Name _____ Class _____ Date _____

SECTION 2 Traits and Inheritance

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What did Mendel's experiments tell him about heredity?
- Are there exceptions to Medel's laws of heredity?

National Science Education Standards
LS 2a, 2b, 2c, 2d, 2e

What Did Mendel Learn About Heredity?

Mendel knew from his pea plant experiments that there must be two sets of instructions for each characteristic. All of the first-generation plants showed the dominant trait. However, they could give the recessive trait to their offspring. Instructions for an inherited trait are called **genes**. Offspring have two sets of genes—one from each parent.

The two sets of genes that parents give to offspring are never exactly the same. The same gene might have more than one version. The different versions of a gene are called **alleles**. ☑

Alleles may be dominant or recessive. A trait for an organism is usually identified with two letters, one for each allele. Dominant alleles are given capital letters (*A*). Recessive alleles are given lowercase letters (*a*). If a dominant allele is present, it will hide a recessive allele. An organism can have a recessive trait only if it gets a recessive allele for that trait from both parents.

STUDY TIP

Organize As you read, make a Concept Map using the vocabulary words highlighted in the section.

READING CHECK

1. Define What is an allele?

_____

_____

_____

PHENOTYPE

An organism's genes affect its traits. The appearance of an organism, or how it looks, is called its **phenotype**. The phenotypes for flower color in Mendel's pea plants were purple and white. The figure below shows one example of a human phenotype. ☑

Albinism is an inherited disorder that affects a person's phenotype in many ways.

READING CHECK

2. Define What is a phenotype?

_____

_____

GENOTYPE

A **genotype** is the combination of alleles that an oganism gets from its parents. A plant with two dominant or two recessive alleles (*PP*, *pp*) is *homozygous*. *Homo* means "the same." A plant with one dominant allele and one recessive allele (*Pp*) is *heterozygous*. *Hetero* means "different." The allele for purple flowers (*P*) in pea plants is dominant. The plant will have purple flowers even if it has only one *P* allele. ☑

READING CHECK

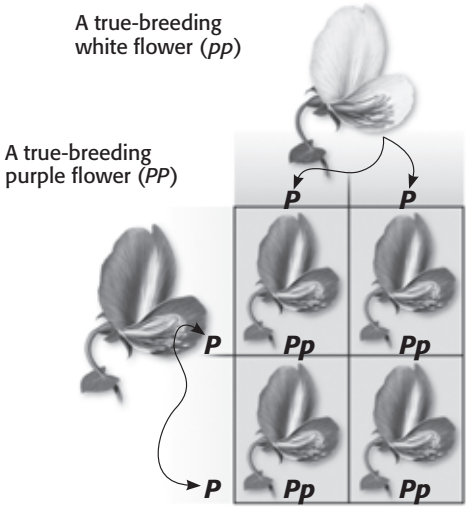
3. Identify What kind of alleles does a heterozygous individual have?

_____

_____

PUNNETT SQUARES

A Punnett square is used to predict the possible genotypes of offspring from certain parents. It can be used to show the alleles for any trait. In a Punnett square, the alleles for one parent are written along the top of the square. The alleles for the other parent are written along the side of the square. The possible genotypes of offspring are found by combining the letters at the top and side of each square.



All of the offspring for this cross have the same genotype—*Pp*.

TAKE A LOOK

4. Identify Is the plant with white flowers homozygous or heterozygous? How can you tell?

_____

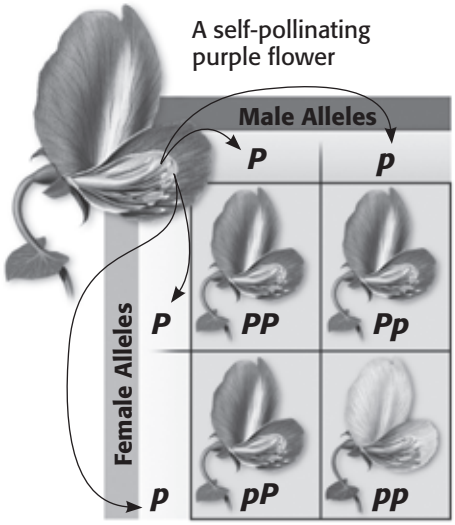
_____

_____

The figure shows a Punnett square for a cross of two true-breeding plants. One has purple flowers and the other has white flowers. The alleles for a true-breeding purple-flowered plant are written as *PP*. The alleles for a true-breeding white flowered plant are written as *pp*. Offspring get one of their two alleles from each parent. All of the offspring from this cross will have the same genotype: *Pp*. Because they have a dominant allele, all of the offspring will have purple flowers.

MORE EVIDENCE FOR INHERITANCE

In his second experiments, Mendel let the first-generation plants self-pollinate. He did this by covering the flowers of the plant. This way, no pollen from another plant could fertilize its eggs. The Punnett square below shows a cross of a plant that has the genotype *Pp*.



This Punnett square shows the possible results from the cross *Pp* × *Pp*.

Notice that one square shows the genotype *Pp* and another shows *pP*. These are exactly the same genotype. They both have one *p* allele and one *P* allele. The combinations *PP*, *Pp*, and *pP* have the same phenotype—purple flowers. This is because they all have at least one dominant allele, *P*. ☑

Only one combination, *pp*, produces plants that have white flowers. The ratio of dominant phenotypes to recessive phenotypes is 3:1. This means that three out of four offspring from that cross will have purple flowers. This is the same ratio Mendel found.

