Lesson 7

Biotechnology

ESSENTIAL QUESTION

How does biotechnology impact our world?

By the end of this lesson, you should be able to explain how biotechnology impacts human life and the world around us.

These glowing bands contain fragments of DNA that have been treated with a special chemical. This chemical glows under ultraviolet light, allowing scientists to see the DNA.

Lesson Labs

Quick Labs

- How Can a Simple Code be Used to Make a Product?
- Observing Selective Breeding

Engage Your Brain

1 Predict Fill in the blanks with the word or phrase you think correctly completes the following sentences.

A medical researcher might study DNA in order to learn _____

_____

_____

A crime scene investigator might study DNA in order to learn _____

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_____

2 Apply *GMO* stands for "genetically modified organism." Write a caption to accompany the following photo.

_____

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Active Reading

3 Apply Use context clues to write your own definition for the words *inserted* and *technique*.

Example sentence
Using special technologies, a gene from one organism can be inserted into the DNA of another.

inserted:

_____

_____

Example sentence
Cloning is a technique in which the genetic information of an organism is copied.

technique:

_____

_____

Vocabulary Terms

- **biotechnology**
- **artificial selection**
- **genetic engineering**
- **clone**

4 Apply As you learn the definition of each vocabulary term in this lesson, create your own definition or sketch to help you remember the meaning of the term.

BioTECHNOLOGY

Protective clothing keeps this geneticist safe as he works with infectious particles.

This scientist works inside of a greenhouse. He breeds potato plants.

What is biotechnology?

A forensic scientist makes copies of DNA from a crime scene. A botanist breeds flowers for their bright red blooms. A geneticist works to place a human gene into the DNA of bacteria. What do these processes have in common? They are all examples of biotechnology. **Biotechnology** is the use and application of living things and biological processes. In the past 40 years, new technologies have allowed scientists to directly change DNA. But biotechnology is not a new scientific field. For thousands of years, humans have been breeding plants and animals and using bacteria and yeast to ferment foods. These, too, are examples of biotechnology.

Active Reading **6 Identify** Name three examples of biotechnology.

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Think Outside the Book

5 Research Research careers in biotechnology. Choose a career that you might like to have and share it with your class. You may choose to present your findings in one of the following ways:

- a poster
- a computer presentation
- a play
- a short essay

Different dog breeds are produced by artificial selection.

What are some applications of biotechnology?

Biotechnology processes fall into some broad categories. Artificial selection, genetic engineering, and cloning are some of the most common techniques.

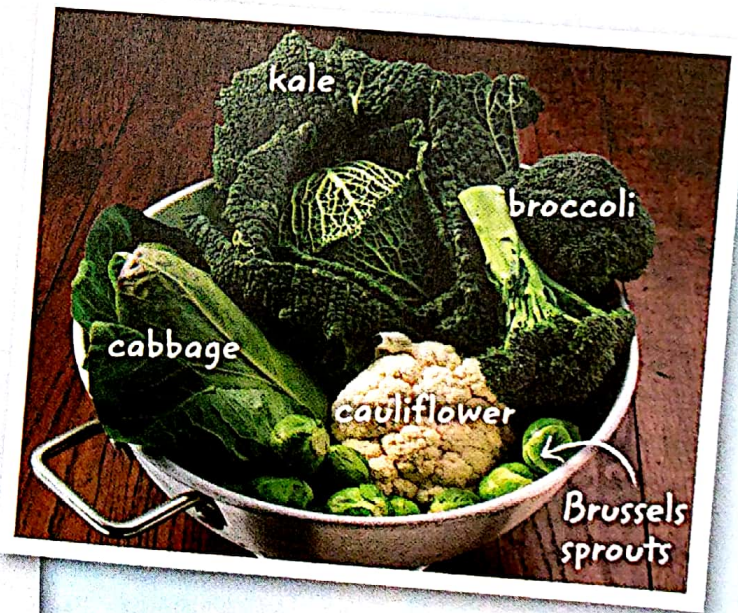
Artificial Selection

For thousands of years, humans have been carefully selecting and breeding certain plants and animals that have desirable traits. Over many generations, horses have gotten faster, pigs have gotten leaner, and corn has become sweeter. **Artificial selection** is the process of selecting and breeding organisms that have certain desired traits. Artificial selection is also known as *selective breeding*.

Artificial selection can be successful as long as the desirable traits are controlled by genes. Animal and plant breeders select for alleles, which are different versions of a gene. The alleles being selected must already be present in the population. People do not change DNA during artificial selection. Instead, they cause certain alleles to become more common in a population. The different dog breeds are a good example of artificial selection. All dogs share a common ancestor, the wolf. However, thousands of years of selection by humans have produced dogs with a variety of characteristics.

