# 3.2 Factors Affecting the Immune System

Vaccines are weakened versions of a disease pathogen that are given to people to protect them from getting the disease later. Allergies and AIDS are examples of immune responses. Allergies are related to a heightened sensitivity to allergens. AIDS results from an infection by human immunodeficiency virus (HIV) that destroys the immune system. There are steps you can take to maintain the health of your immune system and protect yourself from disease.

## Key Terms

allergy
vaccine

Observation is an important skill in any scientific investigation. Sometimes a simple observation of a natural event is the starting point for solving a complex problem. Many scientific discoveries have been made when people looked at something taking place around them and asked, "Why is this happening?" One example is what happened in the early 1700s to an Englishwoman named Mary Montagu.

## Montagu's Observations

**Figure 3.10** Mary Montagu was a poet and writer known for her keen observations about society and politics. Her own experience with smallpox and her brother's death from it strengthened her determination to rid Europe of the disease.

At that time in Europe, smallpox was a dreaded disease that caused serious health problems and often death. In her travels through Turkey in 1717, Montagu was amazed to see women performing a simple procedure that seemed to protect children from getting this terrible disease (see Figure 3.10). The women made a small scratch on a child's arm. Then a drop of pus from a patient who had a mild case of smallpox was placed on the scratch. Soon pus-filled blisters broke out on the child's body, but they healed easily. Children treated this way quickly recovered from this mild version of smallpox without ever developing the serious form of the disease.

When Montagu reported what she had seen to doctors in England and Europe, they wanted more proof. So she conducted a similar experiment using English prisoners. The experiment worked, and doctors slowly began to adopt her idea. Montagu's persistence and hard work eventually led to the eradication, or removal, of smallpox from England. But after her death, the method was forgotten. It was not until 80 years later that Montagu's idea resurfaced.

In 1796, an English doctor named Edward Jenner observed that many people who milked cows seemed to be immune to smallpox. Jenner discovered that these people had previously had cowpox. Symptoms of cowpox included blisters that were similar to those of smallpox, but cowpox was a much milder disease. This was good news. Jenner hypothesized that if people got cowpox, then they could not get smallpox.

## Jenner's Famous Experiment

Jenner gave an eight-year-old boy cowpox by placing him near infected cows. After the boy recovered, Jenner infected him with smallpox. Just as he expected, the boy did not develop any of the symptoms of smallpox. While no one understood how the immune system functioned, it was clear that getting cowpox prevented a person from getting the deadlier disease, smallpox. Once Jenner's findings became known, people began intentionally infecting themselves with cowpox to prevent future smallpox infection (see Figure 3.11). Jenner's experiment, like Montagu's on prisoners, would be considered too risky and unethical to perform today.

### Did You Know?

The last known naturally occurring case of smallpox was recorded in Somalia in 1977. The disease is now thought to be eradicated (completely eliminated) from the world except for samples stored in scientific labs.

