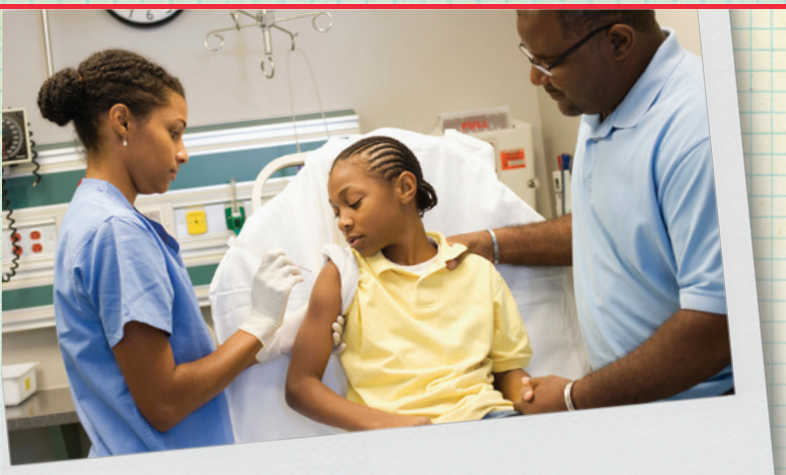

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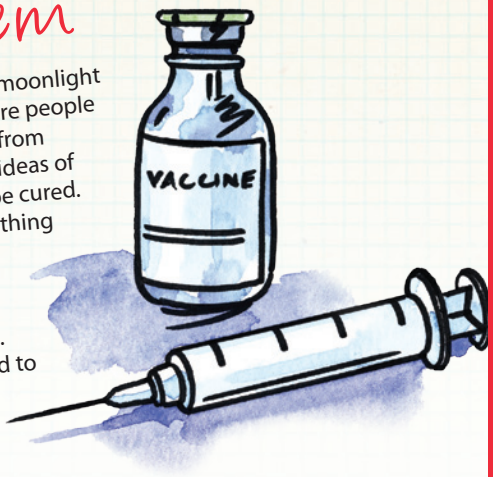
Immune System



What would you think if you were told that moonlight and swamp vapors made you get sick? Before people understood how diseases were contracted from person to person, they had many different ideas of how diseases spread and how they could be cured. At one time, some people believed that bathing weakened the body and caused people to get sick more often. Sometimes people practiced bloodletting, allowing the "bad blood" to drain from a person's body. Unfortunately, the person sometimes bled to death. Today people know more about how diseases spread. We know that healthy habits, such as handwashing, actually slow the spread of disease. But even though much suffering and disease remain in this world, God is still in control. He is much more powerful than any disease (Matt. 9:35).

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Student Text diagrams
Diagrams from the Student Text are included on the Teacher's Toolkit CD for display.

Chapter preview
Other preview and prereading activities may include using a K-W-L chart, a probe, or an anticipation guide.

Objectives

- Recognize that man's inferences are sometimes inaccurate
- Preview the chapter content

Introduction

If you got a cold the day after having taken a bath, would you conclude that the bath caused the cold?
Answers will vary.

People have always tried to find the causes of diseases. Some of their conclusions were based on incomplete information or faulty reasoning. Some of their solutions were comical, but others were very unhealthy.

Teach for Understanding

Provide time for the student to complete Looking Ahead, Activity Manual page 241. For part B, encourage the student to think of things he would like to learn about communicable diseases and allergies. He should write his answers in question form, such as, "What causes allergies?"

Provide the answers for part A and allow the student to check his work. After the chapter is finished, you may choose to have him look back at this page and check his understanding of the items he missed.

As time allows, discuss student questions from part B about communicable diseases and allergies. You may choose to provide trade books or other resources to help answer questions that are beyond the scope of this chapter.

Allow the student to leaf through the chapter, looking at the headings, pictures, captions, charts, etc., and discuss the things he thinks he will be learning about.

Activity Manual

Preview, page 241

The Looking Ahead page is intended to assess the student's prior knowledge before beginning the chapter.

Objectives

- Recognize that disease is a consequence of Adam's sin
- Explain how diseases are classified
- Identify four common pathogens
- List some diseases caused by each pathogen

Vocabulary

communicable
pathogen
noncommunicable

Introduction

What are some health and cleanliness rules that you often hear? Possible answers: wash your hands; brush your teeth; take a bath or shower daily; avoid eating food that has been left out too long

Why are cleanliness rules important? Possible answers: to help prevent disease; to keep you healthy

Today we will be studying about some diseases and their causes.

Teach for Understanding

Purpose for reading

Why is Louis Pasteur important?

How is a virus different from other pathogens?

Discussion

Why did pain, disease, and death enter the world? because of Adam and Eve's disobedience; as a result of sin

Although God often uses doctors and medicines to heal people, is God limited by these methods? no **Explain.** Possible answers: God is more powerful than disease. The Bible records examples of God using miracles to heal illnesses and disease.

What is a miracle? Possible answer: a supernatural event that is outside the usual way in which God works

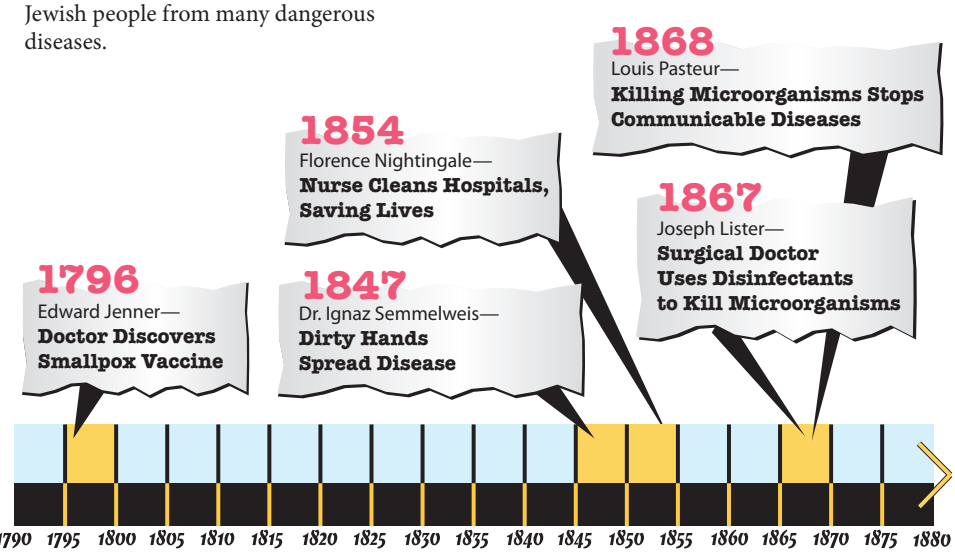
What are some possible reasons that God gave the Israelites some of the laws mentioned in the Old Testament? to promote good health habits; to protect them from dangerous diseases

Diseases

In the beginning, Adam and Eve enjoyed a perfect world. God talked to them directly each day. They did not experience pain, disease, or death. But when Adam and Eve chose to disobey God, everything changed. Not only did they experience spiritual death, but they also began to die physically. Disease and pain became part of their lives.

Although disease is a consequence of sin, God is more powerful than disease. The Bible records many instances where God miraculously healed people of diseases. He also controlled disease by sending and taking away plagues and diseases. In Old Testament times, God gave laws to the Jewish people that promoted good health habits. These laws protected the Jewish people from many dangerous diseases.

Louis Pasteur



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Louis Pasteur
Louis Pasteur (1822–1895) began his scientific career as a chemist, but his research led him from one discovery to another. His diverse accomplishments include the following: vaccinations and treatments for rabies, anthrax, chicken cholera, and silkworm diseases; fermentation and pasteurization (heating food in order to destroy harmful microbes); and showing the inaccuracy of the theory of spontaneous generation.

Pathogen
The Greek word *pathos* means "suffering." The Greek suffix *-gen* means "producer."

Why is the word *pathogen* an appropriate term for what a pathogen is? The word means "producer of suffering," and that describes what a pathogen is.

Since the suffix *-ology* means "the study of," what do you think the study of diseases is called? pathology

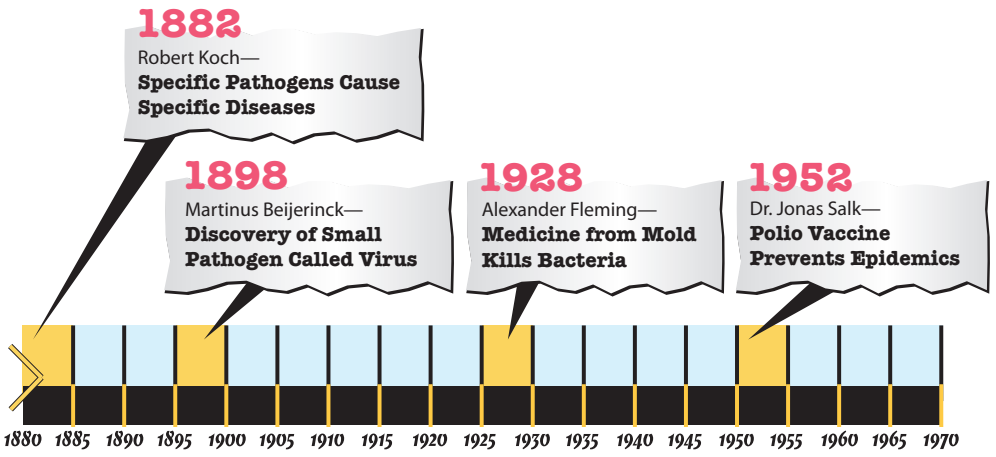
Communicable Diseases

For many years people thought that evil spirits, witches, magical spells, or bad luck caused diseases. Most people did not consider cleanliness to be essential or even important.

Louis Pasteur was one of the first scientists to identify the fact that diseases can be caused by organisms too small to be seen. He thought that if these microorganisms could be killed, then the disease would not spread further. Pasteur's germ theory of disease changed the way people thought about and treated diseases. Today doctors and scientists know even more about diseases. They classify diseases as either **communicable**, contagious, or **noncommunicable**, noncontagious.

Communicable diseases spread from person to person by pathogens. Scientists define a **pathogen** (PATH uh jun) as anything that causes a disease. Pathogens can cause diseases when they invade and attack the cells in your body. Some pathogens interfere with the normal function of your body's cells. Other pathogens produce a *toxin*, or poison, that harms the cells.

Protozoans, fungi, bacteria, and viruses are the four most common kinds of pathogens. However, there are many different types of each kind of pathogen. For example, scientists have identified more than 200 different kinds of cold viruses. Yet each pathogen can cause only one disease. Different diseases attack different cells in the body.



TEACHER HELPS

Preparing for Lesson 178

The timeline on Student Text pages 362–63 gives a possible news headline about each person mentioned. This timeline will be used in the exploration on Student Text page 383. The student may begin researching and writing his article for the exploration any time after this lesson is taught.

HISTORY

Handwashing

In the past, washing hands was not the simple task it is today. Before indoor plumbing and running water, any water used for bathing had to be drawn and carried from its natural source. Even in the early days of running water, if warm water was desired, it had to be heated on a stove or other heat source. The ideas of Dr. Semmelweis and Florence Nightingale were not only revolutionary but also time-consuming and difficult.

Discussion

What is a microorganism? an organism too small to be seen

Who was one of the first scientists to realize that microorganisms can cause disease? Louis Pasteur

What did Pasteur think would prevent the spread of diseases? killing the microorganisms that caused the diseases

How do doctors and scientists classify diseases today? as communicable or noncommunicable

What is the difference between communicable and noncommunicable diseases? Communicable diseases are contagious, and noncommunicable diseases are not contagious.

How do communicable diseases spread from person to person? by pathogens

What is a pathogen? anything that causes a disease

What are some different ways that pathogens cause diseases? Possible answers: invading and attacking cells in the body; interfering with the normal function of cells; producing toxins that harm the cells

What are the four most common kinds of pathogens? protozoans, fungi, bacteria, and viruses

Discuss the timeline.

Which doctor realized that dirty hands can spread disease? Dr. Ignaz Semmelweis

At this time in history, many doctors went from patient to patient without washing their hands. Doctors that followed Dr. Semmelweis's handwashing ideas experienced fewer patient deaths. Today handwashing is a standard procedure, but at that time, many doctors strongly disagreed with Dr. Semmelweis.

