

Section 12.2

When Heredity Follows Different Rules

North Carolina Objectives Objective 3.03 Interpret and predict patterns of inheritance: Dominant, recessive and intermediate traits; Multiple alleles; Polygenic inheritance; Sex-linked traits

Before You Read

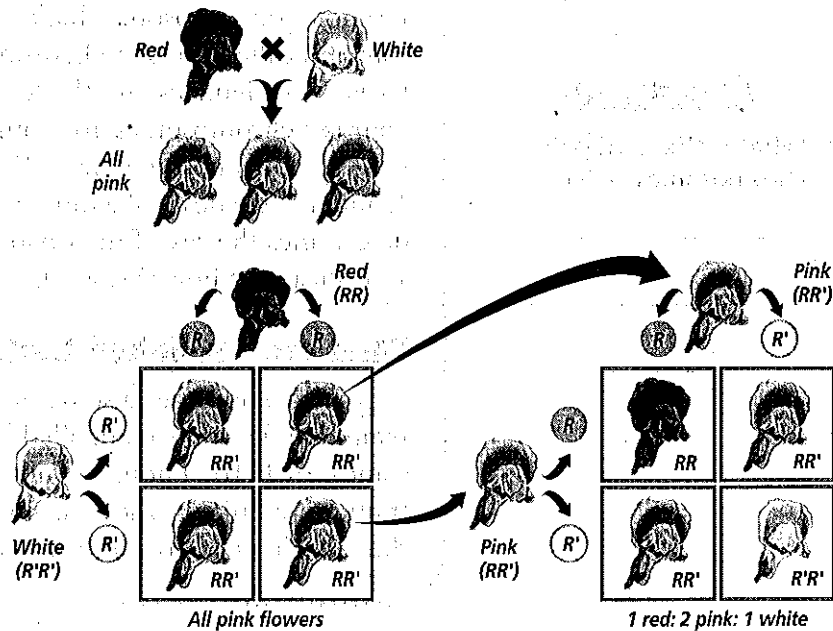
This section is about some of the ways in which inherited traits combine. Think about the plants in a garden or some of the animals you have seen in nature. How many different combinations of colors are there in plant and animal life? In the Read to Learn section, highlight examples of different combinations of inherited traits.

Read to Learn

Complex Patterns of Inheritance

Sometimes traits are not inherited through simple Mendelian genetics. Some traits are not simply dominant or recessive. When neither allele of the parents is completely dominant, the phenotype of the heterozygous offspring is a mix of the two parents. This pattern of inheritance is called **incomplete dominance**. For example, when a homozygous red snapdragon is crossed with a homozygous white snapdragon, the offspring's color will be a mix of the two. It will be pink.

Look at the Punnett squares below. The square on the left shows that the intermediate pink flower happens because neither allele of the pair is completely dominant. The square on the right shows the F₂ generation of snapdragons. Notice that when the pink flowered snapdragons are crossed with each other, the ratio of red to pink to white flowers in the F₂ generation is 1:2:1. That means that there will be one red, two pink, and one white snapdragon in the second generation. This follows Mendel's law of segregation.



STUDY COACH

Create a Quiz After you read this section, create a quiz based on what you have learned. Then be sure to answer the quiz questions.

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When Heredity Follows Different Rules, *continued* Reading Check

1. What is the term that describes when both alleles show up equally?

**Think it Over**

2. **Conclude** Which of the following is the best description of codominance? (Circle your choice.)
- Ratio of the trait in the second generation is 1:2:1.
 - The recessive trait shows up equally with the dominant trait.
 - Phenotypes of both parents are expressed equally.

 Reading Check

3. What is the 23rd pair of chromosomes called?

What is codominant inheritance?

In codominant inheritance, both alleles show up equally. **Codominant alleles** cause the phenotypes of both homozygote parents to be expressed equally in the heterozygote offspring. For example, when a certain variety of black chicken is crossed with a white chicken, all of the offspring are checkered. Some of the feathers are black and some of the feathers are white. ☑

How do multiple alleles work?

