

CHAPTER 13**Frontiers of Genetics****Summary of Key Concepts****Concept 13.1** Biologists have learned to manipulate DNA. (pp. 266–267)

The use of organisms to perform tasks for humans is called *biotechnology*. Today, a major area of biotechnology involves changing the genomes of organisms using DNA technology. For example, scientists use *recombinant DNA technology* to combine genes from different organisms or species. Another area of research involves sequencing the genomes of many organisms. This information can lead to advances in medicine, agriculture, and other fields.

1. What is biotechnology? _____

2. What does recombinant DNA technology allow scientists to do? _____

Concept 13.2 Biologists can engineer bacteria to make useful products. (pp. 268–273)

Many bacteria contain *plasmids*, which are small, circular DNA molecules that are separate from the much larger bacterial chromosome. Biologists use plasmids to move genes into bacteria. A *restriction enzyme* “cuts” a DNA molecule into fragments at specific points. Another enzyme “pastes” a fragment carrying a particular gene into a plasmid. Then the plasmid is put back into a bacterial cell. When the bacterial cell reproduces, it creates clones, or identical copies, of the desired gene. A *genomic library* is the complete collection of cloned DNA fragments from an organism. Scientists use nucleic acid probes to locate specific genes in a genomic library. A *nucleic acid probe* is a molecule that has been labeled with radioactivity, making it easy to detect. Bacteria are genetically engineered to produce pesticides, medicines, and hormones such as insulin.

3. What role do plasmids play in genetic engineering? _____

4. List some of the products bacteria have been genetically engineered to produce. _____

Concept 13.3 Biologists can genetically engineer plants and animals. (pp. 274–277)

Any organism that has acquired one or more genes by artificial means is called a *genetically modified organism (GMO)*. If the new genetic material came from a different species, the GMO is referred to as *transgenic*. Many plants have been genetically modified to resist herbicides, pest insects, and fungi. To genetically modify a plant, researchers insert a plasmid containing

the desired gene into a plant cell. To genetically modify a mammal, the desired gene is inserted into a fertilized egg. The egg is then returned to a female animal's body. In this way researchers have developed animals with genes for desired traits, such as pigs with leaner meat.

Entire genomes can also be cloned. Plants can be cloned from cuttings. Cloning animals involves replacing the nucleus of an egg cell with another cell's nucleus.

GMOs have created controversy. Some people wonder whether GMOs might be harmful to human health or the environment. For example, there is concern that human proteins produced by GMOs might differ slightly from natural human proteins and cause problems for the people receiving them.

5. What is a GMO? _____

6. Identify some of the ways biologists have genetically engineered plants and animals. _____

Concept 13.4 DNA technologies have many applications. (pp. 278–280)

The *polymerase chain reaction (PCR)* is a technique that makes billions of identical DNA molecules in just a few hours. It is used to produce large enough samples of DNA for further analysis. *Gel electrophoresis* is a technique for sorting DNA fragments by length. Shorter fragments pass more quickly through the electrically charged gel than longer fragments. DNA fragments often are analyzed for *genetic markers*. These are particular stretches of DNA that vary from person to person. Each person's DNA fragments produce a unique pattern of banding, called a *DNA fingerprint*.

7. How is PCR used? _____

8. How does gel electrophoresis sort DNA fragments? _____

Concept 13.5 Control mechanisms switch genes on and off. (pp. 281–285)

In prokaryotes, clusters of genes are controlled by two short stretches of DNA called control sequences. A cluster of genes, along with its two control sequences, is called an *operon*. One control sequence, the *promoter*, is a binding site for an enzyme needed in DNA transcription. The other control sequence, the *operator*, switches the promoter on and off. A protein called the *repressor* turns the operator off by binding to it. This process enables prokaryotes to match their cell chemistry to different conditions.

Eukaryotic cells have more complicated ways of regulating genes. *Gene expression* is the transcription and translation of genes into proteins. Some genes have promoter sequences that are regulated by proteins called *transcription factors*. Transcription factors are controlled by chemical signals in the cell.

In organisms with many cells, individual cells become more specialized in structure and function as the organism develops. This process is called *cellular differentiation*. An exception is *stem cells*, cells that remain able to differentiate into various other types of cells.

Studying the effects of mutations in genes helps scientists understand gene expression. Scientists have learned that master control genes, called *homeotic genes*, produce proteins that regulate the expression of other genes.

9. How are genes regulated in prokaryotes? _____

10. What is gene expression? _____

Reading Skills Practice

Listing key ideas Make a list of the key ideas under the heading Comparing DNA on pages 279–280.

Vocabulary Review and Reinforcement

In 1–5, write true if the statement is true. If the statement is false, replace the underlined term with a term that makes the statement true.

- _____ 1. The use of organisms to perform tasks for humans is called biotechnology.
- _____ 2. A small, circular DNA molecule found in bacteria is known as a(n) operon.
- _____ 3. If a genetically modified organism receives new genetic material from a different species, the organism is said to be homeotic.
- _____ 4. A cluster of genes, along with its control sequences, is called a(n) operator.
- _____ 5. The first control sequence in an operon is the promoter.

In 6–13, fill in the blank with the appropriate term from the chapter.

6. Combining genes from different sources is called _____ technology.
7. The “tools” used to cut DNA are _____.
8. The complete collection of cloned DNA fragments from one organism is called a(n) _____.
9. A technique for sorting DNA fragments by length is _____.
10. Particular stretches of DNA that vary from person to person are referred to as _____.
11. The unique banding pattern produced by a person’s DNA fragments is his or her _____.
12. In prokaryotes, a protein that binds to the operator and blocks the promoter is called a(n) _____.
13. Groups of cells that remain undifferentiated during development are called _____.

In 14–18, write the letter of the correct definition on the line next to each term.

- | | |
|-----------------------------------------------|--------------------------------------------------------------------------------------------|
| _____ 14. nucleic acid probe | a. protein that regulates transcription in eukaryotes by binding to promoters |
| _____ 15. genetically modified organism (GMO) | b. process in which cells become increasingly specialized in structure and function |
| _____ 16. polymerase chain reaction (PCR) | c. radioactively labeled nucleic acid molecule |
| _____ 17. transcription factor | d. organism that has acquired one or more genes by artificial means |
| _____ 18. cellular differentiation | e. technique that makes many copies of a certain segment of DNA without using living cells |

WordWise

Answer the questions by writing the Key Terms in the blanks. Then put the numbered letters in order to find the hidden Key Term. Write a definition for the hidden Key Term.

- What three letters stand for a technique that can make billions of identical molecules in just a few hours?

 1
- What type of cell remains undifferentiated as the organism develops?

 2
- In a prokaryote, what control sequence turns the promoter on and off?

 3
- What term describes an organism that has acquired new genetic material from a different species?

 4
- What three letters are used to refer to any organism that has acquired one or more genes by artificial means?

 5
- What type of gene is a master control gene that directs development of body parts in specific locations in many organisms?

 6
- What is the unique banding pattern produced by a person’s DNA fragments?

 7

Key Term: _____
 1 2 3 4 5 6 7

Definition: _____
