2.3 Interdependent Organ Systems

Here is a summary of what you will learn in this section:

- Organ systems are interdependent groups of tissues and organs.
- Healthy organ systems work together to maintain homeostasis.
- Healthy organ systems respond to changes in the environment.
- Simple medical tests can provide information about the health of organ systems.

Figure 2.32 Our bodies obtain nutrients from the foods that we eat.

Body Systems Working Together

Each day, your body's cells, tissues, and organs work together to keep you responsive to the environment. Consider the example of eating your lunch. The lunch buzzer sounds just as your stomach is making some rumbling noises. Your brain records the information that the buzzer and time of the day mean you should eat. You proceed down the hall and enter the school cafeteria.

In the cafeteria, your eyes see a poster advertising the daily specials, and your nose senses the odour of freshly made pizza. The message is sent to your brain, and you decide that you should eat pizza for lunch (Figure 2.32). While in the line, you decide to reach out and select a slice of pizza from the warming oven. The muscles in your hand and arm contract and relax, which enables you to pick up the slice of pizza without dropping it.

Once in your seat, you chew and swallow a bite of pizza using your teeth and tongue (Figure 2.33). As the muscles in your digestive system push the food along, a variety of glands add juices to assist in breaking down the food into the necessary nutrients. In several hours, the nutrients in the pizza are absorbed into your bloodstream and carried through your body to the cells. In this example, several organ systems, including the circulatory, digestive, and nervous systems, interact to enable you to obtain, digest, and transport essential nutrients from the pizza to all cells of your body.

Figure 2.33 Eating a piece of pizza involves the interaction of different organ systems.

Maintaining a Steady State

Our body systems function in a way to maintain **homeostasis**, which means "steady state." Generally, this means that there is an acceptable range of physical and chemical conditions in which body cells, tissues, and organs can operate efficiently. To keep the body within this acceptable range, different organ systems must work together to maintain homeostasis in the body.

WORDS MATTER

The word "homeo" is from the Greek word *homoios*, which means similar. The word "stasis" is from the Greek word meaning standing.

A21 Quick Lab

How Do They Do It?

Athletes must be able to perform tasks consistently to be successful at their sports (Figure 2.34). For example, to make a successful shot on goal, all the organ systems in an athlete's body must work together in harmony.

Purpose

To identify organs and organ systems that work together

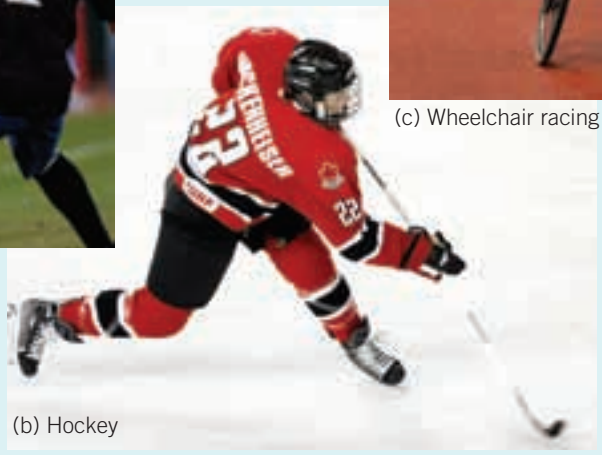
Procedure

1. Think about a particular sport or athlete. Identify the organs and organ systems that work together when an athlete plays sports.
2. Record your ideas in the form of a graphic organizer or mind map.

Questions

3. Explain what would happen to an athlete's performance if the organ systems were not working together effectively.
4. How do you think that athletic training affects the working relationships of the organs or organ systems? Explain.

(c) Wheelchair racing



(b) Hockey

Figure 2.34 (a) Soccer

How Organ Systems Work Together

Organ systems are **interdependent** because the action of one system contributes to the action of another system. For example, the circulatory system, made up of the heart, blood, and blood vessels, works to supply the body with oxygenated blood. The body cannot survive for more than six minutes if the heart stops beating. However, it is the respiratory system, made of the nose, trachea, and lungs, that supplies the blood with oxygen. Thus, the circulatory system and the respiratory system are interdependent.

