Lesson Title: The Stages of Mitosis

Essential Questions
What is mitosis and why does it occur?
How do cells divide?

Lesson Rationale
Students need hands-on practice with the scientific method, engaging with material that deepens their understanding of foundational science concepts. During this lesson, students take notes on the phases of mitosis and then model each stage of mitosis with manipulatives. In part two, students continue working with the concept of mitosis based on their observations. They practice creating ratios, proportions, and solving for x using cross-multiplication by analyzing images of onion root cells.

<table>
<thead>
<tr>
<th>CCRS Standards</th>
<th>CCTC Standards</th>
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<tbody>
<tr>
<td>• Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.</td>
<td>• Communicate clearly, effectively, and with reason.</td>
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<tr>
<td>• Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings.</td>
<td>• Demonstrate creativity and innovation.</td>
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<td>• Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.</td>
<td>• Use critical thinking to make sense of problems and persevere in solving them.</td>
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<tr>
<td>• Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.</td>
<td>• Work productively in teams.</td>
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<td>• Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.</td>
<td>• Apply critical thinking skills to review information, explain statistical analysis, and to translate, interpret and summarize research and statistical data.</td>
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<tr>
<td>• Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.</td>
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## Bridge to Science: Stages of Mitosis

<table>
<thead>
<tr>
<th>Academic Skills</th>
<th>Sector-Focused Content</th>
</tr>
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<tbody>
<tr>
<td>• Identify patterns and categorize according to patterns</td>
<td>• The process of mitosis</td>
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<tr>
<td>• Make observations about appearance and structure of cells</td>
<td>• The phases of mitosis in sample cells</td>
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<tr>
<td>• Collect, organize and analyze data</td>
<td>• The scientific method</td>
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<td>• Compare different representations of data</td>
<td>• Vocabulary of the cell</td>
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<td>• Explain phenomena of mitosis</td>
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<tr>
<th>Professional/Affective Skills</th>
<th>Academic Content</th>
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<tr>
<td>• Work productively as a member of a team (or with a partner)</td>
<td>Percent, ratio</td>
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<tr>
<td>• Present and share work in small and large groups</td>
<td>Degrees</td>
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<tr>
<td>•Persist with a difficult task</td>
<td>Graphic representations of data</td>
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<thead>
<tr>
<th>Evidence of Learning</th>
<th>Assessment</th>
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<tbody>
<tr>
<td>Modeling the Phases of Mitosis handout, models Charts with phases of mitosis data Onion Root Tip handout responses Whole class presentations</td>
<td>• Circulate during group work to assess teamwork skills and individual understanding</td>
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<td>• Collect students’ Onion Root Tip handout to monitor for understanding</td>
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<td>• Review presentation of data and charts</td>
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<td>• Optional: rubric to assess presentations</td>
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### Materials & Resources
- Lesson handouts and instructions
- Overhead projector
- Mitosis video [http://vcell.ndsu.edu/animations/mitosis/movie-flash.htm](http://vcell.ndsu.edu/animations/mitosis/movie-flash.htm)
- Pipecleaners
- Popsicle sticks
- String
- Index Cards
- Paper star
- Brass fastener
Camera
Compass
Chart paper & markers

The Immortal Life of Henrietta Lacks

Background information

After becoming familiar with the concept of cells through the introduction to the book *The Immortal Life of Henrietta Lacks*, students learn about the process of mitosis, or cell division.

Part 1

Steps:

Whole Class Work: 10 minutes
1. Hand out a photograph of stained onion root cells. Students will identify 5 distinct cell formations and sketch these on the provided hand out. Students will then be asked to make some observations about the cells.

Share Out: 10 minutes
2. Record these observations on the board and explain that some of the cells are empty because these are three-dimensional cells, but we are looking at just thin slices of them. If you slice a hardboiled egg at random, would you definitely see the yolk in your slice? Instruct students to ignore cells where they cannot see dark areas.

Small Group Work: 30 minutes
3. Watch the mitosis video at least twice and have students take notes on their handout.

4. Distribute the “Modeling the Stages of Mitosis” handout and review the instructions. In pairs or groups of three, students will use the materials they are given to create a model of each stage of mitosis and write a description of what is happening in their own words. Students will then take a picture of each stage with the written description.

Whole Class Discussion: 10 minutes
5. Project the photos students have taken of the stages of mitosis and invite students to share their work with the class describing the activity in the cells during each stage of mitosis.
Part 2

Steps:

**Independent work: 15 minutes**
1. Give students the two short readings and ask them to annotate with questions and connections to what they have already learned about cells.
2. Ask students to answer the questions on the "Cells: The Most Basic Unit of Life" handout.
3. After giving time for students to work, briefly take two to three responses for each question.

**Small Group Work: 20 minutes**
4. Divide students into groups of three or four. Invite them to work on the “Collecting Data” and “Using Proportions” handouts. While students are working in groups, move through the room, making sure that everyone understands the questions and knows what to do.

