

B.C. Science **PROBE** 9

Teacher's Resource

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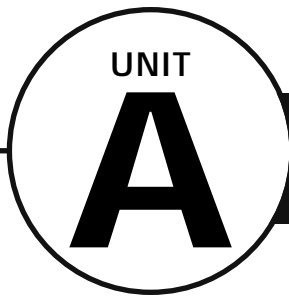
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Reproduction

Contents

Lesson Plans

Chapter 2 Cell Growth and Reproduction	1
2.1 The Importance of Cell Division	4
2.2 Cell Structures Involved in Cell Division	9
2.3 From DNA to Proteins	14
2.4 The Cell Cycle	21
2A Investigation: Observing Cell Division in Plants and Animals	26
2B Investigation: Determining the Rate of Cell Division in Plant and Animal Cells	30
2.5 Changes to a Cell's DNA	34
2.6 Cell Division and Asexual Reproduction	38
2.7 Explore an Issue: Beyond Dolly – Cloning Mammals	43
Chapter 2 Review	46
Chapter 2 Blackline Masters	
BLM 2.3-1 The Chemical Constituents of DNA	53
BLM 2A-1 Diagram of a Root	54
BLM 2.7-1 Cloning Using a Somatic Cell as a Source of DNA	55
Chapter 2 Blackline Masters and Worksheets Answer Key	56

Key Ideas	Vocabulary		
The functions of cell division are growth, repair, and reproduction.	nuclear membrane	daughter cells	carcinogen
DNA in the nucleus plays a key role in normal cell functions and in cell division.	DNA	mitosis	sexual reproduction
The cell cycle includes the normal cell functions and cell division.	nucleolus	cytokinesis	zygote
Mutations in a cell's DNA can cause diseases, including cancer.	nucleotide	prophase	asexual reproduction
Some organisms reproduce asexually through cell division.	nitrogenous bases	spindle	clones
	amino acids	metaphase	binary fission
	gene	anaphase	budding
	genome	telophase	vegetative reproduction
	traits	mutation	fragmentation
	cell cycle	cancer	spores
	interphase	benign tumours	
	sister chromatids	malignant tumours	
	parent cell	metastasis	

Science Skills and Processes	Intro	2.1	2.2	2.3	2.4	2A	2B	2.5	2.6	2.7
Inquiry Skills										
Questioning										
Hypothesizing						✓	✓			
Predicting	✓	✓				✓	✓			
Planning										
Conducting				✓		✓	✓			
Recording	✓	✓		✓		✓	✓			
Analyzing		✓				✓	✓			✓
Evaluating						✓	✓			✓
Synthesizing						✓	✓			
Communicating					✓	✓	✓			✓
Additional Inquiry Skills (Try This Activity)										
Controlling Variables										
Creating Models					✓					
Observing	✓			✓	✓					
Estimating										
Measuring	✓			✓						
Classifying										
Inferring										
Interpreting Data				✓						

Language Arts Connections

In science, names are assigned by the people who discover something new. When nucleic acids were discovered, they were thought to exist only in the nucleus of a cell, hence the name “nucleic acids.” We now know that nucleic acids are found in some organelles, but the name has not been changed to reflect this new knowledge.

TEACHING NOTES

- Have students look at the photograph of a blue whale. Discuss the wide range in the sizes of living things, both between species and among the members of a species, and the variations in the rates at which different types of plants and animals grow.
- Use the questions in the text to activate prior knowledge about cells. Prompt students, as needed, with questions such as the following:
 - *What are cells?* (what living things are made up of)
 - *Are there living things that aren't made up of cells?* (no)
 - *Are cells the same as molecules?* (No, a cell contains many molecules.)
 - *What does a cell look like?* (a little compartment surrounded by a membrane)
 - *What is the nucleus of a cell?* (the control centre of the cell)
 - *Are all the cells in your body the same?* (No, there are different types of cells. Some types of cells are more abundant than others. Cells have many functions. A main purpose of a cell is to organize.)
 - *Are plant and animal cells the same?* (All cells are similar. All cells have a nucleus. Animal and plant cells are similar in some ways and different in other ways; for example, plant cells can make their own food; also, plants have a thick cell wall.)
 - *What is photosynthesis?* (the process by which plants transform light energy into chemical energy)
 - *Where do cells come from?* (All new cells arise only from cells that already exist.)
 - *What is DNA?* (the genetic material of the cell; the “construction plans” for all the pieces of the cell)
 - *In what part of the cell is DNA found?* (in the chromosomes inside the nucleus)
 - *Why is DNA important in solving crimes?* (Each individual's DNA is unique.)
 - What is a mutation? (a change in the DNA of the cell that may have either a beneficial, harmful, or neutral affect on the organism)
- Have students complete Steps 1 and 2 of **Try This:** Replacing Cells.
- Put a potato in a moist, dark location to sprout. This will be used in Section 2.6.
- Have students who need additional support with reading use the scaffolding masters provided for each section.
- You can use the *Chapter 2 Study Guide Outline* and the key question on each scaffolding master, found in the Student Workbook, to review the ideas in the section.
- You can use any or all of the following BLMs to help students study the vocabulary in this chapter.
 - <BLM to be provided in the final version of this resource>
- To assess students, you may want to use or adapt <Rubric to be provided in the final version of this resource>.

TRY THIS: REPLACING CELLS

Purpose

- Students observe that skin cells are replaced as they are shed, but that different regions shed skin at different rates.

Notes



Student Safety

Be sure students are not sensitive to the ink used. This is rare, but students should be cautioned.

- Have several colours of permanent marker, to give students a choice (the same colour must be used for both dots on a given student).
- Instead of the dot suggested in the activity, allow students to give themselves small "tattoos" in the specified locations, with the proviso that the design should be the same on both the back and palm of the hand.
- Permit students to apply the same dot or design to one other location (e.g., back of neck, upper arm, leg) to allow for further comparisons.
- Caution students not to scrub the dots or wash one more than another. (Students should maintain personal hygiene.)
- Students should continue to take observations until the first dot (the one on the palm) has disappeared.
- Have students design a data table in which to record their daily observations. Discourage the use of disorganized notes to record data.
- Students may predict that all spots will fade at the same rate. After all, skin is skin. Or, they may choose one spot over the other. Reasons may include the fact that the palm is more protected, or that the palm has more sweat glands.

Suggested Answers

- A.** The palm should fade faster, because the palm of the hand is used for lifting and carrying, so the cells are wearing out faster than those in a region of the hand that is rubbed against other surfaces less often. This should also be true if students mark another spot, unless it is a region that gets a lot of wear, like the sole of the foot.

Technology Connections

Have students use the Internet and other sources to research cell regeneration (i.e., which type of cells regenerate fastest, what factors promote/limit regeneration, how understanding of cell regeneration is used in medicine).

ESL

- Ask the same question in more than one way, using simple, common words where possible.
- Students come from a variety of educational backgrounds; use their responses to assess which concepts may need reinforcing.

Extra Support

- When asking a leading question, break it down into smaller steps to help students make connections and guide them to an answer.

Extra Challenge

- Expand the Try This activity to include more areas of the body. Have students predict the order in which the dots will disappear and continue to make observations until the last dot has faded. They can then compare the predicted order with the observed order.

Meeting Individual Needs

Time

40–50 min

Key Ideas

The functions of cell division are growth, repair, and reproduction.

Skills and Processes

Predicting
Recording
Analyzing

Lesson Materials**per student**

- scientific calculator

Program Resources

SM 2.1 The Importance of Cell Division
WS 2.1-1 Try This: From One Cell to Trillions
Nelson Science Probe 9 website
www.science.nelson.com

Related Resources

The Visual Dictionary of the Human Body.
Scarborough, ON:
Thomson Nelson, 1991.

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- represent and interpret information in graphic form
- demonstrate scientific literacy

KNOWLEDGE

- type(s) of reproduction

SKILLS AND ATTITUDES

- apply the relationship between scientific principles and technology
- communicate results
- use appropriate types of graphic models and/or formulae to represent a given type of data
- use tables and diagrams to extract and convey information
- deduce relationships between variables

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools

SCIENCE BACKGROUND**Cell Differentiation**

- In most multicellular organisms, not all cells are alike. For example, the cells that make up the human skin are different from those that make up the inner organs. Yet all of the different cell types in the human body are derived from a single fertilized egg cell through "differentiation." Differentiation is the process by which an unspecialized cell becomes specialized into one of the many cells that make up the body, such as a heart, liver, or muscle cell. During differentiation, certain genes are turned on, or become activated, while other genes are switched off, or inactivated. This process is intricately regulated. As a result, a differentiated cell will develop specific structures and perform certain functions. Differentiation can involve changes in numerous aspects of cell physiology.

Cell Division and Replacement

- In bacteria, all the instructions come from a single closed loop of DNA. Each cell can divide in 20 min and,

given suitable conditions, can keep dividing to produce 5 billion cells in 11 h. Cells of this type produce some 400 different proteins, by chemical reactions working at the rate of 100 per second. This is why diseases such as meningitis and food poisoning can attack a person so quickly. Bacteria reproduce so rapidly that it is unlikely that just one cell will be present; you are more likely to see a group or colony of them.

- Some human cells are frequently replaced by new ones and other cells are rarely duplicated. Cells in the stomach lining are replaced approximately every 5 days; the surface cells of skin, about every 4 weeks; and liver cells, every 6 weeks. Hair, skin, and fingernails are replaced constantly and at a rapid rate throughout our lives. In contrast, brain and nerve cells in the central nervous system are rarely produced after we are a few months old. Subsequently, if they are destroyed later, the loss is usually permanent, as in the case of

paraplegics. Liver cells usually do not reproduce after an individual has finished growing and are not replaced unless there is an injury. Red blood cells are also an exception. While they are being constantly produced in our bone marrow, the specialized cells from which they come do not have nuclei, nor do the red blood cells themselves.

- Liver tissue can be transplanted and will reproduce in the recipient of the

transplant and regenerate in the donor's body. Recent advances in the study of spinal cord injuries are showing some success with spinal neurons regenerating; this does not appear to happen under normal circumstances. Other nerve cells do regenerate; many people have burned their tongue with hot drinks and lost their sense of taste until their taste buds (gustatory nerves) have regrown.

At Home

Have students ask their parents what they remember about cell division from high school.

TEACHING NOTES

1 Getting Started

• Possible Misconceptions

- *Identify:* Some students may believe that they started life fully formed, but smaller, rather than starting life as a single cell.
- *Clarify:* Remind students that a sperm and egg fused to produce a cell that became them. Students will be aware that both parents contribute to the formation of a child.
- *Ask What They Think Now:* Ask, *How did you go from being a single cell to the multicellular being you are today?* (cell division)

2 Guide the Learning

- Discuss with students the Preview, Scan, and Read strategy described in **Strategies for Success**. Have them use this strategy and the **Reading and Thinking Strategy** of paraphrasing as they read this section.
- Announce to students that you are going to draw a picture of each of them. Draw a small dot on the blackboard, asking if it is a good likeness. Clarify that the picture you have drawn is of them approximately 13 years ago (depending on the age of the students). Ask how they have changed (answers should include size increase, number of cells, and possibly type of cells). Then have students complete **Try This:** From One Cell to Trillions.
- You could briefly discuss the following characteristics of science (introduced in Chapter 1) in the context of cells and cell division:
 - Science starts from observations that lead to questions.
 - Scientific knowledge comes from observation.
 - Scientific knowledge is tentative but reliable.
 - Science is progressive.

Language Arts Connections

Students could brainstorm pairs of words with the prefixes *uni-* and *multi-* and compare the words, meanings (e.g., unicellular and multicellular, unilateral and multilateral, unichrome and multichrome, unidimensional and multidimensional).

TRY THIS: FROM ONE CELL TO TRILLIONS

Purpose

- Students demonstrate the effects of exponential growth.

Notes

- Students should be familiar with using tables to determine pattern rules. Guide students to see that each generation is double the size of the previous one, and to develop the equation $y = 2^n$, where y represents the number of cells and n represents the number of divisions.
- Students first work with powers in Grade 9 mathematics; they may not have studied them yet when this lesson is taught.
- Have students estimate the size of the population after 25 divisions before using repeated multiplication on a calculator to calculate the answer. Students can record their work on *WS 2.1-1 Try This: From One Cell to Trillions*.
- Similarly, have students predict how many cell divisions will be needed to make about 1 trillion cells and then use a calculator to determine the answer, recording their work on *WS 2.1-1 Try This: From One Cell to Trillions*, using scientific notation.

Suggested Answers

A.

Table 1

Number of divisions	Number of cells
0	1
1	2
2	4
3	8
4	16
5	32

The number of cells for a given number of divisions is the number of cells in the term before times two. This pattern can be represented by the equation $y = 2^n$, where y represents the number of cells and n represents the number of divisions.

- B. After 25 cell divisions, there would be $2^{25} = 33\,554\,432$ cells.
- C. It will take 40 cell divisions to produce more than a trillion cells ($2^{40} = 1\,099\,511\,627\,776$ or 1.1×10^{12}).

Math Connections

Students can graph the results of the Try This activity. Have them label the number of divisions on the x -axis. Students could compare $y = 2^n$ to other exponential functions. For example, students can produce a data table and graph with each division producing 3 cells. Students can also compare exponential to linear growth. There are likely other interesting human growth functions they could graph over time, such as height/age. Students can explore the relationship between surface area and volume for various rectangular prisms and other 3-D shapes; e.g., how the same volume can have a variety of surface areas, and how to maximize the surface area to volume ratio.

3 Consolidate and Extend

- Have students complete the **Check Your Understanding** questions in pairs or small groups, and then discuss the questions as a class, guiding students to activate prior knowledge about cells and the human body and connect it with the concept of cell division.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. Cells divide to repair damaged or worn-out cells, to increase the number of cells so the organism can grow, and for reproduction.
2. Cell division increases the number of cells, making the organism larger.
3. Cell reproduction could repair/replace damaged nerve cells.
4. Skin cells wear out faster than other cells because they experience more wear and tear.
5. Cells inside the mouth and bone marrow cells that produce new blood cells are examples of regions with rapid cell divisions.
6. It takes a long time to add muscle to a body or heal broken bones.
7. **(a)** repair **(b)** repair/regeneration **(c)** reproduction **(d)** growth
8. Red blood cells last about four months, so everybody's blood is about the same age.
9. Skin cells wear out faster than muscle cells. Muscle cells are more specialized than skin cells so do not divide as fast.
10. Not all cells undergo division; red blood cells do not reproduce, and the cells of the brain and spinal cord (CNS) do not reproduce under normal circumstances.
11. As a cell grows, the volume of cytoplasm increases at a greater rate than the surface area of the cell. Once a cell grows beyond a certain size, it cannot function efficiently.
12. As in question 11, there is a limit to cell size. A large organism has more cells, not bigger cells.
13. Bacteria and yeast use cell division for reproduction.
14. After 6 divisions, 12 cells would become 768 cells.

