

The Cell Cycle

Terms to Learn

- | | |
|------------------------|-------------|
| cell cycle | chromatids |
| chromosome | centromere |
| binary fission | mitosis |
| homologous chromosomes | cytokinesis |

What You'll Do

- ◆ Explain how cells produce more cells.
- ◆ Discuss the importance of mitosis.
- ◆ Explain how cell division differs in animals and plants.

In the time that it takes you to read this sentence, your body will have produced millions of new cells! Producing new cells allows you to grow and replace cells that have died. For example, the environment in your stomach is so acidic that the cells lining it must be replaced every few days!

The Life of a Cell

As you grow, you pass through different stages in life. Similarly, your cells pass through different stages in their life cycle. The life cycle of a cell is known as the **cell cycle**.

The cell cycle begins when the cell is formed and ends when the cell divides and forms new cells. Before a cell divides, it must make a copy of its DNA. DNA contains the information that tells a cell how to make proteins. The DNA of a cell is organized into structures called **chromosomes**. In some organisms, chromosomes also contain protein. Copying chromosomes ensures that each new cell will be able to survive.

How does a cell make more cells? Well, that depends on whether the cell is prokaryotic or eukaryotic.

Making More Prokaryotic Cells Prokaryotic cells (bacteria) and their DNA are not very complex. Bacteria have ribosomes and a single, circular molecule of DNA, but they don't have any membrane-covered organelles. Because of this, cell division in bacteria is fairly simple. It is called **binary fission**, which means "splitting into two parts." Each of the resulting cells contains one copy of the DNA. Some of the bacteria in **Figure 11** are undergoing binary fission.

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MATH BREAK

Cell Multiplication

It takes Cell A 6 hours to complete its cell cycle and produce two cells. The cell cycle of Cell B takes 8 hours. How many more cells would be formed from Cell A than from Cell B in 24 hours?

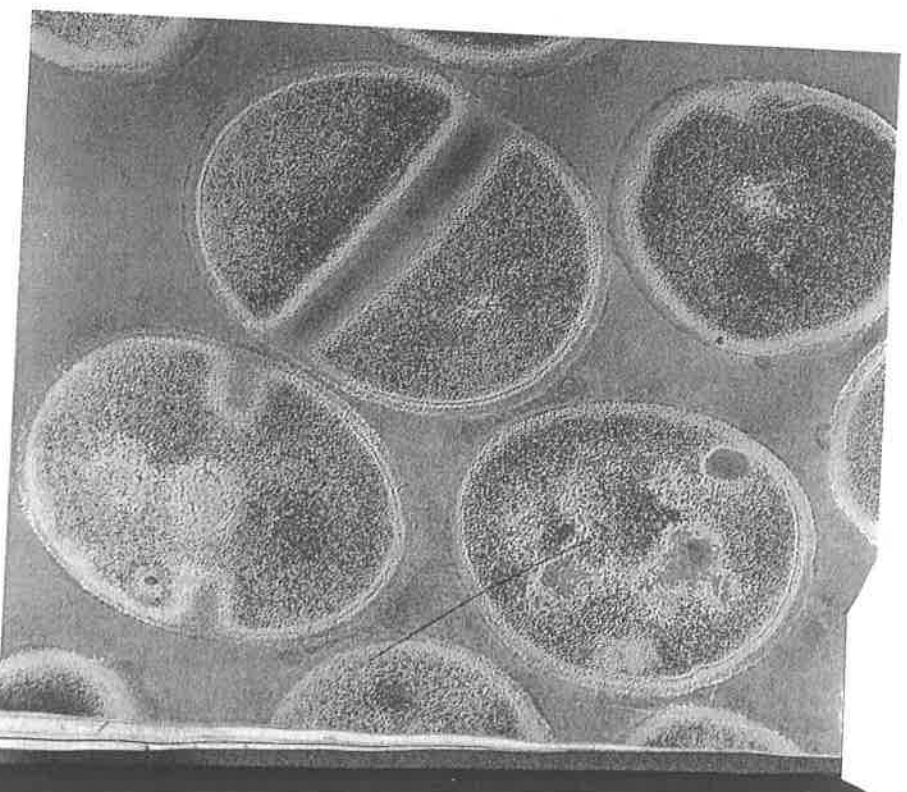


Figure 11 Bacteria reproduce by pinching in two.

