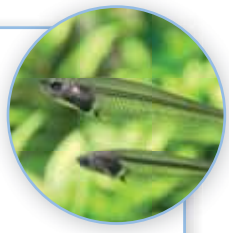
Chapter 3 Summary

3.1 Cells and Tissues

Key Concepts

- Cell specialization is influenced by the contents of an individual cell's cytoplasm, environmental factors such as temperature, and secretions from neighbouring cells.
- Animals have four main types of tissues: muscle, epithelial, connective, and nervous.
- Because stem cells have the potential to repair and replace damaged cells, they offer opportunities to develop new medical treatments. However, their use also raises some ethical questions.



3.2 Organs and Systems

Key Concepts

- The human body has 11 organ systems that interact with one another in order to perform the tasks necessary for survival and reproduction.
- The stomach is a major organ in the body's digestive system, which is responsible for taking in nutrients and breaking them down into a form that can be used by other cells in the body.
- The heart is a major organ in the body's circulatory system, which is responsible for moving gases, nutrients, and wastes throughout the body.
- The lungs are major organs in the body's respiratory system, which is responsible for gas exchange.

3.3 Maintaining Healthy Systems

Key Concepts

- Many technologies, such as ultrasound and various forms of biophotonics, have become important for diagnosing and treating abnormalities in tissues, organs, and systems.
- Public health strategies for a variety of diseases and conditions work to improve the health of Canadians by encouraging healthy lifestyle choices and other preventive measures.

Chapter 3 Review

Make Your Own Summary

Summarize the key concepts of this chapter using a graphic organizer. The Chapter Summary on the previous page will help you identify key concepts. Refer to Study Toolkit 4 on pages 565–566 to help you decide which graphic organizer to use.

Reviewing Key Terms

Match each key term listed below to its definition.

a. ultrasound
b. muscle tissue
c. epithelial tissue
d. biophotonics
e. stem cells
f. cell differentiation
g. nervous tissue

1. groups of cells that become specialized to act as a barrier (3.1)

2. the process of cells becoming specialized (3.1)

3. groups of cells that are specialized to change shape (3.1)

4. cells that maintain their ability to divide and produce new cells (3.1)

5. technology that uses sound waves to create an image of a body part (3.3)

6. groups of cells that are specialized to send electrical signals (3.1)

7. technology that uses light for advanced surgical procedures (3.3)

Knowledge and Understanding K/U

8. Give four levels of organization in the human body, from smallest to largest.

9. How are scientists working to decrease the controversy over using embryonic stem cells in research?

10. Draw a flowchart showing the following structures in the correct sequence for digestion:

rectum
anus
mouth
esophagus
duodenum
stomach
colon
small intestine

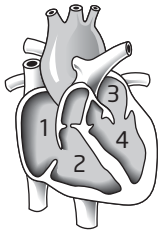
11. What conditions can result in fluid accumulating in the lungs?

12. When people have pneumonia, their alveoli become inflamed and the air spaces within them become clogged. What symptoms would the patient show?

13. Where in your circulatory system do you think your blood pressure is highest? lowest? Justify your answer.

14. Name the three categories of blood vessels and the function of each.

15. Use the figure below to answer the following questions.



a. Which heart chamber pumps blood to the lungs?

b. Where does the blood go after leaving chamber 4?

c. From which part of the body does chamber 3 receive blood?

d. Does the vessel carrying blood into chamber 3 have oxygenated or deoxygenated blood?

