Section 1.3 Cells from Cells (Student textbook pages 29 to 39)

Specific Expectations

- **B1.2** assess the importance to human health and/or society of medical imaging technologies used in Canada in diagnosing or treating abnormalities in tissues, organs, and/or systems
- **B2.1** use appropriate terminology related to cells, tissues, organs, and systems of living things, including, but not limited to: *absorption, anaphase, capillaries, concentration, differentiation, diffusion, meristematic, mesophyll, phloem, prophase, red blood cells, regeneration, stomate,* and *xylem*
- **B2.2** examine cells under a microscope or similar instrument to identify the various stages of mitosis in plants and animals
- **B2.5** investigate the rate of cell division in cancerous and non-cancerous cells, using pictures, videos, or images, and predict the impact of this rate of cell division on an organism
- **B3.1** describe the cell cycle in plants and animals, and explain the importance of mitosis for the growth of cells and repair of tissues
- **B3.2** explain the importance of cell division and cell specialization in generating new tissues and organs

In this section, students will learn about cell reproduction (mitosis). They will explore why cells undergo mitosis and the structural components that support the process. Students will also learn how cells obtain materials and remove waste through diffusion, and will explore osmosis as it relates to the passive diffusion of water.

Common Misconceptions

- Mitosis is not the only time organelles move in the cell. All organelles, molecules, and particles are in constant motion. Some move about the cell freely, with "waves" of cytosol, while others are attached to microtubules that help direct their movement.
- Students may expect to see cell activity when they look in the microscope. Explain that classroom samples are not alive, but "fixed" to illustrate a certain stage.
- Students generally struggle to keep the volume of terminology organized and use similar terms correctly. As they read, have students create a concept web to group terms. Encourage them to use diagrams when possible and identify prefixes (e.g., *pro-*, *meta-*, *ana-*, and *telo-*) to decode meaning.
- Students may experience some difficulty because of the multiple terms used to describe chromosomes (chromatids, sister chromatids, chromosome copy, DNA, etc.). As a class, create a word map for *chromosome* and post it on the classroom wall. Have students brainstorm other cases wherein multiple words are used to talk about the same thing (e.g., chicken, poultry, foul; or house, home, residence).

Background Knowledge

Diffusion happens fastest in gases, and slowest in solids (if there is enough space between molecules to allow diffusion at all). Because cells are made of liquids/solvents, diffusion is relatively slow.

In some cases, mitosis is initiated because a cell has grown too big to be efficient. Mitosis is such a dynamic, quick, necessary process of cell reproduction that it occurs somewhere in the adult human 25 million times every second. In addition to the chromosomal separation described in the text, the other organelles must be replicated for each daughter cell. Many organelles simply grow then bisect (during interphase, described in Section 1.4). This process is not as precise as chromosomal division, nor as critical. A cell can survive with extra mitochondria, for example, but an incorrect complement of chromosomes can mean cell death. The complex process of mitosis ensures (for the vast majority of nuclear divisions) that equal division of the replicated chromosomes occurs when the time is right.

The curriculum expectations do not require a deeper understanding of mitosis than is presented in the student textbook, but it may help to reinforce that the process is continuous (not discrete) by explaining that many sub-stages of the named phases have been identified and described in detail. For example, prometaphase (between prophase and metaphase). Many of these subphases include checkpoints that insure the quality of cell copies and the accuracy of cell division.

During mitosis, spindle fibres push and pull chromosomes by attaching to their centromeres via the kinetochores (protein complexes surrounding the centromeres). The spindle also defines the equator (where chromosomes station momentarily and where the cell will pinch in, initiating cytokinesis).

Plant and animal cells differ here. Animal cells contain a region called the centrosome, which is associated with a pair of centrioles made by the centrosome during interphase. During mitosis, these two sets of centrioles migrate away from each other, forming mitotic poles. One end of each spindle fibre innervates these two centrosome regions, while the other grows and radiates outward.

Centrioles are not required as a point of origin for spindle fibres in plants; plant centrosome regions lack centrioles (a few animal species also lack centrioles). In plants, centrosome regions are not clear prior to mitosis. However, once mitosis has begun, two poles are noticeable as the points of assembly and radiation for spindle fibres. Go to **www.scienceontario.ca** for more information on mitosis.

