Science Inquiry

Science Instructional Lesson Type

Uncommon Schools | Change History.

Do Now & Launch → **Build Evidence** → **Discuss** → **Stamp** → **Apply** → **Assessment**

Lesson Plan Background	
Teacher:	**Lesson:** U4L6 (50 min)
Course: AP Biology	**Unit:** 4
Objectives	
Skills/Content: SWBAT explain how mitosis results in the transmission of chromosomes from one generation to the next.	**Standard:** IST-1.D IST-1.E

Lesson Goals

Guiding Question: How and why is genetic material transmitted from one generation to the next?

In the previous lesson, students learned how organisms regulate processes through negative and positive feedback. One of these highly regulated processes is cell division, or mitosis. In this lesson, students will analyze a graph of DNA mass per cell vs phase and diagrams of the various phases of mitosis. For each phase, students will draw a brief sketch and describe what occurs in each phase. In the discussion, students will explain why each phase is necessary to form the products of mitosis. In this lesson, teachers should focus more on the overall goal of mitosis instead of students simply memorizing each step. Students will have an opportunity to take detailed notes on the phases in tonight's homework assignment.

Planning

Planning

Vocabulary:

- **Genome**
- **Interphase**
- **Mitosis**
- **Sister chromatids**
- **Daughter cells**
- **G1/S/G2**
- **Kinetochores**
- **Microtubules**
- **Prophase**
- **Metaphase**
- **Anaphase**
- **Telophase**
- **Spindle Fibers**
- **Genetically identical**

Key Understanding/Skill:

- Mitosis is a process that ensures the transfer of a complete genome from a parent cell to two genetically identical daughter cells. Mitosis alternates with interphase in the cell cycle.
- DNA is duplicated during the S phase of a cell, followed by the G2 phase, where DNA replication is checked. Mitosis then occurs in a sequential series of steps (prophase, metaphase, anaphase, telophase) where sister chromatids are condensed, attached to spindle fibers, aligned at the equator of the cell, and pulled apart by the spindle fibers into two genetically identical daughter cells.
- Mitosis is necessary for organism growth, tissue repair, and asexual reproduction.

Setup/Materials

- Color copy of U4L6_APBiology_Mitosis_Models_SHO (1 per group of 2)

Exit Ticket (4 min)

Exemplar

1. *Insert MCQ about the Cell Cycle from AP Classroom Question Bank here.*
2. *Insert MCQ about the Cell Cycle from AP Classroom Question Bank here.*

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<table>
<tr><td></td><td>Start to Class</td></tr>
<tr><td>Do Now & Review

(6 min./6)</td><td>
Do Now (4 minutes):
1: (C) Cell A is the most efficient at exchanging heat energy and nutrients, because (E)it has the highest surface area-to-volume ratio. (R)The cell has a large amount of surface area on which to exchange heat energy and nutrients and its small volume allows these substances to reach all parts of the cell.

2: If large organisms were composed of just one cell, the surface area-to-volume ratio would be extremely low, leading to inefficient transfer of heat energy and nutrients. Therefore, large organisms exist as multiple tiny cells which are more efficient at exchange of heat energy and nutrients. This ensures that these essential substances are delivered to all parts of the organism.

3a: Increase in height is caused by increased division of cells to form new cells.
3b: The cut opened into the skin is closed within 3-4 days because the division of cells to form new cells closes the wound.

Note: Students may or may not mention mitosis, which is fine; this is a chance for students to start thinking about the purpose.

Monitoring Laps:
<table>
<tr><th>#...</th><th>...for:</th><th>If mastery is...</th><th>...respond by:</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Cell A – highest surface area-to-volume ratio</td><td>>70%</td><td>Move on to Lap 2</td></tr>
<tr><td><70%</td><td>Stop the Show (<45 sec)</td></tr>
<tr><td>2</td><td>Large cells result in a lower surface area-to-volume ratio</td><td colspan="2">Note trend in mastery, common error and students to call on.</td></tr>
<tr><td>3</td><td>Mentioning “Cell division” or “mitosis”</td><td colspan="2">Note trend in mastery, common error and students to call on.</td></tr>
</table>
Review:

Show-call an almost-there response for question 1 and have students evaluate for claim, evidence, and reasoning.

What is your claim? What evidence do you have to support the claim? What is your reasoning?
Stamp in bullet 1 of stamp below.

T&T: Why is it important that individual cells remain small? [To maintain a high surface area-to-volume ratio, which allows for the most efficient exchange of nutrients.]
T&T: Why do cells within an organism need to divide? [So that organisms can grow and damaged tissue can be repaired.]