Paraphrase

- Read the section heading and the first two paragraphs with students.
- Explain to students that when paraphrasing a section of text, they first need to decide what are the important (main) ideas and then rephrase the ideas in their own words in a condensed form.
- Arrange students in pairs. Have them read the subsections in *Functions of Cell Division*, pausing after each subsection to restate or paraphrase what they have read.
- Conclude by asking students to note the similarities and differences in their rephrasing.

Reading and
Thinking Strategies

Summarizing and Making Notes

- Knowing how to read informational text is an important part of summarizing and making effective notes. Discuss with students how using a three-step reading system—Preview, Scan, and Read (PSR)—will improve the effectiveness of their reading. Using this system, students preview the reading selection to look at headings, subheadings, and figure captions. Then they scan each section, noting key ideas and words highlighted in bold. Finally, they read the section carefully and thoughtfully, making notes as they go. Conclude by asking students how this three-step system helps them read more effectively.

Strategies for Success

ESL

- Explain how terms such as *multicellular* and *unicellular* are “built up” from smaller words.

Extra Support

- Model the correct use of the calculator during **Try This**: From One Cell to Trillions to guide student calculations.
- Describe the photographs to support auditory learners.
- Encourage students to use a dictionary to help them avoid confusing meanings of a word they may know with the new meaning (e.g., *division* may be known from math but is used differently in biology).

Extra Challenge

- Challenge students to use graphing software to answer Try This question C.
- Students can use the Internet to research the work of Virchow, Schleiden, Schwann, Hooke, Pasteur, and van Leeuwenhoek to discover the knowledge contributed by each to what became the Cell Theory.

ASSESSMENT FOR LEARNING**What To Look For in Student Work**

Evidence that students can

- explain the significance of cell division
- identify the main points in a science-related photograph
- calculate the number of cells after several divisions
- identify and use the most appropriate type of formula to convey information (rate of cell division)
- extract information (a pattern/relationship) from tables

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- represent and interpret information in graphic form

KNOWLEDGE

- contents of the nucleus

SKILLS AND ATTITUDES

- communicate results
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- use appropriate types of graphic models to represent a given type of data

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

Time

30–40 min

Key Ideas

The cell cycle includes the normal cell functions and cell division.

Vocabulary

- nuclear membrane
- DNA
- nucleolus
- centrioles

Program Resources

SM 2.2 Cell Structures Involved in Cell Division
 WS 2.2-1 Animal Cell and Plant Cell
 WS 2.2-2 Comparing a Plant Cell to a Factory
 Nelson Science Probe 9 website
www.science.nelson.com

SCIENCE BACKGROUND

Cell Types and Structures

- Although organisms appear to be drastically different from one another, all cells have basically the same features and carry out the same chemical processes as limited by their organelles. The biggest difference (at this level) is the ability of plant cells to perform photosynthesis, determined only by the presence of chloroplasts. (Later, students will learn that mitochondria are necessary for aerobic respiration.)

Chromosome Numbers

- More complex organisms do not necessarily have more DNA. It should be noted that much of an organism's genome does not code for anything: not all DNA is genes. Older books called this "junk DNA"; this term is falling out of favour and the material is now called *non-coding*

DNA. Some organisms (plants) may have multiple copies of genes or chromosomes. Giant strawberries, for example, come from such polyploid plants. In humans, extra chromosomes can cause serious health problems (Down syndrome results from the presence of 1 extra chromosome [21] in most cases).

Chlorophyll

- Chlorophyll looks green because it absorbs red and blue light, making these colours unavailable to be seen by our eyes. The green light, which is not absorbed, finally reaches our eyes, making chlorophyll appear green. However, the energy from the red and blue light is absorbed and is thereby available for photosynthesis. The green light we can see is not/cannot be absorbed by the plant and thus cannot be used in photosynthesis.

Related Resources

Discovering the Cell (video and TR). Oakville, ON: National Geographic Society, School Publishing, 1992.

TEACHING NOTES

1 Getting Started

• **Teacher Demo**

Project or display a large photograph of a modern city (preferably students' own, if applicable).

- Point out a hospital, grocery store, mall, industrial region, and so on (as appropriate); students can help with this, depending on their knowledge.
- Ask a question such as, *Why does a city have this variety?* (There are many different types of jobs; related jobs are grouped together for efficient communication and collaboration.) Or ask *Why don't you go to the hospital to get your car repaired?* (Specialized jobs need to be done by specialists.)
- Have students consider the human body and ask, *Which organs are most important?* Once again, elicit the concept of specialization.

• **Possible Misconceptions**

- *Identify:* Students may think of cells as simple and not needing specialized structures, although they will accept the complexity of multicellular organisms.
- *Clarify:* Explain that, in bacteria, chemical reactions take place almost anywhere within the cell, but in animal and plant cells, specific functions, such as making protein, converting energy, and transporting proteins and fats, are carried out by specialized structures called *organelles*. All the parts of a cell work together as a system, communicating and linking with each other.
- *Ask What They Think Now:* Ask, *In an orchestra (or team), who is the most important player? What is the most important career? Who is the most important person in a family?* (The response that no one player, job, or family member is more important will demonstrate understanding.) These questions can be modified to match school and/or community interests.

2 Guide the Learning

- Have students use the **Reading and Thinking Strategy** as they read this section, to help them understand the diagrams and remember new words.
- Have students prepare a chart with two columns, labelled “Part of the cell” and “What it does” or “Function.” Then:
 - Have students read the first two paragraphs and look at Figures 1 and 2. Have them locate the cell membrane in both cells. Guide students to recall that all cells have this boundary membrane, which holds the contents of the cell in place (a little like a plastic bag holds the things inside it) and acts like a gatekeeper, controlling the movement of materials, such as nutrients and waste, into and out of the cell. In animal cells, the cell membrane consists of a double layer of fat molecules (bilipid layer). Plant cells also have a distinct rigid cell wall. Have students record this information in their chart.

Art Connections

The diagrams of cells in this section are cross-sections—plane sections of 3-D objects cut at right angles to their length to show the interior of the object. The shapes of the cell structures are simplified and stylized. Students can explore techniques for drawing cross-sections and for simplifying drawings to better communicate the most important information. They can consider how colour, line, and shading can each be used to enhance the representation and improve communication.

- Next, have students locate a *mitochondrion*. Recall that mitochondria are circular or rod-shaped organelles. They are often referred to as the power plants of cells. They provide cells with energy that is used in almost every other function of the cell. Plants also have chloroplasts, which use chlorophyll to convert sunlight energy into carbohydrates. Have students record this information.
 - Have students continue reading the text and summarizing the functions of the organelles in the chart. Guide the class to focus on those structures that are involved in cell division.
 - If students do not recall from Grade 8 the functions of the golgi complex, vesicles, lysosomes, and the vacuole, you may want to briefly review these cell structures. You might note that a vacuole is often considered the plant equivalent of a lysosome in animal cells because of its ability to break down large molecules, but vacuoles also have distinct functions of contributing to the rigidity of the plant and processing and storing waste.
 - Note that when the cell is not in the process of cell division, the chromosomes are found arranged in the nucleus and appear as a network of long, thin threads, called *chromatin*.
- Distribute copies of *WS 2.2-1 Animal Cell and Plant Cell*. Have students label these diagrams, using the text as a guide.
 - Have students use the **Strategy for Success** to consolidate their learning for this section, and then have students complete the **Check Your Understanding** questions.

3 Consolidate and Extend

- Have students build a 3-D model of the cell, using common objects such as marbles, pipe cleaners, thread, plastic bags, and so on.
- Have students write a comparison of a cell to some organization (such as a city, province, corporation, etc.), showing the parallels between the cell and the organization (e.g., the nucleus is equivalent to city hall, the mitochondrion is the gas or electric company).
- Have small groups of students use the Internet and other sources to research and report back to the class on each of the cell parts listed, providing more detail about their function.

At Home

Distribute copies of *WS 2.2-2 Comparing a Plant Cell to a Factory*. Have students complete this at home, by combining their knowledge of a cell with a parent's or relative's knowledge of factory operation.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. Both the cell membrane and nuclear membrane control what can go in and out.
2. The nucleus is the control centre of the cell and contains the chromosomes (or DNA). The nucleolus does not control the cell and contains only the materials needed to make ribosomes. (Some students may also note that the nucleus is surrounded by a membrane; the nucleolus has no membrane.)
3. The main structures found in the nucleus are chromosomes and the nucleolus.
4. The materials used to make ribosomes are found in the nucleolus.

5. Ribosomes can be found in the cytoplasm or attached to rough endoplasmic reticulum (rough ER).
6. Materials are transported in the canals of the endoplasmic reticulum, in the cytoplasm, and by microtubules.
7. Rough endoplasmic reticulum has ribosomes attached to its membrane; smooth ER has no ribosomes.
8. Chromosomes are made of DNA.
9. Humans have 23 pairs of chromosomes in most cells.
10. The DNA molecule is shaped like a twisted ladder (double helix).
11. DNA is located in chromosomes, which are located in the nucleus.
12. A: chromosomes, B: nuclear membrane, C: cytoplasm
13. Plant cells have a cell wall, but animal cells do not. (Note that both have a cell membrane.) Plant cells (often) have a large vacuole; animal cells do not. Plant cells (may) have chloroplasts; animal cells do not. Animal cells have centrioles; plant cells do not.
14. (a) Centrioles are found in animal cells.
(b) Centrioles are most active when the cell is dividing.
(c) Centrioles are made up of special microtubules.
15. A: cell wall, B: chloroplast, C: nucleus, D: rough endoplasmic reticulum, E: mitochondrion
16. Chromosomes are located in the nucleus.
17. Nutrients are absorbed and transported in the cytoplasm.

Reading and
Thinking Strategies

Analyze a Diagram/Determine the Meaning of Scientific and Technical Terms

- Ask students to read the Learning Tip on page 39. Have them look at the caption in Figure 1 (b), and set a purpose for reading the diagram (to learn about the structure of animal cells).
- Discuss the strategy of scanning with students (locate facts or words in a text by moving eyes quickly down the page). Ask them to scan pages 39 and 40 and look for words in bold.
- Reinforce the strategies students could use to remember new words, eliciting that one way is to identify the link between the words in bold, the related information in the text, and the diagram.
- Arrange students in pairs. Have one student explain to the other the structure of animal cells using the labels in Figure 1 (b), the words in bold, and the related information in the text. Suggest they start with the nuclear membrane and nucleus and read clockwise.
- Conclude by having students explain how the nucleus and the nucleolus are different.

Strategies for Success

Summarizing and Making Notes

- Students who can effectively summarize learn to synthesize. Synthesizing is an important literacy skill. Have students work in pairs to write a definition of a summary and to think of examples when a summary could be used. Possible definitions include the following: a summary takes a larger section of text and reduces it to its bare essentials; it is a shorter version of the original text that keeps the main

message; it includes only the main points of a passage; it reduces a passage to its key ideas. Uses for summarizing include pulling out the main ideas, breaking down large chunks of text into smaller parts, and making succinct study notes. Conclude by having students share their definitions and examples with each other.

ESL

- Sound out new vocabulary to help with pronunciation.
- Encourage the use of a dictionary to improve understanding of subject-specific words (i.e., word structures).

Extra Challenge

- Have students use the Internet and other sources to research the structure of the cell membrane and the structure of the nuclear membrane. Students will find that the structures of these two types of membrane are almost the same. You can then extend this concept to include all cell membranes and the “lipid bilayer with embedded proteins” model. Students can then share the information they located through oral or written reports or a multimedia presentation (i.e., a PowerPoint presentation). After students have presented their information, ask them how they think their presentation approach impacted the audience’s understanding of the information.
- Students can compare the chemical reactions performed by the mitochondrion and the chloroplast, noting how one reflects the other.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- identify the main cellular organelles and their functions
- identify the contents of the nucleus (chromosomes, DNA, nucleolus, etc.)

Time

50–70 min

Key Ideas

DNA in the nucleus plays a key role in normal cell functions and in cell division.

Vocabulary

- nucleotide
- nitrogenous bases
- amino acids
- gene
- genome
- traits

Skills and Processes

Conducting
Recording
Observing
Measuring
Interpreting Data

Lesson Materials

per class

- large 3-D model of DNA

per student

- calculator

Program Resources

SM 2.3 From DNA to Proteins
BLM 2.3-1 The Chemical
Constituents of DNA
Nelson Science Probe 9
website
www.science.nelson.com

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- represent and interpret information in graphic form

KNOWLEDGE

- relationship between genes and proteins
- application of scientific principles in the development of technologies
- metric system (SI units)

SKILLS AND ATTITUDES

- make accurate measurements using a variety of instruments
- communicate results
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools

SCIENCE BACKGROUND

Proteins and Amino Acids

- Ribosomes produce proteins.
- All proteins are made up of the same 20 amino acids.
- Digestion breaks down proteins into amino acids; human amino acids are the same as those of a chicken, a cow, or a peanut.
- The cytoplasm contains processed nutrients (such as amino acids).
- The sequence of amino acids determines the characteristics of the protein; the source of the amino acids does not.

Inherited Genetic Traits

- If a genetic trait is dominant, a person only needs to inherit one copy of the gene for the trait to be expressed. Of the genetic traits listed in **Try This:** Human Traits Survey, the following are dominant: free earlobes, no hitch-hiker's thumb, mid-digital hair, dimples in face (in children), and widow's peak. This does not mean these traits will appear in the majority of individuals in a sample.

- If a genetic trait is recessive, a person needs to inherit two copies of the gene for the trait to be expressed.
- It is possible for both parents to have one inherited trait and their child to have another. For example, it is quite possible for two parents with brown eyes to have a blue-eyed child, or for two parents who cannot roll their tongue to have a tongue-rolling child. There are a number of reasons this can happen. Sometimes genes also need environmental triggers before a trait will be seen, so you could have the gene but not the trait. Sometimes you need two or more different genes to see a trait, so parents that each have only one of the necessary genes might not show the trait, but if they each pass on one of the needed genes to their child, he or she could have the trait. There are also genes called *modifier genes* that can turn genes on and off, and these can affect whether or not an inherited trait appears. As well, some genetic traits skip generations.

