Mitosis and Cytokinesis

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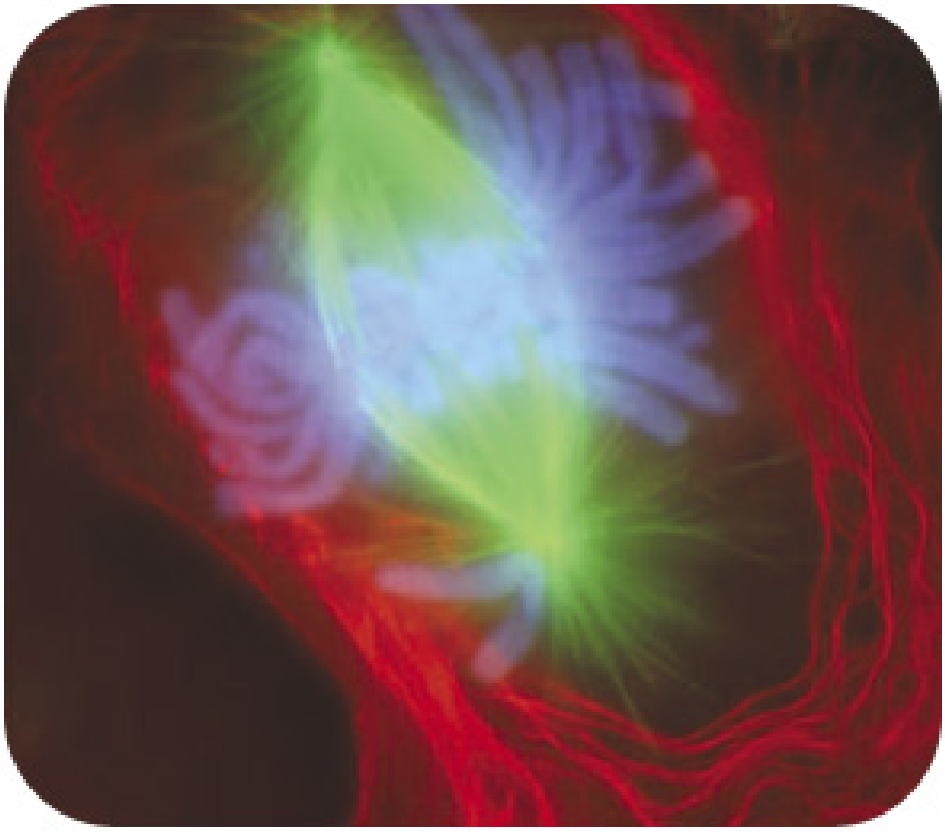
CHAPTER 1 Mitosis and Cytokinesis

- Summarize mitosis.
- Outline the phases of mitosis.
- Describe the function of the centrioles and the spindle.
- Explain the importance of the metaphase plate.
- Define cytokinesis.



What is meant by the "division of the nucleus"?

What do you think this colorful picture shows? If you guessed that it's a picture of a cell undergoing cell division, you are right. But more specifically, the image is a lung cell stained with fluorescent dyes undergoing mitosis, during early anaphase.

Mitosis and Cytokinesis

During **mitosis**, when the nucleus divides, the two chromatids that make up each chromosome separate from each other and move to opposite poles of the cell. This is shown in **Figure** 1.1. You can watch an animation of the process at the following link: http://www.biology.arizona.edu/Cell_bio/tutorials/cell_cycle/MitosisFlash.html .

Mitosis actually occurs in four phases. The phases are called prophase, metaphase, anaphase, and telophase. They are shown in **Figure** 1.2 and described in greater detail in the following sections.

