Name _____ Class _____ Date _____

15.1 Selective Breeding

Lesson Objectives

- Explain the purpose of selective breeding.
- Explain how people increase genetic variation.

Lesson Summary

Selective Breeding Through **selective breeding**, humans choose organisms with wanted characteristics to produce the next generation.

- This takes advantage of natural variation among organisms and passes wanted traits to offspring.
- The numerous breeds of dogs and varieties of crop plants and domestic animals are examples of selective breeding.

Hybridization crosses dissimilar individuals to bring together the best of both parents in the offspring. **Inbreeding** is the continued breeding of individuals with selected characteristics. It ensures that wanted traits are preserved, but can also result in defects being passed on.

Increasing Variation Mutations are the source of biological diversity. Breeders introduce mutations into populations to increase genetic variation. **Biotechnology** is the application of a technological process, invention, or method to living organisms. Selective breeding is one example of biotechnology.

- Radiation and chemicals can increase the mutation rate. Diverse bacterial strains have been bred from mutated lines.
- Drugs can prevent the separation of chromosomes during mitosis, leading to polyploidy in plants. Such plants may be larger or stronger than their diploid relatives.

Selective Breeding

For Questions 1–5, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ **1.** Selective breeding works because of the natural genetic variation in a population.

_____ **2.** Hybridization crosses similar individuals to bring together the best of both.

_____ **3.** The individuals produced by crossing dissimilar parents are purebreeds.

_____ **4.** The continued crossing of individuals with similar characteristics is hybridization.

_____ **5.** Inbreeding increases the risk of genetic defects.

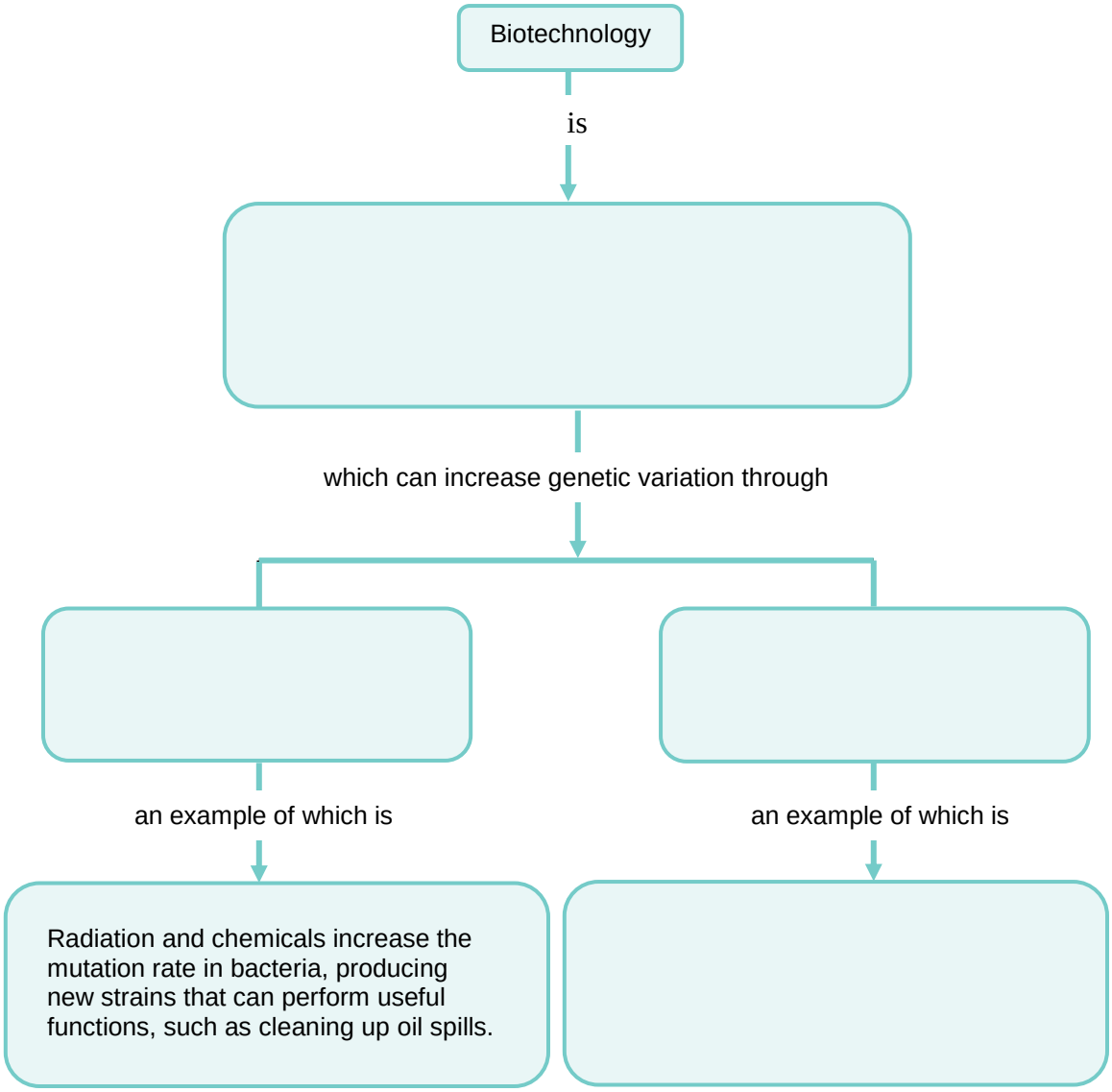
Name _____ Class _____ Date _____

6. Complete the table describing the types of selective breeding.

Selective Breeding		
Type	**Description**	**Examples**
	Crossing dissimilar individuals to bring together the best of both organisms	
	The continued breeding of individuals with similar characteristics	

