The Book Planter

FARM BUREAU NORTH CAROLINA

Ag in the Classroom

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Gregor Mendel: The Friar Who Grew Peas

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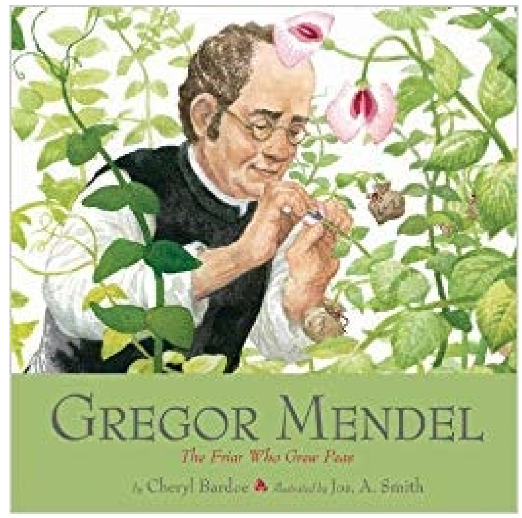


Regarded as the world's first geneticist, Gregor Mendel overcame poverty and obscurity to discover one of the fundamental aspects of genetic science: how traits are inherited from one generation to the next. This biography, with illustrations show the early scientist's progress, tells the story of his remarkable life. Readers will be inspired by Gregor's never-ending search for knowledge, and his famous experiments are easy to understand.[1] His work has shaped agriculture by pioneering plant breeding concepts, which earned him his nickname—the "father of modern genetics."

Fun Facts

- Gregor Mendel worked to show that traits are not blended, as was thought during the time of Mendel's studies. For example, people used to believe that a tall parent and a short parent would produce a medium sized offspring. Mendel's work showed that traits are not blended, they are passed on intact.[2]
- Gregor Mendel chose to study peas because pea plants produce a lot of "offspring" (flowers/fruits), and it was easy to control their pollination.[2]
- Gregor Mendel was the first scientist to determine that the mathematic principles of probability can be used to predict the outcomes of genetic crosses (the results of two parents passing down traits to offspring).[2]
- A **Punnett square** is a chart that shows all possible gene combinations in a cross.[2]
- Understanding Medelian Genetics enables animal and plant breeders to produce new, improved, and higher yielding varieties with more accuracy. These genetic advances, along with improvements in farm management, have led to significant increases in agricultural productivity.[2]
- **Genetic engineering** specifies when genetic material of something is modified to reach a desirable outcome. In relative terms, everything is genetically engineered because genes naturally change with their environment, but scientists use genetic engineering

when change can produce an advantage— such as making a plant more disease resistant, or also manipulating the genetic material of the disease to weaken its effects.[3]

- Most genetically engineered crops are not for direct human consumption, but rather are used for animal feed, seed oils, and fuel production.[3]
- Genetically engineered crops grown in North Carolina are: soybeans, corn (for grain), and cotton.[4]
- North Carolina is a large producer of specialty crops such as sweet potatoes, peanuts, cucumbers, cabbage, and tobacco. None of these crops are genetically modified.[4]
- With regard to field crops and GMO prevalence, North Carolina is very similar to the rest of the U.S. and other major grain and cotton producers (e.g. Brazil).[4]

Vocabulary

Friar: a male member of a religious order.

Mathematician: an expert in or student of mathematics.

Botanist: a scientist who studies the classification of plants.

Philosopher: a person engaged or learned in philosophy (the study of the fundamental nature of knowledge, reality, and existence).

Geologist: a scientist who studies the solid, liquid and gaseous matter that makes up the Earth and other planets.

Universal Law: a set of simple rules that explain why things happen in nature.

Experiment(s): a scientific procedure with an outcome that will make a discovery, demonstrate a fact, or test something.

Trait: a genetic characteristic that distinguishes a person, such as hair color or eye color.

Hybrids: the offspring of two plants or animals of different species or varieties.

Offspring: a person's child or children, an animal's young, or the product or result of something.

Gene(s): a unit of heredity that is passed on from parent to offspring.

Dominant genes: genes that "mask" other genes that are passed from parent to offspring.