Literacy Support

Using the Text

- ELL Practise using the key terms using **BLM 1-3 Chapter 1 Key Terms.**
- Have students anticipate which statements in **BLM 1-4 Chapter 1 Anticipation Guide** may be discussed in this section.

Before Reading

- Have students return to their anticipation guide; review those statements that were discussed in Section 1.2, and prepare students for new learning by reviewing the other statements. Have students anticipate which statements may be discussed in this section by connecting to the title of the section.
- Some students may experience difficulty learning the terminology associated with cell division. Have a practice day for the terminology before students read the section and explore the process of mitosis in full. One way to do this is to play a practice game with students. Have students draw a couple of circles on their note page and then draw organelles that are called out by the teacher or students. Pay particular attention to the nucleus and nuclear structures like nucleolus and chromosomes. Next, carefully introduce centrioles (for animal cells drawings) and microtubules/spindle fibres. Some students may also need to practice using the different terms for chromosome (chromatid, sister chromatid, chromosome and its copy, DNA) BEFORE they begin a concentrated lesson on mitosis.

During Reading

- Have students do a think-pair-share activity to discuss what substances/molecules a cell needs to absorb and release to sustain life. Have students make a list, and then order the list from largest to smallest substance (in size).
- Have students do a think-pair-share activity to consider how cells absorb substances that cannot travel down their concentration gradient because there is a higher concentration inside the cell.

After Reading

- Ask students to predict which cells in the human body might need to perform mitosis (cell division) more often and/or more quickly than other cells.
- Have students create a flow chart cycle just for the phases of mitosis.
- Create a word wall, or visit an existing word wall to add new words and review old words.

Using the Images

- ELL Use Figure 1.24 and its caption to clarify what a chromosome is. Note the multiple terms used when discussing chromosomes. Biologists use *chromosome* to refer to both un-replicated and replicated pairs. This figure also illustrates the different sizes of chromosomes, and the locations of centromeres (not always in the centre). Link this to previous learning about genes and DNA by asking questions such as “Why are there different sizes of chromosomes?” and “What are chromosomes made of?”
- DI Ask logical-mathematical learners to compare the magnification of the micrograph in Figure 1.27 (400 times) to the magnification of the kidney cell in Figure 1.25 (1800 times). Ask which cell is smaller (or larger) and by how much.

- Have students summarize Figures 1.19, 1.26, and 1.27 in a table listing the type of organism, type of cell, characteristics, and unique characteristics of division in this type of cell.
- Explain that karyotyping (Figure 1.18) is done when chromosomes are most distinct, condensed, and separated: after prophase. However, this is also when chromosomes have duplicated, so we see sister-chromatid pairs. Explain to students that they are viewing 46 chromosomes attached to their copies, yet, for simplicity, we say that they are viewing 46 (different) chromosomes (when in fact, there are 92 strands in view). This is simply the convention of the system. Ask student pairs to take turns explaining to the other what they observe in this image.
- Use Figure 1.19 to help students differentiate between the use of mitosis in unicellular and multicellular organisms. The first grows the population, the latter grows (or repairs) the individual.
- Figure 1.25 summarizes the key points of the section. Encourage students to refer to it often. They may wish to add details on sticky notes as they read the section, or use this as a base for creating the graphic organizer on **BLM 1-12 Mitosis.**
- Have students identify the dark area the Figure 1.26 (chromosomes). Ask students to predict (before turning the page) how plant cytokinesis may differ.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learners**
Learning Check questions, pages 32, 36	Students identify diffusion as the mechanism by which substances cross the membrane until concentration is equal on both sides. They summarize the identifying features and structures of each phase of mitosis, using labelled diagrams.	Demonstrate diffusion. Contrast diffusion of a drop of dye in water to diffusion of coloured water across a membrane such as a coffee filter. Carry out a jigsaw activity where the class is divided into four groups, whose members will become experts in one phase using pages 34 and 35 of the student textbook, then regroup so that panels of four specialists help each other correct their organizers.
Activity 1-3 Modelling Mitosis, page 32	Models depict the identifying features and structures of each phase of mitosis.	Act out mitosis using the shoe activity described on the next page. Have students create a graphic organizer as described in Learning Check question 7, page 36 or Section 1.3 Review question 3, page 39.
Section 1.3 Review questions, page 39	Students identify the cell wall as a key difference between plant and animal cytokinesis.	Have students complete **BLM 1-12 Mitosis,** then trade organizers to gain insight and detect gaps in each others' understanding.