- Studies of families and twins have not provided clear evidence for a genetic involvement in human handedness variation. Handedness may arise from the same developmental mechanisms that produce left-hemisphere language processing in most people. However, recent research suggests that relative hand skill is influenced by at least one genomic region. Humans have a 90% preference for right-handedness.
- It was long thought that tongue rolling is genetically inherited. However, there is also evidence of a learned basis. The issue is unresolved. One possibility is that you can learn to tongue roll with practice, but you need to carry the gene in order to succeed. Between 65%–80% of individuals can roll their tongue.

Related Resources

Cronkite, Donald. *Cells and Heredity*. Don Mills, ON: Pearson Education Canada, 2004.

TEACHING NOTES

1 Getting Started

• Possible Misconceptions

- *Identify*: Students often think that human proteins are special in some way and that we make these proteins from food, without thinking about what that means.
- *Clarify*: Students are familiar with recycling. The reuse of amino acids can be considered in a similar way (at this level). Protein in food is broken down into amino acids during digestion and the amino acids are built into “human proteins” using the DNA code.
- *Ask What They Think Now*: Ask, *If you eat a lot of chicken, would a doctor be able to find chicken protein in your muscles, or anywhere else in your body?*

2 Guide the Learning

- Have students use the **Reading and Thinking Strategy** of visualizing as you begin this section.
- If possible, display a large 3-D model of DNA while you explain DNA structure. Refer to *BLM 2.3-1 The Chemical Constituents of DNA*. This works well as a transparency to help students learn the component parts of the DNA molecule on the master.
- Have students complete **Try This**: Measuring Your DNA to gain an appreciation of the amount of genetic information in a human cell.
- As a class, complete **Try This**: Human Traits Survey to illustrate a few of the variations found in humans.
- See the additional information in **Awesome Science**: Using Mitochondrial DNA to Solve Mysteries on Student Book page 48 (teaching notes on page 20).

Math Connections

Once students know there are 20 amino acids that DNA codes for, have them calculate the number of "two-letter" possibilities using the four DNA bases (GG, GC, GA, etc., or 4×4). When they do the same for the "three-letter" words (GGG, GGC, GGA, etc., or $4 \times 4 \times 4$), they get 64. These "three letter words" are called codons. Discuss how all 64 codons are used.

TRY THIS: MEASURING YOUR DNA

Purpose

- Students calculate the total length of the DNA in an average human body and gain an appreciation of the amount of coded information each individual carries.

Notes

- Have students make up word equations to guide their calculations; discourage the practice of putting numbers into the calculator without a clear understanding of the specific reason.

Suggested Answers

- A.** The DNA for 1 human cell measures 2 m.

There are 1×10^{14} cells in the human body.

The combined length of all the DNA in the human body equals the length of the DNA in 1 cell times the number of cells in the body.

Length of all DNA from one person = $2 \times 1 \times 10^{14}$ m = 2×10^{14} m = 2×10^{11} km.

The distance from Earth to the Moon is about 380 000 km = 3.8×10^5 km.

So the distance from Earth to the Moon and back is $2 \times 3.8 \times 10^5$ km.

The number of times the DNA from one person would stretch from Earth to the Moon and back again is the total length of the DNA divided by the total round-trip distance.

$$\frac{2 \times 10^{11} \text{ km}}{2 \times 3.8 \times 10^5 \text{ km}} = \frac{1 \times 10^6}{3.8} = 2.6 \times 10^5 \text{ times.}$$

TRY THIS: HUMAN TRAITS SURVEY

Purpose

- Students observe a number of traits that can be studied by simple observation and compare the number of individuals in a sample who have the trait to the total number of individuals.

Notes

- Observe students before this activity and try to identify one person who has each of the traits listed. If no one in the class has the trait, use photographs to show what the trait looks like.
- Stress that the traits observed are a result of genes that are smaller sections of the 2 m of DNA found in every body cell.
- Review the traits with students, pointing out or describing the appearance of each trait. Then have students draw Table 2 in their notes.
- Students may need to be reminded of how to write a ratio. You may want to briefly review part:part and part:whole ratios, reminding students that a part:whole ratio can be written as a fraction or percent (e.g., if $\frac{5}{25}$ have a trait, $\frac{5 \times 4}{25 \times 4} = \frac{20}{100}$ or 20% have the trait).
- If students will be comparing their results with those of another class and then combining the data, ensure students understand that, to calculate combined ratios, they must combine both the parts and the wholes (e.g., 2:3 combined with 4:5 gives a ratio of 6:8).
- You may want to discuss the idea of validity in experiments as it relates to the amount of data collected or the size of the sample.
- Mid-digital hair is hair appearing on the middle section of any finger.

Suggested Answers

A. Students' data will vary. Their completed table should resemble the following:

Trait		Present	Number of students	Ratio
Earlobes	free	15	25	15:25
	attached	10	25	10:25
Thumb shape	hitch-hiker	6	25	6:25
	straight	19	25	19:25
Tongue	can roll	16	25	16:25
	cannot roll	9	25	9:25
Mid-digital hair	hair present	14	25	14:25
	hair absent	11	25	11:25
Dimples on face	present	22	25	22:25
	present	3	25	3:25
Hairline	widow's peak	13	25	13:25
	straight	12	25	12:25

- B. Predominance of traits in a sample will vary.
- C. The ratios would likely be different, because different individuals have different genes.
- D. Student answers may resemble the following: for example, in the other class, more students had face dimples, could roll their tongue, and had straight thumbs, but fewer had free earlobes, hair on the middle of digits, and a widow's peak.
- E. Combined ratios will vary depending on the data collected.
- F. Patterns will vary depending on the data collected. It is likely that more students will have dimples and more will be able to roll their tongue. Free earlobes, straight thumbs, hair on the middle of digits, and a widow's peak occur more frequently in populations, but there will be wide variation in small samples.

Technology Connections

Have students use a computer-based graphing program to create a variety of different types of graphs to show the typical distribution patterns of traits that can be studied by simple observation (e.g., attached/detached earlobes). Encourage students to discuss which type of graph is most effective in presenting the information.

3 Consolidate and Extend

- Have students complete the **Check Your Understanding** questions.
- Variations in the code for a given trait (such as hair colour) result in differences in appearance. In later courses, these differences will be extended to physiological features (such as blood type and insulin production).
- The location of every gene has been mapped by the Human Genome Project, a multinational, cooperative scientific project. We now know where the genes are; we do not know yet what every gene does. Once the functions of these genes are understood, cures for diseases may be developed.
- Presently, DNA evidence is used by the courts and mitochondrial DNA is being used to identify family members in times of disaster.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. Chromosomes are made up of DNA.
2. (a) The sides of the “ladder” are made of phosphate and sugar joined together.
(b) The rungs are made of nitrogenous bases.
(c) The nitrogenous bases are adenine, thymine, cytosine, and guanine.
3. To replicate, a DNA molecule splits and new bases are added onto each of the open sides to make two identical DNA molecules.
4. (a) cytosine pairs with guanine
(b) thymine pairs with thymine
(c) adenine pairs with thymine
(d) guanine pairs with cytosine
5. The genetic code is made up of “three-letter words” formed from the DNA’s nitrogenous bases.
6. An organism’s genome is all of that organism’s genes, so the human genome is all of the genes in a human.
7. 1: chromosome, 2: DNA, 3: nucleotide, 4: nitrogenous bases
8. (a) Proteins are made in the ribosomes.
(b) Amino acids are the building blocks of protein.
9. Enzymes are chemicals that control reactions in the body.
10. (a) Keratin and collagen are human structural proteins.
(b) Keratin forms hair and nails, while collagen forms connective tissue and makes up bone.
11. Three proteins found in blood are hemoglobin, which carries oxygen in red blood cells; insulin, which controls the level of sugar in the blood; and fibrinogen, which helps blood clot.
12. A gene is a shorter segment of a DNA molecule that codes for a specific protein.
13. The gene is copied as a molecule of RNA, which leaves the cytoplasm, taking the instructions for the protein to a ribosome.
14. DNA is double-stranded but RNA has a single-strand formation. (In addition, RNA has uracil instead of thymine.)
15. The correct order of events is c, b, d, e, a.
16. 1: nitrogenous bases, 2: sugar, 3: phosphate

Reading and Thinking Strategies

Visualize

- Have students close their Student Books. Tell students you will be reading a section about the structure of DNA to them, and you will be using a twisted ladder analogy to describe a DNA molecule.
- Read the section heading and the first two paragraphs to students, asking them to listen to the description and try and “see” in their mind what the words are saying (make a mental picture of what DNA looks like). Invite students to share the pictures in their heads.
- Tell students that you will read the description again, and this time, they are to sketch and label what they see in their minds.
- Have students open their books and compare their sketches with Figure 2 on page 42.

- Conclude by engaging students in a class discussion about the importance of visualizing text in their minds (to get the idea or concept the words are trying to convey). Ask students how visualizing the DNA molecule helped them understand better how DNA is structured, and if it might help them remember the information.

Prompt Prior Knowledge/Predict

- Read the section heading to students. Ask them what they already know about the genetic code: what it is; what scientists can learn from studying it.
- Then have students scan the section to note how it is set up and to predict what they will learn. They should note that there are three subheadings: each subheading gives them information about the genetic code and that the information is supported by diagrams, tables and photographs. List their predictions on the board.
- Read pages 41 to 44 with students. Ask them what new information they have learned. Have students check the list on the board to see if any of their previous ideas were incorrect or incomplete.
- Conclude by having students work with a partner to do the Learning Tip on page 46.

Strategies for Success

Summarizing and Making Notes

- Knowing how to paraphrase text is an important step in writing a summary. Ask students what they know about paraphrasing and to think of examples of when it could be used. Possible responses include the following: paraphrasing is rephrasing the words of the writer; putting the writer's thoughts in your own words; reworking the source's ideas with your own. Paraphrasing can be used to present information in your own voice; to help you understand what the text says; and to make study notes. Conclude by having students work in pairs to read a selection and paraphrase the section, verbally or in writing.

Meeting Individual Needs

ESL

- Use a model or diagram of DNA to reinforce the shape and terminology used when describing it.
- Encourage the use of an "other language/English" dictionary when discussing "Genes to Proteins" and during Awesome Science to assist with vocabulary.

Extra Support

- Use models reinforced with written instructions to address learning-style differences within the class.
- Substitute simple words when uncommon words are used. For example, the concept that antibodies "bind foreign substances" could be simplified to "hold onto things that are not supposed to be there."

Extra Challenge

- Students can access the Human Genome Project website to find the total number of genes in the body.

Awesome Science: Using Mitochondrial DNA to Solve Mysteries

PAGE 48

- Some researchers believe that mitochondria were once independent bacteria that formed a symbiotic (mutualistic) relationship with a simple cell in the very early history of life on Earth.
- Mitochondria perform cellular respiration to provide energy for most organisms.
- Mitochondria have their own DNA (mtDNA), independent of the nuclear DNA. In fact, mitochondria can reproduce to meet energy demands, independent of cell division. As a result, there can be many mitochondria in one cell. In cells where there is a high demand for energy, large numbers of mitochondria are found.
- Egg cells have many mitochondria to provide the energy for the many divisions that will have to occur. Sperm cells, which have to swim to fertilize the egg, have mitochondria to supply energy to the flagellum (tail) used for swimming; these mitochondria are found in the mid-piece between the sperm head and flagellum. When the sperm fertilizes the egg, only the head enters; the mid-piece and tail are left behind. The zygote, therefore, has mitochondria only from the mother and none from the father.
- Closely related people will have similar mtDNA; if two people have similar mtDNA, they are related. Through analysis of mtDNA from an ethnic mix, genetic evidence supports the idea that the main pool of human ancestors came out of Africa about 200 000 years ago and that we did not descend from Neanderthals.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- explain the relationship between genes and proteins
- demonstrate how scientific principles have resulted in the development of technologies (e.g., using mtDNA to identify familial relationship)

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division

KNOWLEDGE

- contents of the nucleus
- changes to cell membrane and nucleus during the cell cycle

SKILLS AND ATTITUDES

- communicate results
- use models to demonstrate how systems operate

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

SCIENCE BACKGROUND

Cell Reproduction

- Three basic categories of cells make up the mammalian body: somatic cells, stem cells, and germ cells. Each of the approximately 100 trillion (10^{14}) cells in an adult human has its own copy, or copies, of the genome, with the only exception being certain cell types that lack nuclei in their fully differentiated state, such as red blood cells.
- Somatic cells have two copies of each chromosome. This category of cells includes most of the cells that make up the human body, such as skin and muscle cells. Somatic cells are duplicated by mitosis. Since the vast majority of our cells are somatic, mitosis is the most common form of cell replication, and it is this process that produces new cells for growth, repair, and the general replacement of older cells. Because of mitosis, every cell in a person's body (except germ cells) has the same chromosomes as every other cell. Human somatic cells go through the 6 stages of mitosis in 0.5 to 1.5 h, depending on the kind of tissue being duplicated.

- Stem cells have the ability to divide for indefinite periods and to give rise to specialized cells. Examples include blood stem cells that give rise to red blood cells, white blood cells, and platelets, and skin stem cells that give rise to the various types of skin cells.
- Germ cells are any line of cells that give rise to gametes—eggs and sperm—and are continuous through the generations. These cells are produced by meiosis in special tissues of male testes and female ovaries. (Reproduction of sex cells is discussed later in the unit.)

Interphase

- Cells reproduce by mitosis; when not dividing, they are in interphase.
- *Interphase* used to be called the “resting phase”; it is now known that the cell is actively performing all life processes during this stage except reproducing.
- The cells in an embryo may divide over and over without interphase, as happens during the early stages of human embryonic division. More

Time

45–60 min

Key Ideas

DNA in the nucleus plays a key role in normal cell functions and in cell division. The cell cycle includes the normal cell functions and cell division.

Vocabulary

- cell cycle
- interphase
- sister chromatids
- parent cell
- daughter cells
- mitosis
- cytokinesis
- prophase
- spindle
- metaphase
- anaphase
- telophase

Skills and Processes

Communicating
Creating Models
Observing

Lesson Materials

per pair

- craft materials, such as modelling clay, pipe cleaners, wool, twist ties, string, rubber bands, and paper clips
- sheet of cardboard or Bristol board

Program Resources

SM 2.4 The Cell Cycle
WS 2.4-1 Stages of Cell Division
Nelson Science Probe 9 website
www.science.nelson.com

typically, cells will divide, grow, and then divide again. The whitefish embryo follows this pattern.

