The Story of Gregor Mendel and his Peas

1-17: This is the story of Gregor Mendel and how his pea experiments were used to study heredity. People had noticed for thousands of years that family resemblances were inherited from generation to generation, but no one knew how or why this pattern of heredity occurred. The study of genetics was soon created to help explain this idea of heredity. Mendel was the first person to succeed in predicting how traits would be transferred from one generation to the next. BUT, how was he able to solve this problem of heredity you ask?

Mendel loved his garden at the monastery and was extremely curious why certain plants had certain traits and others did not. He began his experiments using pea plants because they reproduced sexually (have two distinct sex cells – male and female) and both of these gametes are located in the same flower. The male gamete is in the form of pollen grains and the female gamete is in the ovule, which is located on the pistil. When pollination occurs a seed is formed. This type of fertilization occurs naturally. The gametes are tightly enclosed within the petals, preventing the pollen of other flowers to enter. The peas therefore self-pollinate. Mendel used this method of pollination but also cross pollinated. By using these two forms of pollinating, Mendel could be sure of the parents in his crosses.

18-35: Mendel studied seven traits that are specific to garden peas. Seed shape, seed color, flower color, flower position, pod color, pod shape and plant height. Although he studied seven traits, he only studied one trait at a time to control variables and analyze his data mathematically.

Mendel's first crosses were called monohybrid crosses. He started with a set of tall pea plants, from generations that had produced tall plants. He crossed this plant with a set of short pea plants, from generations that had produced short plants. The tall and short plants were a part of the *P generation*. The cross resulted in a *F_1 generation* that Mendel called the hybrid. Every one of the offspring in the F_1 generation were tall. Next he created another monohybrid cross with two of the hybrids from the F_1 generation. The cross resulted in a *F_2 generation* that consisted of 3 tall plants and 1 short plant.

36-55: From this experiment Mendel was able to conclude that there are at least two factors that control each trait. We now know these factors are genes and that they are located on chromosomes. Genes exist in alternate forms called alleles. Each of Mendel's pea plants had two alleles of the gene that determined height. A plant could have two alleles for tallness, two alleles for shortness or one allele for tallness and one for shortness. One allele is inherited from the female parent and one from the male parent.

Mendel also observed that certain traits showed up and others seemed to disappear. He deemed one of the alleles dominant and the other recessive. In the first monohybrid cross of the P generation, he crossed a tall and short plant. In the F_1 generation, all the plants were tall. Although they were all tall they had a hybrid genotype. Each offspring received one allele from the tall and one from the short. The allele for tallness masks the alleles for shortness in the pea plants. The tall allele is therefore dominant over the short allele. To show this we use the same letter for different alleles of the same gene. An uppercase letter is used for the dominant allele and a lowercase letter for the recessive. The dominant allele is always written first.

Mendel's Law of Segregation explains why hybrid offspring can occur. Two organisms can look alike, have the same phenotype, but have different genotypes. The genotypes for tall plants can be TT or Tt. The genotype of short is only tt. If the genotype is TT or tt then it is said to be homozygous or pure breed. If the genotype is Tt, it is said to be heterozygous or hybrid. The only way to get a phenotype of short is to have the alleles be tt.

In 1905, Reginald Punnett devised a short handed way of finding the expected proportion of possible genotypes in the offspring of a cross. This method is called a punnett square. It takes account of the fact that fertilization occurs randomly as Mendel's law of segregation states. If you know the genotypes of the parents you can use a punnett square to predict the possible genotypes of their offspring. Knowing the genotypes, you can also know the phenotype.

Give Peas a Chance

What is heredity?

Imagine a puppy. The puppy has long floppy ears like his mother has, and the puppy has dark brown fur like his father has. How did the puppy get these traits? The traits are a result of information stored in the puppy's genetic material. The passing of genetic material from parents to offspring is called **heredity**.

What did Gregor Mendel discover about heredity?

The first major experiments investigating heredity were performed by a monk named Gregor Mendel. Mendel lived in Austria in the 1800s. Before Mendel became a monk, he attended a university and studied science and mathematics. This training served him well when he began to study the inheritance of traits among the pea plants in the monastery's garden. Mendel studied seven different characteristics of pea plants: plant height, flower and pod position, seed shape, seed color, pod shape, pod color, and flower color. A *characteristic* is a feature that has different forms in a population. Mendel studied each pea plant characteristic separately, always starting with plants that were true-breeding for that characteristic. A true-breeding plant is one that will always produce offspring with a certain trait when allowed to self-pollinate. Each of the characteristics that Mendel studied had two different forms. For example, the color of a pea could be green or yellow. These different forms are called *traits*.

