



- ## Key Concept Review

2. Students' answers will vary. A sample answer is that waste removal and the exchange of gases within a cell use many different organelles to accomplish these tasks. The cell membrane is designed to allow different substances to move through by diffusion. The nucleus is the control center of the cell. It is surrounded by the nuclear envelope, which contains pores to allow the transport of materials. The vacuoles and vesicles are membrane-bound organelles that store nutrients, wastes, and other substances used by the cell. Lysosomes are organelles where digestion takes place and they essentially are the clean-up system of the cell. The Golgi apparatus modifies, sorts, and packages the proteins that are received from the endoplasmic reticulum, which is an organelle that carries materials through the cell. Chloroplasts, found only in plant cells and some algae, contain chlorophyll, which uses energy from the Sun to convert carbon dioxide and water into sugar and oxygen in a process called photosynthesis. Carbon dioxide and oxygen are exchanged through the stomata in the leaves.
3. The cells in the picture have cell walls, which are only present in plant cells. These cells are therefore plant cells.

4. A photograph taken through either a transmission electron microscope or a scanning electron microscope is called an electron micrograph. An electron microscope uses a beam of electrons that passes through thin sections of cells and produces an image that shows the surface and texture of a cell, the shape and size of the particles in the cell, and the arrangement of the materials in a cell.
5. There are four phases in the cell cycle: first growth phase (G1), synthesis phase (S), second growth phase (G2), and mitosis (M). The first three phases are part of interphase, where a cell is preparing for cell division.
 - During the first growth phase (G1), the cell grows and produces new proteins and organelles. If the cell is healthy and conditions are favourable, the cell moves into the next phase.
 - During the synthesis phase (S) phase, the cell makes (synthesizes) an entire copy of the DNA of the cell. Key proteins that are associated with chromosomes are also produced during this phase.
 - The cell moves to the second growth phase (G2) once the DNA has been copied. During this phase, the cell produces the organelles and structures needed for cell division. This phase is the shortest of the phases of interphase.
 - Mitosis involves packaging the genetic information in the nucleus into two equal portions. The cytoplasm is split into two portions so that the original parent cell divides to form two new daughter cells.
6. During mitosis, the cell makes identical copies of the genetic material in its nucleus. The material is then split into identical portions and the cell is separated into two identical cells. Thus, the genetic material is the same from cell to cell.
7. Cell division provides new cells to replace cells that wear out or break down. In a growing organism, there is rapid mitosis of cells in areas of growth. Cells that are likely to be damaged or injured as they function also have high rates of mitosis.
8. The various stages of mitosis are as follows:
 - During prophase, the chromatin (DNA and proteins) condenses to form chromosomes. At this stage, there are actually two identical copies called sister chromatids attached together at a centromere. To enable the movement of the chromatids within the cell, the nuclear structures and nuclear envelope disintegrate. In addition, the mitotic spindle forms to move the chromatids around in the cell. Chromatids are attached to the spindle at their centromeres. In animal cells, a pair of organelles called centrioles move to each end of the cell, forming the poles of the mitotic spindle.
 - During metaphase, each chromosome completely condenses. They move toward the centre of the cell and line up at the middle of the cell. The mitotic spindle is complete and is made of tiny tubes that extend from each pole to the centromere of each chromosome.
 - During anaphase, the sister chromatids separate at the centromere. The separated chromosomes are pulled to opposite ends of the cell, leaving one copy at each pole.

- During telophase, the cell divides the cytoplasm into two portions. Cytokinesis is the process of splitting the cytoplasm. In animal cells, the cell membrane pinches inward, eventually splitting the one cell into two cells. In plant cells, the cell plate forms the cell wall and inner plasma membrane in each of the new cells. At the end of cytokinesis, the two new cells return to interphase conditions. Two nuclei form where each pole of the parent cell was. The mitotic spindle disappears. Each cell enters the G1 phase of the cell cycle until the cell cycle is repeated.
9. Three differences between cancer cells and normal cells are as follows:
 - the rate of division: normal cells live for 50–60 divisions, while cancer cells do not stop dividing
 - self-destruction: a normal cell will self-destruct when it is too old or damaged, while a cancer cell will not
 - mass together: normal cells stick together to form masses of cells, while cancer cells do not stick to other cells and behave independently
 10. All plant tissues are formed out of meristematic tissue, which is made of unspecialized cells capable of dividing by mitosis. Meristematic tissue is responsible for growing new parts of the plant, such as stems, and is found in several locations in the plant.
 11. Students' answers will vary. Refer to Table 1.5 on page 43 of the student book and Table 1.6 on page 44 for examples of animal and plant tissues. Two examples are the epidermal tissue of a plant and the epithelial tissue of an animal. Both tissues are made of specialized cells that perform a specific function. The epidermal tissue forms the protective outer covering, which regulates the exchange of materials and gases into and out of the plant. The epithelial tissue lines body cavities and the outer surface of the body. It also protects structures, and it forms glands that produce hormones, enzymes, and sweat.

