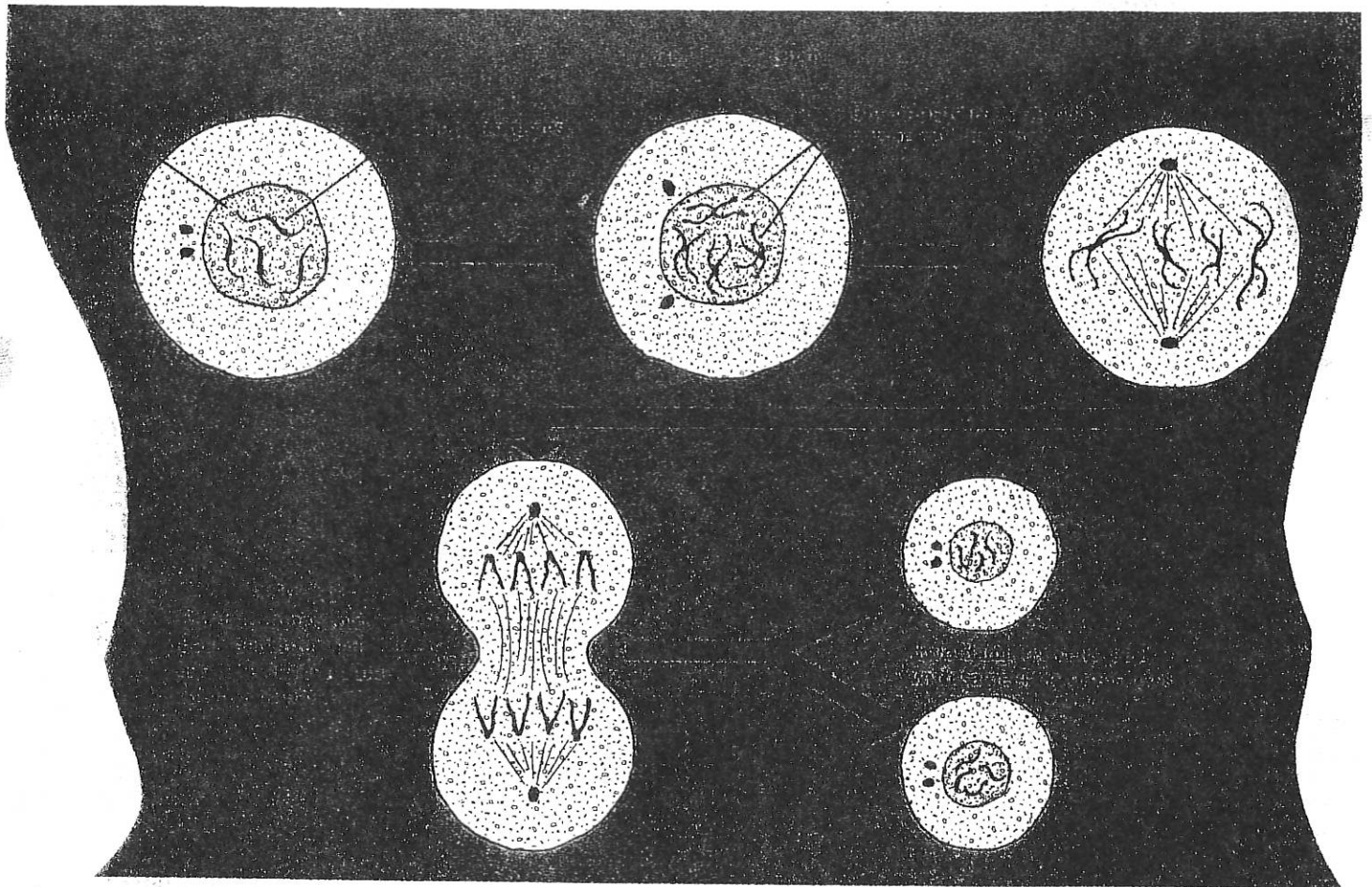
FINDING OUT MORE

Human genetics is difficult to study. For one thing, a scientist cannot really do experiments with humans. Also, the life span of humans is long. Therefore, a scientist could not study all the offspring produced in many generations of a family during his own lifetime. Another difficulty is that humans produce few offspring. Because of this, it is hard to compare traits. Scientists study plants and animals to help them learn more about human genetics. The plants and animals used in experiments have short life spans. With these organisms, many offspring can be studied and compared in a short time. By studying genetics, scientists hope to learn more about inherited diseases and how to prevent them.