Plant Cells

- Plant roots grow into the soil by a combination of elongation of cells and the production of new cells. The onion root tip readily shows mitotic division in plant cells.

Related Resources

Cell Division (video and TR). Scarborough, ON: Omega Films, 1995.

Cell Division 1: Mitosis and the Cell Cycle (CD-ROM). Lewiston, NY: Tangent Scientific Supply, 1995

Math Connections

Students can practice calculating the percentage of cells in each stage of cell division using the following data for 36 observed onion root tip cells: Interphase—20; prophase—10; metaphase—3; anaphase—2; telophase—1. Students can construct the cell division clock in Investigation 2B with this data.

TEACHING NOTES

1 Getting Started

• Teacher Demo

Display several advertisements for laundry detergent, and ask students what the washing of clothes has to do with cell division. The answer: Scientists have determined that most of the “dirt” that people wash out of their clothes is, in fact, shed skin cells. Tell students that even as they sit in class, their clothes are rubbing off skin cells. Ask, *Why, then, are you not rubbed raw and stripped of your skin?* (Skin cells are being replaced as fast as they are being worn off, providing an endless supply of skin—and dirty laundry.)

• Possible Misconceptions

- *Identify:* Some students may think that all cells are the same in all ways, or that different types of cells are completely different.
 - *Clarify:* Both misconceptions are over-simplifications of the reality of the situation. Explain that all cells in a person’s body have the same chromosomes but specializations have made the characteristics of individual cells different. Remind students of Section 2.3 and the variations in human traits.
 - *Ask What They Think Now:* Ask, *Are you replacing brain cells as quickly as you are replacing skin cells?*
- Remind students that every somatic cell in their body has the same chromosomes (and genes) as every other cell. Ask, *If a cell divides, why doesn’t the number of chromosomes get smaller with every division?* (Chromosomes are duplicated during mitosis.)

2 Guide the Learning

- Students can use the **Reading and Thinking Strategy** for this section to help them understand the scientific terms.
- Remind students that they all started as a single cell (a fertilized egg).
- Guide students through the stages of mitosis using the text. Direct students to pay close attention to what is happening to the cell membrane and chromosomes.
- Project *WS 2.4-1 Stages of Cell Division* to illustrate the cell division cycle.

- Remind students that plant cells have a wall, which changes the cytokinesis slightly; instead of pinching in, new membranes are formed as the cell wall forms between the two new cells, as seen in Figure 4 on Student Book page 51.
- Have students perform **Investigation 2A: Observing Cell Division in Plants and Animals**. (See teaching notes for Investigation 2A on p. 26.)
- Reinforce the idea that between divisions is interphase, and cells spend more time in that stage than in performing mitosis.
- The time spent in interphase and in each stage of mitosis can be represented on a cell division clock, which students can develop by completing **Investigation 2B: Determining the Rate of Cell Division in Plant and Animal Cells**. (See teaching notes for Investigation 2B on p. 30.)
- Students can demonstrate their knowledge of the stages of mitosis by working with a partner to make a model of cell division in **Try This: A Model of Cell Division**.

At Home

Have students diagram the stages of mitosis, using a graphic method of their choice. Encourage them to use computer art, but also suggest alternative media such as crayons or markers.

TRY THIS: A MODEL OF CELL DIVISION

Purpose

- Using common items such as string, students will make a physical model to illustrate the stages of cell division.

Notes

- Students can use strings of different colours, thicknesses, and lengths when making the model to clearly differentiate between the chromosomes. Only two to four chromosomes should be modelled; one pair is not sufficient and five become too cumbersome.
- Have students move the chromosomes through the stages, making a drawing (or taking a photograph) of each stage.
- If sufficient materials are available, have students make copies of the chromosomes at each stage and glue these to a piece of cardboard or Bristol board. Both partners should draw copies of the stages for their notes.

Suggested Answers

- A.** Before mitosis begins, the chromosomes must replicate (make copies of themselves). This occurs during interphase. The structures are called *sister chromatids*.
- B.** Students should describe, in their own words, what is happening to the chromosomes. For example,
- Prophase:* Chromosomes appear as X-shaped objects jumbled up where the nucleus was.
- Metaphase:* The X-shaped chromosomes line up in the middle of the cell.
- Anaphase:* The Xs pull apart, and the single strands from each move to opposite ends of the cell.
- Telophase:* The single chromosomes group together to form a new nucleus after a membrane forms around them. In animal cells, the cell membrane pinches in to form two smaller cells.
- C.** In animal cytokinesis, there is an indentation or pinching of the cell membrane and cytoplasm between the two new nuclei. In plant cytokinesis, a new wall (the cell plate) forms between the new nuclei and grows to separate the new cells; a new cell membrane is formed for each new cell.

Language Arts Connections

Have students brainstorm words with a singular ending of *-us* that have a plural form ending in *-i* (e.g., cactus/cacti, focus/foci, nucleus/nuclei, nucleolus, nucleoli).

Technology Connections

Encourage students to use the Internet and other sources to research mitosis and to locate a series of pictures/graphics that depict the process. Have them either print the picture and create a static poster display with captions, or import the graphics into a multimedia program (i.e., PowerPoint) and create a slide-show presentation.

Encourage students to reflect on how the format they used to present their knowledge reinforced their understanding, and what impact they think it had on their intended audience.

3 Consolidate and Extend

- Have students use their models of cell division to explain the process of mitosis.
- Use the answers to **Check Your Understanding** to assess student learning.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. The stages of the cell cycle are interphase and cell division.
2. The cycle runs from one cell division to the next. (Since it is a cycle, it could be considered to have no start and no end, until the cells dies.)
3. Cells spend approximately 90% of their time in interphase.
4. Before mitosis can begin, chromosomes must replicate (or, the DNA must make a copy of itself).
5. Daughter cells are genetically identical to the parent cell.
6. New daughter cells are in interphase, having just finished telophase and cytokinesis.
7. A human body cell has 23 pairs of chromosomes; after cell division the new daughter cells also have 23 pairs of chromosomes.
8. A anaphase B metaphase C telophase D prophase
9. (a) Prophase, metaphase, anaphase, and telophase are the stages of mitosis, in order.
(b) For example, in prophase, the nucleolus is no longer visible; in metaphase, the sister chromatids are lined up along the middle of the cell; in anaphase, the sister chromatids are pulled apart by the spindle; and in telophase, the new chromosomes have reached the opposite poles of the cell.
10. If the cell did not have a duplicate set of chromosomes, the daughter cells would get one-half of the information needed. Duplication allows both daughter cells to get a complete set of chromosomes.
11. The duplicated material forms sister chromatids.
12. In prophase, the nuclear membrane disappears, spindles form, and the chromosomes thicken, shorten, and become visible. In telophase, the nuclear membranes are formed, spindles disappear, and the chromosomes lengthen, get thinner and become indistinguishable.
13.

Event	Animal Cell	Plant Cell
Indentation	• membrane indents	• no indentation of membrane
Cell plate	• no cell plate	• cell plate forms between daughter cells
Membrane formation	• no new membrane formed	• new membrane forms at cell plate
14. Because a human red blood cell does not have a nucleus, it cannot undergo cell division. (Red blood cells are formed by division; the nucleus disappears as they mature.)
15. The cell is active during interphase; the only activity not being performed is division. The cell is growing and carrying out all of the activities necessary for life. Before cell division, a cell in interphase is replicating its chromosomes.
16. (a) Cells without a nucleus could not perform cell division, so these skin cells could not produce other skin cells.

- (b) The company's claims are fraudulent.
17. (a) A: plant, B: plant, C: animal, D: animal
- (b) A: cytokinesis, B: prophase, C: anaphase, D: cytokinesis

Reading and
Thinking Strategies

Determine the Meanings of Scientific and Technical Terms

- Discuss the strategy of scanning with students (locate facts or words in a text by moving eyes quickly down the page, keeping in mind the exact type of information that is to be located).
- Ask students to scan page 50 to look for words in bold (prophase, spindle, metaphase, anaphase, telophase).
- Arrange students in pairs to read the section, asking them to stop at the end of each sentence in which bold words appear in the text. Have them take turns explaining the meaning of the words to each other. Encourage students to look at the accompanying figures to help with their explanations.
- As a check of understanding, have students refer to the Glossary in the Student Book.

Meeting Individual Needs

ESL

- Use simple language to describe the movement of chromosomes.
- Support verbal instructions with visual support whenever possible.

Extra Challenge

- Have students turn their models of the stages of mitosis into an animated video, using computer software or “claymation” animation. This will appeal to students interested in photography and/or computer applications.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- describe what happens inside the nucleus and the cell during the stages of mitosis
- describe the differences between plant and animal cells with respect to mitosis
- describe the movement of the chromosomes during cell division
- explain what happens to the cell membrane during cell division and the difference between plant and animal cell membranes

Investigation: Observing Cell Division in Plants and Animals

Time

45–60 min

Key Ideas

DNA in the nucleus plays a key role in normal cell functions and in cell division. The cell cycle includes normal cell functions and cell division.

Skills and Processes

Hypothesizing
Predicting
Conducting
Recording
Analyzing
Evaluating
Synthesizing
Communicating

Lesson Materials

per pair

- microscope
- prepared slide of an onion root tip
- prepared slide of a whitefish embryo

Program Resources

BLM 2A-1 Diagram of a Root
Nelson Science Probe 9
website
www.science.nelson.com

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- represent and interpret information in graphic form
- demonstrate competence in the use of technologies specific to investigative procedures and research

KNOWLEDGE

- contents of the nucleus
- changes to the cell membrane and nucleus during the cell cycle

SKILLS AND ATTITUDES

- use microscopes
- communicate results
- use diagrams to convey information

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

SCIENCE BACKGROUND

- Roots grow into the ground by forming new cells, which elongate. The end of the root tip is protected by a root cap. This region should be avoided during this investigation; the cells are often damaged and do not show active division.
- Just above the root cap is the zone where active cell division is taking place; cells in this area will show all stages of mitosis, as well as interphase. Above this zone, the cells are growing longer, not dividing.
- As with all sexually reproducing species, a whitefish develops from a fertilized egg.
- One cell becomes two, two become four, and so on, by the process of mitosis.
- A whitefish embryo is a ball of cells, all dividing, or, in interphase, preparing to divide.
- By careful examination of an embryo, all the stages of mitosis can be observed.
- In both cases, a stain has been applied to make the thickened chromosomes more visible; chromosomes are not visible during interphase.
- The stages are drawn for the convenience of the observer. It is important to realize that a cell may be observed in transition from one stage to the next. Some senior books go so far as to label “early” and “late” stages of each stage.

INVESTIGATION NOTES



Student Safety

Prepared slides are glass and easily broken if handled carelessly. Remind students that low power is used for finding cells to observe and may be focused using both the coarse and fine adjustment knobs of the microscope, but once medium or high power is in use, the coarse adjustment knob should not be touched. If a slide breaks, students should let you know so that the slide can be safely disposed of in a broken-glass receptacle. Broken glass is never put in the garbage.

It is recommended that the ocular lenses (eyepieces) of the microscopes be swabbed with alcohol between classes to avoid transmission of infections, such as conjunctivitis (pink eye).

- Students often focus on the wrong region of the root tip; refer to *BLM 2A-1 Diagram of a Root* to show the region to observe to find cells in mitosis. This works well as a transparency; the regions of the root can be pointed out and students can show you where they are observing.

Question

- Students will respond in the affirmative and identify differences such as the following:
 - Plant cells have a cell wall, animal cells do not.
 - The animal cell may have visible centrioles; plant cells do not have centrioles.
 - During cytokinesis, animal cells are formed by the “pinching in” of the cell membrane. In plant cells, a cell plate can be observed forming at the cell equator. This extends across the cell until it has met the cell wall, forming two new cells with a wall between them. New membranes form but are rarely visible.
- Note that although plant cells are often described as having chloroplasts, these cells are in a root and will not have these photosynthetic structures.

Prediction

- Student predictions may include any, or all, of the points above. Most students will predict the presence of chloroplasts and will be distressed at not observing them, or will insist that they did see them. Remind them of the function of the chloroplasts and where the root grows. They should be able to connect these two ideas.

Experimental Design

- Both of the prepared slides follow the same design idea. The cells have been stopped during division, literally “frozen” forever in whatever

Technology Connections

Challenge students to create an interactive quiz (i.e., using a multimedia authoring program) on the process of cell division. Have students locate graphics/pictures of the process of cell division on the Internet, and copy and paste the graphics into the program. Students can then create questions and answer buttons related to identifying the stages of cell division. The answer buttons and distracters can then be linked to text pages that either identify the answer provided as correct, or return students to the question page to try taking the “quiz” again.

Math Connections

Students can calculate the magnification of their cell drawings by first determining the actual size (see the Skills Handbook) of the cell. $\text{Magnification} = \text{Drawing Size} \div \text{Actual Size}$. Have students convert both sizes to the same units (μm or mm).

stage they were in. It is almost guaranteed that every stage of mitosis is present; students only have to find them. Fortunately, the stages are distinctive enough that students should be able to match the cells they find to a similar picture in the text.

Materials

- Students should have all necessary materials collected before beginning.

Procedure

- Many students attempt to find dividing cells on medium or high power. This is not recommended. Encourage students to look for chromosomes (dark thread-like structures) under low power, centre that cell in the field before changing to a higher magnification, and then move to medium or high as needed to identify the stage of mitosis.
- Encourage students to make half-page diagrams of each cell they observe; in small diagrams it is difficult to clearly show the chromosomes. You should initial each diagram while the cell is being viewed; this will avoid the problem of copying from the Student Book instead of observing the slides.

Analysis

(a) Differences observed between plant and animal cell division:

Structure	Plant cell	Animal cell
cell wall	present	absent
centrioles	absent	present
cell plate	present	absent
membrane pinches in	no	yes

- (b) Whether the observations matched the predictions will depend on an individual student's predictions and observations.
- (c) Depending on the slide, some stages may have been harder to find than others. In all cases, interphase should be the easiest to observe (as approximately 90% of the cells would have been in interphase).
- (d) The chromosomes should be the easiest to locate in any dividing cell.

Evaluation

- (e) Root tips and embryos were used because they have a large number of cells dividing (for growth).
- (f) The cells have been stained and fixed (killed); dead cells are unable to divide.
- (g) Because animal cells have only a membrane around them, the membrane can pinch off to form a new cell. Plant cells have a membrane and a wall. A new wall has to be formed; the wall is a solid structure and cannot pinch off like a flexible membrane.

(h) Interphase: the chromosomes are not visible.

Prophase: the chromosomes can be seen but are “jumbled up” in the middle of the cell.