16. Why are some tissues (such as in the lungs and small intestine) structured to increase surface area?

17. Give an example of two organ systems that interconnect or rely on each other to function.

18. Compare and contrast frog anatomy with human anatomy.

19. What type of blood cell is involved in fighting pathogens?

20. How does a vaccination work?

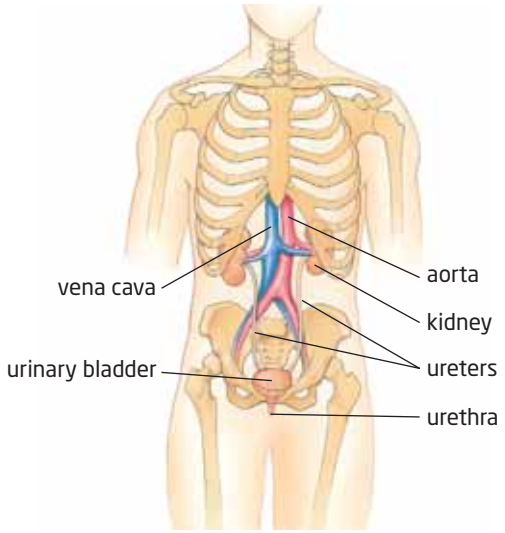
21. What is the main purpose of cancer screening?

Thinking and Investigation T/I

22. Nerve cells have long, fibre-like projections, and red blood cells are thick and disk shaped. Explain how their differences in structure are related to the different functions they perform.

23. Childhood illnesses such as rheumatic fever can result in damage to the valves of the heart. The valves can accumulate scar tissue that makes them less flexible and unable to completely stop the backflow of blood in the heart. When this occurs, the heart often gets bigger. What tissues in the heart do you think might get bigger? Why do you think this would occur?

24. Examine the diagram below.



a. What system is shown in this diagram?

b. Why does the kidney have such large blood vessels going to and from it?

Communication C

25. BIG IDEAS Developments in medicine and medical technology can have social and ethical implications. For example, imagine that your local newspaper published a letter to the editor that argued that all research involving stem cells is unnecessary and unethical. Write a response to the editor in which you describe how stem cells are used in the body, acknowledge ethical concerns about the use of stem cells, and offer your opinion about whether the benefits outweigh the costs. Be sure to support your opinion with your knowledge of science.

26. A local hospital has started a fundraising campaign to buy new imaging equipment. A friend says his parents do not want to support the campaign because they supported a drive last year to buy a new X-ray machine. Discuss why this new fundraising campaign may still be needed.

27. BIG IDEAS Plants and animals, including humans, are made of specialized cells, tissues, and organs that are organized into systems. How can heart disease affect organs in other systems?

Application A

28. An elderly woman has just had her gall bladder removed. Describe the kind of diet you think she should follow.

29. In each of the situations below, hypothesize how you think the number of breaths you take per minute would compare with your breathing rate as you read this question. Give an explanation for your hypotheses.

a. while sleeping

b. while exercising

c. while on top of Mt. Logan, Canada's highest mountain (elevation 5959 m)

30. Why do you think babies and young children might contract infectious diseases more frequently than teenagers do?

Science at Work

In his research, Tedros Bezabeh applies magnetic resonance spectroscopy techniques to detect changes in human fluids and tissues. Magnetic resonance spectroscopy uses radio frequency waves to study the chemistry of tissues.

Canadians in Science

When cancer is diagnosed early, the odds that a patient will survive are often excellent. Unfortunately, many cancers are only diagnosed at advanced stages. Tedros Bezabeh, a senior research officer with Canada's National Research Council, is developing methods to detect cancer early and save lives. In one study, Tedros is using magnetic resonance spectroscopy to compare stool samples from healthy people with samples from patients with colorectal cancer, a cancer of the colon or rectum. He is trying to detect chemical changes that occur in colon cells when cancer is developing. He hopes this work will lead to the development of a non-invasive test to detect colorectal cancer at a very early stage.

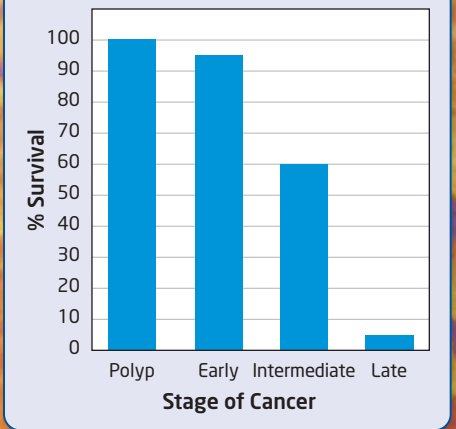
In Tedros Bezabeh's Words

I am working to develop new techniques for the early detection and better diagnosis of cancer. Early detection is critical in improving treatment outcomes and increasing survival rates in cancer patients. Knowing that what I do in the laboratory now can be used in clinics to save lives in the future gives me a special feeling of accomplishment and pride.

