Topic 1.2
Why do animal cells divide and what happens when they do?

Specific Expectations

- **B2.1** use appropriate terminology related to human cells, tissues, organs, and systems, including, but not limited to: *absorption*, *anaphase*, *capillaries*, *concentration*, *differentiation*, *diffusion*, *interphase*, *metaphase*, *osmosis*, *prophase*, *red blood cells*, *regeneration*, and *telophase*
- **B2.2** examine cells under a microscope or similar instrument to identify the various stages of mitosis in animals
- **B2.4** compare, on the basis of observation, the division of cancerous cells and non-cancerous cells, and describe the impact of cancerous cells on the human body
- **B2.6** use scientific investigation skills to research health problems related to tissues, organs, or systems in humans, and communicate their findings
- **B3.1** describe the cell cycle in animals, and explain its importance for the growth of cells and repair of tissues

Skills

- formulate scientific questions, and make predictions and hypotheses
- select appropriate instruments and materials for inquiries
- identify relevant resources
- conduct inquiries, using standard equipment and materials safely
- draw conclusions
- communicate using a variety of formats
- express the results of calculations accurately and precisely

Materials

Please see the teaching notes for each activity for a list of the materials required. Please see pages TR-38 to TR-41 for a summary of the materials required in this topic.

Overview

In this topic, students will discover that cells need to divide to survive. All hereditary material contained in the DNA molecule is passed on during cell division. Animal cells have a life cycle that includes both growth (interphase) and division (the phases of mitosis—prophase, metaphase, anaphase, and telophase—and cytokinesis, in which the cytoplasm and the organelles divide into two identical separate cells). All new animal cells are created during this controlled cell cycle. If division of animal cells becomes uncontrolled, it can result in cancer.

Common Misconceptions

- **Because the process of mitosis is described as a series of stages, students may visualize it as discrete stages, with pauses between them.** Mitosis is a continuous process where one stage flows smoothly into the next. There is no stopping between the stages of mitosis.
- **Students may believe that all cells replace themselves at the same rate.** Skin cells are replaced almost daily whereas brain cells take over 40 years to be replaced. Cells divide more often in a young organism and less often in an older organism. Cancer cells never stop reproducing and self destruct as they get older.
- **Students may think that all errors in DNA replication are harmful.** All evolutionary change is a result of mutation. Most mutations have no effect on the organism, some are harmful, and some errors lead to evolutionary change that improves the organism. An example would be a mutation that makes the organism resistant to a common disease.
- **Students may think that all tumours are cancerous.** In fact, most tumours are benign and relatively harmless.

Background Knowledge

All cells are derived from pre-existing cells; cells must divide in order to survive. To meet its basic needs, a cell must transport nutrients, oxygen, water, and waste materials within its cytoplasm and through its cell membrane. The only way for nutrients and wastes to get in and out of a cell is to pass through the cell membrane. As a cell increases in size, its cell membrane gets larger. However, the volume of the cell increases at a much greater rate than does the surface area of the cell membrane. At a certain size, the membrane cannot keep up with the needs of the cell. Instead of simply growing larger, cells divide to efficiently use and transport nutrients, oxygen, water, and waste materials.

The instructions for cell division are found in DNA molecules in the nucleus of the cell. These DNA molecules must replicate in preparation for cell division. During the **interphase** portion of the cell cycle, the tightly-coiled DNA forms threads of chromatin within the nucleus. These form chromosomes when the cell divides. The cell cycle includes interphase (the majority of time in the cycle where growth and replication occur) and the division stage, which includes **mitosis** and **cytokinesis**. In mitosis, the contents of the nucleus separate into two identical parts. There are four phases in mitosis:

1. **Prophase:** During prophase, the nucleus and the membrane that surrounds the nucleus disappear, the chromatin condenses, and chromosomes form.
2. **Metaphase:** During metaphase, the chromosomes align in the centre of the cell.
3. **Anaphase:** During anaphase, the chromosomes separate and move to opposite ends of the cell.
4. **Telophase:** During telophase, the membrane surrounding the nucleus re-forms, creating two new nuclei.

In cytokinesis, the cytoplasm and organelles divide into two identical, separate cells. The cell cycle is a highly controlled process. Unchecked cell growth results in tumours that may be either benign or malignant. Normal cells can reproduce about 50 to 60 times whereas cancer cells may never stop reproducing.

Literacy Strategies

Before Reading

- Work with students to prepare a key word concept map or a flow chart about the stages of mitosis. This will help you assess students' prior knowledge of cell division.
- Have students prepare a K-W-L chart about cancer using **BLM G-44 K-W-L Chart.** On their own, or in pairs, they can record what they know and what they would like to learn. Invite willing students to share some of their responses with the class. When they have completed reading the topic, they can complete the last column of their chart to show what they have learned. This tool provides a good opportunity to eliminate any misconceptions students may have about cancer. Encourage sensitivity should there be students who may have undergone or are undergoing cancer events in their lives.
- Preview the text features with students. Invite students to point out the features that they see on pages 20–37 and suggest how each one might help them learn about cell division. If necessary, draw their attention to diagrams, captions, boxed text, such as that on page 29, activities, headings, marginal definitions, and Learning Checks.
- ELL Preview key terms with English language learners before reading. Have students keep a list (dictionary) of new words with definitions, examples and non-examples, and sketches.