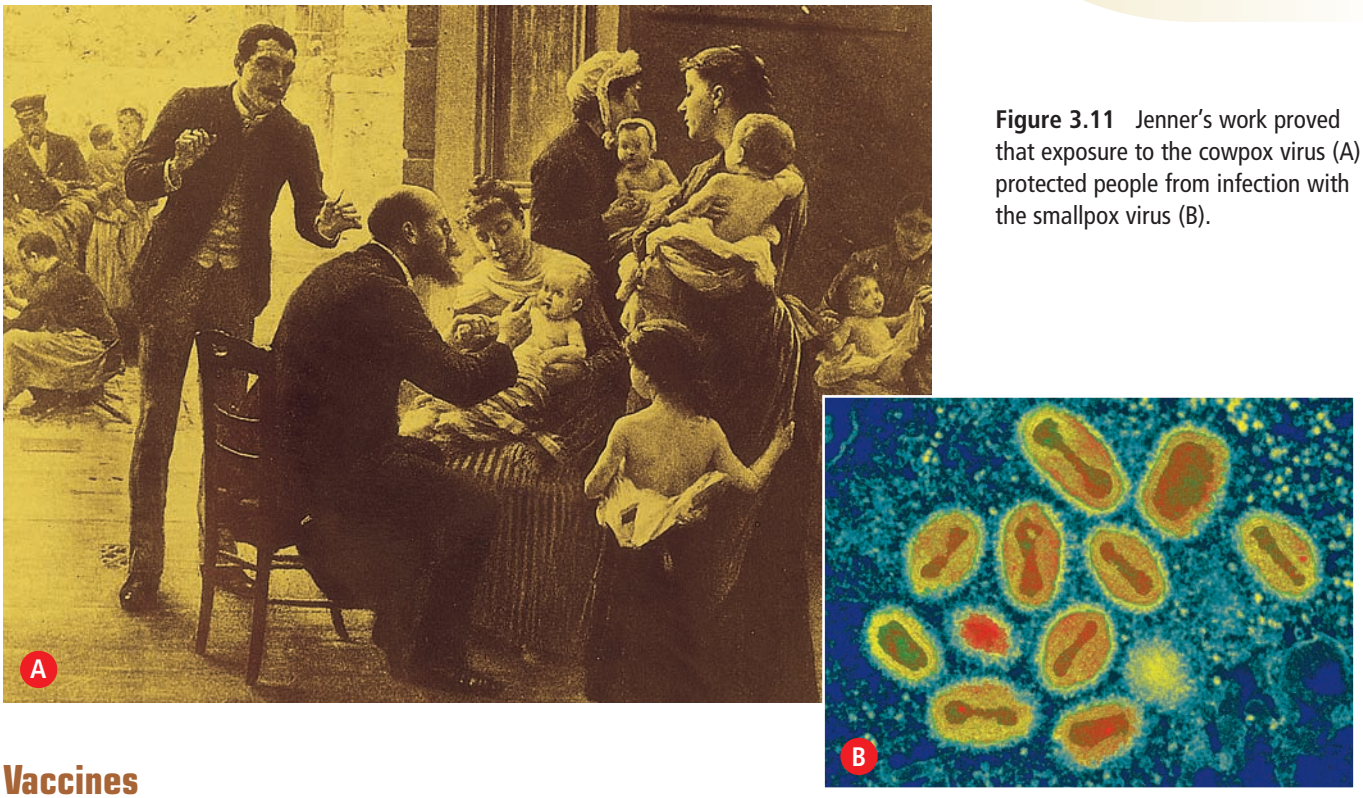



**Figure 3.11** Jenner's work proved that exposure to the cowpox virus (A) protected people from infection with the smallpox virus (B).

## Vaccines

We now know that people who were infected with cowpox 200 years ago were actually receiving a vaccination for smallpox. You probably remember receiving vaccinations at school or in your doctor's office. A vaccination is the process of receiving a **vaccine**. A vaccine is a special version of an antigen that gives you immunity against a disease. You can think of a vaccine as a weakened form of a disease. Vaccines are usually given by needle or in liquid form. They work by stimulating your immune system to create antibodies against the disease. These antibodies can then be reactivated to fight the antigen if it enters your body in the future. Some vaccines, such as the one for tetanus, require a booster shot every 10 years. This additional vaccine boosts antibody production and extends the immune system's memory for that antigen.

## Did You Know?

Tetanus can cause muscle paralysis if left untreated. Tetanus bacteria are often found in soil. They usually enter the body through deep cuts or puncture wounds, which you might get from stepping on a nail, for example. Other possible sources are animal bites and road rash from bicycle accidents.

**Figure 3.12** A vaccine is usually injected into the arm.

## Word Connect

The word "vaccine" comes from the Latin word *vacca*, which means cow.

As of 2006, all Grade 9 students in British Columbia receive booster shots for tetanus, diphtheria, and pertussis (Figure 3.12). The last time you received this booster shot was when you were between four and six years old. As our understanding of diseases grows, other vaccines may be added to these three. You may also receive additional vaccines later in life, especially if you travel to parts of the world where you risk being exposed to particular diseases.

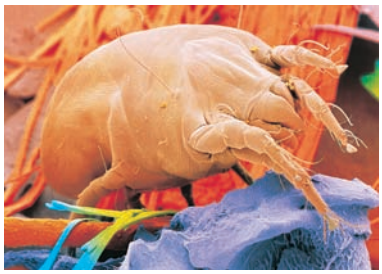


**Figure 3.13** Anton van Leeuwenhoek was the first person to report that mites live in dust. Dust mites dine on dead skin flakes and are common inhabitants of bedding, carpets, and old clothes.

## Disorders of the Immune System

Sometimes the immune system malfunctions, working against the body rather than protecting it. The effects can range from minor irritations, such as a mild allergy to grass, to life-threatening diseases such as AIDS.

### Allergies

An **allergy** is an unusually high sensitivity to some substance. If you have an allergy to milk, for instance, milk acts as an antigen for you. Your immune system kicks in, and you have an allergic reaction. Any substance that causes an allergic reaction is called an **allergen**. Allergens come in many forms, including foods, pollen, dust, and cats. The true source of an allergen is sometimes surprising. For example, the allergen from cats is the dried saliva on their skin flakes, or dander. A dust allergy may be due to the feces of tiny dust mites that live in ordinary house dust (see Figure 3.13).

Common symptoms of an allergy are a runny nose and watery eyes. These symptoms result from a side effect of a substance called **histamine**. Histamine is a chemical that your body releases when you have an injury or need to fight invaders such as allergens. That is why some people need to take "antihistamine" drugs for allergies. These drugs do not cure the allergy, but they reduce the symptoms caused by the release of histamine. Some people are highly allergic to allergens such as bee-sting venom and peanuts. Exposure to these substances can trigger a severe reaction called **anaphylactic shock**. Anaphylactic shock can result in swelling, breathing difficulty, and sometimes death. For safety, these people carry an adrenaline auto-injector (see Figure 3.14). These one-time-use needles inject adrenaline into the body to counter the allergic reaction.

**Explore More**

Another category of immune system diseases are the autoimmune diseases. These diseases include multiple sclerosis, type 1 diabetes, and rheumatoid arthritis. Find out how these diseases affect the immune system and the body. Begin your research at **www.bcscience8.ca.**


**Figure 3.14** This auto-injector (A) is designed to automatically deliver adrenaline to help reduce the effects of an allergic reaction. The best place to use an auto-injector is in the thigh (B).