Increasing Variation

7. Complete this concept map about biotechnology.



Name _____ Class _____ Date _____

For Questions 8–11, match the example with the probable method used to introduce the mutation. Each answer can be used more than once.

_____ **8.** Bacteria that clean up radioactive substances

_____ **9.** Larger, stronger banana trees

_____ **10.** Bacteria that clean up metal pollution

_____ **11.** Watermelons that grow faster and larger

A. radiation or chemicals

B. polyploidy

12. Is it easy for breeders to produce mutants with desirable mutations? Explain.

_____

_____

_____

13. Why are radiation and chemicals useful techniques for producing mutant bacteria?

_____

_____

_____

14. What technique do scientists use to produce mutant plants?

_____

_____

15. What are polyploid plants?

_____

_____

_____

Apply the Big idea

16. The muscles that racehorses use to move their legs are strong, heavy, and powerful. The bones of racehorses are very lightweight. How are these traits advantageous in racehorses? Describe a process that breeders might have used, over time, to produce racehorses with these characteristics.

_____

_____

_____

_____

_____

_____

Name _____ Class _____ Date _____

15.2 Recombinant DNA

Lesson Objectives

- Explain how scientists manipulate DNA.
- Describe the importance of recombinant DNA.
- Define transgenic and describe the usefulness of some transgenic organisms to humans.

Lesson Summary

Copying DNA Genetic engineers can transfer a gene from one organism to another to achieve a goal, but first, individual genes must be identified and separated from DNA. The original method (used by Douglas Prasher) involved several steps:

- Determine the amino acid sequence in a protein.
- Predict the mRNA code for that sequence.
- Use a complementary base sequence to attract the predicted mRNA.
- Find the DNA fragment that binds to the mRNA.

Once scientists find a gene, they can use a technique called the **polymerase chain reaction** to make many copies.

- Heat separates the DNA into two strands.
- As the DNA cools, primers are added to opposite ends of the strands.
- DNA polymerase adds nucleotides between the primers, producing two complementary strands. The process can be repeated as many times as needed.