During Reading

- Have students rewrite topic headings as "How?", "Why?", or "What?". For example, "Why must cells divide?" Consider discussing how some of the headings might be rewritten as questions as a class. Then students can take notes as they read to answer the questions they have written.
- Use GIST. Have students write a summary statement about cell division or about each stage of mitosis. Students could discuss their summary statements with a classmate, and revise as necessary. To support students in writing summaries, consider distributing **BLM G-37 Summarizing.**
- ELL Encourage students to use diagrams to summarize each stage of mitosis. Diagrams should clearly show what is happening, and should include labels indicating the stage. Large versions of these diagrams could be posted in the classroom. Refer to these as you are teaching and interacting with students. This will encourage them to use these charts as reference material.

After Reading

- Students could complete **BLM 1-8 Stages of the Cell Cycle, BLM 1-9 The Cell Cycle, BLM 1-10 Steps of Mitosis,** and/or **BLM 1-11 Cell Growth and Division,** to demonstrate what they have learned in this topic.
- Investigation 1A, on pages 32 and 33, provides a practical review of what students have learned about phases of the cell cycle.
- Enrichment—Students could complete **BLM 1-12 Effects of Aging.**

Assessment FOR Learning		
Tool	**Evidence of Learning**	**Supporting Learners**
Activity 1.5, page 23 Learning Check, page 23 Review, question 3, page 37	Students explain why a cell must divide to survive.	• Dramatize the difference between transporting something in a large cell and in small cells by handing out papers or other items in class. Pass a class set of the item to one student near the front, and ask that student to take one and pass the rest on. Draw students' attention to how long the process takes, or have a student time it. Then divide the items to be distributed into three or four groups and give each group to one student, asking them to distribute the items to other students in their part of the classroom. Compare the times for the two processes and encourage students to make a connection to the difficulties large cells would face.
Learning Check, page 27 Learning Check, page 28, Investigation 1A, pages 32 and 33	Students state the purpose of cell division and describe the stages of the cell cycle, including the phases of mitosis.	• In question 2, on page 27, students can create their flowchart using **BLM G-43 Flowchart.** • Allow students to use a cooperative strategy such as think-pair-share to answer question 3, on page 27. • Students can complete **BLM 1-8 Stages of the Cell Cycle, BLM 1-9 The Cell Cycle, BLM 1-10 Steps of Mitosis,** and/or **BLM 1-11 Cell Growth and Division** with a classmate to provide further reinforcement of the concept.
Investigation 1A, pages 32 and 33	Students draw representations of cells that are thorough, clear, and accurate.	• Read Science Skills Toolkit 5, Scientific Drawing, on pages 350 and 351, with students.
Review, question 4. page 37	Students describe the role of DNA in cell division.	• Use analogies or have students develop analogies to illustrate the role of DNA in passing on hereditary material during cell division. For example, two friends have one copy of an assignment, but they both need to complete it. What can they do? They can photocopy or replicate it, and then both go home with a complete set of instructions. If the instructions are long, they can even fold them up to prevent them from getting damaged in transit.
Learning Check, page 31 Activity 1.11, page 35	Students describe cancer as uncontrolled, rapid division of animal cells.	• To help them organize new information, have students complete the first column of **BLM 1-13 The Cell Cycle and Cancer,** reread pages 30 and 31, and then complete the second column.

Topic 1.2 (Student textbook pages 20–37)

Using the Topic Opener

- Like Topic 1.1, this topic begins with a fictional example of change. Science fiction creatures often regenerate body parts. Ask students whether this can happen in real life. Guide the discussion to include examples such as cuts healing, plants growing new branches when old ones are cut off, and animals that can regenerate small parts of their bodies, such as starfish and planaria, as described on page 20.
- Invite students to suggest what happens to cells when a body grows or changes. Do cells get bigger? Do more cells grow? How does a new cell know what type of cell to become (a leaf or a stalk, for example)? Explore any answers to these questions that students already have ideas about.
- Record other questions students have. You could leave students' questions on display and refer to them as students work through the topic and find the answers.

Starting Point Activity (Student textbook page 20)

Pedagogical Purpose

When does an organism need to produce new cells? We know that cells need to divide to survive and that all new cells come from pre-existing cells. As the organism develops, cells must be repaired, replicated, or regenerated for the organism to grow. Certain primitive organisms have excellent regenerative abilities whereas mammals, in particular, have little regenerative capability. In this activity, students are asked to compare when different organisms might need to produce new cells and to identify organisms capable of regeneration.