Mini-Stamp:

Cells with a higher surface area-to-volume ratio are the most efficient at nutrient transfer because the cell has a large surface area on which to exchange nutrients, and a smaller volume that these nutrients must reach.
Individual cells must remain small to allow for an efficient exchange of nutrients and heat energy.
Cells need to divide into more cells for organism growth and repair.

</td></tr>
<tr><td>Daily Drill (6 min/12)</td><td>
Vocabulary Drill (4 min):
T: Today we are going to practice describing a signal transduction pathway using precise vocabulary. As you respond to the prompt, reference the checklist to make sure you are using ALL the correct terms.
Teacher Note – As students are writing, monitor for an exemplar response.

Exemplar
The pathway is initiated by reception, when a ligand binds to a specific receptor. The binding of the ligand to the receptor changes the shape of the receptor and initiates the transduction pathway inside the cell. The transduction pathway consists of a signaling cascade, where multiple proteins are activated via phosphorylation. At the end of the cascade, the response is triggered when a protein transcribes the targeted portion of the gene.
</td></tr>
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Science Inquiry

Science Instructional Lesson Type

Uncommon Schools | Change History.

	Review (2 min) • Show-call an exemplar response. • Have students T&T: *Compare your response to the exemplar. What terms did you miss or use incorrectly and what do you need to remember for next time?* (COLD CALL 2-3 students to share out.) • Collect this drill and grade to give students specific feedback on vocabulary.
Launch (2 min/14)	**Guiding Question: How and why is genetic material transmitted from one generation to the next?** **T:** *Yesterday, we saw how all biological processes are controlled through feedback mechanisms. For the next three days, we are going to dive into one crucial process that is highly regulated – the cell cycle, where the cell grows and divides.* **T&T:** *T&T to your partner – what are some reasons that cell division is essential?* (COLD CALL – Cells must divide to support organism growth and repair.) **Bright Line:** *Today we will briefly analyze the cell cycle as a whole but spend most of our time on the process of mitosis to explain how cells pass on genetic material from one generation to the next. Turn to page 3 of your packet and open your notebooks. We will begin by analyzing a model of the cell cycle and the process of mitosis.*

Inquiry (16 min./30)

Summary:

- Students will analyze a graph of amount of DNA in a cell vs cell cycle phase and a model of the phases of mitosis. Students will use the models to provide evidence for how and why the process of mitosis occurs during the discussion. Note that students do not need to memorize the specific phases of mitosis; rather, students should be able to explain the purpose of each phase.

Setup (16 min):

- **3 minutes:** Students independently answer 1 a and 1 b.
- **8 minutes:** In pairs, students fill in the table (this should go in notebooks so students can use it as a reference). Before students fill in the table, say: *On your tables, you have a model of the different phases of mitosis. Our goal is not to memorize the phases of mitosis, but to explain how the events in each phase allow the cell to divide into two identical daughter cells.*
- **5 minutes:** Students independently answer questions 3 and 4.

Academic Monitoring:

Question #	Monitor For	Common Error	How to Respond
1	Stating that DNA was doubled, then halved back to original amount.	Students may not specify that DNA is halved back to original amount and just say "halved"	*If the cell starts out with x amount of DNA, how much DNA is present in a cell after the cell cycle is complete?*
2	Accurate descriptions and sketches; use of vocabulary from the model in descriptions.	Chromosome number in each sketch may not be consistent.	Stop the show: *Make sure that the chromosome numbers in each cell are the same as in the model.*
3 and 4	Mitosis is essential for organism growth and tissue repair. Use of accurate vocabulary to respond to question 4. Stating that genetically identical daughter cells are produced through mitosis.	Students may state that DNA is replicated during mitosis. Students may not specifically use the terminology: genetically identical daughter cells.	Make note of students with exemplar/close-to-exemplar responses to cold call during discussion.

Science Inquiry

Science Instructional Lesson Type

Uncommon Schools | Change History.

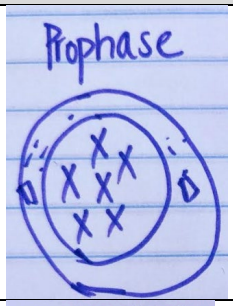
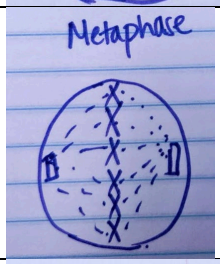
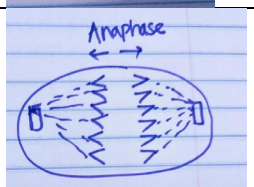
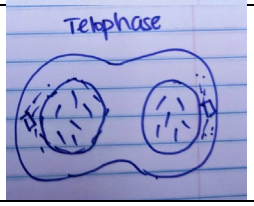
Exemplar:

1a: During interphase, the cell grows, duplicates its DNA, and checks that the DNA duplication was accurate and complete. The cell divides during mitosis.