The most challenging thing about being a scientist is to not expect quick results. You have to be in there for the long haul. It takes a lot of hard work and a great deal of perseverance to get to the goal line, but it's worth it in the long term.

As researchers, we take the ethical implications of working with human subjects, and by extension human fluids and tissues, very seriously. First, we need to make sure that the subjects understand very clearly what we need them to do or why we need specimens–that's called informed consent. Research ethics boards ensure that our subjects are treated with respect and that our research is conducted in a safe, ethical manner.

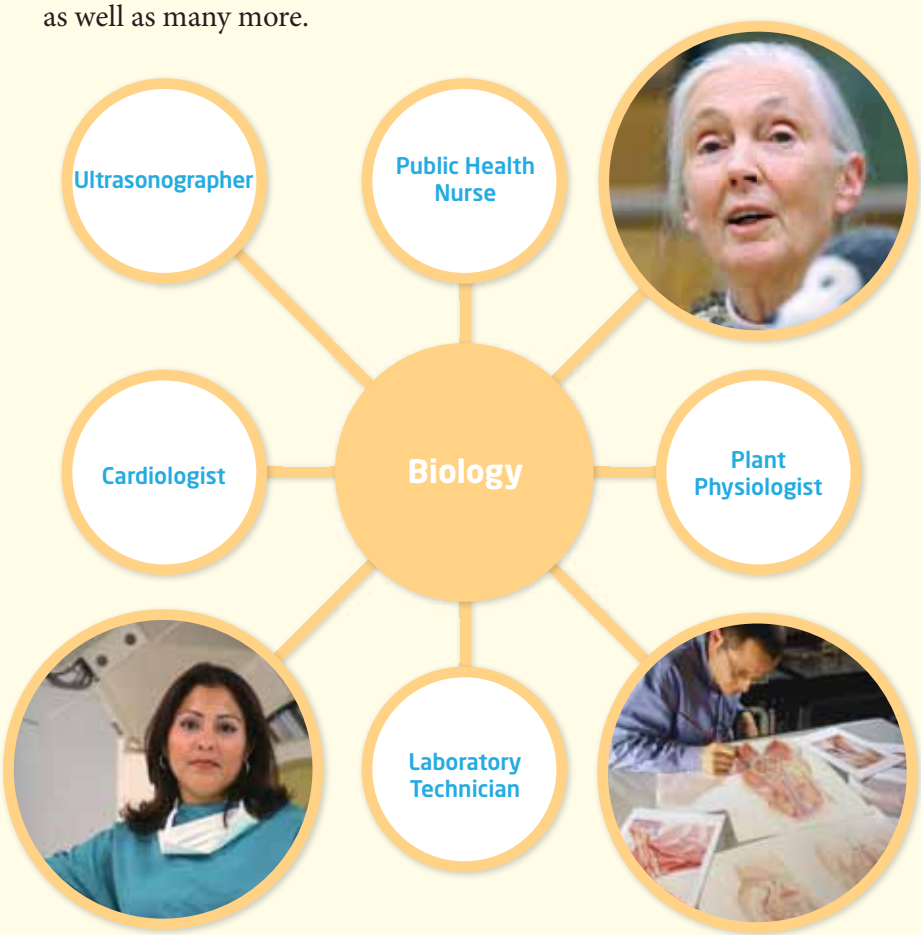
Colorectal Cancer Survival Rates



When colorectal cancer is diagnosed early, more than 90% of patients survive for at least five years. Unfortunately, only about one third of patients are diagnosed with colorectal cancer when it is still at an early stage. Polyps are benign tumours that can develop into colorectal cancer.

Biology at Work

The study of biology contributes to these careers, as well as many more.