Planning	
Materials	pictures of organisms that can regenerate body parts (optional)
Time	20 min in class

Activity Notes and Troubleshooting

- To facilitate brainstorming and creative explanations, students should work in small groups. Groups can then share their responses with the class.
- If possible provide pictures of starfish, snakes, planaria, and other organisms that can regenerate body parts, such as worms, salamanders, grass, and other plants.
- Each group should be able to produce a concept map that highlights their new insights.

Additional Support

- You may want to conduct this activity as a whole class, modelling appropriate brainstorming behaviours, and ways to include ideas from all students.
- Enrichment—Encourage students to think globally and act locally. What does what they have learned mean to them as stewards for their environment?
- ELL Understanding the verbs repair, replicate, and regenerate is essential to the study of cells. Teach a mini-lesson to English language learners about the prefix *re-* and how it means "to do again" or "another time." Print the three words on the board underlining the *re*. Provide a simple synonym for each word. For example, repair = fix, replicate = copy, and regenerate = to replace by new growth. Have students add these words to an ongoing dictionary.

Starting Point Activity Answers

1. All three organisms would need to produce new cells to grow when they are young. A starfish might need to produce new cells if an arm were lost or damaged. A snake might need to produce new cells after shedding its skin (moulting). A human might need to produce new cells after an injury such as breaking a limb, a bruise, or a cut.
2. A planarian flatworm can grow a new head because it is a very simple organism with a minimal nervous system. As long as the nucleus in each individual cell is intact, then regeneration of that area is possible. Humans cannot regenerate our heads because our cellular structure is too complex.

Instructional Strategies for Topic 1.2

Student textbook pages 22–23

- Have students predict some reasons for cell division and cell growth before they read.
- Remind students of Activity 1.4, in which they measured how long it took diffusion to move food colouring different distances. Ask what this can tell us about cell size.
- As a summary, invite students to share their answers to Learning Check question 1.

Student textbook pages 24–25

- If possible, show the class a three-dimensional model of DNA and allow students to investigate its structure.
- Invite students to think of other items that get packed tightly together to avoid damage during sorting or transportation. (Clothes get packed in a suitcase, yarn gets rolled into balls, and so on.)

Student textbook pages 26–29

- Encourage students to read page 29 with a classmate, with one student reading about each phase, and the other pointing out what happens in that part of Figure 1.10.

Student textbook pages 30–31

- Encourage students to keep track of any words they do not understand as they read. Discuss the meanings of these words as a group after reading.
- Encourage students to share any questions they have about the causes or mechanisms of cancer. Do your best to answer the questions in a clear, simple way. If students have unanswered questions, suggest ways they could work with you to find answers.

Activity 1.5 Cell Number Crunch (Student textbook page 23)

Pedagogical Purpose

In this activity, students will determine mathematically why as a cell grows, its volume increases more quickly than the surface area of its cell membrane. The surface area of an object is the area of the surface that encloses it. Thus the surface area of a cell is the area that is covered by its cell membrane. The ability of a cell to take in nutrients and get rid of wastes is related to the size of this surface area. Conversely, the volume of an object is the amount of space it takes up. The volume of a cell is related to the amount of material that the cell contains. By comparing two different sized cubes, students will be able to use mathematics to illustrate that a cell's volume will increase at a much greater rate than its surface area.

Planning	
Materials	calculators cube shaped cardboard boxes of different sizes **BLM 1-14 Cell Number Crunch** (optional)
Time	30 min in class 15 min preparation

Skills Focus

- calculate accurately and use appropriate units of measurement
- analyze and interpret quantitative data

Activity Notes and Troubleshooting

- You could distribute **BLM 1-14 Cell Number Crunch,** and allow students to use it as a model for their calculations.
- Supply students with calculators.
- To help students consolidate the connections this activity illustrates, have them complete **BLM G-45 Main Idea Web** as a summary of what they learned in the activity.

Additional Support

- DI Logical-mathematical and visual learners may benefit from constructing or viewing a double line graph showing how both surface area and volume increase as side length increases. Consider having interested students create one, or create one as a class.
- Use think-pair-share. Before submitting their answers, have students compare their results with a classmate's.

Activity 1.5 Answers

1. **a)** surface area = 3 mm × 3 mm × 6 = 54 mm^2 (length × width × number of sides)
   b) volume = 3 mm × 3 mm × 3 mm = 27 mm^3 (length × width × height)
2. **a)** The volume has increased more rapidly than the surface area.
   b) If the cube were a cell, this would be a problem because the surface area is not large enough to meet the demands of the cell's volume.