Metaphase: the chromosomes start to get organized and look like a bunch of worms forming a line.

Anaphase: the chromosomes look like a bunch of V-shapes being pulled apart to the opposite sides of the cell.

Telophase: the chromosomes form two jumbled bunches at opposite ends of the cell.

Synthesis

- (i) Rapidly dividing cells should be found in any part of the plant where growth takes place, such as the tips of branches. (Students may be aware that trees increase in diameter, but may not be aware that cell division takes place in the vascular cambium.)
- (j) Chromosomes are visible when a cell divides; it is easiest to count the chromosomes during division.
- (k) If scientists know how cell division is supposed to happen, they can tell when something abnormal is happening. An identified error in cell division may lead to a way to diagnose or cure a disease.
- (l) If a cell has 12 pairs of chromosomes, each daughter cell produced by mitosis will also have 12 pairs of chromosomes.

ESL/Extra Support

Meeting Individual Needs

- Some classes may not be ready to use microscopes for this investigation, due to lack of experience, ability, or maturity. In this case, micro-viewers with mitosis slide strips may be substituted for the microscopes and slides. The slide strips show only a cell in each of the stages, allowing students to concentrate on the process without worrying about finding the cell and identifying it.

Extra Challenge

- Have students look for the transition stages of mitosis (e.g., early prophase, late prophase, and so on).

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- identify each stage of mitosis on the slide
- demonstrate knowledge of the stages by drawing each one, clearly showing the chromosomes, after observing each one on a slide
- identify the differences between plant cells and animal cells with respect to cell division

Time

45–60 min

Key Ideas

The cell cycle includes normal cell functions and cell division.

Skills and Processes

Hypothesizing
Predicting
Conducting
Recording
Analyzing
Evaluating
Synthesizing
Communicating

Lesson Materials**per student, pair, or group**

- microscope
- prepared slide of an onion root tip
- prepared slide of a whitefish embryo
- calculator
- compass and protractor

Program Resources

BLM 2A-1 Diagram of a Root
Nelson Science Probe 9
website
www.science.nelson.com

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- represent and interpret information in graphic form
- describe the relationship between scientific principles and technology
- demonstrate competence in the use of technologies specific to investigative procedures and research

KNOWLEDGE

- contents of the nucleus
- changes to the cell membrane and nucleus during the cell cycle
- application of scientific principles in the development of technologies

SKILLS AND ATTITUDES

- use microscopes
- apply the relationship between scientific principles and technology
- communicate results
- use appropriate types of graphic models and/or formulae to represent a given type of data
- use pie charts to convey information

ICT OUTCOMES

- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

Investigation Notes**Student Safety**

Prepared slides are glass and easily broken if handled carelessly. Remind students that low power is used for finding cells to observe and may be focused using both the coarse and fine adjustment knobs of the microscope, but once medium or high power is in use, the coarse adjustment knob should not be touched. If a slide breaks, students should you know so that the slide can be safely disposed of in a broken-glass receptacle. Broken glass is never put in the garbage.

It is recommended that the ocular lenses (eyepieces) of the microscopes be swabbed with alcohol between classes to void transmission of infections, such as conjunctivitis (pink eye).

- Students often focus on the wrong region of the root tip; use a transparency of *BLM 2A-1 Diagram of a Root* to show the most appropriate region in which to find cells in mitosis.

Question

- The cells, as noted in Investigation 2A, are dead. At first glance, students may think that it is not possible to determine the rate of cell division from dead cells. Compare the slide to a family photo album; one could determine how quickly someone grew by comparing a series of photos taken over a period of time. These slides provide a similar “snapshot” of cell division.

Hypothesis

- In Part 1, most of the cells observed are in interphase. In terms of time, if a cell spends a long time in a certain stage, more cells will be observed in that stage. This is the statistical basis for Part 2.

Prediction

- Students should expect to see more cells in mitosis in dividing tissue than in tissue that is not dividing.

Experimental Design

- In Part 1, students are simply counting the number of dividing cells relative to those not dividing. Remind them that during division, chromosomes are visible; during interphase, they are not.
- In Part 1, the root tip cell arrangement (parallel rows) permits students to count 20 cells easily. Care must be taken when using the whitefish embryo slides to count all the cells in a region, avoiding any bias. If low power is used, chromosomes will be visible and dividing cells and those in interphase can be counted. If the slide is not moved, a given region can be assayed.
- In Part 2, care must be taken to identify the stages of mitosis accurately. Cells in transition from one stage to another should be ruled on by you, if students in a pair or group cannot agree.
- Students should calculate the time spent in each stage to one decimal place. Students often need reminding that time is not metric and that 30 min is 0.5 h and not 0.3 h.
- Many students are familiar with digital timepieces and may be less familiar with analogue. A brief review of a standard clock face may be necessary.

Materials

- Students should have all necessary materials collected before beginning.

Procedure

- In Part 1, students should observe three rows of cells from different areas of the root tip, not three adjacent rows. Similarly, three different areas of the whitefish embryo should be observed, not overlapping regions.

Math Connections

Students can also construct the cell clock, remembering that there are 360° in a circle and calculating the number of degrees taken by each stage. They will need a protractor for this method.

Have students practice using a protractor to draw angles and converting fractions and percentages into degrees.

Students can also use Excel to produce circle graphs with their data.

- In Part 2, encourage students to accurately identify the stage of mitosis being observed before adding it to the data table.
- The root tip cells are dividing for growth purposes; the embryonic cells are dividing to increase the number of cells, to allow for growth. It is reasonable to expect more cells dividing in the embryonic sample than in the root tip.
- Individual student results will vary; a collection of data from all students will provide a more reliable result.
- Students should round off calculations to $\pm 1\%$ and to one decimal place for the cell clock, regardless of the number of decimals in the calculator display.

Analysis

- (a) The region just behind the root cap (the meristematic zone) has the most actively dividing cells.
- (b) If students observe differences in rates of division in the embryo cells, explain that some regions are growing faster due to the stage of embryonic development that the specimen is in. If no difference is observed, the embryo was in a growth phase, producing more cells prior to differentiated growth.
- (c) The whitefish embryo has the greater percentage of dividing cells.
- (d) The results may or may not support students' hypotheses. A summary of their findings compared to their hypotheses is needed.
- (e) This response will depend on students' predictions. Sources of error are the major explanation for inaccurate predictions.
- (f) The clocks will indicate that all stages occupy the same amount of time, or that one stage takes much longer. Results will vary.

Evaluation

- (g) The major sources of error in this investigation are not viewing an actively dividing region of the specimen and incorrectly identifying the stages of mitosis.
- (h) The procedure could be improved by observing more cells, taken from a variety of samples. Collecting data from the class and performing the calculations using these larger samples would also improve results.
- (i) Missing stages will depend on students' observations; in a large enough sample, no stage should be missing.

Synthesis

- (j) Knowing how fast cells divide would permit estimates of growth rates, recovery rates, and the success of certain treatments, such as fertilizer or pesticide application.

- (k) The change in height of some organisms (e.g., humans and many plants) over time is used to determine growth rate. In some cases, weight (mass) gain over time is used as an indicator of growth; this is commonly used by animal breeders (e.g., cattle ranchers, dog breeders).
- (l) The stage of mitosis are not as clear as in the pictures; often cells were observed as between two stages in their appearance. These cells had been passing from one stage to the next when their activity was stopped.
- (m) Students will demonstrate the ability to convert a percentage (such as 90%) into some fraction of a 12 h clock (or some fraction of 360° ; e.g., $90\% = 0.90 \times 12 \text{ h} = 10.8\text{h}$, or $0.90 \times 360^\circ = 324^\circ$).
- (n) Students may be quite creative in this response. One likely answer would be to take a digital photograph of the cells in mitosis and have the computer look for certain patterns, as specified by the stages of mitosis.

ESL

Meeting Individual Needs

- Use a large display or projectable calculator to guide students through the calculations required.

Extra Support

- When calculating the percentage of cells and the relative number of hours spent in each stage, demonstrate the calculations using a calculator display, or have every student enter the numbers and perform the operations one step at a time. After the first calculation, provide less assistance for the second, gradually reducing your support.
- With some students or classes, perform a full set of calculations on a complete set of imaginary data, following the guiding principle. Students can follow the pattern using their own results.

Extra Challenge

- Have students use a calculator and protractor to produce the cell clock. The expression of the percentage of time as the number of degrees (of arc) in the circle will produce a more accurate pie graph. As an additional challenge, encourage students to use a computer graphing program to create and display their data in a variety of graphing formats. Students could then discuss which format best presents their data.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- identify the stages of mitosis and interphase
- collect data and record it in a table
- calculate percentages from sampled data
- convert percentages into fractions of a circle in order to produce a pie graph

Time

30–40 min

Key Ideas

Mutations in a cell's DNA can cause diseases, including cancer.

Vocabulary

- mutation
- cancer
- benign tumours
- malignant tumours
- metastasis
- carcinogen

Program Resources

SM 2.5 Changes to a Cell's DNA
Nelson Science Probe 9 website
www.science.nelson.com

Related Resources

Information from the local branch of the Canadian Cancer Society

PRESCRIBED LEARNING OUTCOMES

- explain the process of cell division
- demonstrate ethical, responsible, cooperative behaviour

KNOWLEDGE

- cancer

SKILLS AND ATTITUDES

- recognize dangers

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- demonstrate an understanding of the ethical use of information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

SCIENCE BACKGROUND

- Cancer is not one disease but has approximately 200 different variants. In all cases, the cause can be linked to a change in the genetic code, a mutation.
- A mutation is a random change in the DNA of a cell. If the cell is healthy, any change is unlikely to be beneficial and will most likely be harmful.
- Not all mutations cause cancer; only those that change the genes responsible for controlling cell division are cancer causing.
- The cause of a mutation has nothing to do with its effect; a change caused by UV radiation will not produce a mutation that will protect against UV (although it could, theoretically).
- Cancer is not contagious; a person with cancer cannot give it to someone else.
- Different cancers respond to different treatments, and many types are considered curable. The key to curing cancer is early detection.
- For historical interest, cancer is named for its spreading out (metastasis), which to the ancients resembled the claws of a crab.

TEACHING NOTES

1 Getting Started

• Possible Misconceptions

– *Identify:*

- Smoking (UV radiation, human papilloma virus [HPV], etc.) causes cancer.
- Cancer is genetic; if you do not have it in your family, you cannot get cancer.

– *Clarify:*

(a) Nothing automatically causes cancer, but many things increase your chances of getting a cancer. (If smoking automatically caused cancer, every person who ever smoked would have lung cancer.) However, smoking greatly increases your chances of getting a cancer.

(b) Genetics may be a contributing factor in some cancers, but this does not exclude others from getting that cancer (e.g., the breast cancer genes BRCA1 and BRCA2 are found in people with a family history of breast cancer, but four-fifths of the cases occur in people with no family history).

– *Ask What They Think Now: Ask, Do tanning salons give you cancer? If there is no history of cancer in a patient's family, should the doctor check the patient for cancer during regular checkups?*

2 Guide the Learning

- Have students write two or three sentences summarizing what they know about cancer.
- Have students use the **Reading and Thinking Strategy** of identifying the main ideas and making notes when reading this section.
- Note that a mutation is any random change in the cell's DNA; the gene that is changed is not determined by the causal agent of the change.
- Although some cancers may be linked to viral infection (e.g., HPV and cervical cancer), cancer is not contagious.
- From television, students perceive cancer as a deadly disease; point out the many “walks” held annually by survivors of breast cancer, among others.
- The danger of cancer is its ability to spread through metastasis. The earlier a cancer is diagnosed, the sooner it can be treated.
- Be positive throughout; students fear cancer. Demonstrate that many carcinogens (smoke, UV radiation, chemicals, viruses) can be avoided with common sense and healthy living. Cleaning up the environment may also reduce daily contacts with carcinogens.

3 Consolidate and Extend

- Have students refer to the two or three sentences they wrote at the beginning of the section and reflect on what they have learned.
- Have them list three things they could do to reduce their risk of getting cancer. (Answers could include, but are not limited to, stop/do not start smoking, use sunscreen, avoid tanning salons, use caution when handling chemicals, and get regular medical checkups.)
- Successful completion of the **Check Your Understanding** questions will indicate that the student has attained the concepts.

At Home

Have students look for a bottle of sunscreen. Note the SPF value; what is the importance of this figure when buying sunscreen?

Math Connections

Students can calculate the number of mutations that occur in humans using the following data: humans have approximately 3 billion base pairs; 20–30 mutations per billion per individual. Emphasize that most mutations are neutral. Have students calculate the numbers for cancer risk factors for their school population. Use the estimates in Figure 5, p. 55.

Technology Connections

Have students use the Internet and other sources to research a known environmental cancer-causing agent. Encourage them to locate information on: why it is needed (what is it used for), how it affects people, what can be done to reduce the risks, who is responsible for informing people of the risks, and who is responsible for the damage caused by this cancer-causing agent.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. A harmful mutation of the genes that control cell division can cause cancer.
2. The genes that control division are the part of the cell affected; the result is out-of-control cell division.
3. Normal cells divide at different rates as determined by their lifespan. Bone cells live a long time, so normal division is slow. Skin cells are always being produced by division to replace ones that are shed.
4. Cancer cells divide repeatedly with little, or no, interphase. They do not specialize as normal cells do, so they produce a large mass of cells that uses nutrients but does not contribute to the body.
5. Cancer cells do not always stay in contact with each other after division, so they can spread to other parts of the body.
6. Any substance (or agent) that causes cancer is known as a carcinogen. Examples include, but are not limited to, radiation, asbestos, some pesticides, some viruses, and chemicals such as those found in tobacco.
7. Only mutations to the genes that control cell division cause cancer.
8. (a) A benign tumour does not spread to other areas of the body and often does not interfere with normal functions. Malignant tumours can spread to other tissues and do interfere with body processes; these are harmful tumours.
(b) Warts or polyps are examples of benign tumours.
9. Benign tumours are typically removed by some type of surgery.
10. (a) Photo B shows cancerous cells.
(b) Cancer cells have larger nuclei than normal cells.
(c) The nuclei are larger because the cells are dividing out of control. The nuclei contain double the number of chromosomes before they divide.
11. Cancers that metastasize can spread to other body systems and grow into new cancers, making them more dangerous.
12. Radiation therapy kills cancer (and normal) cells by interfering with cell division. Chemotherapy also stops cell division but has other negative side effects. (Note that different cancers respond to different treatments.)
13. Radiation kills cells by disrupting the reproduction of cells by division.
14. Cancer is caused by many chemicals. As we pollute the environment, more potentially dangerous chemicals are being put into the air and water. This may be increasing cancer rates. Radiation is also known to cause some cancers; the thinning of the ozone layer has resulted in an increase in skin cancer as UV levels have increased.
15. Radiation produces heat and can cause burns. Chemotherapy drugs attack rapidly growing cells, like cancer cells. Hair follicle cells also multiply very quickly. Chemotherapy drugs are unable to tell a cancer cell from a non-cancer cell. Thus, hair loss occurs. Radiation therapy also attacks quickly growing cells, but unlike chemotherapy, it affects only the specific area where treatment is concentrated. If you have radiation to your head, you'll likely lose the hair on your head.