## Acquired Immunodeficiency Syndrome (AIDS)

AIDS is an infection of the immune system that leads to various health complications and often death. So far, AIDS has resulted in the death of more than 11 million people worldwide and currently affects more than 40 million people. AIDS is caused by the human immunodeficiency virus (HIV). HIV is a powerful pathogen that attacks the immune system itself and can destroy it by infecting helper T cells (see Figure 3.15 on the next page). This means that when other pathogens or antigens enter the body, the immune system is unable to activate killer T cells or B cells. As a result, a person infected with HIV can die from other, less serious infections such as pneumonia.

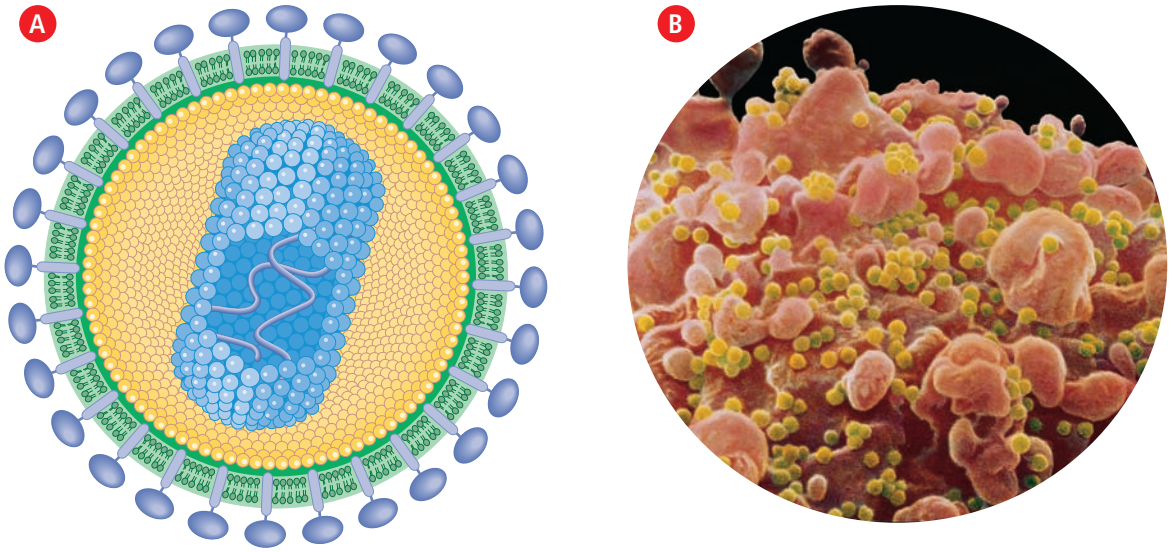



**Figure 3.15** HIV is a virus with an outer envelope covered with knob-like attachment proteins (A). Researchers are studying these proteins to find ways to stop the spread of the virus in humans. The micrograph shows a T cell with yellow-green HIV particles on its surface (B).

**internet connect**

When you travel to other parts of the world, you sometimes need vaccinations for diseases that are rare in Canada but more common elsewhere. Go to **www.bcscience8.ca** to investigate the different vaccines you may need when travelling.

HIV is mainly transmitted in two body fluids, semen and blood. People are infected by the virus through unsafe behaviour such as having sex with a person who has HIV and not using a condom, or sharing needles contaminated with infected blood. HIV cannot be transmitted by casual contact such as shaking hands.

There is no known cure for AIDS, and developing a vaccine to prevent it is very difficult. That is because HIV keeps changing its structure slightly, making it hard to identify the antigens on the virus. There are several forms of the virus. New forms are discovered every year. A person infected with HIV may live an average of four to 10 years. Researchers do not understand why infected men live longer on average than infected women.

## Taking Care of Your Immune System

Some infectious and immune system diseases are difficult to protect yourself from. Table 3.2 summarizes some important steps you can take to help keep your immune system healthy.

**Table 3.2 Taking Care of Your Immune System**

- Eat a well-balanced diet.
- Maintain your personal hygiene—brush your teeth, shower or bathe, and wash your hands often.
- Keep your home clean.
- Avoid tobacco and other non-prescription drugs.
- Get plenty of rest and exercise.
- Keep your vaccinations up to date.
- Do not engage in activities that involve sharing body fluids with others.

# 3-4 Dealing with Deadly Viruses

**Conduct an INVESTIGATION**

**Decision-Making Focus**

## SkillCheck

- Predicting
- Evaluating information
- Working co-operatively
- Identifying ethical issues

## Issue

Small samples of potentially deadly viruses exist in scientific laboratories throughout the world. The smallpox virus is one example. The issue is: should these samples be destroyed?

## Background Information

Smallpox is the first disease thought to be eradicated from the human population because of vaccinations. This is a remarkable achievement, and health organizations are working to repeat this success for other diseases. It is estimated that smallpox killed 500 million people up to 1977, and 30 percent of all people that got smallpox died.

Once the disease was eradicated, countries like Canada stopped providing the vaccine for smallpox. This means that many people are not protected against the disease. If the virus were ever accidentally released from one of Canada's two scientific laboratories dealing with smallpox, millions of people could become infected by this highly infectious pathogen.

## Identify and Analyze Alternatives

Consider these two viewpoints on this issue. The pro-smallpox group believes the virus should be stored in laboratories in case there is ever a smallpox outbreak. Research on the existing virus samples may provide clues to preventing future outbreaks. The anti-smallpox group believes it is dangerous to keep any supply of the virus, since it could accidentally, or even intentionally, be released into the environment.