Why are chromosomes important?

Heredity

2



The thread of life. Chromosomes are the fine threads found in the nucleus of cells. During cell division, each chromosome doubles to form a pair of identical chromosomes. Each daughter cell receives one chromosome from each of the pairs.

► What are chromosomes?

Chromosomes and reproduction. In both asexual and sexual reproduction, chromosomes are passed from parent to offspring. In asexual reproduction, each daughter cell receives its chromosomes

from the single parent. In sexual reproduction, each parent gives a set of chromosomes to the new individual. All new organisms contain chromosomes from the parent or parents.

► Where do the chromosomes of a new organism come from?

Chromosomes and genes. Along each chromosome, there are many dark bands. Each band is a small part of the chromosome called a gene (JEEN). Genes control inherited traits. Each gene is located at a



CHROMOSOMES

definite place on the chromosome. Each gene affects a certain trait. Genes determine how tall you are. They control the color of your hair, eyes, and skin. Genes also control all the life activities of your cells. In fact, genes control all your inherited characteristics.

► **What do genes control?**

WHAT YOU LEARNED

1. All new organisms contain chromosomes from their parents.
2. Chromosomes contain genes.
3. Genes control inherited traits.

SCIENCE WORD

genes (JEENS)

parts of the chromosome that control inherited traits

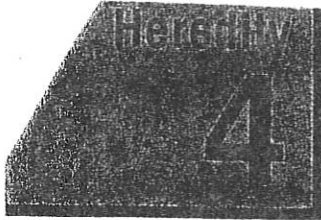


PEOPLE IN SCIENCE

Francisco Ayala (1934-)

Francisco Ayala is an internationally-known geneticist. He is Professor of Genetics at the University of California, Davis. His research has been on the genetic variation that exists in natural populations of organisms. He has investigated the effects that certain environmental factors have on the genetic changes that occur in populations over time. He is the author of eight books and over 300 articles. In recognition of his contributions to biology, Dr. Ayala has received many honors and awards.

Why can offspring look different from their parents?



Parents and children do not look exactly alike. Parents with brown eyes can have children with blue eyes. How can this happen? Scientists have found that parents can carry hidden genes. The gene for a certain trait is there, but the trait does not show itself. Traits that do not show themselves are called hidden traits.

► What are hidden traits?

T is for tall. Mendel studied pea plants. Some of the plants he studied were tall. Others were short. Mendel decided there must be a gene for tallness and another gene for shortness. Scientists label these genes T for tall and t for short. Today we know that every individual has two genes for each trait—one from each parent.