Recessive genes: genes which are less likely to produce a trait if a dominant gene is present.

Geneticist: a scientist who studies genetics, the science of genes, and heredity.

Chromosomes: threadlike structures in the nucleus of the cell that control the cell's activities.

Organism: any living thing made of cells.

Purebred: the offspring produced by parents of the same breed.

Inherited: when a trait is passed on from parent organism to offspring.

Discussion Questions

1. What does it mean that Gregor decided to "feed his mind" and "feasted on lessons"? What kind of speech is this?
2. How did Gregor pay his school tuition?
3. What is a friar? Why did Gregor Mendel decide to become a friar?
4. What are universal laws? Give an example mentioned in the book.
5. What are traits?
6. What plant did Gregor Mendel decide to focus on?
7. What part of the flower creates pollen?
8. How many flowers did Gregor Mendel pollinate by hand?
9. What is heredity?
10. What are genes?
11. Explain the difference between dominant and recessive genes.
12. Why did people reject Gregor Mendel's findings?
13. What are some things we use genetics for today?

Note: Refer to the attachment *Background Agricultural Connections* which will aid in the activities.

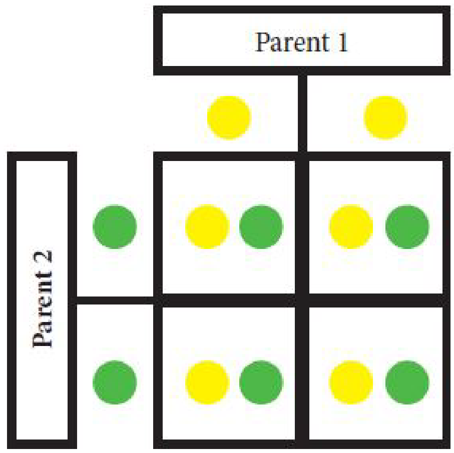
Interest Approach – Engagement[2]

1. Ask the students what a trait is. Allow students to offer their answers and guide them to the correct answer. Traits are distinguishing characteristics. Explain that many traits are determined by genetics.
2. Ask the students to list different plants or animals that a farmer might raise. List them on the board. Students could list livestock such as cattle, sheep, or pigs as well as plants such as wheat, corn, fruits, and vegetables. Explain to students that animals raised on a farm such as cattle, sheep, or pigs are called livestock because they are an asset to the farmer – sold as income.
3. Using the list on the board, ask students if there are any specific traits a farmer would want to have in their plants or animals. Allow students time to think about the question and then give them an example. For example, if they named a strawberry in step 2, explain that the farmer wants their strawberries to be juicy, sweet, and medium sized. Each of these characteristics are traits that are influenced or determined by the plant's genetics to fulfill the demand of the consumer. After giving the example, see if students can think of any other traits for the remaining farm crops or livestock.
4. Explain that farmers use their knowledge of inherited traits to try to produce the best product for the consumer.

The Friar Who Grew Peas[2]

1. Discuss the information found in the *Background Agricultural Connections*. You may also use the Peas in a Pod PowerPoint (in **Links** section) or excerpts from *Gregor Mendel: The Friar Who Grew Peas*.

2. Make a Punnett square model on the board to illustrate the results of Mendel's experiments with pea plants. Yellow pompoms represent the recessive gene for green seeds. Use two yellow pompom magnets for Parent 1 and two green pompom magnets for Parent 2. In this case, we are crossing two parents with purebred traits.



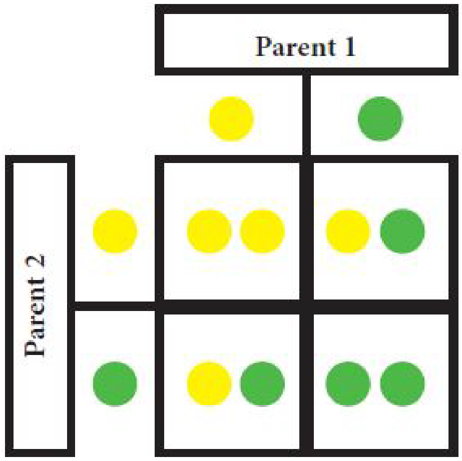
When a purebred pea plant with yellow seeds is crossed with a purebred pea plant with green seeds, there is a 100% probability that the offspring will have yellow seeds. If this F1 generation (the first generation resulting from a cross between the first set of parents) is cross, the results will be different.