Visualize It!

These vegetables have been developed through artificial selection. Their common ancestor is the mustard plant.



7 Infer Why might farmers use artificial selection to develop different types of vegetables?

Scientists have disabled a gene in the mouse on the right. As a result, this mouse cannot control how much food it eats.

Genetic Engineering

Within the past 40 years, it has become possible to directly change the DNA of an organism. **Genetic engineering** is the process in which a piece of DNA is modified for use in research, medicine, agriculture, or industry. The DNA that is engineered often codes for a certain trait of interest. Scientists can isolate a segment of DNA, change it in some way, and return it to the organism. Or, scientists can take a segment of DNA from one species and transfer it to the DNA of an organism from another species.

Active Reading **8 Describe** For what purposes can genetic engineering be used?

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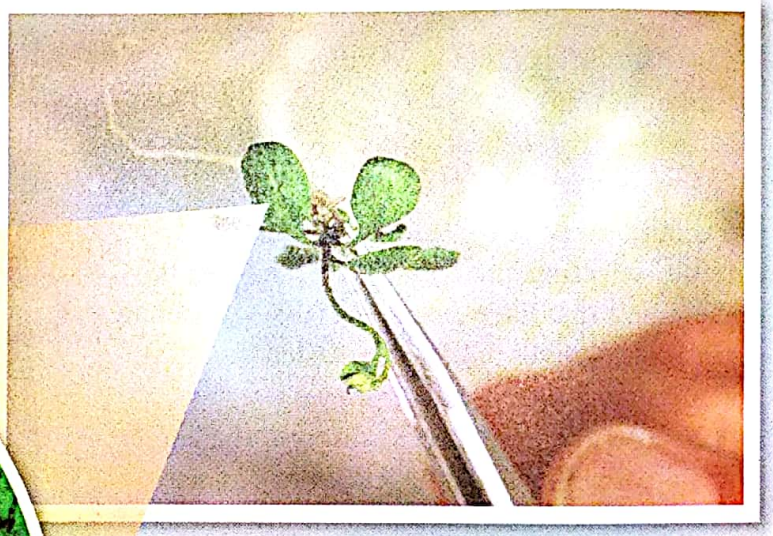
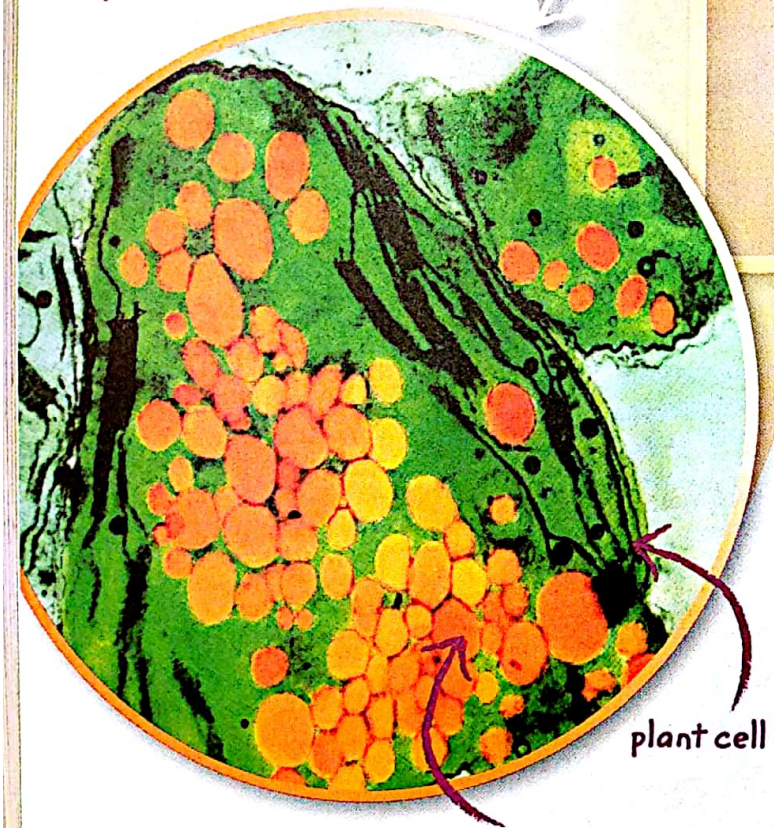
_____

_____

These genetically modified plant cells produce tiny, biodegradable plastic pellets. The pellets are then collected to make plastic products.





9 Infer Traditional plastics are made from petroleum, a nonrenewable resource. What benefit could plastic made by plants have over traditional plastic?

