Name _____ Date _____ Class _____

Assess Your Understanding

What Is Heredity?

What Did Mendel Observe?

1a. DEFINE What happens during fertilization? _____

_____

b. COMPARE AND CONTRAST In Mendel's cross for stem height, how did the plants in the F_2 generations differ from the F_1 plants? _____

_____

got it?

○ **I get it!** Now I know that Mendel found that one form of a trait _____

_____

_____

○ **I need extra help with** _____

_____

How Do Alleles Affect Inheritance?

2a. RELATE CAUSE AND EFFECT Why is a pea plant that is a hybrid for stem height tall? _____

_____

b. CHALLENGE Can a short pea plant be a hybrid for the trait of stem height? Why or why not? _____

_____

_____

got it?

○ **I get it!** Now I know that an organism's traits are controlled by _____

_____

○ **I need extra help with** _____

_____

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Name _____ Date _____ Class _____

Key Concept Summaries

What Is Heredity?

What Did Mendel Observe?

Heredity is the passing of physical characteristics from parents to offspring. In the mid-nineteenth century, Gregor Mendel wondered why pea plants had different characteristics. Each characteristic, such as height or seed color, is called a **trait.** Mendel wondered why the forms of the pea plants' traits were often—but not always—similar to their parents. His discoveries form the foundation of **genetics,** the study of heredity.

In a pea plant flower, the pistil produces female sex cells, or eggs. The stamens produce pollen, which contains the male sex cells, or sperm. A new organism begins to form when egg and sperm cells join, a process called **fertilization.** For this to occur in plants, pollen must reach the pistil of a flower, a process called pollination. Pea plants usually self-pollinate: Pollen from a flower lands on the pistil of the same flower.

A **purebred** organism is the offspring of many generations that have the same form of a trait. Mendel cross-pollinated, or "crossed," purebred tall with purebred short plants. Scientists call these the parental, or P, generation. The offspring of the P generation are called the first filial, or F_1, generation. Their offspring are called the second filial, or F_2, generation. **In all of his crosses, Mendel found that only one form of the trait appeared in the F_1 generation. However, in the F_2 generation, the "lost" form of the trait always reappeared in about one fourth of the plants.**

How Do Alleles Affect Inheritance?

Today, scientists use the word **gene** to describe the factors that control a trait. **Alleles** are the different forms of a gene. The gene that controls stem height in peas has one allele for short stems and one allele for long stems.

An organism's traits are controlled by the alleles it inherits from its parents. Some alleles are dominant, while other alleles are recessive.

A **dominant allele** is one whose trait always shows up when the allele is present. A **recessive allele** is hidden whenever the dominant allele is present. Geneticists, scientists who study genetics, often use letters to represent alleles. A dominant allele is symbolized by a capital letter. A recessive allele is symbolized by the lowercase version of the *same* letter.

In his pea plants, Mendel observed that a form of a trait that disappeared in the F_1 generation reappeared in about one fourth of plants in the F_2 generation. On a separate sheet of paper, explain the role that genes and dominant and recessive alleles play in this process.

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Name _____ Date _____ Class _____

Lesson Quiz

What Is Heredity?

If the statement is true, write *true.* If the statement is false, change the underlined word or words to make the statement true.

1. _____ The scientific study of heredity is called fertilization.

2. _____ A hybrid organism is the offspring of many generations that have the same form of a trait.

3. _____ Capital letters are used to represent recessive alleles.

4. _____ Mendel called an individual that has one dominant allele and one recessive allele for a trait a purebred.

5. _____ Mendel said that the factors that control a trait exist in pairs.

6. _____ Mendel's experiments showed that the traits of an offspring were not a blend of the characteristics of the parents.

Write the letter of the correct answer on the line at the left.

7. ___ What Mendel called factors are now called
   - A heredity
   - B genes
   - C purebreds
   - D traits

8. ___ When parent plants are crossed, scientists refer to the first generation of offspring as
   - A P
   - B F_2
   - C 1^F
   - D F_1

9. ___ A seed can be round or wrinkled. Seed shape is
   - A a trait
   - B an allele
   - C a factor
   - D a gene

10. ___ The alleles for a hybrid tall pea plant are represented as
    - A *TT*
    - B *Tt*
    - C *TS*
    - D *tt*

Name _____ Date _____ Class _____

Assess Your Understanding

Probability and Heredity

How Is Probability Related to Inheritance?

