CHAPTER 4

Genetics

The BIG Idea

Inherited genes determine an organism's traits.

LESSON 1 2.b, 2.d

Foundations of Genetics

Main Idea Gregor Mendel discovered the basic principles of genetics.

LESSON 2

2.c, 2.d, 7.a, 7.b, 7.c, 7.e

Understanding Inheritance

Main Idea The interactions among alleles, genes, and the environment determine an organism's traits.

It's all in the genes! These dogs are purebred boxers, but they are not identical. Purebred dogs inherited similar sets of genes. However, the differences in each set of genes result in dogs with distinct appearances.

Science Journal List the differences and similarities that you observe among this dog and her puppies.

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Start-Up Activities

Launch Lab

00:10 minutes

How well can you predict?

Probability describes the likelihood that something will happen. For example, if you had a penny, a nickel, a dime, and a quarter in your pocket, the probability that you would pull out the quarter is 1 in 4.

Procedure

1. Your teacher will give you **marbles** in a **paper bag.**
2. Open the bag and examine its contents.
3. Create a data table to record the contents.

Think About This

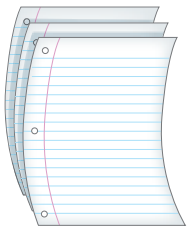
- **Examine** your data table. How many marbles are in the bag? How many of each color are included?
- **Predict** If you pulled out a marble, what is the probability of choosing one particular color?

2.d, 7.c

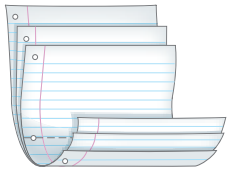
FOLDABLES™ Study Organizer

Patterns of Inheritance
Make the following Foldable to organize information about patterns of inheritance.

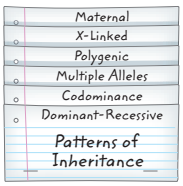
STEP 1 **Collect** three sheets of paper and layer them about 2 cm apart vertically. Keep the left edges even.



STEP 2 **Fold** up the bottom edges of the paper to form 5 equal tabs. Crease the fold to hold the tabs in place.



STEP 3 **Staple** along the fold. **Label** as shown.



Reading Skill

Reviewing
As you read Lesson 2, add information about each type of pattern of inheritance under the appropriate tab.

Science Online

Visit ca7.msscience.com to:

- view Concepts in Motion
- explore Virtual Labs
- access content-related Web links
- take the Standards Check

Get Ready to Read

Monitor

1 Learn It! An important strategy to help you improve your reading is monitoring, or finding your reading strengths and weaknesses. As you read, monitor yourself to make sure the text makes sense. Discover different monitoring techniques you can use at different times, depending on the type of test and situation.

2 Practice It! The paragraph below appears in Lesson 1. Read the passage and answer the questions that follow. Discuss your answers with other students to see how they monitor their reading.

> After analyzing the results of his experiments, Mendel concluded that two factors control each inherited trait. He also proposed that when organisms reproduce, each gamete contributes one factor for each trait.
>
> *—from page 175*

- What questions do you still have after reading?
- Do you understand all of the words in the passage?
- Did you have to stop reading often? Is the reading level appropriate for you?

3 Apply It! Identify one paragraph that is difficult to understand. Discuss it with a partner to improve your understanding.

Reading Tip

Monitor your reading by slowing down or speeding up depending on your understanding of the text.

Target Your Reading

Use this to focus on the main ideas as you read the chapter.

1. **Before you read** the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   - Write an **A** if you **agree** with the statement.
   - Write a **D** if you **disagree** with the statement.
2. **After you read** the chapter, look back to this page to see if you've changed your mind about any of the statements.
   - If any of your answers changed, explain why.
   - Change any false statements into true statements.
   - Use your revised statements as a study guide.

Before You Read A or D	Statement	After You Read A or D
	1 A gene is a section of RNA that has information about a specific trait.	
	2 Only the genotype determines the phenotype.	
	3 The movement of chromosomes during meiosis supports Mendel's law of independent assortment.	
	4 Mendel's ideas about inheritance remain true today.	
	5 Plant breeders do not need to use tools to predict traits.	
	6 For accurate genetic studies, a few offspring are just as good as many offspring.	
	7 All inherited traits follow Mendel's patterns of inheritance.	
	8 Every trait is determined by just one gene.	
	9 Humans inherit mitochondrial genes from both parents.	

Science Online

Print a worksheet of this page at ca7.msscience.com.

LESSON 1

Science Content Standards

2.b Students know sexual reproduction produces offspring that inherit half their genes from each parent.

2.d Students know plant and animal cells contain many thousands of different genes and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.

Reading Guide

What *You'll Learn*

- **Model** Mendel's pea plant experiments.
- **State** Mendel's two laws of heredity.
- **Define** dominant and recessive alleles.
- **Distinguish** between the phenotype and genotype of a trait.

Why *It's Important*

Genetics helps to explain how traits are passed from parents to offspring.

Vocabulary

heredity
genetics
dominant
recessive
gene
allele
phenotype
genotype
homozygous
heterozygous
law of segregation
law of independent assortment

Review Vocabulary

chromosome: a structure in a nucleus made of coiled, long chains of DNA; contains genetic material (p. 60)

Foundations of Genetics

Main Idea Gregor Mendel discovered the basic principles of genetics.

Real-World Reading Connection Why are all dogs of the same breed similar? Why do some disorders run in families? Why do grapevines produce only one type of grape? People have asked questions like these for many years, but scientists have found the answers only recently.

Early Ideas About Heredity

In Chapter 3, you read that a sperm and an egg contain genetic material that combines at fertilization. The combined genetic material determines the traits or features of an offspring. The passing of traits from parents to offspring is called **heredity** (huh REH duh tee).

Have you ever mixed two paint colors to get a new paint color? People used to believe that the genetic material from a sperm cell and an egg cell mixed like colors of paint. They believed that because offspring resembled both parents, the genetic material mixed or blended. Blending inheritance is the idea that offspring are a blend of genetic material from both parents. Supporters of this idea proclaimed that, over many generations, populations would eventually look alike because of blending inheritance. This does not happen. Blending inheritance also cannot explain why some traits appear to skip generations, such as eye color, as shown in **Figure 1.** Because of the work of Gregor Mendel, these questions have new answers.

Figure 1 Some traits seem to skip generations. Brown-eyed parents might have blue-eyed children.

Infer why eye color of the children does not support the idea of blending inheritance.

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Gregor Mendel and His Experiments

The first person known to record evidence that traits of organisms are determined by factors passed from parents to offspring was Gregor Mendel. He was born in 1822 in a part of Europe that is now the Czech Republic. Mendel made his discoveries during the 1850s at a monastery, as shown in **Figure 2.** The monks at the monastery were dedicated to teaching science and scientific research.

Mendel experimented with garden pea plants in the monastery's gardens. After carefully analyzing the results of his experiments, Mendel established the basic laws of heredity. Because of his scientific research, Mendel is known as the father of genetics. **Genetics** (juh NE tihks) is the study of how traits of organisms are passed from parents to offspring.

Figure 2 Mendel experimented in a garden at this monastery in Brno, Czech Republic.

Mendel's Experimental Methods

Mendel studied genetics by conducting breeding experiments with pea plants. He chose pea plants because they are easy to grow, they flower and reproduce quickly, they come in many varieties, and the peas are edible. Mendel studied seven different traits of pea plants, as shown in **Table 1.** Each trait had only two variations. For example, flower color was either purple or white and seeds were either round or wrinkled.

Reading Check Why did Mendel use pea plants for his experiments?

WORD ORIGIN
genetics
from Greek *genesis;* means *origin*

Concepts in Motion
Interactive Table To organize information about pea traits, visit Tables at ca7.msscience.com.

Table 1 Pea Traits Studied by Mendel

Flower Color	Flower Position	Seed Color	Seed Shape	Pod Shape	Pod Color	Stem Length
Purple	Axial	Yellow	Round	Inflated	Green	Long
White	Terminal	Green	Wrinkled	Constricted	Yellow	Short