Suggested Activity •
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We can see the complexity of connections between organ systems by considering what happens to your body when you play a sport outside on a sunny day (Figure 2.35).

Figure 2.35 Your organ systems work together to maintain homeostasis — even when you are outside playing sports.

Integumentary System

As you play in the Sun, you may begin to feel hot. Your skin begins to turn red because the blood vessels dilate so that excess heat can be released to the environment. You also produce sweat that cools your body and keeps you within the acceptable temperature range so that your body cells function efficiently.

Circulatory System

To keep you moving, your muscles use oxygen and glucose and produce carbon dioxide. Your heart rate increases so that more oxygen-rich blood is brought to your muscles and carbon dioxide is removed. The rate at which the blood moves to the lungs also increases. Blood flow to other organs may be reduced. As well, stored glucose is released from the liver and enters the bloodstream to be taken to muscles so that the cells will have the necessary energy.

Respiratory System

To make sure that your muscles receive oxygen and get rid of excess waste products, your rate of breathing increases. At the same time, the blood circulates around the body faster because your heart rate increases. This means that more gas can be exchanged in the alveoli and more oxygen can be picked up by the red blood cells and carried to the tissues of the body.

Skeletal System

As you exercise in the sunshine, the weight placed on your bones causes them to become stronger, assuming that the appropriate nutrients — calcium and vitamin D — are present. Calcium is essential for the formation and maintenance of healthy bones. Vitamin D is formed naturally in the skin after exposure to sunlight. Your body needs vitamin D to absorb calcium.

Muscular System

Your muscles require extra oxygen to provide the energy needed to move. The oxygen is carried to the muscles by the blood. Exercise causes an increase in the flow of blood so that more oxygen is delivered to the muscles. As you play the game vigorously, your muscles generate heat, which your body does not need. To rid the body of the excess heat, blood vessels in the skin dilate so that this heat can be lost quickly. The skin also releases sweat, which cools the body as it evaporates.

Nervous System

When you exercise, your nervous system stimulates an increase in your heart rate. Nervous signals also travel to blood vessels in various parts of the body, causing them to get smaller so that blood flow to those areas will decrease. This diverts blood flow from tissues that do not need it, such as your stomach, to the muscles where it is needed, such as your arms and legs.

Learning Checkpoint

1. Define the term "homeostasis."
2. Explain, using an example, how organ systems function in an interdependent way.
3. Explain how the integumentary system and the circulatory system work together to maintain homeostasis while you are playing outside.
4. Explain how the respiratory, circulatory, and nervous systems maintain homeostasis while you are playing outside on a sunny day.
5. Explain how the muscular and skeletal systems work together to maintain homeostasis while you are playing outside on a sunny day.

Diagnosing Problems in Organ Systems

The organ systems in our body interact with each other in very complex ways. This makes it difficult to diagnose and treat problems in organ systems. When you go to the doctor's office for a physical examination, you may undergo a few medical tests (Figure 2.36). The doctor may check your eyes and ears and look at your skin, the largest organ. Often the doctor taps your chest and abdomen to determine the size and density of your organs. Using a stethoscope, the doctor listens to sounds made by the heart and the lungs to determine if they are working properly (Figure 2.37). These tests provide information about how well your organs and organ systems are working.

Figure 2.36 During a physical exam, the doctor may look into your eyes for signs of hemorrhage (blood spots) or reduced blood flow.

Figure 2.37 To measure blood pressure, a sphygmomanometer, also called a blood pressure cuff, is used. The cuff is inflated so that the blood flow in the artery is restricted. As the cuff deflates, the doctor listens with a stethoscope to the sounds of the blood pumping through the artery.