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12. (a) Students' answers will vary. Refer to pages 59 and 60 in the student book. Two examples of tissues found in plant organs are meristematic tissue within the roots and vascular tissue within the leaf.
 - (b) Students' answers will vary. For example, meristematic tissue found within the roots allows the roots to grow. Vascular tissue from the leaf carries water needed for photosynthesis from the root up the stem to the leaf. The sugar produced is carried by the vascular tissues to the rest of the plant.
13. (a) Students' answers will vary. Refer to pages 56 to 58 in the student book. Two examples of tissues found in animal organs are nervous tissue found within the dermis of the skin and connective tissue within the lungs.
 - (b) Students' answers will vary. For example, nervous tissue found within the dermis of the skin senses pain, pressure, heat, and cold,

and sends information to the brain. Connective tissue in the lungs coats the lungs with two sacs of tissue separated by a thin layer of fluid. This not only protects the lungs, but also reduces the effects of friction when the lungs move.

- 14.** Students' answers will vary. Refer to pages 66 to 72 in the student book. An example of an animal organ system is the excretory system, which includes the kidneys, bladder, urethra, and skin. These organs work together to remove waste products from the blood. An example of a plant organ system is the shoot system, which is made up of the stem, leaves, buds, flowers, and fruits. These organs work together to help the plant grow, reproduce, and ensure the plant survives changes in its environment.
- 15.** The integumentary system contains glands that respond to changes in the environment in various ways. For example, the sweat glands secrete sweat, a clear fluid made of water and body salts. Evaporation of sweat cools the body when it is overheated. Sebaceous glands produce oil that lubricates, waterproofs, and helps prevent skin infections.
- 16.** Students' answers will vary. Essentially the digestive systems of a person, earthworm, fish, and frog perform the same major function — the absorption of nutrients.
 - In a human, the digestive system is a tube that extends from the mouth to the anus and transports nutrients through the body, where the food passes from the mouth, down the esophagus, into the stomach, through the small and large intestines, and into the rectum.
 - In an earthworm, digestion begins as the earthworm moves through the soil and takes in dirt through its mouth. The dirt is pushed by muscular contractions through the esophagus to the crop, and into the muscular gizzard, where the food is ground into smaller pieces. It is then pushed into the intestines where digestion and absorption of nutrients occurs and finally waste material is expelled through the anus.
 - In fish, food passes from the mouth, down the esophagus into the stomach where the food is broken down. Some fish have a special pouch, called the pyloric caecum, which further breaks down the food and absorbs the nutrients. In either case, digestion is completed in the intestine, and waste material is expelled through the anus.
 - In frogs, digestion begins in the mouth where it catches its prey using a special tongue attached to the front of the mouth so that it can capture flying insects effectively. Two sets of teeth hold the prey. As the frog swallows, it closes its eyes and pushes its eyes downward. This action causes pressure on the roof of the mouth, which forces the food to move into the gullet, then down the esophagus to the stomach and then to the intestines and finally, waste materials exit the body through an opening called the cloaca.

17. The diaphragm contracts and moves downward during inhalation, at the same time as the rib cage rises, which increases the size of your chest cavity. This causes a decrease in the internal air pressure in the cavity, making it less than the air pressure in the environment. To equalize the pressure, air rushes into the lungs. During exhalation, the diaphragm relaxes and moves upward as the rib cage lowers. This decreases the size of the chest cavity causing an increase in the internal air pressure in the cavity. Since the internal air pressure is higher than the pressure in the environment, air moves out of the lungs.
18. (a) The heart is divided into four chambers: the left and right atria, and the left and right ventricles.
(b) The structure of the heart enables it to pump blood effectively from the lungs, back to the heart, and then throughout the body. Deoxygenated blood, which enters the right atria and then the right ventricle, is pumped to the lungs so that the blood can pick up oxygen. The oxygenated blood is pumped from the lungs to the left atria, the left ventricle and through the aorta to the rest of the body.
19. (a) The function of the skin is to protect the inner structures (organs and tissues) from damage, to defend the body against foreign organisms and disease, to insulate or release heat, and to excrete bodily wastes.
(b) The skin is made up of two different layers of tissues: the epidermis and the dermis. The epidermis is the outer protective layer made up of epithelial tissue. The epidermis prevents bacteria and viruses from entering the body. The dermis is the inner layer of the skin, and is made up of connective tissue, nervous tissue, and muscle tissue. The connective tissue provides structure and support. The nerves sense external information, such as pain, heat, and cold, and send that information to the brain. Muscle tissue produces “goosebumps.”
20. The role of the kidneys in maintaining homeostasis in the body is to regulate levels of fluids in the body and to remove waste products, such as urea and excess water, 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.