Which nurse saved many soldiers' lives by insisting on clean hospitals? Florence Nightingale

Viruses were the last of the four common pathogens to be identified. In what year were viruses discovered? 1898

For what is Edward Jenner remembered? the smallpox vaccine

A virus causes polio. How many years passed between the discovery of virus pathogens and the polio vaccine? 54

Discussion

Which organisms are the largest known pathogens? protozoans

Name a disease caused by a protozoan. malaria

What are some diseases caused by fungi? athlete's foot, ringworm

Through what part of a fungus is disease spread? spores

What is the function of spores? reproduction

Why do you think a fungal disease such as athlete's foot occurs in warm and moist places on the body? Possible answer: The warmth and moisture are needed for the spores to grow and spread.

Which pathogen causes the most infections? bacteria

Why do you think bacteria can cause so many infections? because they reproduce quickly and can be found almost anywhere

What are some infectious diseases caused by bacteria? Possible answers: leprosy, conjunctivitis, strep throat, tetanus

What is another name for conjunctivitis? pink eye

Which part of the body do tetanus bacteria attack? the nervous system

Types of pathogens

Protozoans and fungi

Protozoans are members of the kingdom Protista. These single-celled organisms are the largest known pathogens. Many protozoans live in unpurified water, such as in streams and creeks. Drinking unclean water can cause severe illness. A tropical disease called malaria is usually associated with mosquitoes. However, malaria is actually caused by a protozoan that infects a certain type of mosquito.


athlete's foot

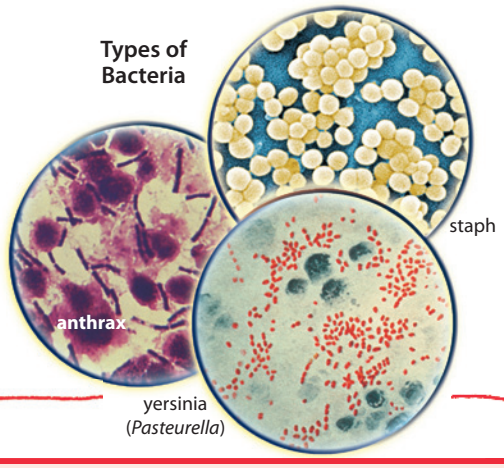
Some *fungi* cause uncomfortable diseases, such as athlete's foot and ringworm. These infections spread by direct contact with spores produced by the fungi.

Bacteria

Most infections are caused by bacteria. *Bacteria* are single-celled microorganisms that can reproduce quickly and can be found almost everywhere.

Harmful bacteria cause infections, such as leprosy, conjunctivitis, strep throat, and tetanus. Leprosy bacteria often infect the skin and peripheral nerves. The bacteria that can cause conjunctivitis (kun JUNG tuh VY tis), also called pink eye, are very similar to bacteria that cause ear infections. Strep throat bacteria attack the cells of the throat. The tetanus, or lockjaw, bacteria produce toxins that attack the nervous system. For this reason, if you step on a nail or get bitten by an animal, a doctor may give you a shot to prevent tetanus.


girl with leprosy



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SCIENCE BACKGROUND

Viruses

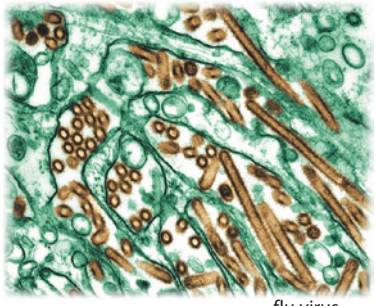
The genetic material in viruses can be either RNA or DNA. RNA acts like a genetic messenger in the cell as it carries copies of the DNA chemical code throughout the cell. The fastest virus can replicate in less than thirty minutes. Some viruses exit the host cell gradually, but others cause the cell to burst and release many viruses at once.

Other pathogens

Other pathogens include parasitic animals, such as lice and tapeworms, as well as pathogens smaller than viruses. These smaller pathogens include viroids, virusoids, and prions.

SCIENCE MISCONCEPTIONS

Students may think that all protozoans, fungi, and bacteria are harmful. But many are harmless, and some are actually beneficial to man. Yeast, penicillin, lactobacilli found in yogurt, and other bacteria found in cheese and sauerkraut are generally not harmful to man. Bacteria are also involved in the decomposition of dead plants and animals. In addition to removing unsightly waste, decomposition frees up elements and compounds to be used in other living things.



flu virus

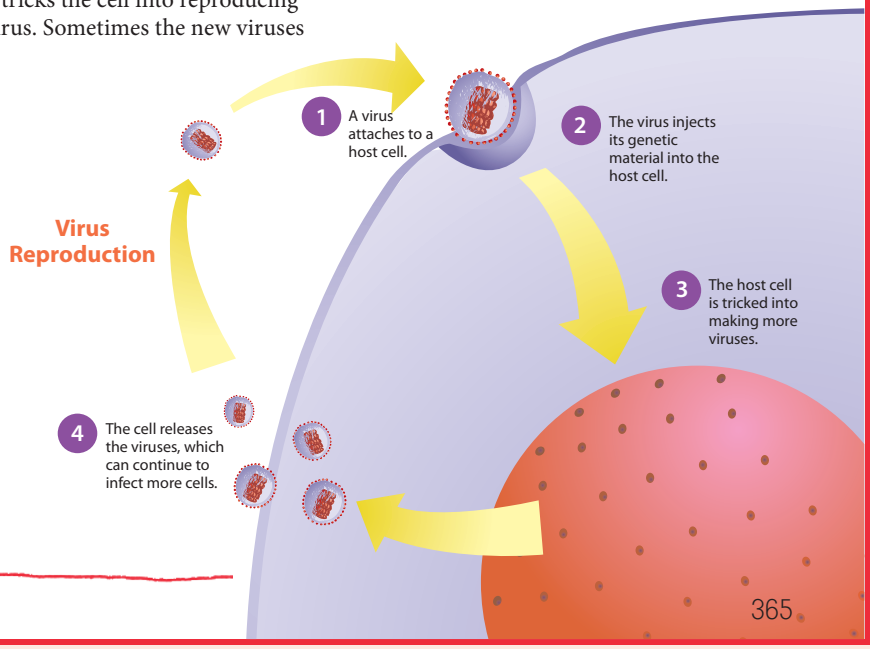
Viruses

Unlike bacteria, protozoans, and fungi, a *virus* is not a living organism. It is not made of cells. A virus usually has a protective coat and its own genetic material. It cannot move on its own and can reproduce only in cells of living organisms. A virus invades a cell by injecting its genetic material into it. Once inside the host cell, the virus tricks the cell into reproducing the virus. Sometimes the new viruses are released gradually. At other times, the increasing number of viruses causes the host cell to explode. These new viruses then attack other cells and repeat the process.

Viruses can reproduce quickly, but they cannot attack every cell. A specific virus attacks only a specific type of cell. Viruses are some of the smallest known pathogens. They can cause colds, chickenpox, flu, rabies, hepatitis, and many other diseases.

QUICK CHECK

1. Into what two groups do scientists classify diseases?
2. What is a pathogen?
3. What are the four common types of pathogens?



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BIBLE

Leprosy

Most Bible scholars agree that when the Bible describes "leprosy" the term includes leprosy, other skin diseases, some molds, and other fungi. The Old Testament laws helped prevent the spread of highly contagious diseases. Leprosy can be compared to sin, since leprosy comes upon the body, spreads, and cripples, just like sin does in our spiritual lives.

Discussion

How are viruses different from bacteria, protozoans, and fungi? Possible answer: A virus is not a living organism. It is not made of cells, and it cannot move on its own.

Why do we say that a virus cannot be a living organism? A virus is not made of cells. According to the cell theory, a living organism must be made up of cells.

What does a virus need in order to reproduce? cells of a living organism

How do most viruses reproduce? A virus invades a cell by injecting its genetic material into the cell. Then the virus tricks the cell into reproducing the virus. The viruses are then released from the cell and attack other cells.

What are some diseases caused by viruses? Possible answers: colds, chickenpox, flu, rabies, hepatitis

Answers

1. communicable and noncommunicable
2. anything that causes a disease
3. protozoans, fungi, bacteria, and viruses

Activity Manual

Reinforcement, page 242

Lesson 172

Student Text pages 366–69
Activity Manual pages 243–44

Objectives

- Identify and explain several ways that pathogens are spread
- Differentiate between communicable diseases and noncommunicable diseases
- Explain some of the jobs of an epidemiologist

Vocabulary

vector
epidemic
airborne pathogen
contact
food-borne pathogen
waterborne pathogen
epidemiologist

Introduction

What are some diseases that you are familiar with? Answers will vary.

Which of these diseases are communicable, and which are noncommunicable? Answers will vary.

How do you think people get diseases? Answers will vary.

Today we will study how diseases spread and about scientists who track diseases.

Teach for Understanding

Purpose for reading

What are some ways that pathogens are spread?

What is an epidemiologist?

Discussion

What caused the bubonic plague? bacteria

How did the bacteria spread to people? through infected fleas and rats

What is a *vector*? any insect or animal that carries pathogens

Name some of the most common vectors. Possible answers: mosquitoes, fleas, flies, lice, and ticks

Name some diseases that are spread by vectors. Possible answers: malaria, dengue fever, West Nile virus, yellow fever, sand fly fever, sleeping sickness, trench fever, Rocky Mountain spotted fever, Lyme disease

What term is used to describe a disease that has spread to a great number of people in a short time? epidemic

Why would an epidemic give scientists an opportunity to learn more about how that disease is spread? Possible answer: Since the disease spreads quickly, scientists can more easily trace the previous activities of infected people.

Why is it important for doctors and scientists to know more about the spread of disease? The information can be used to educate people and possibly prevent epidemics.

Which epidemic helped doctors realize that some pathogens spread through the air? the influenza epidemic

How pathogens are spread

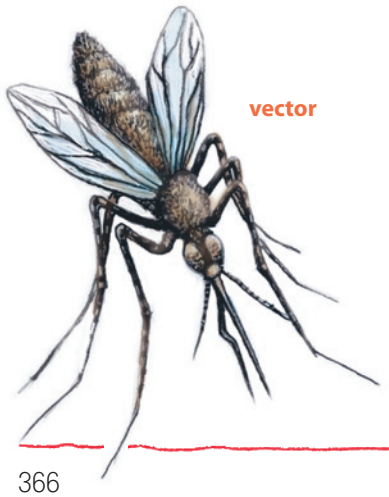
Several hundred years ago, millions of people died from the bubonic plague. Doctors blamed swamp vapors, heat, and baths for causing the disease. Some people thought that the plague was a punishment from God. Some of them beat themselves, hoping to earn God's forgiveness. But the plague kept spreading.

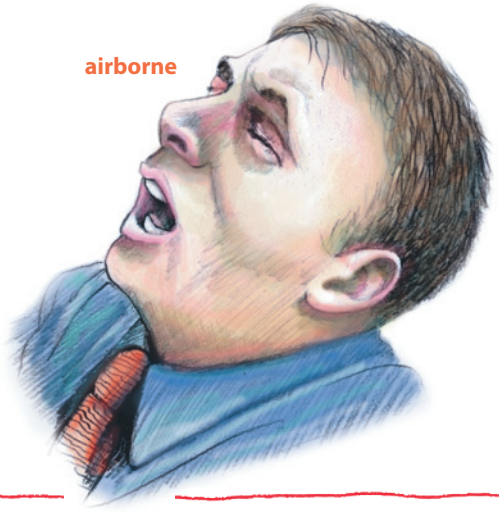
Many years later, doctors learned that bacteria caused the bubonic plague. Infected rats and fleas spread these pathogens to people. A flea that bit an infected rat would become a carrier of the bacteria. Then when the flea bit a person, the bacteria would infect the person.

Insects and other animals that carry pathogens are called **vectors**. Some of the most common vectors include mosquitoes, fleas, flies, lice, and ticks. Mosquitoes can spread many diseases, such as malaria, dengue (DENG gee) fever, the West Nile virus, and yellow fever. Even tiny sand flies can spread viruses that cause sandfly fever. The tsetse fly can carry a protozoan that causes a disease called sleeping sickness. Lice and ticks can spread many bacterial diseases, such as trench fever, Rocky Mountain spotted fever, and Lyme disease.