Your task is to choose one side of the argument and research the issue. You will present your findings in either a debate or a class presentation. Your teacher will provide more details about how to present your information.

Begin your research using the following resources:

1. Go to **www.bcscience8.ca** to begin your search for information. Also use search engines. Try keywords such as "smallpox," "research," and "World Health Organization."
2. Look in print materials such as magazines, newspapers, and books for information on smallpox stockpiles in research laboratories.
3. Summarize the information you find in a short report for presentation to your class or for use in a debate. If you are debating, be sure to include only information that supports your viewpoint or refutes the opposite view.

## Evaluate

Present your findings and conclusions to your classmates either in a presentation or as a debate.

**Science Skills**

Go to Science Skill 4 for information about developing decision-making skills.

# Science Watch

## Pig Parts for People?

A 13-year-old patient lies seriously ill in hospital. He must get a new kidney immediately or he will die. No suitable human kidneys are available. His doctor has a solution but she must convince the ethics board of the hospital that it is a good decision.

Thousands of Canadians are waiting for kidney transplants because they have kidney disease. Kidney disease occurs in young people most often because of a bacterial or viral infection. In adults, kidney disease is usually caused by hereditary factors, diabetes, or high blood pressure.

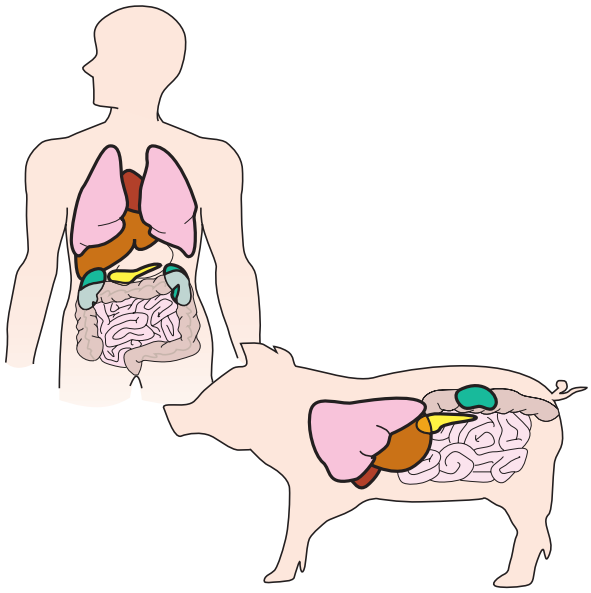
The number of successful organ transplants increases each year as techniques to match donors and organ recipients improve. However, the recipient's white blood cells might attack the foreign tissue of the donated organ and reject it. Patients must take powerful drugs to prevent organ rejection.

The problem for people with kidney disease is that donated organs are in short supply. Pigs may be the solution. Pigs could offer an endless supply of organs for humans in the future. Pig organs are similar in size to human organs, and pigs reproduce quickly. Most importantly, scientists can change pig cells genetically so that a human body will not recognize pig organs as foreign tissue.

Transplanting an organ from one species into another is called xenotransplantation. *Xeno* is pronounced ZEENO and means "foreign" in Greek. The major concern with xenotransplantation is the risk of transferring an animal disease to the patient, who could transfer it to others. The disease would be new to humans so we would not have the natural ability to fight off this disease.

We will not know for certain if xenotransplantation is dangerous until experiments are done on humans. Laws controlling xenotransplantation may require patients to agree to certain life restrictions to prevent the possible transmission of diseases. These could include never having children, never travelling outside the country, and being monitored by authorities for as long as they live.

At present, about 20 percent of all people on waiting lists die before a suitable organ is found. Despite concerns, xenotransplantation offers hope to the thousands of patients on transplant waiting lists in Canada.



### Questions

1. Why are scientists considering pigs for human organ transplants?
2. What major concern do scientists have about xenotransplantation?
3. The 13-year-old patient will die within the next few days without a new kidney. Do you think his doctor should recommend xenotransplantation of pig kidneys?

# Check Your Understanding

## Checking Concepts

1. Outline how Mary Montagu discovered a vaccine for smallpox.
2. Describe the symptoms of an allergic reaction.
3. What is a vaccine?
4. Where does the word "vaccine" come from?
5. Why does a vaccine have to be a specially prepared version of a disease pathogen?
6. What is a vaccine's booster shot?
7. What is the effect of an antihistamine?
8. Describe how an allergy is different from an allergen.
9. What is an adrenaline auto-injector and how is it used?
10. Explain the difference between AIDS and HIV.
11. Which of the following statements describe activities that would help to take care of your immune system? For activities that are not helpful, change the statement to make it a helpful activity.
    (a) Eat fast food and foods high in sugar.
    (b) Wash your hand occasionally.
    (c) Keep your home tidy and neat.
    (d) Avoid smoking.
    (e) Balance the amount of rest and exercise you get.
    (f) Keep your vaccinations up to date.
    (g) Never share anything contaminated with blood.
12. For each of the seven things you can do to protect your immune system, describe one specific action you could take.

## Understanding Key Ideas

13. Why was observing an important skill for Edward Jenner to have?
14. For each set of terms below, explain the relationship that exists between the terms.
    (a) Montagu, Jenner
    (b) vaccine, antigen
    (c) allergy, allergen
    (d) AIDS, HIV
15. If vaccines stimulate the production of antibodies to defeat antigens, why do some vaccines need a booster shot?
16. People infected with HIV may die from other causes. Why?
17. How is HIV transmitted?

