Mendel's Discoveries

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CHAPTER 1 Mendel's Discoveries

Lesson Objectives

- Identify Mendel, and explain why peas were good plants for him to study.
- Outline Mendel's experiments, and state his laws of heredity.
- Summarize Mendel's scientific legacy.

Lesson Vocabulary

- dominant
- genetics
- law of independent assortment
- law of segregation
- Mendel
- pollination
- recessive

Introduction

People have long known that offspring are similar to their parents. Whether it's puppies or people, offspring and parents usually share many traits. However, before Gregor Mendel's research, people didn't know how parents pass traits to their offspring.

A Monk and His Peas

Mendel was an Austrian Monk who lived in the 1800s. You can see his picture in **Figure** 1.1.

Mendel the Scientist

Mendel didn't call himself a scientist. But he had all the traits of good scientist. He was observant and curious, and he asked a lot of questions. He also tried to find answers to his questions by doing experiments. Working alone in his garden in the mid-1800s, he grew thousands of pea plants over many years. He carefully crossed plants with different traits. Then he observed what traits showed up in their offspring. He repeated each experiment many times.

Why Study Peas?

Pea plants were a good choice to study for several reasons. One reason is that they are easy to grow. They also grow quickly. In addition, peas have many traits that are easy to observe, and each trait exists in two different forms.

FIGURE 1.1
Gregor Mendel

Figure 1.2 shows the traits that Mendel studied in pea plants. For example, one trait is flower color. Flowers may be either white or violet. Another trait is stem length. Plants may be either tall or short.

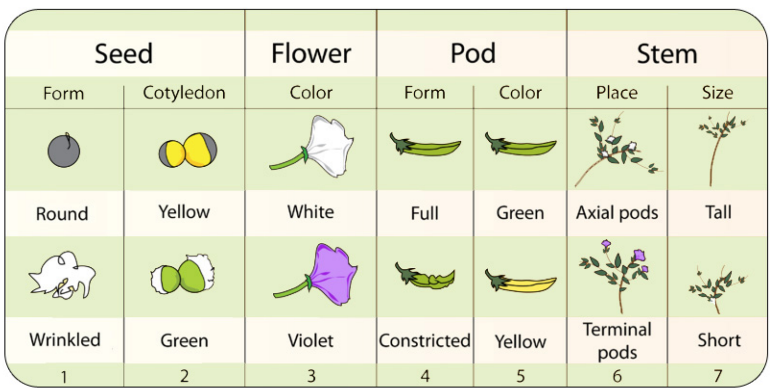


FIGURE 1.2
Traits Mendel studied in peas

Pea plants reproduce sexually. The male gametes are released by tiny grains of pollen. The female gametes lie deep within the flowers. Fertilization occurs when pollen from one flower reaches the female gametes in the same or a different flower. This is called **pollination**. Mendel was able to control which plants pollinated each other. He transferred pollen by hand from flower to flower.

Mendel's Experiments and Laws of Heredity

At first, Mendel studied one trait at a time. This was his first set of experiments. These experiments led to his first law, the law of segregation. Then Mendel studied two traits at a time. This was his second set of experiments. These experiments led to his second law, the law of independent assortment.

Mendel's First Set of Experiments

An example of Mendel's first set of experiments is his research on flower color. He transferred pollen from a plant with white flowers to a plant with violet flowers. This is called cross-pollination. Then Mendel observed flower color in their offspring. The offspring formed the first generation (F1). You can see the outcome of this experiment in **Figure** 1.3.