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21. The MRI scan is a popular tool because it is useful for imaging the structure and function of the brain, heart and liver, soft tissues, and the inside of bones. It is also used to diagnose forms of cancer, brain diseases, and cardiovascular conditions.
22. Ultrasound is used during amniocentesis to guide a needle that is inserted through the abdomen of the mother so that a sample of amniotic fluid can be withdrawn and studied.

- 23.** Students' answers will vary. Refer to pages 102 and 105 in the student book for information on vaccines. An example of a vaccine is the influenza vaccine, which helps prevent and control the spread of influenza by protecting individuals from becoming ill, and by reducing the impact that influenza has on the health-care system.
- 24.** Students' answers will vary. Refer to pages 104–107 in the student book for information on lifestyle choices. Examples of how lifestyle choices can affect your health include exposing yourself to toxins from cigarette smoke, exposing yourself to UV radiation from the Sun, and exposing yourself to West Nile virus from mosquitoes.
- 25.** Tobacco smoke has many effects on the systems of the human body. Inhaled smoke deposits carcinogens in the body. These carcinogens affect cells, tissues, and organs, particularly the lungs. Second-hand smoke can affect the heart rate and blood pressure, and can increase the cellular levels of poisonous gas. In addition to causing cancer, smoking aggravates other conditions, such as heart disease, liver disease, and emphysema. Babies of mothers who smoke have a higher incidence of neurological damage and lower birth weights.
- 26.** Simple lifestyle changes that could reduce the threat of acquiring the West Nile virus include reducing exposure to mosquitoes from dusk to dawn when mosquitoes are most active; removing all sources of standing water and dense brush to limit the breeding ground for mosquitoes; applying insect repellent that contains no more than 30 percent DEET to clothes and exposed skin; and wearing light-coloured clothing that covers arms and legs.
- 27.** Gene therapy may be used to treat or prevent disease by replacing an absent or faulty gene with a normal gene. This involves using a virus to carry the gene into the cell. The virus is modified so that it cannot cause disease, and the replacement gene is added to its DNA. The modified virus is injected into the patient to carry the gene into cells to treat or prevent the disease.
- 28.** There are three types of cloning:
- Reproductive cloning involves the transfer of a nucleus from a donor body cell into an egg cell that has no nucleus. The egg is transferred to the womb of a mother to help it grow.
- Gene cloning involves the transfer of a gene into bacteria so that the gene can be reproduced multiple times.
- Therapeutic cloning is similar to reproductive cloning, but the purpose is to harvest embryonic stem cells from a developing embryo. The harvested stem cells are used to re-grow healthy tissue in place of damaged tissue.
- 29.** Students' answers will vary. Refer to page 116 in the student book for information on transgenic crops. One example is transgenic trees that contain genes to increase the amount of cellulose, making the timber more desirable to paper mills. This transgenic crop has been developed to help address the environmental challenge of tree harvesting because more pulp can be harvested from fewer trees.

30. Artificial insemination (AI) and in vitro fertilization (IVF) are two reproductive technologies. These technologies are used to help with fertility problems in animals and humans. Artificial insemination (AI) involves collecting sperm from a male and placing it in the reproductive system of a female. In IVF, sperm and eggs are collected and placed in a test tube or petri dish so that fertilization occurs. The developing embryos are implanted in the uterus of a female.

