

## 20.3 Diseases Caused by Bacteria and Viruses

### Lesson Objectives

- Explain how bacteria cause disease.
- Explain how viruses cause disease.
- Define emerging disease and explain why emerging diseases are a threat to human health.

### Lesson Summary

**Bacterial Diseases** Microorganisms that cause diseases are known as **pathogens**. Bacterial pathogens can produce many diseases that affect humans and other animals. They do so in one of two general ways:

- ▶ They destroy living cells and tissues directly or by causing an immune response that destroys tissue.
- ▶ They damage the cells and tissues of the infected organism directly by breaking down the cells for food.
- ▶ They release toxins (poisons) that travel throughout the body, interfering with the normal activity of the host.

Many bacterial pathogens can be controlled by washing, using disinfectants, preparing and storing food safely, or sterilizing exposed items. Bacterial diseases can be prevented and treated through the following methods:

- ▶ A **vaccine** is a preparation of weakened or killed pathogens or inactivated toxins. A vaccine can prompt the body to produce immunity to the disease. Immunity is the body's natural way of killing pathogens.
- ▶ When a bacterial infection does occur, **antibiotics** can be used to fight the disease. Antibiotics are compounds that block the growth and reproduction of bacteria.

**Viral Diseases** Viruses produce disease by directly destroying living cells or by affecting cellular processes in ways that disrupt homeostasis. In many viral infections, viruses attack and destroy certain body cells, causing the symptoms of the disease. Viral diseases in humans include the common cold, influenza, AIDS, chicken pox, and measles. Viruses produce other serious diseases in other animals and in plants. Protection against viruses, either by hygiene or vaccination, is the best way to avoid viral illness. A handful of antiviral drugs have been developed that help reduce the symptoms of specific viruses.

**Emerging Diseases** An unknown disease that appears in a population for the first time or a well-known disease that suddenly becomes harder to control is called an **emerging disease**. The increase of worldwide travel and food shipments is one reason new diseases are spreading. Another is virus and bacteria evolution. Scientists are struggling to keep up with changes. They recently discovered **prions**, which are disease-causing forms of proteins. Prions cause disease in animals, including humans.

## Bacterial Diseases

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

- One way bacteria can cause disease is by breaking down and damaging cells (or tissues) of the infected organism.
- Bacteria can also cause disease by releasing toxins that harm the body.
- A(n) pathogen is a disease-causing agent.
- One way to control bacterial growth is by subjecting the bacteria to high temperatures during a process known as sterilization.
- A(n) vaccine is a preparation of weakened or killed pathogens or inactivated toxins that can prompt the body to produce immunity to a disease.
- What organs do the bacteria that cause tuberculosis typically damage?  
the lungs
- What are antibiotics?  
They are compounds that block the growth and reproduction of bacteria.
- How are the causes of tuberculosis and diphtheria similar? How are they different?  
Both are caused by bacteria. However, the bacteria that cause tuberculosis break down tissue, whereas the bacteria that cause diphtheria release toxins.
- Describe the similarities and differences of antibiotics and disinfectants.  
Both kill bacteria. Antibiotics are compounds that kill bacteria in an organism. Disinfectants are chemical solutions that kill bacteria on surfaces.
- Why should meat be cooked until it is well-done?  
Cooking meats until they are well done raises the temperature of the meat to a point at which bacteria are killed.

Match the bacterial control method with an example of the method.

Bacterial Control Method	Example
<u>D</u> 11. physical removal	A. Putting milk in a refrigerator
<u>B</u> 12. disinfectant	B. Using bleach to clean a countertop
<u>A</u> 13. safe food storage	C. Using boiling water to clean dishes
<u>E</u> 14. safe food processing	D. Washing hands
<u>C</u> 15. sterilization by heat	E. Boiling soup

## Viral Diseases

16. What are some human diseases caused by viruses?

**SAMPLE ANSWER: AIDS, influenza, and the common cold**

17. How do antiviral medications work? Why don't they also kill host cells?

**They attack specific viral enzymes. Hosts do not have these enzymes.**

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

- B   18. A person has a low helper-T cell count. What viral disease does he or she most likely have?
- |         |                |
|---------|----------------|
| A. HPV  | C. hepatitis B |
| B. AIDS | D. chicken pox |
- D   19. A person has blister-like lesions on the skin. What viral disease does he or she most likely have?
- |         |                |
|---------|----------------|
| A. HPV  | C. hepatitis B |
| B. AIDS | D. chicken pox |