Reading and Thinking Strategies

Identify Main Ideas/Make Notes

- To help students synthesize the most important information they will read, have them write outline notes (a format of notes based on space indentation) or use the Study Guide found in the Student Workbook.
- Ask students to scan the section to note headings, figures, and captions. Discuss what they think the topic is (for example, Cancer). On the blackboard, place this point farthest to the left. This is the heading for the notes.

- Have students read the subsection on Characteristics of Cancer Cells. Ask: *What is the main idea?* Discuss what the main idea is and write it under the heading, indenting to the right (for example Cells Divide).
- Then ask students: *What relevant details about how cancer cells divide are provided?* Discuss why they think the information is relevant, then summarize the information, and write it under Cells Divide, indenting to the right (for example, abnormal division results in two types of tumour; benign tumours usually do not interfere with tissue or organ functioning; malignant tumours invade tissues and interfere with functioning; metastasis happens when cells separate and spread).
- The outline notes to this point may look like this:
 - Cancer
 - Cells Divide
 - Abnormal division results in two types of tumour
 - Benign - usually do not interfere with tissue or organ functioning
 - Malignant - invade tissues and interfere with functioning
 - Metastasis happens when cells separate and spread
- Ask students to make outline notes on the rest of the subsections.
- Conclude by having students consider how making outline notes helps them study for a chapter test (helps to identify which information is important and to write it in their own words).

ESL/Extra Support

Meeting Individual Needs

- Help students sound out the new terms, and have them look new terms up in a dictionary whenever necessary.
- Point out the important features to be observed in the photographs to ensure that students see what they are supposed to see.

Extra Challenge

- Have students choose a specific cancer and use the Internet and other sources to research the suspected causes, diagnosis, treatment(s), and frequency nationally and internationally. Students could then share their findings through posters or multimedia presentations (i.e., a PowerPoint presentation or an interactive multimedia format).
- This can be extended by looking at the frequency over a number of years. In cases of suspected environmental contributing factors, the frequencies can be correlated with the suspected causal agent.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- describe factors that may lead to changes in a cell's genetic information
- describe cancer as abnormal cell division
- exhibit a willingness to question and promote discussion

Time

45–60 min

Key Ideas

Some organisms reproduce asexually through cell division.

Vocabulary

- sexual reproduction
- zygote
- asexual reproduction
- clones
- binary fission
- budding
- vegetative reproduction
- fragmentation
- spores

Lesson Materials**per class**

- sprouting potato

Program Resources

SM 2.6 Cell Division and Asexual Reproduction
Nelson Science Probe 9 website
www.science.nelson.com

PRESCRIBED LEARNING OUTCOMES

- compare sexual and asexual reproduction in terms of advantages and disadvantages
- describe the relationship between scientific principles and technology

KNOWLEDGE

- sexual and asexual reproduction
- types of reproduction

SKILLS AND ATTITUDES

- apply the relationship between scientific principles and technology
- demonstrate ethical, responsible, cooperative behaviour
- acquire and apply scientific and technological knowledge to the benefit of self, society, and the environment

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

SCIENCE BACKGROUND

- Just before a cell divides, the chromosomes in the nucleus are replicated. This is the basis for every type of asexual reproduction and assures that the offspring will be identical to the parent (and each other).
- If a parent is successful in a given environment, any identical offspring will also be successful. In a stable environment, asexual reproduction is beneficial.
- In changing environments, the variations produced by sexual reproduction (Chapter 3) offer a better chance of survival for the species, if not the individual.
- There are some populations (of fish and frogs) that are entirely female, as long as conditions are not changing. During times of environmental stress, some of the females turn into males, allowing the population to reproduce sexually. Once the environment stabilizes, the males die off, leaving an all-female population.
- Many house plants are reproduced by vegetative reproduction. African violets, a popular house plant, can be grown by rooting a leaf, which will grow into a whole new plant. In this way, one plant can produce dozens of identical offspring.

TEACHING NOTES

1 Getting Started

• Teacher Demo

If this starter is used, advance preparation is required.

Display a sprouting potato to the class, with the announcement that you have successfully cloned a potato! The individual reactions and questions to this announcement will provide some idea of the background of the class. (A spider plant could also be used; find one with “babies.”)

• Possible Misconceptions

– *Identify:*

- (a) Single-celled organisms reproduce using cell division; multicellular organisms must have two parents in order to reproduce.
- (b) Cloning is a complex process, only accomplished by scientists in a laboratory.

– *Clarify:*

- (a) Many multicellular organisms can reproduce asexually.
- (b) Many plants produce offspring that are identical to the parent and each other by a process known as vegetative reproduction, a natural form of cloning.

– *Ask What They Think Now:*

- (a) A farmer finds that all of the strawberry plants in the garden have exactly the same genes. Ask, *How is this possible?*
- (b) Ask, *How will the plants grown from the potato (or spider plant) compare to each other and to the parent plant?*

2 Guide the Learning

- Binary fission, literally meaning splitting into two pieces, is essentially the same as mitosis, studied in Section 2.4.
- Budding in single-celled organisms shows the same nuclear activity as mitosis, but cytokinesis does not divide the cytoplasm equally.
- Circles of spruce trees can result when a tree grows so large, its branches touch the ground. Where a branch touches, it sends down roots. After the parent tree dies, the offspring (all genetically identical) appear to have been planted in a circle.
- When a piece of a sea star (at least one arm and part of the central disc) is cut off, a new organism will grow out of the cut-off piece. Thus five new sea stars can be created from one.
- Both methods of reproduction have advantages and disadvantages. Biologically speaking, if one method were “good” and the other “bad,” one method would have disappeared. Nature favours the successful method, as will be discussed under Evolution in a later course.

At Home

Have students try to grow a potato or some other plant from a cutting. If plants are available in the classroom, provide cuttings. Note that the availability of plants may be seasonal.

3 Consolidate and Extend

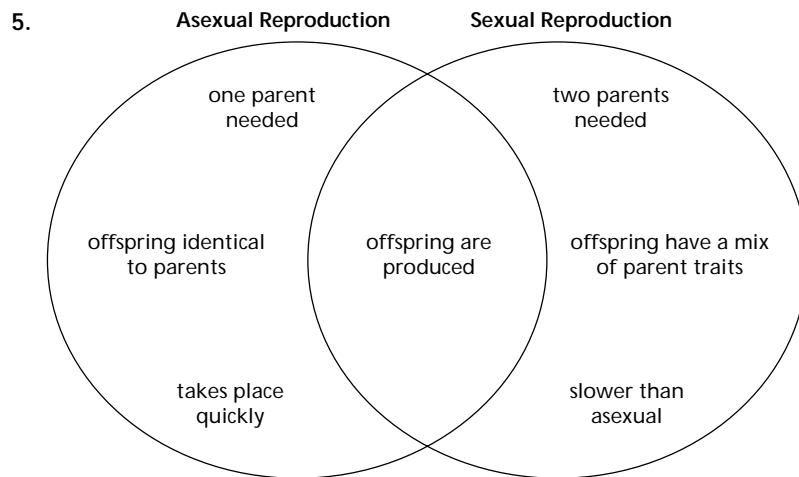
- Have students prepare a chart summarizing the types of asexual reproduction and including examples of typical organisms that use each method.
- Or, have students use the **Reading and Thinking Strategy** to make summary notes.
- Having students answer the **Check Your Understanding** questions will provide an opportunity to monitor their progress in this unit and clarify any areas of weakness.

Technology Connections

Have students work with a partner or in a small group and use the Internet to research asexual reproduction. Ask students to look at as many sites as they can find and select the one they think provides the best information. (This activity could lead to a class discussion on creating criteria for evaluating web-based information.) As a culminating activity, have students use information and graphics from the Internet to create posters or a multimedia presentation that shows examples, and identifies benefits, of asexual reproduction.

CHECK YOUR UNDERSTANDING—SUGGESTED ANSWERS

1. No specialized cells are needed for asexual reproduction, but they are needed for sexual reproduction.
2. Cloning is the production of identical offspring from one parent cell. Since all the offspring resulting from asexual reproduction are identical to the parent, they are (technically) clones.
3. Before asexual reproduction can take place, the chromosomes (DNA) of a cell must be replicated (as in mitosis).
4. Because only one cell is needed and no specialized cells or structures are involved, asexual reproduction can take place much faster than sexual reproduction.



6. (a) vegetative reproduction (b) binary fission
(c) spore formation (d) budding
7. Binary: "consisting of two parts or two separate elements" and Fission: "the act or process of separating into parts" (from Encarta). During binary fission, a cell splits into two parts.
8. Both budding and vegetative reproduction produce a new organism that grows out from the parent (the difference is that animals use budding whereas plants use vegetative reproduction).
9. (a) During binary fission, two cells or organisms of equal size are produced, but after budding, the offspring is smaller than the original parent.
(b) Both binary fission and budding result in two organisms that are identical.
10. Strawberries send out runners that grow into a new plant identical to the parent. Some trees send out shoots that grow into a new tree. Many plants can be grown from a cutting, a small piece of the plant. Bulbs and tubers can be used to produce new plants, for example, tulips and daffodils.

11. Spores have thick cell walls and can spread or lie dormant until conditions are good. In other forms of asexual reproduction, the offspring are produced immediately.
12. (a) In fragmentation, a small piece of an organism can grow a new organism. Regeneration is used to replace lost or damaged parts.
(b) The sea star (once known as the starfish) can grow lost arms, and a new sea star can grow from an arm with some of the central disc intact.
13. One parent is needed and can produce many offspring in a short period of time. The offspring are identical to the parent, so in a stable environment asexual reproduction is advantageous.
14. Reproduction using one parent saves the energy and competition of looking for a partner and produces identical offspring. In a changing environment, this is a disadvantage, as all of the offspring are susceptible to the same hazards, decreasing the chances of population adaptation and survival.
15. Using the equation from Section 2.1, used in **Try This:** From One Cell to Millions ($y = 2^n$), and their completed *WS 2.7-7*, students can determine that 262 144 offspring can be produced in 6 h ($360 \text{ min} \div 20 \text{ min} = 18 \text{ divisions}$).
16. This practice did not reduce the number of sea stars because new sea stars would have grown from any pieces of the original sea star that contained part of the central disk.
17. Breakable tails are used by lizards to evade capture in two main ways: by enabling reptiles to break away from predators that have grasped them by the tail and by providing a distraction which deflects the attention of the attacker away from the vulnerable head and body. Many lizards possess conspicuously coloured tails to help distract attention. (Differences in the readiness with which all or part of the tail is shed exist between species and are likely to reflect the balance of costs and benefits in particular cases. Costs include the expense of regrowing the tail and the loss of a variety of possible tail functions that may cause partial incapacitation, at least until the tail regenerates. Benefits are liable to be low if predation is rare, if the animal is able to protect itself effectively in other ways, if it is too slow to evade further pursuit after the tail is shed, or if the tail is small or unpalatable and consequently not likely to distract a predator.)

Identify Main Ideas/Summarize

- Have students scan the section to note headings, figures, and captions. Have students discuss what they think the section is about and have them write the topic (Asexual Reproduction) in their notebook as a heading for their summary or use the Study Guide found in the Student Workbook.
- Arrange students in pairs. Have them read the first paragraph in the section *Types of Asexual Reproduction* and do four things: identify what they think the main idea is; discuss why they think the information is important; rephrase the main idea in their own words; and write the summary in point-form in their notebooks.
- To help students write in a condensed form, tell them that each word they use will cost 10¢, and they have \$2.50 to spend for each section, limiting their paragraph summaries to 25 words.
- Have students tally the cost for each section. If they go beyond the set amount for each section, ask them to rewrite to condense further.

Reading and
Thinking Strategies

- A summary of Binary Fission could be similar to the following:
Binary Fission = \$2.40
 - parent produces two identical daughter cells
 - only single-celled organisms (e.g., bacteria) and some protists and algae reproduce by binary fission
 - allows for rapid population growth (e.g., red tide)
- Ask students to make summary notes for the rest of the subsections. Suggest to students that summarizing is a strategy they can use to help them make concise study notes.
- Conclude by having students use their summaries and Figures 2 to 7 to review asexual reproduction.

Meeting Individual Needs

ESL

- Stress the differences in similar words, pointing out how one letter can change the meaning (i.e., *sexual* versus *asexual*).
- Break down complex words by using simpler alternatives; the word *fragment*, defined as “a piece” may make words such as *fragmentation* easier to understand.

Extra Support

- When using the photographs to illustrate a concept, talk about the picture while pointing out the event of interest, to accommodate auditory and visual learners.

Extra Challenge

- Buy an African violet (or a similar plant), some potting soil, and pots. Have students carefully remove one leaf each, and suspend it in water until it roots (or use rooting hormone to increase the chances of success). They can carefully transplant this rooted leaf cutting and care for their very own cloned plant.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- distinguish between sexual and asexual reproduction in representative organisms
- relate sexual and asexual reproduction to adaptability of organisms
- give examples of scientific principles that have resulted in the development of technologies (e.g., cell division—reproductive technologies)

PRESCRIBED LEARNING OUTCOMES

- relate the processes of cell division and emerging reproductive technologies to embryonic development
- demonstrate scientific literacy
- demonstrate ethical, responsible, cooperative behaviour
- describe the relationship between scientific principles and technology

KNOWLEDGE

- types of reproduction
- application of scientific principles in the development of technologies

SKILLS AND ATTITUDES

- respect diverse opinions
- use the Internet as a research tool
- communicate results
- identify main points, supporting or refuting information, and bias in a science-related article or illustration
- demonstrate ethical, responsible, cooperative behaviour

ICT OUTCOMES

- demonstrate the ability to use the Internet to access, capture, and store information
- demonstrate an understanding of the ethical use of information
- apply the principles of effective communication and good design when using information technology tools
- analyze the impact of multimedia documents on the intended audiences

TEACHING NOTES

• Possible Misconceptions

- *Identify:* Clones will be identical twins of the parent. (Other misconceptions may arise if students have read or watched science fiction.)
- *Clarify:* A clone has the same genes as the parent, but many factors determine how genes are expressed. A person with genes for light skin colour will have darker skin if they are exposed to UV radiation. (Many people tan in the summer.) Personality traits are even more complex; psychologists are still trying to determine the effects of genetics versus environment on personality. A clone is born as an infant and still has to grow at the normal rate into an adult. The “identical twin” may be 30 or more years younger than the parent.
- *Ask What They Think Now:* Ask, *If I clone myself, will I be able to share my teaching duties with my clone?*
- Introduce the issue in one class and discuss it in the next, after students have had time to contemplate the topic. Use a transparency of *BLM 2.7-1 Cloning Using a Somatic Cell as a Source of DNA* to illustrate the cloning process.

