chapter 10 Sexual Reproduction and Genetics

section 2 Mendelian Genetics

Before You Read

Think about what you have learned about the scientific method. On the lines below, list some of the steps Mendel might have used to learn about the natural world. In this section, you will learn about Gregor Mendel's experiments.

MAIN Idea

Mendel explained how a dominant allele can mask the presence of a recessive allele.

What You'll Learn

- the law of segregation and the law of independent assortment
- how to use a Punnett square

Read to Learn

Mark the Text

Check for Understanding

As you read this section, highlight any parts you do not understand. After you have read the section, reread the parts you have highlighted.

How Genetics Began

Gregor Mendel, an Austrian Monk, lived in the 1800s. He experimented with pea plants in the monastery gardens.

Pea plants usually reproduce by self-fertilization. This means that the female gamete is fertilized by a male gamete in the same flower. Mendel discovered a way to cross-pollinate peas by hand. He removed the male gametes from a flower. He then fertilized the flower with the male gamete from a different flower.

Through these experiments, Mendel made several hypotheses about how traits are inherited. In 1866, he published his findings. That year marks the beginning of the science of **genetics**, the science of heredity. Mendel is called the father of genetics.

The Inheritance of Traits

Mendel used true-breeding pea plants—plants whose traits stayed the same from generation to generation. Mendel studied seven traits—flower color, seed color, seed pod color, seed shape, seed pod shape, stem length, and flower position.

Reading Check

1. Define What is a true-breeding plant?

What did Mendel find when he crossed pea plants with different traits?

Mendel called the original plants the parent, or P, generation. The offspring were called the F_1 generation. The offspring of the F_1 plants were called the F_2 generation.

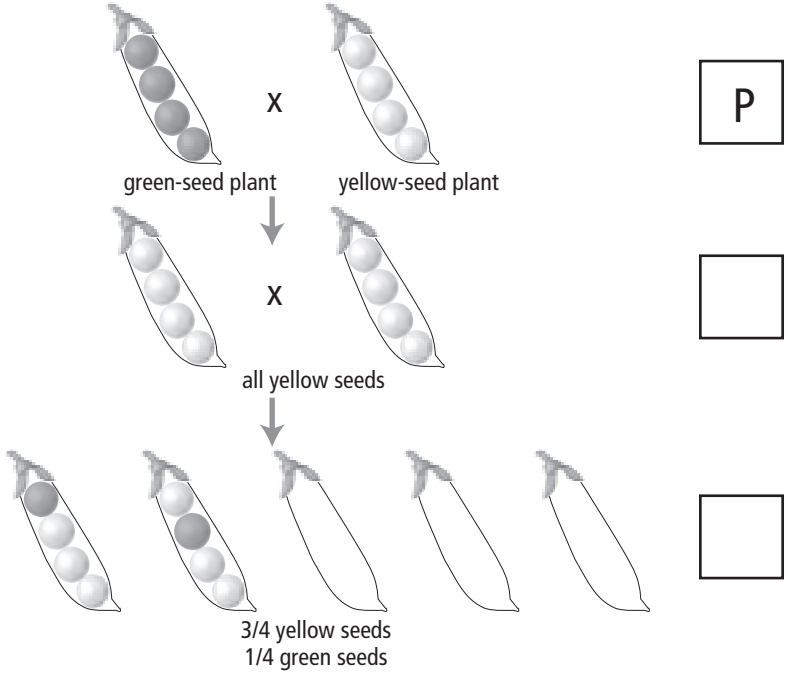
In one experiment, Mendel crossed yellow-seeded and green-seeded plants. All the F_1 offspring had yellow seeds. The green-seed trait seemed to disappear.

Mendel allowed the F_1 plants to self-fertilize. He planted thousands of seeds from these plants. He saw that in these offspring, the F_2 generation, three-fourths of the plants had yellow seeds and one-fourth had green seeds, a 3:1 ratio.

Mendel performed similar experiments for other traits. Each time, he observed the same 3:1 ratio.

Picture This

2. Label Fill in the boxes with the name of each generation of offspring. Draw the peas you would expect to see in the empty pods. Use shading to indicate a green pea.



How did Mendel explain his results?

Mendel proposed that there were two forms of each trait, and each form was controlled by a factor, which is now called an allele. An **allele** (uh LEEL) is a different form of a gene passed from generation to generation. Yellow-seed plants have a different allele than green-seed plants.