Learning Check Answers (Student textbook page 23)

1. Cells divide instead of simply growing larger and larger because they need to be able to obtain nutrients, oxygen, and water, and to get rid of waste. If they simply became larger, they would not be able to obtain enough of the materials they needed to survive.
2. Explanations may vary. As the size of a cell increases, it takes longer to transport nutrients and wastes between the cell membrane and the rest of the cell. If a cell becomes too large, this time factor becomes that much more important and the cell may starve itself.
3. As the cell grows, the cell contents increase faster than the cell membrane because the volume of a cell is related to the amount of material that the cell contains and the volume of the cell increases more rapidly than the surface area.

Activity 1.6 Modelling the Coiling and Condensing of DNA

(Student textbook page 25)

Pedagogical Purpose

DNA molecules are shaped like long strands of a very thin, twisted ladder called a double helix. To fit into a small space, they coil and compact to form threads called chromatin. The chromatin are packed together tightly within the nucleus. The analogy that students act out in this activity allows students to better visualize the extent to which DNA will coil and condense to pass on the hereditary materials during cell division.

Planning		
Materials	Per group: box from a deck of cards	ball of string pictures of coiled and condensed DNA (optional)
Time	15 min in class 5 min preparation	

Skills Focus

- make analogies
- draw and justify conclusions

Activity Notes and Troubleshooting

- You could have pictures of coiled and condensed DNA available for students to examine.
- You could turn this activity into a friendly competition, challenging groups to get as much string as possible into their box. At the end, lengths of string could be measured with metre stick, or laid out on the floor to compare.
- To reinforce the analogy, students could complete a sentence starter such as: "The string we put into a box is like DNA in a cell's nucleus because _____." in as many ways as they can. Invite students to share some of their analogies with a classmate. Then invite pairs to select an analogy to share with the class.

Additional Support

- This activity will appeal to kinesthetic and logical-mathematical learners. If possible, ensure that groups include learners with strengths in both areas.
- ELL Once the instructions are explained, there are few language requirements in this activity. Encourage English language learners to participate fully, offering suggestions to the group as appropriate.

Activity 1.6 Answers

Answers may vary depending on the string used. Students might be surprised by how much string they can stuff into a box of cards!

Learning Check Answers (Student textbook page 25)

1. The new cells are identical to the original cells when a cell divides.
2. DNA is further condensed into coiled threads called chromatin because the chromatin are packed together tightly within the nucleus and they are conveniently packaged to pass on the hereditary materials once a cell divides.
3. DNA is packed together even more tightly into chromosomes when a cell divides because all hereditary materials are passed on during cell division and the nucleus must contain as much information as possible in order for the new cell to survive.

Activity 1.7 How is DNA replication like a game of "Telephone"?

(Student textbook page 27)

Pedagogical Purpose

When we consider the number of times that DNA replicates during a person's life, we can begin to appreciate that errors in DNA replication may occur. DNA replication is a truly amazing biological phenomenon. Consider the countless number of times that your cells divide to make you who you are—not just during development, but even now, as a fully mature adult. Then consider that every time a human cell divides and its DNA replicates, it has to copy and transmit the exact same sequence of 3 billion nucleotides to its daughter cells. While most DNA replicates with fairly high fidelity, mistakes do happen, with polymerase enzymes sometimes inserting the wrong nucleotide or too many or too few nucleotides into a sequence. Fortunately, most of these mistakes are fixed through various DNA repair processes. Repair enzymes recognize structural imperfections between improperly paired nucleotides, cutting out the wrong ones and putting the right ones in their place. But some replication errors make it past these mechanisms, thus becoming permanent mutations. These altered nucleotide sequences can then be passed down from one cellular generation to the next, and if they occur in cells that give rise to gametes, they can even be transmitted to subsequent generations. Moreover, when the genes for the DNA repair enzymes themselves become mutated, mistakes begin accumulating at a much higher rate. Students are given the opportunity to share a message within a larger group to appreciate that the message itself will change as it reaches a new messenger.

Planning	
Time	20 min in class

Skills Focus

- cooperate to conduct inquiries
- use models

Activity Notes and Troubleshooting

- Assign students to one of four groups. Each group should include at least six to eight students to allow for communication errors to occur.
- Suggest that students choose a fairly complex message to pass on.
- You could supply students with pictures that highlight how human DNA replication may be upset and how the body is able to restore the balance: mutations, inversions, crossovers, and reading errors.
- Use GIST. After the activity, have each student write a summary statement about what might have gone wrong (or right) with the information sharing and what it might illustrate about errors in DNA replication.
- Have students add a journal entry about any new information that they acquired in this activity.

Additional Support

- ELL Consider providing sentence starters for student summaries. For example, "When we whispered our message, the message at the end was _____ (the same as/different from) the message at the beginning. When DNA replicates, the information in the DNA is sometimes _____(the same as/different from) the information at the beginning. This is because _____."
- DI Consider having students illustrate errors in DNA replication in other formats, as well. For example, if students are asked to transcribe a long series of letters or numbers, perform a long series of dance steps, or place a set of objects in a certain order, errors will occasionally be introduced.