Changing DNA **Recombinant DNA** molecules contain DNA from two different sources. Recombinant-DNA technology can change the genetic composition of living organisms.

- **Plasmids** are circular DNA molecules found in bacteria and yeasts; they are widely used by scientists studying recombinant DNA, because DNA joined to a plasmid can be replicated.
- A **genetic marker** is a gene that is used to differentiate a cell that carries a recombinant plasmid from those that do not.

Transgenic Organisms **Transgenic** organisms contain genes from other species. They result from the insertion of recombinant DNA into the genome of the host organism. A **clone** is a member of a population of genetically identical cells.

Copying DNA

For Questions 1–5, complete each statement by writing in the correct word or words.

1. Genetic engineers can transfer _____ from one organism to another.

2. As a first step toward finding a gene, Douglas Prasher studied the _____ sequence of part of a protein.

3. Prasher next found the _____ base sequence that coded for the protein.

Name _____ Class _____ Date _____

4. Using the technique of _____, Prasher matched the mRNA to a DNA fragment that contained the gene for GFP.

5. Southern blot analysis uses _____ probes to bind to fragments with complementary base sequences.

6. **THINK VISUALLY** Make a sketch to show the steps in the polymerase chain reaction (PCR) method of copying genes. Label each part of your sketch.

Changing DNA

For Questions 7–10, write the letter of the correct answer on the line at the left.

_____ **7.** Why is DNA ligase so important in recombinant DNA technology?

A. It causes DNA to make multiple copies of itself.

B. It joins two DNA fragments together.

C. It shapes bacterial DNA into a circular plasmid.

D. It cuts DNA into restriction fragments.

_____ **8.** A recombinant plasmid can be used to

A. prevent nondisjunction at meiosis.

B. double the number of chromosomes in a plant cell.

C. cut DNA into restriction fragments.

D. transform a bacterium.

Name _____ Class _____ Date _____

_____ **9.** What do genetic engineers use to create the "sticky ends" needed to splice two fragments of DNA together?

A. an amino acid sequence

B. DNA ligase

C. restriction enzymes

D. mRNA

_____ **10.** Why must a genetically engineered plasmid contain a genetic marker?

A. to prevent the construction of an artificial chromosome

B. to separate cells that contain recombinant DNA from those that do not

C. to produce multiple copies of the recombined plasmid after heat treatment

D. to break apart the circular plasmid and introduce another DNA fragment

11. Give a reason why a plasmid is useful for DNA transfer.

_____

_____

_____

_____

Transgenic Organisms

12. Complete the flowchart about how a transgenic plant is produced, using *Agrobacterium* as an example.

Agrobacterium can cause tumors in plants. The part of the DNA that causes tumors is deactivated and replaced with _____ DNA.

↓

The _____ bacteria are placed in a dish with plant cells. The bacteria infect the plant cells.

↓

Inside a plant cell, *Agrobacterium* inserts part of its DNA into the host cell _____.

↓

A _____ is generated from the transformed cell.

Name _____ Class _____ Date _____

13. What is a transgenic organism?

_____

_____

14. What can happen when DNA is injected into the nucleus of an animal's egg cell?

_____

_____

15. How is a DNA molecule constructed so that it will eliminate a particular gene?

_____

_____

_____

16. What is a clone?

_____

_____

17. What kinds of mammals have been cloned in recent years?

_____

_____

For Questions 18–22, write True if the statement is true. If the statement is false, change the underlined word to make the statement true.

_____ **18.** An organism that contains one or more genes from another species is inbred.

_____ **19.** Transgenic organisms can be made by inserting recombinant DNA into the genome of the host organism.

_____ **20.** Examining the properties of a transgenic organism allows scientists to discover the function of the transferred chromosome.