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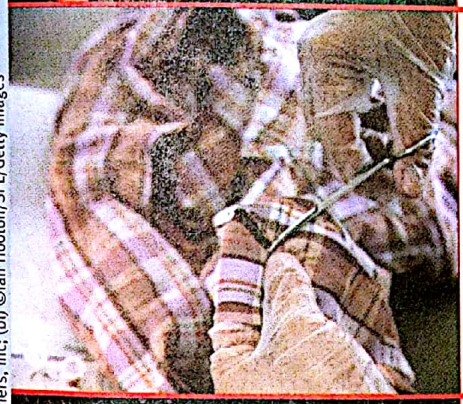
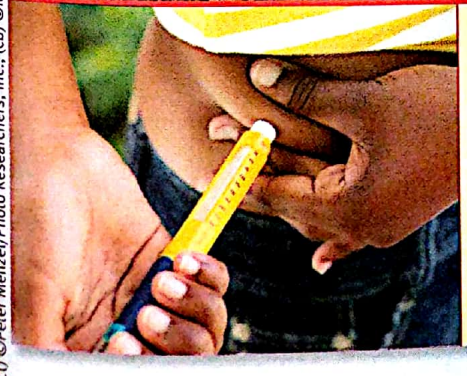
Cloning

A **clone** is an organism, cell, or piece of genetic material that is genetically identical to the one from which it was derived. Cloning has been used to make copies of small traces of DNA found at crime scenes or on ancient artifacts. Also, cloning can be used to copy segments of DNA for genetic engineering.

In 1996, scientists cloned the DNA from one sheep's body cell to produce another sheep named Dolly. The ability to clone a sheep, which is a mammal, raised many concerns about the future uses of cloning, because humans are also mammals. It is important that people understand the science of genetics. Only then can we make informed decisions about how and when the technology should be used.

Dolly was cloned from a body cell of an adult sheep.

10 Apply Review each of the examples of biotechnology below. Then classify each as artificial selection, genetic engineering, or cloning.

	Scientists have introduced a gene to the DNA of these fish that causes the fish to glow.	☐ artificial selection ☐ genetic engineering ☐ cloning
	A scientist is gathering DNA from clothing found at a crime scene. Then many copies of the DNA sample will be made. This will allow the scientist to better study the DNA. Then the scientist might be able to confirm the identity of the person at the crime scene.	☐ artificial selection ☐ genetic engineering ☐ cloning
	Wild carrots have thin, white roots. Over time, carrot farmers have selected carrots that have thick, bright orange roots.	☐ artificial selection ☐ genetic engineering ☐ cloning
	Diabetes can be treated in some people with injections that contain the hormone insulin. The gene responsible for producing insulin in humans has been inserted into the DNA of bacteria. These bacteria then produce the human insulin that is used in the injection.	☐ artificial selection ☐ genetic engineering ☐ cloning

Feel the IMPACT!

How does biotechnology impact our world?

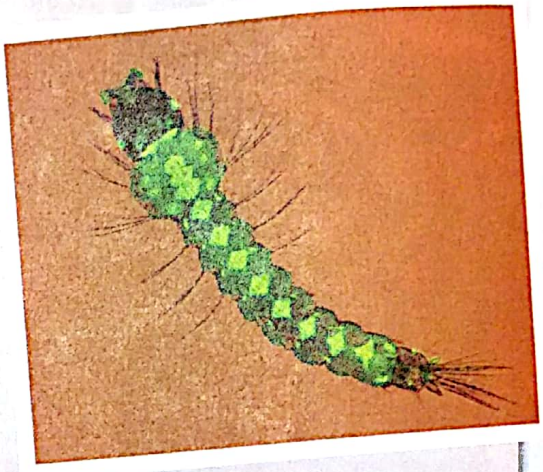
Scientists are aware that there are many ethical, legal, and social issues that arise from the ability to use and change living things. Biotechnology can impact both our society and our environment. We must decide how and when it is acceptable to use biotechnology. The examples that follow show some concerns that might be raised during a classroom debate about biotechnology.

11 Evaluate Read the first two examples of biotechnology and what students had to say about their effects on individuals, society, and the environment. Then complete Example 3 by filling in questions or possible effects of the technology.

Example 1

A Glowing Mosquito?

This is the larva of a genetically engineered mosquito. Its DNA includes a gene from a glowing jellyfish that causes the engineered mosquito to glow. Scientists hope to use this same technology to modify the mosquito's genome in other ways. For example, it is thought that the DNA of the mosquito could be changed so that the mosquito could not spread malaria.