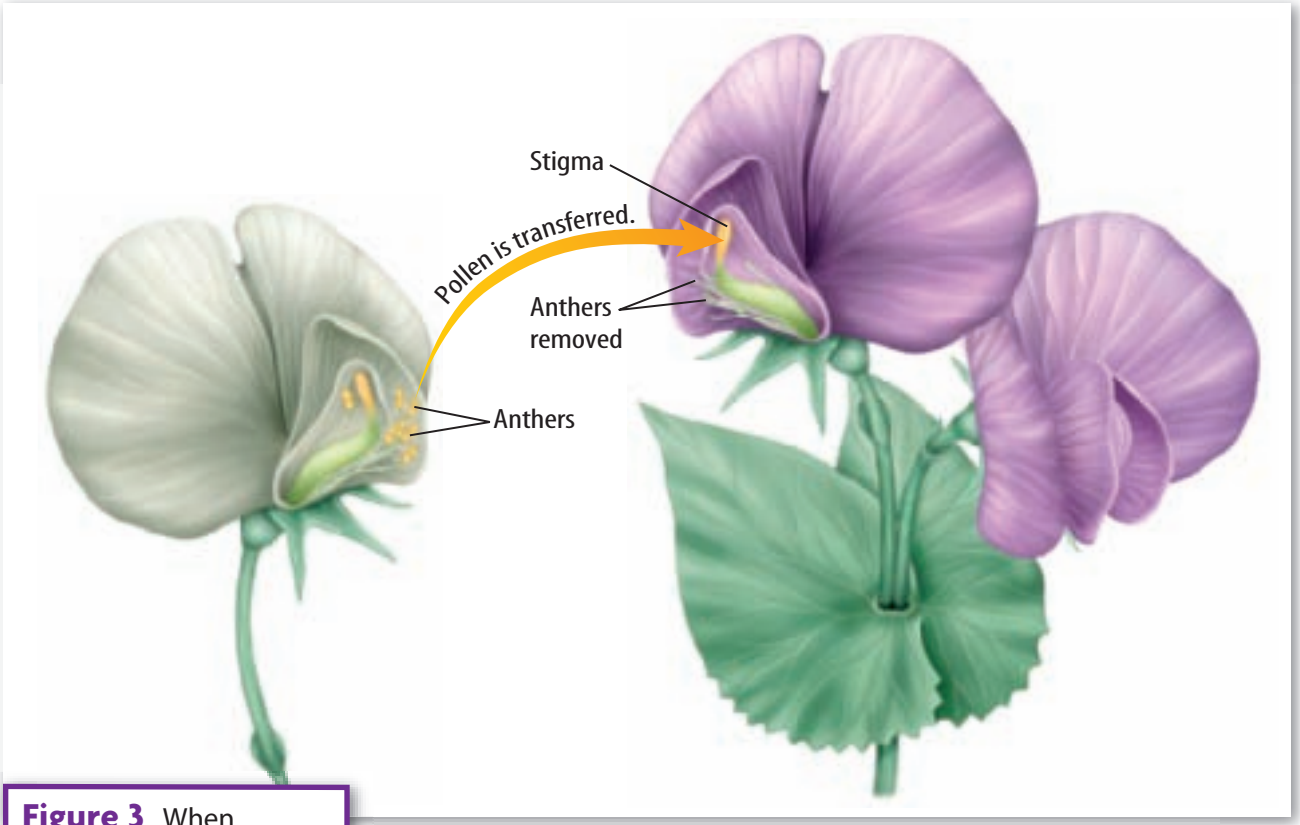

Figure 3 When performing cross-pollination of the pea flowers, Mendel removed the anthers from the flower receiving pollen to prevent self-fertilization.

Controlled Exeriments Recall from Chapter 3 that a flower contains male reproductive organs (stamens) and/or female reproductive organs (pistils). The flowers of pea plants have both stamens and pistils. Mendel controlled fertilization in the experimental pea plants. He allowed some of the flowers to self-fertilize as they usually do in nature. Mendel also performed cross-fertilization by transferring pollen from the stamen of one pea flower to the stigma of a pistil in another pea flower, as shown in **Figure 3.** This allowed him to record the parents of the offspring produced from the cross, and observe how traits pass from one generation to the next.

ACADEMIC VOCABULARY
method (MEH thud)
(noun) a way of doing something
Juan's method of reviewing for the science test helped him remember the important information.

Mendel's Unique Methods Mendel was not the first person to breed plants. So, what made his experimental **methods** unique? First, Mendel used true-breeding plants for each trait. When true-breeding plants for a trait self-pollinate, they always produce offspring with that trait. For example, when pea plants that are true-breeding for wrinkled seeds self-pollinate, they only produce offspring with wrinkled seeds. Second, Mendel recorded the inheritance of traits for several generations. Last, and most importantly, Mendel used a mathematical approach. He was careful to breed large numbers of plants and count the number of each kind of offspring, generation after generation. He collected and recorded large amounts of numerical data.

Reading Check How were Mendel's plant-breeding methods unique?

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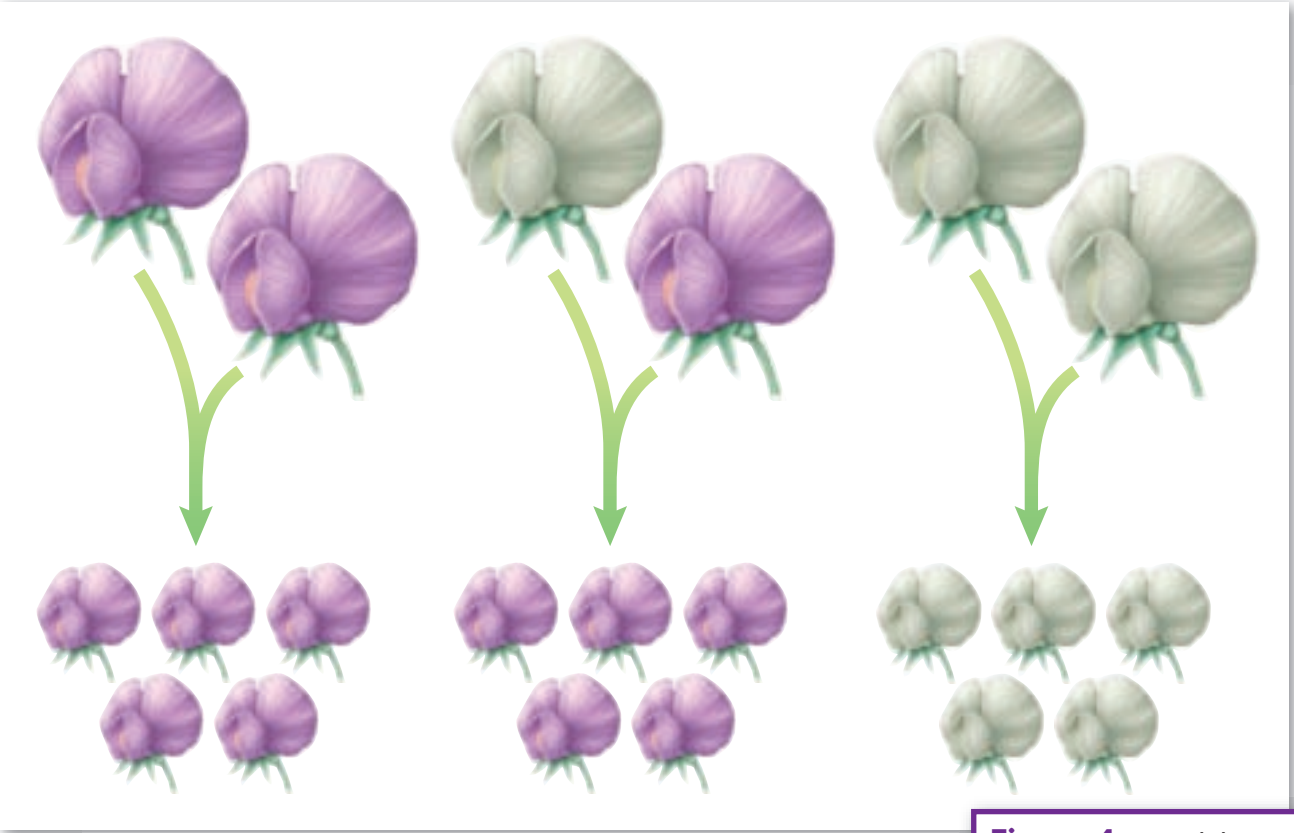


Figure 4 Mendel observed that the color of a pea plant's flowers was the result of dominant and recessive genetic factors.

Mendel's Experimental Results

After analyzing the results of his experiments, Mendel concluded that two factors control each inherited trait. He also proposed that when organisms reproduce, each gamete—sperm or egg—contributes one factor for each trait.

Visual Check **Figure 4** Explain to a classmate which color factor is dominant and which factor is recessive.

Dominant Factors Mendel often crossed true-breeding plants to create hybrids. A hybrid inherits a different form of a specific trait from each parent. For example, when Mendel crossed a true-breeding, purple-flowered plant with a true-breeding, white-flowered plant, the hybrid offspring had purple flowers, as shown in **Figure 4.** Why were there no white flowers? Mendel hypothesized that the offspring had one genetic factor for purple flowers and one genetic factor for white flowers, but only the purple factor is observed because it blocks the white factor. A genetic factor that blocks another genetic factor is called **dominant** (DAH muh nunt). A dominant trait, such as purple flower color in pea plants, is observed when offspring have one or two dominant factors.

Recessive Factors A genetic factor that is blocked by the presence of a dominant factor is called **recessive** (rih SE sihv). A recessive trait, such as white flower color in pea plants, can be observed only when two recessive genetic factors are present in offspring.

Science Use v. Common Use

cross

Science Use to cause animals or plants to breed. *Ivan plans to cross two different roses to produce a new variety of roses.*

Common Use move or pass from one side to another side. *Always cross a street at a traffic light.*

DataLab

00:30 minutes

Peas, Anyone?

One of Mendel's fellow monks supposedly said, "Brother Mendel, we grow tired of peas." Mendel's records show that he had counted at least 300,000 peas!

Data Collection

Mendel's Data

	Round Peas	Wrinkled Peas	Total Peas
Trial 1	5,474	1,850	7,324
	Yellow Peas	**Green Peas**	**Total Peas**
Trial 2	6,022	2,001	7,324

Source: Henig, Robin Marantz. *The Monk in the Garden: The Lost and Found Genius of Gregor Mendel, the Father of Genetics.* New York: Houghton Mifflin, 2000.

Data Analysis

1. **Calculate** these ratios: round peas to wrinkled peas, and yellow peas to green peas.
2. **Infer** which traits are dominant and which are recessive.

2.d

Try at Home

MA7: NS 1.0

Mendel's Laws of Heredity

Because Mendel did many experiments and carefully recorded the results, he was able to form two important hypotheses that allowed him to predict how traits are inherited. His hypotheses have been supported by other scientists and are called Mendel's laws of heredity—the law of segregation and the law of independent assortment.

According to the **law of segregation,** the two factors for each trait segregate or separate from each other during meiosis when gametes form. You can review meiosis in Chapter 3.

Mendel's **law of independent assortment** states that the factors for one trait separate independently of how factors for other traits separate, and gametes have all possible combinations of traits. For example, the separation of the two factors for seed color does not affect how the two factors for seed shape separate. The independent separation of the factors for these two traits makes four possible combinations of traits, as shown in **Figure 5.**

Modern Definitions of Mendel's Ideas

Mendel did not know about DNA or how cells reproduce, yet his ideas about inheritance remain true today. However, the terms used to describe his ideas have changed over time.

Figure 5 Mendel found that the inheritance of one trait, such as pea color, does not influence the inheritance of another trait, such as pea shape.

Explain why yellow peas can be round or wrinkled.

Yellow, round — Yellow, wrinkled

Green, round — Green, wrinkled

Genes and Alleles

Recall that a chromosome is made up of DNA and proteins. A section of DNA that has information about a specific trait of an organism is called a **gene** (JEEN). However, the gene's information about a trait can vary among the same kind of organisms.