3. Discuss the meaning of the Punnett square with the students. Write the following on the board to explain how dominant and recessive genes are expressed.

dominant + dominant = dominant
dominant + recessive = dominant
recessive + recessive = recessive

When two dominant genes are present, the dominant gene will be expressed. When a dominant and a recessive gene are present, the dominant gene will be expressed. When two recessive genes are present, the recessive gene will be expressed.

4. Make another Punnett square model on the board to illustrate the F2 generation (the second generation resulting from a cross between two individuals from the F1 generation). Use one yellow and one green pompom magnet for Parent 1 and one yellow and one green pompom magnet for Parent 2. In the F2 generation (offspring), we are crossing two parents with hybrid traits.



When a hybrid pea plant with yellow seeds is crossed with another hybrid pea plant with yellow seeds, there is a 75% probability that the offspring will have yellow seeds and a 25% probability that the offspring will have green seeds. It is important to note that in the case of a hybrid, the dominant trait is what will be expressed.

Pompom Punnett Squares[2]

1. Fill lunch-size paper bags with 12 yellow and 12 green pompoms. Divide students into groups of four. Provide each student with a *Punnett Square Activity Sheet* (in **Links** section, and attached to end of this activity sheet) and each group with a *Punnett Square Chart* (in **Links** section, and attached to end of this activity sheet) and a bag of yellow and green pompoms.
2. In each group, students will take turns being Parent 1 and Parent 2. Each parent will close their eyes, and choose two pompoms from the bag. They will then begin creating a Punnett square on their chart by placing their pompoms in the space provided for Parent 1 and Parent 2. The group will use the remaining pompoms to fill out the rest of the Punnett square.
3. Each student will record the results on their *Punnett Square Activity Sheet* using *Y* to present yellow seeds and *g* to represent green seeds. Underneath each Punnett square, students can record the probability of the offspring having yellow or green seeds.
4. This process can be repeated as many times as desired by choosing new pompoms from the bag. Pompoms can be replaced with other props to represent different pea plant traits such as tall and short pipe cleaners for stem height. Use the *Pea Plant Traits Chart* (in **Links** section, and attached to this activity sheet) to determine whether the traits are dominant or recessive when creating Punnett squares for different traits.
5. **Extension Activity** – Have students create a chart based on their parents' traits (eye color, hair color, height, etc.), and see if they can create a Punnett square of their inherited traits.

Trait Variation[5]

1. Remind students about the similarities and differences among humans that come from inherited traits. Tell them that the class is now going to investigate the amount of variation present in crop plants.

2. Divide students into groups and provide each group with a picture of a field of crop plants, such as corn, beans, etc. Ask each group to make a chart of the similarities and differences they can see between plants in the pictures. Discuss how the amount of variation they observe compares to the amount of variation that can be observed in humans. As a class, brainstorm reasons why farmers might not want variation among plants as they grow to produce crops.
3. Show each group of students an ear of dried popcorn and an ear of Indian corn. If you do not have these items, you can use pictures.
4. Ask each group to make a chart of similarities and differences between the kernels on an ear (each kernel is an individual offspring of the plant that produced the ear). As a class, discuss their observations. Discuss the possible sources of variation (sexual reproduction, open pollination—pollination that occurs naturally without human interference). Also compare the traits of the two corn varieties.
5. Explain to the students that in general, it is easier for farmers to manage uniform crops. For example, most corn is harvested using a machine called a combine. All of the corn is harvested at the same time, so it is best if it all matures at the same time. However, sometimes variation is desirable. Indian corn is used mostly for ornamental purposes (for looks, or decoration), so variation in the color of the kernels is desirable.