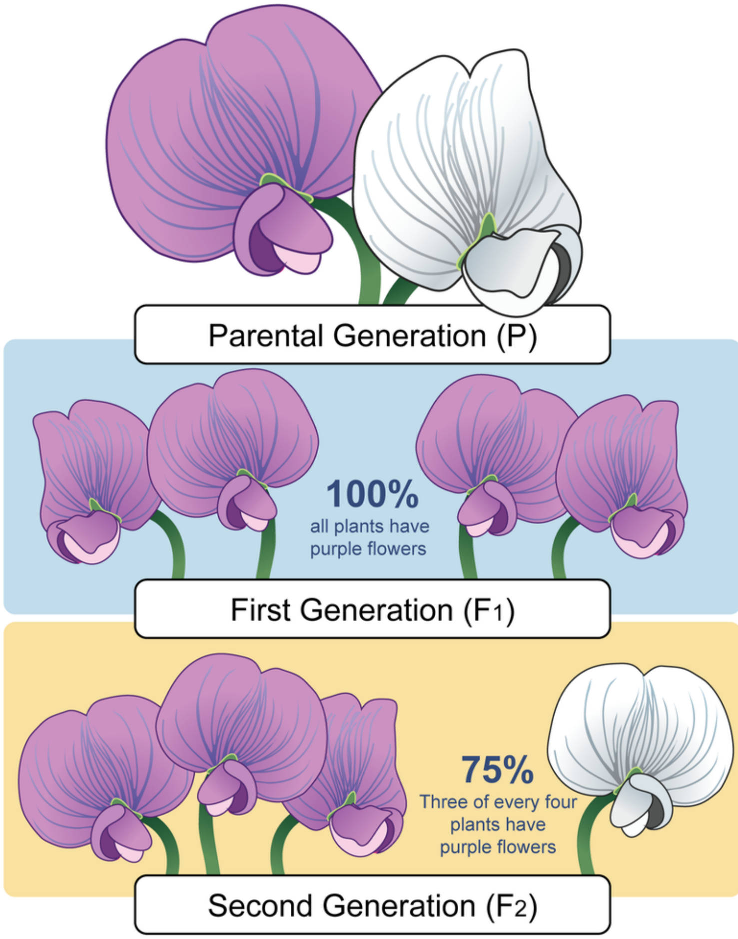


FIGURE 1.3
Mendel's flower color experiment

All of the F1 plants had violet flowers. Mendel wondered, "What happened to the white form of the trait?" "Did it disappear?" If so, the F1 plants should have only violet-flowered offspring. Mendel let the FI plants pollinate themselves. This is called self-pollination. Then he observed flower color in their offspring. These offspring formed the second generation (F2). Surprisingly, the trait of white flowers showed up in the F2 plants. One out of every four F2 plants had white flowers. The other three out of four had violet flowers. In other words, F2 plants with violet flowers and F2 plants with white flowers had a 3:1 ratio.

Mendel repeated this experiment with each of the other traits. For each trait, he got the same results. One form of the trait seemed to disappear in the F1 plants. Then it showed up again in the F2 plants. Moreover, the two forms of the trait always showed up in the F2 plants in the same 3:1 ratio.

Law of Segregation

Based on these results, Mendel concluded that each trait is controlled by two factors. He also concluded that one of the factors for each trait dominates the other. He described the dominating factor as **dominant**. He used the term **recessive** to describe the other factor. If both factors are present in an individual, only the dominant factor is expressed. This explains why one form of a trait always seems to disappear in the F1 plants. These plants inherit both factors for the trait, but only the dominant factor shows up. The recessive factor is hidden.

When F1 plants reproduce, the two factors separate and go to different gametes. This is Mendel's first law, the **law of segregation**. It explains why both forms of the trait show up again in the F2 plants. One out of four F2 plants inherits two of the recessive factors for the trait. In these plants, the recessive form of the trait is expressed.

Second Set of Experiments

Mendel wondered whether different traits are inherited together. For example, are seed form and seed color passed together from parents to offspring? Or do the two traits split up in the offspring? To answer these questions, Mendel studied two traits at a time. For example, he crossed plants that had round, yellow seeds with plants that had wrinkled, green seeds. Then he observed how the two traits showed up in their offspring (F1). You can see the results of this cross in **Figure** 1.4. All of the F1 plants had round, yellow seeds. The wrinkled and green forms of the traits seemed to disappear in the F1 plants.