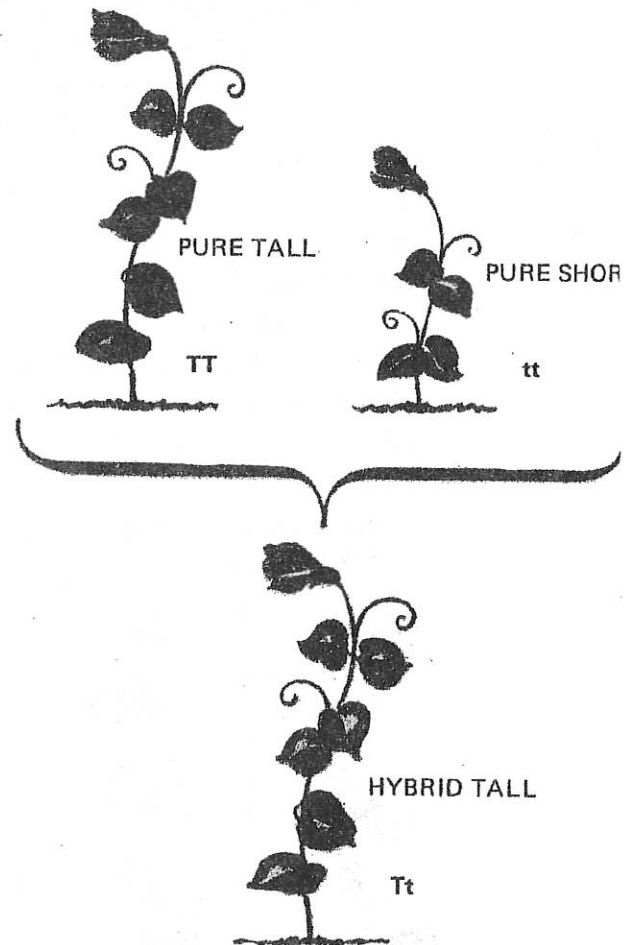
► How many genes do we have for each trait?

It's a tall story. Mendel found that one kind of tall pea plant always has tall offspring. These plants have two T genes, one from each parent. We say they have TT genes. Mendel called these plants pure tall.

► What genes does a pure tall pea plant have?

Forever short. Mendel found that short pea plants always have short offspring. These plants have two t genes, one from each parent. We say they have tt genes. Mendel called these plants pure short.

► What genes does a short pea plant always have?

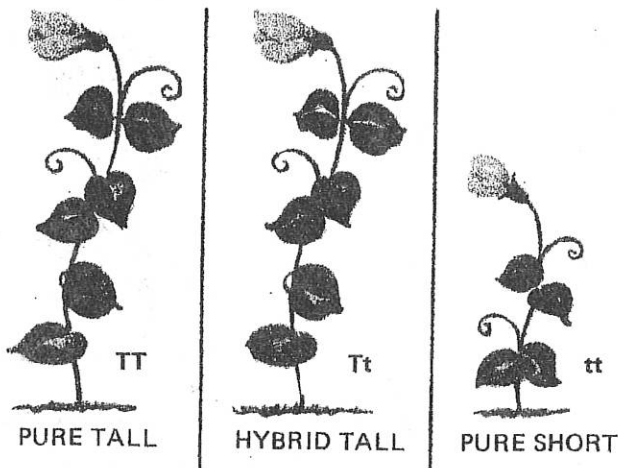


Another way to get tall. Mendel wondered what would happen to offspring if one parent was tall and the other short. He cross-pollinated pure tall and pure short pea plants. He found that the offspring were all tall. But they had a T gene from the tall parent and a t gene from the short parent. They had Tt genes. But still they grew up tall. Mendel called these plants hybrids (HY-brids). He said they were hybrid tall. Organisms that have two like genes for a trait are called pure for that trait. Organisms that have two unlike genes for a trait are called hybrid for that trait.

► What genes does a hybrid tall pea plant have?

Who is hiding? Mendel studied many traits in pea plants. He found that in a hybrid, one gene always shows itself, and the other gene is hidden. Mendel called the gene that shows itself the dominant (DOM-uh-nent) gene. He called the hidden gene recessive (rih-SESS-iv). T is dominant in pea plants. Plants with Tt genes are always tall. The t gene is there, but it is hidden. When a pure tall is mated with a pure short pea plant, the offspring are always tall. This is called the Law of Dominance.

► **What do we call the gene that always shows itself?**



WHAT YOU LEARNED

1. Traits are controlled by two genes.
2. An organism with two like genes for a trait is pure for that trait.
3. An organism with two unlike genes for a trait is hybrid for that trait.
4. A dominant gene always shows itself.
5. A recessive gene is hidden when the dominant gene is present.