Connect Your Understanding

31. Students' answers will vary. An example of a city as an analogy for a cell would have city hall functioning like the nucleus of a cell. At city hall, decisions are made for how the city will be run. Before you can build a new structure, or renovate an old one, you must obtain a permit from city hall. The nucleus is similar to city hall in that it controls all the activities in the cell, including growth and reproduction. In a city, the waste management plant deals with the waste of the city, which is similar to the lysosomes in a cell. The power plant in a city is similar to the mitochondria in the cell because they both produce energy.
32. Knowledge about the cell cycle is important to cancer research because cancer cells reproduce during mitosis. Certain drugs can affect the rate of mitosis. Currently, cytostatic drugs are used in chemotherapy because they slow the rate of mitosis in cancer cells. With more research to slow or stop mitosis in cancer cells, better treatments may be developed for cancer.
33. There are many factors that influence the rate of mitosis, such as the environment and antibiotics. Some antibiotics, called bacteriostatic drugs, temporarily stop bacteria from growing by interfering with mitosis and inhibiting the replication of DNA.
34. Muscles cells are used in movement and are often under strain. They need more mitochondria to provide the energy needed for them to work.
35. The interaction between vascular tissue and ground tissue helps a plant survive. The ground tissue provides structure and support, while the vascular tissue transports nutrients throughout the plant.
36. Students' answers will vary. The mind map should show the relationships between cell, tissue, organ, organ system, and organism.
37. Students' answers will vary. A short paragraph to show the relationships between structures and processes in the transport of materials in plants should include some of the following points:
- Water travels from the roots to the chloroplasts in the leaves; when water enters the root hairs through the root epidermis, it travels to the xylem, and moves against gravity up the stem to the leaves through the process of transpiration.
 - When the water reaches the leaf, it moves from the xylem to the ground tissue through transpiration.

- Small openings on the underside of the leaf called stomata allow water to evaporate, which maintains the transpiration pull.
 - Phloem transports the sugar produced during photosynthesis from the leaves to other parts of the plant where it is used to provide energy.
- 38.** Cell division allows new cells to be formed. Cell specialization allows specific types of cells to be formed. Both these processes are involved in creating new organs in a fetus. For example, stem cells divide to form more cells. Some stem cells specialize to form tissues, which group together to form an organ.
- 39.** Students' answers will vary. A short paragraph to describe how gas exchange occurs in the alveoli should include some of the following points:
- Oxygen enters the lungs and diffuses from a higher concentration across the alveoli into red blood cells in the capillaries, where the concentration of oxygen is lower.
 - Diffusion is the movement of the oxygen from an area of high concentration to an area of low concentration.
 - Red blood cells contain hemoglobin, which is a protein that can absorb and release oxygen.
 - Carried by hemoglobin in red blood cells, oxygen flows back to the heart and then is pumped to the rest of the body.
- 40.** Students' answers will vary. Essentially, the heart slows down during sleep because the body is resting and various body functions are not working as hard. For example, during sleep, the muscles do not need oxygen as much as when they are active. Other tissues and organs also require less oxygen, so that the heart does not need to pump as quickly as it does during the day when the body is active.
- 41.** Human survival depends on the uptake of oxygen and removal of carbon dioxide from tissues. The respiratory system allows for the exchange of carbon dioxide out of the blood and oxygen into the blood. The circulatory system moves oxygen through the blood to the rest of the body, and brings carbon dioxide back to the lungs.
- 42.** When you exercise, your muscle tissues undergo cellular respiration at a higher rate to provide the energy required to move the muscles. Oxygen is necessary during cellular respiration. Also, your body cells produce carbon dioxide as a by-product of respiration. This must be removed from the body. Your breathing rate increases to meet the increased demand of the cells.
- 43.** A circulatory system is a necessity for complex multicellular organisms because it transports nutrients and waste materials within the organism. A circulatory system provides a way to transport nutrients and oxygen to all cells, and to remove wastes and carbon dioxide from all cells. The waste is transported to the excretory system and the carbon dioxide is transported to the lungs where it is exhaled.