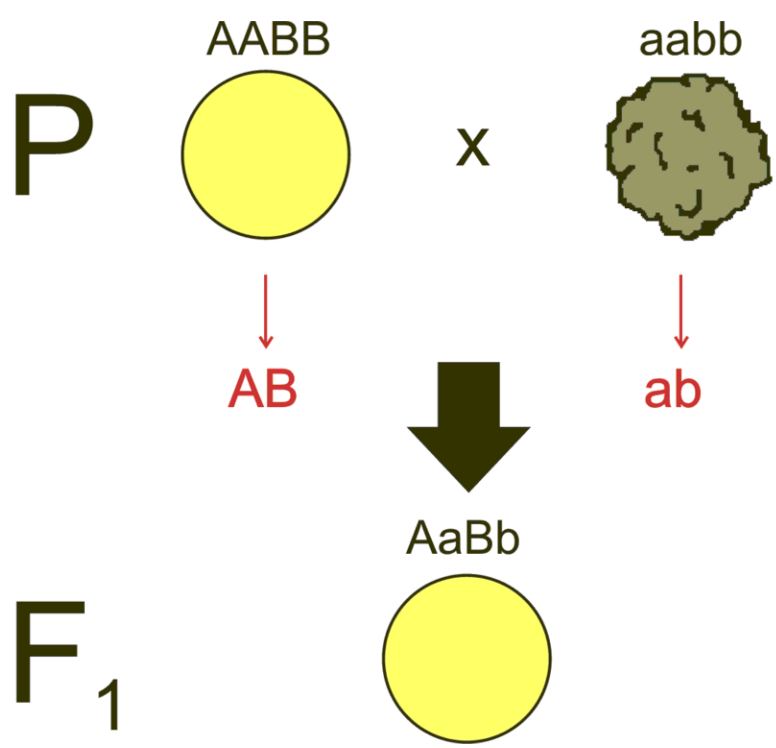


FIGURE 1.4
Seed color: B = yellow (dominant); b = green (recessive)

Then Mendel let the F1 plants self-pollinate. Their offspring, the F2 plants, had all possible combinations of the two traits. You can see this in **Figure** 1.5. For example there were plants that had round, green seeds, as well as plants that had wrinkled, yellow seeds. In this case the ratios were 9:3:3:1. The ratios are shown across the bottom of **Figure** 1.5.

Mendel repeated this experiment with other combinations of two traits. In each case, he got the same results. One form of each trait seemed to disappear in the F1 plants. Then these forms reappeared in the F2 plants in all possible combinations. Moreover, the different combinations of traits always occurred in the same 9:3:3:1 ratio.

Law of Independent Assortment

The results of Mendel's two-trait experiments led to the **law of independent assortment**. This law states that factors controlling different traits go to gametes independently of each other. This explains why F2 plants have all possible combinations of the two traits.