Bioethicist

Bioethicists study moral issues related to medicine and science. For example, a bioethicist may study the arguments for and against embryonic stem-cell research. Bioethicists work in hospitals and post-secondary institutions, where they help health-care workers and researchers make decisions about ethical dilemmas. They are also involved in developing policies in hospitals and in research settings that involve human or other animal subjects.

Medical Illustrator

Medical illustrators are artists who have a detailed knowledge of the structure and functions of the human body. They create illustrations and models for advertising, textbooks, and other teaching tools. They work for medical schools, research institutions, publishers, and companies that manufacture pharmaceuticals and medical devices.

Radiation Therapist

Radiation therapists work with other health-care workers to plan and administer treatment for cancer patients. They operate equipment that delivers high-energy radiation to tumour cells. They also help patients prepare and deal with the side effects of treatment.

Go to **scienceontario** to find out more

Over to You

1. Why do you think it is important that non-invasive tests be developed for the early detection of cancers? (An invasive test involves the cutting or removal of tissue from a patient, or the placement of a diagnostic instrument inside a patient's body.)
2. Why is informed consent important for research that involves human subjects?
3. A pharmaceutical company has designed a drug for patients with advanced colorectal cancer. The drug is new and has not been used on humans. What are the ethical arguments for and against administering this new drug to patients with advanced colorectal cancer?
4. Research a career involving biology that interests you. If you wish, you may choose a career from the list above. **What essential skills would you need for this career?**

Unit 1 Projects

Inquiry Project

Investigating Phases of Mitosis

In this unit, you learned how mitosis in cells allows them to divide their nuclear material equally, thus producing new cells. In this project, you will plan and conduct an investigation to examine the relative amount of time each phase of mitosis takes in the cells of actively growing onion root tips.

Inquiry Question

How can you confirm the relative amount of time each phase of mitosis takes in onion root tip cells?

Initiate and Plan

1. Using a visual format, describe the cell cycle in plants. Consider the various phases of mitosis and the time spent in each phase.
2. See Science Skills Toolkit 8, on page 547, for the technique of growing onion roots from bulbs and staining the root tip cells for observation under a microscope.
3. List the materials you will need, the steps in your procedure, and any safety precautions you should take.
4. Infer the relative amount of time each phase of mitosis takes by counting the number of cells in each phase. Decide how many cells would be appropriate to count for scientific validity.
5. Decide on a type of graph suitable for summarizing your data and illustrating relative amounts of time for each phase of mitosis.
6. Have your teacher approve your procedure before you begin.

Perform and Record

1. Conduct your investigation. Select an appropriate format, such as a table, to organize and record your data.
2. Display the data collected in a graph using appropriate scientific conventions. Write a summary statement that describes any trends or patterns you observe in the graph and record it beneath the graph.

Analyze and Interpret

1. What can you conclude about the relative rates of the phases of mitosis? Did your results confirm your previous knowledge? If they did not, discuss possible reasons for any discrepancies.
2. Did you find you had to prepare more than one slide of the onion root tip cells in order to complete your investigation? If so, why?
3. Why could you not observe the entire process of mitosis occurring in real time?
4. What practical benefits might result from knowing the relative time each phase of mitosis takes, and therefore speeding up or slowing down one of the phases?

Communicate Your Findings

5. Present your results using visual and written components, suited to your purpose and audience.

Assessment Criteria

Once you complete your project, ask yourself these questions. Did you...

- K/U describe the cell cycle in plants, including a description of mitosis?
- T/I describe an appropriate procedure?
- T/I identify in your procedure the number of cells required for scientific validity?
- T/I propose a conclusion that either confirms your prior knowledge or describes any possible reasons for discrepancies?
- T/I describe how you addressed challenges?
- A describe the practical benefits of knowing the relative times of each phase of mitosis?
- C organize the data collected using an appropriate format and scientific conventions?
- C display the data appropriately in a graph?

