Heredity

section ❶ Genetics

🌓 Before You Read

Think of a parent and a child that you know. On the lines below, list four ways the child looks like the parent.

What You'll Learn
- how traits are inherited
- Mendel's role in the history of genetics
- how to use a Punnett square
- the difference between genotype and phenotype

🌓 Read to Learn

Inheriting Traits

Do you look more like one parent or grandparent? Do you have your father's eyes? Eye color, nose shape, and many other physical features are traits. Traits also include things that cannot be seen, such as your blood type. An organism is a collection of traits, all inherited from its parents. **Heredity** (huh REH duh tee) is the passing of traits from parent to offspring, or children.

What is genetics?

Usually, genes on chromosomes control an organism's shape and function. The different forms of a trait that a gene may have are called **alleles** (uh LEELZ). When a pair of chromosomes separates during meiosis (mi OH sus), alleles for each trait also separate into different sex cells. As a result, every sex cell has one allele for each trait, as shown in the figure on the next page. The allele in one sex cell may control one form of the trait, such as dimples. The allele in another sex cell may control a different form of the trait, such as no dimples. The study of how traits are inherited through the interactions of alleles is called **genetics** (juh NE tihks). ☑
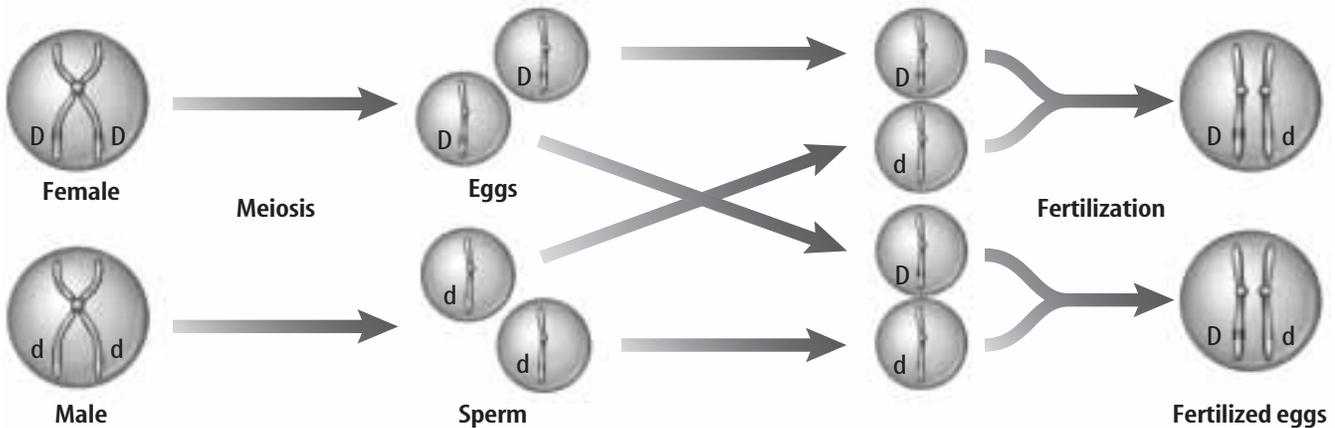
Study Coach

Create a Vocabulary Quiz Write a question about each vocabulary word or term in the section. Exchange quizzes with another student. Together discuss the answers to the quizzes.

✓ Reading Check

1. **Define** the word genetics.

Chromosomes Separate During Meiosis

Female → **Meiosis** → **Eggs** → **Fertilization** → **Fertilized eggs**

Male → **Sperm**

A The alleles that control a trait are located on each duplicated chromosome.

B During meiosis, duplicated chromosomes separate.

C During fertilization, each parent donates one chromosome. This results in two alleles for the trait in the new individual formed.

Picture This

2. Identify Circle the sex cells on the diagram.

Think it Over

3. Analyze When Mendel studied traits, how did his methods differ from those of other scientists?

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Mendel—The Father of Genetics

Did you know that an experiment with pea plants helped scientists understand why your eyes are the color they are? Gregor Mendel was an Austrian monk who studied mathematics and science. His job at the monastery where he lived was gardening. His interest in plants began as a boy in his father's orchards. He learned to predict the possible types of flowers and fruits that would result from crossbreeding plants.