Activity 1.7 Answers

Answers will vary. The results of the game are an analogy to the errors in DNA replication. Just as the message that the students shared in their groups was likely changed between the first and the last person, errors are occasionally made during DNA replication.

Errors in DNA replication might affect the human body as mutations and cancers. Some might affect the body in a positive way, such as creating resistance to a disease, and some might not affect the body at all.

Learning Check Answers (Student textbook page 27)

1. Answers may in include two of the following reasons. Cells reproduce to replace cells that are growing too large, to produce new types of cells such as muscle, bone, or blood as the organism grows, and to repair and/or replace damaged or missing cells.
2. Flowcharts will vary. Charts should include DNA replication, the nucleus dividing during mitosis, and the entire cell dividing during cytokinesis.
3. Cell division occurs more often in a 4-year-old than in a 40-year-old because the child is growing quickly and the need for more cells through reproduction is greater. The adult also has a slower rate of cell division because older cells reproduce more slowly.

Activity 1.8 Cell Cycle Mnemonics (Student textbook page 28)

Pedagogical Purpose

Mnemonics are a useful tool that students can apply to remember things and to improve their study skills. In this activity, students are asked to compose a mnemonic that will describe the events in the cell cycle.

Planning	
Time	20 min in class

Skills Focus

- practise study skills
- use creative thinking

Activity Notes and Troubleshooting

- Students should work independently for this activity.
- Have students verbalize their mnemonics to the class or to a small group after they have written them. If students share in groups, invite groups to share one or two mnemonics with the class.
- Allow students to run the gamut in their creativity; do not critique their early attempts.

Additional Support

- DI If students are musically inclined, they may want to set their mnemonic to music.
- DI Some students may want to incorporate movement or actions into their mnemonic.
- ELL Be sure that English language learners understand the purpose of this activity. Provide examples of mnemonics helping someone remembersomething, such as the names of the planets, or the spelling a difficult word or name. Students could create a mnemonic in their first language.

Activity 1.8 Answers

Students mnemonics will vary, but should relate to the order interphase, prophase, metaphase, anaphase, telophase, and cytokinesis.

Learning Check Answers (Student textbook page 28)

1. interphase, mitosis, and cytokinesis
2. Main idea webs should include the following phases: prophase (the nuclear membrane disappears and DNA condenses into chromosomes), metaphase (chromosomes line up in the centre of the cell), anaphase (chromosomes split into two identical parts and each part is pulled to one end of the cell), and telophase (nuclear membranes reform, chromosomes begin to uncoil).
3. Both Figure 1.9 and Figure 1.10 show the cell cycle. Figure 1.9 shows how much time is spent in each of the two main stages. Figure 1.10 shows what happens in each stage in detail.
4. Predictions will vary. If a cell makes an error copying its DNA during interphase, then mutations, cancers, and polymorphisms can occur.

Activity 1.9 Comparing Cells (Student textbook page 31)

Pedagogical Purpose

In this activity, students will compare and contrast benign and malignant tumours with normal cells. The term *benign* refers to a tumour, condition, or growth that is not cancerous. This means it is localized and has not spread to other parts of the body or invaded and destroyed nearby tissue. In general, a benign tumour or condition is usually not harmful and benign tumours usually grow slowly. The opposite of a benign tumour is a malignant tumour. Malignant tumours are cancerous—the cells can invade and damage tissues and organs near the tumour. Also, cancer cells can break away from a malignant tumour and enter the lymphatic system or the bloodstream. This is how cancer spreads from the original tumour to form new tumours in other parts of the body. In this activity, students examine a photograph of cells, and compare and contrast cancer cells and normal cells.

Planning	
Materials	labelled drawings of normal and cancerous cells (optional) **BLM G-39 Cause-and-Effect Map** to **G-49 Venn Diagram** (optional)
Time	30 min in class 10 min preparation

Skills Focus

- make and record observations
- organize data
- collaborate with classmates to revise a product
- communicate in a variety of formats, using appropriate terminology

Activity Notes and Troubleshooting

- Have students work on their own to draft a graphic organizer, then work in pairs to share the information gathered and answer the questions.
- Students can complete a graphic organizer of their choice. Review Literacy Skills Toolkit 5, Organizing Your Learning: Using Graphic Organizers, on pages 412–417 with them, and discuss which organizers could be most effective to show similarities and differences. A Venn diagram or a table with rows labelled "shape," "size," and "colour" could work well, for example. Students can use one of **BLM G-39 Cause-and-Effect Map** to **G-49 Venn Diagram** to help them create the graphic organizer they choose to use.
- Invite students to present their completed graphic organizer showing similarities and differences to the class or to a small group.
- Use GIST. After they have completed their graphic organizers, students can develop a summary statement about the similarities and differences between cancer cells and normal cells.