SCIENCE WORDS

pure

having two like genes

hybrid (HY-brid)

having two unlike genes

dominant (DOM-uh-nent) **gene**

a gene that always shows itself

recessive (rih-SESS-iv) **gene**

a gene that is hidden when the dominant gene is present



FINDING OUT MORE

Sometimes a new gene appears in an organism that was not present in the parents. The new gene may occur because of a change in an old one. New traits can also appear because a chromosome changes. The chromosome may lose a piece, or it may become attached to another chromosome. Changes in genes and chromosomes are called mutations (mew-TAY-shuns). The organism with the new trait is called a mutant (MEWT-unt). Most mutations are harmful to the organism. But some mutations help organisms to survive. In this way, new kinds of organisms may arise. Scientists believe that long-necked giraffes developed from short-necked ancestors by a series of mutations.

Heredity 5

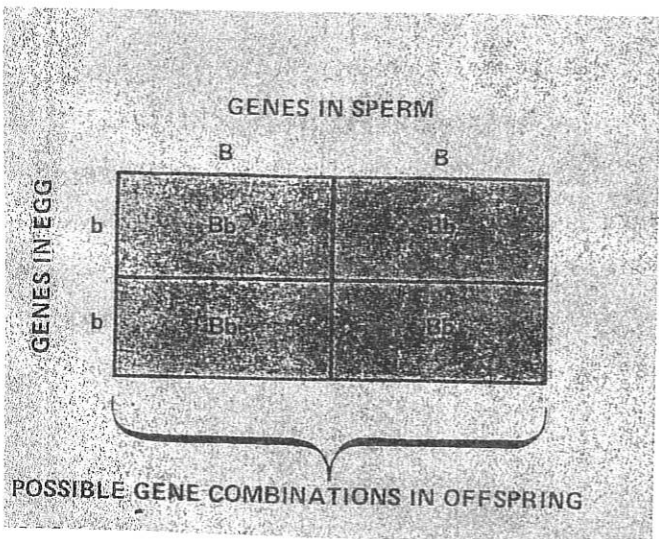
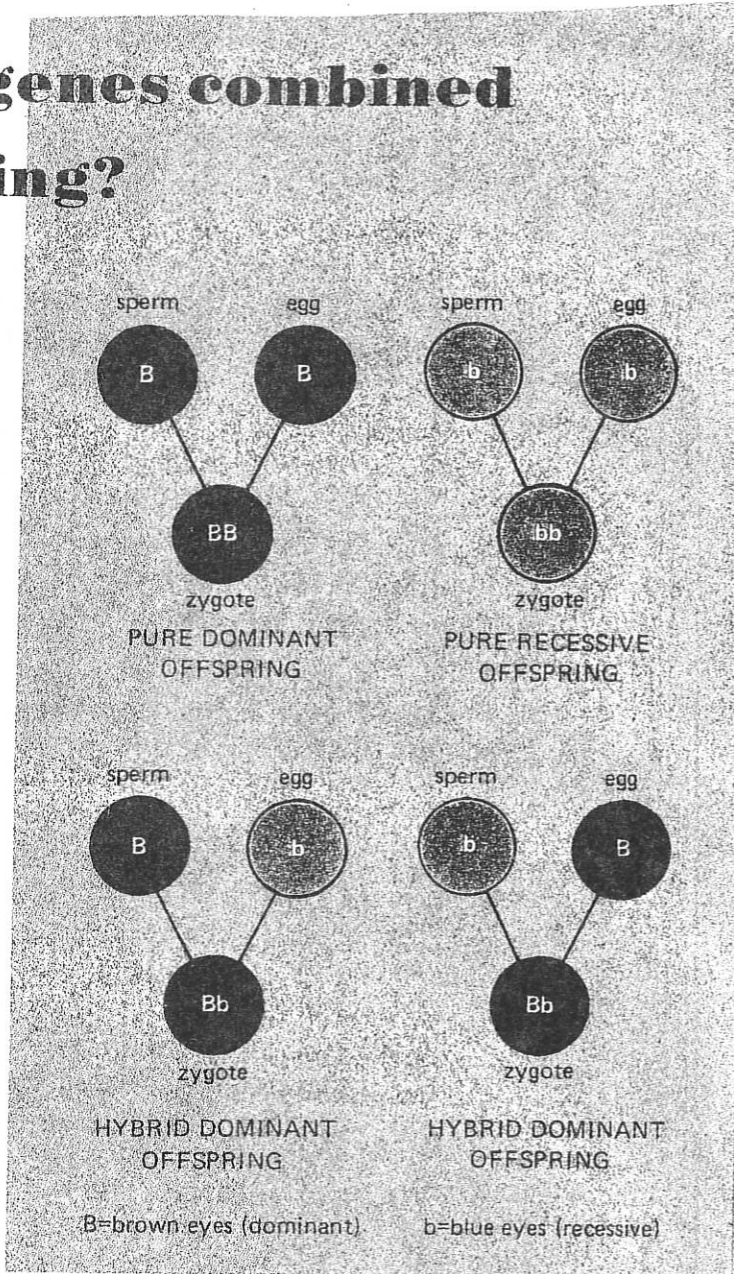
How are genes combined in offspring?