Recall that Mendel used pea plants with purple or white flowers. Each pea plant had a gene for flower color, but each plant's gene for flower color had either purple or white information. In a similar way, we all have genes for eye color, but we all do not have the same information about the color of our eyes. Each form of a gene with different information is called an **allele** (uh LEEL). Mendel called these *factors* instead of alleles. As shown in **Figure 6,** scientists now know that the alleles of a gene are at the same locations on a pair of homologous chromosomes.

Reading Check

How many alleles were there for flower color in Mendel's experiments?

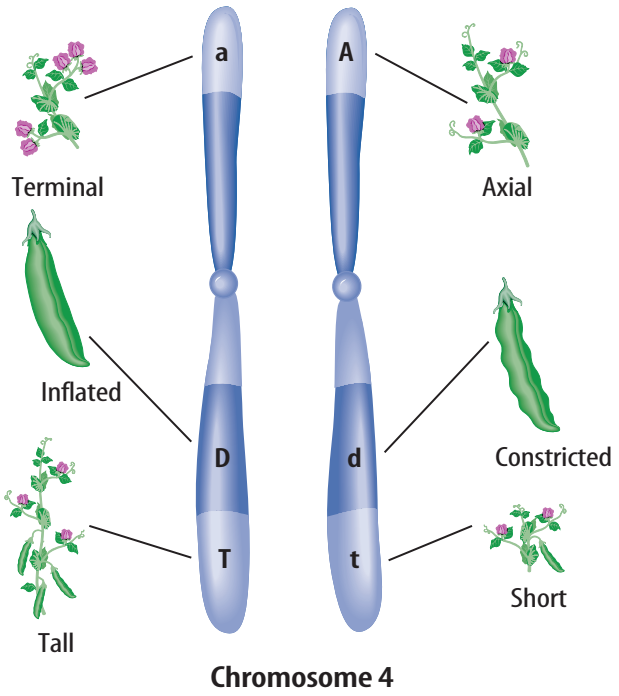


Figure 6 Homologous chromosomes have genes for the same traits. A gene's alleles are in the same location on homologous chromosomes.

Phenotype and Genotype

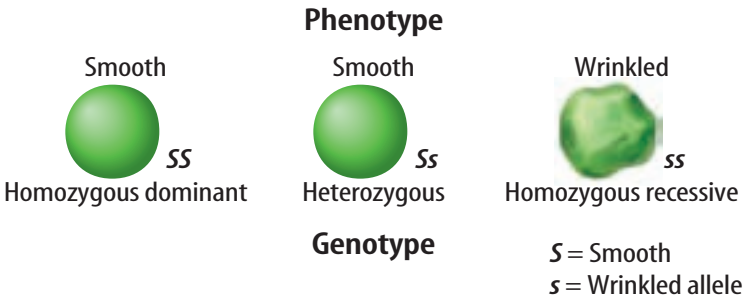
How would you describe the dog in **Figure 7?** You might say the dog has a lot of hair, short legs, and a wrinkled face. These observable traits and all characteristics of an organism make up the organism's **phenotype** (FEE nuh tipe). You read in Chapter 2 that an organism can have different levels of organization—organ system, organ, tissue, and cell. Each level of organization has a phenotype. A dog's phenotype includes not only its physical appearance, but also how its organs function, how it reproduces, and many other characteristics.

An organism's phenotype results from the interactions among its alleles and genes. In the next lesson, you will read that the environment can influence phenotype, too. The alleles of all the genes on an organism's chromosomes make up the organism's **genotype** (JEE nuh tipe). An organism's genotype can refer to one or more genes. The alleles of a particular gene are that gene's genotype.

Figure 7 The phenotype of this chow chow distinguishes it from other dog breeds.

Figure 8 Peas can show the phenotype smooth or wrinkled. A homozygous genotype for pea shape consists of two of the same alleles, but a heterozygote genotype consists of two different alleles.

Explain why the heterozygous pea is smooth.



Word Origin

homozygous
heterozygous

homo– from Greek *homos;* means *one and the same*
hetero– from Greek *heteros;* means *the other, different*
–zygous from Greek *zygotos;* means *yoked*

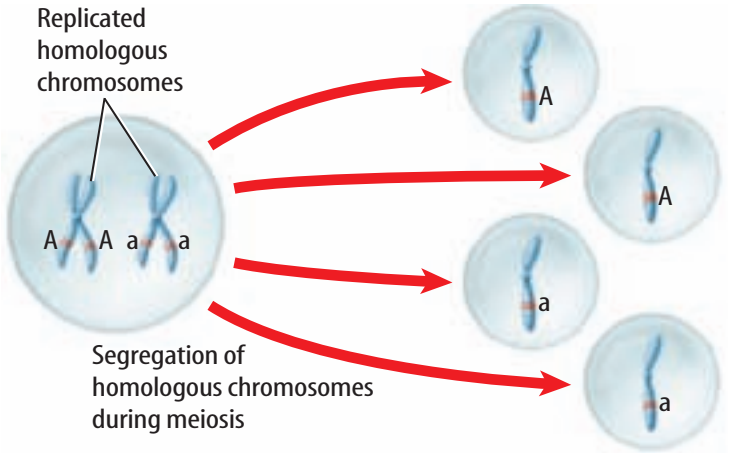
Homozygous and Heterozygous Genotypes Because eukaryotic organisms have pairs of chromosomes, a genotype for a gene has two alleles. If the two alleles have the same information, their genotype is called **homozygous** (hoh muh ZI gus), as shown in **Figure 8.** If the two alleles for a gene have different information, their genotype is called **heterozygous** (he tuh roh ZI gus).

Representing Genotypes Also shown in **Figure 8** are the possible genotypes for the smooth-pea phenotype—*SS* and *Ss.* Uppercase letters represent dominant alleles, and lowercase letters represent recessive alleles. Both of these genotypes result in a smooth phenotype because the *S* allele is dominant over the *s* allele. The wrinkled phenotype is possible only if the two recessive alleles—*ss*—are present.

Law of Segregation Explained

The movement of chromosomes during meiosis explains Mendel's law of segregation. Recall that in meiosis I, replicated homologous-chromosome pairs separate from each other. Then, each set of sister chromatids separates into different gametes during meiosis II, as shown in **Figure 9.** Each gamete only receives one allele.

Figure 9 Homologous chromosomes separate into different daughter cells during meiosis.



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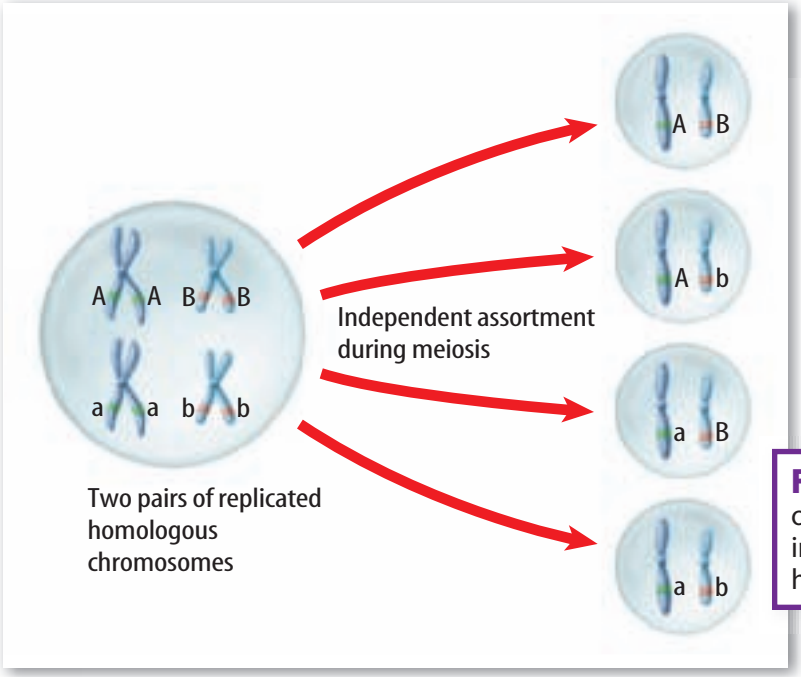


Figure 10 The separation of one pair of homologous chromosomes is independent of the separation of other homologous pairs.

Law of Independent Assortment Explained

In Mendel's law of independent assortment, he hypothesized that the separation and movement of two factors for a trait is independent of the separation and movement of the factors for other traits. This can also be explained by the movement of chromosomes during meiosis. The daughter cells produced by meiosis receive only one chromosome from each pair of homologous chromosomes. As shown in **Figure 10,** a daughter cell might receive a chromosome with an **A** allele from one pair and a chromosome with a **B** allele from the other pair. On the other hand, a daughter cell might receive a chromosome with an **a** allele from one pair and a chromosome with a **b** allele from the other pair. This results in four possible allele combinations for two homologous pairs of chromosomes.

Importance of Mendel's Genetic Studies

You might be surprised to learn that Mendel's discoveries were unnoticed for about 35 years. In the 1860s, no one knew about the existence of chromosomes or about the process of meiosis. Therefore, it might have been hard for others to understand Mendel's discoveries. However, scientists doing background research for their genetic studies rediscovered Mendel's work early in the 1900s. All the research of modern genetics is based on Mendel's conclusions from his work with pea plants.

Reading Check Why were Mendel's studies important?

Mendel's Studies: A Summary

Mendel's discoveries about how traits are inherited paved the way for future genetic scientists. Below are Mendel's principles about genetics that are true today for many characteristics.

- An individual has two sets of factors (alleles) for each trait—one from each parent.
- A factor (allele) might not be observed in one generation if it is recessive and masked by a dominant allele.
- The two factors (alleles) for each trait can be the same (homozygous) or be different (heterozygous).
- The two factors (alleles) for each trait segregate or separate from each other during meiosis—the law of segregation.
- The separation and movement of the two factors (alleles) for a trait during meiosis is independent of the separation of the factors for other traits—the law of independent assortment.

LESSON 1 Review

Summarize

Create your own lesson summary as you write a script for a **television news report.**

1. **Review** the text after the **red** main headings and write one sentence about each. These are the headlines of your broadcast.
2. **Review** the text and write 2–3 sentences about each **blue** subheading. These sentences should tell *who, what, when, where,* and *why* information about each **red** heading.
3. **Include** descriptive details in your report, such as names of reporters and local places and events.
4. **Present** your news report to other classmates alone or with a team.