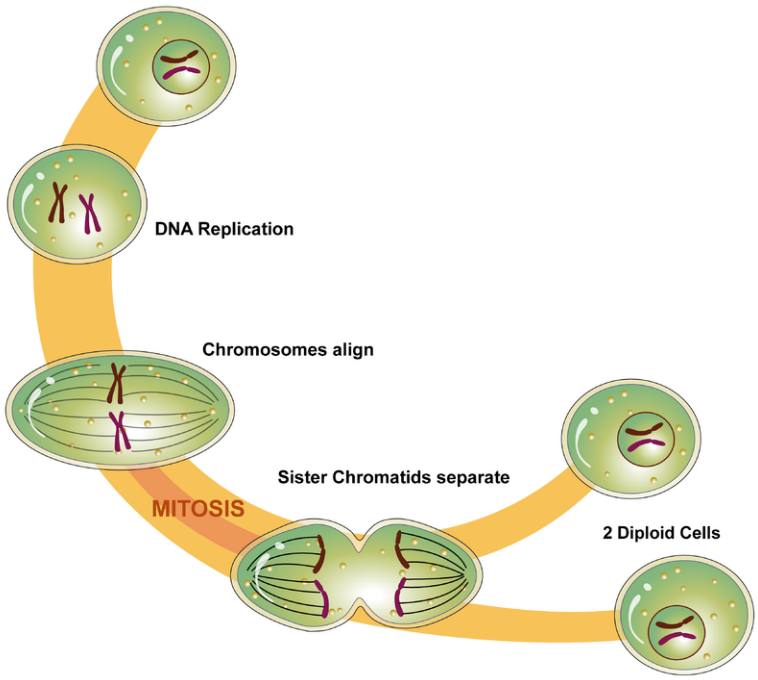


FIGURE 1.1

Mitosis is the phase of the eukaryotic cell cycle that occurs between DNA replication and the formation of two daughter cells. What happens during mitosis?

Prophase

The first and longest phase of mitosis is **prophase**. During prophase, chromatin condenses into chromosomes, and the nuclear envelope, or membrane, breaks down. In animal cells, the **centrioles** near the nucleus begin to separate and move to opposite poles (sides) of the cell. As the centrioles move, a **spindle** starts to form between them. The spindle, shown in **Figure** 1.3, consists of fibers made of microtubules.

Metaphase

During **metaphase**, spindle fibers attach to the centromere of each pair of sister chromatids (see **Figure** 1.4). The sister chromatids line up at the equator, or center, of the cell. This is also known as the metaphase plate. The spindle fibers ensure that sister chromatids will separate and go to different daughter cells when the cell divides.

Anaphase

During **anaphase**, sister chromatids separate and the centromeres divide. The sister chromatids are pulled apart by the shortening of the spindle fibers. This is like reeling in a fish by shortening the fishing line. One sister chromatid moves to one pole of the cell, and the other sister chromatid moves to the opposite pole. At the end of anaphase, each pole of the cell has a complete set of chromosomes.

Telophase

During **telophase**, the chromosomes begin to uncoil and form chromatin. This prepares the genetic material for directing the metabolic activities of the new cells. The spindle also breaks down, and new nuclear membranes (nuclear envelope) form.

