

Advances in Genetics

Reading Preview

Key Concepts

- What are three ways of producing organisms with desired traits?
- What is the goal of the Human Genome Project?

Key Terms

- selective breeding
- inbreeding • hybridization
- clone • genetic engineering
- gene therapy • genome



Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a question for each heading. As you read, write answers to your questions.

Advances In Genetics

Question	Answer
What is selective breeding?	Selective breeding is . . .

Lab
zone

Discover Activity

What Do Fingerprints Reveal?

1. Label a sheet of paper with your name. Then roll one of your fingers from side to side on an ink pad. Make a fingerprint by carefully rolling your inked finger on the paper.
2. Divide into groups. Each group should choose one member to use the same finger to make a second fingerprint on a sheet of paper. Leave the paper unlabeled.
3. Exchange your group's fingerprints with those from another group. Compare each labeled fingerprint with the fingerprint on the unlabeled paper. Decide whose fingerprint it is.
4. Wash your hands after completing this activity.

Think It Over

Observing Why are fingerprints used to identify people?

Would you like to have your picture taken with a 9,000-year-old family member? Adrian Targett, a history teacher in the village of Cheddar in England, has actually done that. All that's left of his ancient relative, known as "Cheddar Man," is a skeleton. The skeleton was discovered in a cave near the village. DNA analysis indicates that Targett and Cheddar Man are relatives.

Like your fingerprints, your DNA is different from everyone else's. Because of advances in genetics, DNA evidence can show many things, such as family relationships.

FIGURE 12

Distant Relatives

Adrian Targett visits his distant relative, Cheddar Man. Unfortunately, Cheddar Man cannot respond to questions about life 9,000 years ago.



FIGURE 13

Inbreeding

Turkeys such as the one with white feathers were developed by inbreeding. Breeders started with wild turkeys.



Wild turkey



Domestic turkey

Selective Breeding

Genetic techniques have enabled people to produce organisms with desirable traits. **Selective breeding**, **cloning**, and **genetic engineering** are three methods for developing organisms with desirable traits.

The process of selecting organisms with desired traits to be parents of the next generation is called **selective breeding**. Thousands of years ago, in what is now Mexico, the food that we call corn was developed in this way. Every year, farmers saved seeds from the healthiest plants that produced the best food. In the spring, they planted those seeds. By repeating this process over and over, farmers developed plants that produced better corn. People have used selective breeding with many different plants and animals. Two selective breeding techniques are inbreeding and hybridization.

Inbreeding The technique of **inbreeding** involves crossing two individuals that have similar characteristics. For example, suppose a male and a female turkey are both plump and grow quickly. Their offspring will probably also have those desirable qualities. Inbred organisms have alleles that are very similar to those of their parents.

Inbred organisms are genetically very similar. Therefore, inbreeding increases the probability that organisms may inherit alleles that lead to genetic disorders. For example, inherited hip problems are common in many breeds of dogs.

Hybridization In **hybridization** (hy brid ih ZAY shun), breeders cross two genetically different individuals. The hybrid organism that results is bred to have the best traits from both parents. For example, a farmer might cross corn that produces many kernels with corn that is resistant to disease. The result might be a hybrid corn plant with both of the desired traits.



Reading Checkpoint

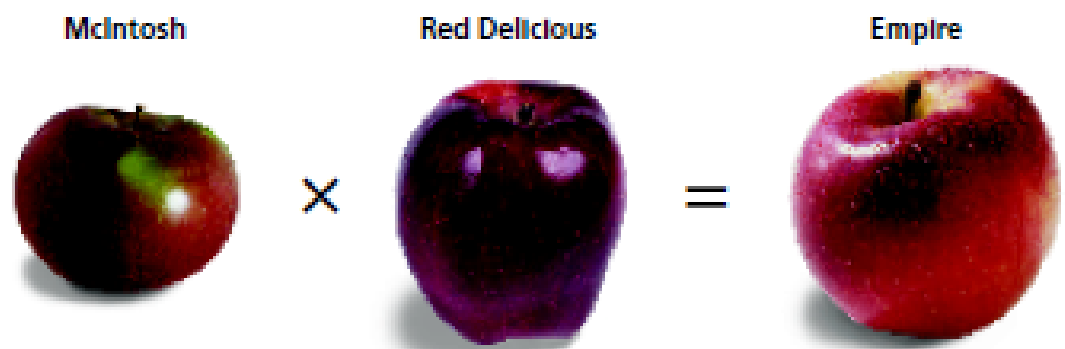
What is the goal of hybridization?