ELA7: LS 2.2

Standards Check

Using Vocabulary

1. **Define** the terms *dominant* and *recessive*. 2.d
2. **Distinguish** between an allele and a gene. 2.d
3. **Relate** the terms *phenotype* and *genotype*. 2.d

Understanding Main Ideas

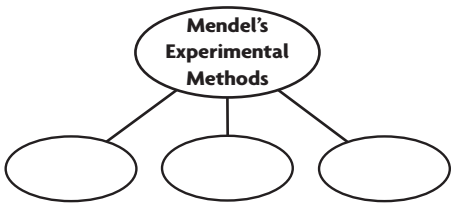
4. Which helps to explain Mendel's laws of heredity? 2.b

   A. meiosis **C.** mitosis
   B. proteins **D.** phenotypes

5. **Describe** the methods Mendel used in his experiments. 2.d
6. **Summarize** Mendel's two basic laws of heredity. 2.d

Applying Science

7. **Design an experiment** to test for true-breeding plants. 2.d
8. **Examine** how Mendel's conclusions disprove the blending theory of inheritance. 2.d
9. **Organize Information** Copy and fill in the graphic organizer below to identify three things that made Mendel's experiments unique. 2.d



Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

Applying Math

Probabilities in Inheritance

MA7: NS 1.2, NS 1.3, MR 2.4

2.c

Probabilities can be used to predict the likelihood of a particular outcome. The probability, P, of an event can be written as either a percentage or a fraction. For example, for every birth there is a 50 percent probability that the baby will be a boy and a 50 percent probability that the baby will be a girl. The probability of each event can be written as $\frac{1}{2}$. To find the probability of two events both occurring, the two probabilities, written as fractions, are multiplied.

Example

If the probability of having one girl is 50 percent, what is the probability that a woman will have two girls? What is the probability that a woman will have two girls and then a boy?

1 This is what you know:

The probability of having a girl is 50 percent. This can be written as $\frac{1}{2}$.

2 This is what you need to find:

- the probability that a woman will have two girls: P(G, G)
- the probability that a woman will have two girls and then a boy P(G, G, B)

3 Multiply the probabilities of individual events.

- $P(G, G) = \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

  The probability of having two girls in a family is $\frac{1}{4}$ = 25 percent.
- $P(G,G,B) = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}$

  The probability of having two girls and then a boy is $\frac{1}{8}$ = 12.5 percent.

Practice Problems

1. Find the probability of a woman having four boys.
2. Find the probability of a woman having two girls, a boy, and then two girls.

Science Online

For more math practice, visit Math Practice at ca7.msscience.com.

LESSON 2

Science Content Standards

2.c Students know an inherited trait can be determined by one or more genes.
2.d Students know plant and animal cells contain many thousands of different genes and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.
Also covers: 7.a, 7.b, 7.c, 7.e

Reading Guide

What *You'll Learn*

- **Interpret** a Punnett square and a pedigree.
- **Distinguish** between multiple alleles and polygenic inheritance.
- **Explain** how the environment influences inherited traits.
- **Describe** three human genetic disorders.

Why *It's Important*

Genetics helps to explain why each person is unique.

Vocabulary

Punnett square
pedigree
incomplete dominance
codominance
multiple alleles
sex chromosome
polygenic inheritance
genetic disorder

Review Vocabulary

soil: a mixture of weathered rock, minerals, and organic matter on Earth's surface (Grade 6)

Understanding Inheritance

Main Idea The interactions among alleles, genes, and the environment determine an organism's traits.

Real-World Reading Connection Have you ever wondered why your nose or lips are shaped the way they are? How can scientists determine if you are at risk for carrying alleles for any genetic disorders, such as sickle cell disease? Scientists now have tools to answer these questions and study patterns of human inheritance over many generations.

Modeling Inheritance

Plant breeders and animal breeders need a way to predict how traits will appear in offspring. Two tools—a Punnett square and a pedigree—can be used to identify and predict traits among genetically related individuals, such as the family shown in **Figure 11.**

Punnett Squares

If the genotypes of the parents are known, then the different genotypes and phenotypes of the offspring can be predicted. A **Punnett square** is a model used to predict possible genotypes and phenotypes of offspring.

Figure 11 Offspring of the same parents resemble each other because they carry some of the same gene combinations.

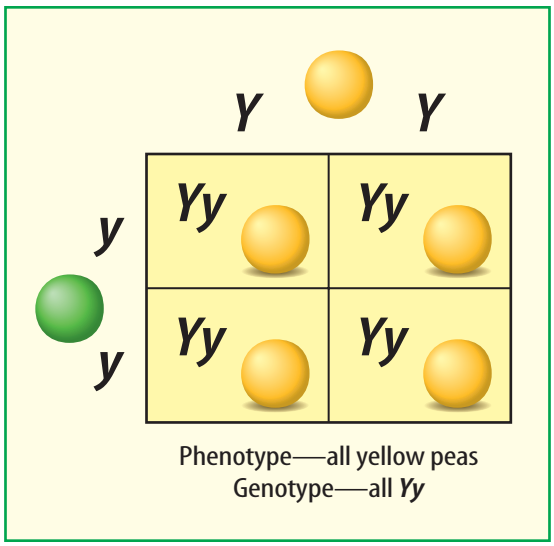
One-Trait Model **Figure 12** shows a Punnett square of the possible offspring of two parents—a true-breeding pea plant for yellow seeds and a true-breeding pea plant for green seeds. *Y* represents the dominant allele for yellow seeds, and *y* represents the recessive allele for green seeds. The Punnett square shows that the only possible genotype for hybrid offspring is heterozygous—*Yy*. The true-breeding pea plant for yellow seeds only can contribute gametes that have a *Y* allele. The true-breeding pea plant for green seeds can only contribute gametes that have a *y* allele. All, or 100 percent, of the offspring will have the genotype *Yy*. The phenotype of the genotype *Yy* is yellow seeds because *Y* is dominant to *y*.

Visual Check **Figure 12** Use the top Punnett square to explain to a classmate why all offspring are heterozygous.

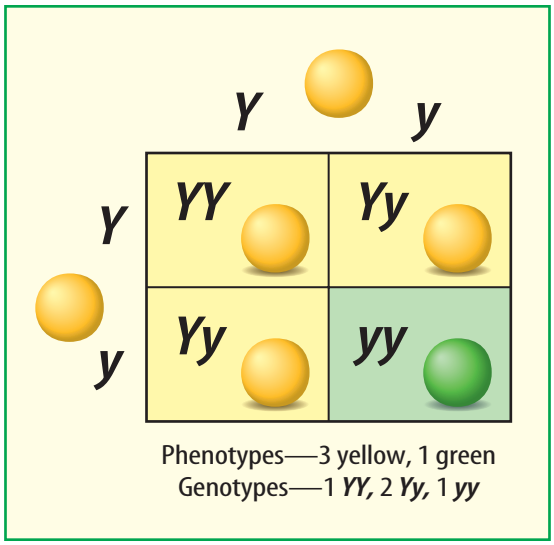
Hybrid-Cross Model What would a Punnett square look like if two of these hybrid offspring were crossed? The second Punnett square, also shown in **Figure 12,** is the cross between two organisms with heterozygous genotypes—*Yy* and *Yy*. The possible offspring from this cross includes three different genotypes but only two phenotypes. We expect that three-fourths, or 75 percent, of the offspring from this cross will have yellow seeds and one-fourth, or 25 percent, will have green seeds. In other words, the probability is that for every four seeds, three should be yellow, and one should be green. This can be stated as a 3:1 ratio. However, you cannot expect that every group of four seeds will consist of three yellow seeds and one green. When studying genetics, a large number of offspring need to be counted in order to get accurate results, as Mendel determined during his experiments. The more individuals counted, the closer the actual numbers will be to the predictions.

Reading Check Why are a large number of offspring needed to get accurate results in genetic experiments?

Figure 12 In the top cross, all the offspring have the same phenotype and genotype. In the bottom cross, they are not the same.



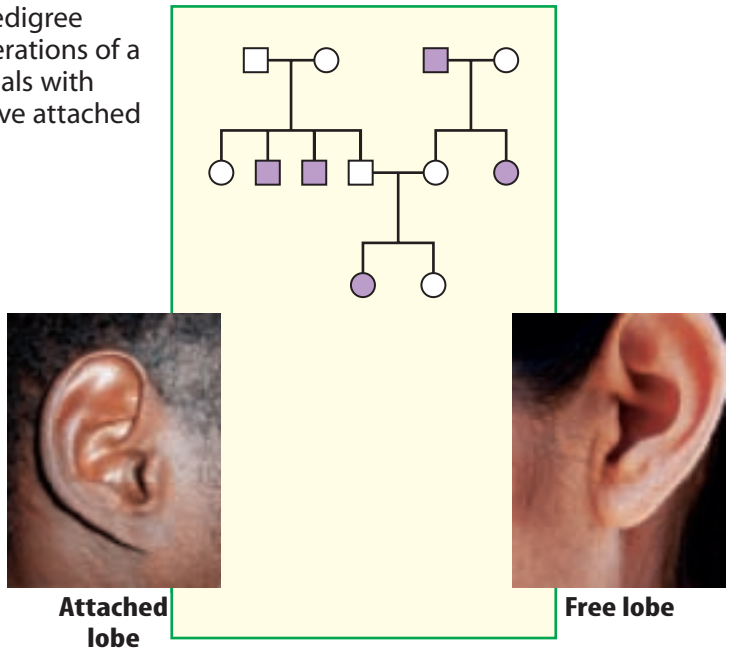
Phenotype—all yellow peas
Genotype—all *Yy*



Phenotypes—3 yellow, 1 green
Genotypes—1 *YY,* 2 *Yy,* 1 *yy*

The ratio of phenotypes is 3:1, yellow:green. The ratios of genotypes are 1:2:1, *YY:Yy:yy*.