**Whole Class Discussion: 15 minutes**
5. Invite each group to present their solutions to the class. Ask students if they notice any similarities or differences in their answers. Once all the questions are discussed, ask students to reflect on their process of solving the problems, asking the following questions:
   - What difficulties did you have when looking for an answer?
   - How did you overcome them?
   - What similarities and differences do you notice between solutions to the problems?
   - Are there different ways to solve the same problem?

Part 3

Steps:

**Small Group Work: 30 minutes**
1. In their small groups, students use data collected about the number of cells in each stage to calculate percentages and find the degree on a pie graph, as instructed on the “Graphing the Data” handout.
2. Students then plot their data on a template which they will transfer to chart paper when they have finished.

**Group Presentations**
3. Students will have the opportunity to share their work and describe their process for collecting and interpreting the data they found.
Stages of Mitosis

As you watch the video, take notes on the following stages and cellular structures.

Mitosis
Cytokinesis
Mitotic Phase
  Prophase
  Prometaphase
  Metaphase
  Anaphase
  Telophase
Interphase
  G1
  S
  G2
Chromosome
Microtubules
Centrosome
Nucleus
Kineticore
Chromatid
Nuclear membrane
Modeling the Stages of Mitosis

Using your notes and what you’ve learned about mitosis, create a model of each stage of mitosis using the supplies you are given. Use the following tips to guide you:

- **Model each stage of mitosis** with the supplies you are given. Use the key below to guide your group in representing the cell.
- **Describe what is happening** in each phase of mitosis on an index card: with the microtubules, chromosomes/chromatids, nuclear membrane, centrioles and kinetochores.
- **Take a picture** of your model, including the index card.

### KEY

**Pipe cleaner:** microtubules

**Popsicle sticks:** chromosomes/chromatids

**String:** nuclear membrane

**Paper star:** centrioles

**Brass fastener:** kinetochores
Cells: The Most Basic Unit of Life

1. Where do cells come from? How do cells reproduce? The text message to the right might give you some clues.

2. What do you notice about the onion root tip you've been given? What questions or comments do you have about it?

Fun Cell Facts

- The biggest cell in the world is the ostrich egg.
- It is believed that there are more nerve cells in your brain than stars in the Milky Way.
- There are anywhere from 75 to 100 trillion cells in our body. (A trillion is 12 zeros).

3. Are there any connections between the text you read about mitosis and this image of an onion root tip? Quote a line or two from the text and explain how it might be connected to this image.
Why do Cells Divide?

Humans have about $10^{14}$ cells. There are many types of cells in our body in each and every organ. For example, skin has skin cells, hair has hair cells, and the kidney has kidney cells, and so on. In adult humans, adult nerve and muscle cells do not divide at all. Liver cells divide once a year. Blood cells in the bone-marrow divide more than once per day, and the same holds true even for the cells lining the gut.

It was believed, until recently, that brain cells did not regenerate. They simply make new contacts. Recent research has shown that some regeneration can occur, but this is still in dispute.

Why do we use onion root tips to study mitosis?

In plants, roots continue to grow as they search for water and nutrients. These regions of growth are good for studying the cell cycle because they grow quickly and at any given time, you can find cells that are undergoing mitosis.

In order to examine cells in the tip of an onion root, a thin slice of the root is placed onto a microscope slide and stained so the chromosomes will be visible. The cells you'll be looking at in this activity were photographed with a light microscope.

Although slicing the onion root captures many cells in different phases of the cell cycle, keep in mind that the cell cycle is a continuous process. Scientists have divided the process into 5 phases, each characterized by important events, but these divisions are still arbitrary.
Collecting Data

With your group, identify the number of cells in each phases of mitosis in the sample of an onion root given to you. Use the figure above to guide you and the table below to record your findings.

<table>
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<tr>
<th>Phase</th>
<th># of cells</th>
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<tr>
<td>Interphase</td>
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<td>Early Prophase</td>
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<td>Mid Prophase</td>
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<td>Metaphase</td>
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<tr>
<td>Anaphase</td>
<td></td>
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<tr>
<td>Telophase</td>
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Total cells
Using Proportions to Make Predictions About Mitosis

1. Use the table below to calculate how many cells in anaphase you could expect to find in an onion root tip sample with 100 total cells.

2. Use a proportion to show how many cells an onion root tip with 360 total cells would have in anaphase.

3. Use a proportion to show how many cells an onion root sample with 8 cells in prophase would likely have in telophase.
### Graphing the Data

#### DIRECTIONS

1. Calculate the percentages for each of the five stages of the Cell Cycle.
2. Express this data on both the pie graph and the bar graph.
3. Find the degrees in each slice of the pie (a circle has 360 degrees) and use a protractor to measure and draw this. (Display slices clockwise in descending order)
4. Label the each slice of the pie graph with the fraction and percent it represents.
5. Label your bar graph with the number of cells/percent on the y-axis (vertical) and the phase on the x-axis (horizontal).
6. Label your graphs and key and put them on chart paper.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Ratio</th>
<th>Percent</th>
<th>Degrees</th>
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1. In what stage were the majority of the cells in the water-treated root tips? Why do you think this is the case?

2. Explain how you converted from percents to degrees.

3. What are some connections between “Mindset” and what you have learned about cells in this activity?