Epidemics (ep ih DEM iks) occur whenever a disease spreads to a great number of people in a short time. In 1918 about half a million people in America died from a type of influenza called the "Spanish Flu." As a result of this epidemic, doctors learned how influenza and other viruses spread.

Influenza can spread through the air, so it is called an **airborne** pathogen. When a sick person coughs or sneezes, he expels infected droplets into the air.





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SCIENCE BACKGROUND

Vehicle
The term *vehicle* is sometimes used to refer to food and water that carry pathogens.

Poliovirus
The poliovirus usually affects the digestive system. Most cases of polio in the digestive system are mild, with symptoms such as a sore throat and intestinal upset. However, if the poliovirus enters the bloodstream, it usually attacks the nervous system, often causing paralysis and sometimes death. Another name for this type of polio is *infantile paralysis*. Some polio survivors experience muscle and joint difficulties many years after having had polio. Today both the Sabin and Salk vaccines are used to vaccinate against polio. The vaccinations have helped prevent further epidemics of this disease.

SCIENCE MISCONCEPTIONS

Vectors
Vectors such as mosquitoes and ticks are not actually infected with the disease that they spread. They carry the disease without becoming ill. Vectors also include other arthropods, snails, and some clams.

HISTORY

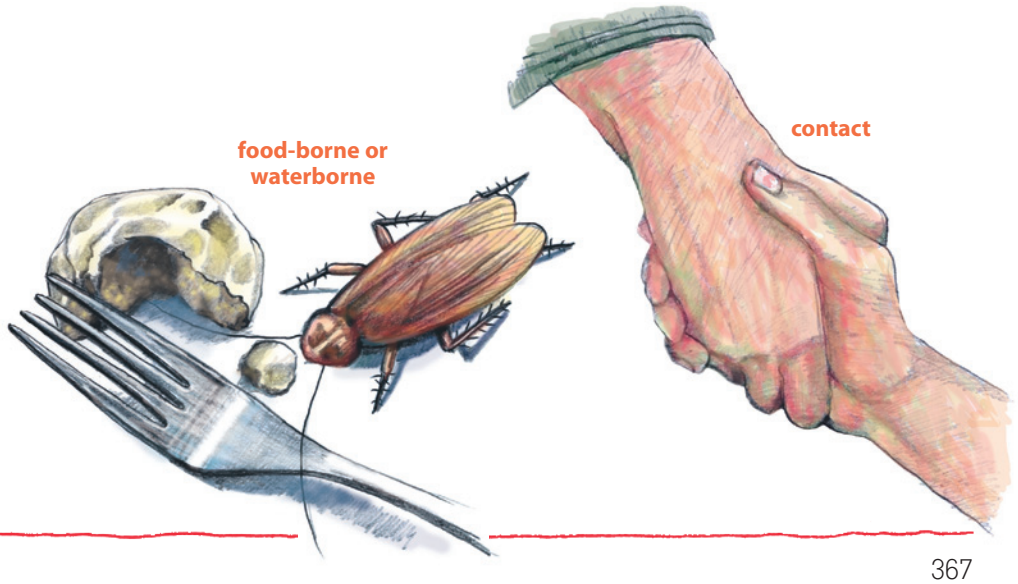
Bubonic plague
This disease killed millions of people throughout history and still exists today. Prompt medical treatment is needed for both the infected person's health and to prevent an epidemic.

The pathogen is transmitted from one person to another when another person breathes in the droplets.

Viruses also spread by **contact**. Touching a sick person or something that a sick person has touched can spread the pathogens. Many common viruses, such as cold viruses, are spread both through the air and by contact.

Other illnesses, such as typhoid (TY foyd) and cholera (KOL ur uh), are also spread by **food-borne** and **waterborne** pathogens. Contamination occurs when something infected with a pathogen touches water or food. People that drink the infected water or eat the contaminated food often become sick with the disease. Today water treatment systems help keep drinking water clean and pathogen-free. In areas without water treatment systems, some people purify their drinking water by boiling it or by using special filtering systems to eliminate pathogens.

Epidemics allow people to learn more about how diseases spread. Between 1893 and 1955, many cities and towns in America had polio epidemics. These epidemics caused great anxiety and fear because many children were being paralyzed and some even died. People were not sure how the polio was spreading, because the poliovirus did not act like other pathogens. Scientists observed that the virus did not appear to be spread through the air or by vectors. After much observation and research, scientists learned that polio usually spreads through contaminated food and water. Sometimes contact with an infected person may also spread the disease.



Discussion

Viruses such as the influenza virus can be airborne pathogens. What is another way that viruses can spread? by contact

What are some examples of a virus spreading by contact? touching a sick person or something that a sick person has touched

Why do you think you do not always become sick when you are around someone who has a communicable disease, such as a cold? Possible answers: The sick person might have been careful not to spread the pathogen. You may not have come in contact with enough of the pathogen to make you sick. You may not be susceptible to that disease.

What did scientists learn from the polio epidemics? The poliovirus can be spread through contact and through contaminated food or water.

What are some other diseases that can be spread by food-borne and waterborne pathogens? Possible answers: typhoid, cholera

TEACHER HELPS

Current epidemics

Discuss news reports of current epidemics in various areas of the world. Locate the areas on a map. Encourage students to pray for not only the health needs of the people involved but also for their spiritual needs.

DIRECT A DEMONSTRATION

Demonstrate airborne pathogens

Materials: a small plastic bag of flour or chalkboard erasers with yellow chalk dust

Lightly clap the erasers or squeeze the open bag of flour. Notice how the air carries the chalk dust or flour particles. Explain that even though we cannot see airborne pathogens, the air carries them in much the same way.

DIRECT AN ACTIVITY

Model spreading pathogens by contact

Materials: glitter or hand lotion with glitter

Allow one or two students to cover one hand in glitter. Direct the "infected" students to shake hands with other students or to touch surfaces that other students would normally touch. Notice how the glitter spreads through contact.

Pathogens spread in much the same way as the glitter does.

Some websites offer lotions and sprays that show "germs" when held under a black light. Products like these could be used in place of the glitter.

Discussion

How are noncommunicable diseases different from communicable diseases? Noncommunicable diseases are not contagious and cannot be spread by contact, contamination, animals, or the air.

What are some possible causes of noncommunicable diseases? Possible answers: health habits, heredity, environment, or a combination of these or other factors

When someone develops a lifelong disease, does that mean that God is not in control? no **How do we know?** The Bible tells us that all things work together for good to those who love God (Rom. 8:28). God is sovereign over all things (Dan. 4:35), even the things that are bad (Job 2:10). **[Bible Promise: I. God as Master]**

What is it called when a disease seems to disappear? remission

What is an epidemiologist? a scientist who studies the causes and spread of diseases

What is one of the first goals of an epidemiologist? to keep diseases from spreading to more people

Why do epidemiologists try to find the source of a disease? Possible answers: to prevent it from infecting anyone else; to inform people of how to avoid and prevent the spread of the disease

Discuss the photo of the epidemiologist.

What vector do you think this epidemiologist is studying? a mosquito

This epidemiologist, Mike Fink, is identifying and separating the Culex genus mosquitoes that can carry the West Nile virus from other mosquitoes caught in traps throughout Arizona in 2004. The mosquitoes were later tested to see if the virus was present. A drawing of a female mosquito is in the foreground.

What agency was started as a training center and a response unit for epidemics? The Epidemic Intelligence Service

What organization is this agency under? Centers for Disease Control and Prevention

Suppose a small town has just hosted its annual festival and barbecue. The day after the festival, many of the townspeople became sick with the same illness. What kinds of things might the epidemiologists want to find out? Possible answers: Who is sick? Were the sick people at the festival? Did they eat at the barbecue? What exactly did they eat and drink?

Noncommunicable Diseases

Not all diseases are contagious. A person cannot catch diabetes, arthritis, or heart disease. Noncommunicable diseases do not spread by contact, contamination, animals, or the air. Scientists do not know exactly what causes some noncommunicable diseases. A person's health habits, genes, environment, or any combination of these factors may be part of the cause. Some noncommunicable diseases, such as Huntington's disease, are not usually evident until adulthood. Other diseases, such as cancer and heart disease, may occur in both children and adults.

Once someone develops a noncommunicable disease, he usually has it for the rest of his life. Doctors can treat the symptoms of the disease, but most noncommunicable diseases cannot be cured. Some of these diseases may go into *remission*, or seem to disappear but then come back. Even so, scientists continue searching for cures and new treatments for diseases. Good health habits can help prevent many noncommunicable diseases. When a person develops a lifelong disease, it is often hard for him to understand God's purpose. However, Christians should remember that God works all things together for good (Rom. 8:28). God is sometimes glorified most in situations that seem tragic to us.

Epidemiology

Do you enjoy detective mysteries? Some scientists are actually disease detectives. **Epidemiologists** (ep ih dee mee AHL uh jists) are scientists who study the causes and spread of diseases through communities. They look for ways to prevent and control diseases. One of their first goals is to keep a disease from spreading to more people. Epidemiologists try to track a disease's progress to find the source, or cause, of the disease. Once they find out how the disease began and spread, they can teach people how to avoid having another outbreak of that disease.

The Epidemic Intelligence Service started in 1951 as part of the Centers for Disease Control and Prevention. These scientists travel all over the world trying to solve disease mysteries. Epidemiologists study illnesses that can cause epidemics, such as meningitis (men in JY tis), influenza, and tuberculosis (too BUR kyuh LO sis). At times, they also research diseases caused by contaminated food and water.

epidemiologist

SCIENCE BACKGROUND

Epidemiologists

When the SARS epidemic started in the winter of 2002, hundreds of epidemiologists began working to identify the pathogen that causes the disease and find out how it is transmitted from person to person. Other epidemiologists study diseases such as Ebola, AIDS, and the West Nile virus. State and local governments also have epidemiologists who keep track of smaller disease outbreaks, such as food poisoning cases and influenza.

TEACHER HELPS

Research resources

Resources to use for the Geography link and the Writing link can include the Centers for Disease Control and Prevention, the World Health Organization, and the *CDC Health Information for International Travel: The Yellow Book*.

Some epidemiologists concentrate on health issues such as strokes and heart diseases. These scientists may also be involved with nutritional issues, studying how the food that people eat affects their health. Other epidemiologists specialize in a specific disease, such as cancer. Epidemiologists may also study types of diseases, like genetic diseases or infectious diseases.

Epidemiologists often work for state and local health departments or for federal government health agencies. Some teach at universities and may work for individual research programs. Others may be part of international health agencies. These medical detectives help identify diseases and trace their causes.

QUICK CHECK

1. Name some ways that pathogens are spread.
2. How are noncommunicable diseases different from communicable diseases?
3. What is an epidemiologist?

Dr. John Snow

During the 1800s, epidemics of cholera, a severe intestinal disease, were common in many countries. An English doctor, John Snow (1813–1858), was one of the first people to realize that cholera was spread through contaminated water. During Britain's second cholera epidemic, he was able to prove his theory. Dr. Snow drew maps of the London streets and marked the homes of people who had died from cholera. Through careful research he was able to trace the outbreak of cholera to a specific water pump. Dr. Snow found that more than three-fourths of the people who had become ill drank water from that pump. He used a microscope to look at a water sample from the pump and noticed that the water showed some contamination. Because of Dr. Snow, England's water systems were improved, and there were fewer cases of cholera. Epidemiologists still use some of the research methods that Dr. Snow used.

GEOGRAPHY

Travel requirements
Provide a blank world map that can be colored or marked. Direct the student to research to find the health and immunization requirements needed to enter ten to twelve countries around the world. Choose countries from various latitudes and continents. Tell the student to mark countries that require immunizations or preventative medications and to compare the locations of the countries with their requirements.

Do the countries that require immunizations have similar latitudes? Answers will vary.

Is there a particular continent(s) that has a higher rate of requirements? Answers will vary.

Why do you think these similarities exist? Possible answers: The similarities of climates and economic development may lead to similar diseases.

