Section 3.2 Organs and Systems (Student textbook pages 93 to 107)

In this section, students will learn about medical imaging technologies that are used by physicians and researchers to study the human body. Students will be introduced to how the different technologies work and how they are used to view tissues, organs, and systems in different ways and for different reasons. Students will also be introduced to the hierarchy of organization and the different organ systems in the human body. Students will learn more about the function of some of these systems (digestive, circulatory, respiratory and excretory) and will explore factors that can affect the function of some of these systems. They will also compare open and closed circulatory systems. Finally, students will be introduced to the significance of anatomical arrangement in the ability of organs and organ systems to work together.

Common Misconceptions

- It is important to emphasize that organs and organ systems do not function in isolation. Emphasize that although body tissues and organs may be divided into functional systems, there is interaction between all systems and a problem in one system can affect another system.
- Students may believe that blood exits blood vessels and enters into different parts of the body, or that blood vessels "end" at target tissues. Refer students to Figure 3.22, which includes an illustration of capillaries, to help eliminate this misconception.
- Students may believe that de-oxygenated blood in veins is actually blue. This misconception is reinforced by anatomical images and by the appearance of veins through our own skin. In fact, the blue appearance of veins is a result of the way tissues in veins absorb and reflect different frequencies of light.

Background Knowledge

German physicist Wilhelm Roentgen discovered the X ray in 1895 and X ray technology has been used in diagnostics since the early 1900s. Sonar technology, which is the basis of ultrasound, was developed for use during World War II. However, ultrasound was not used widely in medical diagnostics until the 1970s. Computerized tomography (CT scan), which involves the use of a digital computer, was not developed until the 1970s. Magnetic resonance imaging (MRI) was first developed in the 1950s and used to study the structure and function of different chemicals. The technology did not become a widely available diagnostic tool until the 1980s.

The field of medical diagnostics became a big news story in 2009 because of the closure of Ontario's Chalk River reactor. The reactor produces radioactive isotopes, which are used in nuclear medicine diagnostics and treatment. Imaging using medical isotopes can provide physicians with detailed images of organs and organ systems. For example, nuclear medicine can be used to help physicians diagnose cancer and determine how best to treat the disease in a specific patient. Medical isotopes must be continuously produced. Unfortunately, the world's reactors are aging. The problem is increased by the growing demand for radioactive isotopes for medical use throughout the world. Experts from around the world are working together on the problem, but it may be many years before new reactors are built.

Other diagnostic tests can be used if there is a shortage of medical isotopes. For example, computerized tomography or magnetic resonance imaging might be used instead of nuclear medicine to provide physicians with images necessary for diagnostics. However, computerized tomography cannot be used in all patients. It requires patients to ingest a fluid and some patients can have severe allergic reactions to this fluid. Computerized tomography and magnetic resonance imaging are also not as useful for detecting the early stages of cancer.

Specific Expectations

- **B1.2** assess the importance to human health and/or society of medical imaging technologies used in Canada in diagnosing or treating abnormalities in tissues, organs, and/or systems
- **B1.3** describe public health strategies related to systems biology, and assess their impact on society
- **B2.1** use appropriate terminology related to cells, tissues, organs, and systems of living things, including, but not limited to: *absorption, anaphase, capillaries, concentration, differentiation, diffusion, meristematic, mesophyll, phloem, prophase, red blood cells, regeneration, stomate,* and *xylem*
- **B3.3** explain the links between specialized cells, tissues, organs, and systems in plants and animals
- **B3.4** explain the primary functions of a variety of systems in animals
- **B3.5** explain the interaction of different systems within an organism and why such interactions are necessary for the organism's survival

Literacy Support

Using the Text

- Have students create a concept map that shows links between the four major systems covered in the section (digestive, excretory, circulatory, and respiratory).

Before Reading

- ELL Preview the terms used to describe the 11 organ systems with English language learners before students read the section. Have students provide translations of these words in their own language to refer to when they read the section.
- Have students preview the text features and headings. Have them look at the terms used to describe medical technologies and organ systems, and consider whether they are already familiar with any of these terms. This will help them identify the main ideas in the section.

During Reading

- Have students make connections to prior knowledge as they read. Students may be familiar with many of the topics in this section. Encourage students to identify what they already know about the material in this section.
- Have students create study notes as they progress through the section. They will need to identify the most important information and decide how to record in a way that is most meaningful to them.
- Have students stop to ask questions or compile a list of questions they have as they read the chapter. Have students pause after reading a section and determine what questions they may still have about the material presented.

After Reading

- Have students return to the list of questions they compiled during reading and determine whether the rest of the section answered their questions. Students can then work with a partner to see if they have similar questions or answers.
- Encourage visual learners to summarize their notes using graphic organizers or word webs to consolidate their learning.