Figure 13 This pedigree includes three generations of a family. The individuals with shaded symbols have attached earlobes.



Pedigrees

All genetically related members of a family are part of a family tree. A **pedigree** shows genetic traits that were inherited by members of a family tree, as illustrated in **Figure 13.** A pedigree usually only indicates the phenotype of individuals. The genotypes of the individuals in a pedigree might not be known but can often be determined. In a pedigree, circles represent females, and squares represent males. Connecting lines indicate relationships among members of the family tree. A line connects a set of parents. Branching lines below a set of parents indicate their offspring. The inheritance of attached and free earlobes in two generations of a family is shown in **Figure 13.** Besides tracking common inherited traits, pedigrees are important tools to track **complex** patterns of inheritance and genetic disorders in families.

ACADEMIC VOCABULARY
complex (kuhm PLEKS)
(adjective) complicated or intricate
Eva deciphered the complex code left by the spies and solved the mystery.

Reading Check Why are pedigrees used?

Complex Patterns of Inheritance

By chance, Mendel studied traits only influenced by one gene with two alleles. However, we know now that some inherited traits have complex patterns of inheritance.

Types of Dominance

You read in Lesson 1 about dominant alleles and recessive alleles. Recall that for pea plants, the presence of one dominant allele results in a dominant phenotype. Not all allele pairs, however, have a dominant-recessive interaction.

CONTENTS

Figure 14 The interaction of alleles with incomplete dominance determines the color of camellia flowers.

Incomplete Dominance Sometimes traits appear to be blends of alleles. Alleles show **incomplete dominance** when they produce a phenotype that is a blend of the parents' phenotypes. For example, a pink camellia, as shown in **Figure 14,** results from incomplete dominance. A cross between a white camellia flower and a red camellia flower only produces camellia plants with pink flowers.

Codominance The human blood type AB is an example of another type of interaction between two alleles. When both alleles can be observed in a phenotype, this type of interaction is called **codominance.** If an individual inherits the B allele from one parent and an A allele from the other parent, he or she will have type AB blood, not type A blood or type B blood.

Word Origin

dominance
from Latin *dominari;* means *to rule, have dominion over*

Multiple Alleles

Some genes only have two alleles. However, there are genes that have more than two alleles, or **multiple alleles.** Besides codominance, the human ABO blood group also is an example of a trait that is determined by multiple alleles. There are three different alleles for the ABO blood type—I^A, I^B, and i. The I^A and I^B alleles are codominant to each other, but both are dominant to the i allele. Even though there are multiple alleles, a person can only inherit two of these alleles—one from each parent, as shown in **Table 2.**

Visual Check **Table 2** Which blood types have only one genotype?

Table 2 Human ABO Blood Types

Phenotype	Possible Genotypes
Type A	I^AI^A or I^Ai
Type B	I^BI^B or I^Bi
Type O	ii
Type AB	I^AI^B

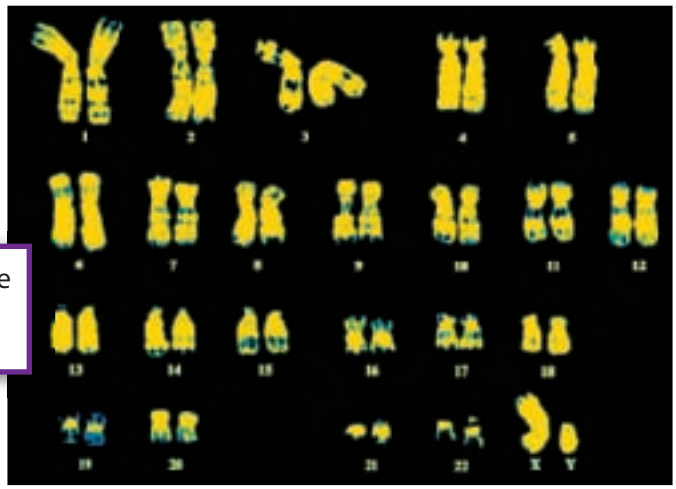


Figure 15 This chart of chromosome pairs of a human male shows the X and Y sex chromosomes.

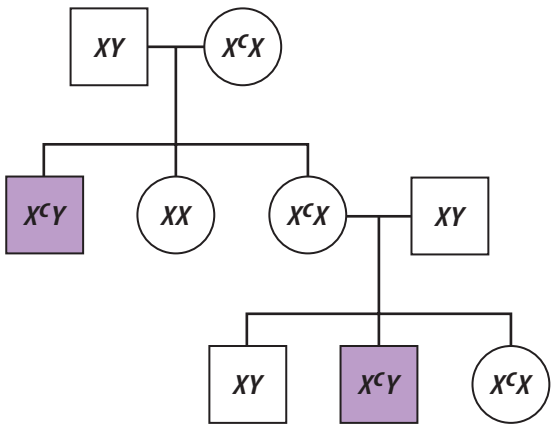
Sex-Linked Inheritance

Recall that we have 23 pairs of homologous chromosomes in the cells of our bodies, except for sperm and egg cells that have only one chromosome from each chromosome pair. Most pairs of homologous chromosomes are of equal size with one exception—the long X and short Y pair, as shown in **Figure 15.** Chromosomes X and Y are the **sex chromosomes** because they contain the genes that determine a person's gender or sex. With the exception of sperm and eggs, each cell in a male has an X chromosome and a Y chromosome, and each cell in a female has two X chromosomes.

Because the Y chromosome is shorter than the X chromosome, many genes on the X chromosome are not on the Y chromosome. Therefore, each of those genes has only one allele, not two. It is the allele on the X chromosome. Recall that a recessive phenotype usually is observed only if the genotype is homozygous. However, a recessive phenotype is observed in a male when a one-allele gene on his X chromosome has a recessive allele. That's why males are more likely than females to have X-linked recessive conditions, as shown in **Figure 16.**

Figure 16 In this family, the grandmother's genome included the color blindness allele.

Infer why males are more likely than females to be color-blind.



CONTENTS

Figure 17 At least seven different genes determine the coat color of horses. However, a horse with just one dominant allele for the inability to form pigment in skin and hair, will lack color regardless of the information in the other six genes.

Polygenic Inheritance

Some traits are determined by only one gene, but one gene can affect more than one trait in an organism. In fact, many traits result from the interactions of more than one gene. **Polygenic inheritance** is when multiple genes determine the phenotype of a trait. When several genes determine a trait, many alleles affect the phenotype even though each gene has only two alleles. Therefore, many phenotypes are possible when polygenic inheritance determines a trait, such as the color of horses, as shown in **Figure 17.** Height, weight, and skin color in humans are examples of characteristics that are determined by polygenic inheritance.

Maternal Inheritance

When discussing human heredity, we usually only talk about the DNA that makes up the chromosomes in the nucleus in each of our cells. But, you read in Chapter 1 that mitochondria contain DNA too. Mitochondria are scattered throughout the cytoplasm of cells, including an egg cell, but a sperm cell only has mitochondria in its tail. A sperm's tail does not enter the egg during fertilization. As a result, humans inherit mitochondrial genes, such as the genes involved in making ATP during cellular respiration, only from their mothers. This means that the inheritance of traits related to mitochondria can be traced from a grandmother to her children and then to her grandchildren.

Reading Check

Why do humans inherit mitochondrial genes only from their mothers?

Human Genetic Disorders

Imagine that you are putting a bicycle together. You have all the right parts, but the directions say to put the handlebars on the seat post. If you did this, your bicycle could not function the way it should. A similar thing can happen if a mutation, or a change to a gene, occurs. The organism with the mutation cannot function as it should.

An inherited mutation can result in a phenotype called a **genetic disorder.** A genetic disorder can result in minor or major health problems and sometimes shorten a person's life. A common genetic disorder among Caucasians is a recessive disorder called cystic fibrosis. People with cystic fibrosis have tissues that produce abnormally thick mucus. This thick mucus can affect the functions of the respiratory, digestive, and reproductive systems. Other human genetic disorders are listed in **Table 3.**

Table 3 Which human genetic disorders affect the blood?

Genes and the Environment

You read earlier in the chapter that the genotype determines the phenotype. Scientists have determined that genes are not the only factors that can affect phenotypes. An organism's environment can also affect its phenotype.

Many genes affect a person's chances of having heart disease. However, what a person eats and the amount of exercise he or she gets can influence whether heart disease will develop. Also, your genotype for skin color determines the amount of pigment in your skin. But, long exposures to sunlight can temporarily change your skin color. Other examples of how environmental factors can affect phenotype are shown in **Figure 18.**

What factors affect phenotype?

Table 3 Some Human Genetic Disorders

Genetic Disorder	Type of Disorder	Health Problems
Huntington's disease	Dominant	Breakdown of brain tissue; shortened life span
Sickle-cell disease	Codominant	Red blood cell destruction; clogged blood vessels
Hemophilia	X-linked recessive	Excessive bleeding due to blood clotting problems
Down syndrome	Trisomy—extra chromosome # 21	Mental retardation; heart defects

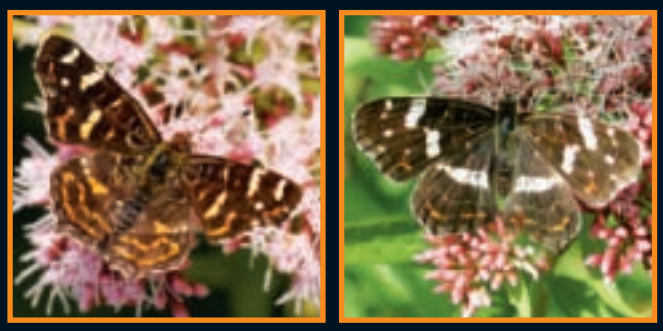
Visualizing the Interactions of Genes and the Environment

Figure 18

Environmental factors, such as temperature, soil conditions, and the number of hours of light, can affect the phenotypes of genotypes.

◀ These hydrangea plants are genetically identical. The acidic condition of the soil in which they grow determines flower color—more acidic produces blue flowers and less acidic produces pink flowers.