WRITING

Disease research
Direct the student to research and write a paragraph about a disease in a third-world country. The paragraph should include information about how the disease is spread, possible vectors, and what prevention measures are taken in that country.

Discussion

Other than epidemics, what else might an epidemiologist study? Possible answers: diseases caused by contaminated food and water; strokes; heart diseases; nutritional issues; cancer; genetic diseases; infectious diseases

What are some places that employ epidemiologists? Possible answers: state and local health departments; federal government health agencies; universities; international health agencies

Discuss the Dr. John Snow box.

What is one way that cholera is spread? by contaminated water

Who was one of the first people to realize this? Dr. John Snow

How did he prove to others that cholera could be spread by water? He drew maps to trace the outbreak back to a specific water pump.

How did Dr. Snow influence present-day epidemiologists? Epidemiologists still use some of his research methods to track diseases.

Answers

1. vectors, air, contact, food, and water
2. Noncommunicable diseases are not contagious and cannot be spread by animals, contact, contamination, or air. They also are usually permanent rather than temporary illnesses.
3. a scientist who identifies diseases and traces the causes of those diseases

Activity Manual

Reinforcement, page 243

Review, page 244

This page reviews Lessons 171 and 172.

Assessment

Quiz 15-A

The quiz may be given any time after completion of this lesson.

Objectives
- Recognize how quickly pathogens can spread
- Infer the source of contamination

Materials
- sodium hydroxide solution (1.2 mL [1/4 tsp] granular lye mixed with 1 liter distilled water)
- See Student Text page
- buckets or large containers to dispose of liquids

Introduction
Infectious diseases can spread rapidly! Epidemiologists not only try to identify a disease but also try to trace that disease back to its source. This is not always an easy job. In today's activity, you will create an epidemic and then work together to determine its source.

Teach for Understanding
Purpose for reading
The student should read all the pages before beginning the activity.

Before the Activity
Pour 150 mL of the sodium hydroxide solution (contaminant) into one cup. Pour 150 mL of distilled water into each of the remaining cups. Do not let students know which cup has the contaminant.

During the Activity
Distribute safety supplies and other materials. Discuss the importance of using the chemical solution safely.

Explain how you expect students to exchange liquids with others. You may want to divide students into two lines with a table between them. One line could remain stationary, and the other line could move down two places each time liquid is exchanged. The two people at the end of the moving line would then come to the front of their line to keep exchanging liquid with partners.

Remind students to record the name of the person that they gave liquid to each time an exchange is made. Those names are needed to track the spread of the "disease."

After the indicator is added, remind the students to mark the cards as directed. Tell each student to write the color of his solution on his own card before disposing of the liquid.

ACTIVITY

Of Epidemic Proportions

Process Skills
- Making and using models
- Observing
- Inferring
- Recording data
- Communicating

Epidemics often catch people by surprise. Because pathogens are so small, a person can easily spread a disease without knowing it. In this activity you will create an epidemic. When the epidemic is over, you will work as an epidemiologist and search for the source of the contamination.

Problem
Which cup contained the original chemical solution—the source of contamination?

Procedures
Note: This activity uses a chemical solution to create the epidemic. Use safety precautions and be careful not to spill any liquid. If any liquid splashes onto your skin, stop and wash the skin thoroughly. Do not try to pour the liquid when exchanging solutions. Do not drink any of the liquid.

Materials
goggles or safety glasses
foam cups
prepared epidemic solution
distilled water
eye dropper
red cabbage juice indicator solution
3 × 5 note card
latex gloves (optional)

1. Get a cup of liquid, an eyedropper, and a note card from your teacher. Your cup may have distilled water, or it may have the contaminated solution. Keep the cup away from your face. Write your name at the top of your note card.
2. Using the eyedropper, draw up one dropperful of liquid from your cup. When instructed, add one dropperful of your liquid to someone else's cup. On your note card record the name of the person that you gave liquid to.
3. Repeat step 2 three more times. After exchanging liquid 4 times, stop and wait for your teacher to add the red cabbage juice indicator solution.
4. Observe the color of the red cabbage juice indicator before and after it is added to your liquid. If your solution is not contaminated, the color of the cabbage juice will remain the same. If your solution is contaminated, the color will change.

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TEACHER HELPS

Epidemic solution
Mix the lye and water in a bottle. Clearly label the bottle.

The solution is a weak sodium hydroxide solution. It is colorless and odorless and can be poisonous if ingested. Any liquid splashed on the skin should be washed off immediately. Do not use liquid lye or other drain cleaners in the solution.

Prepared solutions are available from science supply companies.

Indicator
Directions for preparing cabbage juice indicator are found on TE page 200.

Eyedropper
If eyedroppers are not available, plastic spoons may be substituted.

Students
This activity works best with at least ten students. If there are less than ten students, give some students an additional cup and index card. If there are more than twenty students, you may want to add a second cup of contaminant.

Chart
Prepare a chart with a column for each student. Under each student's name, list the names from that student's card in the same order he has them written. You may choose to give each student a copy of the chart and allow him to work on his own to determine the source of the contamination.

Solution colors
The darkest yellow will be the source of contamination. Solutions with colors closer to yellow were most likely infected during the first two exchanges. Solutions closer to purple were most likely infected in the later exchanges.

5. If your solution is infected, circle your name at the top of your card.
6. Use the note cards to make a chart that traces the spread of the infection.

Conclusions

- What is the ratio of infected to uninfected people?
- Can you determine who had the original contaminated solution?

Follow-up

- Try the activity again with a different number of people or change the number of times you exchange liquid. Notice how this affects the ratio of infected to uninfected people.

SCIENCE PROCESS SKILLS

Inferring

Inferring is taking evidence or a result and drawing conclusions without having seen the origin or process leading to that result. Evidence is often gathered through observations.

Why would you not consider any of the purple solutions at the end of the activity as a possible source of the contamination? If the solution is not contaminated at the end, it could not have been contaminated earlier.

Look at partners for the first exchange. What inference can be made about the source of the infection if one is infected at the end and the other is not? Since one remained uncontaminated until the end, neither could have been the original source of contamination.

What other solutions could you infer are not the source? any solution that did not contaminate other solutions in any of its four exchanges **Why?** If a solution remains uncontaminated until the end, none of the solutions in any of its exchanges could have been the original source of contamination.

What can be inferred about the degree of contamination based on the colors of the solutions? Possible answer: The closer the color is to purple, the less contamination is in the solution.

What can be inferred about a yellowish-green solution compared to a green or blue solution? The yellowish-green solution contains more contamination.

After the Activity

Discuss the chart. Guide the students in finding the source of the contamination. Mark the names of those who ended with an infected solution. Working from the bottom to the top of the chart, track the exchange activity of each of the marked students. Eliminate those who received solution from an uninfected source.

Conclusions

How many people ended with a contaminated solution? Answers will vary.

How many people did not have a contaminated solution? Answers will vary.

How would you write the number of contaminated and noncontaminated results as a ratio? Answers will vary.

It may not be possible to trace the exact source. The chart should help the students eliminate all but two possible sources. Epidemiologists often have unexpected difficulties as they track diseases. The diseases they study are not as contained and controlled as this mock epidemic.

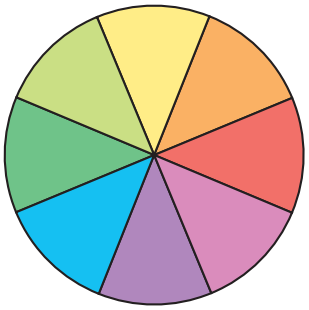
After students have discussed the chart and tried to trace the source, discuss the color variations of the solutions.

What color were the solutions that did not become contaminated? purple

What are some of the colors of the contaminated solutions? Possible answers: blue, green, yellow

How much contamination do you think a blue solution contains—a lot or a little? a little **Why?** Blue is close to purple on the color wheel, and purple is not contaminated.

Which color solution do you think shows the source of the infection? yellow **Why?** Yellow is the farthest color from purple on the color wheel.



Use the questions in the Science Process Skills to discuss inferring.

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Lesson 174

Student Text pages 372–75
Activity Manual page 245

Objectives

- Identify several defensive barriers of the body
- List two of the body's nonspecific defenses
- Identify the body's specific defense against pathogens
- Explain some functions of white blood cells during the immune response

Vocabulary

defensive barrier
immune response
inflammatory response

Introduction

Whenever a soldier goes to battle, he wears special gear and carries equipment for protection against an enemy's attacks. Just like a soldier, the body has some special defenses against enemy pathogens. Today we will be studying how the body reacts to pathogens.

Teach for Understanding

Purpose for reading

How do cilia help protect air passages?

What is the body's specific defense against pathogens?

Discussion

There are pathogens all around us. Why are we not always sick? God created our bodies with many defenses against pathogens.

What are some of your body's natural barriers to pathogens? skin, scabs, sweat, mucous membranes, cilia, tears, earwax

What are some ways that pathogens enter your body? skin openings, nose, eyes, throat, ears

What is one purpose for scabs? They cover open wounds and prevent pathogens from entering your body through the wounds.

What are some other ways that skin protects itself from pathogens? sweat and natural body oils

What traps pathogens that enter the nose and throat? mucus from the mucous membranes

What are cilia? hairlike projections lining the air passages

What do cilia do? filter out pathogens and sweep trapped pathogens away from the lungs

What does the body produce that can kill any pathogen that gets swallowed? hydrochloric acid in the stomach

How do tears help protect the eyes? Possible answers: They wash dust and dirt away from the surface of the eyes. They contain a special substance that can kill some bacteria.

What helps protect your ears from dust and pathogens? earwax

The Immune System

Pathogens are always around us. Many times we are exposed to pathogens without even realizing that they are there. But though we are surrounded by pathogens, we do not always become sick. God created our bodies with many defenses against disease-causing pathogens. Scientists have grouped these defenses into three main categories. Each category of defense has a job in the fight against disease.

Defensive Barriers

Ancient warriors often dug moats to surround their castles or fortresses. These barriers helped protect the castles from the enemy's attack. In a similar manner, your **defensive barriers** help to keep pathogens out of your body. Your skin keeps many pathogens from entering into your body. However, pathogens can enter through cuts and scrapes. Scabs, although not beautiful, are part of your body's defenses. Scabs cover open wounds and help prevent pathogens from entering your body through the wounds. Some pathogens, though, attack skin cells directly. Your sweat and natural body oils contain chemicals that help to kill these pathogens.

Pathogens can also enter through natural body openings, such as your nose and eyes. The mucous membranes in your air passages produce sticky mucus that traps pathogens that enter your nose and throat. Tiny hairlike projections called *cilia* (SIL ee uh) line your air passages. Cilia help filter out pathogens and sweep any trapped pathogens back up the air passages toward the throat and away from the lungs. Your body then expels some of these mucus-trapped pathogens by coughing or sneezing. Pathogens that are swallowed are usually killed by the *hydrochloric acid* in your stomach.

Tears help to protect your eyes from pathogens. Not only do tears wash dust and dirt away from the surface of your eyes, but they also contain a special substance that can kill some bacteria. Earwax helps to protect your ears from dust and pathogens. God has designed these barriers to work together to help prevent pathogens from gaining entrance into your body.

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SCIENCE BACKGROUND

Defenses of the body
The body's defense system includes several nonspecific responses and a specific response. Nonspecific responses include defensive barriers, such as skin, the inflammatory response, and special white blood cells called macrophages. Macrophages are often found in the lymph nodes, but they are also found in other parts of the body, such as the liver. These white blood cells protect the body by surrounding pathogens and eating them. During the inflammatory response, macrophages increase in number.

The body's specific response, called the immune response, is pictured on Student Text pages 374–75. Nonspecific responses and the immune response can happen at the same time.

White blood cell carriers
Although many white blood cells are carried by the lymph fluid, the blood is the primary carrier of white blood cells.

Lymph fluid
Lymph fluid originates from blood plasma. It is a colorless liquid containing water, white blood cells, nutrients, cell debris and waste, and some pathogens. The lymph fluid flows through channels that help drain excess fluid from body tissues. Nodes and glands help filter the pathogens from lymph fluid.