### Pause and Reflect

New pathogens and antigens are being discovered all the time. Sometimes a pathogen is detected by the outbreak of a new disease in some part of the world. Think back over the past year and describe any such outbreaks that have made the news.

## Prepare Your Own Summary

In this chapter, you investigated the immune system and how it protects the human body. Create your own summary of the key ideas from this chapter. You may include graphic organizers or illustrations with your notes (See Science Skill 10 for help with using graphic organizers.) Use the following headings to organize your notes:

1. Transmission of Infectious Diseases
2. First Line of Defence
3. Second Line of Defence—Innate Immune Response
4. Second Line of Defence—Acquired Immune Response
5. Vaccines
6. Disorders of the Immune System

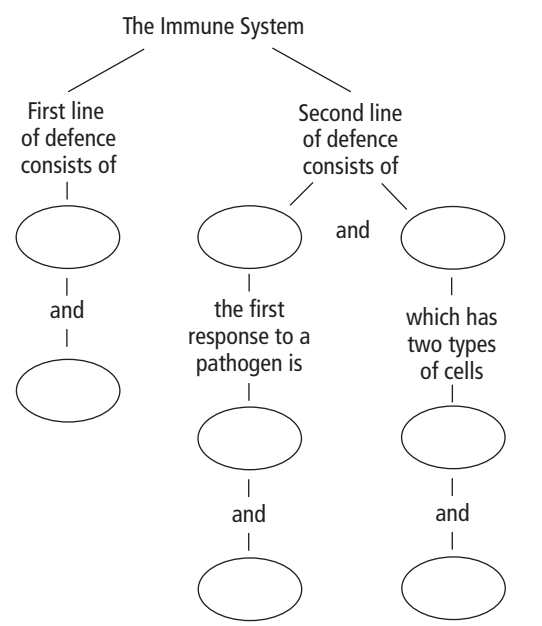
## Checking Concepts

1. What is a pathogen?
2. In terms of transmitting infectious diseases, why is it considered a good idea to cover your mouth when you cough?
3. If bacteria get into the stomach of a human, what first line of defence of the immune system will potentially stop the bacteria?
4. What are the characteristics of an innate immune response?
5. Why is the presence of phagocytes an indication of an infection by a pathogen?
6. What type of blood cells are involved in an acquired immune response?
7. Arrange the following statements in the correct order to describe the acquired immune response of the immune system to a pathogen.
   (a) Antibodies destroy pathogens.
   (b) B cells mobilize to produce antibodies.
   (c) Some immunity remains for future use.
   (d) Pathogen is recognized.
8. What are the four steps that describe an immune system response to a pathogen?
9. What are the differences in function between a B cell and a memory B cell?
10. If a helper T cell recognizes an antigen, what happens next?
11. How is the function of a killer T cell different from that of a helper T cell?
12. What immunizations do Grade 9 students in British Columbia usually receive?
13. What is an allergen?

14. Why do people with allergies take antihistamines?
15. Describe one method of treating a person with anaphylactic shock.
16. What part of the immune system does HIV attack? Why does this damage the immune system?
17. Describe three activities you can do to take care of your immune system.

## Understanding Key Ideas

18. Copy the following concept map into your notebook and fill in the blanks with the correct term.




19. After a person receives a vaccination, the body produces antibodies for the antigens of a particular disease. How does the immune system react if the vaccinated person becomes infected with that disease?
20. Owen has a sore throat. The doctor prescribes an antibiotic. After taking this antibiotic for a day, Owen breaks out in a rash. What is happening to him?
21. You and a younger cousin have been invited to a friend's house for a sleepover party. Your friend's brother has just come down with chicken pox. You have never had this disease, and your cousin received the vaccine for chicken pox last year.
    (a) Should you both attend the party?
    (b) What is likely to happen to you?
    (c) What is likely to happen to your cousin?
22. Would getting a vaccination for chicken pox be a good thing for someone who had chicken pox three years ago? Explain your answer.
23. Do you think it is better to vaccinate people or to wait until they build up their own immunity? Explain your answer.

## Pause and Reflect

The immune system is sometimes compared to an army. For example, an army protects a country and an immune system protects a body. A pathogen is the enemy fighting the army. What parts of an army would the following parts of the immune system function as?

(a) first line of defence
(b) innate immune response
(c) acquired immune response
(d) B cells
(e) helper T cells
(f) killer T cells
(g) active immunity
(h) vaccine