Checking on the Circulatory System

Your doctor can determine how well your circulatory system is working by checking your pulse and blood pressure. Your pulse indicates how often your heart is beating. The average pulse ranges from 60 to 80 beats/min, although there are factors that can alter that rate.

Blood pressure is a measure of the pressure of blood against the walls of the arteries and is represented as two numbers, for example 124/84 mm Hg. The first number indicates the pressure when the heart contracts and pushes blood out (systolic). The second number indicates the pressure when the heart relaxes between beats and fills with blood (diastolic). If the numbers are too high — more than 135/85 mm Hg — there is too much blood pressure in the arteries. High blood pressure can cause damage to the arteries, which can lead to heart attacks and heart failure.

Sometimes, samples of blood are taken for testing the levels of red and white blood cells and the amount of sugar in the blood. Hormone levels may also be tested. Hormones are chemicals that carry messages through the body to regulate cells, tissues, or organs. Samples of blood can be taken to check levels of particular hormones to determine if there is an infection or a problem with the function of a gland or organ.

Learning Checkpoint

1. Describe two ways in which doctors can obtain information about the health of your organs during a routine physical examination.
2. What information is provided by the measurement of a pulse?
3. How can the measurement of the blood pressure be used to determine the health of the circulatory system?
4. Use an example to explain what is meant by the term "blood pressure."
5. What information can be gained from analysis of a blood sample?

Checking on the Excretory System

Your doctor can determine how well your excretory system is working by testing a sample of urine. As blood enters your kidneys, the kidneys remove urea, excess water, and other waste products from the blood. These waste products include the by-products, or chemical products, that are left over after you have metabolized nutrients, poisons, or drugs that you have ingested. In other words, what you eat and drink, as well as how well your kidneys are working, affects what is in your urine. The filtered blood leaves the kidneys and returns to circulation in the body. The waste material, called urine, is stored in the bladder until it can be released from the body. Urine is yellow because it contains bile pigments from the liver.

Doctors can check urine to see if it contains different components. For example:

- If there are white blood cells in the urine, there is probably an infection in the excretory system.
- If too little urine is being produced, it may be possible that the kidneys are not working effectively to clean the blood of wastes.
- If too much urine is being produced, it may indicate that the pancreas is not working properly. Excessive urine production is a symptom of a type of diabetes.

During Reading

Thinking Literacy

Revise to Synthesize

Good readers revise their ideas as they read and learn about new puzzle pieces. They think about the knowledge they had before reading about a topic, add the new information, and let the puzzle reveal a revised picture. Before you read this chapter, what would you have said was the most important organ or organ system? What do you think now that you have read and studied about these organs and systems?

Take It Further

Diabetes is the fourth leading cause of death in the world after heart disease, cancer, and influenza. The increase in cases of diabetes is attributed to the rising levels of obesity. Learn about the two types of diabetes, the history of diabetes, and how it is treated. Begin your research at ***ScienceSource***.

Drugs, including prescription drugs, cannabis, cocaine, and methamphetamine, can be detected in the urine for a period of time. For some jobs and at some sporting events, urine is tested for the presence of drugs, both legal and illegal (Figure 2.38).

Figure 2.38 A technician prepares a urine sample for testing at the Swiss Laboratory for Doping Analysis in Epalinges, Switzerland. Urine testing was conducted during the 2008 Beijing Olympic Games.

A22 STSE Science, Technology, Society, and the Environment

Green Livers

Scientists have found that environmental toxins can accumulate in our tissues and organs. A build-up of toxins can cause disease, allergies, environmental sensitivities, and even asthma.

Researchers have found that certain plants can be used to remove environmental toxins from the soil. In fact, the roots of some grasses have been called "green livers" because they store toxins in much the same way as a liver stores toxins in the human body. In one example, plants were grown in soils that contained a high concentration of metals. Over time, the plants absorbed and concentrated the metals in their root systems. At the same time, the plant itself was apparently unaffected by the high concentration of metals. When the plant's roots were removed, the metal was also removed from the environment.