Nonspecific Defenses

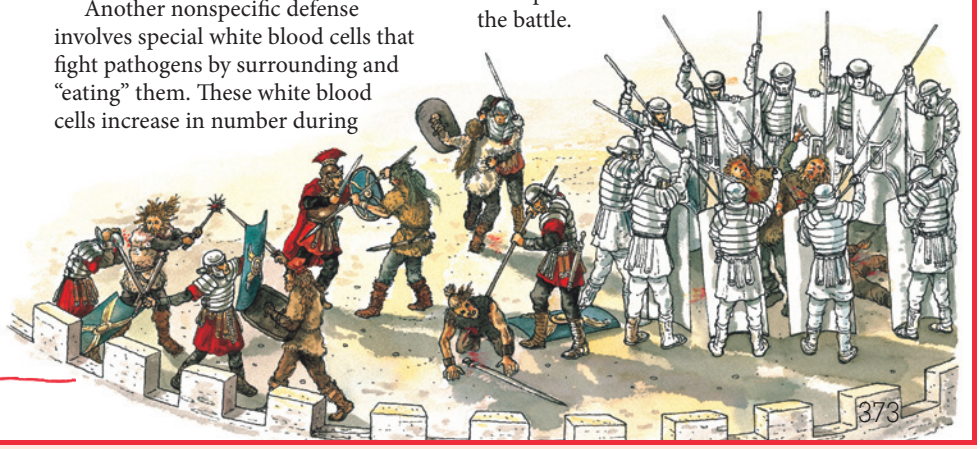
If enemy soldiers managed to cross the castle moat, they still faced direct attacks. Soldiers high on the castle wall could respond to an attack by shooting arrows, dropping rocks, or pouring boiling oil on the enemy. Your body has many ways to defend itself against any pathogens that make it past the first line of defense. These other defenses are divided into two categories: *nonspecific* and *specific*.

One nonspecific defense is often called the **inflammatory response**. Symptoms of the inflammatory response include swelling, redness, heat, and pain. If a pathogen does infect you, your body increases the supply of blood to the area of infection. This increased supply of blood often makes the infected area swollen and painful. Sometimes, too, your brain signals your body to increase its temperature. Higher temperatures can kill some pathogens. A fever can be helpful as long as the body temperature does not get too high.

Another nonspecific defense involves special white blood cells that fight pathogens by surrounding and "eating" them. These white blood cells increase in number during the inflammatory response, and they also protect your body before infection sets in.

Specific Defense

While enemy soldiers outside the castle dodge boiling oil and arrows, some enemy soldiers may actually manage to enter the castle. These soldiers engage in hand-to-hand combat with the soldiers inside the castle. Your body's specific defense, also called the **immune response**, is similar to the defending soldiers. The *lymphatic* (lim FAT ik) *system* includes special tissues and organs, such as your tonsils, appendix, and spleen. A transparent fluid called *lymph* moves throughout this system. Your blood and the lymph fluid carry many different types of white blood cells throughout the body. Other white blood cells remain in *lymph nodes*, the tiny masses of tissue found throughout the lymphatic system. All of these white blood cells act as soldiers, identifying and fighting the pathogens. Each type of white blood cell has its own special mission in the battle.



Discussion

How are the other defenses of the body categorized? nonspecific and specific

Into which category does the inflammatory response fit? nonspecific

What are some symptoms of the inflammatory response? Possible answers: swelling, redness, heat, pain

Why are some fevers helpful? The higher temperature can kill some pathogens.

What is a second nonspecific defense? special white blood cells that can surround and "eat" pathogens

These special white blood cells are always present in your body. When does your body make more of them? during the inflammatory response

What is another name for the body's specific defense? the immune response

Which system includes special tissues and organs that are often involved with the immune response? the lymphatic system

What are some special tissues and organs that are part of the lymphatic system? Possible answers: tonsils, appendix, spleen

If a person has his spleen removed, why does he need to be more careful to avoid exposure to pathogens? Possible answer: The spleen is part of the body's immune response. Without it the body's defenses are weakened.

How are white blood cells carried throughout the body? by the blood and the lymph fluid

Although disease is a result of Adam's sin, the immune system demonstrates God's mercy. Without the immune system, man would not be able to live to glorify God.

Discussion

Discuss the Immune System diagram and text.

How soon does the body respond to pathogens? very quickly—often in just seconds

Which pathogen is pictured here as attacking the immune system? bacteria

The diagram shows the response of many kinds of white blood cells to a pathogen. What type of white blood cell can surround and eat a pathogen? macrophage

How do macrophages help other white blood cells identify the pathogen? Little pieces of the pathogen that macrophages surrounded and "ate" are displayed on the outside of the macrophage.

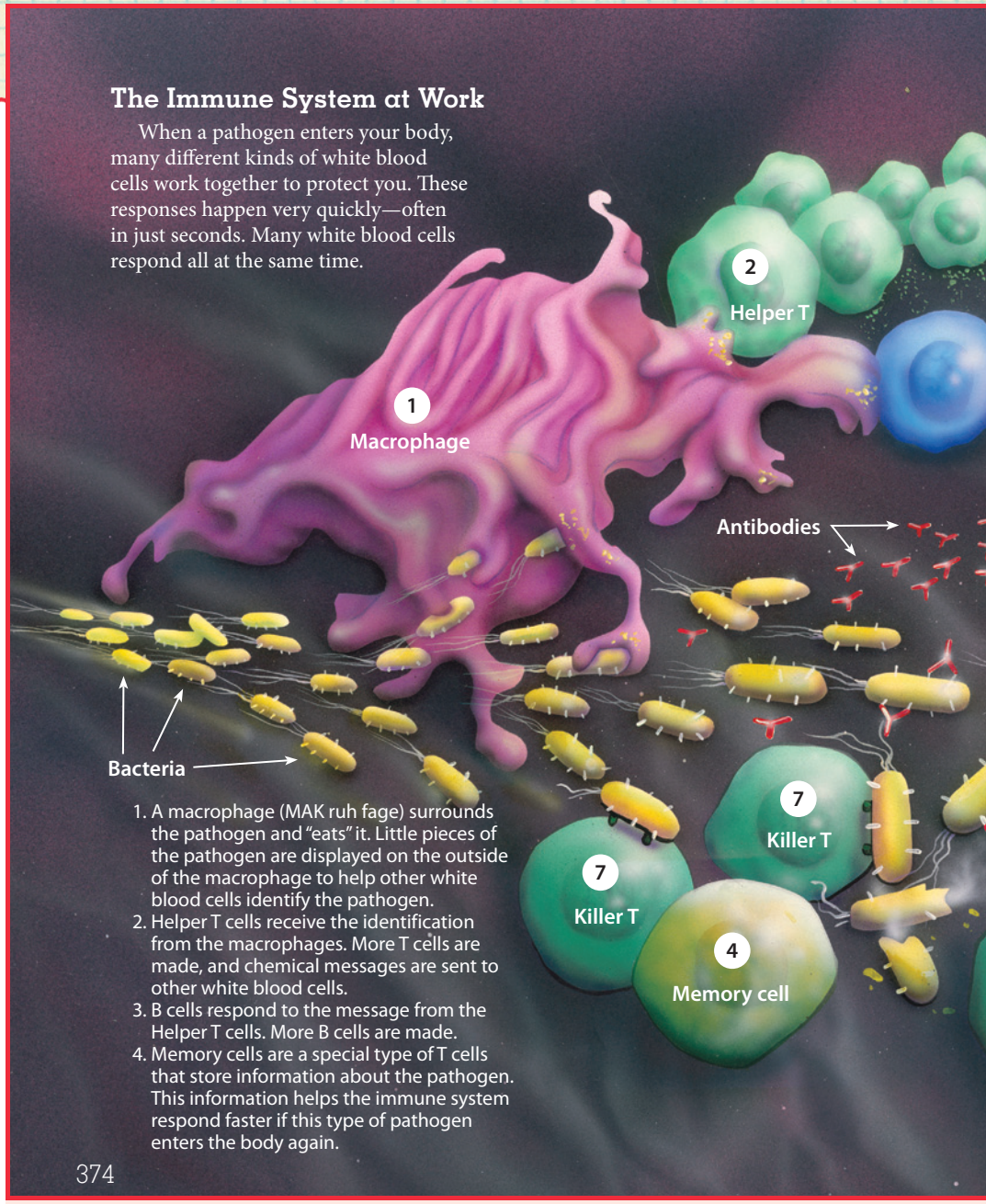
Which kind of white blood cell receives the identification from the macrophage and sends chemical messages to other white blood cells? a Helper T cell

What kind of white blood cells are memory cells? a special type of T cell

What do memory cells do? store information about the pathogen

Why do memory cells store information about the pathogen? so that the immune system can respond faster if this type of pathogen enters the body again

Do you think that the immune system responds more quickly to exposure to a new pathogen or to a pathogen that it has been exposed to before? to a pathogen it has been exposed to before **Why?** Memory cells have been produced to help identify and produce antibodies for that pathogen.



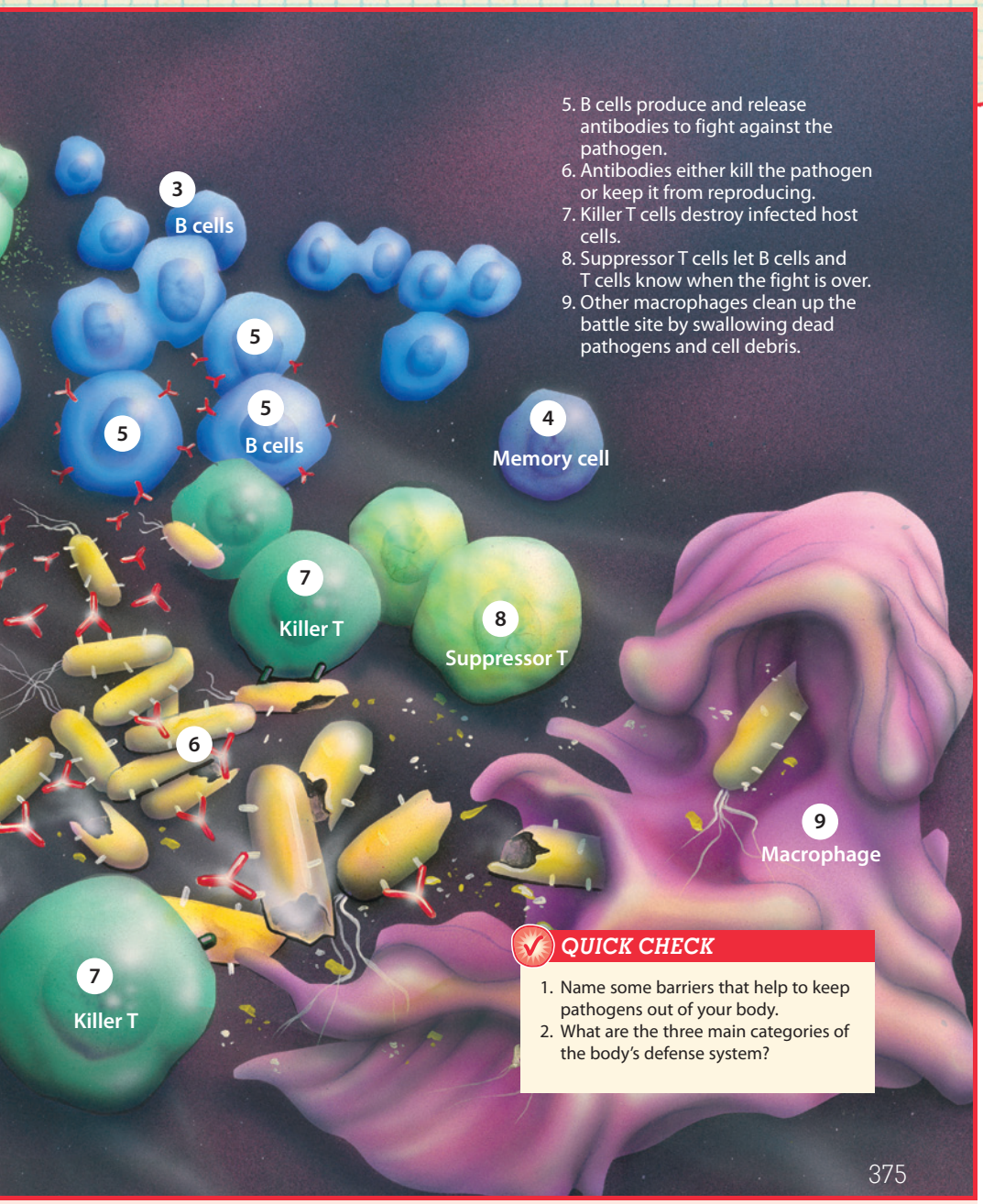
SCIENCE BACKGROUND

The immune system reaction
The immune system reaction varies slightly from the cycle illustrated when the pathogen is a virus.