# Unit Summary

## 1 The cell is the basic unit of life.

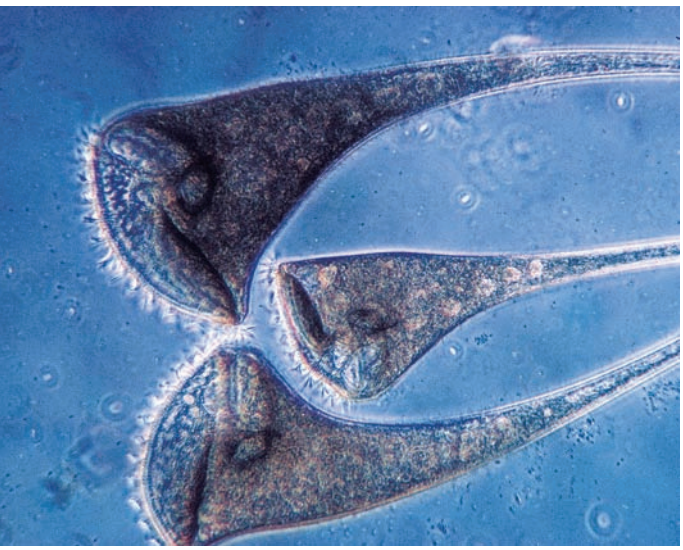
- Living things have five main characteristics: they respond to their environment, they need energy, they grow, they reproduce, and they get rid of wastes. (1.1)
- A compound light microscope is an important tool in the study of microscopic living things. (1.1)
- Cell theory states that the cell is the basic unit of life. (1.2)
- Each cell structure and organelle carries out a specific task to help support the life functions of a cell. (1.2)
- Diffusion is the movement of particles from an area of higher concentration to an area of lower concentration. (1.3)
- Osmosis is the movement of water from an area of higher concentration to an area of lower concentration. (1.3)

## 2 Human body systems work independently and together.

- The human body is organized into different organ systems. (2.1)
- Cells with the same structure and function form tissues, and groups of tissues form organs. (2.1)
- There are four stages in digestion: ingesting, digesting, absorbing, and eliminating. (2.2)
- The digestive system is like a long tube along which organs perform different functions during the digestion process. (2.2)
- In the excretory system, the process of excretion removes liquid wastes from the body. (2.2)
- The circulatory system consists of the heart and a network of blood vessels that carry blood throughout the body. (2.3)
- The respiratory system is made up of structures and organs that help move oxygen into the body and carbon dioxide out of the body. (2.3)

## 3 The immune system protects the human body.

- Infectious diseases are caused by pathogens. (3.1)
- The immune system attacks and destroys invaders such as pathogens and antigens that enter the body. (3.1)
- The immune system's first line of defence is the skin and linings of the body's internal systems. (3.1)
- The immune system's second line of defence may be either an innate immune response or an acquired immune response to an invading pathogen. (3.1)
- Vaccines are weakened versions of a disease pathogen. (3.2)
- Immune system disorders occur when the immune system malfunctions and works against the body it is supposed to protect. (3.2)



## Key Terms

- bacteria
- cell
- cell membrane
- cell theory
- cell wall
- chloroplast
- compound light microscope
- cytoplasm
- diffusion
- electron micrograph
- endoplasmic reticulum
- eukaryotic cells
- Golgi body
- lysosome
- metabolism
- mitochondria
- nucleus
- organelle
- organism
- osmosis
- prokaryotic cells
- ribosome
- scanning electron microscope
- selectively permeable membrane
- vacuole
- virus

## Key Terms

- arteries
- capillaries
- circulatory system
- digestion
- digestive system
- excretion
- excretory system
- gas exchange
- gastric juice
- mucus
- nutrients
- organ
- organ system
- respiratory system
- tissue
- veins
- villi

## Key Terms

- antibody
- antigen
- immune system
- pathogen
- white blood cells
- vaccine

# Building a 3-D Model of Human Body Systems

In Find Out Activity 2-1 on page 55, you and a partner made outlines of each other's bodies. Then you sketched in the body systems you knew on the outline of your own body. As you learned new information in Chapter 2 about various organ systems in the human body, you revised your drawing. In this project, you will work in groups to create a life-sized, three-dimensional model of four organ systems using a variety of everyday materials.

## Problem

How can you use everyday materials, such as those you find at home and at school, to build a three-dimensional model of the digestive, excretory, circulatory, and respiratory systems?

## Criteria

- The different structures of each organ system are made from everyday materials.
- Each structure in each organ system is correctly labelled.
- The model demonstrates at least one example of the interaction between two organ systems.
- The way the model is presented to your class follows your teacher's instructions.

## Procedure

### Part 1 Brainstorming Ideas

1. With your group, brainstorm various materials you could use to create your model of the digestive, excretory, circulatory, and respiratory systems. Write down any materials and the body parts they represent in a particular organ system on a large sheet of chart paper. An example is at the top of the next column.

| | |
|---|---|
| **Digestive System**<br>vacuum hose—small or large intestine | **Excretory System**<br>bean bag—kidney |
| **Circulatory System**<br>rubber tubing—blood vessels | **Respiratory System**<br>sponge—lung |

2. Decide on a final list of materials you will use for each organ system. Assign different group members to collect the materials. (Use any material that is available and safe. If you are unsure, check with your teacher.)
3. Ask your teacher to review this list before you collect your materials.

### Part 2 Building Your Model

4. Outline the body of one member of your group on a large piece of chart paper.
5. Using the materials your group collected, build your three-dimensional model. Your materials should fit within the body outline you have drawn and clearly show the four organ systems.
6. When you have completed your model, review the criteria at the beginning of this project and make sure you have correctly labelled each system. Be sure to include an example of where two systems interact.

## Report Out

1. After building your model, follow the directions provided by your teacher for presenting your work to the class. In your presentation be sure to explain your choice of materials to build each organ system and describe where two organ systems interact.