The process whereby plants are used to remove contaminants from their environment is known as phytoremediation. Scientists have been researching different types of plants that can be used in this process (Figure 2.38). They are also looking for ways to engineer plants that can do the job.

1. Working in a small group, list some environmental toxins that you have heard discussed in the media.
2. Discuss some strategies that are used to lessen our exposure to these toxins.
3. Go to ***ScienceSource*** and find out about how plants are genetically engineered to work as "detoxifiers."

Figure 2.39 Indian mustard is a plant used for phytoremediation. It has demonstrated an ability to tolerate and accumulate a range of different metals.

A23 Design a Lab

Skills Reference 2

SKILLS YOU WILL USE

- Making predictions, developing hypothesis
- Defining and clarifying the inquiry problem

Responding to Environmental Changes

The heart pumps blood throughout the body. The blood carries necessary nutrients and gases to the cells and takes waste materials away from cells. Several systems of the body interact together to obtain, transport, and process nutrients, gases, and waste. If the environment in the body changes, the body systems respond quickly. The heart responds to meet the new needs of its cells by increasing or decreasing the rate of pumping of blood. The pulse is a measure of the pumping action of the heart. We can use the pulse as a measure of the heart's reaction to environmental changes in the body system.

Question

How does the pulse change with a change in physical activity level?

CAUTION: Do not perform this activity if you are not well or if you have respiratory or cardiovascular problems. Perform this exercise in an open area.

Design and Conduct Your Investigation

1. Determine your resting pulse. To determine your "resting pulse," you need to have been at rest for 10 min. Select your wrist or your neck as the source of your pulse. Place your index and middle finger on the underside of your wrist near to the base of your thumb or on the hollow of your neck (Figure 2.40). You will need to use a firm pressure. Count the pulse beats for 1 min, or count the beats for 30 s and multiply by 2 to get the number of beats per minute. Note that one pulse is equal to one heartbeat.
2. Identify the experimental variables that could affect the outcome of your experiment.
3. Decide on the variable that you would like to test. Write a hypothesis that indicates how a change in that variable would affect the outcome of the experiment. It may be helpful to write your hypothesis statement in an "if... then..." format.
4. Design a method to test your hypothesis. Remember that you need to indicate how you will measure your results.
5. Prepare a list of your materials, equipment, and safety precautions needed for the experiment.
6. Have your method approved by your teacher before you begin the experiment.
7. Perform the experiment and record your results in an organized and effective manner.
8. Include a discussion of the sources of experimental error.