Links

- Peas in a Pod (Lesson Plan) https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=130&grade=3&author_state=0&search_term_lp=genetics
- The importance of crop genetic diversity (article) https://phys.org/news/2017-03-importance-crop-genetic-diversity.html
- Peas in a Pod PowerPoint https://naitc-api.usu.edu/media/uploads/2015/02/11/Peas_in_a_Pod.pptx
- Punnett Square Activity Sheet (used in Pompom Punnett Squares activity) https://naitc-api.usu.edu/media/uploads/2015/02/10/PeasinaPod_punnett_square_activity_sheet.pdf
- Punnet Square Chart (used in Pompom Punnett Squares activity) https://naitc-api.usu.edu/media/uploads/2015/02/10/PeasinaPod_punnett_square_chart.pdf
- Pea Plant Traits Chart (used in Pompom Punnett Squares activity) https://naitc-api.usu.edu/media/uploads/2015/02/10/PeasinaPod_pea_plant_traits.pdf
- Pea Plant Breeding (video) – demonstrates how Gregor Mendel would have cross pollinated pea plants to create a desired cross https://www.youtube.com/watch?v=PE0zsuzxxMc

Sources

1. https://www.scholastic.com/teachers/books/gregor-mendel-the-friar-who-grew-peas-by-cheryl-bardoe/
2. https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=130&grade=3&author_state=0&search_term_lp=genetics
3. https://currituck.ces.ncsu.edu/2018/01/genetic-engineering-what-is-it-really/
4. https://www.ncfieldfamily.org/farm/whats-portion-gmo-vs-non-gmo-crops-grown-north-carolina/
5. https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=219&author_state=0&grade=3&search_term_lp=genetics

K-5 Subject Areas

Reading, Speaking and Listening, Science

Common Core/Essential Standards

Reading

- **RL.K.1.** With prompting and support, ask and answer questions about key details in a text**.**
- **RL.1.1.** Ask and answer questions about key details in a text.
- **RL.2.1.** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding **of** key details in a text**.**
- **RL.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **RL.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RL.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RL.K.3** With prompting and support, identify characters, settings, and major events in a story.
- **RL.1.3** Describe characters, settings, and major events in a story, using key details.
- **RL.2.3** Describe how characters in a story respond to major events and challenges.
- **RL.3.3** Describe characters in a story and explain how their actions contribute to the sequence of events.
- **RL.4.3** Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text.
- **RL.5.3** Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text.
- **RL.3.4** Determine the meaning of words and phrases as they are used in a text, identifying words that impact the meaning in a text.
- **RL.4.4** Determine the meaning of words and phrases as they are used in a text, including words that affect meaning and tone
- **RL.5.4** Determine the meaning of words and phrases as they are used in a text, recognizing specific word choices that contribute to meaning and tone.
- **RI.K.1** With prompting and support, ask and answer questions about key details in a text.
- **RI.1.1** Ask and answer questions about key details in a text.
- **RI.2.1** Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- **RI.3.1** Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- **RI.4.1** Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- **RI.5.1** Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

Speaking and Listening

- **SL.K.2** Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- **SL.1.2** Ask and answer questions about key details in a text read aloud or information presented orally or through other media.

- **SL.2.2** Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.
- **SL.3.2** Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.4.2** Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.5.2** Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- **SL.K.4** Speak audibly and express thoughts, feelings, and ideas clearly.

Science

- **2.L.2.1** Identify ways in which many plants and animals closely resemble their parents in observed appearance and ways they are different.
- **2.L.2.2** Recognize that there is variation among individuals that are related.
- **5.L.3.1** Explain why organisms differ from or are similar to their parents based on the characteristics of the organism.
- **5.L.3.2** Give examples of likenesses that are inherited and some that are not.

Background Agricultural Connections
source**:**
https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=130&grade=3&author_state=0&search_term_lp=genetics

In the 1850s, an Austrian monk named Gregor Mendel started a series of experiments with garden peas. Mendel was fascinated with plants and was curious about why some pea plants had different physical characteristics than others. For more than ten years, Mendel carried out thousands of experiments on pea plants that laid the foundation for the study of **heredity**.