An Issue to Analyze

Organ Donation

Canada has one of the lowest organ donation rates in industrialized countries. In 2008, 4195 people were on the national waiting list for an organ or tissue transplant. Due to a lack of donors, 195 of those people died. For the past 15 years, the number of organ donations has held steady at approximately 400 donations per year. However, in this same amount of time, the population of Canada has increased by 4 000 000.

As a research scientist for the Ministry of Health, prepare a recommendation related to one medical technology that would be useful in supporting patients in need of a new organ, given the lack of organ donors available.

Issue

What are the issues related to medical technologies available to support people in need of organs?

Initiate and Plan

1. Select a medical technology used in treating people in need of new organs.

Perform and Record

2. Using electronic, print, and human sources, research the scientific and technical principles underlying the technology.
3. Brainstorm a list of the economic, political, and ethical issues related to the technology.
4. Consider the following questions to guide your research:
   - What are the risks of being a donor?
   - Does a donor have to be of the same race or ethnic group as the recipient?
   - How are recipients identified? Who chooses which person is a better candidate?
   - How are organs matched to a recipient?
   - How much money and time are being spent finding alternatives to organ donation?
   - Should people be required by law to sign an organ donor card?
   - How can we control the black-market sale of organs?
5. Select an appropriate graphic organizer to summarize your research.

Analyze and Interpret

1. Prepare a risk-benefit table outlining, from a variety of perspectives, the risks and benefits associated with the chosen medical technology.
2. Based on the risks and benefits, make a recommendation to the Ministry of Health on use of the technology as support for patients in need of organs.
3. If the technology is not appropriate support, propose other courses of action to consider.

Communicate Your Findings

4. Decide on an appropriate format to present your recommendation to the Ministry of Health.

Assessment Criteria

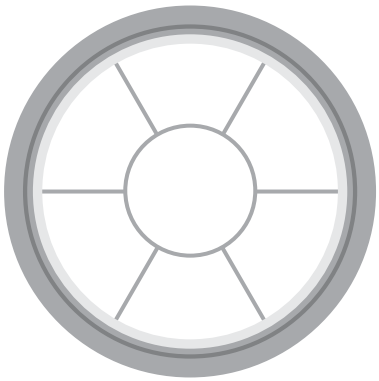
Once you complete your project, ask yourself these questions. Did you...

- K/U describe the scientific and technical priniciples related to the medical technology?
- A identify the economic, political, and ethical issues related to the technology?
- A make a recommendation based on the risk-benefit analysis of whether or not the technology is appropriate for patients in need of organs?
- A propose other courses of action if the technology is not appropriate?
- C organize the research using an appropriate format and appropriate academic documentation?
- C select a format for the recommendation that is appropriate for both audience and purpose?
- C use scientific vocabulary appropriately?

Unit 1 Review

Connect to the BIG IDEAS

Use this bicycle wheel graphic organizer to connect what you have learned in this unit to the Big Ideas, found on page 1. Draw one bicycle wheel for each Big Idea and write the Big Idea in the centre. Between the spokes of the wheel, briefly describe six examples of that Big Idea.



Knowledge and Understanding K/U

1. In which of the following organelles would you expect to find DNA?

a. vacuole

b. Golgi apparatus

c. endoplasmic reticulum

d. nucleus

2. Which of the following is *not* one of the main ideas in the cell theory?

a. Living organisms are made of cells.

b. Cells come from pre-existing cells.

c. Cells are the basic organizational unit of life.

d. All cells have a nucleus.

