Cells: The Basic Unit of Life

Your entire body is made of cells—trillions of them! Cells are the tiny structures that make up all living organisms, including sharks, plants, cats, insects, bacteria, and you. People often say that cells are the basic building blocks of life. That's true, but the phrase "building blocks" makes it sound as if all cells are the same. In fact, organisms are different from one another because of the *differences* in their cells. There are many types of cells.

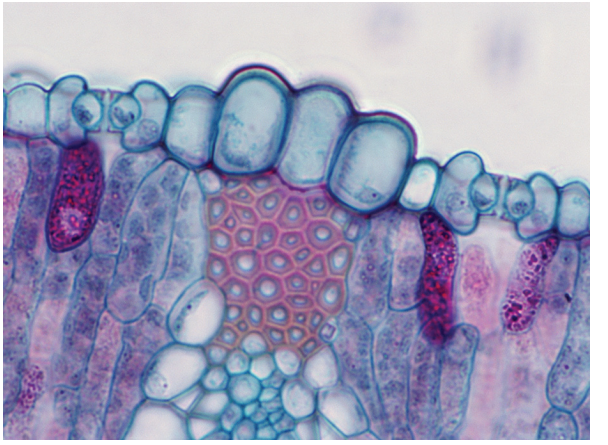
How Do We Know About the Cell?

Cells got their name from a scientist named Robert Hooke way back in 1665. Hooke used a basic microscope to look at thin slices of cork, and saw that they were made of many tiny, hollow structures that looked like rooms. In fact, Hooke thought they looked like the rooms where monks lived, so he called them cells.

The cells Hooke saw weren't actually living cells. Cork is made from the bark of a tree called a cork oak—the cells of the bark are alive when they're on the tree, but they die when they're cut off for people to use.

By the time a scientist named Anton van Leeuwenhoek arrived on the scene in 1680, lenses had improved, making it easier for scientists to see much smaller things. Van Leeuwenhoek put things like blood, rainwater, and scrapings from teeth under a microscope, and what did he see? Tiny organisms moving around! Van Leeuwenhoek argued that motion is a sign of life, and was the first scientist to say that cells are living things.

This photo was taken through a microscope. It shows one cell from the cheek of a human, with almost 100 bacteria on it. Each one of those bacteria is a single cell. The bacteria and cheek cell all appear 945 times larger than actual size. Each one of the bacteria is about 1 micrometer long. The cheek cell is 50 to 70 times longer in every direction!



The plant cells in this photo appear 500 times larger than their actual size. The photo was taken through a microscope and shows the cells that make up the edge of a leaf. Since this photograph shows a cross-section, we can't tell exactly how long these cells are, but they are roughly 10–20 micrometers tall. Plant cells can be very different from one another, but tend to be 20–50 micrometers in length.

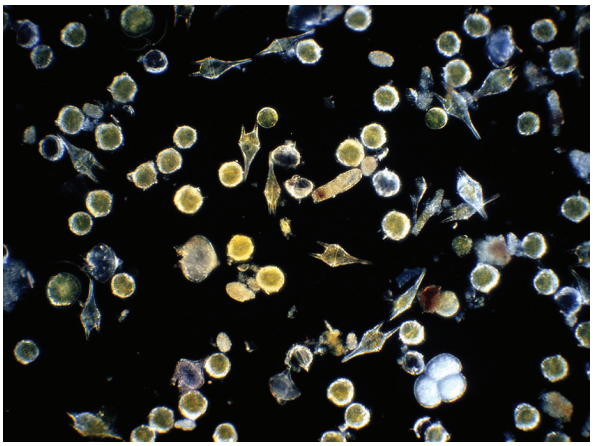
The Basic Unit of Life

All living things are made of cells, including plants and animals and other organisms like bacteria, whether they're made of just one cell or trillions of cells put together. Things that used to be alive but aren't anymore, like wood, are still made of cells—but the cells are dead. Things that were never alive, like glass and water, aren't made of cells at all.

