Name Date Class

Section 12.3

Complex Inheritance of Human Traits

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

Before You Read

Before you read about family gene pools, think about your own family. Then, on the lines below, make a list of the ways the members of your family resemble each other.

Read to Learn

Codominance in Humans

You will remember that in codominance the phenotypes of both homozygote parents are expressed equally in the heterozygote offspring. One example of this in humans is a group of inherited red blood cell disorders called sickle-cell anemia.

What is sickle-cell anemia?

Sickle-cell anemia is a major health problem in the United States and in Africa. It is most common in African Americans and in white Americans whose families came from countries around the Mediterranean Sea.

In a person who is homozygous for the sickle-cell allele, abnormal sickle-shaped red blood cells are produced. Normal red blood cells are disc shaped. Sickle-shaped cells occur in the body's narrow capillaries. They slow blood flow, block small vessels, and cause tissue damage and pain. Because of the short life span of the sickle cells, individuals with this disease have several related disorders.

Individuals who are heterozygous for the sickle-cell allele produce both normal and sickle-shaped red blood cells. This is an example of codominance. These individuals produce enough normal red blood cells that they do not have the serious health problems of those individuals who are homozygous for the allele. Individuals who are heterozygous for the allele can lead relatively normal lives.

STUDY COACH

Check for Understanding
As you read this section, be sure to reread any parts you don't understand. Highlight each sentence as you reread it.

Think it Over

1. **Analyze** Which term describes when the phenotypes of both parents are expressed equally? (Circle your choice.)
   a. multiple alleles
   b. codominance

Possible Genotype Combinations	Phenotypes
A and A	A
A and B	AB
A and O	A
B and O	B
O and O	O

Multiple Alleles Govern Blood Type

The ABO blood group is a good example of a single gene that has multiple alleles in humans. Human blood types are determined by the presence or absence of certain molecules on the surface of red blood cells. Refer to the chart at the left to study the gene combination of blood types.

Why is blood typing important?

Blood typing determines the ABO blood group to which an individual belongs. It is necessary to know the blood type of a person before a blood transfusion can be given. If the wrong blood type is given, the red blood cells could clump together and cause death.

Blood typing can also be helpful in cases of disputed parentage. For example, if a child has type AB blood and his or her mother has type A blood, a man with type O blood could not be the father. Blood tests cannot prove that a man is the father, only that he could be. DNA tests are needed to determine actual parenthood.

Think it Over

2. Conclude If a mother has type O blood and a father has type A blood, their child can have which of the following blood types? (Circle ALL that apply.)

a. A
b. O
c. AO

Sex-Linked Traits in Humans

Genes that are carried on the sex chromosomes determine many human traits. Most of these genes are located on the X chromosome. You will remember that males pass an X chromosome to each daughter and a Y chromosome to each son. Females pass an X chromosome to both daughters and sons. If a recessive X-linked allele is passed to a son, the recessive phenotype will be expressed because there are no X-linked alleles on the Y chromosome received from the male.

Two traits that are determined by X-linked recessive inheritance in humans are red-green color blindness and the blood disorder, hemophilia. X-linked dominant and Y-linked human disorders are rare.

What is red-green color blindness?

People who have red-green color blindness are unable to tell the difference between these two colors. Color blindness is caused by the inheritance of a recessive allele on the X chromosome. One problem people with red-green color blindness have is the inability to identify red and green traffic lights by color.

Section 12.3 **Complex Inheritance of Human Traits,** *continued*

What is hemophilia?

If you have ever cut yourself, you may have noticed that cuts usually stop bleeding quickly. The cut stops bleeding because the blood clots. Hemophilia is an X-linked disorder that keeps blood from clotting quickly. This means cuts do not stop bleeding very rapidly. It also means that a person could have internal bleeding from a bruise.

Hemophilia can be treated with blood transfusions and injections of the blood-clotting enzyme that is absent in people with hemophilia. These treatments, however, are very expensive.