Instructional Strategies

- DI Introduce mitosis for logical-mathematical learners by drawing a large circle on the board with the number 46 in the middle. Have students identify 46 as the number of chromosomes in a human cell. Tell them this cell is too big and will split into two daughter cells. Ask, "How many chromosomes does each daughter cell need? How will it get these from the parent cell?" Draw a line down the middle of the "cell" or rip a paper model in half. Ask, "Does each daughter cell have the chromosomes or organelles it needs?" Cells are not symmetrical. This section explores how accurate replicates are made.

- DI Model mitosis for spatial and bodily-kinesthetic learners with a shoe activity. Create a circle in the middle of the classroom, big enough for all students to move around in (you may wish to use the gymnasium). Tie each of eight volunteers' shoes to a separate long string (2 m) and toss one shoe of each pair into the circle. This represents all the chromosomes in a fruit fly's cell. Tell students the cell has gotten too big for its own good and needs to divide. Have the volunteers enter the circle and tie their shoes together (prophase). Then, have two students gather one string from each shoe pair and move to poles of the cell circle (metaphase). Have a third student enter the circle and disconnect the paired shoes so the other two students can drag the shoes toward their poles (anaphase). If the circle outline is movable, you can now pinch the cell in the middle, separating the two students with their collection of shoes into two separate cells (telophase and then cytokinesis): knotted shoes = centromere; shoe = chromosome; string = spindle fibres.
- Illustrate diffusion for concrete learners by placing a smelly object at one corner of the classroom (e.g., coffee or mint) and asking students to raise their hand when they can smell it. Beware of allergies. Assign one student to time this diffusion across the classroom. Point out that the smell moved from an area of high concentration (near the object) to areas of lower concentration (across the room).
- To demonstrate the rate of diffusion in a semi-solid, have a student knead a drop of food colouring through a lump of dough.
- DI ELL Linguistic, musical, and English language learners may benefit from creating a very short rhyme, poem, or song outlining the sequence of mitosis.
  Example:
  PMAT is the shortform for the precision
  Of cells when performing nuclear division
  Mitosis ensures that daughter cells will be
  The same in chromosome number as originally
- ELL Allow students to show their comprehension of mitosis in a way of their choosing. For example, a diagram, model, narrative, or animation.
- Show a video or animation of mitosis to show that the process is gradual and dynamic, without distinct steps. You might also convey at this point that the process is fast, occurring millions of times each second.
- Ensure students have an opportunity to explore mitosis in words, pictures, graphic organizers, and models. Encourage them to use correct terminology in each case. **BLM 1-12 Mitosis** scaffolds the making of a graphic organizer that consolidates words and pictures, developing both a study tool and an answer to Learning Check question 7 and Section 1.3 Review question 3.

Activity 1-3 Modelling Mitosis (Student textbook page 36)

Pedagogical Purpose

Mitosis is an intricate process, dynamic and full of details. Hands-on modelling of such a sequentially elaborate process encourages exploration of the phases while building big picture understanding.

Students will need to move around the classroom to arrange models in the order in which mitosis occurs.

Planning		
Materials	Coloured paper Poster paper Scissors Construction materials such as: toothpicks, string, twist-ties, paper clips, pipe cleaners, tongue depressors, yarn, elastic bands, thread	Markers Glue
Time	20 min to gather materials 10 min to perform You may wish to have students pre-select materials and gather them from home.	
Safety	Use caution when working with scissors. Ensure students can move around safely. Glue is mildly toxic.	

Background

Threads are a good representation of chromosomes, considering the Greek term mitosis means "thread."

