The Cell Cycle

MIDDLE GRADES SCIENCE NSPIRED

TEACHER NOTES

Science Objectives

- Students will identify the changes that occur in cells during each phase of mitosis.
- Students will correlate these changes to the duration of time cells spend in each phase.
- While looking at a section of an onion root tip, students will count the number of cells observed in each phase of the cell cycle. They will then estimate the amount of time that a cell spends in each of the phases of the cell cycle.
- Students will watch a simulation of the process of mitosis and answer accompanying questions.

Vocabulary

- anaphase
- cell cycle
- chromosomes
- interphase
- metaphase
- mitosis
- nucleus
- prophase
- telophase

About the Lesson

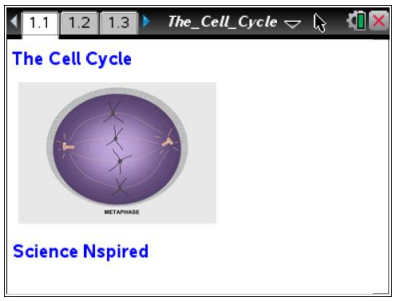
- In this lesson students investigate the cell cycle, which includes interphase and mitosis.
- Students will:
  - Identify the major changes that occur in a cell during each phase of mitosis by watching a simulation.
  - Correlate the time a cell spends in each phase with the number of cells in a rapidly dividing region of an onion root tip undergoing each phase.
  - Understand the implications of the differences between cells that have long or short cell cycles.

TI-Nspire™ Navigator™

- Send out the *The_Cell_Cycle.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

- This activity includes class captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- The_Cell_Cycle_Student.doc
- The_Cell_Cycle_Student.pdf

TI-Nspire document

- The_Cell_Cycle.tns

Discussion Points and Possible Answers

Allow students to read the background information stated on their activity sheet and then in the .tns file on pages 1.2 and 1.3.

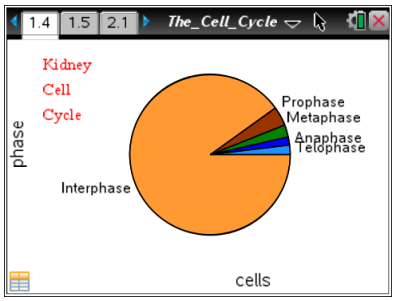
Move to pages 1.4 and 1.5.

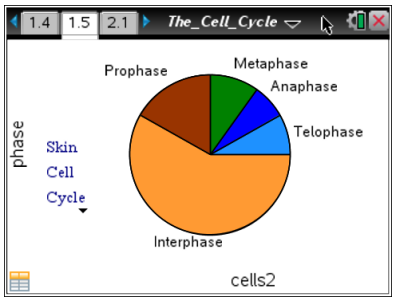
Have students answer questions 1 - 10 on their activity sheet.

1. When the students analyze the pie charts of the cell cycles of kidney and skin cells, remind them that the mitosis portion of the cell cycle generally lasts for the same amount of time for each type of cell.

   The variation in the lengths of the cell cycle occurs in the interphase. For example, some cells may have a cell-cycle duration of 48 hours, half of which is in interphase and half is in mitosis.

   Liver cells, on the other hand, may divide only once a year, even though the mitosis portion may last only 24 hours, just as with a skin cell. Students should use proportions to answer the following questions.





iPad Tip: To see the number of cells in the sample that are in a particular phase, students can tap on each phase in the pie chart.

Q1. Select each phase in the Kidney Cell Cycle pie chart. You will see the number of cells in the sample that are in each of the different phases. Record the number of cells in each phase in the table that follows. Add the number of cells in prophase, metaphase, anaphase, and telophase to find the total number of cells in mitosis. Then do the same for the Skin Cell Cycle pie chart.

Answers:

Phase	Kidney	Skin
Prophase	10	10
Metaphase	6	6
Anaphase	4	4
Telophase	5	5
Total in Mitosis	25	25
Interphase	225	35

Q2. Suppose the mitosis portion of the cell cycle lasts for 24 hours in both kidney cells and skin cells. Estimate how long interphase lasts in each cell by solving the proportion for *x*, the number of hours of interphase.

$$\frac{\#\text{ of cells in mitosis}}{\#\text{ of cells in interphase}} = \frac{24}{x}$$

Note: Remember your answer is in hours. Divide it by 24 to also see how many days it lasts.