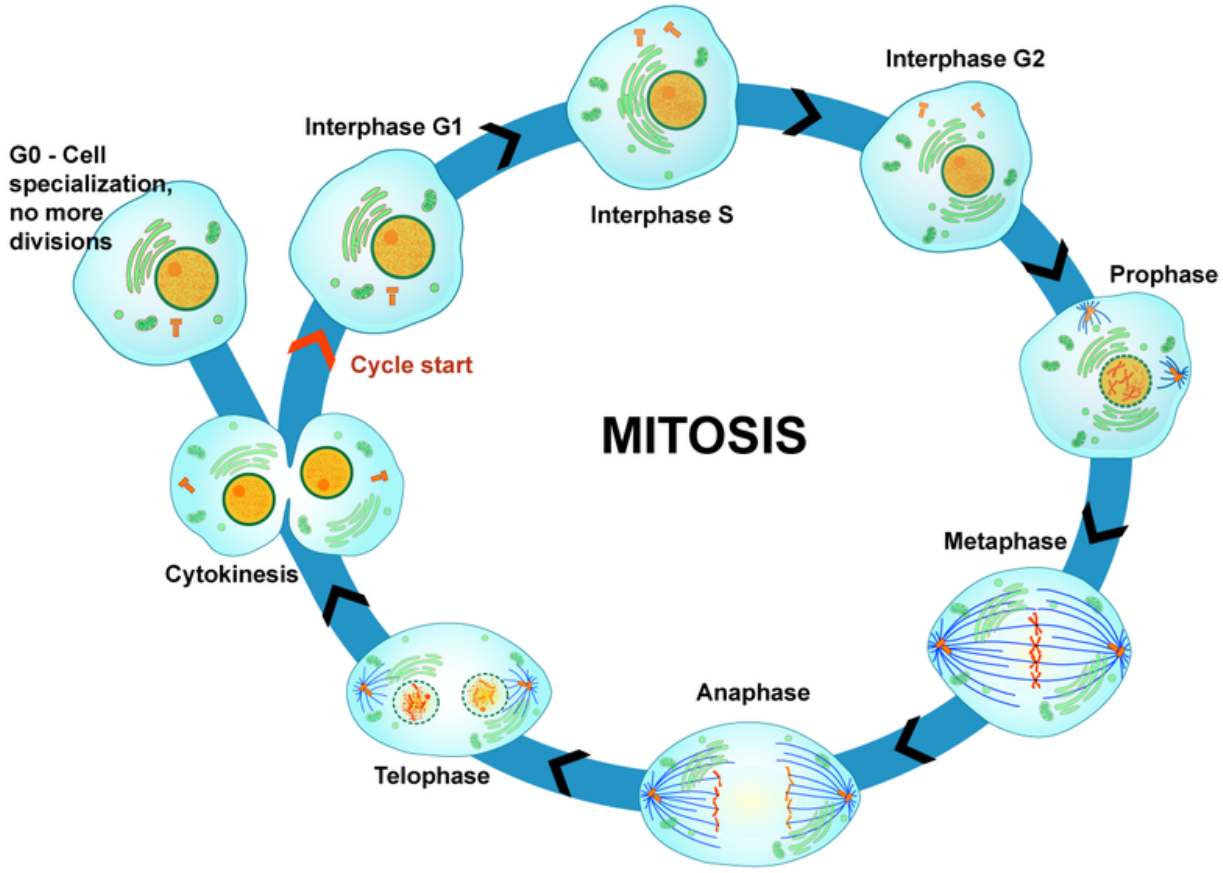


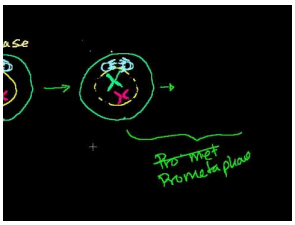
FIGURE 1.2

Mitosis in the Eukaryotic Cell Cycle. Mitosis is the multi-phase process in which the nucleus of a eukaryotic cell divides.

Cytokinesis

Cytokinesis is the final stage of cell division in eukaryotes as well as prokaryotes. During cytokinesis, the cytoplasm splits in two and the cell divides. Cytokinesis occurs somewhat differently in plant and animal cells, as shown in **Figure** 1.5. In animal cells, the plasma membrane of the parent cell pinches inward along the cell's equator until two daughter cells form. In plant cells, a cell plate forms along the equator of the parent cell. Then, a new plasma membrane and cell wall form along each side of the cell plate.

The phases of mitosis are discussed in the video: http://www.youtube.com/watch?v=LLKX_4DHE3I .



