Section 3.1 Cells and Tissues (Student textbook pages 85 to 92)

In this section, students will explore cell specialization and the factors that influence it. They will be introduced to the reasons why abnormal development sometimes occurs, and will explore how groups of similarly specialized cells form tissues. Students will learn about the different types of tissues in the human body and will examine these tissues under a microscope. Finally, students will learn about stem cells, and will explore the ethical issues raised by the use of embryonic stem cells.

Common Misconceptions

- Students may visualize cells as being in the human body, but not making up the human body. Explain to students that that each part of their body is made up of cells that perform specialized functions. For example, students may understand that red and white blood cells move through arteries and veins, but they may not appreciate that the arteries and veins themselves are made up of specialized cells (smooth muscle cells).
- Students may assume that cells continue to grow in size and that the size of cells determines the size of the organisms they make up. Explain that though larger animals may have larger cells than smaller animals, it is not the size of the cells that determines the size of an animal, but the number of cells.
- Students may have misconceptions about the appearance of embryos that are used for stem cell research. They may visualize these embryos as fetuses. Show students the pictures of the early embryos on page 90 of the student textbook. Embryonic stem cells are found in the blastocyst stage of early development. Emphasize that the cells have not specialized at this stage (they are pluripotent). This is not meant to be a value judgement on the use of embryonic stem cells, but rather a clarification of a point that students may be confused about from accounts in the media or science fiction.
- Students may be confused about the appearance of the chick embryo in Figure 3.3. They may ask why the chick embryo is beginning to resemble a chick at 12 days while a human embryo still appears more like a mass of cells at this stage.
- Remind students that the images of cells they see in the microscope are affected by slicing, fixing, and staining. Therefore, they are not totally accurate pictures of what the cells and tissues look like. However, microscopy is still an important tool to use to relate structure to function and in fact viewing tissues this way is an important tool used by pathologists who study and diagnose disease.

Background Knowledge

At about five days after fertilization, an early embryo is called a blastocyst. Early embryonic stem cells are found at this stage. Blastocysts are made up of pluripotent embryonic stem cells. Adult stem cells, on the other hand, can be found in many different tissues in the human body, including blood and bone marrow, brain, epithelial, fat, umbilical cords, and muscle. These cells are important for tissue repair and in some cases regeneration.

The use of adult stem cells is a rapidly growing area of research. Recent developments in adult stem cell research are encouraging, not only because they will deal with the ethical issues and debate surrounding embryonic stem cells, but because they will also reduce the risks of tissue rejection. With the use of adult stem cells, patients can receive transplants that are made up of their own cells. In fact, adult stem cells have been used to treat some conditions for many years. Certain cancers of the blood are treated with stem cells from donor bone marrow. Current research may lead to exciting new treatments and uses for adult stem cells. For example, stem cells that are resistant to HIV could be developed. These cells could be used to replace immune cells in patients with AIDS.

Specific Expectations

- **B1.1** analyse, on the basis of research, ethical issues related to a technological development in the field of systems biology, and communicate their findings
- **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*
- **B2.4** investigate, using a microscope or similar instrument, specialized cells in the human body or in plants, focusing on different types of cells, and draw labelled biological diagrams to show the cells' structural differences
- **B3.2** explain the importance of cell division and cell specialization in generating new tissues and organs
- **B3.3** explain the links between specialized cells, tissues, organs, and systems in plants and animals

Stem cells can also be very useful tools for studying disease. For example, certain diseases (e.g., Parkinson's, Type 1 diabetes, ALS) are difficult for scientists to study because specific types of cells become destroyed or severely damaged before the patients are diagnosed with a disease. Therefore, researchers are not able to see and study the progression of the disease by examining the cells. Stem cells taken from the relevant tissues involved in the disease can be cloned and scientists can study how the disease process begins and progresses by studying the development of the cells in a laboratory setting. Cell lines from these stem cells can be cultured in a laboratory and used for a variety of different studies.