## Emerging Diseases

For Questions 20–24, write *True* if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- True   20. Pathogens are able to evolve over time.
- emerging   21. A(n) noninfectious disease is an unknown disease that appears in a population for the first time.
- antibiotics   22. The widespread use of vaccines has led to the emergence of resistant strains of bacteria.
- True   23. Slight genetic changes would be needed for the bird flu virus to become infectious to humans.
- prions   24. Scrapie is most likely caused by pathogens known as viroids.

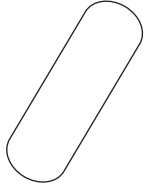
### Apply the Big idea

25. RNA viruses have shown an ability to evade antiviral drugs. How do you suppose this is possible, when viruses are not alive? How may the reproductive methods of viruses help the process?

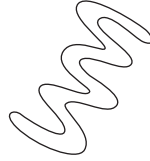
**SAMPLE ANSWER: Viruses reproduce quickly, so their genetic makeup can also change quickly. The DNA of RNA viruses must be translated by the host cell. This allows the opportunity for mutations to occur. Also, many RNA viruses are made inside one cell before bursting forth. They may exchange genetic information at that time. This genetic variation allows them to evolve.**

## Chapter Vocabulary Review

1. The picture shows three different bacteria shapes. Label each shape.



**bacillus**



**spirillum**



**coccus**

Match the term with its definition.

**Term**

- F**   2. lysogenic infection
- B**   3. prion
- K**   4. bacteriophage
- A**   5. antibiotic
- E**   6. virus
- J**   7. prokaryote
- C**   8. prophage
- G**   9. pathogen
- I**   10. lytic infection
- D**   11. endospore
- L**   12. binary fission
- H**   13. vaccine

**Definition**

- A.** Compound that can block the growth and reproduction of bacteria
- B.** Misfolded protein that causes disease in animals
- C.** Bacteriophage DNA that is embedded in the host's DNA
- D.** Protective structure formed by a prokaryote when growth conditions are unfavorable
- E.** A particle made of nucleic acid, protein, and in some cases, lipids that can replicate only by infecting living cells
- F.** Process in which viral DNA becomes part of a host cell's DNA
- G.** Disease-causing microorganism
- H.** Preparation of weakened or killed pathogens or inactivated toxins used to produce immunity
- I.** Process in which a host cell bursts after being invaded by a virus
- J.** Organism consisting of one cell that lacks a nucleus
- K.** Virus that infects bacteria
- L.** Process in which a bacterium replicates its DNA and divides in half

Complete each statement by writing the correct word or words.

- 14. A protein coat surrounding a virus is a(n)   **capsid**  .
- 15. Viruses that have RNA as their genetic material are called   **retroviruses**  .
- 16. Some bacteria exchange genetic material through the process of   **conjugation**  .
- 17. SARS, MRSA, Ebola, and bird flu are all examples of   **emerging diseases**  .

## CHAPTER MYSTERY

### THE MAD COWS



The Chapter Mystery investigated the 1986 outbreak of “mad cow” disease (also known as bovine spongiform encephalopathy, or BSE) in the United Kingdom. Subsequent outbreaks occurred around the world, and controversy about how to deal with the disease continues today.

21st Century Learning

## Assuring the Safety of the Beef Supply

The Kansas-based beef producer Creekstone Farms Premium Beef, Inc. filed a lawsuit against the United States Department of Agriculture (USDA) over BSE testing. Creekstone Farms claims that its export sales plummeted after a cow infected with BSE was found in the United States in 2003. To combat its losses, Creekstone sought to conduct its own BSE testing on every cow it slaughtered to assure consumers, and especially foreign buyers, of the beef’s safety. Creekstone argued that this would be an improvement over the USDA’s testing procedures because the USDA only tests approximately 1 percent of all U.S. beef.