3. Which of the following is a list of types of plant tissues?

a. dermal, vascular, connective

b. dermal, vascular, chloroplasts

c. dermal, vascular, ground

d. ground, chloroplasts, grana

4. In which human organ would you expect to find *E. coli*?

a. heart **c.** intestine

b. lung **d.** brain

5. Which of the following organ systems is specialized to transport materials for use throughout the body?

a. digestive system **c.** endocrine system

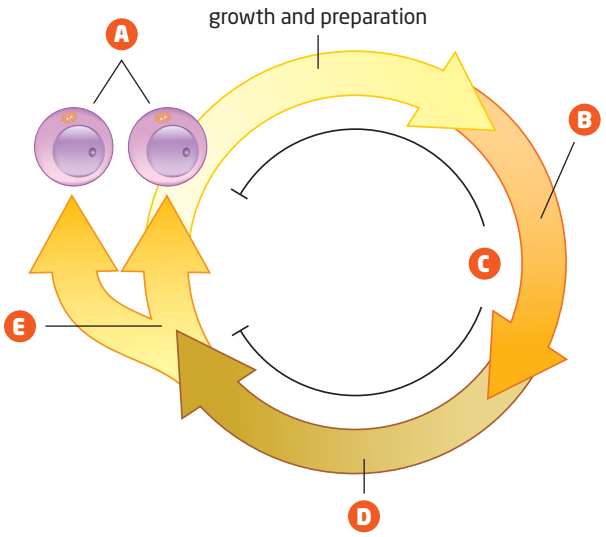
b. circulatory system **d.** nervous system

6. Explain the meaning of the term *daughter cells*.

7. Using a specific example, describe how DNA screening is a valuable tool, but one that raises ethical issues.

8. Explain the meaning of the term *transgenic*.

9. Copy the following diagram into your notebook, and fill in the labels for the different parts of the cell cycle.



10. How is cell division related to cancer?

11. Explain the roles of cell division and cell specialization in plants and animals.

12. Explain how the early embryonic stem cells of animals differ from adult stem cells.

13. How is the arrangement of organs in the human digestive system suited to its main functions?

14. Describe one example of a public health strategy and its effect on human health.

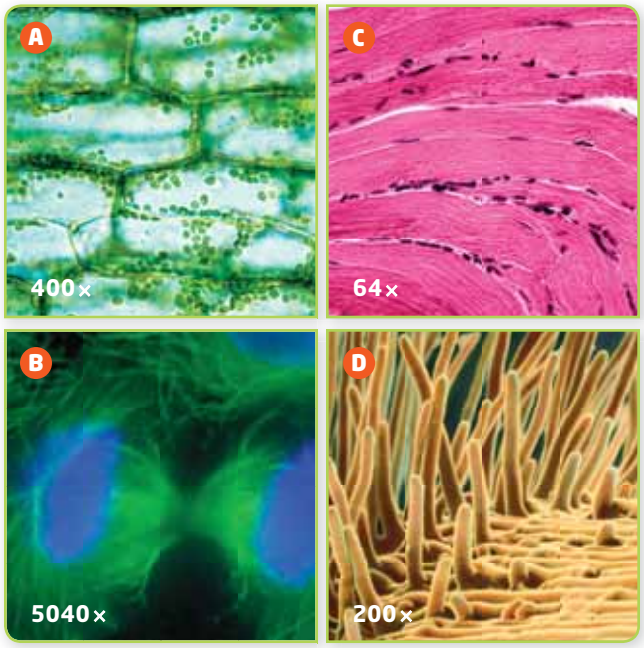
Thinking and Investigation T/I

15. Some chemicals prevent the organization of spindle fibres.

a. Predict the effect of one of these chemicals on cell division and growth.

b. Design an investigation to test your prediction.

16. The specimens below were observed using a microscope. Identify each specimen, and list the evidence you used to make your identifications.



17. Is it better to water plants in the evening or in the morning? Write a procedure for an investigation that would allow you to answer this question.

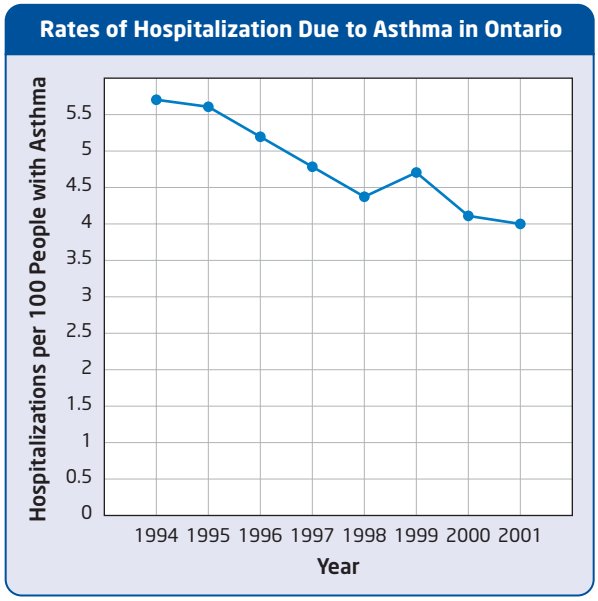
18. Despite having generously watered your indoor plants before you left on a short trip, you return home to find that their leaves have all wilted. Develop a hypothesis for why this has occurred, and suggest what you could do to correct the problem.