Mendel proposed that each trait was controlled by two alleles. The **dominant** form is the version of the trait that appears in the F_1 generation. The **recessive** form is the version that is hidden in the F_1 generation.

Think it Over

3. Apply In Mendel's experiment with green and yellow seeds, what was the dominant trait?

How does dominance work?

When written, the dominant allele is represented by a capital letter. The recessive allele is represented by a lowercase letter.

An organism is **homozygous** (hoh muh ZI gus) if both alleles for a trait are the same. The organism is **heterozygous** (heh tuh roh ZY gus) if the alleles for a trait are different. In heterozygous organisms, only the dominant trait can be seen. Dominant alleles mask recessive alleles.

How do genotype and phenotype differ?

It is not always possible to know what alleles are present just by looking at an organism. A yellow-seed plant could be homozygous (*YY*) or heterozygous (*Yy*). An organism's allele pairs are called its **genotype** (JEE nuh tipe). The expression of an allele pair, or the way an organism looks or behaves, is called its **phenotype** (FEE nuh tipe).

What is the law of segregation?

Recall that the chromosome number is divided in half during meiosis. The gametes contain only one of the alleles. Mendel's **law of segregation** states that the two alleles for each trait separate from each other during meiosis and then unite during fertilization. When parents with different forms of a trait are crossed, the offspring are heterozygous organisms known as **hybrids** (HI brudz).

A cross which involves hybrids for a single trait is called a monohybrid cross. Mono means one. The offspring of the cross have a phenotypic ratio of 3:1.

How are two or more traits inherited?

Mendel also performed dihybrid crosses, crossing plants that expressed two different traits. Mendel crossed yellow, round-seed plants with green, wrinkle-seed plants. Round seeds are dominant to wrinkled, just as yellow color is dominant to green. He wondered whether the two traits would be inherited together or separately. Members of the F_1 generation are dihybrids because they are heterozygous for both traits.

Mendel found that the traits were inherited independently. Members of the F_2 generation had the phenotypic ratio of 9:3:3:1—9 yellow round seeds, 3 green round, 3 yellow wrinkled, and 1 green wrinkled. From experiments with dihybrid crosses, Mendel developed the **law of independent assortment,** which states that alleles distribute randomly when gametes are made.

Think it Over

4. Predict What would be the phenotype of a homozygous, recessive (*yy*) pea plant?

Think it Over

5. Apply True-breeding yellow-seeded and green-seeded plants are crossed and produce yellow-seeded offspring. Which of these plants is a hybrid?

Punnett Squares

In the early 1900s, Dr. Reginald Punnett developed a square to predict possible offspring of a cross between two known genotypes. Punnett squares are useful for keeping track of genotypes in a cross.

Reading Check

6. Identify What is one purpose of a Punnett square?

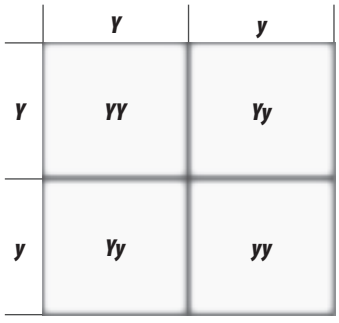
What information does a Punnett square contain?

A Punnett square can help you predict the genotype and phenotype of the offspring. The genotype of one parent is written vertically, on the left side of the Punnett square. The genotype of the other parent is written horizontally, across the top. A Punnett square for a monohybrid cross contains four small squares. Each small square represents a possible combination of alleles in the children.

The Punnett square below shows the results of Mendel's experiment with seed color. The Punnett square shows that four different genotypes are possible—one *YY*, two *Yy*, and one *yy*. The genotypic ratio is 1:2:1.

Picture This

7. Define Circle the genotypes in the small squares that will give a yellow-seed phenotype. What will be the phenotypic ratio in the offspring?



How is a Punnett square used for two traits?

Punnett squares also can be used to predict the results of a dihybrid cross. A Punnett square for a dihybrid cross is larger. It has 16 boxes to represent 16 allele combinations.

Probability

Genetics follows the rules of probability, or chance. It is like flipping a coin. The probability of flipping heads is one out of two. Because of chance, if you flip a coin 100 times, it might not land heads exactly 50 times, but it will be close.

It is the same in genetics. A cross might not give a perfect 3:1 or 9:3:3:1 ratio. The larger the number of offspring, the more closely the results will match the ratio predicted by the Punnett square.