Time

45–60 min

Key Ideas

DNA in the nucleus plays a key role in normal cell functions and in cell division.

Skills and Processes

Evaluating
Communicating

Program Resources

BLM 2.7-1 Cloning Using a Somatic Cell as a Source of DNA
Nelson Science Probe 9 website
www.science.nelson.com

- Avoid judgment or value statements; a technology in and of itself cannot be “good” or “bad.” The people who use the technology determine this by how it is used. As an example, refer to the splitting of the atom. The technology can be used to provide non-polluting power or for military aggression. One use is good; the other is bad (depending on the politics of the reader).

The Issue: Beyond Dolly—Cloning Mammals

- After much research and many attempts, researchers have developed the technology to clone mammals.
- If sheep and dogs can be cloned, is the cloning of a human the next step?

Statement

- Students will probably hold a current position on the issue of cloning and will assume an unqualified agreement or disagreement with the statement.
- In many cases, students’ current positions will not have been carefully thought out and may be based on misinformation or emotional reactions, rather than on valid scientific evidence.

Background to the Issue

- Some of the arguments that could be used in favour of cloning include
 - Cloning could be used to save endangered species that are presently being bred in zoos in hopes of increasing their populations and preventing extinction.
 - Every day, people die because organs are not available for transplant; cloned organs could save these lives.
 - People are starving around the world; cloning selected breeds of animals with desirable traits could provide food and save starving millions.
 - Cloning could produce large numbers of fur-bearing animals to be slaughtered for their coats.
 - People could have themselves cloned so that they had “spare parts” for replacement; their clones would then die.
- Some arguments against cloning mammals include
 - Humans have not been cloned (as of this printing), but many people are worried that cloned humans will be treated like other animals.
 - There are religious and ethical arguments against cloning.
 - Human cloning would foster an understanding of children, and of people in general, as objects that can be designed and manufactured for specific characteristics.
 - Human cloning would diminish the sense of uniqueness of an individual and could lead to a devaluation of clones in comparison with non-clones.
 - If human cloning is permitted and becomes accepted, it is difficult to see how any other dangerous applications of genetic engineering technology could be proscribed.

At Home

Each student should research one point and counterpoint, as decided upon by the group during discussion. Asking their parent(s) or guardian(s) for an opinion should be encouraged.

Technology Connections

Have students research cloning. Encourage them to use a wide range of information sources (e.g., newspapers, magazines, brochures, the Internet). Before students begin their research, discuss how to conduct effective Internet searches. Be sure the discussion includes different search engines, key word searches, and the importance of spelling. Also have students discuss any apparent bias of websites and what criteria make an interesting/effective website. Students could present their findings to the class through posters, orally, or through multimedia presentations. Ask students if the presentation of their research and that of other students displays a bias. If so, what is it and how could they tell?

Make a Decision

1. Note that every point has a counterpoint. After explaining the examples, have the groups set up a similar table to record their ideas.
2. Students' groups expand on the statements provided and add ideas of their own.
3. Each group should research, and then compile, current information and consider both the potential benefits and risks of the technology.

Communicate Your Decision

- The debate should be structured; this is a debate, not an open discussion. Set up a speaking order. (For guidelines on debating, see the Skills Handbook, p. 559.)

ESL

- Encourage ESL students to write a script for their debates. Act as a coach to assist with pronunciation, vocabulary, and organization of ideas.

Extra Support

- Debates are about structure. Take time to explain the formal structure of the debate. Encourage students to speak slowly and make notes while the other side is speaking, and allow time between speakers for the group to organize a response to the arguments.

Extra Challenge

- The option of having debaters argue against their own beliefs is most appropriate in a class of more capable students. Debate teams, instead of individual speakers, will encourage cooperation and allow more students to participate in the discussion.

ASSESSMENT FOR LEARNING

What To Look For in Student Work

Evidence that students can

- present arguments for and against cloning
- take a personal position on cloning and support the position with rational arguments and evidence
- research current technologies and consider the benefits and risks of cloning

Meeting Individual Needs

Time

30–45 min

Skills and Processes

The Chapter Review provides an opportunity for students to demonstrate their understanding of and their ability to apply the key ideas, vocabulary, and skills and processes.

Program Resources

WS 2.0 Chapter 2 Quiz
 WS 2.0-1 Concept Map, Cell Division
 Nelson Science Probe 9 website
www.science.nelson.com

Chapter 2 Review Chart

- For every point in the Key Ideas, have students provide an example that illustrates and reinforces that point (e.g., the point: “Cell division produces new cells to increase the size of the organism” could allow the student to respond: “I have grown because I have more cells than when I was born”).
- Divide students into small groups to answer and discuss the questions. Circulate to address problems. Common difficulties can be addressed as a class.
- Have students complete *WS 2.0-1 Concept Map, Cell Division* to reinforce their grasp of the topics within the chapter.
- Have students complete *WS 2.0 Chapter 2 Quiz* to review the vocabulary and concepts in this chapter.

Review Key Ideas and Vocabulary—Suggested Answers

1. Cells are replaced because they are worn out or damaged. New cells are produced by mitosis.
2. (c)
3. (d)
4. (c)
5. (b)
6. (a)
7. (b)
8. Skin cells and cells lining the upper digestive tract reproduce faster than many other cells in the body. Because they are exposed to difficult conditions, they wear out quickly and must be replaced more often than other cells. This would be true of any cells with a short lifespan.
9. (a) phosphate (b) sugar (c) nitrogenous bases
10. The daughter cells of a single-celled organism are identical to the parent. The daughter cells of a multicellular organism are genetically identical, but may appear different because of specialization. A skin cell and a muscle cell for a given organism have the same genes, but are very different in appearance.
11. Mutations in the genes that control cell division are responsible for cancer.

12. Asexual reproduction requires only one parent and in most cases does not require specialized cells, produces offspring that are identical to the parent, and may produce a large number of offspring in a (relatively) short time. Sexual reproduction requires two parents producing specialized cells, which results in offspring with a combination of parental traits and takes much longer to produce large numbers of offspring.
13. Genetic material is duplicated before cell division so that when the double quantity is divided between the daughter cells, each will receive a complete set of chromosomes. If division took place without replication, the daughter cell would have half of the parental chromosomes.
14. (a) vegetative reproduction (b) vegetative reproduction
(c) budding (d) spore formation

Use What You've Learned—Suggested Answers

15. After 8 divisions there will be 71 680 cells.
16. (a) Pine seedling roots are actively multiplying to produce new cells needed for the growth of the plant.
(b) When a tadpole turns into a frog, new cells are being produced (e.g., lungs and legs), so division must happen quickly to produce these new cells.
(c) Human cheek cells are being worn out by hard and scratchy foods; these cells must be replaced as fast as they are destroyed.
(d) White blood cells fight disease. When a person has chicken pox, more white cells are needed to fight the infection and must be produced quickly to stop the infection from spreading.
17. (a) interphase
(b) anaphase
(c) prophase, metaphase, anaphase, telophase
(d) interphase
(e) prophase
(f) telophase
18. (a) If a parent cell has 12 pairs of chromosomes, after mitosis, each daughter cell would also have 12 pairs of chromosomes.
(b) If all of the chromosomes moved to the same pole during anaphase, one daughter would have twice as many chromosomes as the parent and the other would have no chromosomes.
19. Vegetative reproduction would most likely be used by a plant nursery. Several versions are commonly used: cuttings of mature plants such as shrubs are rooted and grown into plants for sale, daffodil bulbs are split and replanted to produce multiple plants, and strawberries send out runners that grow new plants. In all cases, the new plants are identical to the parent, a benefit to the nursery.

20. DNA is a double strand, looks like a twisted ladder (double helix), codes for proteins, and is found in the nucleus of a cell. RNA is a single strand found in the nucleolus and ribosomes and is part of the mechanism used to make proteins.
21. There is a gene that codes for a protein that gives the eye its colour. Within this gene are several variations. These “variations on a theme” produce the different eye colours that are seen.

Think Critically—Suggested Answers

22. Every cell in the body came from one fertilized egg and contains the same genes. Different cells have used different genes to specialize; the skin cell used the genes to produce a skin cell, a muscle cell used the genes to produce a muscle cell, and so on. Despite these differences, every body cell is genetically identical to every other body cell.
23. Many possible answers may be used here; some examples follow: If hospitals knew how quickly cells divide, they could provide exact times for recovery from disease or injury. Farmers would know exactly when to plant and harvest crops if cell division rates (therefore, growth) were known.
24. During interphase, plant cells would be performing photosynthesis to obtain energy for growth. During cell division, cell activity stops. A herbicide that forced a plant to stay in a cell division stage would eventually “starve the cell to death.” With no energy from photosynthesis, the cell would die.
25. Some pesticides contain chemicals that cause mutations. If these mutations affect the genes that control division, the chemicals are said to be carcinogenic. Some of the chemicals in some pesticides fall into this category.

Reflect on Your Learning—Suggested Answers

26. Students’ answers will depend on their original opinions and the strengths and weaknesses of the evidence brought out during debate. Those who strongly believe in the technology may not be swayed by the negative evidence. Similarly, those strongly against the technology, especially for religious reasons, will rarely change their opinion. The reasons expressed will be personal and should be respected. The explanation is the important part of this question.
27. During examination of the root tip and whitefish egg cells, all stages of division were observed. In most cases, the cells did not match the Student Book illustrations exactly, but were close. This suggests that cells were in transition between one stage and the next. (Note: this can be compared to a family photo album that shows only events, not everyday activities. Students know that they did not jump from one size or grade or holiday, but changed gradually. The views of the stages of mitosis are like snapshots taken during a continuous process.)

ESL

- Review vocabulary, providing familiar words to clarify meaning.
- Reinforce concepts by referring to photos and other visuals from the chapter.

Extra Support

- Review vocabulary, providing familiar words to clarify meaning.
- Have students write definitions in their own words, instead of copying from text.

Extra Challenge

- Students could be challenged to write a letter to their MP or to the federal minister responsible for matters relating to cloning, outlining their position and making recommendations for government legislation or guidelines.
- Challenge students to build an interactive quiz based on the unit's vocabulary, concepts, and key ideas using a multimedia authoring program. Students could create a multiple-choice-style quiz that allows other students to select possible answer buttons that either indicate they are correct or return them to the question page to try answering the question again.