In 1856, Mendel began experimenting with garden peas. He wanted to know the connection between the color of a pea flower and the type of seed the plant produced. Before Mendel, scientists relied on observation and description. They often studied many traits at one time. This made it hard to develop good hypotheses about how traits are inherited. Mendel used scientific methods in his study. Mendel was the first person to trace one trait through many generations. He was the first person to record the study of how traits pass from one generation to another. He was also the first person to use the mathematics of probability to explain heredity.

In 1900, three plant scientists repeated Mendel's experiments and reached the same conclusions as Mendel. For this reason, Mendel is known as the father of genetics.

Genetics in a Garden

When Mendel studied a trait, he crossed two plants with different forms of the trait. He found that the new plants all looked like one of the two parents. Mendel called each new plant a **hybrid** (HI brud) because it received different genetic information, or different alleles, for a trait from each parent.

What is a purebred?

Garden peas are easy to breed for pure traits. An organism that always produces the same traits, generation after generation, is called a purebred. For example, plants can be purebred for the trait of tall height. The table below shows the pea plant traits that Mendel studied.

Traits Compared by Mendel							
Traits	**Shape of Seeds**	**Color of Seeds**	**Color of Pods**	**Shape of Pods**	**Plant Height**	**Position of Flowers**	**Flower Color**
Dominant Trait	Round	Yellow	Green	Full	Tall	At leaf junctions	Purple
Recessive Trait	Wrinkled	Green	Yellow	Flat, constricted	Short	At tips of branches	White

What are dominant and recessive factors?

In nature, insects carry pollen as they move from plant to plant. The pollination by insects is random. In his experiments, Mendel pollinated the plants by hand to control the results. He used pollen from the flowers of purebred tall plants to pollinate the flowers of purebred short plants. This process is called cross-pollination. He found that tall plants crossed with short plants produced seeds that produced all tall plants. Mendel called the tall form the **dominant** (DAH muh nunt) factor because it dominated, or covered up, the short form. He called the short form the **recessive** (rih SE sihv) factor because this form seemed to disappear. Today, these factors are called dominant alleles and recessive alleles.

FOLDABLES

A Describe Make a two-tab Foldable, as shown below. Write notes under the tabs to describe dominant and recessive alleles.
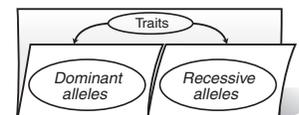
Traits

Dominant alleles | Recessive alleles

What is probability?

A branch of mathematics that helps you predict the chance that something will happen is called probability. For example, there are two sides to a coin. If you toss the coin in the air, the probability that one side of the coin will land facing up is one out of two, or 50 percent. Mendel used probabilities in his study of genetics. His predictions were very accurate because he studied large numbers of plants over a long period of time. He studied almost 30,000 pea plants over a period of eight years. This increased Mendel's chances of seeing a repeatable pattern. Valid scientific conclusions need to be based on results that can be repeated.
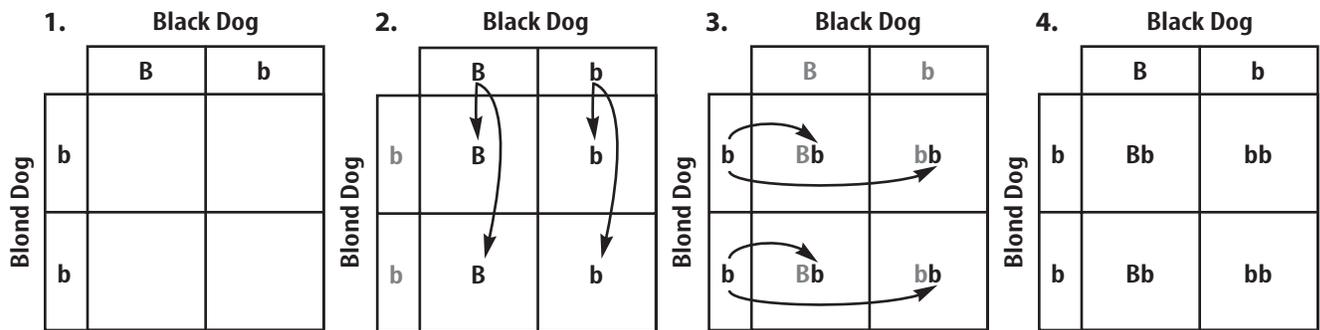
What is a Punnett square?

