

### ● Before You Read

Think about the life cycle of a human. On the lines below, write some of the stages that occur in the life cycle of a human. In this section, you will learn about the life cycle of a cell.

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### MAIN Idea

**Cells grow until they reach their size limit, then they either stop growing or divide.**

### What You'll Learn

- why cells are small
- the stages of the cell cycle
- the stages of interphase

### ● Read to Learn

#### Cell Size Limitations

Most cells are smaller than the period at the end of this sentence. In this section, you will learn why cells are so small.

#### What is the surface area to volume ratio?

Recall that all cells are surrounded by a plasma membrane. All substances moving into or out of the cell must cross the plasma membrane. The surface area of the cell is the area covered by the plasma membrane. The volume of a cell is the space taken by the inner contents. Because cells are small, their surface area is high in relation to their volume. This relationship is called the ratio of surface area to volume.

To understand this ratio, imagine a cube-shaped bacterial cell with sides measuring one micrometer ( $\mu\text{m}$ ) in length. Surface area can be calculated as length times width times the number of sides, or  $1 \mu\text{m} \times 1 \mu\text{m} \times 6 \text{ sides} = 6 \mu\text{m}^2$ . Volume is length times width times height, or  $1 \mu\text{m} \times 1 \mu\text{m} \times 1 \mu\text{m}$ , which equals  $1 \mu\text{m}^3$ . The ratio of surface area to volume of this cell is 6:1.

What happens as the cell grows larger? Imagine a cube-shaped bacterial cell that is  $2 \mu\text{m}$  per side. The surface area is now  $24 \mu\text{m}^2$ , and the volume is  $8 \mu\text{m}^3$ . The ratio of surface area to volume is 3:1. Notice that the ratio of the larger cell is lower than that of the smaller cell.

### Mark the Text

#### Identify Main Ideas

As you read, underline or highlight the main ideas in each paragraph.

### Applying Math

1. **Explain** Show the equations used to calculate  $24 \mu\text{m}^2$  for the surface area and  $8 \mu\text{m}^3$  for the volume of the larger cell.

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**Reading Check**

**2. Explain** What happens to ratio of surface area to volume as cells grow?

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## What are the benefits of a high surface area to volume ratio?

As cells grow in size, the ratio of surface area to volume gets smaller. A low ratio means a cell might have trouble bringing nutrients into and moving wastes out of the cell.

Small cells also have an easier time moving substances around inside the cell. Substances are moved by diffusion or by motor proteins pulling them along the cytoskeleton. Movement of substances over long distances is slow and difficult, so cells remain small to maintain efficiency.

Cells use signaling proteins to communicate. Signaling proteins move around the cell to relay messages. In larger cells, communication becomes slow because signaling proteins have to move over longer distances.

## The Cell Cycle

When a cell reaches its size limit, it will either stop growing or it will divide. Cell division keeps cells from getting too large. It is also the way that cells reproduce. A cell's cycle of growing and dividing is called the cell cycle.

The cell cycle has three main stages. They are described in the table below. During interphase, the cell grows, carries out cellular functions, and copies its DNA. Interphase is followed by mitosis (mi TOH sus), the period when the nucleus divides. Cytokinesis (si toh kih NEE sis) follows mitosis and is the stage when the cytoplasm divides and two cells are created.

The time it takes a cell to complete the cell cycle varies depending on the type of cell. A typical animal cell takes 12–24 hours to complete the cell cycle. Some cells might complete the cycle in eight minutes. Other cells might take as long as a year to complete one cycle.

### Picture This

**3. State** Complete the table by writing the number of cells present at the end of each stage. The first one has been done for you.

Stage	Description	Number of Cells
Interphase	The cell grows in size, performs normal functions, and copies its DNA.	one cell
Mitosis	The cell nucleus divides, and the chromosomes separate into the two nuclei.	
Cytokinesis	The cytoplasm of the cell divides, forming two daughter cells.	

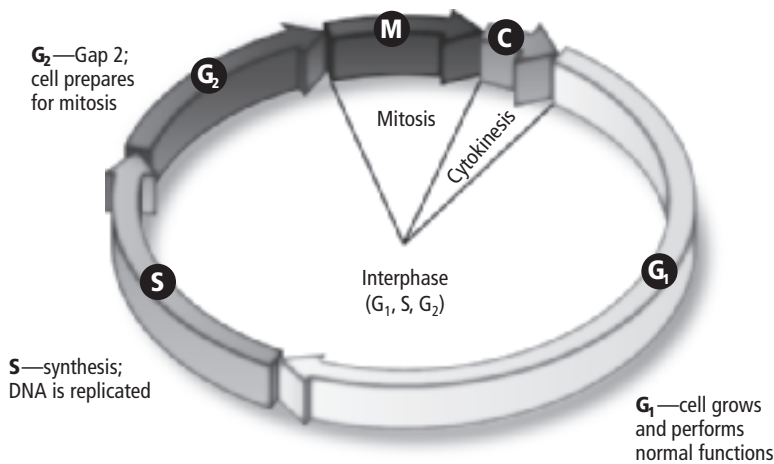
## What happens during interphase?

The stages of the cell cycle are shown in the figure below. Most of the cell cycle is taken up by interphase. During interphase the cell grows, performs normal cell functions, and copies its DNA in preparation for cell division. Interphase is divided into three stages:  $G_1$ , S, and  $G_2$ , also called Gap 1, Synthesis, and Gap 2.

As soon as a cell divides, it enters the  $G_1$  stage. During  $G_1$ , a cell grows, performs normal cell functions, and prepares to copy its DNA. Some cells, such as muscles and nerve cells, exit the cycle at this stage and do not divide again.

During the S stage, the cell copies its DNA. **Chromosomes** (KROH muh sohmz) are the structures in the nucleus that contain DNA, the genetic material that is passed from generation to generation of cells. The DNA in chromosomes is tightly wound. **Chromatin** (KROH muh tin) is the relaxed, or unwound, form of DNA and proteins in the nucleus.

The  $G_2$  stage is the period when the cell prepares for the division of its nucleus. When preparations are complete, the cell enters mitosis.



## How is the cell cycle completed?

Mitosis and cytokinesis follow interphase. They are described in the next section. At the end of the cell cycle, cell division is complete, and the original cell has become two daughter cells.

## How do prokaryotic cells divide?

The cell cycle you have just learned about—interphase, mitosis, and cytokinesis—occurs in eukaryotic cells. As you have learned, prokaryotic cells are simpler cells. They reproduce by a method called binary fission.

## Picture This

- 4. Label** Circle the stage of interphase during which DNA is copied.

## Reading Check

- 5. Name** What is cell division in prokaryotes called?

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