Using the Images

- Before reading, have students preview the images in this section and brainstorm a list of ideas, words, and feelings they have about the topics covered. Have students list any questions they may have about the topics in the section.
- Encourage visual learners to summarize the illustrations throughout the section as a preview to the material.
- Have students summarize the information provided in Figure 3.13 in a different way.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check questions, pages 99, 106	Students describe organ systems and explain how an organ system is similar to a machine. They explain how cells, organs, tissues and systems are related. Students determine which system is not critical for maintenance of the body and describe its function. They draw and label the four chambers of the heart and explain why they think the left side of the heart has stronger muscles than the right. Students describe the path air takes to reach the alveoli. They use their knowledge of the circulatory system to explain symptoms of anemia.	Provide students with **BLM G-17 Using Models** and **Analogies in Science,** or refer them to Science Skills Toolkit 9 Using Models and Analogies in Science in the Appendix of the student textbook. Refer students to Study Toolkit 4 Organizing Your Learning: Using Graphic Organizers in the Appendix of the student textbook, or provide students with **BLM G-44 Main Idea Web** or **BLM G-42 Concept Map** to help them answer question 3. Pair visual learners with students who are experiencing difficulty answering question 5. Allow visual learners to answer question 7 by drawing the pair air must take to reach the alveoli.
Activity 3-3 Changing Your Pulse Rate, page 101	Students measure their own pulse rate before and after exercise. They use their results to explain how exercise affects pulse rate. They also infer why regular exercise is good for their hearts.	Pair students to encourage peer tutoring. Alternatively, discuss the questions as a class. Remind students about what they learned about different tissue types in Section 3.1.
Section 3.2 Review questions, page 107	Students name and understand features of the small intestine, and blood flow through the heart and lungs. Students explain the importance of the duct joining the small intestine and pancreas, the connection between the circulatory and respitory systems, and the alveoli.	Pair visual learners with students who are experiencing difficulties answering questions 4 and 8 and encourage peer tutoring.

Instructional Strategies

- DI Spatial/visual learners may particularly enjoy studying and learning about the graphics in this chapter. Pair these learners with students are experiencing difficulty interpreting the diagrams and encourage peer tutoring.
- DI Have students with logical-mathematical intelligence, or those who would benefit from more development in this area, create a flowchart to show the fate of a meal.
- ELL Check often for comprehension, among all students, and especially English language learners. Students may need to demonstrate their understanding of the concepts in a variety of ways.
- ELL Encourage English language learners and students who are experiencing difficulties to ask for assistance from peers, or pair them with students who will be able to provide support.
- ELL Encourage English language learners to translate the terms in this section into their own language.
- Provide students with **BLM 3-3 Word Origins: Describing the Human Body and Medical Technology.**
- If you have not already done so, provide students with **BLM G-11 Scientific Drawing.**
- Provide students with **BLM 3-6 The Digestive System, BLM 3-7 Heart Structure and Function,** and **BLM 3-8 The Respiratory System.**

- Post large images of the major organ systems around the classroom. Encourage students to move around and look at the images. Ensure you reinforce the idea that these systems do not function in isolation.
- Have a class discussion about the term "hierarchy." Ask students if they can think of other examples of hierarchy. If students have trouble with the concept, use the following simple analogy: relate people, towns, provinces, and countries to cells, tissues, organs, organ systems and the body. Another example: letters, words, sentences, paragraphs. Challenge students to think of other examples of hierarchies they may have learned about in other courses (e.g., political hierarchies). Provide students with **BLM G-17 Using Models and Analogies in Science.**
- Students may be familiar with some of the technologies listed on page 94 from their own medical experiences or through conversations with family members or friends. Have students share their personal knowledge of these technologies if they are comfortable doing so. There are a number of online animations and graphics available that illustrate how these technologies work.
- There are some interesting photos and videos available on the web that show how endoscopy works. Visit the following sites for more information. Go to **www.scienceontario.ca** for more information.
- If possible, invite a medical imaging technician or technologist or a medical specialist to visit your class and discuss the applications of diagnostic imaging.
- Use **BLM A-7 Scientific Drawing Checklist, BLM A-40 Scientific Drawing Rubric,** and **BLM A-13 Concept Map Checklist** for assessment.

Activity 3-3 Changing Your Pulse Rate (Student textbook page 101)

Pedagogical Purpose

Students will explore a factor that affects the rate at which their heart pumps blood by measuring their heart rate before and after exercise.

Planning	
Materials	Watch or timer
Time	10–20 min
Safety	Students run in place for Step 3. Ensure they have enough space around them and that they will not bang into anything if they lose their balance. Do not allow students to perform this activity if they are not wearing proper shoes (e.g., shoes with flat soles or heels) that provide adequate support. Students with health problems that may put them at risk should not take part in the running in Step 3.

Background

Normal resting heart rate or pulse rate is affected by a person's age and level of physical fitness. The range of normal rates for teenagers and adults is between 60 to 100 beats per minute (bpm). Babies and children have faster heart rates. People who have a high level of fitness may have resting heart rates between 40 and 60 bpm. Exercise increases heart rate. Target heart rate is the heart rate people should stay within while they are exercising or training to gain maximum benefit without overworking their hearts. This rate is calculated as 50 to 85 percent of a person's maximum heart rate. Maximum heart rate is roughly calculated as 220 minus a person's age. Therefore, a 15-year-old would have a maximum heart rate of 195 bpm and a target heart rate range of 97 bpm to 166 bpm, depending on the intensity of exercise or training they are doing.