B cells and T cells
B cells mature in bone marrow. They produce antibodies to fight against the invading pathogen.

T cells mature in the thymus. They help produce antibodies but also are responsible for recognizing and killing cells that are foreign to the body or that have been infected by a pathogen.

Macrophages
Some macrophages are free macrophages, moving throughout the body to clean up pathogens and cellular debris. Other macrophages are fixed and remain in places such as the lymph nodes, liver, spleen, and red bone marrow.



AIDS

Acquired Immune Deficiency Syndrome is caused by the Human Immunodeficiency Virus (HIV). This virus attacks the Helper T cells and prevents them from functioning properly within the immune system. Scientists do not know where the virus and disease originated, but the term *AIDS* began to be used in 1982.

Discussion

Which type of white blood cell produces antibodies? B cells

What are two ways that antibodies can affect the pathogen? They either kill it or keep it from reproducing.

What are two other types of T cells involved in the immune response? Killer T cells and Suppressor T cells

Why do you think it is necessary for the body to have Suppressor T cells? Answers will vary. Elicit that God designed the Suppressor T cells to end the body's battle against infection. Without these cells, the overabundance of white blood cells might cause other problems.

Why do you think Killer T cells must destroy any host cells infected by a pathogen? Possible answer: Some pathogens, such as viruses, use host cells to reproduce. If the host cell is not destroyed, the virus may still be able to reproduce.

Which type of white blood cell helps to clean up the battle site? macrophages

What machine or occupation can a macrophage be compared to? vacuum cleaner or garbage collector

Why is the immune response known as a specific response? It identifies and fights against a specific pathogen.

Answers

1. skin, scabs, sweat, natural body oils, mucous membranes, cilia, tears, earwax
2. defensive barriers, nonspecific defenses, and a specific defense

Activity Manual

Reinforcement, page 245

Lesson 175

Student Text pages 376–79
Activity Manual pages 246–49

Objectives

- Explain three ways that the body can obtain immunity
- Compare and contrast antibiotics and antibodies
- Identify some problems that can occur when the immune system malfunctions

Vocabulary

antibody
antibiotic
memory cell
allergen
immunity
autoimmune disease
vaccine

Introduction

Have you ever had to get a tetanus shot because of an injury? Answers will vary.

Why do you think tetanus shots and other vaccines are needed? Accept reasonable answers.

Teach for Understanding

Purpose for reading

What are some ways that the body can receive immunity from pathogens?

How are antibiotics different from antibodies?

How is the immune system involved in an organ transplant?

Discussion

What are antibodies? special proteins made by white blood cells that can destroy pathogens

Why does the body usually respond to a pathogen faster the second time it is exposed to that specific pathogen? Memory cells have stored information about the pathogen and the antibody that is needed to defeat it.

What is immunity? special protection against disease

What kind of immunity does the body have after a person has had a disease, such as chickenpox? active immunity

What is another way to obtain active immunity? vaccines

What is passive immunity? The temporary protection that a baby receives from his mother's immune system until his own immune system begins to produce antibodies.

Why do you think young children tend to get sick more often than older children? Answers will vary. Elicit that the body of a young child has not had the exposure necessary to develop antibodies to fight sickness.

Immunity

Perhaps you know someone who has had chickenpox. An airborne virus causes this disease. However, if someone has had chickenpox before, he usually cannot get the disease again. Once a pathogen has entered the body, certain white blood cells make antibodies. These **antibodies** are special proteins that can destroy pathogens. The immune system can then react faster the next time it is exposed to a certain pathogen. It will usually be able to defeat that pathogen before you get sick because some white blood cells store information about that pathogen. **Memory cells** are white blood cells that remember the enemy and the specific antibody needed to defeat it.


chickenpox

These white blood cells provide your body with **immunity**, special protection against disease. Immunity can happen in several different ways. For example, after a person has had the chickenpox, his body remembers the chickenpox pathogen. This *active immunity* allows his body to resist the disease if it meets that pathogen again.

Active immunity can also be provided through vaccines. A doctor can give you a **vaccine**, or a shot that contains dead or weakened pathogens. Your immune system reacts to the pathogens in the vaccine and stores information about them. A person who has had the chickenpox vaccine usually does not become ill when exposed to chickenpox.

A baby receives *passive immunity*, or temporary protection, from his mother. The antibodies produced by his mother's immune system are shared with the baby's immune system. This protects him until his own immune system begins to work. The baby will develop active immunity as his immune system begins to produce its own antibodies.


vaccination

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SCIENCE BACKGROUND

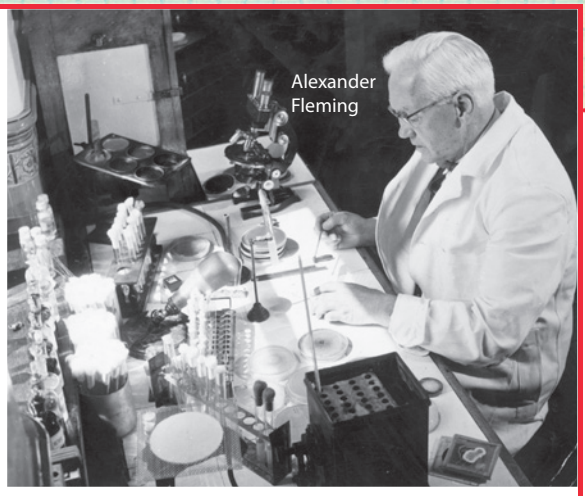
Vaccines
Some vaccines, such as the measles vaccine, can provide immunity for a lifetime. Other vaccines, such as the tetanus vaccine, provide immunity for only a few years. Booster shots are then needed to keep the body protected from that disease.

Chickenpox vaccine
Chickenpox used to be a common disease for most children. Since the introduction of a vaccine in the United States in 1995, however, the number of cases has drastically declined. Children vaccinated between the ages of 12 and 18 months have only a 10 to 15 percent chance of developing even a mild case if later exposed, and full-blown cases are almost never seen. Since 2005, the vaccine given to children is called MMRV and protects against measles, mumps, rubella, and varicella (chickenpox). The same virus that causes chickenpox can sometimes trigger a later reaction in adults called shingles.

Penicillin
The mold observed by Alexander Fleming was not penicillin but was from the genus *Penicillium*. The bacteria-killing substance it released was later named penicillin. The antibiotic compound was named for the mold name.

Antibodies and Antibiotics

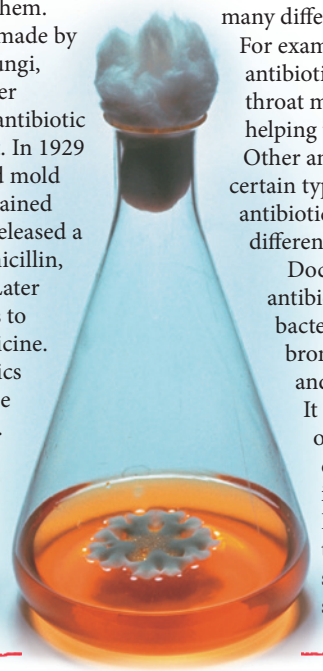
Your immune system produces antibodies that help to destroy pathogens. These antibodies are able to destroy all types of pathogens, including viruses and bacteria. However, the white blood cells produce different antibodies for different pathogens. For example, the antibodies that can kill the chickenpox virus are not effective against the measles virus.


Alexander Fleming

Antibiotics, though, are different. They also help your immune system destroy pathogens. However, your body does not make them. **Antibiotics** are chemicals made by microorganisms, such as fungi, that are able to destroy other microorganisms. The first antibiotic was discovered by accident. In 1929 Alexander Fleming noticed mold growing in a dish that contained some bacteria. This mold released a substance, later named penicillin, which killed the bacteria. Later other scientists found ways to use the penicillin as a medicine. Today many more antibiotics have been discovered. Some are synthetic, or manmade. Others are either made naturally from fungi and certain types of bacteria or are part synthetic and part natural.

Antibiotics can work only against bacterial infections and some types of fungi. They cannot kill viruses. Some antibiotics are able to fight against many different types of bacteria. For example, the same antibiotic that fights strep throat may also be effective in helping to heal an infected cut. Other antibiotics can fight only certain types of bacteria. Each antibiotic destroys pathogens differently.

Doctors may prescribe antibiotics for certain bacterial diseases, such as bronchitis, pneumonia, and some ear infections. It is important to take all of each antibiotic that a doctor prescribes, even if you are feeling better. Failing to take all of the medicine can allow some of the bacteria to survive.


mold containing penicillin

TECHNOLOGY

Making antibiotics
Although at one time antibiotics were chemicals made only by microorganisms, scientists have learned to produce many antibiotics synthetically. The microorganisms are no longer needed for these antibiotics.

Discussion

How are antibodies and antibiotics similar? They both help the immune system destroy pathogens.

What are antibiotics? chemicals made by microorganisms that are able to destroy other microorganisms

How were antibiotics discovered? Alexander Fleming discovered that a mold growing in a dish with bacteria was able to kill the bacteria. Later other scientists found ways to use a chemical compound from this mold as a medicine.

Which are not made by the body—antibodies or antibiotics? antibiotics

Can the body produce antibodies to fight all types of pathogens? yes

Against which type of pathogens are antibiotics usually not effective? viruses

Do all antibiotics work against only one pathogen? No; most work against more than one pathogen.

Why is each type of antibody effective only against a specific pathogen? White blood cells produce each antibody based on the body's response to a specific pathogen.

Why is it important to always take all of an antibiotic that a doctor prescribes? Taking less may allow the bacteria to survive.

Discussion

Do all immune system malfunctions cause serious problems? no **Explain.** Some are minor, but others can be life threatening.

What causes an allergic reaction? Special white blood cells mistakenly identify a harmless foreign particle as a pathogen, causing the immune system to attack.

What is an allergen? anything that causes the immune system to have an allergic reaction

Do all people have the same reactions to each allergen? no

What are some common allergens? Possible answers: dust, smoke, pollen, specific foods, insects, poison ivy

Some people have such severe reactions to allergens that they must keep an allergy kit of medication available.

What is a blood transfusion? the transfer of blood from one person to another

Why is it necessary for the blood types to match during a blood transfusion? The immune system would attack unmatched donated blood.

What two things must match in order for an organ transplant to be successful? the blood type and the tissue type

Are all organ transplants successful? no **Why?** The immune system will usually treat the new organ as an enemy and attack it.

What can be done to help prevent this from happening? Medicine can be taken that suppresses, or limits, the immune system.

Why is it dangerous for a person with a transplant to get an illness? The person with a transplant takes medication to suppress the immune system. A suppressed immune system may not be able to fight the illness.

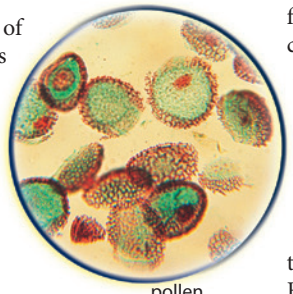
Discuss similarities between a believer's old nature and an allergen or pathogen. Only God can strengthen the new nature and give victory. [BATs: 8b Faith in the power of the Word of God; 8c Fight]

Malfunctions of the Immune System

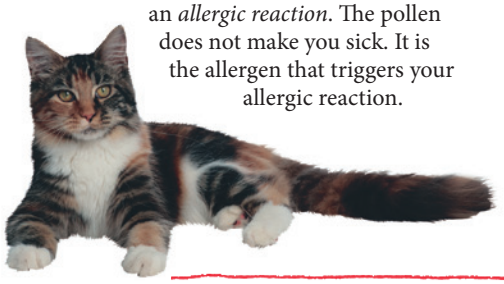
The immune system is a very important part of your body. It protects your body from pathogens that might attack it. Its main goal is to destroy the enemy pathogens before they can make you sick. Sometimes, though, the immune system malfunctions, or breaks down. Some malfunctions cause annoying problems, such as itching or congestion. Other malfunctions, though, can cause life-threatening situations.