Answers: Kidney Cell: $\frac{25}{225} = \frac{24}{x}$, approx. 216 hours or 9 days

Skin Cell: $\frac{25}{35} = \frac{24}{x}$, approx. 33 to 34 hours or about a day and a half

Q3. Mitosis includes 4 mitotic phases: prophase, metaphase, anaphase and telophase. Estimate how long each of the 4 mitotic phases lasts in skin cell mitosis. Use the formula below.

$$\frac{\#\text{ of cells in phase}}{\text{total }\#\text{ of cells in mitosis}} \times 24$$

Answer: Prophase: 10 hours Metaphase: 6 hours Anaphase: 4 hours Telophase: 5 hours

Q4. How long is each of the 4 phases in kidney cell mitosis?

Answer: Prophase: 10 hours Metaphase: 6 hours Anaphase: 4 hours Telophase: 5 hours

Q5. Estimate the length of one entire cell cycle (mitosis and interphase combined) in each of the cell types in the activity.

Answer: Kidney Cell: approx. 10 days Skin Cell: approx. 55 hours

Q6. You're looking in a microscope at a tissue sample of living cells. In which stage of the cell cycle would you expect to find the most cells? In which stage would you expect to find the fewest cells?

Answer: Most: Interphase Fewest: Anaphase

Q7. Which of the two types of cells, kidney or skin, divides more often? Explain.

Possible Answer: Skin cells divide more often. The cell cycle is shorter, which means that they go through mitosis more frequently. This is so because skin cells need to be replaced more frequently than kidney cells do.

Q8. The process of mitosis produces new body cells for you. What are two reasons your body needs to produce new cells?

Possible Answers: growth, repair, replacing dead cells

Q9. When, (at what stages), during a human's lifetime, would you expect to find lots and lots of cells undergoing mitosis? When would you expect to find fewer? Explain both of your answers.

Possible Answer: Find lots in a developing fetus, in an infant, during the “growth spurt” years. Find fewer in middle-age and beyond.

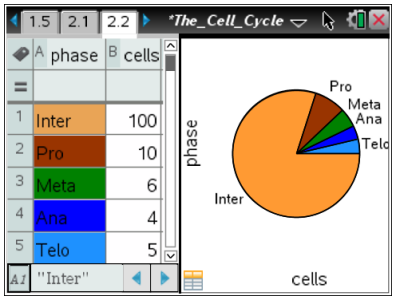
Q10. Interphase is an equally important part of the cell cycle. It is when the cell really does its regular job, such as filtering blood for kidney cells or digesting food in the stomach. During this time, the cell can consume energy and can perform cell functions. Based on what you now know about the cell cycle, what might happen if interphase did not have enough time before mitosis?

Possible Answer: Cells that don’t have enough time in interphase may not have the energy resources to make it through mitosis. Some cell types stay in interphase for a long time because they don’t die often, too much mitosis could lead to unchecked cell growth (including cancer), or failure to divide properly.

Teacher Tip: Students often get confused about the point of interphase, and wonder why it takes so long to divide. Be sure to point out that cell division is not the only purpose of a cell; the other important functions can happen during interphase.

Move to pages 2.1 and 2.2.

2. In this part of the activity, students will interact with the .tns document. The spreadsheet on page 2.2 contains arbitrary data collected from an imaginary biology student. The student looked at a prepared microscope slide with a longitudinal section of actively dividing onion root tip tissue and counted the number of cells that she observed in each phase of the cell cycle. The numbers have been recorded in Column 2 of the spreadsheet, and then displayed in the adjacent pie chart.



In order for your students to interact with this page, you may choose one of three possible options:

A) Have students examine their own onion root tip slides and count the number of cells in each phase. The protocol for that process will not be included here, but can be found on several websites. If this is what you wish to do, have the students count cells while looking at the section on either medium or high power, and have them look in the area just "above" the tip of the root. If time permits, have them do cell counts from 3-4 different areas on the same slide, or on different slides and enter the total number of cells from all of the counts. The more cells they count, the more accurate their results may be.