FIGURE 14

Hybridization

McIntosh and Red Delicious apples were crossed to produce Empire apples.

Applying Concepts What desirable traits might breeders have been trying to produce?

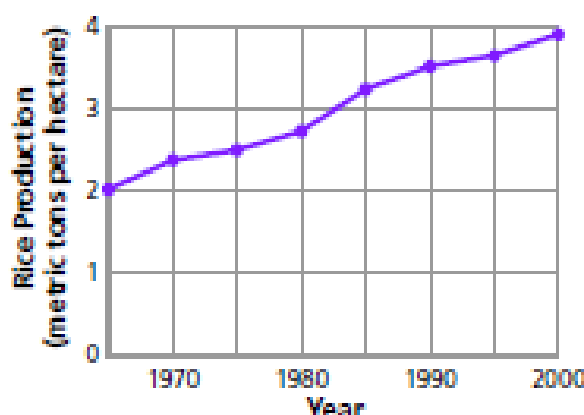


Changing Rice Production

The graph shows how worldwide rice production changed between 1965 and 2000. New, hybrid varieties of rice plants are one factor that has affected the amount of rice produced.

1. **Reading Graphs** According to the graph, how did rice production change between 1965 and 2000?
2. **Reading Graphs** How many metric tons of rice per hectare were produced in 1965? How many were produced in 2000?
3. **Calculating** Calculate the approximate difference between rice production in 1965 and 2000.
4. **Developing Hypotheses** What factors besides new varieties of plants might help account for the difference in rice production between 1965 and 2000?

Worldwide Rice Production



Cloning

For some organisms, a technique called cloning can be used to produce offspring with desired traits. A **clone** is an organism that has exactly the same genes as the organism from which it was produced. It isn't hard to clone some kinds of plants, such as an African violet. Just cut a stem from one plant, and put the stem in soil. Water it, and soon you will have a whole new plant. The new plant is genetically identical to the plant from which the stem was cut.

Researchers have also cloned animals such as sheep and pigs. The methods for cloning these animals are complex. They involve taking the nucleus of an animal's body cell and using that nucleus to produce a new animal.



Reading Checkpoint

How can a clone of a plant be produced?

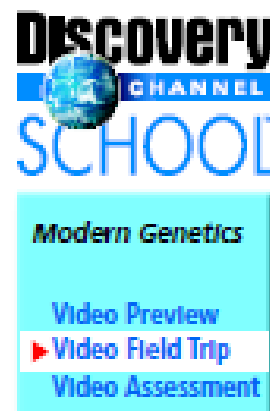


FIGURE 15
Cloned Goats
These goats were produced by cloning.



Genetic Engineering

Geneticists have developed another powerful technique for producing organisms with desired traits. In this process, called **genetic engineering**, genes from one organism are transferred into the DNA of another organism. Genetic engineering can produce medicines and improve food crops.

