Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Student Exploration:** **Cell Division**

**Vocabulary:** cell division, centriole, centromere, chromatid, chromatin, chromosome, cytokinesis, DNA, interphase, mitosis

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

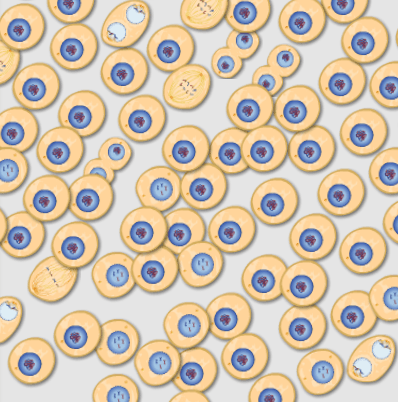
1. Cells reproduce by splitting in half, a process called **cell division**. What do cells need to do between divisions to make sure that they don’t just get smaller and smaller?

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1. The genetic information of a cell is carried in its **DNA** (short for deoxyribonucleic acid). What do cells need to do between divisions to make sure that a full set of DNA gets passed on to each daughter cell?

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**Gizmo Warm-up**

On the SIMULATIONpane of the *Cell Division* Gizmo, check that the **Cycle Length** is set to 12 hours. Click **Play** (Play), observe until the maximum number of cells is shown, and then click **Pause** (Pause).

1. Look at the cells. Do they all look the same? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Cells that are in the process of dividing are said to be in **mitosis** or **cytokinesis**. Cells that are not dividing are in **interphase**.

Check the **Magnify** box and move the cursor over the cells.

* 1. Of the 100 cells shown, how many are in the process of dividing? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. Select the BAR CHART tab, and turn on **Show numerical values**. How many cells are in the interphasestage of their life cycle? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  3. Based on these two observations, would you say that a cell spends most of its life cycle in interphase or in mitosis/cytokinesis? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- | --- | --- |
| **Activity A:**  **Phases of the cell cycle** | Get the Gizmo ready:   * Click **Reset** (Reset). * Select the DESCRIPTION tab. * Click on the right arrow once so that **Interphase** is shown. | 443SE2 |

**Question: What are the stages of the cell cycle?**

1. Observe: Click **Play** and hold the cursor over the cell. Observe the cell as it divides several times. (This happens quickly!) What do you notice happening during this process?

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1. Summarize: On the DESCRIPTION pane, read about each phase in the cell cycle. In the spaces below, sketch the cell in each phase and summarize what occurs in your own words.

|  |  |  |
| --- | --- | --- |
| **Phase** | **Sketch** | **Summary** |
| Interphase |  |  |
| Prophase |  |  |
| Metaphase |  |  |
| Anaphase |  |  |
| Telophase |  |  |
| Cytokinesis |  |  |

**(Activity A continued on next page)**

**Activity A (continued from previous page)**

1. Analyze: Use your summaries and the Gizmo to answer the following questions:
   * 1. What are the four phases of mitosis? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_,

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. During which phase is the DNA duplicated? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. What is the relationship between **chromatin** and **chromosomes**? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* + 1. In which phase are **chromatids** pulled apart? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    2. What is the role of the **centrioles**? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    3. In which phase does a new nuclear membrane develop? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    4. A cell has a single line of chromosomes. What is the phase? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    5. During which three phases are individual chromosomes no longer visible?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Think and discuss: Why is it important that the cell’s DNA is duplicated before cell division?

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1. Challenge: Human cells have 46 chromosomes. Each chromosome consists of a pair of identical chromatids attached together by a structure called a **centromere**. Once the chromosome has split, each chromatid is called a daughter chromosome. At the end of cytokinesis, how many daughter chromosomes will be found in each cell? Explain.

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| **Activity B:**  **Duration of phases** | Get the Gizmo ready:   * Click **Reset**. * Select the TABLE tab. | 443SE3 |

**Question: What is the relative duration of each phase of the cell cycle?**

1. Collect data: Set the **Cycle Length** to 10 hours and click **Play**. Click **Pause** when the maximum number of cells has been reached. On the TABLE tab, click **Record data**.

Record the number of cells in each phase of the cell cycle in the table below. Then click **Play**, wait for a while, and click **Record data** again. Repeat this process until you have recorded four sets of results, and then find the average number of cells in each phase.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Trial | Interphase | Prophase | Metaphase | Anaphase | Telophase | Cytokinesis |
| 1 |  |  |  |  |  |  |
| 2 |  |  |  |  |  |  |
| 3 |  |  |  |  |  |  |
| 4 |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Avg. |  |  |  |  |  |  |

1. Analyze: Which phase of the cell cycle is longest? \_\_\_\_\_\_\_\_\_\_\_\_ Shortest? \_\_\_\_\_\_\_\_\_\_\_\_

Explain your answers: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Calculate: You can use your data to estimate the duration of each phase of the cell cycle. For example, if 8% of the cells were in prophase and the cell cycle was 10 hours long, then prophase would last 8% of 10 hours, or 0.8 hours (48 minutes).

Use percentages to estimate the duration of each phase of the cell cycle. Show your work.

Interphase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Prophase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

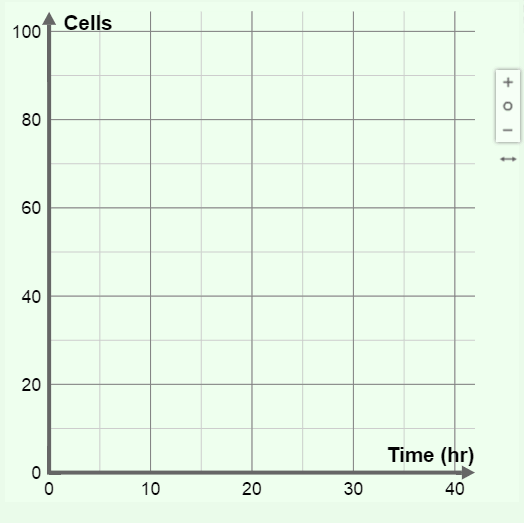
Metaphase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Anaphase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Telophase: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cytokinesis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| **Extension:**  **Cell populations** | Get the Gizmo ready:   * Click **Reset**. * Select the GRAPH tab. * Set the **Cycle Length** to 5 hours. | 443SE4 |

**Question: How quickly do cells multiply?**

1. Collect data: Click **Play** to start a new simulation. Click **Pause** when the maximum number of cells is reached. View the total number of cells on the GRAPH tab. (Click the “–” button until the whole graph is visible.)

Draw a sketch of this graph here.

What is the general shape of the graph?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Analyze: Look closely at the graph.
   1. About how long did it take to grow the first 20 cells? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* 1. About how long did it take to grow the last 20 cells? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  2. Would you say the rate of cell growth is increasing or decreasing? Explain.

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1. Extend your thinking: In living organisms, the cell cycle is closely regulated. What do you think will happen if cell division is *not* controlled?

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