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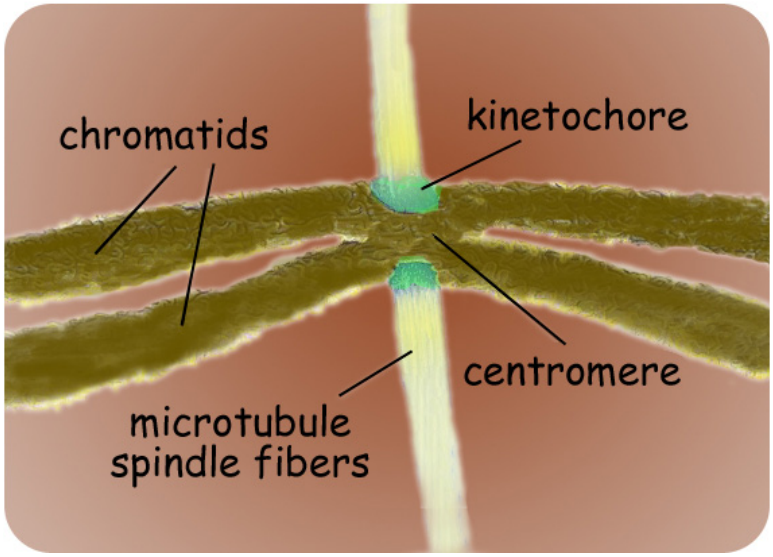

FIGURE 1.3

Spindle. The spindle starts to form during prophase of mitosis. Kinetochores on the spindle attach to the centromeres of sister chromatids.

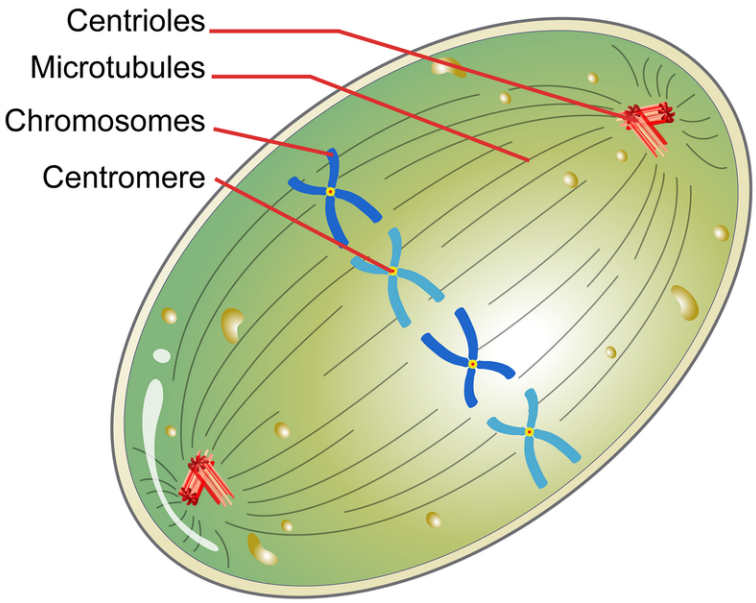

FIGURE 1.4

Chromosomes, consisting of sister chromatids, line up at the equator or middle of the cell during metaphase.

Summary

- Cell division in eukaryotic cells includes mitosis, in which the nucleus divides, and cytokinesis, in which the cytoplasm divides and daughter cells form.
- Mitosis occurs in four phases, called prophase, metaphase, anaphase, and telophase.

Explore More

Explore More I

Use this resource to answer the questions that follow.

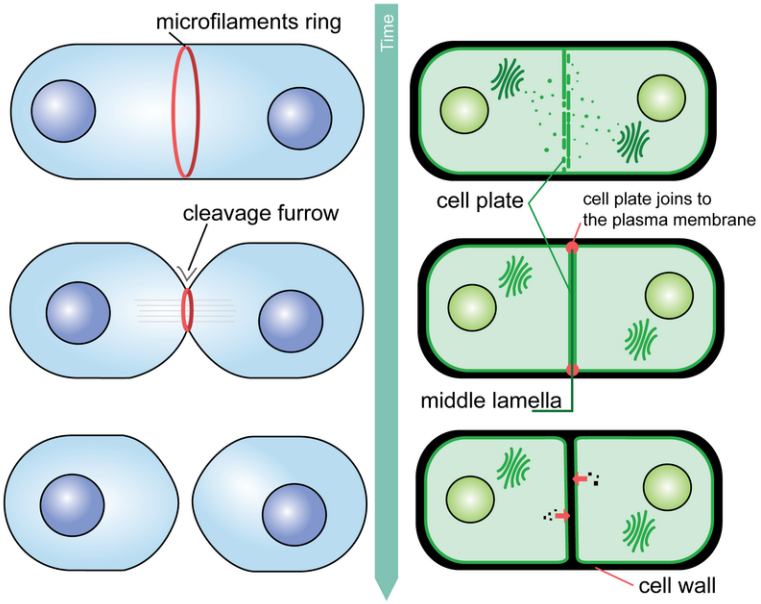

FIGURE 1.5

Cytokinesis is the final stage of eukaryotic cell division. It occurs differently in animal (left) and plant (right) cells.