In some populations, traits can be controlled by **multiple alleles**. This means there are more than two alleles for a genetic trait. We will use the pigeon population for our example. Each pigeon can only have two alleles for a genetic trait. There are multiple allele combinations for some genetic traits within the pigeon population. For example, many combinations of pigeon feather colors exist. The allele for ash-red colored feathers is dominant. The allele for wild-type blue feathers is recessive to the allele for ash-red feathers. The allele for chocolate-brown feathers is recessive to both the ash-red and the wild-type blue alleles. Sometimes there are as many as 100 alleles for a single trait!

What determines the sex of an organism?

Humans have 23 pairs of chromosomes. Twenty-two of these pairs of homologous chromosomes are called **autosomes**. Homologous autosomes look alike. The 23rd pair of chromosomes is called the **sex chromosomes** and is indicated by the letter X for females and the letter Y for males. If you are female, your sex chromosomes are homologous, XX. If you are male, your sex chromosomes are XY. Males make two kinds of gametes, X and Y. Females make only X gametes. The X or Y male gamete determines the sex of the offspring. The Punnett square on page 133 illustrates how this works. ☑

What are sex-linked traits?

Sex chromosomes also determine sex-linked traits. **Sex-linked traits** are the traits controlled by genes located on sex chromosomes. In 1910, Thomas Hunt Morgan discovered that some traits were linked to sex chromosomes. Sex-linked traits follow the inheritance pattern of the sex chromosome on which they are

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found. Eye color in fruit flies is an example of an X-linked trait. This means eye color in fruit flies is determined by a gene on the X chromosome. X-linked traits are passed to both males and females. Y-linked traits are passed only to male offspring because the genes for these traits are on the Y chromosome.

Look at the Punnett square again. You will notice that any trait on a Y chromosome could only pass to a male offspring, since the male offspring are the only ones to receive a Y chromosome.

What is polygenic inheritance?

Some traits, such as skin color and height in humans, vary over a wide range. This is because the traits are controlled by many genes rather than by just one gene. **Polygenic inheritance** is the inheritance pattern of a trait that is controlled by two or more genes. The genes may be on the same or different chromosomes.

Environmental Influences

It is important to know that the genetic makeup of an organism at fertilization determines only the organism's potential to develop and function. Many factors can influence how the gene is expressed, or whether the gene is expressed at all. There are internal and external influences.

How does external environment affect organisms?

Nutrition, light, chemicals, infectious agents such as bacteria, fungi, parasites, and viruses, and other factors can all influence the ways genes are expressed. The arctic fox, for example, has gray-brown fur in warm temperatures. When temperatures fall, the fur becomes white. In this case, temperature is the external factor that affects the phenotype of fur color.

How does internal environment affect organisms?

The internal environments of males and females are different because of hormones and structural differences. Horn size in mountain sheep is expressed differently in males and females. In males, the horns are much heavier and more coiled than the horns of females.

The age of an organism can also affect the way genes function. The internal environment of an organism changes with age, but it is not clearly understood how these changes affect the function of genes.

	X	Y
X	XX	XY
X	XX	XY



Think it Over

4. **Apply** Height in humans is an example of (Circle your choice.)
- polygenic inheritance.
 - external environmental influences.
 - internal environmental influences.

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► After You Read

Mini Glossary

autosomes: pairs of homologous chromosomes

codominant alleles: pattern where phenotypes of both homozygous parent's alleles appear equally

incomplete dominance: neither allele of the parent is completely dominant but combine and display a new trait

multiple alleles: presence of more than two alleles for a genetic trait

polygenic inheritance: inheritance pattern of a trait controlled by two or more genes; genes may be on the same or different chromosomes

sex chromosomes: in humans, the 23rd pair of chromosomes, determine the sex of an individual and carry sex-linked traits

sex-linked traits: traits controlled by genes located on the sex chromosomes

1. Read the terms and definitions in the Mini Glossary above. Circle two terms that are related to each other. On the lines below, tell how these terms are related.

2. Fill in the partially completed outline to help you review what you have read.

I. Sex of an individual

A. Determined by _____

B. Females are represented by the letter _____

C. Males are represented by the letter _____

II. Sex-linked traits

A. First discovered by _____

B. Genes are located on _____



Visit the Glencoe Science Web site at **science.glencoe.com** to find your biology book and learn more about when heredity follows different rules.