Activity Notes and Troubleshooting

- The day before, ask students to bring materials from home.
- Have students work individually but grouped (in four) according to the phase of mitosis they are modelling so that they may support each other.
- **BLM G-17 Using Models and Analogies in Science** may help students get started. **BLM A-6 Developing Models Checklist** can help students check for completemess.
- Enrichment—Have students manipulate one model (any phase) to illustrate the next phase. This should show them how elements move between phases.
- Use **BLM A-26 Developing Models Rubric** to assess students' models.

Additional Support

- DI This is an excellent activity for spatial and bodily-kinesthetic learners.
- DI Linguistic learners may find that starting by writing a caption for their model helps them organize the elements and concept they need to show.
- ELL Have students label each other's models.
- ELL Have students create a graphic organizer of key elements prior to creating the model. Answering Learning Check question 7 may help them with this process.
- Allow students to create a dynamic or interactive model such as a play or animation.

Answers

1. Example: The materials represent the structure or relative size of the feature. Paper may represent the background structure of the entire cell, pipe cleaners may represent chromosomes, and elastic bands may represent spindle fibres.
2. early prophase and late telophase
3. two

Learning Check Answers (Student textbook page 32)

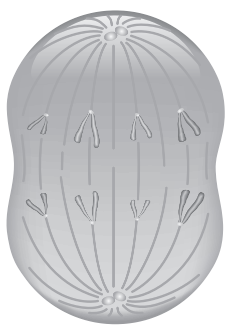
1. Substances cross a cell membrane (if allowed) moving from an area of high concentration to an area of lower concentration until the concentration of the substance is the same on both sides of the membrane.
2. identical
3. to allow the organism to grow, and to replace lost or damaged cells
4. Example: No, because a single-celled organism cannot get big enough to be a threat.

Learning Check Answers (Student textbook page 36)

5. DNA is replicated so there are two copies of each chromosome, one for each daughter cell.
6. spindle fibre, centrosome, and centromere
7. Example:
   Prophase-sister chromatids condense, chromosomes become visible and move to opposite sides, spindle fibres form, and nuclear membrane breaks down.

Metaphase-chromosomes align across centre of the cell, and centromeres attach to one spindle fibre from either end of the cell

Anaphase-centromere splits apart and chromatids are pulled to opposite sides of the cell by spindle fibres



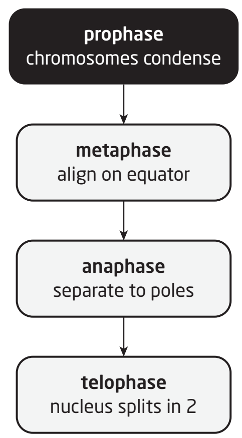
Telophase-two daughter nuclei are formed, spindle fibres disappear

8. Example: Skin cells, because they are constantly replacing dead and damaged cells, and because skin is the largest organ.

Section 1.3 Review Answers (Student textbook pages 39)

Please also see **BLM 1-13 Section 1.3 Review (Alternative Format).**

1. Example: to achieve a more effective volume to surface area ratio (i.e., they got too big), for an organism to grow, and to replace dead or damaged cells
2. Telophase may be thought of as the reverse of prophase. In prophase, the chromosomes coil and become visible, the nuclear membrane begins to break down and the nucleolus disappears, the centrosomes duplicate and the spindle fibres begin to form and attach to the chromosomes. In telophase, the nucleolus appears and the nuclear membrane reforms, the chromosomes uncoil and become invisible, and the spindle fibres break down.
3. Example:



4. *pro-* before, the cell is getting ready to divide; *meta-* mid, centromeres line up across centre; *ana-* back, spindle fibres snap back to ends of cell; *telo-* end, the final phase
5. 20, 10
6. Diagrams should emphasize the "elastic band" type of pinching that occurs in animal cells and the central wall (cell plate) building that occurs in plant cells, as shown in Figures 1.26 and 1.27 on pages 37 and 38 of the student textbook.
7. Coiled chromosomes are visible, so the cell must be undergoing DNA replication.
8. Example: Environmental temperature may limit the size of southern organisms because smaller individuals can cool themselves more efficiently (because of the volume to surface area ratio). Conversely, larger organisms may be better able to maintain heat.