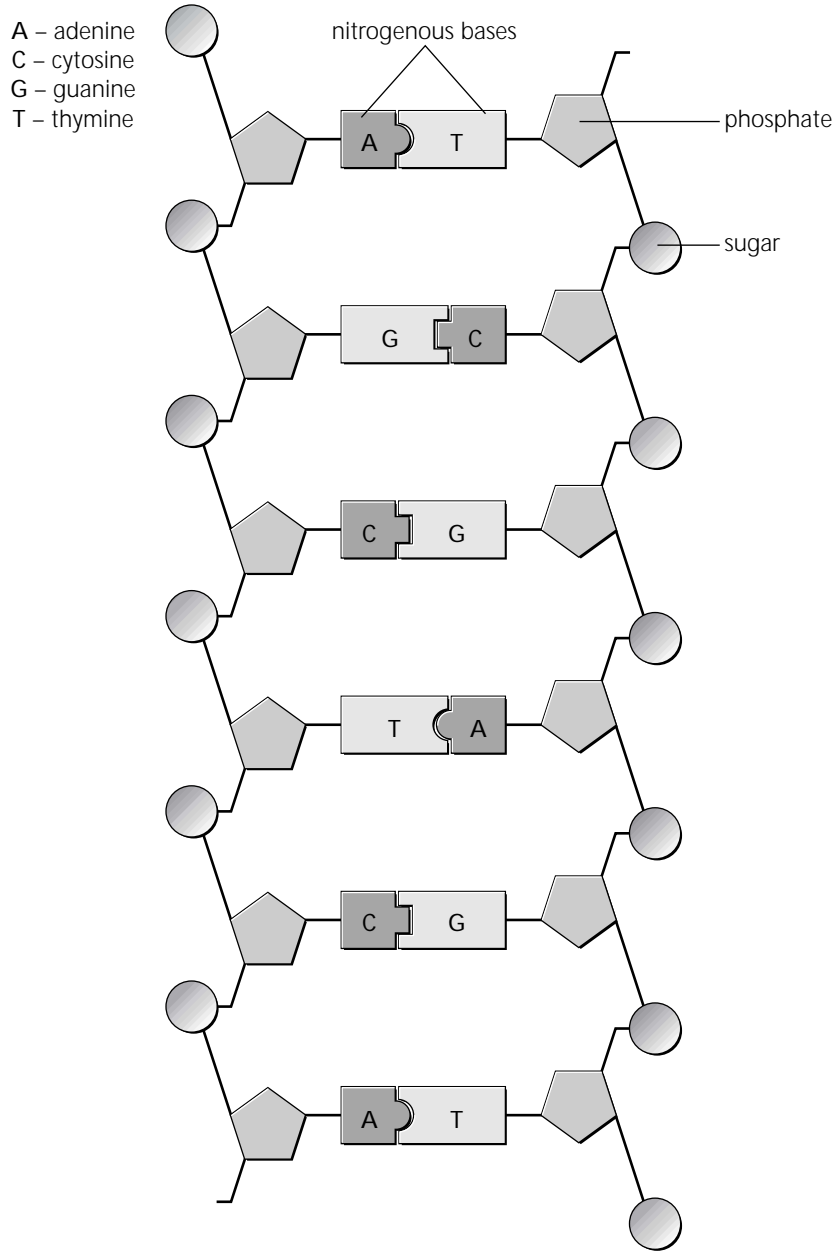
CHAPTER

2

Blackline Masters

Name: _____ Date: _____

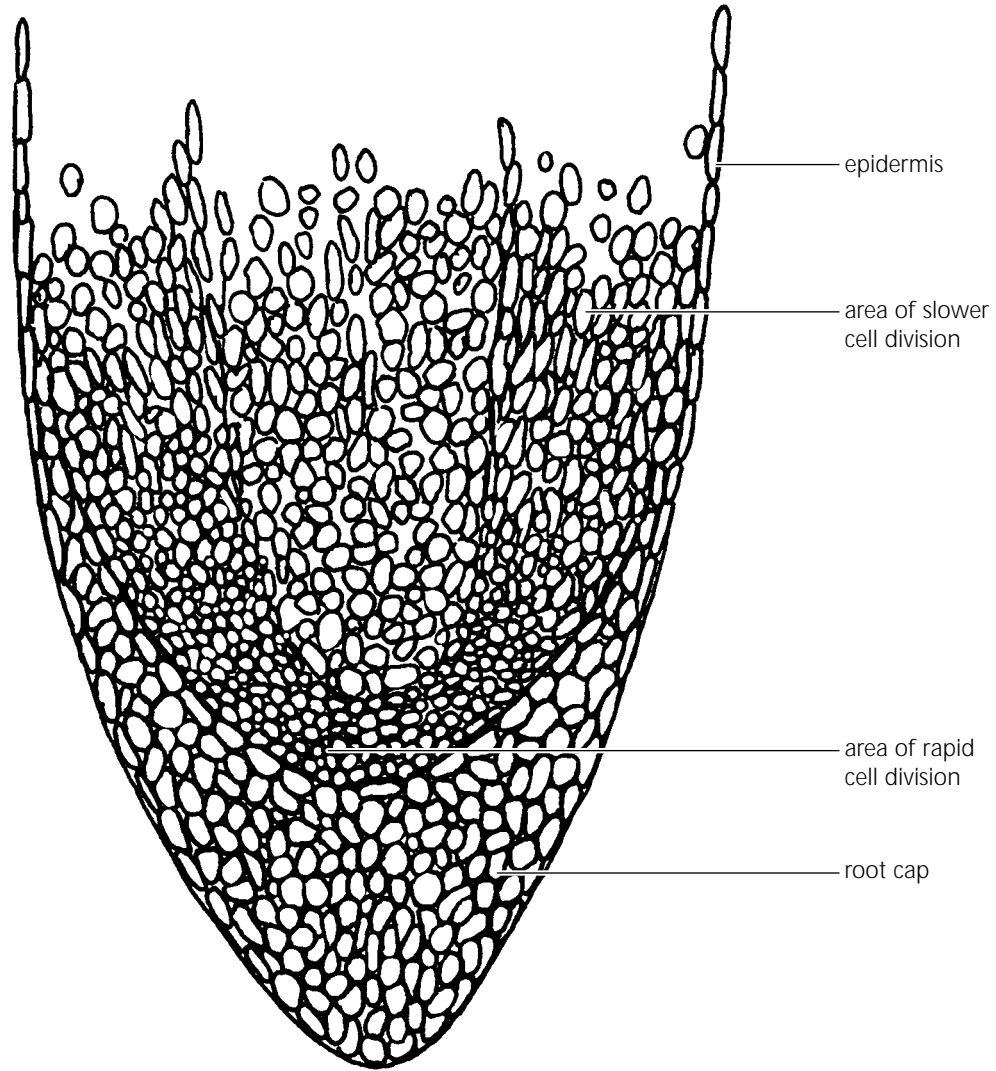
The Chemical Constituents of DNA



Name: _____

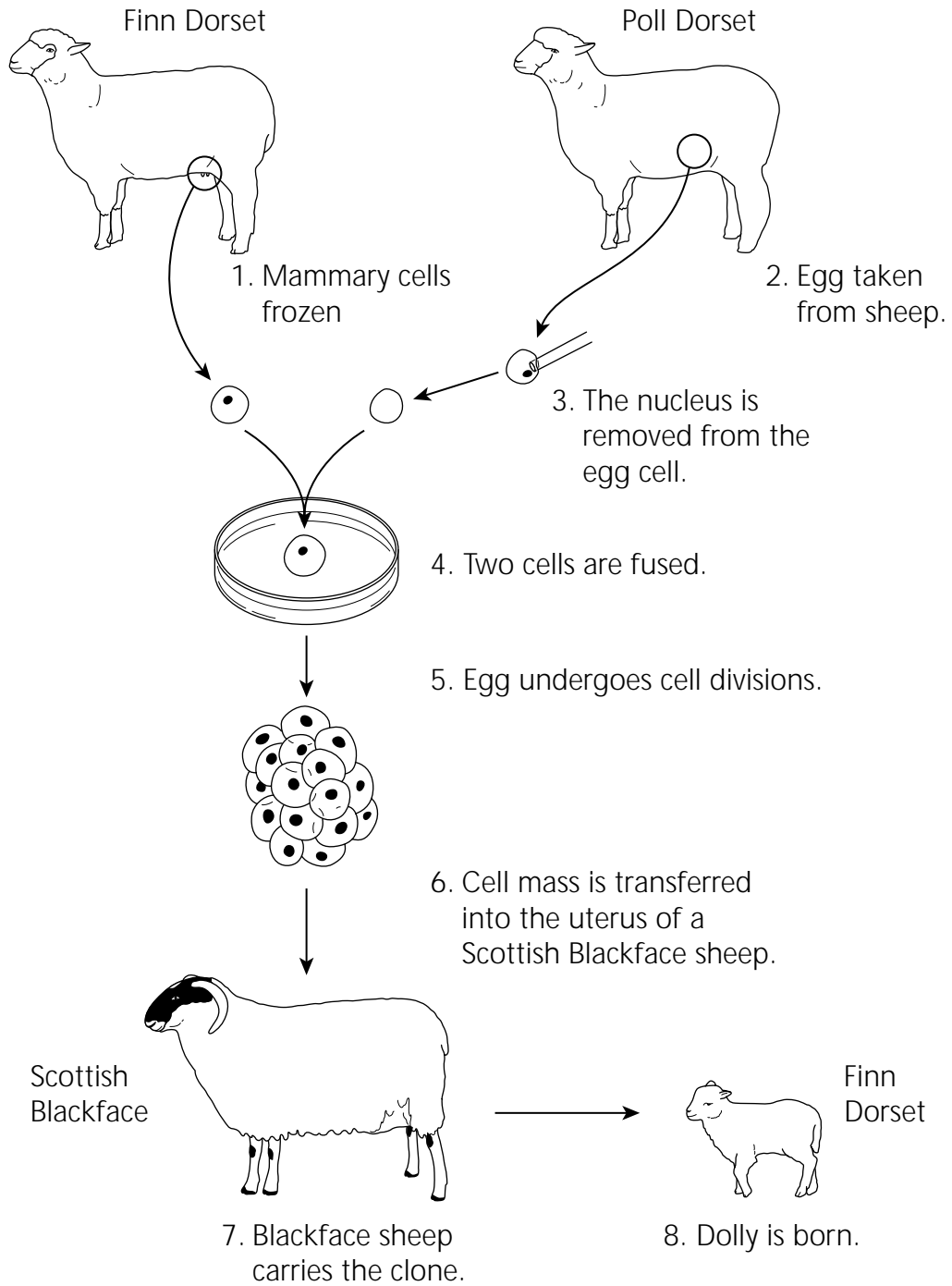
Date: _____

Diagram of a Root



Name: _____ Date: _____

Cloning Using a Somatic Cell as a Source of DNA



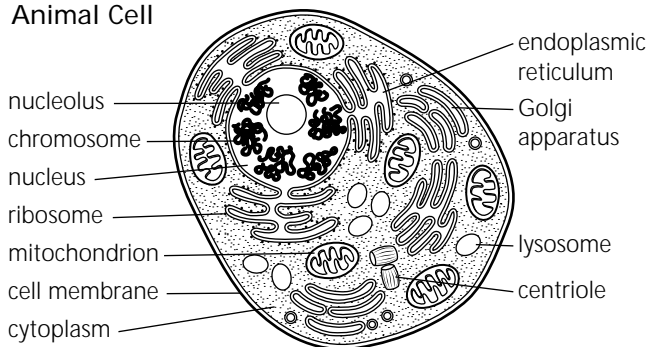
Unit A: Reproduction BLM and WS Answer Key

WS 2.1-1 Try This: From One Cell to Trillions

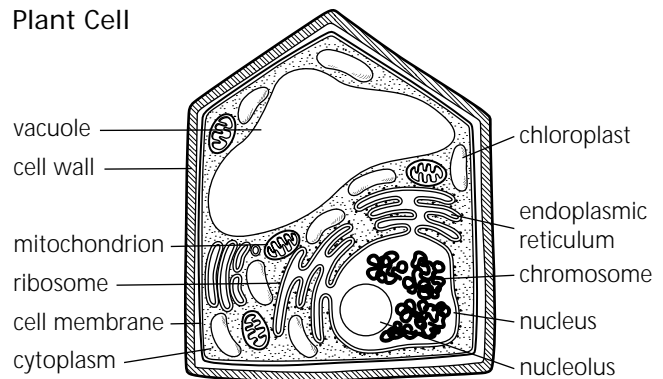
Number of Divisions	Number of Cells	Number of Divisions	Number of Cells
0	1	21	2 097 153
1	2	22	4 194 304
2	4	23	8 388 608
3	8	24	16 777 216
4	16	Part B 25	33 554 432
5	32	26	57 108 664
6	64	27	1.3×10^8
7	128	28	2.7×10^8
8	256	29	5.4×10^8
9	512	30	1.1×10^9
10	1 024	31	2.1×10^9
11	2 048	32	4.3×10^9
12	4 096	33	8.6×10^9
13	8 192	34	1.7×10^{10}
14	16 384	35	3.4×10^{10}
15	32 768	36	6.9×10^{10}
16	65 536	37	1.4×10^{11}
17	131 072	38	2.7×10^{11}
18	262 144	39	5.5×10^{11}
19	524 288	Part C 40	1.1×10^{12}
20	1 048 576		

WS 2.2-1 Animal Cell and Plant Cell

Animal Cell



Plant Cell



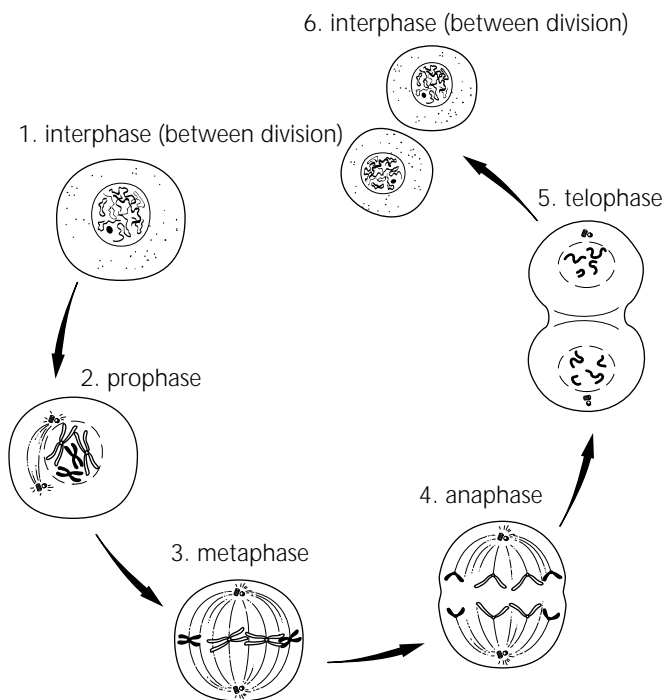
WS 2.2-2 Comparing a Plant Cell to a Factory

Sample Answers

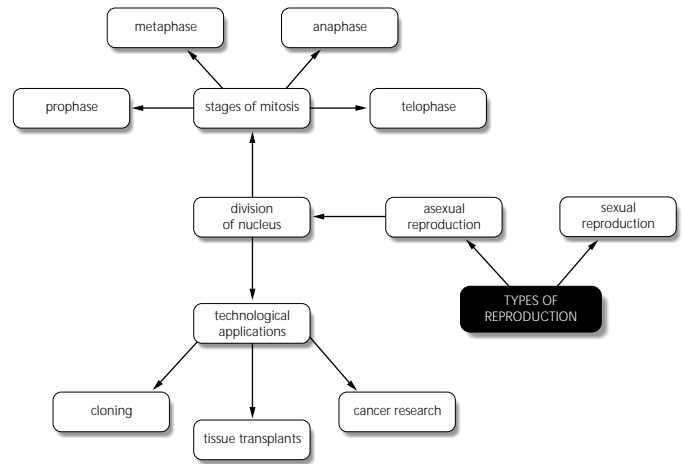
Cell part	Factory equivalent	Reason for comparison
nucleus	manager's office	The nucleus contains DNA, the codes for all cell activities; the manager has knowledge that directs factory operations.
mitochondria	generator/ power supply	The mitochondria release the energy for cell activity; factories need power to operate.
cell membrane	guards and gates to factory yard	The cell membrane controls what goes in and out of the cell; guards and gates control what enters and leaves the factory.
nuclear membrane	manager's administrative assistant/ secretary	The nuclear membrane controls what goes in and out of the nucleus; the secretary controls who goes into the manager's office.
Golgi apparatus	storeroom	The golgi complex stores proteins until needed; raw materials and product are stored in the storeroom until needed.
ribosomes	assembly/ production line	Ribosomes assemble proteins using information from DNA; the assembly/production line assembles the product using instructions from the manager.

Cell part	Factory equivalent	Reason for comparison
endoplasmic reticulum	conveyor belts/ elevators	The endoplasmic reticulum is an internal transport system; conveyor belts move materials around the factory and elevators move people.
chloroplasts	cafeteria/ food services	Chloroplasts make sugar for the cell to use for energy; the cafeteria provides food for the workers.

WS 2.4-1 Stages of Cell Division



WS 2-0-1 Concept Map, Cell Division



WS 2.0 Chapter 2 Quiz

Part A

- False, number
- False, DNA (deoxyribonucleic acid)
- True
- False, mutation
- True

Part B

- 32
- nucleolus
- carcinogen
- metastasis

Part C

10. (c); 11. (a); 12. (d); 13. (b)

Part D

14. (d); 15. (b); 16. (a); 17. (d); 18. (c)

Part E

- Cells were damaged when the cut was made. Cell division in surrounding cells formed new cells to replace the damaged ones.
- Cuttings can be rooted, and by vegetative reproduction grow into plants identical to the original parent plant (shrub, in this case). The operator hopes to quickly produce a large number of plants to sell.