Genetics

Mendel and His Peas

············· **Before You Read** ·············

What do you think? Read the two statements below and decide whether you agree or disagree with them. Place an A in the Before column if you agree with the statement or a D if you disagree. After you've read this lesson, reread the statements to see if you have changed your mind.

Before	Statement	After
	1. Like mixing paints, parents' traits always blend in their offspring.	
	2. If you look more like your mother than you look like your father, then you received more traits from your mother.	

··············· **Read to Learn** ···············

Early Ideas About Heredity

Have you ever mixed two different colors of paint to make a new color? Long ago, people thought that an organism's characteristics, or traits, were determined in the same way that paint colors can be mixed. People assumed this because offspring often resemble both parents. This is known as blending inheritance.

Today, scientists know that heredity (huh REH duh tee) is more complex. **Heredity** *is the passing of traits from parents to offspring.* For example, you and your brother might have blue eyes but both of your parents have brown eyes. How does this happen?

More than 150 years ago, Gregor Mendel, an Austrian monk, performed experiments that helped answer many questions about heredity. The results of his experiments also disproved the idea of blending inheritance.

Mendel's research into the questions of heredity gave scientists a basic understanding of genetics. **Genetics** (juh NE tihks) *is the study of how traits are passed from parents to offspring.* Because of his research, Mendel is known as the father of genetics. ✅

Key Concepts 🔑
- Why did Mendel perform cross-pollination experiments?
- What did Mendel conclude about inherited traits?
- How do dominant and recessive factors interact?

◀ **Study Coach**

Vocabulary Quiz Write a question about each vocabulary term in this lesson. Exchange quizzes with a partner. After completing the quizzes, discuss the answers with your partner.

✅ **Reading Check**
1. Define What is genetics?

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Mendel's Experimental Methods

During the 1850s, Mendel studied genetics by doing controlled breeding experiments with pea plants. Pea plants were ideal for genetics studies because

- they reproduce quickly. Mendel was able to grow many plants and collect a lot of data.

- they have easily observed traits, such as flower color and pea shape. Mendel was able to observe whether or not a trait was passed from one generation to the next.

- Mendel could control which pairs of plants reproduced. He was able to find out which traits came from which plant pairs.

Pollination in Pea Plants

To observe how a trait was inherited, Mendel controlled which plants pollinated other plants. Pollination occurs when pollen lands on the pistil of a flower. Sperm cells from the pollen then fertilize egg cells in the pistil.

Self-pollination occurs when pollen from one plant lands on the pistil of a flower on the same plant. Cross-pollination occurs when pollen from one plant reaches the pistil of a flower on a different plant. Mendel allowed one group of flowers to self-pollinate. With another group, he cross-pollinated the plants himself.

True-Breeding Plants

Mendel began his experiments with plants that were true-breeding for the trait that he would test. When a true-breeding plant self-pollinates, it always produces offspring with traits that match the parent. For example, when a true-breeding pea plant with wrinkled seeds self-pollinates, it produces only plants with wrinkled seeds. In fact, it will produce wrinkled seeds generation after generation.

Mendel's Cross-Pollination

By cross-pollinating plants himself, Mendel was able to select which plants pollinated other plants. Mendel cross-pollinated hundreds of plants for each set of traits he wanted to learn more about. The traits included flower color (purple or white), seed color (green or yellow), and seed shape (round or wrinkled).

With each cross-pollination, Mendel recorded the traits that appeared in the offspring. By testing such a large number of plants, Mendel was able to predict which crosses would produce which traits.

💡 **Think it Over**

2. Explain In his breeding experiments, how did Mendel know which traits came from which pair of plants?

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REVIEW VOCABULARY

sperm
a haploid sex cell formed in the male reproductive organs

egg
a haploid sex cell formed in the female reproductive organs

🔑 **Key Concept Check**
3. Explain Why did Mendel perform cross-pollination experiments?

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Mendel's Results

Once Mendel had enough true-breeding plants for a trait that he wanted to test, he cross-pollinated selected plants. His results are described below.

First-Generation Crosses

Crosses between true-breeding plants with purple flowers produced true-breeding plants with only purple flowers. Crosses between true-breeding plants with white flowers produced true-breeding plants with only white flowers. However, when Mendel crossed true-breeding plants with purple flowers and true-breeding plants with white flowers, all of the offspring had purple flowers.

New Questions Raised

Why did crossing plants with purple flowers and plants with white flowers always produce offspring with purple flowers? Why were there no white flowers? Why didn't the cross produce offspring with pink flowers—a combination of white and purple? Mendel carried out more experiments to answer these questions. ✅

Second-Generation (Hybrid) Crosses

Mendel's first-generation purple-flowering plants are called hybrid plants. They came from true-breeding parent plants with different forms of the same trait. When Mendel cross-pollinated two purple-flowering hybrid plants, some of the offspring had white flowers. The trait that had disappeared in the first-generation always reappeared in the second-generation.

Mendel got similar results each time he cross-pollinated hybrid plants. For example, a true-breeding yellow-seeded pea plant crossed with a true-breeding green-seeded pea plant always produced yellow-seeded hybrids. A second-generation cross of two yellow-seeded hybrids always produced plants with yellow seeds and plants with green seeds.