5 Apply Is flower color a characteristic or a trait?

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Characteristics of Pea Plants

Characteristic	Traits	
Seed color		
Seed shape		
Pod color		
Flower position		

Traits Depend on Inherited Factors

In his experiments with seed pod color, Mendel took two sets of plants, one true-breeding for plants that produce yellow seed pods and the other true-breeding for plants that produce green seed pods. Instead of letting the plants self-pollinate as they do naturally, he paired one plant from each set. He did this by fertilizing one plant with the pollen of another plant. Mendel called the plants that resulted from this cross the first generation. All of the plants from this first generation produced green seed pods. Mendel called this trait the *dominant* trait. Because the yellow trait seemed to recede, or fade away, he called it the *recessive* trait.

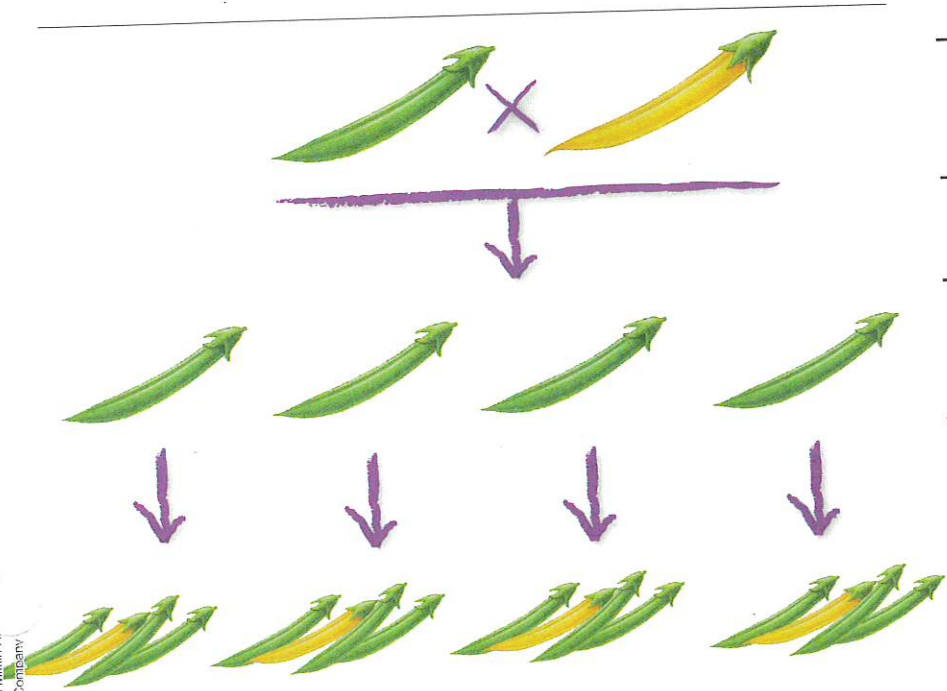
Then Mendel let the first-generation plants self-pollinate. He called the offspring that resulted from this self-pollination the second generation. About three-fourths of the second-generation plants had green seed pods, but about one-fourth had yellow pods. So the trait that seemed to disappear in the first generation reappeared in the second generation. Mendel hypothesized that each plant must have two heritable "factors" for each trait, one from each parent. Some traits, such as yellow seed pod color, could only be observed if a plant received two factors—one from each parent—for yellow pod color. A plant with one yellow factor and one green factor would produce green pods because producing green pods is a dominant trait. However, this plant could still pass on the yellow factor to the next generation of plants.

ACTIVE READING

6 Identify As you read, underline Mendel's hypothesis about how traits are passed from parents to offspring.

Visualize It!

7 Claims • Evidence • Reasoning Which pod color is recessive? Summarize evidence to support your claim, and explain your reasoning.



Parent plants Mendel crossed true-breeding green-pod plants with true-breeding yellow-pod plants.

First generation All of the first generation plants had green pods. Mendel let these plants self-pollinate.

Second generation About three-fourths of the second generation had green pods, and one-fourth had yellow pods.