However, the USDA argues that the regulation of U.S. beef falls solely under its jurisdiction and that it cannot allow a private company to conduct its own testing because the agency cannot oversee the testing to insure its reliability. Furthermore, a beef producer would have a conflict of interest in reporting accurate results of any BSE tests it conducts.

As it currently stands, the appeals court sided with the USDA, preventing Creekstone from conducting its own BSE tests on its meat. Read the document below, which is adapted and excerpted from the appeals court verdict:

### United States Court of Appeals

No. 07-5173

Creekstone Farms Premium Beef, L.L.C.

v.

Department of Agriculture

Bovine Spongiform Encephalopathy, or BSE, was first diagnosed in the United Kingdom in 1986. Since then, more than 189,000 confirmed cases of BSE in cattle worldwide have been reported. While almost all of the cases (95 percent) have occurred in the United Kingdom, BSE has been found in cattle raised in at least 25 other countries as well. Despite prevention efforts by the U.S. government, three BSE-infected cows have been found in the United States. The first was reported in December 2003 in Washington State. Two more BSE-infected cattle were found—one in Texas in June 2005 and one in Alabama in March 2006.

Following the discovery of the first BSE-infected cow in Washington State, several major beef importing countries, including Japan, South Korea and Mexico, (at the time, three of the four largest importers), banned the importation of U.S. beef. Creekstone claims to have suffered \$200,000 per day in lost revenue as a result of the diminished export market.

To allay the concerns of consumers and importers, in 2004 Creekstone made a “business decision” to perform a rapid BSE test on each cow it slaughtered. Creekstone sought to purchase rapid BSE test kits from Bio-Rad Laboratories, Inc. Bio-Rad informed Creekstone, however, that it could not sell Creekstone the kits without USDA authorization. On February 19, 2004, Creekstone requested USDA permission to purchase the test kits. USDA denied Creekstone’s requests. Creekstone challenged the USDA’s action in court.

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## 21st Century Themes Science and Civic Literacy; Science and Health Literacy

1. Where and when was BSE first diagnosed?

*BSE was first diagnosed in the United Kingdom in 1986.*

2. How many BSE-infected cows have been found to date in the United States? When and where did the incidents occur?

*To date there have been three cases of BSE-infected cows in the United States:*

*one in Washington State in 2003, one in Texas in 2005, and one in Alabama in 2006.*

3. Which countries stopped importing beef from the United States after the first U.S. incident of a BSE-infected cow in December, 2003?

*Japan, South Korea and Mexico banned imports of U.S. beef in the aftermath of the 2003 BSE incident.*

4. How much does Creekstone contend it lost in revenue each day from the drop in exports?

*Creekstone says it lost \$200,000 per day as a result of diminished exports.*

5. Infer what the key arguments on each side of the case are. Why does Creekstone think it should be able to conduct its own additional BSE testing? Why does the USDA oppose the idea?

*SAMPLE ANSWER: Creekstone wants to conduct its own tests to assure customers of its beef's safety, especially the export market. The USDA does not want to set the precedent of allowing beef producers to regulate themselves.*

## BSE Testing Debate

**21st Century Skills** The skills used in this activity include **information and media literacy; communication skills; critical thinking and systems thinking; problem identification, formulation, and solution; and creativity and intellectual curiosity.**

Search the Internet to find the actual U.S. appeals court verdict in the Creekstone case. The verdict is filled with legal terminology, but it also offers a wealth of information about the case. Skim the main decision by Judge Karen Henderson, the concurring opinion by Judge Rogers, and the dissenting opinion by Chief Judge Sentelle. Then look for news articles about the case. The legal details might seem complicated, but the underlying issues in the case are clear. Both sides make strong arguments: Creekstone wants more testing to assure its customers; USDA feels that the safety of the beef supply must be regulated by a government agency because companies should not be trusted to regulate their own products. What do you think? Identify some of the different aspects of the problem raised in this case.

*Divide into working groups to debate the issue in class.*

*Evaluate students' participation in the debate by their inclusion of facts supporting their decision. They should be able to distinguish fact from opinion and supporting arguments from opposing arguments.*