

# CELLS AND CELL STRUCTURE

## Big Picture

The cell theory states that all living things are made up of cells, and all cells come from other cells. There are two basic types of cells: prokaryotic cells and eukaryotic cells. Both prokaryotic and eukaryotic cells are integral parts of our everyday lives. Some prokaryotes, such as bacteria, are important in digesting food and helping to decompose materials for reuse. Humans, other animals, plants, and many other organisms are made of eukaryotic cells.

## Key Terms

**Cell:** The basic unit of structure capable of performing the functions of life.

### Common Parts of Cells

**Plasma Membrane** (also known as the cell membrane):

A thin layer of lipids that surrounds the cell, separating the cytoplasm and organelles inside the cell from the surrounding environment.

**Phospholipid Bilayer:** The phospholipids in the plasma membrane are arranged in two layers called a phospholipid bilayer.

**Cytoplasm:** Made up of cytosol and ribosomes and is the material inside the plasma membrane.

**Ribosome:** Found in the cytoplasm, ribosomes are where protein are made.

### Two Types of Cells

**Prokaryotic Cell:** Does not have a nucleus; the DNA lies in a nucleoid region but still remains in the cytoplasm, with no separated nucleus like in eukaryotic cells. Organisms with prokaryotic cells are called prokaryotes.

**Eukaryotic Cell:** Has a nucleus that contains DNA. Compared to a prokaryotic cell, eukaryotic cells have more organelles in the cytoplasm. Organisms with eukaryotic cells are called eukaryotes.

**Organelle:** Performs varying functions for a cell.

### Parts of Eukaryote Cells\*

*\*not all eukaryotes have all of the following*

**Nucleus:** Contains DNA, or the genetic material, of the cell.

**Mitochondrion** (plural, mitochondria): An organelle that makes energy available to the cell.

**Endoplasmic Reticulum (ER):** An organelle that helps make and transport proteins and lipids. There are two types of endoplasmic reticulum: rough endoplasmic reticulum (RER) and smooth endoplasmic reticulum (SER). RER is rough because it contains ribosomes. SER is smooth and does not have ribosomes.

**Golgi Apparatus:** The organelle that processes proteins and prepares them for use both inside and outside the cell.

**Vesicle:** Small membrane-enclosed sack that can store or transport substances.

**Vacuole:** Sack filled with water that contains inorganic and organic molecules.

**Cytoskeleton:** Helps the cell keep its shape and hold all the organelles in their place.

### Special Parts of Plant Cells

**Cell Wall:** Tough layer that surrounds plant cells.

**Chloroplast:** Organelles found in plant cells that play a big part in photosynthesis.

## The Cell Theory

Robert Hooke was one of the first scientists to discover **cells** by looking at a cork through a microscope.

After Hooke's discovery, Anton van Leeuwenhoek observed tiny animals called rotifers through his microscope, which was more powerful than most other microscopes of his time. He looked at many living things and noticed that they all had cells.

Later, scientists continued to look at cells through microscopes and noted that cells divide.

With the ideas of the three scientists - Theodor Schwann, Matthias Jakob Schleiden, and Rudolf Virchow - the cell theory was created, which states:

1. All cells come from other cells.
2. All organisms are made up of multiple cells.
3. All functions of the organism, such as cellular respiration, occurs within the cells.

# CELLS AND CELL STRUCTURE CONT.

## Cell Properties

### Cell Size

Cells are microscopic in order to function efficiently. In order to perform life processes, materials such as nutrients and waste need to be able to pass in and out of the cell.

- A small size allows for a larger surface area relative to its volume.
- If a cell were larger, the surface area will be smaller relative to the volume. As a result, not enough materials will be able to pass through, making the organism less productive.

### Cell Shape

The shape of the cell depends on the function that the cell performs. For example, cells from an algae plant have tail-like structures because algae lives in water, and these tail-like structures allow them to move through water.

### Parts of a Cell

Other **organelles** may or may not be present, but all cells have the following items:

- **Plasma membrane**
- **Cytoplasm**
- **Ribosomes**
- DNA

## Two Types of Cells

Image Credit: National Center for Biotechnology Information, Public Domain

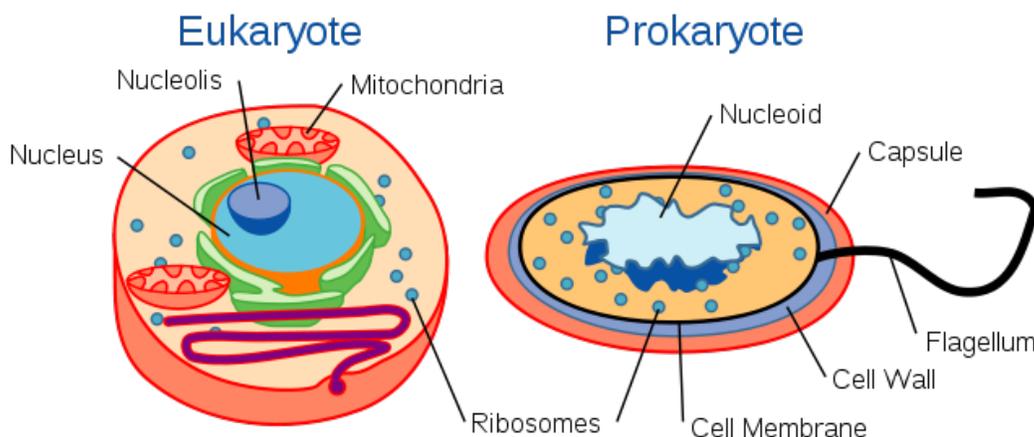


Figure: A diagram highlighting the differences between prokaryotic cells and eukaryotic cells.

The presence of a **nucleus** is the difference between **prokaryotic cells** and **eukaryotic cells**. The table below lists some of the other differences between the two cells.

### Comparison between prokaryotic cells and eukaryotic cells

|                     | Prokaryotic Cells                      | Eukaryotic Cells                 |
|---------------------|--|----------------------------------|
| Genetic Material    | in nucleoid region, no nucleus present | in nucleus                       |
| Relative Size       | smaller                                | larger                           |
| Organization        | typically single-celled                | typically multicellular          |
| Examples            | bacteria, archaea                      | protists, fungi, plants, animals |
| Contain Organelles? | none                                   | yes                              |



*Viruses are neither prokaryotes or eukaryotes; instead, they are just a clump of DNA that need to infect another organism in order to reproduce. They lack the other parts shared by all cells: plasma membrane, cytoplasm, and ribosomes.*

# CELLS AND CELL STRUCTURE CONT.

## Cell Structures

### The Plasma Membrane

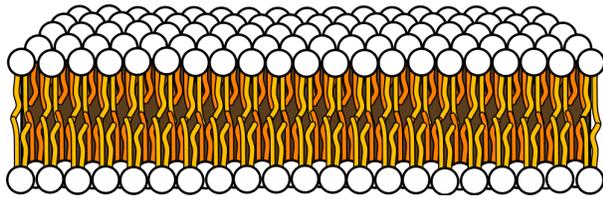


Figure: The phospholipid bilayer.  
Image Credit: Mariana Ruiz Villarreal (LadyofHats), Public Domain

#### Function

- Forms a barrier between the cytoplasm inside the cell and the environment outside the cell.
- Regulates what goes in and out of the cell. Membrane is semipermeable and allows only certain substances to pass through.

#### Structure

- The plasma membrane's structure is known as the fluid mosaic model. The membrane flows like water and is not a stiff structure.
- The membrane is mainly made up of phospholipids. They are arranged in two layers called the **phospholipid bilayer**.
- Each phospholipid molecule has a head and two tails. The head is hydrophilic (loves water) and the tails are hydrophobic (hates water).
- The heads are on the outside of the layer and point toward either the cytoplasm or the fluid surrounding the cell. The tails are in the interior of the layer.
- Membrane contains other molecules, primarily lipids and proteins, and may contain extensions.

### Cell Structures in Terms of a City

The cell can be thought of as a city, and the different organelles can be likened to various structures within the city.

| Cell Structure               | City Structure        | Cell Function   |
|------------------------------|-----------------------|---|
| Nucleus                      | Town hall             | Where DNA is held; responsible for providing instructions to the cell |
| <b>Mitochondria</b>          | Power plant           | Where cellular respiration occurs                                     |
| <b>Golgi apparatus</b>       | Post office           | Packages proteins to be delivered                                     |
| <b>Endoplasmic reticulum</b> | Roads/Highways        | Synthesized proteins and lipids travel down the endoplasmic reticulum |
| Ribosome                     | Factory               | Where proteins are synthesized  |
| <b>Vesicles/Vacuoles</b>     | Garbage dump, storage | Sac-like materials responsible for getting rid of debris              |
| Membrane/ <b>Cell wall</b>   | City border           | Regulates what goes in and out of the cell                            |
| Cytoplasm                    | The foundation        | Holds the organelles in place; gives the cell structure               |
| <b>Chloroplast</b>           | Solar energy plant    | Where photosynthesis occurs   |
| <b>Cytoskeleton</b>          | Infrastructure        | Also gives the cell structure   |

*Note: Both plant cells and animal cells are eukaryotic cells, but one significant difference between plant cells and animal cells is that plant cells have a cell wall that give it a rigid shape, while animal cells have a cell membrane. Other features of plant cells include chloroplasts and a large central vacuole. Chloroplasts are not found in animal cells.*

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