A faster than normal heart rate can also be caused by certain medical conditions, include anemia, hyperthyroidism, and heart disease; medications (e.g., decongestants, asthma medications, caffeine, alcohol); and stress. A slower than normal resting heart rate can be found in people with hypothyroidism or heart disease, in addition to people who are very fit.

Activity Notes and Troubleshooting

- Students who are unable to take part in the running portion of this activity can be paired with other students and asked to help coach them through the activity. These students could also be asked to be the official timer for the entire class, so that the other students in the class are running at the same time.
- Ensure that each student or group has access to a clock or watch if there is not a watch or clock being used for the entire class.

Additional Support

- DI This is an excellent activity for bodily-kinesthetic learners.
- DI Encourage bodily-kinesthetic learners who are interested in physical fitness to share any prior knowledge they have of this topic.
- ELL Review the steps of the activity with English language learners before beginning the activity to ensure they understand the procedure.
- Have students create a poster, multimedia presentation, or promotional pamphlet that explains and illustrates the benefits of regular exercise.
- You may wish to use **BLM A-11 Poster Checklist, BLM A-46 Presentation Rubric,** or **BLM A-47 Communication Rubric** to assist you in assessment.

Answers

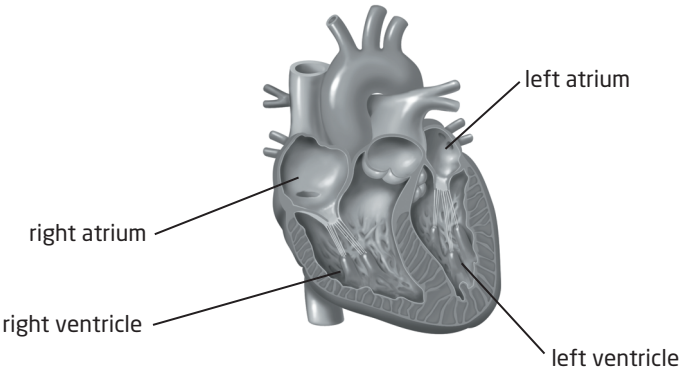
1. Exercise increases pulse rate. The heart needs to pump blood through the vessels faster during exercise because muscles need more oxygen to perform increased function.
2. Regular exercise is good for the heart because it helps keep the heart muscle healthy, strong and functional by challenging it. Cardiac muscle benefits from exercise.

Learning Check Answers (Student textbook page 99)

1. An organ system is a group of organs that are co-ordinated to work together to perform specific tasks in the body.
2. Human organ systems are like machines because they are made up of different parts that work in a co-ordinated way to perform a task. If one part of the system or machine is not working properly, the entire system or machine is affected.
3. Organ systems are made up of groups of organs. Organs are made up of tissues. Tissues are made up of specialized cells.
4. The reproductive system is not critical for the maintenance of the body. The function of the reproductive system is to reproduce and create offspring.

Learning Check Answers (Student textbook page 106)

5.



6. The left side of the heart has stronger muscles than the right side because it pumps blood to all the tissues of the body other than the lungs. The left side needs to pump blood to more tissues and a greater distance than the right side.

7. We breathe air through our nose or mouth. The air is carried to the bronchi. The air then travels to the bronchioles of the lung and then enters the alveoli, where gas exchange takes place.

8. People with anemia might not seem to have as much energy because they are not getting as much oxygen to all the tissues in their bodies because they do not have adequate numbers of red blood cells. Red blood cells contain hemoglobin, which binds to oxygen molecules.

Section 3.2 Review Answers (Student textbook page 107)

Please also see **BLM 3-9 Section 3.2 Review (Alternative Format).**

1. The duodenum of the small intestine has small ducts that connect to the pancreas, liver and gall bladder, which allows these organs to release digestive enzymes into the duodenum. The small intestine also has interior folds called villi and microvilli that maximize the surface area over which nutrients and water can be absorbed into the bloodstream.

2. If this duct is blocked, the pancreas would not be able to release digestive enzymes into the small intestine and chemical digestion would be impaired.

3. The food likely got stuck in the larynx, or the epiglottis did not prevent the food from entering the trachea.

4. **a.** C
b. B
c. D
d. A

5. If there is less oxygen available to breathe, there will be less oxygen available for the circulatory system to transport to the tissues of the body.

6. Gases are exchanged at the alveoli. Oxygen moves out of the alveoli to red blood cells in the capillaries and carbon dioxide in the capillaries moves into the alveoli.

7. The brain is an organ and it has tissues that require oxygen from blood to function properly.

8. Students' cutouts or diagrams will vary. Example explanation: Blood is pumped to the lungs by the right ventricle. Blood is oxygenated at the alveolar sac by gas exchange from the alveolus.