19. Which cell has the greater chance of survival: an amoeba in pond water or a cell that has been isolated from a multicellular plant and placed in pond water? Explain your reasoning.

20. A bacterium evades your body's defence mechanisms and begins to replicate. This bacterium replicates itself every 30 min. Calculate how many bacteria will be in your body after 8 h.

21. The Canadian government is funding a special five-year study to help determine the causes of heart disease among Canadians. The citizens of a small town in Ontario have agreed to participate in the study. You are in charge of designing the study. Your first task is to select one factor that you will focus on, such as diet or exercise. What part of the population will you study? What data will you need to collect? How will you obtain the data? What will your hypothesis be? Identify the independant and dependant variables, as well as the controls for your study. Give reasons for your choices and proposed course of action.

22. The graph below shows the rates of hospitalization due to asthma in Ontario between 1994 and 2001. From the data, can you conclude that asthma is declining in Ontario? Explain your answer.



Unit 1 Review

Communication C

23. Draw and label a diagram of a plant cell. Indicate the structures that make it different from an animal cell.

24. Biologist and science writer Lewis Thomas once compared Earth to a single cell. Make point-form notes about the ways in which you think this analogy works. Use this analogy to explain the structures and functions of a cell to a classmate.

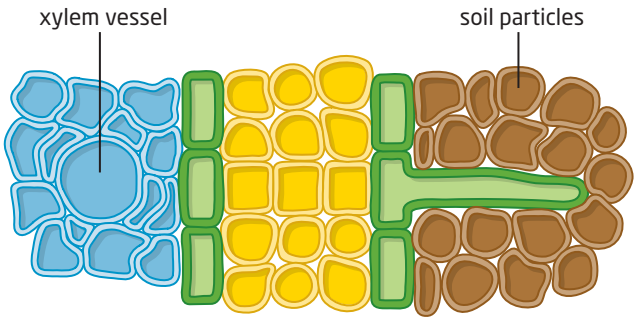
25. Conduct research about one of the medical or other technological developments you have read about in this unit. Examples include medical imaging technologies, surgical techniques, transgenic organ transplants, cloning, and the use of stem cells in research. Create a poster promoting the benefits of this technology for human health.

26. Describe how a plant that is growing to be tall and spindly can be made to start branching out.

27. Make a table showing each of the major types of animal tissues and the main functions they carry out.

28. Give an example that illustrates how organ systems interact. State why this interaction is necessary for an organism's survival.

29. Copy the following diagram of a plant's root system into your notebook. Use arrows to show how water moves through this root system.



30. Create a diagram or flowchart explaining how a molecule of oxygen reaches a cell in your finger.

31. Write a newspaper-style editorial that addresses the following question: "Should the public health-care system continue to pay for individuals who acquire smoking-related illnesses?" Justify your response.

32. Draw and label a diagram to show the stomata on the underside of two leaves: one in which transpiration is actively taking place and one in which transpiration is not occurring.

33. Draw and label a diagram to explain the links between specialized cells, tissues, organs, and organ systems in either a plant or an animal.

Application A

34. Many chemicals that act as poisons work by affecting the functioning of mitochondria. Why do such poisons cause an organism to die?

35. Many genetic diseases can be detected using a blood test for the presence or absence of specific substances in the body. Explain why this kind of genetic test works, even though it does not examine the DNA itself.