Effects on Individuals and Society

"If the mosquito could be engineered so that it does not spread malaria, many lives could be saved."

Effects on Environment

"Mosquitoes are a food source for birds and fish. Are there health risks to animals that eat genetically modified mosquitoes?"

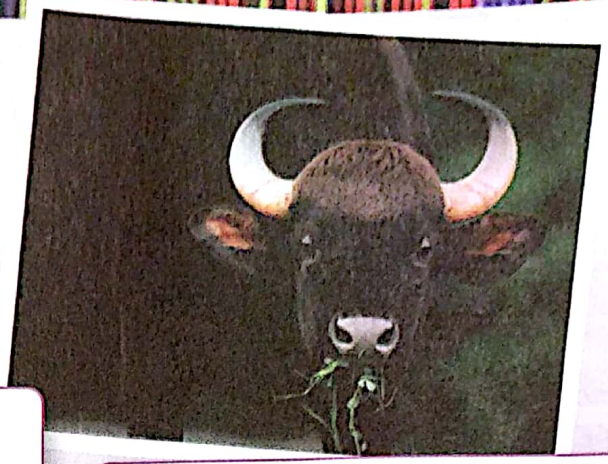
Think Outside the Book Inquiry

12 Debate As a class, choose a current event that involves biotechnology. Then hold a debate to present the benefits and risks of this technology.

Example 2

Cloning the Gaur

The gaur is an endangered species. In 2001, a gaur was successfully cloned. The clone, named Noah, died of a bacterial infection 2 days after birth.



Effects on Individuals and Society

"How will we decide when it is appropriate to clone other types of organisms?"

Effects on Environment

"Cloning could help increase small populations of endangered species like the gaur and save them from extinction."

Example 3

Tough Plants!

Much of the corn and soybeans grown in the United States is genetically engineered. The plants have bacterial genes that make them more resistant to plant-eating insects.

Effects on Individuals and Society

Effects on Environment

Visual Summary

To complete this summary, circle the correct word or phrase. Then use the key below to check your answers. You can use this page to review the main concepts of the lesson.

Biotechnology

Biotechnology is the use of living things and biological processes.

13 Modern biotechnology techniques can change an organism's DNA / environment.

Aritifical selection, genetic engineering, and cloning are three types of biotechnology.

14 The DNA of the mouse on the right has been modified through a technique called cloning / genetic engineering.

Biotechnology impacts individuals, society, and the environment.

15 Creating a clone / gene of an endangered species could impact the environment.

Answers: 13 DNA; 14 genetic engineering; 15 clone

16 Compare Both artificial selection and genetic engineering produce organisms that have traits that are different from the original organism. Explain how these two techniques differ.

Lesson Review

Vocabulary

In your own words, define the following terms.

1 biotechnology

2 artificial selection

3 clone

Key Concepts

4 Identify Wheat has been bred by farmers for thousands of years to improve its ability to be ground into flour. This is an example of what kind of biotechnology?

A artificial selection

B genetic engineering

C cloning

D PCR

5 Identify Which of the following statements correctly describes why society must carefully consider the use of biotechnology?

A Biotechnology is a relatively new scientific field.

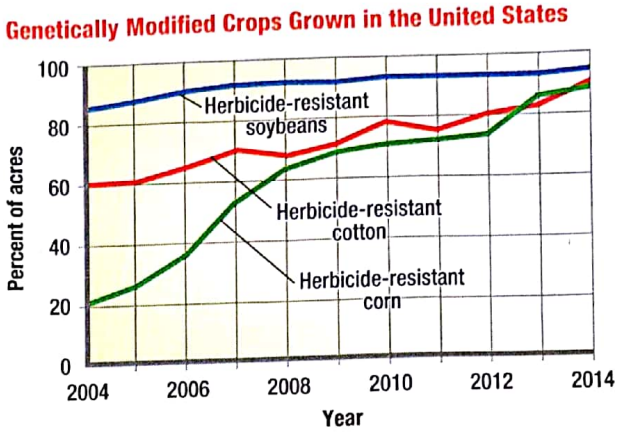
B Biotechnology can impact individuals and the environment.

C The methods of genetic engineering are not well understood.

D Artificial selection is an example of biotechnology.

Critical Thinking

Use this graph to answer the following questions.



Source: *USDA, 2009*

6 Analyze In 2003, what percentage of soybean crops in the United States were genetically engineered to be herbicide resistant?

7 Analyze From 1999 to 2009, which genetically engineered crop had the greatest increase in acreage?

8 Synthesize Some salmon have been genetically engineered to grow more quickly. The salmon are raised in pens set in rivers or in the sea. Describe how these salmon might impact society and the environment.