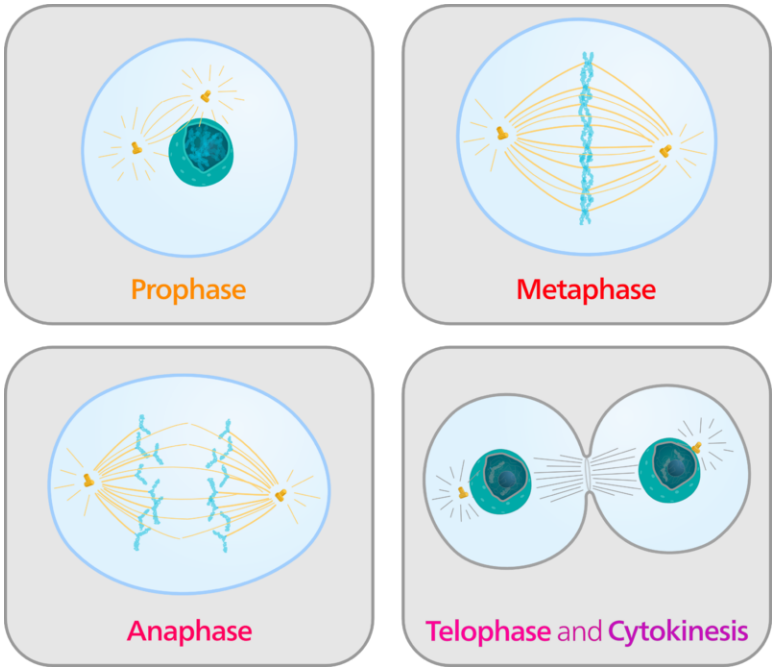

FIGURE 1.6

The four phases of mitosis. Can you describe what happens in each phase?

- **The Cell Cycle Mitosis Tutorial** at http://www.biology.arizona.edu/cell_bio/tutorials/cell_cycle/cells3.html .

1. During which phase of mitosis do the spindle fibers align the chromosomes along the middle of the cell?
2. During which phase of mitosis do poteins attach to the centromeres creating the kinetochores?
3. During which phase of mitosis does chromatin in the nucleus begins to condense?
4. During which phase of mitosis do the paired chromosomes separate at the kinetochores?
5. During which phase of mitosis do new membranes form around the daughter nuclei?

Explore More II

- **Animal Cell Mitosis** at http://www.cellsalive.com/mitosis.htm .

Review

1. List the phases of mitosis.
2. What happens during prophase of mitosis?
3. During which phase of mitosis do sister chromatids separate?
4. Describe what happens during cytokinesis in animal cells.
5. If a cell skipped metaphase during mitosis, how might this affect the two daughter cells?
6. Explain the significance of the spindle fibers in mitosis.

References

1. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. Process of mitosis . CC BY-NC 3.0
2. Zachary Wilson and Mariana Ruiz Villarreal (LadyofHats) (cell images can be found at http://commons.wikimedia.org/wiki Mitosis in the eukaryotic cell cycle . CC BY-NC 3.0
3. Courtesy of Nogales group and Lawrence Berkeley National Laboratory. Spindle fiber and chromatids . Public Domain
4. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. Sister chromatids line up during metaphase . CC BY-NC 3.0
5. Mariana Ruiz Villarreal (LadyofHats) for CK-12 Foundation. Cytokinesis is the final stage of mitosis . CC BY-NC 3.0
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