More Hybrid Crosses

Mendel cross-pollinated many hybrid plants. He counted and recorded the traits of offspring. He analyzed these data and noticed patterns. In crosses between hybrid plants with purple flowers, the ratio of purple flowers to white flowers was about 3:1. This means that purple-flowering pea plants grew from this cross three times more often than white-flowering pea plants grew from the cross. Mendel calculated similar ratios for all seven traits that he tested.
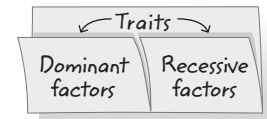
✅ **Reading Check**

4. Predict the offspring of a cross between two true-breeding pea plants with smooth seeds.

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Math Skills

A ratio is a comparison of two numbers or quantities by division. For example, the ratio comparing 6,022 yellow seeds to 2,001 green seeds can be written as follows:

6,022 to 2,001 or
6,022:2,001 or
$\frac{6{,}022}{2{,}001}$

To simplify the ratio, divide the first number by the second number.

$$\frac{6{,}022}{2{,}001} = \frac{3}{1} = 3\text{:}1$$

5. Use Ratios A science class has 14 girls and 7 boys. Simplify the ratio.

Characteristics	Flower Color	Flower Position	Seed Color	Seed Shape	Pod Shape	Pod Color	Stem Length
Results of Hybrid Crosses							
Dominant Trait; # of Offspring	Purple; 705	Axial; 651	Yellow; 6022	Round; 5474	Smooth; 882	Green; 428	Long; 781
Recessive Trait: # of Offspring	White; 224	Terminal; 207	Green; 2001	Wrinkled; 1850	Bumpy; 299	Yellow; 152	Short; 277
Ratio	3.15 : 1	3.14 : 1	3.01 : 1	2.96 : 1	2.95 : 1	2.82 : 1	2.84 : 1

Visual Check

6. Predict If a cross between two hybrid plants with purple flowers produced 12 offspring, how many offspring would you expect to have purple flowers?

Key Concept Check

7. Summarize What did Mendel conclude about inherited traits?

Key Concept Check

8. Describe How do dominant and recessive factors interact?

Mendel's Conclusions

After analyzing the results of his experiments, Mendel concluded that two factors control each inherited trait. He also proposed that when organisms reproduce, the sperm and the egg each contribute one factor for each trait. Mendel's results are shown in the table above.

Dominant and Recessive Traits

Recall that when Mendel cross-pollinated a true-breeding plant with purple flowers and a true-breeding plant with white flowers, the hybrid offspring had only purple flowers. He hypothesized that the hybrid offspring had one genetic factor for purple flowers and one genetic factor for white flowers. But why were there no white flowers? Mendel also hypothesized that the purple factor was dominant, blocking the white factor. *A genetic factor that blocks another genetic factor is called a* **dominant** (DAH muh nunt) **trait.** A dominant trait, such as purple pea flowers, is seen when offspring have either one or two dominant factors. *A genetic factor that is blocked by the presence of a dominant factor is called a* **recessive** (rih SE sihv) **trait.** A recessive trait, such as white pea flowers, is seen only when two recessive genetic factors are present in offspring.

From Parents to Second Generation

For the second generation, Mendel cross-pollinated two hybrids that had purple flowers. About 75 percent of the second-generation plants had purple flowers. These plants had at least one dominant factor. Twenty-five percent of the second-generation plants had white flowers. These plants had the same two recessive factors.

Mini Glossary

dominant (DAH muh nunt) trait: a genetic factor that blocks another genetic factor

genetics (juh NE tihks): the study of how traits are passed from parents to offspring

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

recessive (rih SE sihv) trait: a genetic factor that is blocked by the presence of a dominant factor

1. Review the terms and their definitions in the Mini Glossary. Write one or two sentences that compare and contrast dominant traits and recessive traits.

_____

_____

_____

2. The tables below show a sequence of crosses for the trait of pod color in a type of plant. Study the tables and fill in the trait or traits that the second-generation cross would produce in the offspring.

First-Generation Cross	
Plants Crossed	**Offspring**
true-breeding green-pod × true-breeding yellow-pod	all green-pod hybrids

Second-Generation (Hybrid) Cross	
Plants Crossed	**Offspring**
green-pod hybrid × green-pod hybrid	

3. Why were the pea plants that Mendel used in his experiments a good choice for genetics studies?

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What do you think NOW?

Reread the statements at the beginning of the lesson. Fill in the After column with an A if you agree with the statement or a D if you disagree. Did you change your mind?

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END OF LESSON

Lesson 1 | Mendel and His Peas (continued)

▪▪▪ Main Idea ▪▪▪

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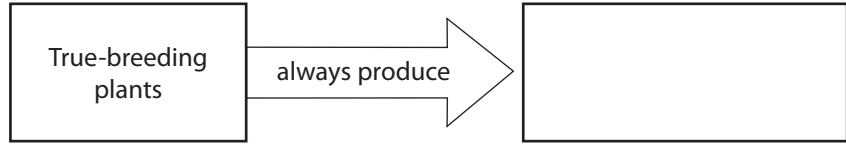
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Mendel's Results

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▪▪▪▪▪▪ Details ▪▪▪▪▪▪

Define *true-breeding plants.*

True-breeding plants	always produce ⟹	

Sequence *the steps in Mendel's cross-pollination process.*

1. Mendel removed the _____

from the _____ .

2. He _____ from

the _____ of the white flower to the

_____ of the purple flower.

3. He planted _____ that _____

_____ of the purple flower.

4. _____

🔑 **Explain** *why Mendel performed these experiments.*

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_____

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_____

Model *the results of Mendel's first generation crosses.*

(P) × (P) = _____

(W) × (W) = _____

(P) × (W) = _____

Write *two questions raised by Mendel's first-generation cross results.*

1. _____

_____

2. _____

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