Scientists use a tool called a Punnett (PUH nut) square to predict results in genetics. A **Punnett square** is used to predict the number of times certain traits will occur. In a Punnett square, letters stand for dominant and recessive alleles. An uppercase letter stands for a dominant allele, and a lowercase letter stands for a recessive allele. The letters are a form of code. They show the **genotype** (JEE nuh tipe), or genetic makeup, of an organism. The way an organism looks and behaves as a result of its genotype is its **phenotype** (FEE nuh tipe). If you have brown hair, the phenotype for your hair color is brown. ☑

How do alleles determine traits?

Most cells in your body have two alleles for every trait. An organism with two alleles that are the same is called **homozygous** (hoh muh ZI gus). In his experiments, Mendel would have written *TT* (homozygous for the tall-dominant trait) or *tt* (homozygous for the short-recessive trait). An organism that has two different alleles for a trait is called **heterozygous** (he tuh roh ZI gus). Mendel would have written *Tt* for plant hybrids that were heterozygous for height.

How do you make a Punnett square?

The letters representing the two alleles from one parent are written in the top row of the Punnett square. The letters representing the two alleles from the other parent are written down the left column. Each square in the grid is then filled in with one allele from each parent. The combinations of letters in the completed Punnett square are the genotypes of the possible offspring those parents could produce.

5. Identify How is a dominant allele shown in a Punnett square?

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_____

💡 **Think it Over**

6. Contrast What is the difference between a homozygous organism and a heterozygous organism?

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_____

1. **Black Dog**

	B	b
Blond Dog b		
Blond Dog b		

2. **Black Dog**

	B	b
Blond Dog b	B	b
Blond Dog b	B	b

3. **Black Dog**

	B	b
Blond Dog b	Bb	bb
Blond Dog b	Bb	bb

4. **Black Dog**

	B	b
Blond Dog b	Bb	bb
Blond Dog b	Bb	bb

How do you use a Punnett square?

You want to know the possible offspring of two dogs. One dog carries heterozygous black-fur traits (*Bb*). The other dog carries homogeneous blond-fur traits (*bb*). How do you complete the Punnett square to find the results? Follow the steps in the figure above.

1. Write the letters representing the alleles from the black dog (Bb) in the top row. Write the letters from the blond dog (bb) in the left column.
2. Write the letter in each column (B or b) in the two squares for that column.
3. Add the letter for each row (b or b) to the squares. You then have two letters in each square.
4. The squares show the possible genotypes of the offspring.

An offspring with a *Bb* genotype will have black fur, and an offspring with a *bb* genotype will have blond fur. In this case, there is one chance in two, or a 50 percent chance, that the offspring will have black fur.

What are the main principles of heredity?

Mendel spent many years repeating his experiments and observing the results. He analyzed the results and reached several conclusions. Mendel's principles of heredity are summarized in the table below.

Mendel's Principles of Heredity
Traits are controlled by alleles on chromosomes.
An allele's effect is dominant or recessive.
When a pair of chromosomes separates during meiosis, the different alleles for a trait move into separate sex cells.

Picture This

7. Identify In step 4, shade the two squares that would result in an offspring with blond fur.

Think it Over

8. Explain What controls traits?

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◉ After You Read

Mini Glossary

alleles (uh LEELZ): the different forms of a trait that a gene may have

dominant (DAH muh nunt): factor that dominates, or covers up, another factor

genetics (juh NE tihks): the study of how traits are inherited through the interactions of alleles

genotype (JEE nuh tipe): genetic makeup of an organism

heredity (huh REH duh tee): passing of traits from parent to offspring

heterozygous (he tuh roh ZI gus): an organism that has two different alleles for a trait

homozygous (hoh muh ZI gus): an organism with two alleles that are the same for a trait

hybrid (HI brud): a plant that receives different genetic information for a trait from each parent

phenotype (FEE nuh tipe): the way an organism looks and behaves as a result of its genotype

Punnett (PUH nut) square: a tool used to predict the number of times certain traits will occur

recessive (rih SE sihv): factor that disappears if a dominant trait is present

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between a dominant allele and a recessive allele.

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_____

2. Complete the Punnett square below to show the probability of an offspring having the *DD*, *Dd*, and the *dd* genotypes.

	D	d
D		
d		

3. How can taking a quiz that another student wrote help you prepare for a test?

_____

_____

End of Section

Science Online Visit **life.msscience.com** to access your textbook, interactive games, and projects to help you learn more about genetics.