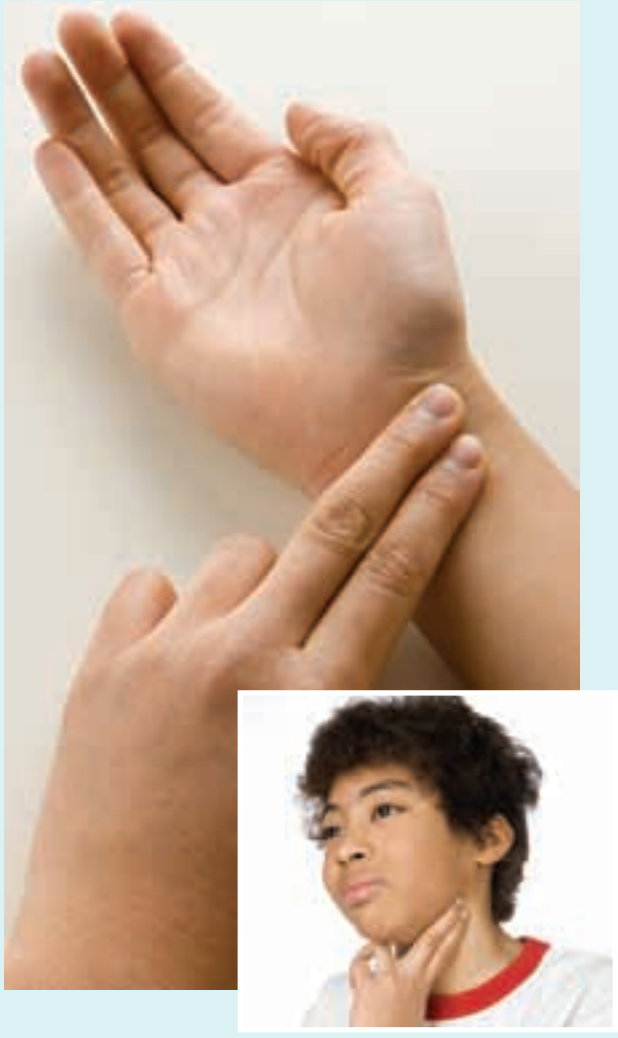

Figure 2.40 You can feel your pulse in your wrist or your neck.

2.3 CHECK and REFLECT

Key Concept Review

1. Explain why it is important for your body to maintain homeostasis.
2. What organ systems interact together to supply your cells with needed nutrients?
3. Look at the following photo. Describe two things that the doctor would check to determine the health of the young woman's respiratory system and circulatory system.

Question 3

4. (a) What is the typical range for the pulse rate of an average teenager?
   (b) Explain what the term "pulse rate" means.

Connect Your Understanding

5. Explain how organ systems are interdependent. Give an example not used in the textbook to illustrate your answer.
6. Explain why a doctor may order a blood test to check the function of your thyroid gland.
7. Explain how some organ systems work together to maintain homeostasis. Give an example to illustrate your answer.
8. Show how measurements of systolic pressure and diastolic pressure may be used to determine the effectiveness of the circulatory system.
9. Sometimes, we are embarrassed when we sweat on a hot day. Explain why sweating is a healthy and necessary response.
10. Explain the interactions that occur between the nervous system and the circulatory system during exercise.
11. Explain how weight-bearing exercise, such as walking outdoors, can build the skeletal system.
12. Describe the interactions that occur between the circulatory system and the muscular system during exercise.
13. Give an example that shows how proper amounts of vitamins and minerals are critical to the health of organ systems.
14. In previous science courses, you learned how water is treated in water treatment plants to produce fresh drinking water. Explain how the kidney functions in a similar way to a water treatment plant.
15. Think about the importance of homeostasis. Why do you think that people who were climbing high altitude mountains, such as Mount Everest, would need to stay at a base camp for a period of time before continuing their climb?
16. Give an example in which your body systems were placed under stress. How did your body respond to maintain homeostasis?

Reflection

17. Your body is designed to function in a healthy manner and maintain a steady state known as homeostasis. What actions do you take that can affect the healthy functioning of your organs or organ systems?

For more questions, go to *ScienceSource*.

Organ Transplants:

Promise or Peril?

People have always been fascinated with organ transplants. In 1818, Mary Shelley wrote the novel **Frankenstein**, a story about Dr. Victor Frankenstein, who created a monster made from selected body parts. The actual transplantation of different tissues and organs has been attempted for over 100 years.

Organ transplants occur when all other means of medical treatment have not worked. Organs can be donated after death or through a living donation, in which an organ or a piece of organ is donated by a living person. In 2007, over 2000 organ transplants were performed in Canada. Kidneys are the most transplanted organ, but transplants of livers, heart, lung, and pancreas also occur. Even limbs can be transplanted. In 2008, a German farmer who had lost both arms in a farming accident became the world's first person to receive a double-arm transplant.

During an organ transplant, an organ or part of an organ is taken from a donor and placed into a recipient. Survival rates are higher for recipients who receive living donations than for recipients who receive an organ from a diseased donor. The most common living donation is a kidney, although it is also possible to transplant a part of the liver, small intestine, and pancreas in a living donation. In a living liver donation, a portion of the liver is taken from the donor. Over a few months, the liver portion grows to form a fully functioning liver.