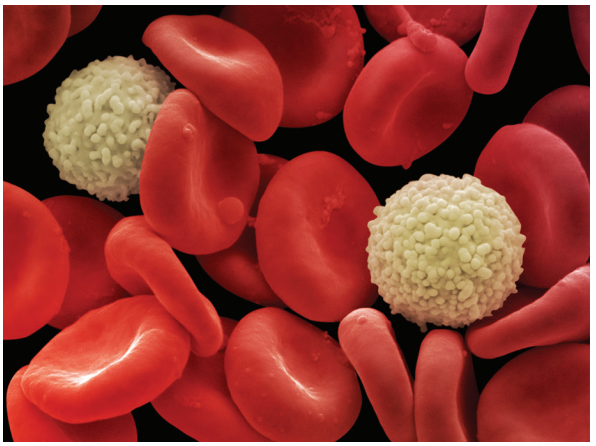
All cells have some things in common. For example, all cells are filled with a jellylike fluid called cytoplasm and enclosed by a cell membrane. This cell membrane controls which substances are allowed in and out of the cell. All cells also have tiny structures called ribosomes that make proteins using instructions from genes. All cells take in food, release energy from the food, and use the energy to do things.

The smallest living organisms are single cells. Most cells are very, very tiny: it takes trillions of them to make a human body. Cells are not the tiniest things in the world, however. Cells are made of molecules, which are much smaller than cells, and molecules are made of atoms, which are even smaller!

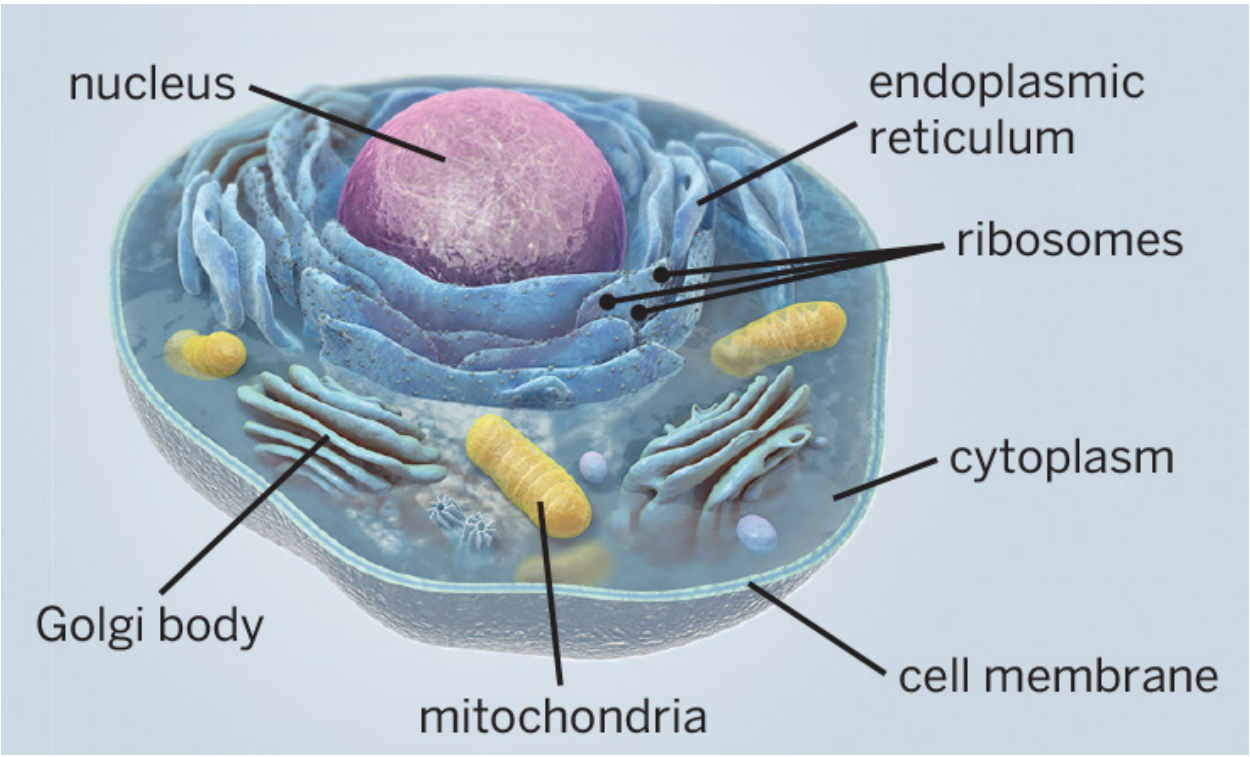
At the same time, many cells put together make much larger structures. A bunch of the same type of cells working together is called a tissue, like muscle tissue or nerve tissue. Different types of tissues working together are called an organ, like the brain or the liver—or the stem and leaves of a plant. Different types of organs working together are called a system, like the circulatory system or the musculoskeletal system. And different systems working together make a body like yours!