Additional Support

- ELL Preview vocabulary that English language learners may find useful in completing this activity: large, small, round, irregular, and so on. Work with these learners to select and start their graphic organizer. Before recording anything, check that students can recognize the cancer cell and compare it to other cells. Talking first will help to generate the vocabulary needed to complete the activity.
  - Encourage English language learners to include labels for diagrams as part of their graphic organizers.

Activity 1.9 Answers

1.-2. Graphic organizers will vary, but should include these observations: All cells have nuclei. Normal cells are smaller, are more regular, and have smaller nuclei. Cancer cells are larger, are more irregular, and have larger nuclei.

Learning Check Answers (Student textbook page 31)

1. The cell cycle is regulated by a chemical system that involves chemical signals.

2. Cancer is unchecked cell division that occurs very quickly. Surrounding cells are damaged or destroyed as the cancer spreads in the body. Cancer may interfere with the function of other cells resulting in possible death if the tumour is not removed.

3. Cancer is more life threatening than a benign tumour because a benign tumour does not spread throughout the body but rather remains localized and cell division only occurs at a moderate rate. Benign tumours are usually relatively harmless unless they are located in the brain or a major organ.

Investigation 1A Observing the Cell Cycle in Animals

(Student textbook pages 32–33)

Pedagogical Purpose

Using prepared microscope slides of whitefish embryos that are in a period of rapid cell division provides students with an opportunity to manipulate appropriate scientific instruments in a laboratory setting. By creating scientific diagrams, students communicate their ideas in an appropriate format that allows them to analyze and apply prior knowledge.

Planning	
Materials	microscopes prepared slides of whitefish embryo cells prepared slides of human skin cells (optional) enlarged pictures of each stage of the cell cycle in whitefish embryo cells (optional) **BLM G-10 Parts of a Microscope** **BLM 1-15 Investigation 1A, Observing the Cell Cycle in Animal Cells** (optional) **BLM 1-16 Observing the Cell Cycle in Plant Cells** (optional)
Time	60 min in class 10 min preparation
Safety	Review correct microscope use with students. Remind students to handle glass slides carefully. Have students clean up any broken glass immediately. Remind students to make sure the microscope is turned off and their hands are dry before plugging it in. Caution students to unplug the microscope by pulling the plug not the cord.

Background

Review correct procedures for using microscopes with students. Whitefish embryos will allow students to easily manipulate the microscope slides to observe each stage of cellular division with relative ease.

Skills Focus

- gather data and organize and record results
- use appropriate techniques and operating equipment safely
- apply prior knowledge

Activity Notes and Troubleshooting

- Review Science Toolkit 4, Using a Microscope, on pages 348 and 349, and **BLM G-10 Parts of a Microscope** with students before beginning this activity.
- Have some demonstration microscopes set up with each stage in view so that students can see what they should be looking for. Beside each one, display an enlarged photograph of whitefish embryo cells at that stage.
- Work with students individually as they operate the microscopes; identification of the first stage is initially difficult for most students at the Applied level.
- Remind students not to touch the slide with the microscope lenses.
- You could supply students with **BLM 1-15 Investigation 1A, Observing the Cell Cycle in Animal Cells.**
- This investigation serves as a good review of the topic, and can be used to assess student learning.

Additional Support

- Assist students as necessary with focussing the microscope and identifying stages.
- DI Invite students to develop a dramatic re-enactment of the events in the cell cycle, then practice it and perform it for the class.
- Before students begin, work with them to identify the various structures in the enlarged pictures.
- Enrichment—Students can use **BLM 1-16 Observing the Cell Cycle in Plant Cells** to see how the cell cycle in animal and plant cells compares.

Investigation 1A Answers

What To Do

2. Drawings should resemble the cells at the bottom of page 33 and in Figure 1.10, on page 29.
3. Most of the cells will probably be dividing.

What Did You Find Out?

1. To determine whether or not a cell is dividing, look for evidence of chromosome movement, presence or absence of the nuclear membrane, the number of nuclei present, and the presence or absence of chromatin.
2. The easiest parts to identify and label will probably be the nucleus, the chromosomes, and the cell membrane.
3. Most of the cells in step 3 will be dividing because this is a whitefish embryo and much rapid cell growth and division is occurring.
4. Most of the cells on an adult whitefish slide would not be dividing because cell division decreases with age.

Inquire Further

Human skin cells would also show less cell division because of age. Hypotheses should relate the age of organism to the amount of cell division.

Activity 1.10 How Many Times Have You Shed Your Skin?

(Student textbook page 34)

Pedagogical Purpose

In this activity, students are given the opportunity to determine how often their skin has been replaced during their lifetime. By using a calendar and a calculator, students can manipulate the mathematical formula to determine this number. Since skin is replaced approximately every 28 days, students can determine the total number of days since their birth and find the number of times that their skin has been replaced.