# Advances in Biotechnology

As our understanding of cells, tissues, and organ systems has grown, so too have the ways in which we use this knowledge. Biotechnology is an example of an area of research that has expanded because of our ability to apply new knowledge to the development of new products for human use. In this integrated research investigation, you will use print and electronic resources to study the role of biotechnology in our society.

## Background

The United Nations, an international organization that promotes world peace, security, and human improvement, defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use."

Biotechnology has expanded to include many different areas of research. Many, but not all, of these areas investigate what happens when changes are made to the DNA of living things such as bacteria, plants, and some animals. The table below describes some of these areas.

British Columbia is emerging as a world leader in the area of biotechnology. For example, researchers in our province have developed new medicines to cure eye diseases and have modified enzymes to improve human health.

## Find Out More

Choose one area of biotechnology from the table and conduct research on a topic in this area. If you would rather select a different area to study, check with your teacher. Start at **www.bcscience8.ca** and use magazines and newspapers to find out information on your topic. You may also wish to contact universities that are conducting research in your chosen area.

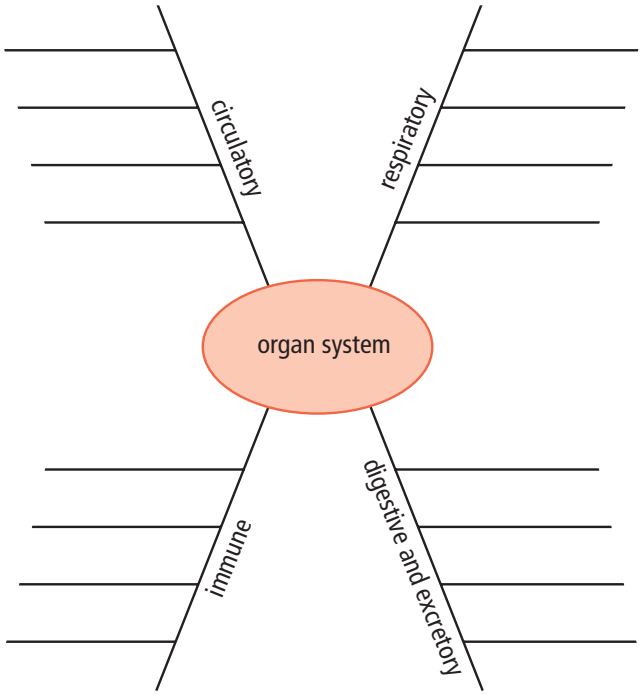
## Report Out

Create an information pamphlet, brochure, or electronic presentation that could be used to inform people about recent advances in the biotechnology topic you selected. Include an overview of your topic area, what new discoveries have occurred in this area, what potential applications could come from this research, and a description of any ethical issues resulting from this type of research.

| Biotechnology Area | Example |
|---|---|
| Bioethics | Changing the DNA of living things has raised questions about the safety and ownership of newly created living things. |
| Biomedicine | Scientists are modifying bacteria in such a way that the bacteria make products useful to humans. For example, insulin that is used by people with diabetes can be made from modified bacteria. |
| Bioengineering | The production of foods such as cheese and yogurt requires bacteria. Bioengineering finds ways to modify the bacteria to produce new and tastier foods. |
| Bioremediation | Certain bacteria can be used to clean up toxic wastes and other types of pollution. |
| Molecular biology | Police use DNA fingerprinting to discover who may be responsible for committing a crime. |

## Visualizing Key Ideas

**1.** Copy the following spider map into your notebook. Beside each topic, fill in as many words as you can that are related to that topic. Do not look at your textbook. When you have completed the map, go back through this unit and look for other words you could include. Add these words to the map using a different colour of pen.




## Using Key Terms

**2.** (a) Use the key terms listed below to create a fill-in-the-blank quiz. For example, for the key term "cell," an acceptable quiz statement is:

The basic unit of life is called a _____.

- antibody
- artery
- atrium
- compound light microscope
- gastric juice
- nucleus
- osmosis
- platelets
- resolving power
- tissue
- vaccine
- vacuole
- villi
- virus
- white blood cell

(b) Create an answer key for your quiz.

## Checking Concepts

1

**3.** You have found something you think is living. What characteristics would your discovery have to demonstrate to be considered living?

**4.** (a) What are two differences between unicellular and multicellular living things?

(b) What are two similarities between unicellular and multicellular living things?

5. In a compound light microscope, what is the function of the following?
   (a) eyepiece
   (b) revolving nosepiece
   (c) coarse focus knob
   (d) light source
6. How does an object appear when viewed through a compound light microscope?
7. What is the difference between a micron and a millimetre?
8. Which organelle produces energy for cell activities?
9. What function does the vacuole perform in a cell?
10. (a) Which organelles are found only in a plant cell?
    (b) What is the function of each of these organelles and why is each one necessary for a plant's survival?
11. (a) Which organelles assemble, transport, and store proteins?
    (b) What is the function of each of these organelles?
12. Summarize in point form how the cell theory developed. Include the three main points of the cell theory in your summary.
13. Are the following statements true or false? If a statement is false, rewrite it so that it is true.
    (a) During diffusion, particles move from an area of lower concentration to an area of higher concentration.
    (b) Osmosis is the movement of solid particles across a membrane.
    (c) A selectively permeable membrane allows only some particles to pass through.
    (d) Equilibrium occurs when there are equal numbers of particles on each side of the membrane.