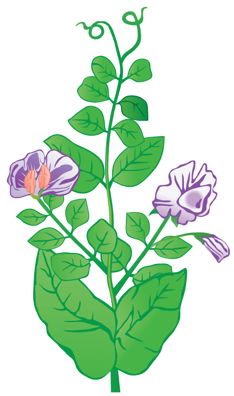
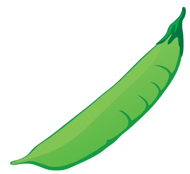
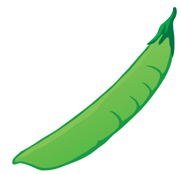
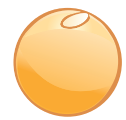
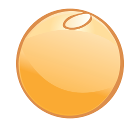
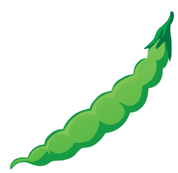
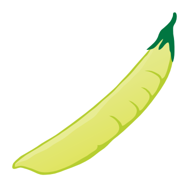
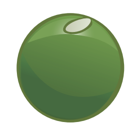
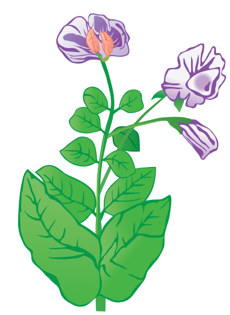
At the time of Mendel's studies, it was a generally accepted belief that **traits** were blended. It was believed that the **offspring** of a tall parent and a short parent would have medium-sized height. Mendel's work showed that traits are not blended; they are passed on intact. He discovered that traits can skip a generation and are either dominant or recessive. Mendel also discovered that traits can be passed on independently of other traits. For example, the size of a pea plant does not affect the color of the plant's flower. The importance of Mendel's discoveries went largely unrecognized until the early 1900s when other scientists, who made many of the same observations, rediscovered his work.

Mendel's decision to study peas is significant. Pea plants are a good choice for study because they produce a large number of offspring, and it is easy to control their pollination. Pea plants also have many traits that exist in only two forms. Mendel selected seven characteristics to study; purple or white flower color, flowers positioned on the top or the side of the stem, smooth or pinched seed pod, yellow or green pod color, yellow or green seed color, round or wrinkled seeds, long or short stems. Mendel studied each trait and learned how they were passed down to the offspring plant.

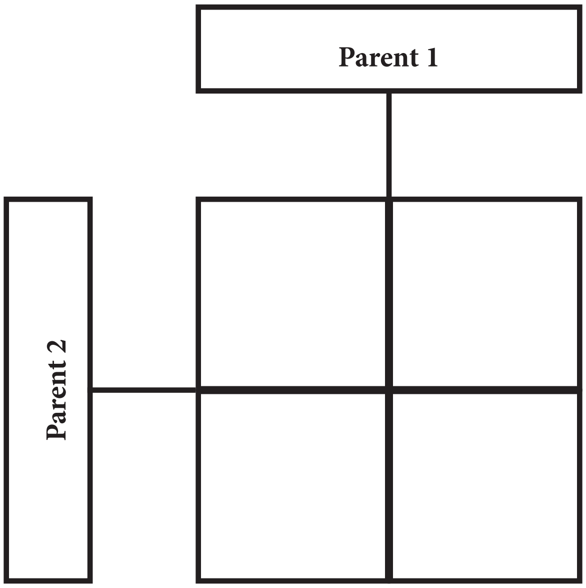
Gregor Mendel was the first scientist to determine that the mathematic principles of probability can be used to predict the outcomes of genetic crosses. In 1905, English geneticist Reginald Punnett created what is now known as the Punnett square to illustrate some of Mendel's discoveries. A Punnett square is a chart that shows all possible **gene** combinations in a cross. This visual representation of Mendelian inheritance was designed as a teaching tool and helps explain how the laws of probability apply to genetics.