The use of viruses to induce adult stem cells to become pluripotent increases the risk of DNA damage, cancer, and may lead to other problems. Dr. Andras Nagy and researchers at Mount Sinai Hospital in Toronto collaborated with a team of researchers from Scotland to induce pluripotent stem cells from adult skin cells without the use of viruses. Their method involves inserting a reprogramming gene using an electric shock. The reprogramming gene is inserted into a gene found in moths and corn called a "jumping gene," which can move around the DNA of a single cell and can be removed once the cell has been induced into an embryonic state. The research was published in the scientific journal *Nature* in April 2009.

Literacy Support

Using the Text

- ELL Have students highlight new terms in their notes and begin a list of these new terms. Have students include definitions, an example and, if appropriate and helpful, a sketch for each new term.

Before Reading

- Provide students with Study Toolkit Master **BLM G-40 Word Study** before they begin reading the section. Explain how the base words in a term can help explain its meaning.
- Have students scan the section and preview the text features and the headings. Have them look at the key terms in the section and consider if they are already familiar with any of the words. This will help them identify the main ideas in the section.
- Provide students with **BLM G-48 K-W-L Chart.** Ask students to fill in the "What I Know" and "What I Want to Know" columns before reading the section.

During Reading

- Ask students to create a list of questions they have as they read the text. This will help focus their reading and will serve as an organizer for information they still need to learn.
- Have students write a short one- or two-sentence summary of the main points in each subsection. Students can then work in groups to compare their summaries and agree on one. The summaries can be shared with the class and recorded so they can be used as review.

After Reading

- Have students complete **BLM G-48 K-W-L Chart** when they have finished reading the chapter.
- To consolidate learning, have students create a graphic organizer to illustrate their understanding and knowledge of the different types of cells and tissues in the human body. Provide students with **BLM G-42 Concept Map** to help them organize their learning. Students can use this concept map as the basis of the graphic organizer they create in the Chapter Review section.

Using the Images

- Before reading, have students look at the photographs and illustrations in the section. Ask them to relate the figures to their own experiences.
- Have students write their own descriptions of the appearance of the tissues in Table 3.1 without reading the textual descriptions in the textbook. If students are able to write descriptions in their own words, it will help enforce their understanding of the different tissue types.
- Have students create flash cards of the different tissue types in Table 3.1. On one side of the cards, they can draw the appearance on the tissue and on the other side they can write a description of the tissue's location and function.

Assessment FOR Learning

Tool	Evidence of Student Understanding	Supporting Learners
Activity 3-2 Tissue Sleuth, page 89	Students use a microscope to view cells from prepared specimen slides of different tissue types. They draw and label a cell from each slide, and identify the type of tissue in each specimen. Students describe the function of each tissue and explain how the appearance of the tissue relates to its function.	Refer students to Science Skills Toolkit 6 Scientific Drawing on pages 543 and 544 of the Appendix in the student textbook. Provide students with **BLM G-11 Scientific Drawing.** Pair visual learners with students who are experiencing difficulty. Some students, particularly linguistic learners, may benefit from orally describing what they see in addition to drawing what they see.
Learning Check questions, page 90	Students explain cell differentiation and identify factors affecting cell specialization. They identify the main types of animal tissues and give examples of each from the human body. Students explain the difference between skeletal muscle and smooth muscle.	Refer students to Study Toolkit 4 Organizing Your Learning: Using Graphic Organizers on pages 565 and 566 of the student textbook to help them answer question 2. Alternatively, provide students with **BLM G-44 Main Idea Web.** Ensure that English Language learners understand the use of the terms "voluntary" and "involuntary" in question 4. Ask these students what words they use in their language(s) to describe these concepts.
Section 3.1 Review Questions, page 92	Students draw and view images of specialized cells and describe how appearance relates to function. They explain how environmental conditions can affect cell specialization. Students explain the significance of cell specialization. They describe stem cells and compare adult stem cells and embryonic stem cells. Students explain ethical issues related to the use of embryonic stem cells.	Refer students to Science Skills Toolkit 6 in the Appendix of the student textbook. Alternatively, provide students with **BLM G-11 Scientific Drawing.** Provide students with **BLM G-47 Venn Diagram** to help them with question 6. This BLM could also be used to answer question 5.