What Is the Chance That Offspring Will Receive a Certain Allele?

Each parent has two alleles for each gene. When an individual reproduces, it passes one of its two alleles to its offspring. When a parent has two different alleles for a gene, such as *Pp*, offspring may receive either of the alleles. Both alleles have an equal chance to be passed from the parent to the offspring.

Think of a coin toss. When you toss the coin, there is a 50% chance you will get heads, and a 50% chance you will get tails. The chance of the offspring receiving one allele or another from a parent is as random as a coin toss.

TAKE A LOOK

5. List What are the possible genotypes of the offspring in this cross?

_____

_____

READING CHECK

6. Explain Why do the genotypes *PP*, *Pp*, and *pP* all have the same phenotype?

_____

_____

_____

PROBABILITY

The mathematical chance that something will happen is known as **probability**. Probability is usually written as a fraction or percentage. If you toss a coin, the probability of tossing tails is 1/2, or 50%. In other words, you will get tails half of the time.

What is the probability that you will toss two heads in a row? To find out, multiply the probability of tossing the first head (1/2) by the probability of tossing the second head (1/2). The probability of tossing two heads in a row is 1/4.

GENOTYPE PROBABILITY

Finding the probability of certain genotypes for offspring is like predicting the results of a coin toss. To have white flowers, a pea plant must receive a p allele from each parent. Each offspring of a $Pp \times Pp$ cross has a 50% chance of receiving either allele from either parent. So, the probability of inheriting two p alleles is $1/2 \times 1/2$. This equals 1/4, or 25%.

Math Focus

7. Complete Complete the Punnett square to show the cross between two heterozygous parents. What percentage of the offspring are homozygous?

	P	*p*
P		
p		

_____

Are There Exceptions to Mendel's Principles?

Mendel's experiments helped show the basic principles of how genes are passed from one generation to the next. Mendel studied sets of traits such as flower color and seed shape. The traits he studied in pea plants are easy to predict because there are only two choices for each trait. ☑

READING CHECK

8. Explain Why were color and seed shape in pea plants good traits for Mendel to study?

_____

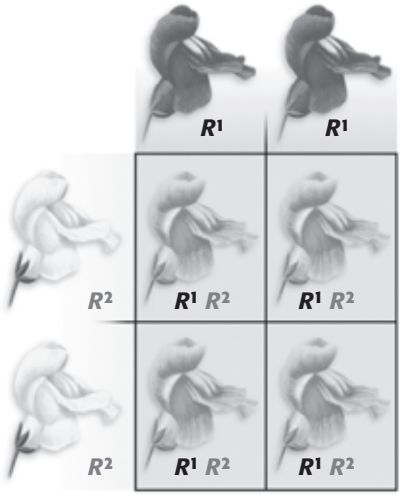
_____

_____

Traits in other organisms are often harder to predict. Some traits are affected by more than one gene. A single gene may affect more than one trait. As scientists learned more about heredity, they found exceptions to Mendel's principles.

INCOMPLETE DOMINANCE

Sometimes, one trait isn't completely dominant over another. These traits do not blend together, but each allele has an influence on the traits of offspring. This is called *incomplete dominance*. For example, the offspring of a true-breeding red snapdragon and a true-breeding white snapdragon are all pink. This is because both alleles for the gene influence color.



The offspring of two true-breeding show incomplete dominance.

ONE GENE, MANY TRAITS

In Mendel's studies, one gene controlled one trait. However, some genes affect more than one trait. For example, some tigers have white fur instead of orange. These white tigers also have blue eyes. This is because the gene that controls fur color also affects eye color.

MANY GENES, ONE TRAIT

Some traits, such as the color of your skin, hair, and eyes, are the result of several genes acting together. In humans, different combinations of many alleles can result in a variety of heights. ☑

THE IMPORTANCE OF ENVIRONMENT

Genes are not the only things that can affect an organism's traits. Traits are also affected by factors in the environment. For example, human height is affected not only by genes. Height is also influenced by nutrition. An individual who has plenty of food to eat may be taller than one who does not.

Critical Thinking

9. Infer If snapdragons showed complete dominance like pea plants, what would the offspring look like?

Critical Thinking

10. Compare How is the allele for fur color in tigers different from the allele for flower color in pea plants?

READING CHECK

11. Identify Give an example of a single trait that is affected by more than one gene.

Name _____ Class _____ Date _____

Section 2 Review

NSES LS 2a, 2b, 2c, 2d, 2e

SECTION VOCABULARY

allele one of the alternative forms of a gene that governs a characteristic, such as hair color	**phenotype** an organism's appearance or other detectable characteristic
gene one set of instructions for an inherited trait	**probability** the likelihood that a possible future event will occur in any given instance of the event
genotype the entire genetic makeup of an organism; also the combination of genes for one or more specific traits	

1. Identify Relationships How are genes and alleles related?

_____

_____

2. Explain How is it possible for two individuals to have the same phenotype but different genotype for a trait?

_____

_____

_____

_____

3. Punnett Square Mendel allowed a pea plant that was heterozygous for yellow seeds (*Y*) to self-pollinate. Fill in the Punnett square below for this cross.What percentage of the offspring will have green (*y*) seeds?

_____

	Y	*y*
Y		
y		

4. Discuss How is human height an exception to Mendel's principles of heredity?

_____

_____

_____