1a. REVIEW What is probability? _____

_____

b. APPLY CONCEPTS What is the probability that a cross between a hybrid pea plant with round seeds and one with wrinkled seeds will produce offspring with wrinkled seeds? (Draw a Punnett square on other paper to find the answer.) _____

_____

got it?

○ **I get it!** Now I know that the combination of alleles parents can pass to offspring _____

_____

○ **I need extra help with** _____

_____

What Are Phenotype and Genotype?

2a. RELATE CAUSE AND EFFECT Explain how two organisms can have the same phenotype but different genotypes. _____

_____

_____

b. CHALLENGE In their lifetimes, two guinea pigs produce 40 black pups and 40 white pups. On a separate paper, make a Punnett square and find the likely genotypes of these parents. _____

_____

got it?

○ **I get it!** Now I know that phenotype and genotype are terms that describe _____

_____

_____

○ **I need extra help with** _____

_____

Name ______________________ Date __________ Class __________

Key Concept Summaries

Probability and Heredity

How Is Probability Related to Inheritance?

Each time you toss a coin, there are two possible ways it can land—heads up or tails up. **Probability** is a number that describes how likely it is that an event will occur. The probability that a tossed coin will land heads up is 1 in 2. A 1 in 2 probability is expressed as the fraction $\frac{1}{2}$ or as 50 percent.

The laws of probability predict what is *likely* to occur, not what *will* occur. If you toss a coin 20 times, you may expect it to land heads up 10 times and tails up 10 times. But you may get 11 heads and 9 tails, or 8 heads and 12 tails. The more tosses you make, the closer your actual results will be to those predicted by probability. The result of one toss does not affect the results of the next toss. Each event occurs independently. Even if you toss a coin five times and it lands heads up each time, the probability that it will land heads up on the next toss is still 1 in 2 or 50 percent.

A tool that can help you grasp how the laws of probability apply to genetics is called a Punnett square. A **Punnett square** is a chart that shows all the possible ways alleles can combine in a genetic cross. **In a genetic cross, the combination of alleles that parents can pass to an offspring is based on probability.** Each parent can pass either one allele or the other to an offspring. The boxes in the Punnett square show the possible combinations of alleles that the offspring can inherit.

What are Phenotype and Genotype?

Two terms that geneticists use are **phenotype** and **genotype. An organism's phenotype is its physical appearance or, visible traits. An organism's genotype is its genetic makeup or alleles.**

The allele for smooth pea pods (*S*) is dominant. Therefore, pea plants with smooth pods—those whose phenotype is smooth pods—can have either of two genotypes, *SS* or *Ss*. The plants with pinched pods, on the other hand, would all have just one phenotype—pinched pods—as well as one genotype, *ss*. An organism that has two identical alleles for a trait is said to be **homozygous** for that trait. An organism that has two different alleles for a trait is **heterozygous** for that trait. Recall that Mendel used the term *hybrid* to describe heterozygous plants.

In pea plants, the allele for tall stems (*T*) is dominant over the allele for short stems (*t*). Suppose two heterozygous parent plants are crossed. List all the possible genotypes for their offspring. For each genotype, calculate its probability as a percent, name the phenotype, and describe the plant's height. (*Hint:* You may draw a Punnett square to determine all possible alleles for offspring.)

Name _____ Date _____ Class _____

Lesson Quiz

Probability and Heredity

Fill in the blank to complete each statement.

1. The physical appearance of an organism is its _____.
2. A number that describes how likely it is that an event will occur is the _____ of the event.
3. An organism that is _____ has two identical alleles for a trait.
4. A Punnett square shows the combination of _____ that parents can pass on to offspring.
5. The genetic makeup of an organism is its _____.
6. An organism that is _____ has two different alleles for a trait.

Write the letter of the correct answer on the line at the left.