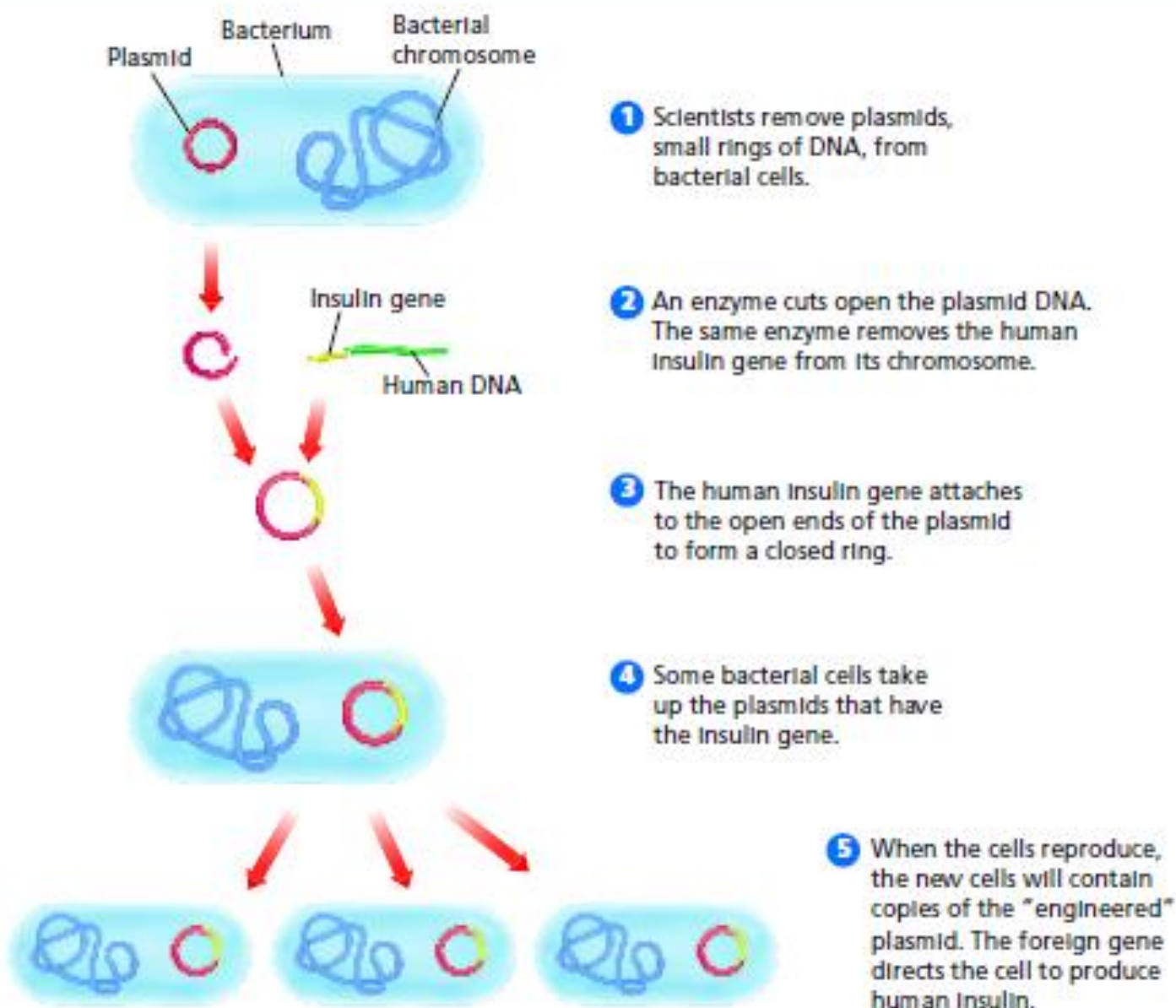
Genetic Engineering in Bacteria One type of genetically engineered bacteria produces a protein called insulin. Injections of insulin are needed by many people with diabetes. Recall that bacteria have a single DNA molecule in the cytoplasm. Some bacterial cells also contain small circular pieces of DNA called plasmids. In Figure 16, you can see how scientists insert the DNA for a human gene into the plasmid of a bacterium.

FIGURE 16

Genetic Engineering

Scientists use genetic engineering to create bacterial cells that produce important human proteins such as insulin.