_____ **21.** Plant cells will sometimes take up DNA on their own if their cell walls are absent.

_____ **22.** Carefully designed DNA molecules can achieve gene replacement.

On the lines below, write T *next to an example of a transgenic organism, and* C *next to an example of a clone.*

_____ **23.** A goat that produces spider's silk in its milk

_____ **24.** A plant that is grown from a cell into which *Agrobacterium* has incorporated recombinant DNA

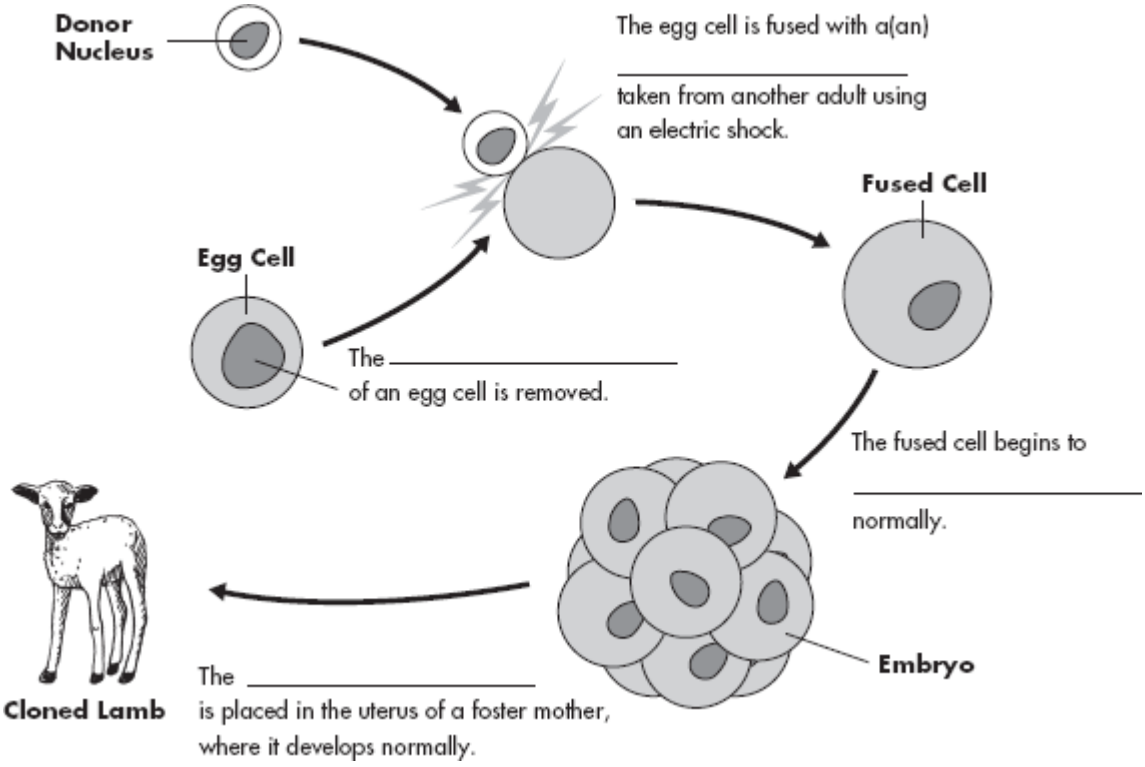
_____ **25.** A lamb that is born with the same DNA as a donor cell

_____ **26.** A colony of bacteria that grows from one bacterium

_____ **27.** A bacterium that can produce human insulin

Name _____ Class _____ Date _____

28. **THINK VISUALLY** Complete the sentences in the diagram below to show the steps in cloning a sheep.



Apply the Big idea

29. The most successful heart transplants occur when proteins in the donor heart closely match those of the recipient's original heart. If the proteins don't match, the recipient's immune system may reject the transplanted organ. Scientists would like to develop a strain of transgenic pigs that could provide donor hearts for humans. How might such an animal be developed? How might cloning help provide hearts for human recipients?

Name _____ Class _____ Date _____

15.3 Applications of Genetic Engineering

Lesson Objectives

- Describe the benefits of genetic engineering as they relate to agriculture and industry.
- Explain how recombinant DNA technology can improve human health.
- Summarize the process of DNA fingerprinting and explain its uses.