7. ___ Which of these genotypes is heterozygous?
   A *AA*
   B *Bb*
   C *Cd*
   D *ee*

8. ___ Which of these is **NOT** a phenotype?
   A tall
   B short
   C homozygous
   D round

9. ___ In a cross between individuals that are *Aa* × *Aa*, how many boxes of the Punnett square will show an offspring that is *AA*?
   A 1
   B 2
   C 3
   D 4

10. ___ Which of these is **NOT** a way to express probability?
    A 1 in 4
    B 50 percent
    C $\frac{3}{4}$
    D 25

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Name _____ Date _____ Class _____

Assess Your Understanding

Patterns of Inheritance

How Are Most Traits Inherited?

1a. DESCRIBE How are the symbols written for alleles that share incomplete dominance? _____

_____

b. CHALLENGE How is polygenic inheritance different from the patterns described by Mendel? _____

_____

got it?

○ **I get it!** Now I know that most traits are produced by _____

_____

○ **I need extra help with** _____

_____

How Do Genes and the Environment Interact?

2a. REVIEW Only genetic changes in (sex cells/body cells) can be passed to offspring.

b. DESCRIBE Give one example of how environmental factors affect gene expression. _____

_____

_____

c. ANSWER Why don't offspring always look like their parents? _____

_____

_____

_____

got it?

○ **I get it!** Now I know that the environment can affect _____

_____

○ **I need extra help with** _____

_____

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Name _____ Date _____ Class _____

Key Concept Summaries

Patterns of Inheritance

How Are Most Traits Inherited?

Most traits are the result of complex patterns of inheritance. Four complex patterns of inheritance are described in this lesson.

Incomplete dominance occurs when one allele is only partially dominant. For example, in snapdragons neither the allele for red flowers (*R*) nor the allele for white flowers (*W*) is totally dominant. That is why both alleles are written as capital letters. If a plant has alleles *RW,* only enough color is produced to make flowers a little red. So they look pink.

Codominance occurs when both alleles for a gene are expressed equally. For example, in certain chickens neither black feathers nor white feathers are dominant. So all offspring of a black hen and a white rooster have both black and white feathers. In this case, F^B stands for the allele for black feathers. F^W stands for the allele for white feathers.

For genes with **multiple alleles,** three or more possible alleles determine the trait. Still, no matter how many possible alleles there are for a trait, an individual can only have two, one from each parent.

Polygenic inheritance occurs when more than one gene affects a trait. The alleles for the different genes work together to produce those traits, such as height in humans or the time it takes a plant to flower.

How Do Genes and the Environment Interact?

Humans are born with inherited traits, such as eye color. But skills you learn and physical changes that occur, such as haircuts, are acquired traits.

Environmental factors can influence the way genes are expressed. For example, you may have inherited the ability to play a musical instrument. But without an opportunity to learn, you may never develop the skill.

Some environmental factors can change an organism's genes. For example, tobacco smoke and other pollutants can affect genes in a person's body cells in a way that results in lung cancer and other cancers. Still other genetic changes happen by chance. Changes in body cells cannot be passed to offspring. Only changes in the sex cells—eggs and sperm—can be passed to offspring. Not all genetic changes have negative effects. Genetic change in sex cells is an important source of life's variety.

Use a separate sheet of paper to describe four complex patterns of inheritance.

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Name _____ Date _____ Class _____

Lesson Quiz

Patterns of Inheritance

Fill in the blank to complete each statement.

1. A cow with a mix of red hairs and white hairs has the genotype H^RH^W. This is an example of _____.
2. Having pierced ears is an example of a(n) _____ trait.
3. Four alleles determine if a rabbit is white, brown, or gray. This is an example of _____.
4. The pattern of inheritance in which more than one pair of genes affects a trait is _____.
5. If a plant with red flowers crossed with a plant with white flowers produces a plant with pink flowers, it is an example of _____.
6. Only changes in _____ cells can be passed to offspring.

Write the letter of the correct answer on the line at the left.