Planning	
Materials	calculators **BLM 1-17 How Many Times Have You Shed Your Skin?** (optional)
Time	20 min in class 10 min preparation

Skills Focus

- analyze quantitative data
- communicate in a variety of formats, using appropriate units

Activity Notes and Troubleshooting

- Allow students to use calculators to complete the activity. Since most students in the class will probably be a similar age, you could work out part of the answer together to determine how many times they shed their skin before their 15th birthday, for example.
- Talk with students about some factors that might affect an organism's need to shed its skin. For example, snakes shed their skin as they grow and to rid themselves of parasites. A dry environment will cause our skin to shed more quickly. An interesting fact to share is that the majority of household dust is shed skin.
- Have students reflect on the findings of this activity—were they surprised?

Additional Support

- For students who require further support with the mathematics, provide **BLM 1-17 How Many Times Have You Shed Your Skin?** for a scaffolded version of the calculation.
- Encourage students to compare their answer to a classmate's to decide if it is reasonable. How different should the answers be? If possible, pair students who require mathematics support with students who have strong math skills.
- ELL Pair English language learners with students with strong English skills to help them understand the instructions. Alternatively, work with English language learners together in a group to help them understand what to do.
- Enrichment—Have students suggest factors related to human activity that have an impact on this biological process, such as the development of calluses and blisters. Recent newspapers and magazines or an Internet search might assist students in their search for human activities that affect the shedding of skin. If students use the Internet for this research, this would be a good time to talk with them about evaluating the accuracy and bias of sites they use.

Activity 1.10 Answers

What To Do

1. Answers should be between 184 and 209 times for students between 14 and 16 years of age.

What Did You Find Out?

1. Answers will vary.
2. This number is not exact because skin is not shed exactly every 28 days, a year has 365.25 days to account for leap years, and as we age this process slows down.

Activity 1.11 Cells Cycling Out of Control (Student textbook page 35)

Pedagogical Purpose

Some mutations cause a cell to ignore the chemical signals to stop dividing. In this activity, students will explore how such a mutation affects cell division in cancerous and non-cancerous cells.

Planning	
Materials	Internet access pictures of a variety of cell types indicating normal cells, mutated cells, and cancerous cells (optional)
Time	30 min in class 10 min preparation

Skills Focus

- gather, interpret, and analyze data
- draw conclusions based on data
- analyze sources for reliability and bias
- communicate in a variety of formats

Activity Notes and Troubleshooting

- See **www.scienceontario.ca** for a list of websites that include animations for student use.
- Review the structure of a paragraph: an introductory sentence that states the main idea, sentences that support the introductory sentence and provide details, and a concluding sentence.
- Encourage students to use what they learn in this activity as well as their graphic organizer from Activity 1.9 to write their paragraphs.
- Have students share their results and any concerns that might arise.

Additional Support

- ELL Consider providing sentence starters to help English language learners compare the types of cells.
- Consider pairing students with strong writing skills with others who require support for this activity.
- Enrichment—Encourage students to bring other information about the growth of cancerous cells to class. Invite a local speaker or cancer survivor to talk about cancer and how it affects the community.
- Enrichment—Students can complete **BLM 1-18 Factors that Affect the Development of Cancer.** They will learn more about these factors in Topic 1.5.

Activity 1.11 Answers

What To Do

2. Cell division in normal cells is different from cell division in cancerous cells. Normal cells divide at a normal rate as cells need to be repaired or replaced. When a normal cell mutates, the cell dies. Cancerous cells divide very quickly. The mutated cells do not die but continue to divide, producing uncontrolled cellular growth that can harm the organism. Cell division in normal cells is controlled and healthy for the organism; cell division in cancerous cells is uncontrolled and dangerous to the organism.

What Did You Find Out?

1. The cells in A and B are in cytokinesis.

2. During normal cell division when a mutation causes the cell to ignore a signal to stop dividing, the result is cell death.

Activity 1.12 Elephants and Cells Run Amok (Student textbook page 36)

Pedagogical Purpose

The analogy presented to the students here is of an elephant population that has skyrocketed and the death rate has decreased to zero. Students will then compare this unchecked elephant population growth with cancer cell division. They should be able to identify the devastation of the environment by the unchecked elephant population resulting in minimal food supplies such that the elephant population would eventually starve to death. Cancer cell division results in uncontrolled cellular growth that eventually also results in death. Students can then make informed decisions based upon their inquiry and research results.

Planning	
Materials	**BLM G-39 Cause-and-Effect Map** to **G-49 Venn Diagram** (optional)
Time	15 min in class

Skills Focus

- make predictions
- compare and contrast
- draw and communicate conclusions

Activity Notes and Troubleshooting

- Discuss with students what types of graphic organizers would help them compare unchecked elephant population growth with cancer cell growth.
- Make **BLM G-39 Cause-and-Effect Map** to **G-49 Venn Diagram** available to students to use for their graphic organizers.
- Invite students to share their comparisons with the class.
- Make consequence labels such as "Destroy the environment" and "Use all available resources." Have students place the labels on a graphic organizer on the chalkboard to simplify the compare and contrast process.
- Avoid leaving students with the impression that the world's elephant population is out of control. Although a few small groups of elephants may run amok, most elephant populations are at risk or endangered.