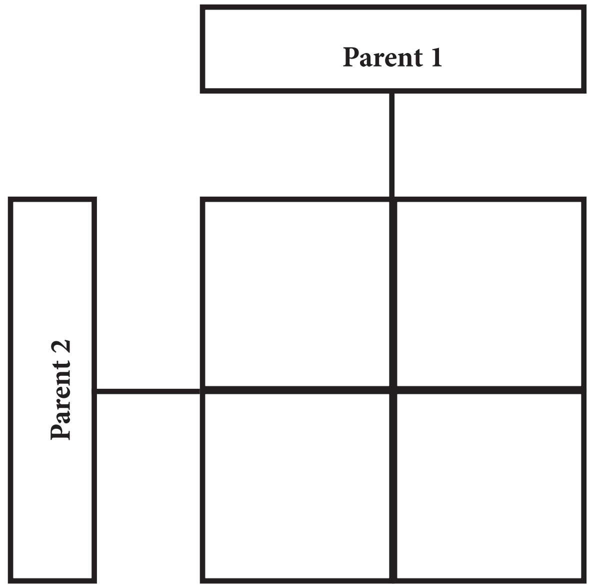
For each **inherited** trait, the offspring has two genes—one from each parent. If both genes are either dominant or recessive, the trait is called a **purebred** trait. If only one gene is dominant, the combination is called a **hybrid** trait. The Punnett square to the right shows a cross between two hybrid tall pea plants. T represents the **dominant gene** for tall and t represents the recessive gene for short. When two hybrid tall pea plants are crossed, three-fourths of the plants are tall, and one-fourth are short. You can predict that there is a 75% probability the offspring will be tall and a 25% probability the offspring will be short.

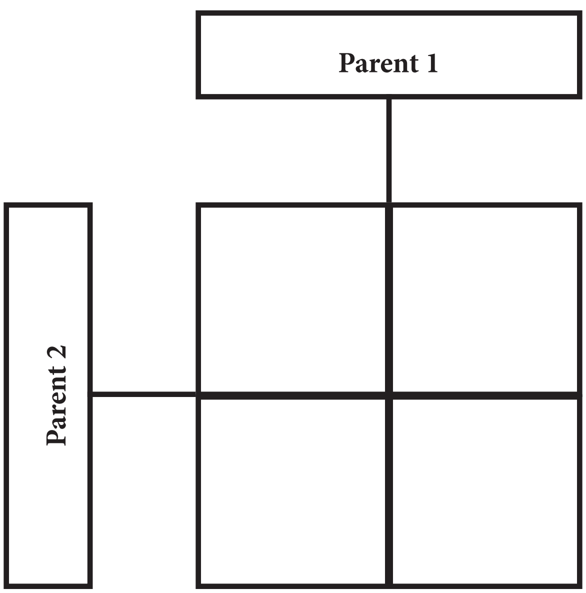
Pea Plant Traits

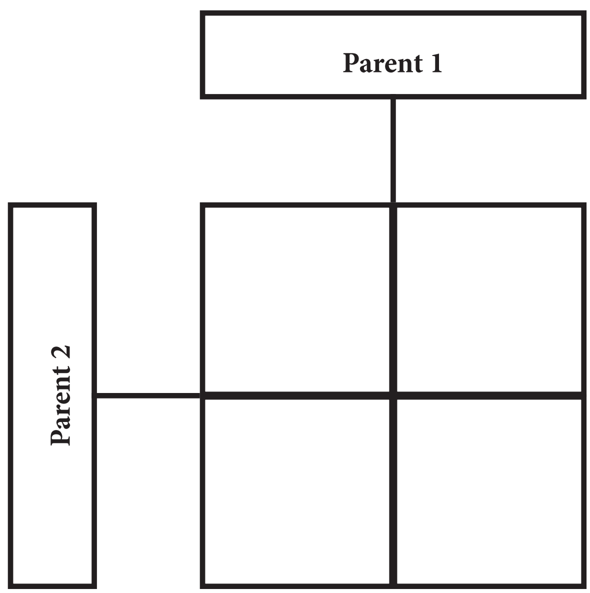
	Flower Color	Flower Position	Pod Shape	Pod Color	Seed Shape	Seed Color	Stem Height
Dominant Trait	 Purple	 Side	 Smooth	 Green	 Round	 Yellow	 Tall
Recessive Trait	 White	 Top	 Pinched	 Yellow	 Wrinkled	 Green	 Short

Punnett Square Activity Sheet









Punnett Square Chart