7. ___ Height in humans is an example of
   A incomplete dominance
   B codominance
   C polygenic inheritance
   D multiple alleles

8. ___ The pattern of inheritance in which one allele is only partially dominant is
   A incomplete dominance
   B codominance
   C polygenic inheritance
   D multiple alleles

9. ___ The pattern of inheritance in which there are three or more possible alleles for a trait is
   A incomplete dominance
   B codominance
   C polygenic inheritance
   D multiple alleles

10. ___ The pattern of inheritance in which both genes are expressed equally is
    A incomplete dominance
    B codominance
    C polygenic inheritance
    D multiple alleles

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Name _____ Date _____ Class _____

Assess Your Understanding

Chromosomes and Inheritance

How Are Chromosomes, Genes, and Inheritance Related?

1a. **DESCRIBE** When two grasshopper sex cells join, the chromosome number in the new cell is (half/double) the number in the sex cells.

b. **SUMMARIZE** Describe the arrangement of genes on a pair of chromosomes. _____

_____

c. **RELATE EVIDENCE AND EXPLANATION** How do Sutton's observations support the chromosome theory of inheritance? _____

_____

_____

got it?

○ **I get it!** Now I know that genes are passed from parents to offspring _____

_____

○ **I need extra help with** _____

_____

What Happens During Meiosis?

got it?

○ **I get it!** Now I know that during meiosis, the number of chromosomes _____

_____

○ **I need extra help with** _____

_____

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Name _____ Date _____ Class _____

Key Concept Summaries

Chromosomes and Inheritance

How Are Chromosomes, Genes, and Inheritance Related?

At the start of the 1900s, American geneticist Walter Sutton was studying grasshoppers. He discovered that sex cells have exactly half the number of chromosomes found in body cells. So when a sperm cell and an egg cell joined, the fertilized egg had the same number of chromosomes as each parent—24 chromosomes in 12 pairs. In each pair, one chromosome came from the male parent and the other from the female parent. Recalling Mendel's work, Sutton realized that paired alleles are carried on paired chromosomes. His idea is now known as the chromosome theory of inheritance. **According to the chromosome theory of inheritance, genes pass from parents to their offspring on chromosomes.**

The body cells of humans contain 46 chromosomes in 23 pairs. Chromosomes are made up of many genes joined together like beads on a string. Your body cells each contain 20,000–25,000 genes. Each gene controls a trait. Each chromosome in a pair has the same genes. Each pair has different alleles for some genes and the same alleles for others.

What Happens During Meiosis?

Meiosis is the process by which the number of chromosomes is reduced by half as sex cells form. **During meiosis, the chromosome pairs separate into two different cells. The sex cells that form later have only half as many chromosomes as other cells in the organism.**

Before meiosis, every chromosome in the parent cell is copied. Centromeres hold the two chromatids together. The chromosome pairs line up in the center of the cell. The pairs separate and move to opposite ends of the cell. Two cells form, each with half the original number of chromosomes. Each chromosome is still made up of two chromatids. Then, in each cell, the chromosomes move to the center, the centromeres split, and the chromatids separate. They become single chromosomes and move to opposite ends of the cell. After meiosis, four sex cells are produced. Each cell has half the number of chromosomes of the parent cell—only one chromosome from an original pair. When two sex cells join at fertilization, the new cell that forms has the full number of chromosomes.

On a separate sheet of paper, briefly describe how traits are passed from human parents to their offspring. In your description, be sure to include the terms *gene*, *chromosome*, and *meiosis*.

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Name _____ Date _____ Class _____

Lesson Quiz

Chromosomes and Inheritance

Fill in the blank to complete each statement.

1. Walter Sutton investigated the number of _____ in grasshoppers.
2. The process that produces sex cells is _____.
3. Each chromosome contains two identical _____.
4. In the _____ division of meiosis, chromosome pairs line up and then separate.
5. In the _____ division of meiosis, chromosomes split.

If the statement is true, write *true*. If the statement is false, change the underlined word or words to make the statement true.

6. _____ Body cells of humans have 46 pairs of chromosomes.
7. _____ Sex cells have twice the number of chromosomes as body cells.
8. _____ Genes pass from parents to offspring on chromosomes.
9. _____ The two chromosomes in a pair have the same genes lined up in the same order.
10. _____ A fertilized egg has twice the number of chromosomes as the body cells of the parent.

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