Lesson Summary

Agriculture and Industry Genetic engineers work to improve the products we get from plants and animals.

- Genetically modified crops may be more nutritious or higher yielding. They may be resistant to insects, diseases, or spoilage. Some can produce plastics.
- Genetically modified animals may produce more milk, have leaner meat, or contain higher levels of nutritious compounds. Transgenic salmon grow rapidly in captivity. Transgenic goats produce spider silk in their milk.

Health and Medicine Recombinant DNA studies are leading to advances in the prevention and treatment of disease.

- Examples include vitamin-rich rice, human proteins made in animals, animal models of human disease (for research), and bacteria that produce human insulin.
- **Gene therapy** is the process of changing a gene to treat a disorder. However, gene therapy is still an experimental and high-risk technique.
- Genetic testing can identify hundreds of inherited disorders.

Not all genes are active in every cell. **DNA microarray** technology lets scientists study thousands of genes at once to determine their activity level.

Personal Identification **DNA fingerprinting** analyzes sections of DNA that may have little or no function but that vary from one individual to another.

- DNA fingerprinting is used in **forensics**—the scientific study of crime-scene evidence—to identify criminals. It is also used to identify the biological father when paternity is in question.
- Common ancestry can sometimes be determined using mitochondrial DNA (mtDNA) and Y-chromosome analysis.

Agriculture and Industry

1. Give two examples of how genetically modified organisms lead to more environmentally friendly agricultural practices.

a. _____

b. _____

Name _____ Class _____ Date _____

2. Name two other benefits that may be gained from genetically engineering food crops.

a. _____

b. _____

3. Give two examples of how DNA modification has increased the importance of transgenic animals to our food supply.

a. _____

b. _____

Health and Medicine

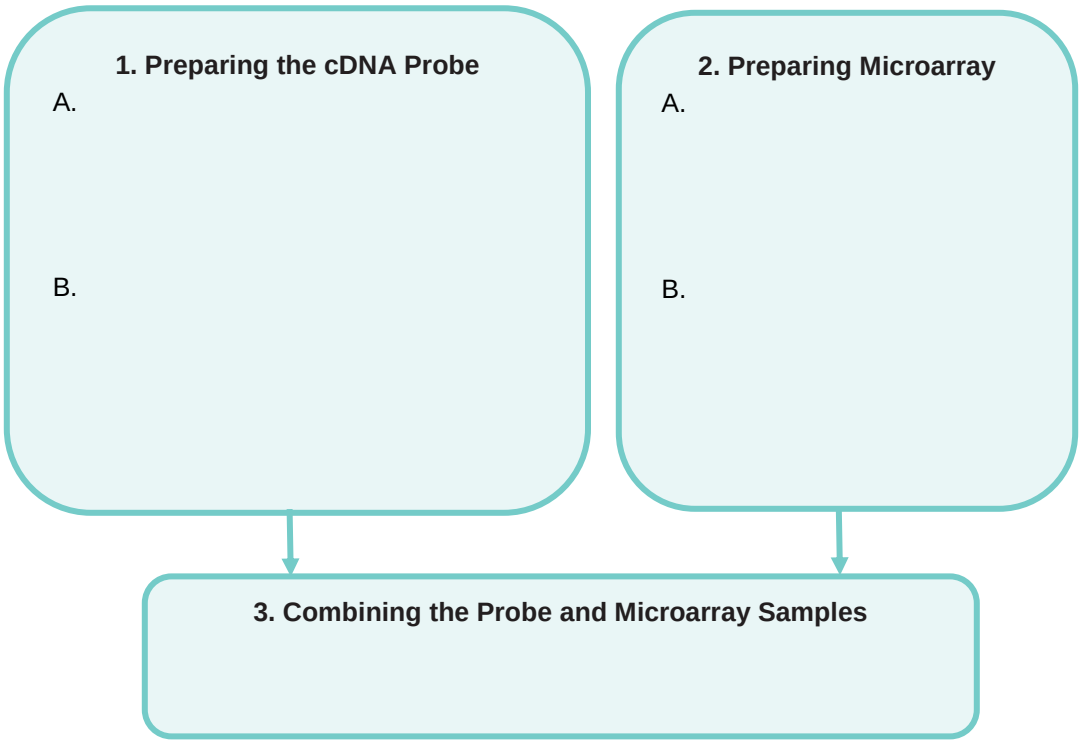
For Questions 4–6, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ **4.** Human growth hormone is now widely available because it is mass produced by recombinant viruses.

