Since they first learned how to breed plants and animals, people have been interested in heredity. In the 1800s, one person figured out some of the first key ideas of genetics. Recall that genetics is the science of heredity and the mechanism by which traits are passed from parents to offspring.

**Mendel’s Breeding Experiments**

A monk named Gregor Johann Mendel lived in the 1800s in Austria. Mendel did breeding experiments with the garden pea plant, *Pisum sativum*, shown in Figure 1. Farmers had done similar experiments before, but Mendel was the first person to develop rules that accurately predict the patterns of heredity in pea plants. Modern genetics is based on Mendel’s explanations for the patterns of heredity in garden pea plants.

As a young man, Mendel studied to be a priest. Later, he went to the University of Vienna. There, he learned how to study science through experimentation and how to use mathematics to explain natural events. Mendel lived the rest of his life in a monastery, where he taught high school and cared for a garden. It was in this garden that he completed his important experiments.

Most of Mendel’s experiments involved crossing different types of pea plants. In this case, the word cross means “to mate or breed two individuals.” Mendel crossed a type of garden pea plant that had purple flowers with a type that had white flowers. All of the offspring from that cross had purple flowers. However, when two of these purple-flowered offspring were crossed, some offspring had white flowers and some had purple flowers.

The white color had reappeared in the second group of offspring! Mendel decided to investigate this strange occurrence. So, he carefully crossed different types of pea plants and recorded the numbers of each type of offspring. He did this experiment many times.

> **Reading Check** How did Mendel experiment with pea plants? (See the Appendix for answers to Reading Checks.)
Features of Pea Plants

Mendel studied seven features in his pea plants, as Figure 2 shows. The garden pea plant is a good subject for studying heredity because the plant has contrasting traits, usually self-pollinates, and grows easily.

Contrasting Traits In the study of heredity, physical features that are inherited are called characters. Several characters of the garden pea plant exist in two clearly different forms. The plant’s flower color is either purple or white—there are no intermediate forms. A trait is one of several possible forms of a character. Purple is one of two possible traits for the flower-color character in pea plants. Other contrasting traits of pea plants are shown in Figure 2. (For some characters, more than two traits may be possible). Mendel wanted to see what would happen when he crossed individuals that have different traits. In such a cross, the offspring that result are called hybrids.

Self-Pollination In garden pea plants, each flower contains both male and female reproductive parts. This arrangement allows the plant to self-pollinate, or fertilize itself. Pea plants can also reproduce through cross-pollination. This process occurs when pollen from the flower of one plant is carried by insects or by other means to the flower of another plant. To cross-pollinate two pea plants, Mendel had to make sure that the plants could not self-pollinate. So, he removed the male parts (which produce pollen) from some of the flowers. But he did not remove the female parts (which produce eggs, fruit, and seeds). Then, he dusted the female parts of one plant with pollen from another plant.

Easy to Grow The garden pea is a small plant that needs little care and matures quickly. Also, each plant produces many offspring. Thus, many results can be compared for each type of cross. Recall that collecting repeated data is an important scientific method.

Figure 2 In the experiments in his garden, Mendel grew and studied many kinds of pea plants. Why did Mendel study pea plants?

Reading Check What is the difference between a trait and a character?

<table>
<thead>
<tr>
<th>Flower color</th>
<th>Seed color</th>
<th>Seed shape</th>
<th>Pod color</th>
<th>Pod Shape</th>
<th>Flower position</th>
<th>Plant height</th>
</tr>
</thead>
<tbody>
<tr>
<td>purple</td>
<td>yellow</td>
<td>round</td>
<td>green</td>
<td>smooth</td>
<td>mid-stem</td>
<td>tall</td>
</tr>
<tr>
<td>white</td>
<td>green</td>
<td>wrinkled</td>
<td>yellow</td>
<td>bumpy</td>
<td>end of stem</td>
<td>short</td>
</tr>
</tbody>
</table>
Mendel’s First Experiments

A monohybrid cross is a cross that is done to study one pair of contrasting traits. For example, crossing a plant that has purple flowers with a plant that has white flowers is a monohybrid cross. Mendel’s first experiments used monohybrid crosses and were carried out in three steps. The three steps are shown in Figure 3. Each step involved a new generation of plants. A generation is a group of offspring from a given group of parents.

Step 1 Mendel allowed plants that had each type of trait to self-pollinate for several generations. This process ensured that each plant always produced offspring of the same type. Such a plant is said to be true-breeding for a given trait. For example, every time a true-breeding plant that has purple flowers self-pollinates, its offspring will have purple flowers. Mendel used true-breeding plants as the first generation in his experiments. The first group of parents that are crossed in a breeding experiment are called the parental generation, or P generation.

Step 2 Mendel crossed two P generation plants that had contrasting traits, such as purple flowers and white flowers. He called the offspring of the P generation the first filial generation, or F1 generation. He recorded the number of F1 plants that had each trait.

Step 3 Mendel allowed the F1 generation to self-pollinate and produce new plants. He called this new generation of offspring the second filial generation, or F2 generation. He recorded the number of F2 plants that had each trait.

Reading Check What is a monohybrid cross?
**Mendel’s Ratios**

You can calculate and compare the \( F_2 \) generation ratios that Mendel obtained from his first experiments.

**Procedure**

1. Copy this partially complete table onto a separate sheet of paper. Then, fill in the ratios of \( F_2 \) traits.
2. Simplify the ratios, and round the terms in each ratio to the nearest hundredth digit.

**Analysis**

1. **Identify** the similarities between the ratios by rounding each term to the nearest whole number.
2. **Critical Thinking** Analyzing Data Why weren’t all of the ratios exactly the same?

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**Ratios in Mendel’s Results**

All of Mendel’s \( F_1 \) plants expressed the same trait for a given character. The contrasting trait had disappeared! But when the \( F_1 \) plants were allowed to self-pollinate, the missing trait reappeared in some of the \( F_2 \) plants. Noticing this pattern, Mendel compared the ratio of traits that resulted from each cross.

When \( F_1 \) plants that had purple flowers were crossed with one another, 705 of the \( F_2 \) offspring had purple flowers and 224 had white flowers. So, the \( F_2 \) ratio of purple-flowered plants to white-flowered plants was 705:224, or about 3:1. Mendel's studies of the other characters gave a similar pattern. For each of the seven characters that Mendel studied, he found a similar 3-to-1 ratio of contrasting traits in the \( F_2 \) generation. As you will learn, Mendel tried to explain this pattern.

**Reading Check** What was the important difference between Mendel’s \( F_1 \) and \( F_2 \) generations?

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**Section 1 Review**

**KEY IDEAS**

1. Identify Gregor Mendel’s contribution to modern genetics.
2. Describe why garden pea plants are good subjects for genetic experiments.
3. Summarize the three major steps of Mendel’s first experiments.
4. State the typical ratio of traits in Mendel’s first experiments.

**Critical Thinking**

5. Using Scientific Methods Why did Mendel record the results of so many plant crosses?
6. Predicting Outcomes Squash plants do not usually self-pollinate. If Mendel had used squash plants, how might his experiments have differed?

**Writing for Science**

7. Technical Writing Imagine that you are Gregor Mendel and you need to document your first experiments for a science magazine. Write out your procedure for breeding pea plants. Be sure to explain how you controlled variables and assured that data was reliable.