Allergies

A special type of white blood cell is responsible for identifying any foreign particle that enters your body. If the particle is a pathogen, these white blood cells signal the rest of the immune system to attack. Occasionally, these white blood cells make a mistake. They might identify harmless foreign particles, such as pollen, as an enemy. The immune system attacks those particles, causing an *allergic reaction*. The pollen does not make you sick. It is the allergen that triggers your allergic reaction.



pollen



An **allergen** (AL ur jun) is anything that causes the immune system to have an allergic reaction. Common allergens include dust, smoke, mold, pets, and pollen. Some people may have an allergic reaction to specific foods, such as milk or peanuts. Other people may have allergic reactions to bee stings, insect bites, or poison ivy. Allergic reactions can be mild, such as a runny nose or watery eyes. However, for some people, allergic reactions can be severe. Severe allergic reactions usually require medical treatment.

Transfusions and transplants

Sometimes the immune system needs to accept something that the body has not made naturally. For example, a person who has lost too much blood may need a blood transfusion. Healthy people can donate blood to give to people who need blood transfusions. However, the immune system accepts donated blood only if the blood types match. If the blood types do not match exactly, the immune system attacks the donated blood. These attacks usually create more problems for the person receiving the blood transfusion.

Because of illness or injury, some people need organ

SCIENCE BACKGROUND

Blood transfusions

It is always better to give blood that matches. In an emergency, Type O can be given to anyone (universal donor), and someone with Type AB can receive any type (universal recipient). Certain precautions must be taken to reduce the risk of transfusion reaction, but it can be done successfully.

Cancer

With some cancers there is a minimal or no immune response. In these cases the body continues to identify the cancer cells as normal cells and does not attack them.

LANGUAGE

***Trans-* prefix**

Trans- means "across," "beyond," or "through."

Which words other than *transfusion* and *transplant* begin with this prefix? Possible answers: transcontinental, transfer, transform, transgress

transplants. If the blood and tissue types match, organ transplants can be successful. The diseased or damaged organ is removed, and a healthy donated organ is put in its place. Usually the person's immune system treats the new organ as an enemy and attacks it. To prevent this from happening, a person who has received an organ transplant takes medicines that suppress, or limit, the reaction of the immune system. As a result, a transplant patient must be more careful to avoid being exposed to germs.

Immune deficiency

A weak immune system is unable to fight pathogens very well. It is deficient, or weak, because not enough white blood cells exist in the body. A low white blood cell count means that the immune system may lose the battle against a disease. Some diseases, such as certain cancers, kill the white blood cells that would identify the pathogen as an enemy. The remaining white blood cells do not attack the cancer or other pathogens because they have not been identified.

Autoimmune (aw toh ih MYOON) **diseases** happen when the immune system malfunctions and attacks the healthy cells that it should protect. Autoimmune diseases, such as multiple sclerosis, can affect the nervous system. Others affect certain endocrine glands. Some, like rheumatoid arthritis, affect the body's joints. These diseases are noncommunicable. Some may be inherited or may result from other major illnesses. Scientists do not know a cause for every autoimmune disease.

Many of the things that scientists know about our bodies and diseases are the results of careful observation and the accumulation of scientists' work. Great discoveries may be credited to only one or two people, but those discoveries were made possible by many observations taken before.

QUICK CHECK

1. How are antibodies and antibiotics similar? How are they different?
2. What is an allergen?
3. What is an autoimmune disease?

TECHNOLOGY

Transplants

In 1967 Dr. Christian Bernard made medical history by performing the first heart transplant. The patient lived twenty-one days before dying of pneumonia. Early organ transplant patients often died from infections because the drugs that helped suppress the body's rejection of the transplanted organ also suppressed the body's ability to deal with pathogens.

In the 1980s cyclosporin was introduced as an antirejection drug. It proved to be a beneficial drug that suppressed rejection while allowing the body to maintain a high degree of immunity. Researchers continue to develop better drugs for use by transplant patients.

In the 2000s surgeons began experimenting with transplanting an organ and bone marrow from the donor. The idea is that the donor bone marrow (which produces blood cells) would combine with the patient's bone marrow so that the patient's body would not produce antibodies against the new organ.

Discussion

If the body does not have very many white blood cells, how is the immune system affected? The immune system is weakened and may lose the battle against an attacking pathogen.

Why does the body sometimes not recognize certain kinds of cancers as pathogens? Cancer cells may have killed the white blood cells that would identify them.

What are autoimmune diseases? malfunctions of the immune system that cause it to attack healthy cells

What are some examples of autoimmune diseases? Possible answers: multiple sclerosis, arthritis

How are autoimmune diseases different from diseases like chickenpox or the flu? They are noncommunicable and are not caused by a pathogen.

The word *disease* is sometimes used in place of *disorder*. A disease must be caught. A disorder is a malfunction. Autoimmune diseases are actually disorders.

Answers

1. Both antibodies and antibiotics help the immune system destroy pathogens. Antibodies are made by the body and can work against all types of pathogens. Different antibodies are made for each pathogen. Antibiotics are chemicals from microorganisms, and they only work against bacteria and fungi, not against viruses. Some antibiotics are effective against more than one pathogen.
2. anything that causes the immune system to have an allergic reaction
3. a malfunction of the immune system that causes it to attack healthy cells

Activity Manual

Reinforcement, page 246

Review, pages 247–48

These pages review Lessons 174 and 175.

Expansion, page 249

This page discusses blood donations and guides the student in writing a persuasive paragraph.

Assessment

Quiz 15-C

The quiz may be given any time after completion of this lesson.

Lesson 176

Student Text pages 380–81
Activity Manual page 250

Objectives
- Compare robotic surgery with traditional surgery
- Describe some advantages and disadvantages of long-distance robotic surgery

Vocabulary
robotic surgery

Introduction
How do you paint or draw a picture on the computer? Answers will vary but should include the idea that you move the mouse and the computer shows your movements as lines and colors on the computer screen.

Some computer programs and games use controls other than the keyboard and mouse. What are other types of computer controls you have seen or used? Possible answers: game controllers, pad and stylus

Teach for Understanding
Purpose for reading
How does a surgeon control the movements of the robot during surgery?

What are some advantages of long-distance surgery using a robot?

Discussion
When you think of a robot performing surgery, what picture comes to mind? Answers will vary.

How are the pictures on these pages different from what you thought of? Answers will vary.

What kinds of medical instruments might a robot use during surgery? a camera, a scalpel, a laser

Doctors use similar instruments during traditional surgeries. What is one way these robotic medical instruments are different than those used in traditional surgeries? Possible answer: They are smaller.

What does the surgeon look at to direct the robotic arms? a 3D image from the camera inside the patient

TECHNOLOGY

Robotic Surgery

Imagine that your doctor says you are in urgent need of surgery. He tells you that he will perform open-heart surgery on you without opening your chest. Then he tells you that his new surgical assistant stands six feet tall and has four arms. No, your doctor has not lost his mind. Many doctors now use robots while performing surgery on a patient. **Robotic surgeries** are happening today in hospitals around the world.

Robots can help doctors perform delicate surgeries. The arms of the robot insert small surgical instruments through tiny incisions. These instruments might include a camera, a scalpel, or a laser. Up to four different robotic arms might be used. The surgeon looks into a viewfinder that shows him a 3-D image from the camera inside the patient. The surgeon directs the robotic arms with joystick-like controls. Each time he moves the joystick, the robotic arms move the instruments inside the patient. For every few centimeters that the surgeon moves, the surgical robot can be programmed to move only a few millimeters. Thus, the robot can make smaller movements than the surgeon can.

Several different robotic operating systems have been developed. Currently, these robotic surgeons are being used for gallbladder removal, heart bypass surgery, cancer surgery, and other similar procedures.

Robotic surgery has many benefits. After robotic surgery, patients usually heal more quickly and spend less time in the hospital. In traditional heart surgery, the surgeon cuts open the skin, muscles, and bone with a long incision. Robotic heart surgery, though, requires only three or four small incisions. Each incision is less than a centimeter wide.

Robots also make long surgeries less tiring for the surgeon. The doctor sits at a control console instead of standing over a patient for hours at a time. The robot can be programmed to ignore small shakes of the surgeon's hands and keep the instruments steady.

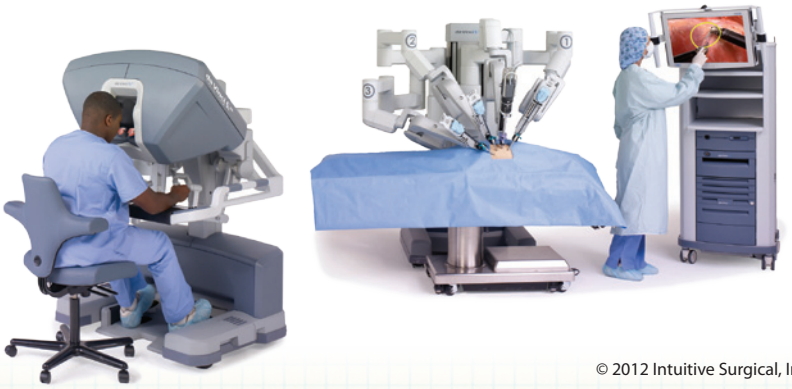
Robotic surgery also allows the surgeon to be in a different location than the patient. The surgeon could even be across the ocean from the patient. Nurses and assistant surgeons are with the patient while the master surgeon controls the robot from somewhere else.

SCIENCE BACKGROUND

Types of robotic surgery
Several different robotic operating systems have been developed in addition to those described in the text. Some use foot pedals, voice-activated software, or hand signals.

Robotic surgery has some drawbacks. Robots are very expensive—over one million dollars—so only a few hospitals can afford them. Another problem is that most robotic surgeries take twice as long as traditional surgeries. However, the surgery time should decrease as surgeons gain more experience using robots. Finally, the robot is unable to feel the patient's tissues. Doctors often make decisions based on their sense of touch. A surgeon using robotic technology must operate without feeling the tissue himself.

What does the future hold for robotic surgery? Someday millions of surgeries may be done this way. As robots become smaller, we may see a day when a surgeon inserts a robot into the patient and lets the robot do all of the work.



HISTORY

Long-distance surgery
Today's telecommunication systems are continually updated to transmit data faster. These developments have allowed long-distance surgery, also called telesurgery, to become possible.

First transatlantic surgery
On September 7, 2001, a surgeon in New York successfully removed a gallbladder. The patient, however, was in France! The New York surgeon sent commands via computer to the robot in the operating room in France. The surgery took 54 minutes.

First robotic brain telesurgery
On September 18, 2002, neurosurgeons in Halifax, Novia Scotia, Canada, removed a cancerous brain tumor from a patient 400 km away in New Brunswick.

Discussion

Why do you think the robot can make smaller movements than a human surgeon can? Possible answers: A human's physical makeup limits how small and precise his movements can be. A robot does not have those limitations and can be programmed to make precise and tiny movements.

Why would the robot only require three or four small incisions for heart surgery instead of making a traditional long incision? Possible answers: The tiny camera allows the surgeon to see under the skin without having to make an extensive incision. More precision results in smaller cuts.

What types of surgeries can the robots perform? Possible answers: gallbladder removal, heart bypass surgery, cancer surgery, and other similar procedures

What are some benefits of robotic surgery? Possible answers: Patients heal more quickly and spend less time in the hospital. Doctors do not get as tired. Smaller, more precise incisions can be made. Long-distance surgery is possible.

What are some disadvantages of robotic surgery? Possible answers: expense; surgery sometimes takes longer; surgeon cannot use his sense of touch

What are some advantages for long-distance robotic surgeries? Possible answers: The surgeon can perform surgery without having to travel to the patient. The patient might be in an emergency situation and not able to reach the doctor in time. The patient might be in an area that is remote and inaccessible to a skilled surgeon.

Because God loves us and tells us to love one another, man should continue to research and develop technology that helps people.