Instructional Strategies

- DI To develop and encourage linguistic intelligence, have a class discussion about the significance of stem cell research and the use of embryonic stem cells. Ask students what they know or have read about stem cells. Some students may have strong opinions about the issue. Encourage students to voice their opinions, provided they are respectful of both sides of the issue. Have students write an opinion essay or letter to the editor about stem cells and stem cell research as a means of expressing themselves.
- Alternatively, if students are capable of debating the issue in a respectful manner, provide them with an opportunity to engage in a class debate. Provide students with **BLM G-26 Debating Procedures** and **BLM G-27 Debating Organizer.**

- ELL This section presents a lot of new terminology that some students may be unfamiliar with. Encourage English language learners to answer their questions in their own language first and then translate.
- Create a bulletin board with news items about stem cells. Add to the board or have students bring in relevant news items as they progress through the chapter.
- Have students continue to add to their journal, list or chart of all the words from the chapter that are unfamiliar to them. Provide students with **BLM 3-2 Cells to Systems Word Tracker** if you have not done so already. Students can use the blackline master to list new terms and their definitions and origins.
- Ask students if they think their opinions on the use of stem cells might change if they or someone they knew had a serious illness that might have the potential to be cured by developments in stem cell research.
- There are many animations and graphics available online that show embryonic and fetal development. Go to **www.scienceontario.ca** for more information.
- Have students create a flowchart, using words or sketches, of embryonic and fetal development after they look at Figure 3.5 on page 90.
- Enrichment—Stem cell research is new enough that government policy on its use is still evolving. Encourage interested students to research current Canadian policies on stem cell research and compare these policies to the policies of other countries. Ask students what kind of policies they would want to implement if they had the political authority.

Activity 3-2 Tissue Sleuth (Student textbook page 89)

Pedagogical Purpose

Students will examine different types of human tissue under a microscope and describe how the appearance of the tissues helps explain their functions and identity.

Planning	
Materials	Microviewer or compound microscope Unidentified, prepared slides or various tissues from the human body
Time	40 min
Safety	Ensure microscopes are moved carefully and electrical safety precautions are taken if necessary. Ensure students handle the glass slides carefully and any broken glass is cleaned up and disposed of in the appropriate receptacle.

Background

The study of cells and tissues using microscopy is called histology. Tissues are sliced into sections and viewed with either light or electron microscopy. A sub-field of histology is histopathology. Histopathology is the microscopic study of diseased tissue and is often used in disease diagnosis. Because tissue needs to be processed before it can be viewed under a microscope and processing can lead to structural changes (e.g., cell shrinkage, colour changes), there are limitations to what we can learn from studying cells using basic histology.

Activity Notes and Troubleshooting

- Ensure students have reviewed how to correctly use a microscope. Provide students with **BLM G-14 Using a Microscope** before beginning the activity.

- Have extra pencils and paper available for students who require them to create their drawings.
- Provide students with **BLM G-11 Scientific Drawing.**

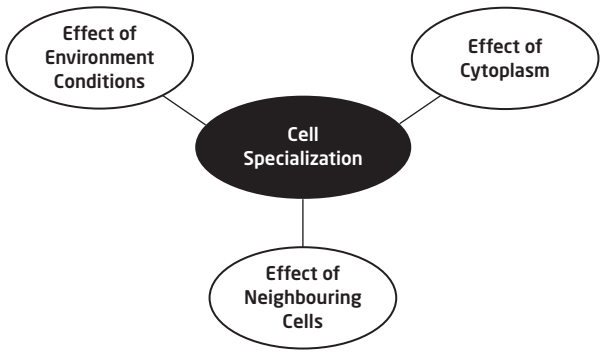
Additional Support

- DI Spatial learners and students who enjoy drawing may be particularly interested in this activity. Pair these learners with students who are experiencing difficulty. Some students may become frustrated if they cannot "see" what another student has described. Ensure that all students can describe the different tissue types in a way that is meaningful to them.
- Encourage students to answer question 2 using their own words and not the descriptions of function found in Table 3.1.
- Provide students with **BLM 3-4 Tissues in the Human Body** and have students draw their own diagrams in the Appearance column. Encourage students to draw what they see in the field of view, not the way they think the tissues are supposed to look according to the photographs in Table 3.1. Students who use the textbook photos as a basis for their drawings may not have a deep understanding of the structure and functions of the tissues.
- Use **BLM A-1 Making Observations and Inferences, BLM G-11 Scientific Drawing,** and **BLM A-40 Scientific Drawing Rubric** for assessment.