It takes two to make a trait. Organisms have two genes for each trait. They receive one gene from each parent. Symbols can be used to study combinations of genes. A capital letter represents a dominant gene. A small letter represents a recessive gene. In humans the gene for brown eyes is dominant. The symbol for this gene is B. The gene for blue eyes is recessive. The symbol for this gene is b.

► What kind of symbol is used to represent a dominant gene?

Pure traits and hybrid traits. When two like genes combine, they produce a pure trait. The trait may be either dominant or recessive. When two unlike genes combine, they produce a hybrid trait. A hybrid trait is always the dominant one.

► What kind of genes produce hybrid traits?



Predicting traits. Suppose a father has pure brown eyes. His genes are BB. Suppose a mother has pure blue eyes. Her genes are bb. We can use a chart to predict the gene makeup of their offspring. All the offspring will have Bb genes. They will all have hybrid brown eyes. When one parent is pure dominant and the other is pure recessive, all offspring are hybrid dominant.

► When two parents have pure traits of different kinds, what trait will their offspring have?

Combining hybrids. What happens when both parents are hybrid for a trait? We can use the same kind of chart to predict the gene makeup of their offspring. One-fourth, or 25%, of their offspring will be BB, or pure dominant. One-half, or 50%, will be Bb, or hybrid dominant. One-fourth, or 25%, will be bb, or pure recessive. This means that three-fourths, or 75%, of the offspring will have brown eyes. Only one-fourth, or 25%, will have blue eyes.

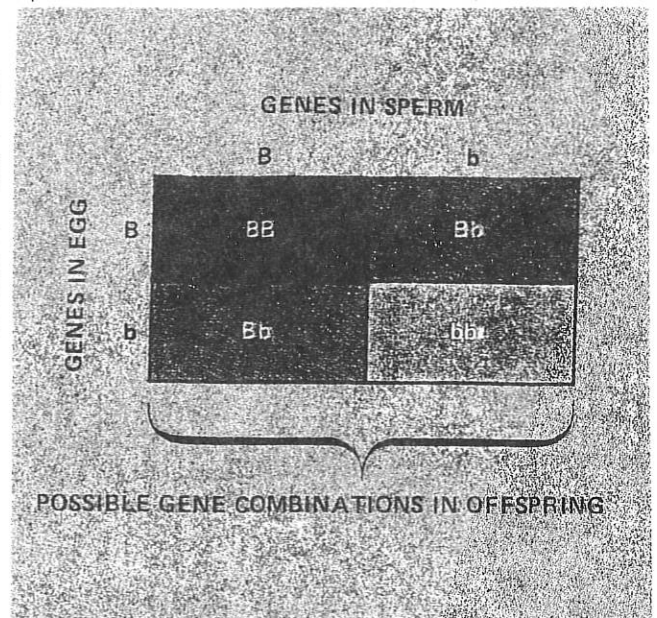
- What are the three kinds of traits that the offspring of hybrid parents can have?