44. Students' answers will vary. Using a factory as an analogy for a cell would have the boss's office functioning as the nucleus in a cell. The "boss" determines what the factory will do and who will work. If the factory produces its own power, for example, using solar panels or biofuels, then the power-generating facility is similar to the mitochondria in the cell, which produces energy for the cell. The production line, which manufactures the product, is similar to the rough endoplasmic reticulum and ribosomes in the cell, which makes proteins, or the smooth endoplasmic reticulum in the cell, which makes fats and oils.
45. When you exercise vigorously, your body's cells have increased cellular respiration. Heat energy is also produced. To release excess heat and to maintain homeostasis, capillaries dilate to allow increased blood flow to the surface tissues. The body also produces sweat, which is water that contains salts. The sweat evaporates at the skin surface, helping to cool the body and maintain homeostasis.
46. If you take medication to control your heart from beating too rapidly, and you exercise heavily, the body may demand more oxygen and nutrients than the blood flow will allow. This may result in fatigue until the body can get the oxygen and nutrients to the cells that need it.
47. (a) In the Arctic, there are months when there is no sunlight. Vitamin D is formed when the skin is exposed to ultraviolet radiation from the Sun. Vitamin D is essential for healthy bone development.
- (b) Since the beluga whales are showing toxic levels of cumulative toxins, the people of the Arctic will likely have to stop eating beluga whale skin because it will make them very sick or possibly kill them. However, the people of the Arctic may begin to suffer weaker bones and other side effects from a vitamin D deficiency unless they take vitamin D supplements.
48. Students' answers will vary. A short paragraph to explain how the ability of an organism to exchange gases is related to homeostasis should include some of the following points:
- An organism requires oxygen to undergo cellular respiration. If it lacks the ability to exchange gases, it may not be able to get enough oxygen for all its tissues to perform properly. This would alter the homeostasis of the organism.
 - If the organism needs to be very active, it would tire quickly if there was not enough oxygen getting into the body.
 - When mountain climbers climb to high altitudes, their body might not be able to acquire enough oxygen.
49. Combining alcohol —a depressant— and caffeine —a stimulant— can create confusion in the body. It may cause some parts of the body to become stimulated, which then require more oxygen and nutrients. However, other parts of the body may slow, preventing the required amount of oxygen and nutrients from reaching the tissues that need them. In general, tissues may start to function inefficiently and homeostasis may be harder to maintain.

- 50.** When a person is wounded in an accident, the body's response is to clot and stop the bleeding. Because alcohol is a depressant, it can slow this response, which increases the risk of injuries becoming life threatening or fatal. Also, alcohol slows a person's reaction time and ability to think clearly.
- 51.** Students' answers will vary. A short paragraph to explain how radiographs are used to provide information should include some of the following points:
- Radiographs show if bones are broken or out of position.
 - Radiographs produced from fluoroscopy can show how organs move.
 - Radiographs can be used to detect and diagnose cancer (e.g., mammograms).
 - Chest X-rays can reveal abnormalities in the lungs and irregularities in the size of the heart.
 - Dental radiographs can show where there are cavities in teeth.
- 52.** Ultrasound uses high-frequency sound waves to produce images of tissues and organs. It is used to study soft tissues and organs. It can also be used to guide needles when performing biopsies and it can be used during pregnancy to look at fetal development. X-rays can be used to check for broken bones, the presence of cancer, and to diagnose problems in the cardiovascular and respiratory systems.
- 53.** Examples of public health strategies that are related to systems biology include immunization programs, education programs about healthy lifestyles, and screening services. People are vaccinated for many diseases that affect organ systems, including polio, tetanus, whooping cough, rubella, measles, and bacterial meningitis. HPV vaccines are given to girls to reduce the chances of developing cervical cancer caused by the human papillomavirus (HPV). Currently, scientists are working on an HIV vaccine to stop AIDS. Smoke-Free Ontario Strategy is a program promoting a healthy lifestyle. Promoting the practice of Sun protection behaviours and the practice of behaviours to reduce exposure to the West Nile virus are also education programs related to healthy lifestyles. Reducing exposure to smoke, harmful UV radiation, and a virus spread by mosquitoes are all strategies that relate to systems biology. Cancer screening and DNA screening programs may provide an early warning about a person's susceptibility to certain diseases.
- 54.** Transgenic animals can have specific human genes incorporated into their systems. For example, there are mice that have human-like immune systems. Since mice reproduce much faster than humans do, it is much easier to study the effects and progression of disease on transgenic mice.
- 55.** Students' answers will vary. Some ethical issues related to reproductive technologies include the fact that people may try to produce specific characteristics in their offspring, such as the sex of the fetus, blood type, or resistance to disease. Another issue relates to the person who donates the eggs. For example, if a donor has some of

her eggs frozen, but then dies, it is possible for her children or parents to carry her baby. This could result in a daughter carrying the fetus of her own sister or a grandmother carrying her own grandchild.

- 56.** Childhood vaccinations such as MMR have almost eliminated the incidence of measles, mumps, and rubella, which are deadly diseases. Vaccinations provide protection against specific diseases that may be difficult to cure, that have serious, lasting side effects, and that are highly contagious. By preventing these diseases, the demands on the health-care system are reduced, and society is generally healthier.
- 57.** Students' answers will vary. Examples of information that a parent would need to know include the rates of disease contraction for the specific disease, the survival rates of children who have contracted the disease, and the side effects of the disease. A parent would also want to read scientific reports to learn about any potential negative consequences of vaccinations.