1b: The amount of DNA is doubled (2x) during the S phase.

1c: The DNA that was doubled is now halved, resulting in the original amount of DNA.

2:

Phase Name		Sketch	How does this step help the cell divide into two identical daughter cells?
Interphase	G1		Cell growth, duplication of cell structures. Cell must be of appropriate size to divide.
	Synthesis		Duplicate DNA to create an identical copy so that each cell receives a complete copy of DNA.
	G2		Check that DNA is correctly and completely copied so that each cell receives accurate and complete DNA.
Mitosis	Prophase, Prometaphase		Chromatin condenses into chromosomes for more organized division. Centrosomes move to opposite poles. Nuclear envelope breaks down. Kinetochores (spindle fibers) are connected to poles and chromosomes.
	Metaphase		Centrosome/kinetochore complexes align in a plane, which is often at the cell's equator. This allows cell to divide in half.
	Anaphase		Paired sister chromatids separate, and new daughter chromosomes move towards poles.
	Telophase		Daughter chromosomes reach poles. Nuclear envelope reforms, chromatin decondenses. After cytokinesis, identical daughter cells enter interphase once again.

3: Mitosis is used for organism growth, single-celled organism reproduction, or tissue repair in organisms.

Science Inquiry

Science Instructional Lesson Type

Uncommon Schools | Change History.

	4: Genetic material is transmitted from one generation to the next through the process of interphase and mitosis. During the S phase of interphase, DNA is replicated. When the cell enters mitosis, the sister chromatids are condensed and attached to spindle fibers. The chromatids are arranged in a line on the cell equator and pulled apart by the spindle fibers so that each daughter cell has an identical copy of chromosomes. This process of cell division supports organism growth and tissue repair.
Discuss (7 min./37)	**Discourse Overview:** • Students will explain the phases of mitosis and how they contribute to the end product of mitosis. Teachers should encourage students to think about why each phase is necessary. **Show Call Student Work or Relevant Diagram:** • Show-call the mitosis model. **Overarching Question:** • T&T: *How and why is genetic material transmitted from one generation to the next?* • Call on 3-4 students to share out before teacher intervenes. • Prompt students to agree/disagree/build off each other. • Use the "Elicit evidence" prompts below to encourage students to pull evidence from the • Use the "Deepen the reasoning" prompts below to have students consider the purpose of each phase. **Elicit the Evidence:** • *What occurs in each phase of mitosis?* • *How many chromosomes does each daughter cell have?* • *What is the difference between sister chromatids and a chromosome?* • *How does the mass of DNA change as the cell cycles through each phase?* **Deepen the Reasoning:** • *Why must the cell go through the S phase before going through mitosis?* • *What is the importance of the G2 phase?* • *Why is it important that chromosomes are condensed before they are attached to spindle fibers?* • *Why do chromosomes align on the cell equator in metaphase?*
Stamp the Under-standing (3 min./40)	**Stamp: How and why is genetic material transmitted from one generation to the next?** • Mitosis is a process that ensures the transfer of a complete genome from a parent cell to two genetically identical daughter cells. Mitosis alternates with interphase in the cell cycle. • DNA is duplicated during the S phase of a cell, followed by the G2 phase, where DNA replication is checked. Mitosis then occurs in a sequential series of steps (prophase, metaphase, anaphase, telophase) where sister chromatids are condensed, attached to spindle fibers, aligned at the equator of the cell, and separated into two genetically identical daughter cells. • Mitosis is necessary for organism growth, tissue repair, and asexual reproduction.
Apply (6 min/46)	**Setup:** • Students practice for 5 minutes with questions 1-3, followed by review. **Monitoring:** • Ensure that all student can answer #1 correctly. • For #2 and #3: Students should state that parent cell and daughter cell are genetically identical and have the same number of chromosomes. **Review**: • COLD CALL a student to respond to #1: *Why is the answer B and NOT A?* • Have students T&T for question 2 and 3: *What is true about the number of chromosomes in the parent cell and in each identical daughter cell?* Stamp in bullet 1.

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	Exemplar **1: B** **2a: 2** **2b: 2** **2c: The amount of DNA in the daughter cells is the same as that in the parent cells.** **3: Student B is correct. Before undergoing mitosis, the chromosomes in the parent cell are duplicated. These duplicated chromosomes (sister chromatids) are separated during anaphase and telophase in mitosis into two daughter cells. This leaves each daughter cell with 32 chromosomes.**
Reference	Teachers are encouraged to read Teach Like a Champion: 49 Techniques that Put Students on the Path to College by Doug Lemov, an Uncommon Schools publication, to better understand the methods of teaching employed in this lesson.