Additional Support

- Part or all of this activity could be completed as a whole class, creating a graphic organizer on large paper or on the chalkboard.
- You may wish to provide students with a format for their comparison. Consider distributing or displaying a table such as the following for students to record their work.

Unchecked Elephant Growth	Characteristic to be Compared or Contrasted	Cancer Cell Growth
	Effect on natural environment	
	Effect on other cells/organisms	
	Initial reactions to uncontrolled growth	
	Final result of uncontrolled growth	

- Use think-pair-share. Allow students to work with a classmate to prepare their graphic organizers, or to answer the What Did You Find Out? questions after they have drafted individual responses.

Activity 1.12 Answers

What To Do

1. Graphic organizers may vary. For example:

Unchecked Elephant Growth	Characteristic to be Compared or Contrasted	Cancer Cell Growth
Elephants destroy their habitat by overgrazing.	Effect on natural environment	Cancer cells form tumours and spread through the body, damaging the body.
Other animals do not have enough food or water and might die.	Effect on other cells/ organisms	Cancer cells use resources that other cells need.
Elephants eat crops, damage property, and crowd out other species.	Initial reactions to uncontrolled growth	A tumour forms; organism is in pain.
Elephants run out of food and die.	Final result of uncontrolled growth	Organism can die if cancer is not successfully treated. If organism dies, cancer cells die as well.

What Did You Find Out?

1. a) The elephant population would affect other plants and animals because food sources and habitats would be used up and destroyed by the rising elephant population and the food chains and food webs would be altered. When more resources were needed, the elephants would invade other territories.

b) Uncontrolled growth of cancer cells invades the surrounding tissues and organs, forcing them to seek new food sources and new habitats until they are also destroyed.

2. Food chains would be altered and organ systems would be stressed, and the stress in both scenarios could result in the destruction of other species or in organ failure.

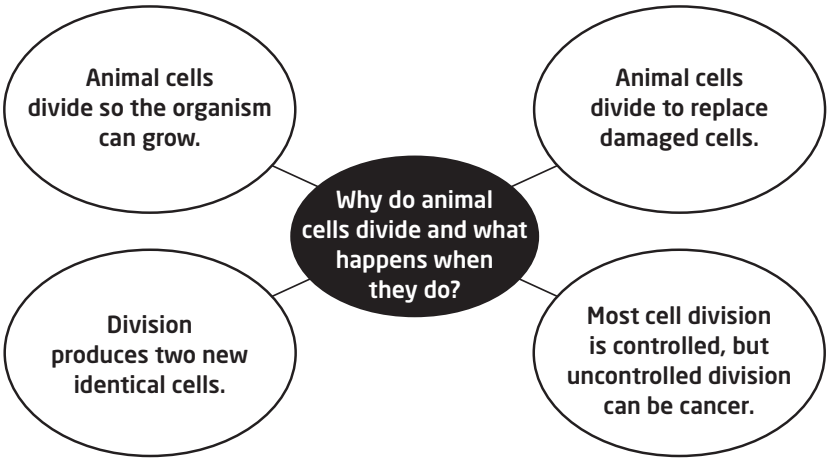
3. Answers will vary. For example, a computer virus grows uncontrollably, uses up memory, and invades other computer files.

Topic 1.2 Review (Student textbook page 37)

Please also see **BLM 1-19 Topic 1.2 Review (Alternative Format)**.

Answers

1. Answers may vary. For example:



2. After you are fully grown, your cells continue to divide because cells need to be repaired and replaced due to damage or stress.

3. Problems could include nutrients not reaching all parts of the cell, wastes not being properly removed due to the greater distance, and lack of communication with all cell parts. In most cases, the giant cell would begin to deteriorate and become damaged or age quickly. Also, it would be impossible for parts of your body to specialize if you were only one cell.

4. In cell division DNA provides all of the hereditary information for the two new identical cells produced.

5. DNA is replicated during interphase.

6. **Prophase:** During prophase, the nucleus and the membrane that surrounds the nucleus disappear and chromosomes form.

Metaphase: During metaphase, the chromosomes align in the centre of the cell.

Anaphase: During anaphase, the chromosomes separate and move to opposite ends of the cell.

Telophase: During telophase, the membrane surrounding the nucleus reforms, creating two new nuclei.

7. Evidence that some cells in the body are dividing could include repairing the skin after a cut, broken bones healing, fingernails and toenails growing, hair growth, changes in height or puberty changes.

8. The skin cancer may have been caused by over-exposure to the Sun or to UV tanning or to inappropriate hormonal changes. Cell division was involved because more than one cell is visible to the observer. Uncontrolled cell division caused the dark spot we see.

9. Answers may vary, but should include the negative effects of mutations on cells and organisms as well as the connection between cigarette smoke and mutations.