_____ **5.** In DNA fingerprinting, an absent or faulty gene is replaced by a normal, working gene.

_____ **6.** Prospective parents can find out if they carry the alleles for a genetic disease through genetic testing.

7. Complete the flowchart to show the steps required to analyze gene activity using a microarray.



Name _____ Class _____ Date _____

Personal Identification

8. Complete the flowchart about how DNA fingerprints are made.

Restriction _____ are used to cut the DNA into fragments containing genes and repeats.

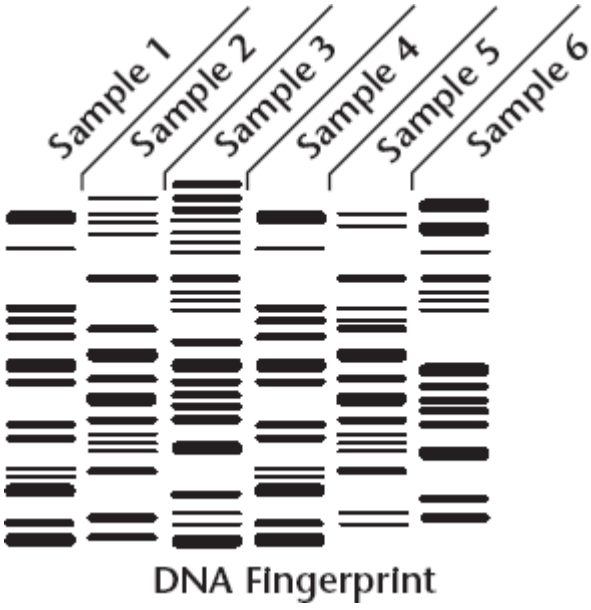
↓

The restriction fragments are separated according to size using gel _____.

↓

The DNA fragments containing repeats are then labeled using radioactive _____. This labeling produces a series of bands—the DNA fingerprint.

9. Study the DNA fingerprint below. Which two samples may be from a set of identical twins? How do you know?



DNA Fingerprint

_____

Apply the Big idea

10. In 2001, scientists reported the successful use of gene therapy to treat three dogs that had been born blind. The animals' blindness was the result of a mutated gene. Explain the steps that the scientists probably would have used to restore sight to the dogs.

_____

_____

_____

Name _____ Class _____ Date _____

15.4 Ethics and Impacts of Biotechnology

Lesson Objectives

- Describe some of the issues that relate to biotechnology.
- Identify some of the pros and cons of genetically modified food.
- Describe some of the ethical issues relating to biotechnology.

Lesson Summary

Profits and Privacy Most of the research in genetic engineering is done by private companies.

- They patent their findings and inventions to protect their investment and make a profit.
- The patents block other scientists from pursuing certain lines of research.
- In 2007, the Genetic Information Nondiscrimination Act was signed into law in the United States. It prohibits discrimination based on genetic information.

Safety of Transgenics There is controversy about the safety of GM foods.

- Proponents of genetically modified foods argue that GM crops are better, safer, and higher yielding than conventional crops. GM crops require less land and energy to grow, and insecticides need not be applied to insect-resistant strains. Careful studies have provided no support for concerns about the safety of GM crops.
- Opponents argue that the safety of GM crops has been neither adequately tested for long-term use, nor regulated. Patents on GM seeds may force small farmers out of business. The resistance of GM plants to insects may harm beneficial insect species. Resistance to herbicides may result in the overuse of toxic chemicals.
- Some states have introduced legislation to require that GM foods be labeled.