36. One type of tree disease is caused by a fungus that plugs up the xylem cells in a tree's trunk. Why could this kill a tree?

37. Treatments for many types of cancer involve killing cells that divide rapidly using chemicals (chemotherapy) or radiation. These treatments often kill the cancer cells by causing mutations in them. Sometimes, however, the treatment of cancer can cause surrounding normal cells to become cancerous. Why might this occur?

38. West Nile Virus is carried by mosquitoes and can cause a disease that is fatal to those who contract it. One response to the risk of West Nile Virus is to spray pesticides (some of which can cause cancers) in and around water sources that contain mosquitoes. Discuss the pros and cons of this response. Research and summarize other methods of prevention

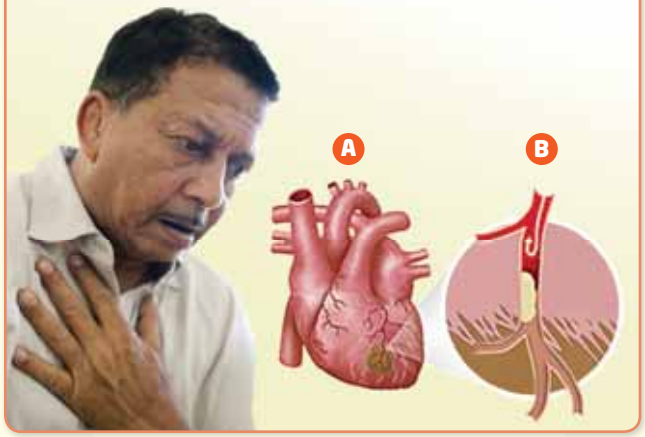
Literacy Test Prep

Read the selection below and answer the questions that follow it.

If a blocked blood vessel prevents the blood supply from reaching the heart, heart cells die because they are robbed of oxygen. If too many heart cells die, the heart may stop working entirely. When this happens, a person typically experiences intense chest pains and has difficulty breathing. In such instances, the person has suffered a heart attack.

Heart attacks can be fatal. If someone suffers a heart attack, it is important that medical treatment begins quickly. The most effective treatment can only be carried out in a hospital. Treatment for heart attack victims may involve the administration of drugs that break up blockages in blood vessels and surgical procedures that open up clogged arteries. The more quickly treatment is administered, the fewer the number of heart cells that will be damaged.

Researchers at several Ontario universities are trying to find ways of using stem cells to replace cells that have been damaged by heart attacks. To avoid future heart problems, heart attack victims are usually encouraged to maintain a healthy diet and get regular exercise.



Multiple Choice

In your notebook, record the best or most correct answer.

39. According to the information in the first paragraph, a heart attack occurs when

a. heart cells die due to a lack of oxygen

b. a person has chest pains and trouble breathing

c. plaque builds up in an artery

d. a person eats poorly and does not exercise regularly

40. How are diagrams A and B related?

a. A occurs before B occurs.

b. B proves that A is accurate.

c. B illustrates an inside view of what A illustrates.

d. B illustrates how plaque builds up in blood vessels.

41. Researchers hope that stem cells can one day

a. prevent heart attacks by supplying oxygen to heart cells

b. repair heart tissue that has been damaged by heart attacks

c. grow new hearts for transplant

d. determine why some people are more likely than others to develop heart problems

42. The main idea of the second paragraph is that

a. heart attacks can be fatal

b. treatment for a heart attack may involve opening clogged arteries

c. heart attack victims must be treated in a hospital as quickly as possible

d. heart cells die during a heart attack

43. Which is the *best* inference you can make about the last sentence?

a. A healthy diet and regular exercise can prevent the conditions that lead to heart attacks.

b. People who have a poor diet and who do not exercise regularly are more likely to have a heart attack than other people.

c. People who eat well and exercise regularly will not have a heart attack.

d. Eating well and exercising regularly can repair muscle tissue that has been damaged by a heart attack.

Written Answer

44. Select appropriate information from this selection to write a paragraph beginning with the following statement: "The best cure for a heart attack is prevention."