Skills Practice

- 58.** The phases of mitosis that can be seen in the photo include prophase (top left), anaphase (middle left), telophase (middle right), and metaphase (bottom left).
- 59.** Organelles found only in plants cells are the cell wall, central vacuole, and chloroplast. Organelles found only in animal cells are centrioles. Common organelles are the cell membrane, nucleus, nucleolus, chromatin, rough endoplasmic reticulum, smooth endoplasmic reticulum, Golgi apparatus, cytoplasm, mitochondrion, and ribosomes.
- 60.** (a) The nucleus, the cell wall, and the cytoplasm can be seen in the photo.
(b) The nucleus controls the cell processes, the cell wall provides structure and support for the cell, and the cytoplasm supports all the organelles in the cell.
(c) Since we can see the cell wall, the photo is of a plant cell. Animal cells do not have a cell wall.
- 61.** The organs shown are the mouth, tongue, esophagus, liver, stomach, pancreas, gall bladder, small intestine, large intestine, and rectum. Refer to Figure 2.7 on page 58 in the student book.
- 62.** The organs shown are the gill cover, spiny dorsal fin, lateral line, esophagus, heart, gall bladder, liver, stomach, intestines, pyloric caeca, anus, and swim bladder. Refer to Figure 2.31 on page 75 in the student book.

Revisit the Big Ideas and Fundamental Concepts

- 63.** The list of terms represents a biological hierarchy because the terms are all related. Each new level includes the previous level at a higher complexity. For example, tissues are made of cells working together. Organs are tissues working together. Organ systems are organs working together. An organism is made from many organ systems working together.
- 64.** Students' answers will vary. A paragraph explaining how the root and shoot systems work in photosynthesis should include some of the following points:
- The root system includes everything below the ground as well as aerial roots.
 - The shoot system includes everything above ground.
 - Nutrients and water are absorbed through the root system and transported to the rest of the plant through the shoots system.
 - Water moves from the roots to the leaves through the process of transpiration.
 - Stomata are small openings on the underside of the leaf. Water evaporates through these holes, which creates a pull to help draw water and nutrients up the stem.
 - Photosynthesis takes place in the leaves, a part of the shoot system.
 - The sugar produced during photosynthesis is moved throughout the shoots and roots to all parts of the plant.
- 65.** Although all cells have the same DNA, they are not all alike. Cells develop in different ways in a process called cell specialization. During cell specialization, cells become specialized to form differentiated cells that perform different functions. For example, animal cells become specialized to form lung cells and skin cells.
- 66.** Mitosis is cell division in which exact copies of each cell are made. An organism grows by creating new cells through mitosis. Damaged tissues are replaced or repaired through the process of mitosis, which provides new cells.
- 67.** There are four phases in the cell cycle: first growth phase (G1), synthesis phase (S), second growth phase (G2), and mitosis (M). The first three phases are part of interphase, where a cell is preparing for cell division. During mitosis, the cell divides. Refer to pages 28–32 in the student book for more information. Examples of the importance of various events in the cell cycle include the first growth phase in interphase, which allows for the growth of the cell, and the synthesis phase in which an entire copy of the DNA of the cell is produced. During mitosis, the genetic information is packaged into two equal portions, or two new daughter cells.
- 68.** Students' answers will vary. One example of a specialized cell in a mangrove tree includes specialized root cells that allow roots to absorb atmospheric oxygen since the mud in which the tree grows is extremely low in oxygen. A blood cell is similarly specialized to absorb oxygen. Another example is that the roots, which are often

submerged in salt water, have protective semi-permeable barrier (like cell membranes) for maintaining the internal environment of the root despite high concentrations of salt outside. Likewise, a cell maintains its internal environment through its cell membrane.