Answers

1. When tissues are magnified, the appearance of their cells can provide clues about the tissue's function and identity because the cells are specialized to perform specific functions. For example, nervous tissue is made up of neurons, which are cells specialized to receive and transfer signals to other cells and tissues. The long projections that come out of the cell bodies and send and receive these signals provide a clue about the function of neurons.
2. Example:
   epithelial—acts as a lining on the outside of the body and between different organs
   muscle—contracts and lengthens to allow the body to move, the heart to pump, and other tissues to perform functions
   nervous—send signals to brain, spinal cord, muscles, and other tissues by receiving and relaying information
   connective—acts as support and protection for other tissues; fat tissue also stores energy and blood cells carry nutrients and oxygen to other tissues and protects against infection.

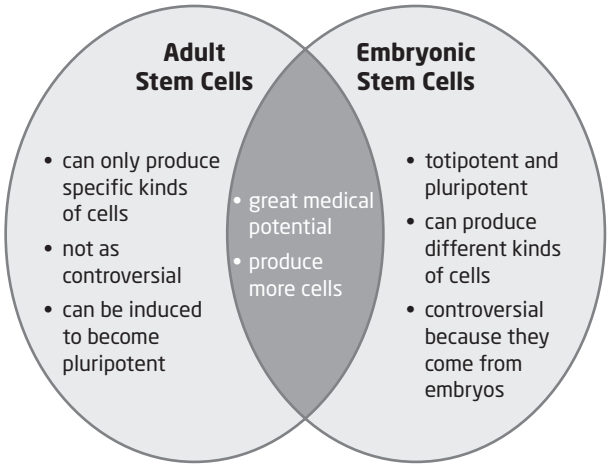
Learning Check Answers (Student textbook page 90)

1. Cell differentiation is the specialization of different cells for different functions.
2. 

3. The four main types of animal tissue are epithelial, muscle, nervous, and connective tissue. Epithelial tissue is found lining surfaces of the body, including internal organs. Muscle tissue is found attached to bone, in blood vessels, and walls of some internal organs, and as the major tissue in the heart. Nervous tissue is found in the brain, the spinal cord, and through the body for the transferring of signals. Connective tissue is found as bone, fat, and blood throughout the body.
4. Skeletal muscle usually contracts or lengthens when a person makes a conscious decision to move a part of his or her body and is therefore called "voluntary" muscle. Smooth muscle is found in blood vessels and internal organs such as the stomach, and contracts to helps these tissues perform their functions (i.e., circulating blood and digesting food).

Section 3.1 Review Answers (Student textbook page 92)

Please also see **BLM 3-5 Section 3.1 Review (Alternative Format).**

1. Example: Columnar epithelial cells have projections that function to absorb nutrients. Skin cells are flat and form a thin sheet over other tissues to act as a covering and protective barrier. Fat cells are large and roomy for the storage of fat.
2. **a.** D
   b. C
   c. B
   d. A
3. The fish and frogs with 20 times the abnormal growths were likely exposed to a high concentration of the chemical at an early stage in their development. As the concentration of the chemicals decreased over time, new fish and frogs would have been exposed to a lower concentration of chemical.
4. If cells of a chick embryo did not specialize, the embryo would not form into a chick.
5. Stem cells are cells that are capable of producing new cells and therefore regenerating tissue. Unlike other cells, they are unspecialized but can produce different specialized cells.
6. 

7. Embryonic stem cells are found in very young embryos. They are totipotent and can continue to divide without differentiating. Adult stem cells are cells from some tissues of the human body that can be produce new cells. These cells can be induced using viruses or other genes to become pluripotent.
8. Researchers are interested in trying to induce adult stem cells to become pluripotent or totipotent because they could replace the use of embryonic stem cells and eliminate the controversy surrounding the use of embryos in medicine and research.