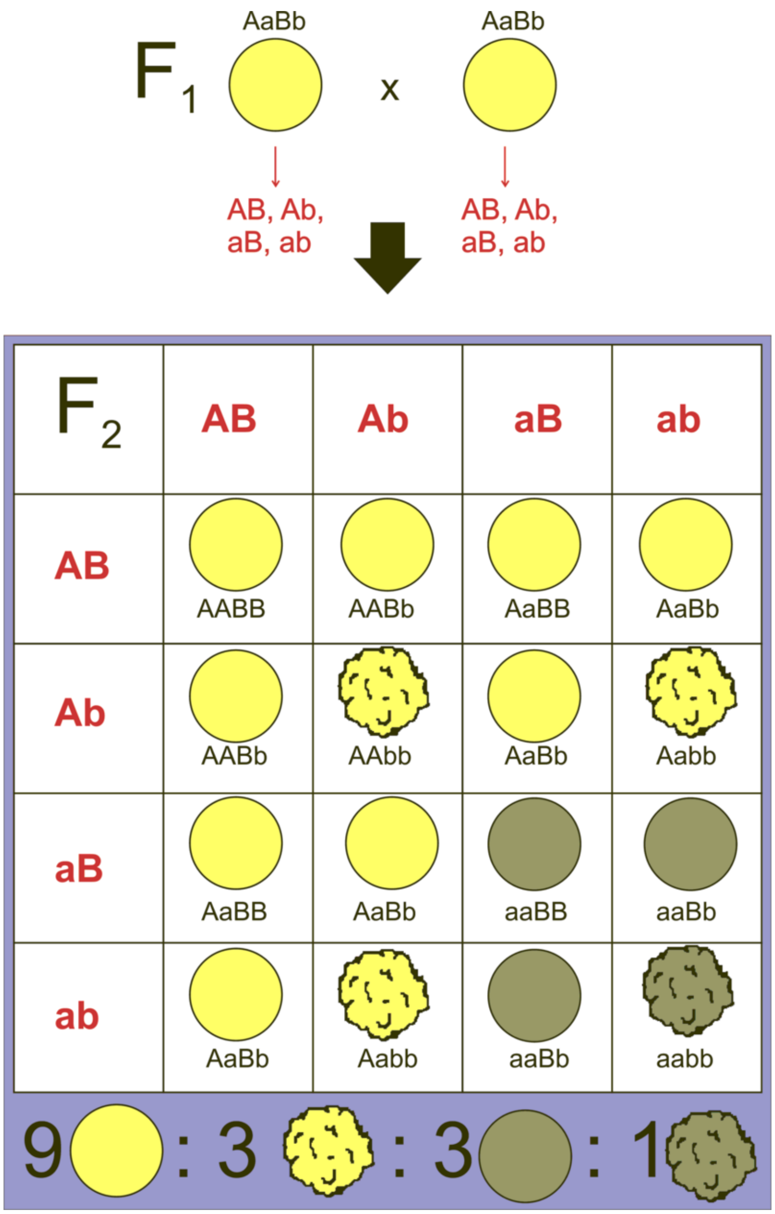


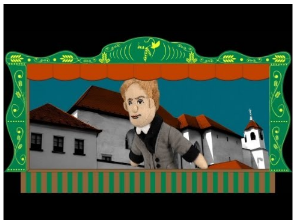
FIGURE 1.5
F2 plants produced when F1 plants self-pollinate

Mendel's Legacy

You might think that Mendel's discoveries would have made him an instant science rock star. He'd found the answers to age-old questions about heredity. In fact, Mendel's work was largely ignored until 1900. That's when three other scientists independently arrived at Mendel's laws. Only then did people appreciate what a great contribution to science Mendel had made. Mendel's discoveries form the basis of the modern science of genetics. **Genetics** is the science of heredity. For his discoveries, Mendel is now called the "father of genetics."

Watch this entertaining, upbeat video for an excellent review of Mendel's life and work. It's also a good introduction to the next lesson, "Introduction to Genetics."

http://www.youtube.com/watch?v=GTiOETaZg4w



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Lesson Summary

- Gregor Mendel was an Austrian monk who studied heredity in pea plants in the mid-1800s. Peas were a good choice for this purpose for several reasons.
- Mendel first experimented with one trait at a time. This led to his law of segregation. According to this law, the two factors that control a trait separate and go to different gametes.
- Mendel then experimented with two traits at a time. This led to his law of independent assortment. According to this law, the factors that control different traits go to gametes independently of each other.
- Mendel's discoveries were not appreciated until 1900. Now Mendel is called the "father of genetics." Genetics is the science of heredity.

Lesson Review Questions

Recall

1. Who was Gregor Mendel?
2. Why were peas a good choice of plants for Mendel to study?
3. State Mendel's laws.

Apply Concepts

4. Some plants reproduce asexually. What results would Mendel have obtained if he had chosen to study these plants instead of peas?

Think Critically

5. Why did Mendel need to grow two offspring generations (F1 and F2) to develop his law of segregation?
6. Explain how the results of Mendel's second set of experiments led to his law of independent assortment.

Points to Consider

Mendel's research revealed that traits are controlled by "factors" that parents pass to their offspring. Today, we know that Mendel's "factors" are genes.

1. What are genes?
2. How do genes control traits?

References

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