Do you think there will ever be a time when a tiny robot can be inserted into a person and programmed to find the problem and perform the surgery? Why? Answers will vary.

Activity Manual

Technology, page 250

Objectives
- Model the interaction between the immune system and pathogens

Materials
- prepared cards, *Blue Identity Cards* and *Red Identity Cards* (IAs)
- See Student Text page

Introduction
Throughout this chapter we have discussed how the immune system battles against pathogens. In today's activity you will model some of the interaction between the immune system and pathogens.

Teach for Understanding
Purpose for reading
The student should read the page before beginning the activity.

Before the Activity
Display the blue identity cards.

Which group do these cards represent—the immune system or pathogens? immune system

Why do you think the spleen, bone marrow, and thymus have high point values? They are important in fighting pathogens. The spleen is part of the lymphatic system. White blood cells mature in the bone marrow and thymus.

During the Activity
Only a 60-point card can capture an ambulance.

Any 1-point card can capture a 60-point card.

The ambulance has no point value and cannot capture another card.

The game ends when either ambulance is captured or when a set time limit has expired.

The home bases are used only for the collection of captured identities, not as a safe zone.

After the Activity
Do you think this activity accurately models the warfare between pathogens and the immune system? Why? Accept reasonable answers. Some of the similarities may include the following: Pathogens can attack most parts of the body. Not all pathogens are the same strength. Some pathogens can defeat the immune system.

Use the questions in the Science Process Skills to discuss models.

ACTIVITY

Defend and Capture

Process Skills
- Observing
- Communicating
- Defining operationally

The cells and organs of the immune system have many different functions. They work together to protect the body from pathogens. However, when any one part of the immune system is not working properly, pathogens can invade the body. In this activity you will experience some of the "battle" between the immune system and pathogens.

Procedure
Materials
red identity cards
blue identity cards
two shoeboxes or other containers

1. Divide the participants into two groups. One group is the immune system, and the other is the pathogens. Each group decides on a home base.
2. Get an identity card from your teacher. To participate in the game, you must have at least one identity card in your possession. At your teacher's signal, begin chasing your opponents. Lightly tag an opponent. Both you and your opponent must show an identity card.
3. A higher number captures a lower number. The person with the higher numbered card receives the opponent's identity card. If you both have the same number, no one is captured, and you may both continue playing the game. However, a 1-point white blood cell may capture a 60-point virus, and a 1-point bacteria may capture the 60-point spleen.
4. Do not tag the same person two times in a row. If you have lost your identity card, check your home base to see if there are any identity cards for your team that have not been used. If there are, you may continue playing. If no identity cards are left, you must sit out for the rest of the game.
5. Put captured identity cards in your team's shoebox. The game ends when one team captures the ambulance card of the other team. Add up the value of the captured identity cards. The team with the most points wins the game.

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TEACHER HELPS

The red cards are the pathogens, and the blue cards are the immune system.

Establish the boundaries for the area that you will use to do this activity. A playground or gymnasium works best.

Choose a location away from the home bases for students to sit once they have lost their identity cards.

You may choose to play multiple rounds and keep a cumulative score.

Students may discover the advantage of protecting their 60-point card and ambulance.

SCIENCE PROCESS SKILLS

Using models
Models help us examine and experience things that are too large, small, or inconvenient to handle.

What are some types of models that we have studied in science this year? Possible answers: earthquake, volcano, cell

The earthquake, volcano, and cell were models that you could hold. Although this game cannot be held, it is still a type of model.

What does the game model? the warfare between pathogens and the immune system

Extra, Extra, Read All About It!

EXPLORATION

As a new reporter for a well-known news agency, you have recently been assigned to cover breaking medical news. Your editor insists on accuracy while reminding you that it is important for your agency to be the first to publish articles about any new discoveries.

Competing reporters are racing to get the big scoop. Don't forget the basics of reporting—who, what, where, when, why, and how—and go cover that story!

What to do

1. Look back at the timeline on pages 362–63. Choose a person and headline that you would like to investigate.
2. Research the information available about your choice. Why is he or she important? What is so important about his or her discovery? What do other people think about this discovery?
3. You already know your headline, so go ahead and write your article. Check your dates, names, and places when you finish. Be sure that you have not mentioned anything that would not be appropriate to the time era of this discovery!
4. If possible, try to include a picture of the person involved or some other pictures significant to your article.
5. Publish your article by presenting it to your classmates.

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TEACHER HELPS

Planning the article
Before researching, the student should prepare a sheet of paper to record his findings. He should list who, what, where, when, why, and how, leaving several lines after each to record information and notes.

You may choose for the student to write a newspaper article rather than a magazine article. If so, discuss the basic differences between the styles of writing found in a magazine and the styles found in a newspaper.

GEOGRAPHY

Locate the places where the different discoveries took place.

Objectives

- Research and write an article about a medical discovery

Materials

- trade books, biographies, and encyclopedias
- online resources

Introduction

What is it like to hear about a new discovery for the first time?

Does it sometimes seem too good to be true?

Do you believe that the discovery is credible, or does your mind automatically start to question whether or not it is true?

In today's exploration you will write an article announcing a new scientific or medical discovery as if you lived in the time era in which it happened.

Teach for Understanding

Purpose for reading

The student should read the page before beginning the exploration.

What to do

Refer to the timeline on Student Text pages 362–63.

If you were the first journalist to cover a great scientific discovery, what types of information would you include in your article? Elicit that a good reporter or journalist answers the questions who, what, where, when, why, and how.

Think how you would use your article to convince the public of the importance of the discovery.

Assign a due date and explain your requirements for presenting the finished article.

Assessment

Rubrics

Select the prepared rubric, or design a rubric to include your chosen criteria.

Objectives
- Recall concepts and terms from Chapter 15
- Apply knowledge to everyday situations

Introduction
Material for the Chapter 15 Test will be taken from Student Text page 384 and Activity Manual pages 244, 247–48, and 251–52. You may review any or all of the material during the lesson. Questions similar to Solve the Problem or the ones in Thinking It Through, Activity Manual pages 251–52, may appear on the test.

You may choose to review Chapter 15 by playing "Pathogen Attack" or a game from the Game Bank on the Teacher's Toolkit CD.

Teach for Understanding
Information on this page reflects the vocabulary and concepts the student should know for the test.

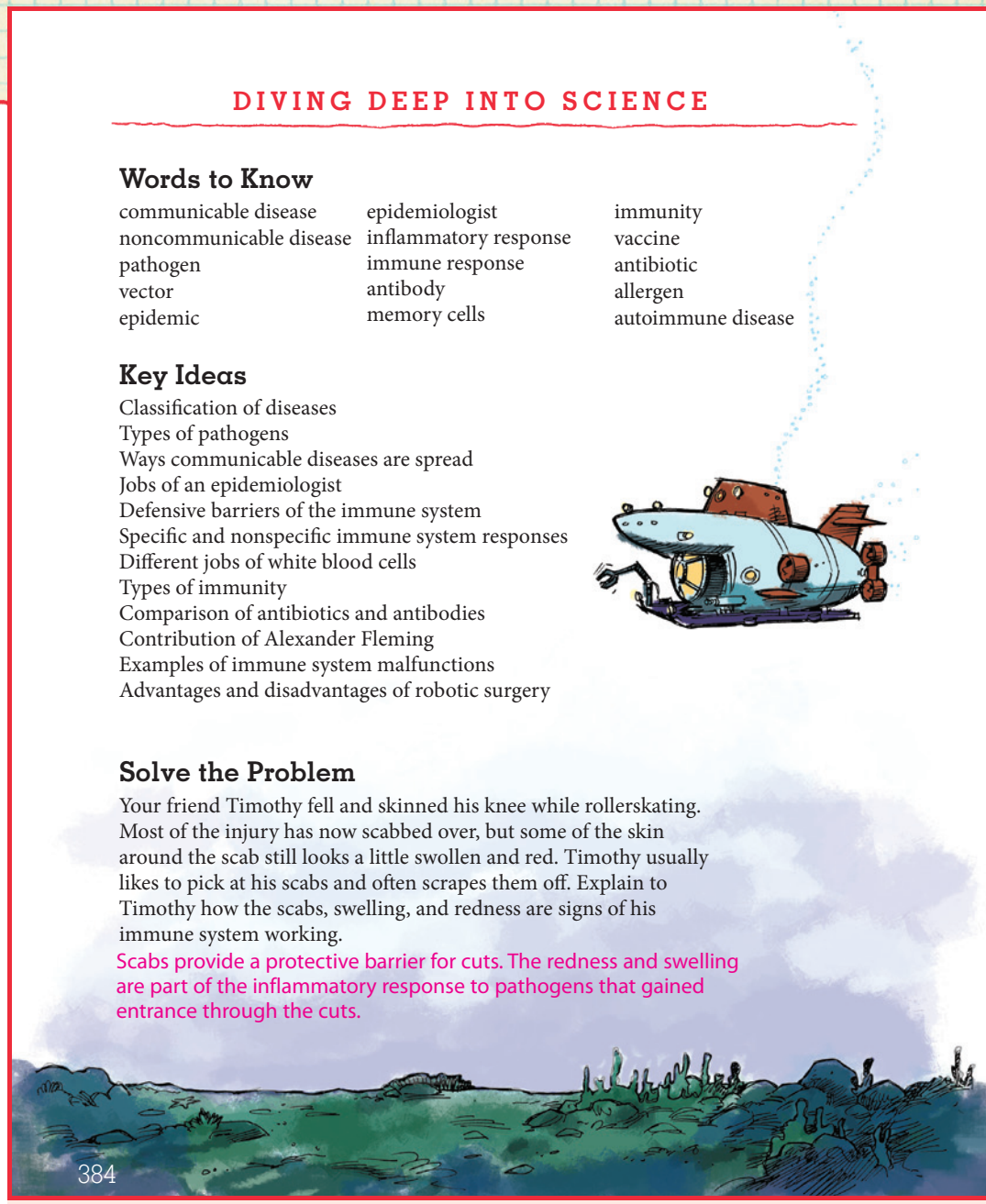
Diving Deep into Science
Solve the Problem
In order to solve the problem, the student must apply material he has learned. The student should attempt the problem independently. The answer for this Solve the Problem is based on the material on Student Text pages 372–73. Answers will vary and may be discussed.

Activity Manual
Thinking It Through, pages 251–52
These pages require written responses to application questions.

Lesson 180

Objective
- Demonstrate knowledge of concepts taught in Chapter 15

Assessment
Tests, Chapter 15



DIVING DEEP INTO SCIENCE

Words to Know
communicable disease
noncommunicable disease
pathogen
vector
epidemic
epidemiologist
inflammatory response
immune response
antibody
memory cells
immunity
vaccine
antibiotic
allergen
autoimmune disease

Key Ideas
Classification of diseases
Types of pathogens
Ways communicable diseases are spread
Jobs of an epidemiologist
Defensive barriers of the immune system
Specific and nonspecific immune system responses
Different jobs of white blood cells
Types of immunity
Comparison of antibiotics and antibodies
Contribution of Alexander Fleming
Examples of immune system malfunctions
Advantages and disadvantages of robotic surgery

Solve the Problem
Your friend Timothy fell and skinned his knee while rollerskating. Most of the injury has now scabbed over, but some of the skin around the scab still looks a little swollen and red. Timothy usually likes to pick at his scabs and often scrapes them off. Explain to Timothy how the scabs, swelling, and redness are signs of his immune system working.

Scabs provide a protective barrier for cuts. The redness and swelling are part of the inflammatory response to pathogens that gained entrance through the cuts.

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Review Game
Pathogen Attack
Use the cards from Lesson 178 to play a review game. In addition to the cards, make two copies of the following chart.

1	25	5	40
20	60	10	1
40	15	45	25
55	50	25	30
25	50	1	10
35	40	5	30
1	20	40	5
55	25	15	1

Divide the students into two teams. Give one team the red pathogen cards and give the other team the blue immune system cards. Display a chart for each team.

Alternate asking review questions between the two teams. After each correct answer, the student draws the top card from his stack and marks the corresponding number on his team's chart. Return the card to the bottom of the pile. The first team to completely fill in the chart wins.

Variation: Prepare questions with varying levels of difficulty to match the card numbers. The student draws a card and then answers a corresponding question.