WHAT YOU LEARNED

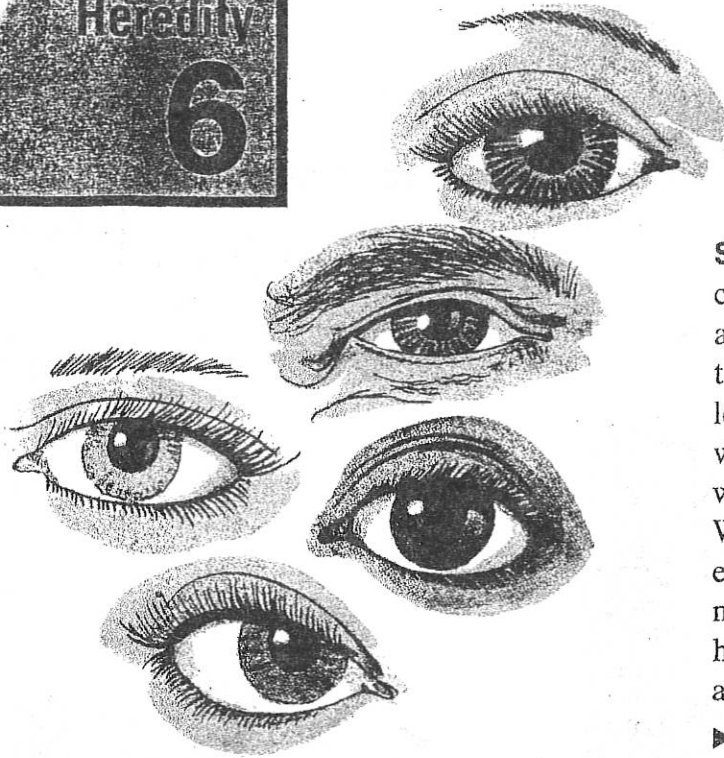
1. When one parent is pure dominant and the other parent is pure recessive, the offspring are all hybrid.
2. When both parents are hybrid, 25% of the offspring are pure dominant, 50% are hybrid dominant, and 25% are pure recessive.

FINDING OUT MORE

We have been discussing traits that are controlled by one pair of genes. However, in humans there are many traits that are controlled by more than one pair of genes. In Pea plants, one pair of genes control height. One gene is dominant and the other is recessive. The plants are either tall or short. Some are very short, and some are very tall. The rest are in between. This happens because there are many genes that affect height. None of these genes is dominant. So height depends on the total effect of all the genes for height.



Can traits be blended?