Interpreting Diagrams How does a human insulin gene become part of a plasmid?



Normal
zebra tetra ▲



Genetically
engineered
zebra tetras ►



FIGURE 17

Genetically Engineered Fish

The bright red zebra tetras are the result of genetic engineering.

Once the gene is inserted into the plasmid, the bacterial cell and all its offspring will contain this human gene. As a result, the bacteria produce the protein that the human gene codes for—in this case, insulin. Because bacteria reproduce quickly, large amounts of insulin can be produced in a short time.

Genetic Engineering in Other Organisms Scientists can also use genetic engineering techniques to insert genes into animals. For example, human genes can be inserted into the cells of cows. The cows then produce the human protein for which the gene codes in their milk. Scientists have used this technique to produce the blood clotting protein needed by people with hemophilia.

Genes have also been inserted into the cells of plants, such as tomatoes and rice. Some of the genes enable the plants to survive in cold temperatures or in poor soil. Other genetically engineered crops can resist insect pests.

Gene Therapy Someday it may be possible to use genetic engineering to correct some genetic disorders in humans. This process, called **gene therapy**, will involve inserting copies of a gene directly into a person's cells. For example, doctors may be able to treat hemophilia by replacing the defective allele on the X chromosome. The person's blood would then clot normally.

Concerns About Genetic Engineering Some people are concerned about the long-term effects of genetic engineering. For example, some people think that genetically engineered crops may not be entirely safe. People fear that these crops may harm the environment or cause health problems in humans. To address such concerns, scientists are trying to learn more about the effects of genetic engineering.



How do genetic engineering techniques enable scientists to produce clotting proteins?



For: Links on genetic engineering
Visit: www.SciLinks.org
Web Code: scn-0343

Lab
zone

Skills Activity

Communicating

Suppose you work for a drug company that uses genetically engineered bacteria to produce insulin. Write an advertisement for the drug that includes a simplified explanation of how the drug is produced.

FIGURE 18

The Human Genome Project
Scientists on the Human Genome Project continue to study human DNA.



Learning About Human Genetics

Recent advances have enabled scientists to learn a great deal about human genetics. The Human Genome Project and DNA fingerprinting are two applications of this new knowledge.

The Human Genome Project Imagine trying to crack a code that is 6 billion letters long. That's exactly what scientists working on the Human Genome Project have been doing. A **genome** is all the DNA in one cell of an organism. The main goal of the Human Genome Project has been to identify the DNA sequence of every gene in the human genome. The Human Genome Project has completed a "first draft" of the human genome. The scientists have learned that the DNA of humans has at least 30,000 genes. The average gene has about 3,000 bases. Scientists will some day know the DNA sequence of every human gene.

DNA Fingerprinting DNA technology used in the Human Genome Project can also identify people and show whether people are related. DNA from a person's cells is broken down into small pieces, or fragments. Selected fragments are used to produce a pattern called a DNA fingerprint. Except for identical twins, no two people have exactly the same DNA fingerprint. You will learn more about DNA fingerprinting in Technology and Society.



Reading Checkpoint

About how many genes are in the human genome?

Section 3 Assessment

Target Reading Skill Asking Questions Work with a partner to check your answers in your graphic organizer.

Reviewing Key Concepts

- Listing** List three methods that scientists can use to develop organisms with desirable traits.
 - Describing** Briefly describe each method.
 - Applying Concepts** Lupita has a houseplant. Which method would be the best way of producing a similar plant for a friend? Explain your answer.
- Defining** What is a genome?
 - Explaining** What is the Human Genome Project?

- Relating Cause and Effect** How might knowledge gained from the Human Genome Project be used in gene therapy?

Lab zone

At-Home Activity

Food and Selective Breeding Go to a grocery store with a parent or other family member. Discuss how fruits and vegetables have been produced by selective breeding. Choose a fruit or vegetable, and identify the traits that make it valuable.