## 2

14. Explain the three characteristics of a system using the circulatory system as an example.
15. List the four types of human tissue and provide an example of each.
16. (a) Which of the following terms defines a group of similar cells working together: cell, tissue, organ, or organ system?
    (b) How are all of the above terms related?
17. Give two examples of foods that contain:
    (a) carbohydrates
    (b) fats
    (c) proteins
18. Identify one mineral you need in your diet and describe what this mineral does in your body.
19. Chewing is an example of what type of digestion?
20. What is peristalsis and where does it occur?
21. Explain why bile is important in digestion.
22. Describe one role of bacteria in digestion.
23. Both the small and the large intestine are responsible for absorption in the digestive system. What materials are absorbed by each of these structures?
24. Explain why capillaries are important structures for both the respiratory and circulatory systems.
25. Draw and describe the flow of blood through the major chambers of the heart.
26. Which artery carries deoxygenated blood?
27. Where are alveoli located and what is their function?
28. What are three harmful chemicals found in cigarettes? What effect do they have on the human body?

3

29. How did Joseph Lister's hypothesis eventually help to reduce the number of deaths after surgery?
30. Describe and provide an example of four ways to transmit an infectious disease.
31. Identify three ways the immune system's first line of defence protects your body from pathogens.
32. Name the cell that recognizes antigens in your body.
33. Describe the role of a helper T cell in identifying and destroying an antigen or pathogen.
34. An antigen enters a cell. How will this antigen be identified and destroyed?
35. What is the difference between a vaccination and a vaccine?
36. Describe three things you can do to take care of your immune system.

## Understanding Key Ideas

37. Is your hair a living thing? Explain your answer.
38. You are viewing a unicellular organism with a compound light microscope. You observe that it takes up three quarters of the field of view at medium power. What is the actual size of the organism?
39. Two dots on a page are 0.2 mm apart. Will you be able to see them as two separate dots or only one dot? Use the term "resolving power" in your answer.
40. Use a diagram to illustrate the differences between prokaryotic and eukaryotic cells.
41. Explain the following terms in a short paragraph: cell membrane, diffusion, osmosis.
42. Why is water not considered to be a nutrient?
43. Describe how a piece of apple undergoes chemical and mechanical digestion as it travels from your mouth to your stomach.
44. How do gastric juice, pepsin, and mucus work together in the stomach?
45. What is the role of a valve in a vein?
46. Why is the left ventricle more muscular than the right ventricle?
47. Why is the release of carbon dioxide from the body considered to be a function of the excretory system?
48. Smoking can damage the cilia in your respiratory system. Why can this become a health problem?
49. Describe the difference between an innate immune response and an acquired immune response.
50. What is the difference between an antigen and a pathogen? How are they similar?
51. What is the difference between B cells and memory B cells?
52. What four steps does your immune system follow when it attacks an antigen or pathogen?
53. How does HIV affect the immune system?

## Thinking Critically

54. Draw a small organism that would take up half the field of view under a compound light microscope at low power. (You may be creative in your drawing.) Now draw what this organism would look like under medium and high power.
55. Why would you not expect to find chloroplasts in the root tip of a Douglas fir tree?
56. Describe the differences between plant and animal cells.

57. Do you think it is better to water plants in the evening or in the morning? Design an experiment and write a procedure that would allow you to investigate this question.
58. When a person is sick with a bacterial infection, she or he may be given antibiotics to help fight the infection. What might happen to the bacteria normally living in the small intestine while the person is taking the antibiotics?
59. What is happening when someone starts choking while drinking water?
60. Your body releases carbon dioxide when you exhale. Where in your body does this carbon dioxide originally come from?
61. What does the presence of inflammation and phagocytes indicate in someone who is not feeling well?
62. Nicole is having an allergic reaction. What symptoms will she have when histamine is released in her body?

## Developing Skills

63. (a) Imagine you could spread out all the villi in the small intestine and measure the total surface area they covered. You would find that their total surface area would be about the size of a tennis court. A standard tennis court is approximately 11 m by 24 m. Calculate the surface area of the villi in your small intestine in square metres.
    (b) Determine the surface area of the floor in your classroom. Compare this surface area to the surface area of the villi in your small intestine. Which is bigger and by how much?
64. The average human heart beats about 70 times per minute. How many heart beats would occur in a day, a month, a year, and in a lifetime of 80 years?
65. How do you prepare a wet mount slide? Use labelled diagrams to describe the steps.
66. Use the following information to create a bar graph showing the percentage daily value of the five food items found in a serving of chocolate ice cream.

**Nutrition Facts: Chocolate Ice Cream**

| Item (1 serving) | Amount (g) | Percentage Daily Value (%) |
|---|---|---|
| Sugars | 22.0 | 7.0 |
| Saturated fat | 11.0 | 55.0 |
| Cholesterol | 0.1 | 42.0 |
| Sodium | 0.9 | 4.0 |
| Calcium | 0.1 | 15.0 |

## Pause and Reflect

There are three key ideas in this unit:
- The cell is the basic unit of life.
- Human body systems work independently and together.
- The immune system protects the human body.

Understanding these key ideas can help you maintain a healthy body. Using what you have learned in this unit, summarize what you think are the most important scientific concepts people should know about how cells and body systems function to maintain their health.