These tiny glowing organisms live in the ocean. Each organism is made of just one cell, and they can range in size from 10 micrometers to 2,000 micrometers! Some can even be seen with the naked eye.



There are different types of cells in your blood, including the red blood cells and white blood cells shown in this photo. White blood cells help protect your body from infection. The photo was taken through a powerful microscope, and shows the cells more than 5,000 times larger than their actual size— only about 710 micrometers across.



Organelles are cell parts that perform certain functions. This diagram shows some of the organelles in a typical human body cell. Many other kinds of cells contain the same organelles.

What's in a Cell?

Cells come in all different kinds, from the cells that make up a carrot to the cells in the human brain. However, many cells have some parts in common, called organelles. Here's a list of important organelles found in your body cells and the cells of many other organisms.

- **Nucleus:** The nucleus is a small enclosure inside a cell. It may be small, but it's very important: the nucleus is the command center of the cell, which contains its DNA and tells the cell how to behave and react.
- **Cell membrane:** The cell membrane surrounds the cell and is in charge of keeping helpful molecules inside the cell and keeping out molecules that are not helpful. In animal cells, the cell membrane is the outer layer, but plant cells have an extra layer of protection called the cell wall, which is outside of the cell membrane.
- **Mitochondria:** Mitochondria are beanshaped organelles that use glucose and oxygen molecules to release energy that the cell can use.
- **Ribosomes:** Ribosomes are tiny organelles that make proteins. They can be found floating freely in the cell or attached to the rough endoplasmic reticulum.
- **Endoplasmic reticulum:** Endoplasmic reticulum, or E.R., is responsible for making and transporting molecules around the cell. E.R. comes in two types: rough, which is covered in ribosomes, and smooth, whic isn't.
- **Golgi body:** The Golgi body is like the post office of the cell—it packs proteins into little packages called vesicles and sends them wherever they're needed in the cell.
- **Cytoplasm:** Cytoplasm isn't an organelle; instead, it's a gel-like substance that fills the cell. The organelles of the cell are suspended in the cytoplasm and can move around in it.

Plant cells usually have all of the same organelles as animal cells, plus a few extra organelles that help them meet the needs of plants. These organelles include:

- **Cell wall:** The cell wall is the waxy outer layer that surrounds plant cells outside of the cell membrane. The cell wall offers extra protection, and its rigid structure helps the plant stand up. The cell wall also keeps the cell from stretching and bursting when too much water flows into the cell.

- **Chloroplasts:** Chloroplasts are organelles that store chlorophyll, a green substance that allows plants to turn sunlight into the molecules they need to release energy.

- **Vacuole:** Plant cells have storage in the form of vacuoles, which are large organelles that allow them to store food, waste, and water. The vacuole can also help maintain the right amount of pressure in the cell and isolate anything that might be a threat to the cell. Some animal cells also have vacuoles, but plant cell vacuoles are bigger and more common.

Using Differences in Cells to Classify Living Things

There are three domains (major types) of living things: eukarya, bacteria, and archaea. These domains are actually based on differences in the structures of cells! All organisms in the domain eukarya are made up of cells with a nucleus that contains genetic information. Some eukarya are tiny organisms that are each made up of only one cell, but most are made up of trillions of cells. Examples of eukarya include birds, pine trees, dogs, mushrooms, and humans. Almost all bacteria and archaea are tiny organisms that are each made up of only one cell with no nucleus. Instead of being contained in a nucleus, their genetic material just floats around inside the cell. Bacteria and archaea are in different domains because they have different kinds of molecules inside their cells. It turns out that these molecules are important for determining where the organisms can live and what they can use to get energy. For example, one way bacteria and archaea cells are different has to do with their cell membranes, the barriers that separate their insides from the outside environment. The cell membranes of archaea can withstand very high temperatures and harsh chemicals. That is one reason why some archaea can sometimes be found living in places where nothing else can survive.

Cells may be tiny, but there's no life without them—everything that's alive is alive because its cells are taking in molecules, releasing energy, and doing jobs like carrying oxygen through the blood and transmitting electricity through the body. Without them, no living things would exist. So if you're reading this, thank your cells!