Eukaryotic Cells and Their DNA Eukaryotic cells are usually much larger and more complex than prokaryotic cells. Because of this, eukaryotic cells have a lot more DNA. The chromosomes of eukaryotes contain DNA and proteins.

The number of chromosomes in the cells of eukaryotes differs from one kind of organism to the next and has nothing to do with the complexity of an organism. For example, fruit flies have 8 chromosomes, potatoes have 48, and humans have 46. **Figure 12** shows the 46 chromosomes of a human body cell lined up in pairs. These pairs are made up of similar chromosomes known as **homologous** (hoh MAHL uh guhs) **chromosomes**.

Making More Eukaryotic Cells The eukaryotic cell cycle includes three main stages. In the first stage, the cell grows and copies its organelles and chromosomes. During this time, the strands of DNA and proteins are like loosely coiled pieces of thread. After each chromosome is duplicated, the two copies are called **chromatids**. Chromatids are held together at a region called the **centromere**. The chromatids each twist and coil and condense into an X shape, as shown in **Figure 13**. After this happens, the cell enters the second stage of the cell cycle.

In the second stage, the chromatids separate. The complicated process of chromosome separation is **mitosis**. Mitosis ensures that each new cell receives a copy of each chromosome. Mitosis can be divided into four phases, as shown on the following pages.

In the third stage of the cell cycle, the cell divides and produces two cells that are identical to the original cell. Cell division will be discussed after mitosis has been described.

✓ Self-Check

After duplication, how many chromatids are there in a pair of homologous chromosomes? (See page 782 to check your answer.)

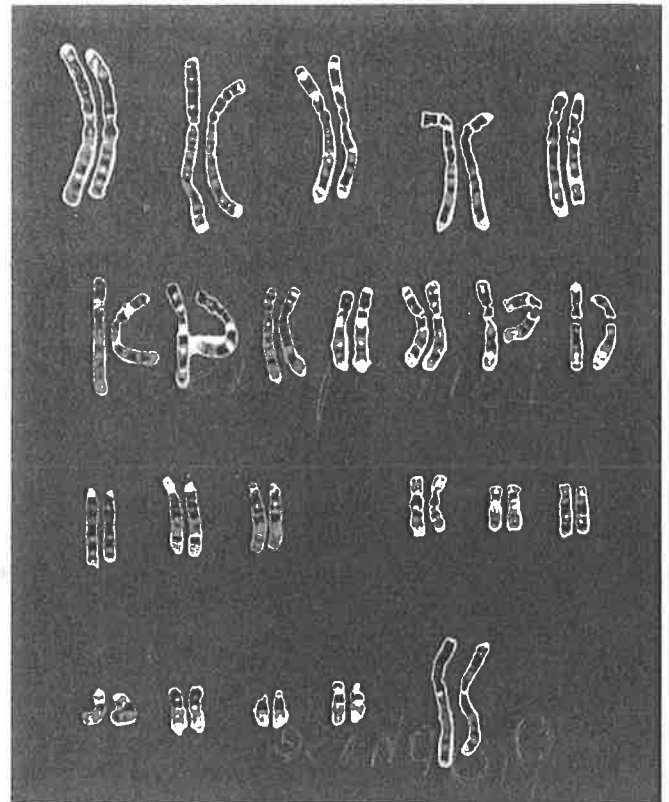


Figure 12 Human body cells have 46 chromosomes, or 23 pairs of homologous chromosomes.