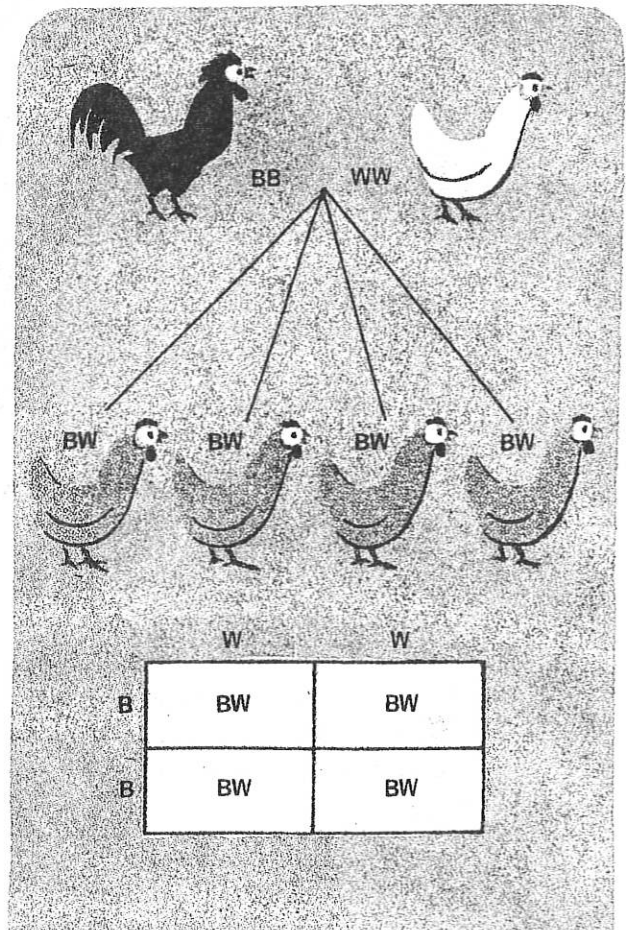


An eye of a different color. In humans the gene for brown eyes is dominant, and the gene for blue eyes is recessive. Do you know anyone with hazel or green eyes? Maybe you have eyes that are not brown or blue. Where do these other eye colors come from? There are genes for eye color that are neither dominant nor recessive. When these genes combine, a mixture of both traits shows. This is true for other color traits, too. Skin color and hair color can be a mixture of traits that are not dominant or recessive. This kind of gene combination is called blending.

► What do we call a gene combination when neither one is dominant?

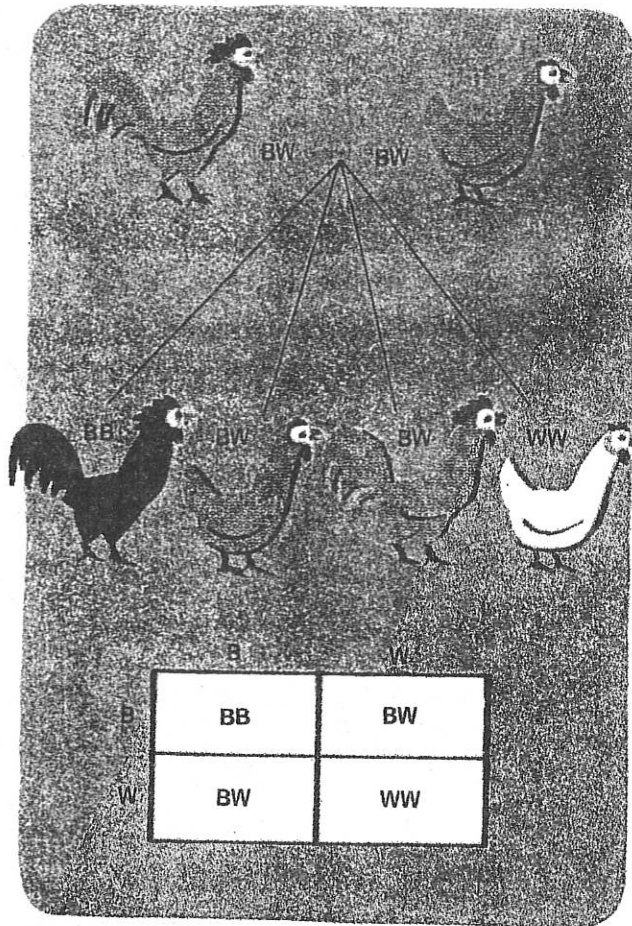
Studying blending. There is a kind of chicken that has a gene for black feathers and a gene for white feathers. Neither of these genes is dominant. We use a capital letter B for black and a capital letter W for white. A chicken that is BB, or pure black, will have black feathers. A chicken that is WW, or pure white, will have white feathers. When pure blacks and pure whites are mated, all of the offspring are BW. These hybrids are neither black nor white. They are gray. Blending has taken place.

► What is the color of a hybrid of black chickens and white chickens?



Are blended genes lost? Blended genes do not disappear. They show up again when hybrids are mated. If two hybrid gray chickens are mated, 25% of the offspring are BB, or pure black, 50% are BW, or hybrid gray, and 25% are WW, or pure white.

► When hybrids with a blended trait are mated, how many different kinds of offspring are produced?