- 69.** Students' answers will vary. Homeostasis, or steady state, is when the body works to preserve the conditions under which it performs best. For example, when you are hot, your body produces sweat to cool itself. When you sweat, you lose fluids and become thirsty so that your body will replenish its fluids.
- 70.** The primary function of the circulatory system is to deliver oxygen and nutrients to the body's tissues and remove wastes. The primary function of the respiratory system is to take up oxygen needed for the body's tissues and to get rid of carbon dioxide from the body. The systems work together as the circulatory system transports deoxygenated blood containing carbon dioxide to the lungs where the carbon dioxide is exhaled and oxygen is inhaled for transport to tissues where it is needed.
- 71.** Answers may vary. To obtain the nutrients from food, the teeth and jaw mechanically break down food, the muscles of the digestive track move food along, and the digestive system adds chemicals, which help break down food to extract nutrients. Or the muscles of the chest wall expand to bring air into the alveoli, where there is air exchange with the capillaries of the lungs. Then the circulatory system transports the oxygen to the body tissues where it is used for energy production.
- 72.** Students' answers will vary. A paragraph describing how oxygen reaches each cell of the body should include the following points:
- Oxygenated blood flows into the heart from the lungs and is pumped out to the body in arteries.
 - The main arteries branch into smaller arteries. The walls of the arteries are too thick to effectively allow oxygen to be transferred to cells so the arteries branch into capillaries.
 - The capillaries are one cell thick, which allows oxygen and carbon dioxide to flow in and out of capillaries through diffusion.
 - Diffusion is the movement of a substance, such as oxygen or carbon dioxide, from an area of high concentration to an area of low concentration.
 - Waste products and carbon dioxide diffuse across the cell membrane into the blood, while oxygen and nutrients diffuse into the cell.
 - The deoxygenated blood continues travelling through capillaries to the veins, and finally returns to the heart where it is pumped to the lungs to be oxygenated.
- 73.** Students' answers will vary. A paragraph describing how plant tissues interact to carry out photosynthesis should include the following points:
- Water is absorbed through the roots.

- It moves to the xylem, where it is drawn up the shoots to the leaves.
 - The water is drawn up the stem, like liquid up a straw, by evaporation of water through the stomata in the leaves. This creates a transpiration pull that draws water up the stem.
 - Once in the leaves, the water is drawn into the mesophyll, which is the specialized ground tissue where photosynthesis and gas exchange occurs.
 - Through photosynthesis, water and carbon dioxide react to produce sugars and oxygen.
 - The phloem is the tissue that transports sugars produced through photosynthesis from leaves to other parts of the plant.
- 74.** Cancer cells reproduce uncontrollably, and they do not self-destruct. They can form masses of cells called tumours. Cancer cells do not stick together, but move to other parts of the body where they can form a tumour. Because cancer cells do not specialize, an organ or tissue that contains cancer cells will not be able to function properly. As well, cancer cells can crowd out normal cells and can prevent normal cells from performing their function.
- 75.** Students' answers will vary depending on the development discussed. A sample answer is that the development of the light microscope allowed scientists to see images of the cell. A compound light microscope has a series of lenses that permit a high level of magnification. The use of stains provides a contrast that allows scientists to see the parts within a cell. The developments in electron microscopes have allowed scientists to see details of the inner structures of cells. Scientists can now even see the molecules inside the inner structures of cells, which allows them to better understand how those structures work.
- 76.** Students' answers will vary. Programs to reduce the rates of cancer include the Smoke-Free Ontario Strategy, which has provided legislation to reduce exposure to second-hand smoke, and which provides programs for people who want to quit smoking. Ontarians are also encouraged to practice Sun protection behaviours to reduce the rate of skin cancer. Cancer screening programs help detect cervical, breast, and colon cancers early. Vaccination programs help reduce the incidence of diseases, such as measles, mumps, HPV, and influenza.
- 77.** Students' answers will vary.

	Plus	Minus	Interesting
DNA screening	<ul style="list-style-type: none"> • early awareness of risk allows the possibility of preventative measures, such as lifestyle changes 	<ul style="list-style-type: none"> • a screening only suggests a likelihood of getting a specific cancer, and many people do not want to know their risks 	<ul style="list-style-type: none"> • who might use this information (e.g., insurance companies, employers)

Stem cell research	<ul style="list-style-type: none"> • may allow for repair or replacement of damaged or defective tissues 	<ul style="list-style-type: none"> • harvesting embryonic stem cells requires the destruction of an embryo 	<ul style="list-style-type: none"> • who retains the rights to the stem cells
Organ transplantation	<ul style="list-style-type: none"> • allows for possible repair or replacement of damaged or defective organs 	<ul style="list-style-type: none"> • questions about the origins of a donated organ possibility of rejection of organ by the new host • health implications for donor 	<ul style="list-style-type: none"> • who is eligible for the transplant • who decides what role money has in determining who receives an organ
Cloning	<ul style="list-style-type: none"> • allows for repair or replacement of damaged or defective organs (and matched to your own genetics) 	<ul style="list-style-type: none"> • what are the rights to a cloned organ 	<ul style="list-style-type: none"> • many ethical considerations here
Cancer screening	<ul style="list-style-type: none"> • may catch a cancer early, which allows for a better chance of survival 	<ul style="list-style-type: none"> • some screenings require the use of X-rays 	<ul style="list-style-type: none"> • regular screening for cervical, breast and colon cancer has led to improved survival rates