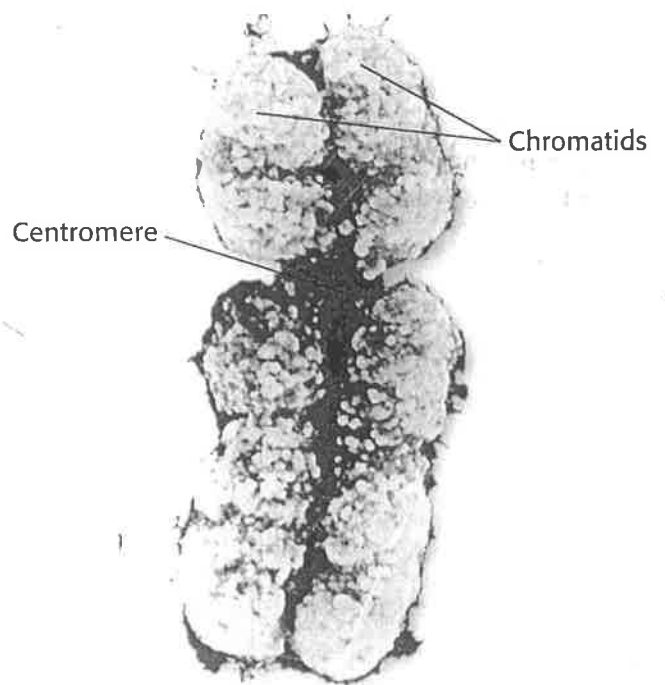


Figure 13 Two strands of DNA and protein coiled together to form this duplicated chromosome, which consists of two chromatids.

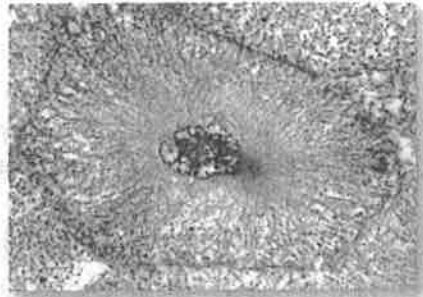
Mitosis and the Cell Cycle

The diagram below shows the cell cycle and the phases of mitosis in an animal cell. Although mitosis is a continuous process, it can be divided into the four phases that are shown and described. As you know, different types of living things have different numbers of chromosomes. In this diagram, only four chromosomes are shown to make it easier to see what's happening.

Interphase



Before mitosis begins, the chromosomes and other cell materials are copied. The pair of *centrioles*, which are two cylindrical structures, are also copied. Each chromosome now consists of two chromatids.

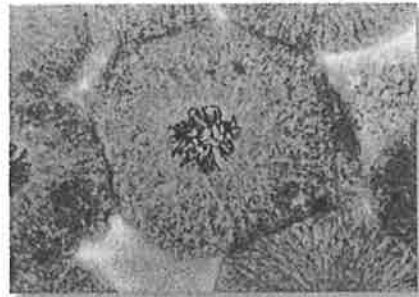


Pro phase

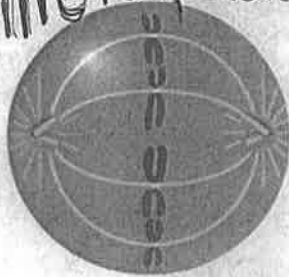


Mitosis Phase 1

Mitosis begins. The nuclear membrane breaks apart. Chromosomes condense into rodlike structures. The two pairs of centrioles move to opposite sides of the cell. Fibers form between the two pairs of centrioles and attach to the centromeres.

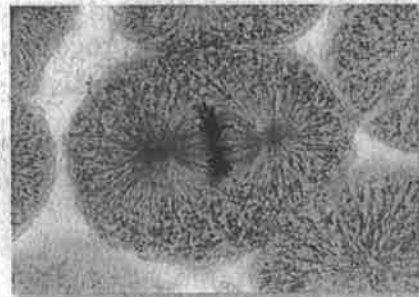


Meta phase

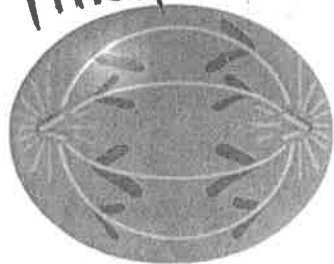


Mitosis Phase 2

The chromosomes line up along the equator of the cell.