Siamese cats have alleles that produce a dark pigment only in cooler areas of the body. That's why a Siamese cat's ear tips, nose, paws, and the end of its tail are darker than warmer areas of its body. ▶



◀ The wing patterns of the map butterfly, *Araschnia levana,* depend on when the adult develops. Adults that develop in the spring have more orange in their wing patterns than those that develop in summer.

Pond water crowfoot, *Ranunculus peltatus,* is an aquatic plant that has two leaf types. Submerged leaves are threadlike and those that float are flat. ▶

Contributed by National Geographic

Inheritance: A Summary

The relationship between a phenotype and a genotype can be complex. Each gene's alleles interact, and genes interact with each other and the environment to produce a phenotype. Here is a summary of what you have read:

- Traits may show intermediate phenotypes.
- Traits may show two phenotypes at the same time.
- Traits may be influenced by more than one allele.
- Traits may be influenced by more than one gene.
- Traits may be sex-specific.
- Traits might be influenced by the environment.
- Gene and chromosomal mutations associated with human genetic disorders might lead to abnormal traits.

LESSON 2 Review

Summarize

Create your own lesson summary as you organize an **outline.**

1. **Scan** the lesson. Find and list the first **red** main heading.
2. **Review** the text after the heading and list 2–3 details about the heading.
3. **Find** and list each **blue** subheading that follows the **red** main heading.
4. **List** 2–3 details, key terms, and definitions under each **blue** subheading.
5. **Review** additional **red** main headings and their supporting **blue** subheadings. List 2–3 details about each.

ELA7: W 2.5

Standards Check

Using Vocabulary

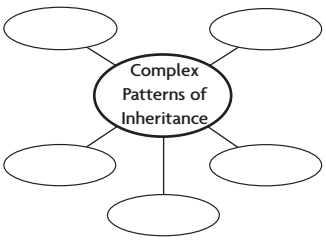
1. **Define** *incomplete dominance* in your own words. 2.c
2. **Distinguish** between multiple alleles and polygenic inheritance. 2.c

Understanding Main Ideas

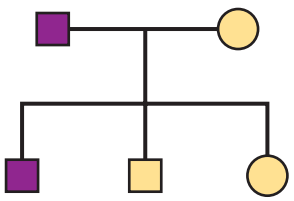
3. **State** what squares and circles represent on a pedigree. 2.c
4. **Predict** the possible blood genotypes of a child, using **Table 2,** if one parent is Type O and the other parent is Type AB. 2.d
5. **Explain** the relationship between the environment and genes. 2.c
6. **Summarize** the symptoms associated with three genetic disorders. 2.c

Applying Science

7. **Organize Information** Draw a graphic organizer similar to the one below to list complex patterns of inheritance. 2.c



8. **Interpret** this pedigree showing the inheritance of Huntington's disease. 2.c



Science Online

For more practice, visit **Standards Check** at ca7.msscience.com.

DataLab

00:25 minutes

Try at Home

Can you see a genotype?

The terms genotype and phenotype can be confusing. A Punnett square shows the genotypes of a specific cross. By knowing the genotype, the phenotype can be determined.

Data

Pea plant crosses (*P* = purple flowers, *p* = white flowers, *Y* = yellow peas, *y* = green peas)

1st Generation Punnett Square

	PY	*PY*
py	*PpYy*	*PpYy*
py	*PpYy*	*PpYy*

2nd Generation Punnett Square

	PY	*Py*	*pY*	*py*
PY	*PPYY*	*PPYy*	*PpYY*	*PpYy*
Py	*PPYy*	*PPyy*	*PpYy*	*Ppyy*
pY	*PpYY*	*PpYy*	*ppYY*	*ppYy*
py	*PpYy*	*Ppyy*	*ppYy*	*ppyy*

Data Analysis

1. **Analyze** Which phenotypes are represented in the 1st generation pea plant crosses? In the 2nd generation? How many of each phenotype are there?
2. **Calculate** the percentage of offspring in the 1st generation that will have a dominant phenotype and the percentage that will have a recessive phenotype.
3. **Determine** the percentage of the 2nd generation that will have a homozygous recessive phenotype.

Science Content Standards

2.d Students know plant and animal cells contain many thousands of different genes and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.

MA7: NS 1.3

Design Your Own Lab

00:45 minutes

Use the Internet:
What makes you unique?

Materials

human traits table
computer with internet access

Science Content Standards

2.d Students know plant and animal cells contain many thousands of different genes and typically have two copies of every gene. The two copies (or alleles) of the gene may or may not be identical, and one may be dominant in determining the phenotype while the other is recessive.

7.a Select and use appropriate tools and technology (including calculators, computers, balances, spring scales, microscopes, and binoculars) to perform tests, collect data, and display data.

7.b Use a variety of print and electronic resources (including the World Wide Web) to collect information and evidence as part of a research project.

7.c Communicate the logical connection among hypotheses, science concepts, tests conducted, data collected, and conclusions drawn from the scientific evidence.

7.e Communicate the steps and results from an investigation in written reports and oral presentations.

Problem

Unless you have an identical twin, you are the only person with your specific set of genes. No one else looks quite like you, but many people probably have the same eye color or hair color.

Form a Hypothesis

What phenotypes do you think are most common in your classroom? In your school?

Collect Data and Make Observations

1. Read and complete a lab safety form.
2. Choose three traits to study from the list below.
3. Make a data table to collect information about the number of your classmates who express each trait. Record the total number of students included in your survey.
4. Collect trait information from each student.

Human Traits

Trait	Phenotype 1	Phenotype 2
Earlobes	free	attached
Forelock	white	not white
Dimples	present	not present
Thumbs	curved	straight
Pinkies	straight	bent
Mid-digit hair	present	not present

Analyze and Conclude

1. **Calculate** what percentage of people had phenotypes you studied.
2. **Graph** the data you collected using a bar graph for each trait you studied.
3. **Compare and contrast** the frequency of each trait. Did any of your findings surprise you?
4. **Infer** from your data the traits that are recessive and those that are dominant.
5. **Error Analysis** Would surveying a larger group of people change your results? Do you think that results from the group you surveyed are scientifically valid? Why or why not?
6. Visit ca7.msscience.com and combine your data with that of other students. Calculate the percentage of the total number of students that express the traits you studied.

Communicate

WRITING in Science ELA7: W 2.2

Write a brief report, including your graphs, and post it at ca7.msscience.com.

Real World Science

Science & Career

Making New Plant Breeds

New plant species with bigger blossoms, better nutritional value, better taste, or plants with more pest resistance are often needed by plant growers or demanded by consumers. Plant breeders identify plants with such traits and breed them to produce new plants that have the trait as part of their genomes. Methods used by plant breeders include tissue culture, breeding through mutation, and genetic engineering.

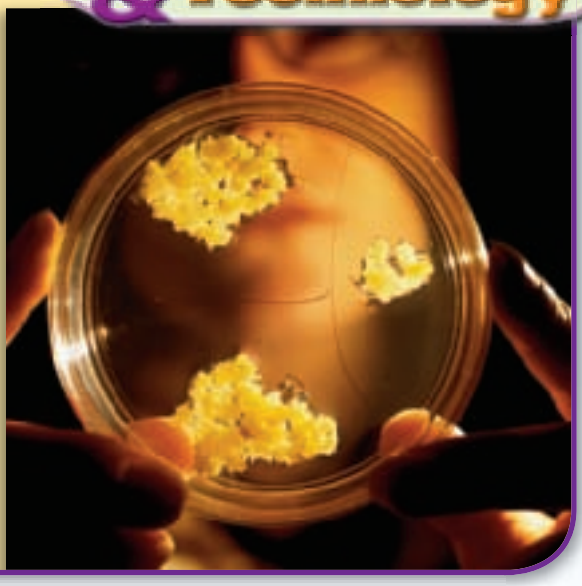
Visit Careers at ca7.msscience.com and find out what plants are being researched by plant breeders and the methods used. Make a table of your results.

Science & Technology

Genetic Engineering

Scientists use a molecule called restriction endonuclease to cut DNA at specific gene sequences. This enables a scientist to insert new DNA with genes that modify an organism's genotype and phenotype. For example, a gene that codes for insect resistance might be inserted into a virus. Then, the virus could be made to infect a plant. The new genetic code carried by the virus would become part of the plant's genome.

Imagine that you're a salesman, trying to sell a new plant that is genetically engineered for some trait, such as insect resistance. Create a promotional brochure to sell this plant to your classmates.



Science & History

Luther Burbank's Legacy

In the mid-nineteenth century, botanist Luther Burbank began breeding plants. He created over 800 new plant varieties including new types of blackberries, strawberries, peaches, potatoes, and almonds. It was common for Burbank to have thousands of breeding experiments in progress at the same time in gardens in Santa Rosa and Sebastopol, California. In 1930, the U.S. Congress passed an act enabling botanists to patent their new plant breeds.

Imagine that you're Luther Burbank and have created a new plant breed. Create an advertisement for the plant.

Science & Society

GENETICALLY-MODIFIED PLANTS

Geneticists have developed techniques to transfer genes from one plant species to another plant species. These genetic modifications can increase a plant's nutritional value, make it disease resistant, or enable it to grow under different conditions than it normally would grow. Many edible, genetically modified plants are available to consumers.

Research and then debate whether genetically modified plants help or harm humans and the environment.

CHAPTER 4

Standards Study Guide

The BIG Idea Inherited genes determine an organism's traits.

Lesson 1 Foundations of Genetics

2.b, 2.d

Main Idea **Gregor Mendel discovered the basic principles of genetics.**

- Early ideas about inheritance could not explain why traits are not present in every generation.
- Gregor Mendel determined the basic laws of genetics.
- Some alleles can be dominant and others can be recessive.
- The movement of chromosomes during meiosis explains Mendel's laws of segregation and independent assortment.
- An organism's phenotype results from the interactions of its alleles and genes.
- Modern genetics research is based on Mendel's conclusions.
- Mendel's principles of genetics still hold true today for many characteristics.