B) Many biological supply companies sell "flash cards" with pictures of onion root tip sections on them. This is a quick, easy, and accurate way to count the cells, although the students will not be given the opportunity to use the microscope.

C) Have the students simply change the numbers in the spreadsheet to their liking. However, ask them to be realistic, as cell cycles always include more interphase than mitosis. You may wish to challenge them to change the numbers to generate pie charts that look identical to the pie charts included in Part 1.

iPad Tip: To modify the spreadsheet, students can double-tap on the appropriate cell and enter the value. Students can observe the changes in the pie chart as they enter new values.

Q11. The entire cell cycle in an onion root tip cell lasts for about 24 hours. Based on your cell counts (or the student's cell count on page 2.2), how long does each of the 5 phases of the cell cycle last? How long does the entire process of mitosis last? Explain how you determined your answers.

Answer: Answers will vary depending on the student cell counts. The student should add the number of cells in each phase to find the total number of cells. To find the length of each phase, students should divide the number of cells in the phase by the total number of cells and then multiply by 24 (the length of the cycle). Students can add the lengths of the 4 phases in mitosis to find the total length of mitosis.

Using the original counts on page 2.2: Interphase = $\frac{100}{125} \times 24 \approx 19$ hours;

Prophase = $\frac{10}{125} \times 24 \approx 2$ hours; Metaphase = $\frac{6}{125} \times 24 \approx 1$ hour; Anaphase = $\frac{4}{125} \times 24 \approx 0.75$ hour or 45 minutes; Telophase = $\frac{5}{125} \times 24 \approx 1$ hour

Mitosis last about 4-5 hours.

Move to pages 3.1 and 3.2.

Have students answer questions 12 - 19 on either the device, on the activity sheet, or both.

3. Students should move to page 3.1, read the information on that page, and then proceed to page 3.2 for the mitosis simulation. After may pause and reset as many times as they'd like; they can also watch the simulation as many times as needed..

Discussion points: Students often get confused about why each of these phases is important or distinct. The cell has control mechanisms called checkpoints that prevent the initiation of each mitotic phase until the previous phase is complete. For example, if spindles pulled apart DNA that was not condensed into chromatids, it would break.

Q12. Which important event does **NOT** happen during mitosis?

Answer: B. DNA is copied.

Q13. During which phase does the nuclear membrane disappear?

Answer: A. prophase

Q14. In the cell shown, how many PAIRS of chromosomes are present?

Answer: A. 1

Q15. One round of the cell cycle makes two new cells. How many cells do you have after 5 rounds of the cell cycle?

Answer: C. 64

Q16. During which phase do the chromatids separate from one another?

Answer: C. anaphase

Q17. At the end of the cell cycle shown, how many chromosomes are present in each "new" cell?

Answer: A. 2

Q18. If you had been watching a simulation of a human cell undergoing mitosis, how many chromosomes would have been present in each new cell?

Answer: C. 46

Q19. What might be the outcome for a cell that doesn't properly finish anaphase?

Answer: B. Chromosomes are not evenly divided into new cells.

TI-Nspire Navigator Opportunities

Use TI-Nspire Navigator to capture screen shots of student progress and to retrieve the file from each student at the end of the class period. The student questions can be electronically graded and added to the student portfolio.

Make several students Live Presenters while doing Problem 2. Cell counts will be different from student to student, and it is interesting to see how these differences show up in the pie charts.

Additionally, the class screen capture feature allows you to see all (or at least most) of the students' handheld screens at one time. This is also a good way to compare the results that students get. In Problem 3, student answers may be collected and analyzed using TI-Nspire Navigator, if desired.

Extension

A possible extension would be to “pool” the class data from Part 2 if the students are doing actual cell counts. This will make the numbers in the spreadsheet much larger, and it is interesting to observe whether the increased numbers of cells appreciably changes the distribution shown in the pie chart.

Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved by TI-Nspire Navigator. The TI-Nspire Navigator Slide Show can be utilized to give students immediate feedback on their assessment.