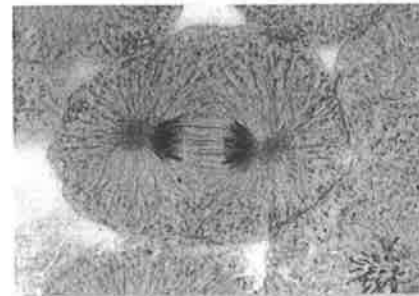


Anaphase

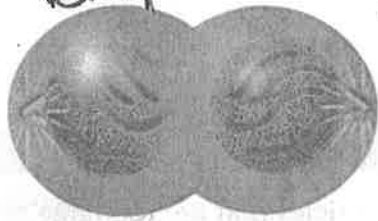


Mitosis Phase 3

The chromatids separate and are pulled to opposite sides of the cell by the fibers attached to the centrioles.

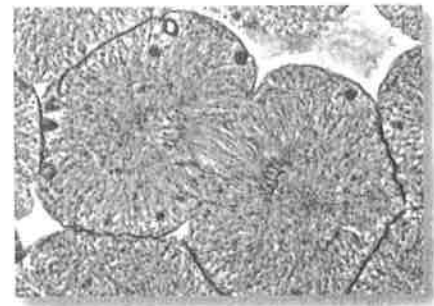


Telophase

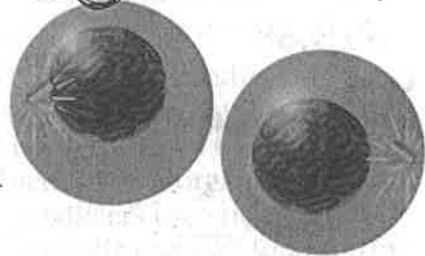


Mitosis Phase 4

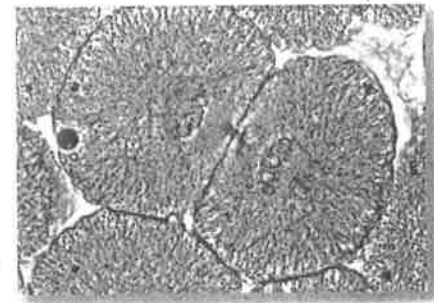
The nuclear membrane forms around the two sets of chromosomes, and they unwind. The fibers disappear. Mitosis is completed.



Cytokinesis



Once mitosis is completed, the cytoplasm splits in two. This process is called **cytokinesis**. The result is two identical cells that are also identical to the original cell from which they were formed. After cytokinesis, the cell cycle is complete, and the new cells are at the beginning of their next cell cycle.



More About Cytokinesis In animal cells and other eukaryotes that do not have cell walls, division of the cytoplasm begins at the cell membrane. The cell membrane begins to pinch inward to form a groove, which eventually pinches all the way through the cell, and two daughter cells are formed. Cytokinesis in an animal cell is shown above.

Eukaryotic cells that have a cell wall, such as the cells of plants, algae, and fungi, do things a little differently. In these organisms, a *cell plate* forms in the middle of the cell and becomes the new cell membranes that will separate the two new cells. After the cell is split in two, a new cell wall forms between the two membranes. Cytokinesis in a plant cell is shown in **Figure 14**.

Cell plate

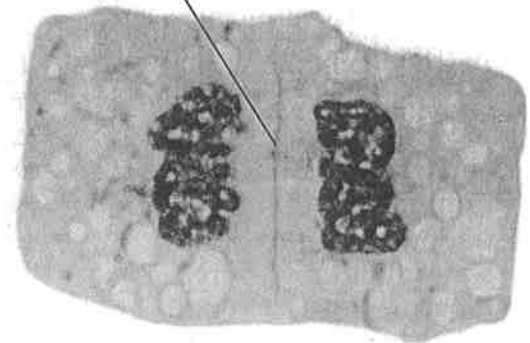


Figure 14 When plant cells divide, a cell plate forms and the cell is split in two.

REVIEW

1. How are binary fission and mitosis similar? How are they different?
2. Why is it important for chromosomes to be copied before cell division?
3. How does cytokinesis differ in animals and plants?
4. **Applying Concepts** What would happen if cytokinesis occurred without mitosis?

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