- **allele** (p. 177)
- **dominant** (p. 175)
- **gene** (p. 177)
- **genetics** (p. 173)
- **genotype** (p. 177)
- **heredity** (p. 172)
- **heterozygous** (p. 178)
- **homozygous** (p. 178)
- **law of independent assortment** (p. 176)
- **law of segregation** (p. 176)
- **phenotype** (p. 177)
- **recessive** (p. 175)

Lesson 2 Understanding Inheritance

2.c, 2.d, 7.a, 7.b, 7.c, 7.e

Main Idea **The interactions among alleles, genes, and the environment determine an organism's traits.**

- A Punnett square is used to predict the genotypes and phenotypes of offspring.
- A pedigree traces an inherited trait in a family.
- Inheritance patterns studied since Mendel include incomplete dominance, codominance, multiple alleles, polygenic inheritance, sex-linked inheritance, and maternal inheritance.
- The human ABO blood group is an example of a trait that shows codominance and multiple alleles.
- Genes are not the only factors that affect phenotype.
- The environment can affect an organism's phenotype.
- Genetic disorders can result in minor or major health problems or can even lead to death.
- Human genetics disorders include Huntington's disease, sickle-cell disease, cystic fibrosis, hemophilia, and Down syndrome.
- The relationship between a phenotype and a genotype can be complex.

- **codominance** (p. 185)
- **genetic disorder** (p. 188)
- **incomplete dominance** (p. 185)
- **multiple alleles** (p. 185)
- **pedigree** (p. 184)
- **polygenic inheritance** (p. 187)
- **Punnett square** (p. 182)
- **sex chromosome** (p. 186)

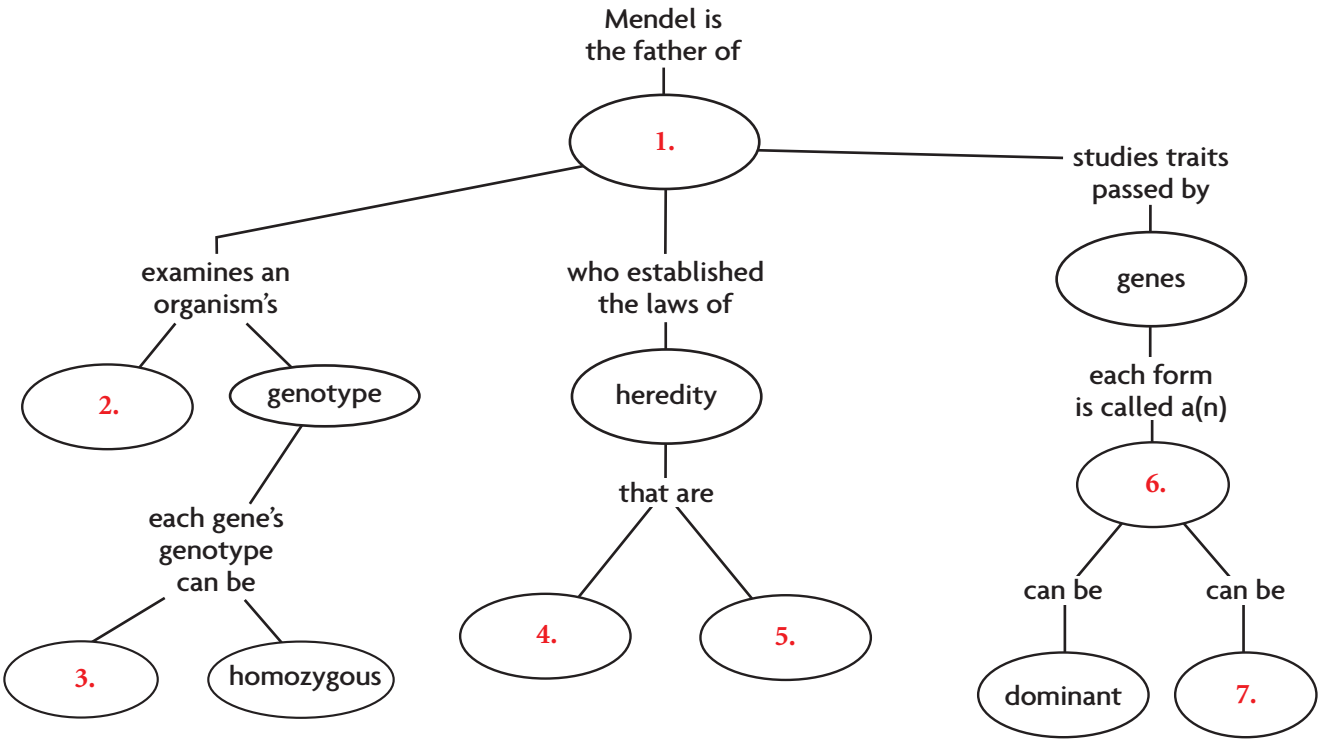
Download quizzes, key terms, and flash cards from ca7.msscience.com.

Science Online Interactive Tutor ca7.msscience.com

CONTENTS

Linking Vocabulary and Main Ideas

Copy this concept map and then use vocabulary terms from page 196 to complete it.



Science Online

Visit ca7.msscience.com for:

- Vocabulary PuzzleMaker
- Vocabulary eFlashcards
- Multilingual Glossary

Using Vocabulary

Fill in the blanks with the correct vocabulary word.

8. The idea that chromosomes separate independently of one another is part of the law of _____.

9. The idea that alleles separate when gametes are produced is part of the law of _____.

10. A(n) _____ chromosome has two different alleles for the same gene.

11. A dominant allele blocks the effects of a(n) _____ allele.

12. A(n) _____ is a family tree that shows a heritable trait.

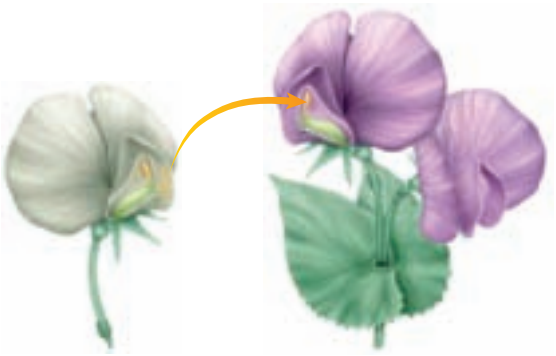
13. Human height, weight, and skin color are examples of characteristics determined by _____ .

14. A(n) _____ is a helpful device for predicting the ratios of possible genotypes.

15. _____ is a type of interaction between alleles in which both alleles can be observed in a phenotype.

Understanding Main Ideas

1. The process shown below was used by Mendel during his experiments.



What is the process called?
A. blending inheritance 2.c
B. asexual reproduction
C. cross-fertilization
D. segregation

2. Which describes Mendel's experiments?
A. Mendel used plants that gave different offspring with every cross. 2.d
B. Mendel counted large numbers of offspring.
C. Mendel observed only one generation.
D. Mendel used plants that reproduced slowly.

3. Which describes how people believed traits were inherited before Mendel's discoveries?
A. Parental traits blend like colors of paint to produce offspring. 2.c
B. Parental traits blend like oil and water to produce offspring.
C. Parental traits sort to produce offspring.
D. Parental traits segregate to produce offspring.

4. Which characteristic did Mendel study?
A. flower size 2.c
B. stem shape
C. pod color
D. root type

5. What term is used for each form of a gene?
A. allele 2.c
B. chromosome
C. pedigree
D. Punnett square

6. Which genetic disorder is also known as trisomy 21?
A. sickle-cell disease 2.c
B. Down syndrome
C. Huntington's disease
D. cystic fibrosis

7. When were Mendel's discoveries noticed?
A. Never; Mendel's discoveries are not important to science. 2.d
B. immediately after he published his results
C. decades after he performed his experiments
D. Before he published his work; other scientists made the same discoveries before Mendel

8. The Punnett square below is of a cross between two pea plants with round seeds.

	R	*r*
R	*RR*	*Rr*
r	*Rr*	*rr*

If mating produces eight offspring, how many will have round seeds?
A. 1 2.d
B. 3
C. 6
D. 8

9. Which is multiple genes affecting the phenotype of one trait?
A. codominance 2.d
B. blending inheritance
C. multiple alleles
D. polygenic inheritance

Applying Science

10. **Restate** the law of segregation and the law of independent assortment. 2.c

11. **Compare** heterozygous genotype and homozygous genotype. 2.d

12. **Distinguish** between multiple alleles and polygenic inheritance. 2.d

13. **Give an example** of how the environment can affect an organism's phenotype. 2.d

14. **Predict** In pea plants, the allele for inflated pods is dominant to the allele for constricted pods. Predict the genotype of a plant with constricted pods. Can you predict the genotype of a plant with inflated pods? Explain. 2.d

15. In tomato plants, red fruit (*R*) is dominant to yellow fruit (*r*).

	R	*r*
r	*Rr*	*rr*
r	*Rr*	*rr*

Interpret the Punnett square between a heterozygous red plant and a yellow plant. Include all the genotypes and corresponding phenotypes. 2.d

WRITING in Science

16. **Write** a paragraph comparing the blending theory of inheritance to the current theory of inheritance.

17. **Write** an essay about how life might be different if Mendel had not made his discoveries. ELA7: W 2.4

Cumulative Review

18. **Compare** regeneration of a body part to regeneration as a type of asexual reproduction. 2.a

19. **Evaluate** the importance of sexual reproduction to genetic variation. 2.b

Applying Math

20. A dresser drawer contains five pairs of socks of different colors. Each pair is folded together. Without looking, you reach into the drawer and pull out a pair but they are not the color you wanted. You put them back and choose a second pair without looking. What is the probability that you will pull out the first pair of socks again? MA7: MR 1.2

21. You flip a coin and then roll a six-sided number cube. Find the probability of the coin landing head side up and the number 3 being on top of the number cube. MA7: MR 1.2

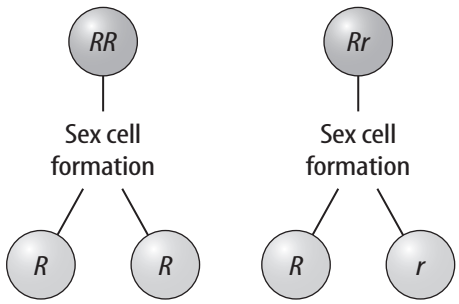
22. To decide who will be first in a game, you place four equal-sized pieces of paper into a paper bag. One piece has an X on it. Without looking, you pull out a piece of paper but it is not marked with an X. What is the probability that the next person will pull out the paper with the X? MA7: MR 1.2

23. A jar contains three red, five green, two blue, and six yellow marbles. You randomly choose a marble from the jar. After replacing it, you choose another marble. What is the probability of choosing a green marble and then a yellow marble? MA7: MR 1.2

24. A school survey found that nine out of ten students like pizza. If you randomly ask three students if they like pizza, what is the probability that all three students like pizza? MA7: MR 1.2

CHAPTER 4 Standards Assessment

1 **In fruit flies, the allele for red eyes (*R*) is dominant over the allele for white eyes (*r*). The diagram below shows the eye-color alleles of two fruit flies.**



When the sex cells from these two fruit flies join, what is the percent chance that the offspring will have red eyes?