Reading Check

3. What is hemophilia?

Polygenic Inheritance in Humans

Think of the traits you have inherited from your parents. Many of these were inherited through simple Mendelian patterns or through multiple alleles, but others were determined by polygenic inheritance. This means two or more genes may control the inheritance pattern of a trait. Usually these traits vary over a wide range. Eye color and skin color are two examples of polygenic inheritance in humans.

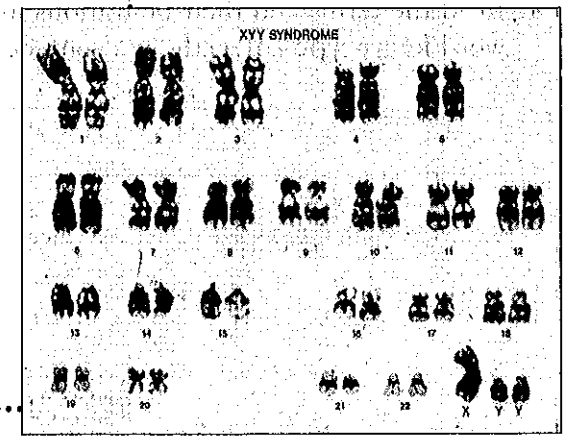
In the early 1900s, scientists studied data collected on skin color. They found that when light-skinned people mate with dark-skinned people, their children have intermediate skin colors. When the children have offspring, the skin colors in the offspring range from the light to the dark of the grandparents. Most of the offspring, however, have an intermediate skin color. This variation indicates that three to four genes are involved in determining skin color.

Reading Check

4. List two examples of polygenic inheritance.

Changes in Chromosome Numbers

Sometimes there are an abnormal number of cells in a set of chromosomes. To identify an abnormal number of chromosomes, a sample of cells is taken from an individual or a fetus (a developing mammal from nine weeks old to birth). The chromosomes are photographed and arranged in pairs by a computer. The pairs are arranged by length and location of the centromere. The chart showing the pairs is called a **karyotype.** It is very useful in identifying unusual chromosome numbers in cells. An example of a karyotype is at right.



Reading Check

5. What is one example of an abnormal number of chromosomes in humans?

_____

_____

_____

What is Down syndrome?

Most human abnormal chromosome numbers result in embryo death, usually even before a woman knows she is pregnant. Down syndrome is one example of an abnormal number of chromosomes in humans. Individuals with Down syndrome can survive to adulthood, unlike most others born with an abnormal number of chromosomes. Individuals with Down syndrome have at least some degree of mental retardation. The incidence of Down syndrome births is higher in older mothers, especially those over 40 years old.

What happens with abnormal numbers of sex chromosomes?

Sometimes an X chromosome will be missing (designated XO). There may also be an extra chromosome, such as in XXX or XXY. There may even be an extra Y chromosome (XYY). Any individual with a Y chromosome is a male. Any individual without a Y chromosome is a female. What happens in these cases? Most of these individuals lead normal lives but cannot have children. Some have varying levels of mental retardation.

After You Read

Mini Glossary

blood typing: determination of ABO blood group to which an individual belongs

karyotype (KAHR ee uh tipe): chart of chromosome pairs arranged according to length and location of the centromere; used to identify an abnormal number of chromosomes

1. Read the terms and their definitions in the Mini Glossary above. On the lines below, use the word **karyotype** correctly in a sentence.

_____

_____

_____

_____

_____

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2. In Column 1 are some concepts you learned in this section. Column 2 gives a fact about each concept. Put the letter of the fact on the line next to the concept that matches it.

Column 1	Column 2
_____ 1. sickle-cell disease	a. human blood types
_____ 2. A, B, AB, O	b. an example of codominance
_____ 3. sex-linked traits	c. abnormal number of chromosomes
_____ 4. 47 chromosomes	d. mostly located on the X chromosome

Visit the Glencoe Science Web site at **science.glencoe.com** to find your biology book and learn more about the complex inheritance of human traits.