- 78.** Students' answers will vary depending on the technologies discussed. A sample answer is that PET scans can detect changes and any abnormalities in heart tissues. X-rays can be used to check the size of the heart and the structure of associated blood vessels. Fluoroscopy uses X-rays to study the blood flow in arteries; a special dye is injected into an artery to produce an angiogram that can be studied to see how the blood and dye flow through the artery. An echocardiogram uses ultrasound to check for abnormalities in the heart or blood vessels. It can also detect blood clots, check how the heart valves are functioning, and check the movements of the heart.
- 79.** Students' answers will vary. A possible answer could be that X-rays were used to diagnose a broken bone or find cavities in teeth. Another answer could be that an ultrasound was used to determine the health and development of a fetus.
- 80.** Students' answers will vary. Possible answers include using the fluorescent green protein in the pig as an easy way to track its stem cells when injected into other animals. Transgenic animals could produce healthier meat, larger quantities of meat, be able to serve as human organ donors, and could become more disease resistant (as could plants).

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- 81.** Students' answers will vary depending on the development chosen. For example, X-rays allow doctors to see broken bones and to ascertain the severity of the break. This allows for better setting and mending of the bone. Using X-rays, it is possible to study approximate size of organs and their placement. If a contrasting fluid is used, X-rays can show how specific tissues and organs move.
- Ultrasound allows doctors to look at soft tissues and to see how they move. This has allowed for examination of baby development during pregnancy without needing to perform surgery or use X-rays. This technique has also allowed the heart to be studied as it is beating, to give a clearer idea of how it is functioning.
- 82.** Students' answers will vary. An ethical argument for and against stem cell research should include some of the following points:
- Tissues that are genetically identical to the recipient could be produced using a person's stem cells.
 - Embryonic stem cells have the ability to become any type of tissue and are incredibly versatile as a result.
 - Embryonic stem cells could be used to treat such diseases as cancer, Parkinson's disease, Alzheimer's disease, stroke, and diabetes, which would reduce the demands on the health-care system.
 - Harvesting embryonic stem cells involves destroying a fetus, which has the potential to become a viable human being.
- 83.** Students' answers will vary depending on the topic chosen. A paragraph outlining some of the ethical implications should include some of the following points:
- Transgenic techniques involve changing the genetics of an organism. Ethical implications include long-term effects of creating transgenic organisms and how this could affect the species.
 - Cloning involves creating organisms that are genetically identical. Ethical implications arise from the possibility of cloning humans and the consequences that cloning animals or crops has on the genetic diversity of a species. The cloning of human organs seems to be an ethical use of cloning that could improve the lives of people.
 - Stem cell research is the use of stem cells — embryonic and adult — to treat various diseases, including cancer, Parkinson's, Alzheimer's, and diabetes. The ethical implications concern harvesting embryonic stem cells, which destroys the embryo.
- 84.** Students' answers will vary. Answers should include some of the following points:
- Our understanding of systems biology has increased greatly because of technological developments.
 - Medical imaging and diagnosis techniques allow us to see how organs function in the body. Using imaging technologies we can diagnose abnormalities in organ systems.

- We can create transgenic organisms to allow us to study the effect of cancers and disease.

Reflection

85. Students' answers will vary. An example answer could be that the student has a deeper understanding about the uses of various medical imaging tests.
86. Students' answers will vary. An example answer could be that the student has made a good choice in getting the influenza vaccine every year, but a bad choice in choosing to be out in the Sun without wearing sunscreen.
87. Students' answers will vary. An example answer could be that the student has chosen to collect money for the Canadian Cancer Society because they understand what cancer is. Another answer is that the student has chosen to participate in a fundraising run for the Heart and Stroke Foundation because circulatory diseases are prevalent in his or her family, and they now understand the circulatory system.
88. Students' answers will vary. An example answer could be that the student has a very healthy lifestyle because he/she participates regularly in sports and eats a healthy diet. Examples of things that a student can do are to limit Sun exposure to limit exposure to mosquitoes.