A 25 percent

B 50 percent

C 75 percent

D 100 percent 2.b

2 **Which is not part of heredity?**

A traits

B chromosomes

C nutrients

D phenotype 2.d

3 **The gender of offspring from sexual reproduction is determined by**

A the mother only, because she has two X chromosomes.

B the father only, because he has one X and one Y chromosome.

C environmental factors.

D polygenetic inheritance. 2.b

4 **In rabbits, the allele for black fur is dominant over the allele for brown fur. What are the phenotypes of four offspring that have parents with brown fur?**

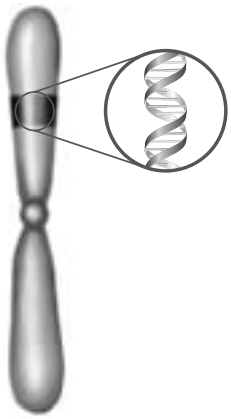
A all brown

B all black

C three black, one brown

D two black, two brown 2.c, 2.d

5 **The illustration below shows a chromosome.**



What is represented in the small circle?

A a cell

B an egg

C a gene

D a sperm 2.d

6 **Which is when two alleles are observed in an individual?**

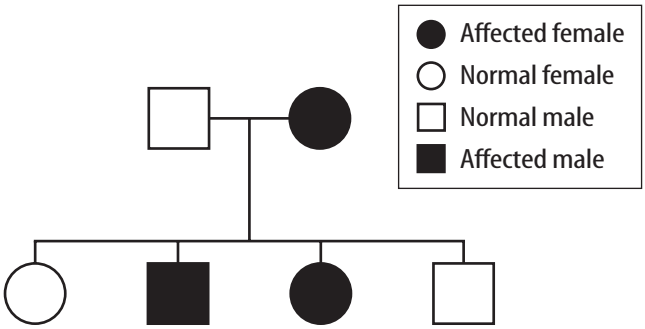
A incomplete dominance

B recessive

C codominance

D multiple dominance 2.d

Huntington disease has a dominant (DD or Dd) inheritance pattern. Use the pedigree below to answer questions 7–9.



7 **What is the genotype of the father?**

A DD

B Dd

C dd

D D 2.b, 2.c

8 **What is the genotype of the mother?**

A DD

B Dd

C dd

D D 2.b, 2.c

9 **What is the genotype of the unaffected children?**

A DD

B Dd

C dd

D D 2.b, 2.c

10 **If a pea plant that has two dominant alleles for wrinkled seeds is crossed with a pea plant that has one dominant allele for wrinkled seeds and one recessive allele for round seeds, what is the probability that an offspring will have wrinkled seeds?**

A 25 percent

B 50 percent

C 75 percent

D 100 percent 2.d

11 **The Punnett square below shows the possible phenotypes of offspring from parents with blood types *A* (I^Ai) and *AB* (I^AI^B).**

	I^A	i
I^A	I^AI^A	I^Ai
B	I^AI^B	I^Bi

How many phenotypes are possible for these offspring?

A 1

B 2

C 3

D 4 2.b, 2.d

12 **The fur colors seen in a Siamese cat are determined by body temperature. This is an example of**

A environmental influences on phenotype.

B maternal influences on phenotype.

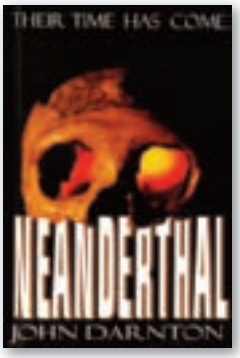
C recessive influences on phenotype.

D sex-linked influences on phenotype. 2.d

Reading on Your Own...

From the Recommended Literature for Science and Math

Are you interested in learning more about cells reproduction and genetics? If so, check out these great books.

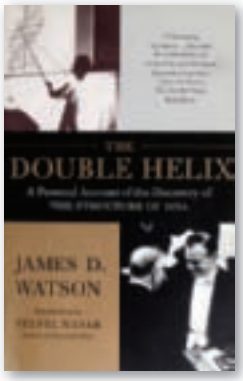


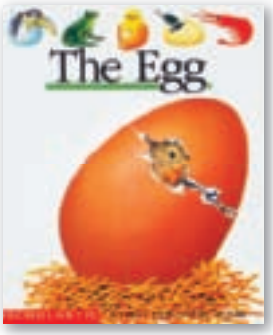
Fiction

Neanderthal: Their Time Has Come, by John Darnton, describes what happens after a team of researchers discovers a tribe of primitive people. The researchers explore whether they could be the "missing link." ***The content of this book is related to*** *Science Standard 7.2.*

Narrative Nonfiction

The Double Helix: A Personal Account of the Discovery of the Structure of DNA, by James Watson, describes the discovery of the structure of DNA by James Watson and Francis Crick. This book describes the process of science, classic scientific method, and the detailed structure of the DNA molecule. ***The content of this book is related to*** *Science Standard 7.2.*



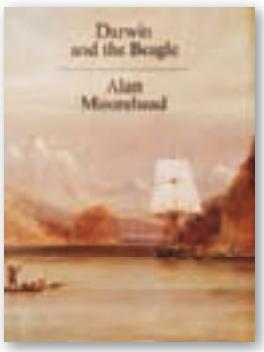


Narrative Nonfiction

The Egg, by Shelley Gill, examines the mythology, legends, evolution, and biology of eggs through short facts and large, colorful illustrations. The book also introduces egg-laying animals and the adaptations they have made to protect their eggs. ***The content of this book is related to*** *Science Standard 7.2.*

Nonfiction

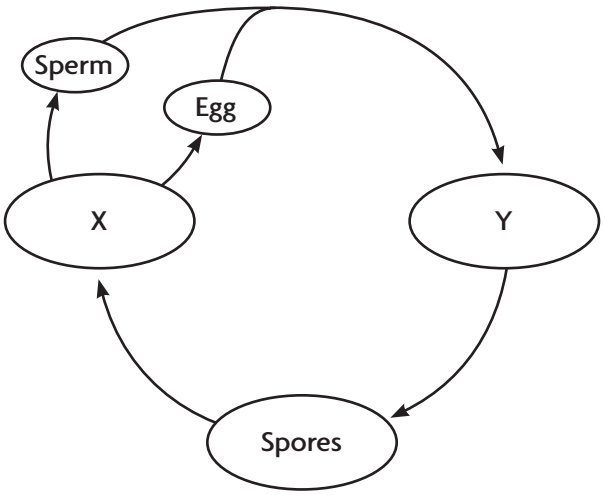
Darwin and the Beagle, by Alan Moorehead, tells the story of Charles Darwin's journey on the HMS Beagle. Darwin collected and observed the plants and animals of the ecosystems he visited. This book details the shaping of modern-day genetics and the theory of evolution. ***The content of this book is related to*** *Science Standard 7.5.*



UNIT 2 Unit Test

Choose the word or phrase that best answers the question.

Use the concept map below about a typical plant's life cycle to answer questions 1 and 2.



1. What term best replaces X?
- **A.** diploid
- **B.** fission
- **C.** haploid
- **D.** mitosis

2.a

2. What term best replaces Y?
- **A.** diploid
- **B.** fission
- **C.** haploid
- **D.** mitosis

2.a

3. Which is not an example of asexual reproduction?
- **A.** a new plant growing from a leaf cutting
- **B.** a sea star regenerating a lost arm
- **C.** a population of bacteria increasing in number
- **D.** yeast cells budding

2.a

4. Which results in a range of phenotypes, such as skin color in humans?
- **A.** codominance
- **B.** multiple alleles
- **C.** polygenic inheritance
- **D.** sex-linked inheritance

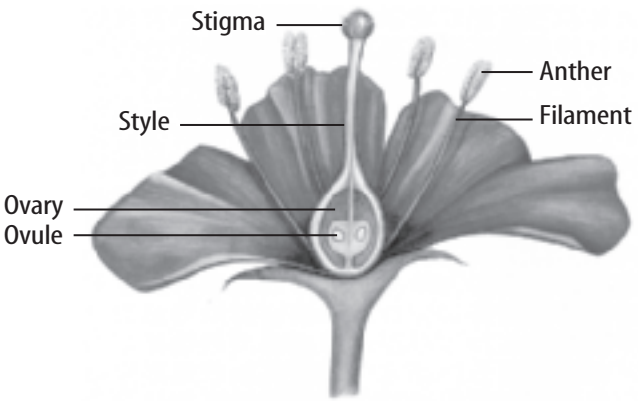
2.c

Write your responses on a sheet of paper.

5. **Explain** how a zygote might have an extra chromosome. 2.b

6. **Explain** how someone with cystic fibrosis can have parents who do not have the disease. 2.b, 2.d

Use the image below to answer questions 7 and 8.



7. **Identify** which structures are part of the male reproductive system of the flower and which are part of the female reproductive system. 5.f

8. **Describe** how a seed would be produced in this flower. 5.f

9. The Punnett square below is for a cross between two fruit flies. In fruit flies, the long-wing trait (*L*) is dominant to the short-wing trait (*l*).

	L	*L*
L	*LL*	*LL*
l	*Ll*	*Ll*

Classify each offspring as homozygous or heterozygous for the trait. Describe the phenotypes of the offspring. 2.b, 2.d