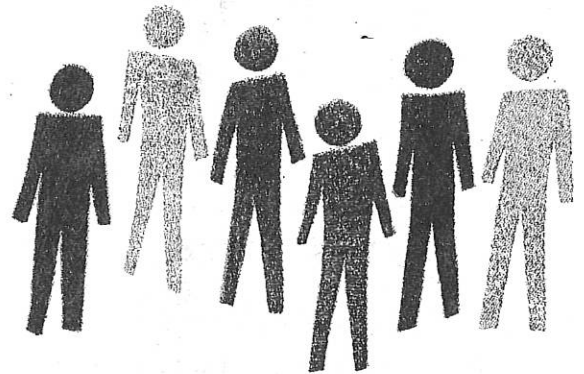
WHAT YOU LEARNED

1. Blending is a gene combination in which a mixture of traits shows.
2. There is no dominant gene in blending.
3. Blending is found only in hybrids.
4. When hybrids with blended traits are mated, the pure traits show again in some of the offspring.

SCIENCE WORD

blending

a combination of genes in which a mixture of the traits of both genes shows



FINDING OUT MORE

There are many different shades of skin in humans. The many different colors are the result of blended inheritance. Scientists have learned that at least six pairs of genes control skin color. None of these genes is dominant. Each affects skin color equally. Since so many genes are at work, many different shades of skin may result. Genes for skin color control the amount of melanin found in the skin. Melanin is a chemical substance that gives skin its color. The more melanin found in the skin, the darker the color. The less melanin found in the skin, the lighter the color.

Can the environment affect inherited traits?

Can genes do it all? You learned that genes control many of your traits. This is true for all living things. Your hair and skin color are determined by genes. So is your sex. The size and color of flowers are also determined by genes. But genes don't do it all. The environment also affects the traits of living things in many ways.

- ▶ What affects the traits of living things besides genes?

Conditions in the environment. Such things as food, air, water, and sunlight are parts of the environment. Each of these is important to living things. Green plants need sunlight to develop and grow properly. Plants that do not get enough sunlight will be smaller and weaker than normal. When the environment is not right for an organism, certain traits may not develop at all. The right environment is important for the development of certain traits.


- ▶ What may happen when the environment is not right?

Can the environment change the genes? Tomato plants grown in poor soil are small. They produce only a few small fruits. Adding nutrients to the soil changes the environment. The plants grow larger and produce more and better fruit. The size of a plant and the amount of fruit it produces are traits. The genes for these traits are not affected by the environment. Only the development of the traits is affected by the environment. A change in the environment will not change the genes. But it may help the gene to do its work.

- ▶ What may happen to a trait when the environment changes?



A PLANT GROWN IN SHADE



A PLANT GROWN IN SUNLIGHT



These children were not getting enough protein in their food. By drinking milk, they overcame the effects of this lack of protein.

Back to normal. Food is a part of the environment. Living things are affected by a shortage of food. A young organism may not develop properly if it does not get enough of the right food. If the food supply increases, development may become normal again. Living things can develop normally when conditions in the environment are normal.

► What do living things need to develop normally?

WHAT YOU LEARNED

1. The environment is important to the development of living things.
2. The environment affects the development of certain traits.
3. Genes are not affected by the environment.

FINDING OUT MORE

An individual once tried to develop a breed of mice without tails. He cut off the tails of mice before letting them mate. He repeated this for many generations. The results were always the same. All the offspring were born with normal tails. Changes in the body cells of parent mice were not passed on to the offspring. They could not be inherited. For a new trait to be inherited the genes themselves have to change.



PEOPLE IN SCIENCE

F. Agnes N. Stroud-Lee (1922-)
F. Agnes N. Stroud-Lee is a biologist who studies cells and their chromosomes. She exposes cells to certain environmental factors, such as X-rays. She looks to see what damage occurs in the chromosomes of the exposed cells. This work helps us understand how chromosomes function. It also provides information about what things cause harmful genetic changes.