Ethics of the New Biology Few argue that gene therapy for curing disease is ethically wrong, but many ask the question of how far genetic modification should go.

- Is it right to try to engineer children to have certain characteristics?
- Should human cloning be allowed?

Profits and Privacy

1. Should you be able to keep your genetic information confidential? State two answers: one giving a reason for a "yes" answer, and the other giving a reason for a "no" answer.

Yes _____

_____

_____

No _____

_____

_____

Name _____ Class _____ Date _____

2. Explain what the Genetics Information Nondiscrimination Act is, and give an example of how it might protect people.

_____

_____

_____

Safety of Transgenics

3. Complete the table to summarize the pros and cons of genetically modified foods. List at least four items in each column.

Pros	Cons

For Questions 4–8, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

_____ **4.** Most GM plants are grown in the United States.

_____ **5.** Growing GM crops requires more energy resources than growing traditional crops.

_____ **6.** With all the questions raised about GM agriculture, the wider use of biotechnology has been blocked.

_____ **7.** Federal laws in the U. S. require that GM foods be labeled as such.

_____ **8.** GM foods are required to undergo safety testing before they enter the U. S. market.

Name _____ Class _____ Date _____

9. Some proponents of GM agriculture argue that GM crops are safer than others. Explain what they mean.

_____

_____

10. Some critics of GM agriculture fear that GM plants' resistance to herbicides could result in the overuse of toxic chemicals. Explain why this may happen.

_____

_____

_____

Ethics of the New Biology

11. It is easy to move genes from one species to another. Is it right to do this? Explain your position.

_____

_____

_____

_____

Apply the Big idea

12. Recent developments have resulted in the ability to clone cats. Many people argue that cloning offers pet owners comfort in a time of need. Others argue that there are many homeless pets at shelters in need of homes, and that adopting one of these animals is a better solution for owners who have lost a pet. Do you think that the cloning of pets is acceptable? Explain why or why not.

_____

_____

_____

_____

_____

_____

_____

Name _____ Class _____ Date _____

Chapter Vocabulary Review

For Questions 1–8, complete each statement by writing in the correct word or words.

1. _____ consists of allowing only those organisms with particular characteristics to produce the next generation.

2. In the process called _____, dissimilar organisms are crossed in order to obtain bigger or stronger offspring.

3. When organisms that are genetically similar are crossed over and over to produce the next generation, the process is called _____.

4. _____ is the application of a technological process, invention, or method to living organisms.

5. The technology that makes copies of DNA is called_____.

6. The DNA that results from the transfer of DNA from one organism into another is _____.

7. The small, circular DNA molecule in a bacterial cell is a(n) _____.

8. A gene that allows scientists to distinguish a cell that carries recombinant DNA from one that does not is a(n) _____.

For Questions 9–15, match the term with its definition.

Definition

_____ **9.** One of a population of genetically identical cells produced from a single cell

_____ **10.** A technique that allows the identification of individuals using differences in their DNA

_____ **11.** A technique that allows scientists to study thousands of genes at once

_____ **12.** Containing genes from another species

_____ **13.** Treating a disease by changing a gene

_____ **14.** The scientific study of evidence from a crime scene

_____ **15.** A gene that scientists use to find transformed bacteria

Term

A. transgenic

B. clone

C. gene therapy

D. DNA microarray

E. DNA fingerprinting

F. forensics

G. genetic marker

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

_____ **16.** Hybridization and inbreeding are both types of

A. gene therapy. **C.** transgenics.

B. forensics. **D.** selective breeding.

_____ **17.** Because of their replication process, plasmids are excellent carriers of

A. genetic markers. **C.** clones.

B. recombinant DNA. **D.** transgenics.