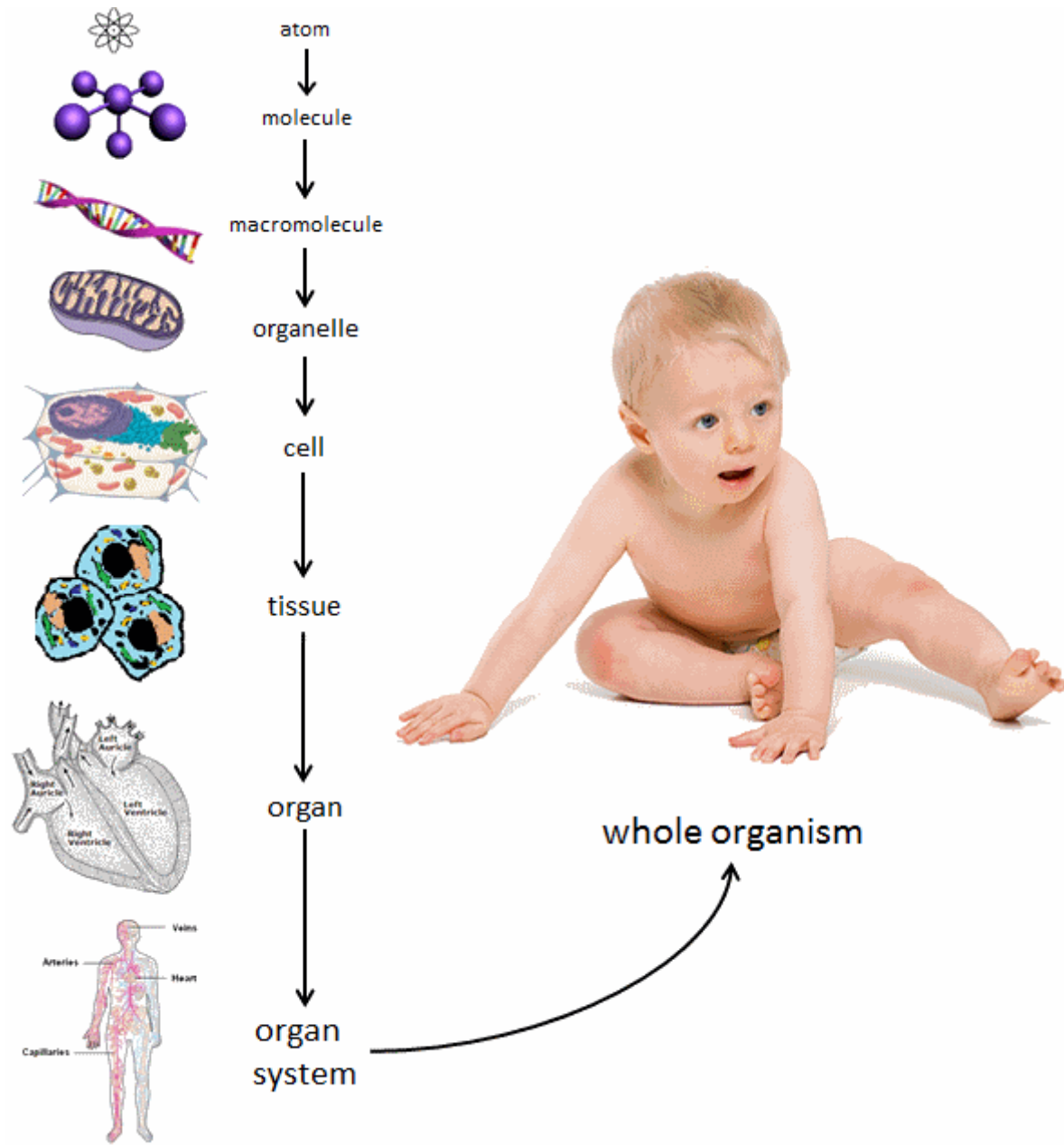


Cell Organization

*All living things are made of one or more **cells**. Cells are the basic building blocks of all organisms. The organization of cells into complex structures allows for the wide variety of life found in multicellular organisms.*

Organization in Multicellular Organisms

From simplest to most complex, the proper levels of organization in multicellular organisms are:



The levels of biological organization in order from smallest to largest are: atom → molecule → macromolecule → organelle → cell → tissue → organ → organ system → whole organism.

Organelles are specialized subunits in the cell, which each have their own specific function. They are usually enclosed in their own lipid membrane. There are many types of organelles, such as ribosomes, nuclei, endoplasmic reticulum, and lysosomes.

Cells are the structural and functional units of all living organisms. Organisms can be made up of one cell, like bacteria, or many cells, like animals. Cells specialize depending upon which part of the body they are located. All cells come from other cells, and they divide by mitosis or meiosis. Cells contain organelles and the genetic information of an organism.

Tissues are composed of many cells that work together to perform a specific function. Tissue covers most parts of an organism. There are several types of tissues, such as connective tissue, muscle tissue, nervous tissue, and epithelial tissue.

Organs are composed of several tissues and perform one or more functions in the body. In most organs there is a unique 'main' type of tissue (such as the myocardium of the heart) and several other tissues that are found in many organs (such as connective tissue). The body is made up of many organs, including the heart, lungs, liver, eyes, and brain.

Organ systems are groups of related organs that work together to perform a function or set of functions. The functions of the various organ systems usually overlap and are influenced by each other. There are eleven major organ systems in the human, including the respiratory, reproductive, digestive, skeletal, muscular, nervous, circulatory, endocrine, urinary, integumentary, and lymphatic systems. There are two main organ systems in vascular plants, the root system and the shoot system.

The **whole organism** is composed of all of the various organ systems. Its functions are carried out by cooperation between all of the systems.

Cells Are Specialized

The cells of multicellular organisms are specialized to perform specific functions. The cellular processes carried out within these specialized cells are essential for the survival of the organism.

Single-celled & Multi-celled Organisms

All living things contain at least one cell. Single-celled organisms perform all of their life processes within a single cell, while multi-celled organisms can have specialized cells for different functions.

Cells contain everything that is necessary for life. They have a variety of parts, and each part has a different set of functions. Cells may be part of a multi-celled organism, or they may be single-celled organisms.

Single-celled Organisms

Single-celled, or unicellular, organisms may live alone or as part of a colony. For single-celled organisms, each cell by itself can get food and air. Many single-celled organisms can move themselves through their environments. Single-celled organisms can reproduce themselves, although some do reproduce sexually.

Single-celled organisms include protozoa, bacteria, and some kinds of fungi. The image on the left is a single protozoan. Its internal structure is visible. The image on the right shows two different kinds of protozoans.



Image courtesy Dr. Stan Erlandsen and Dr. Dennis Feely, CDC

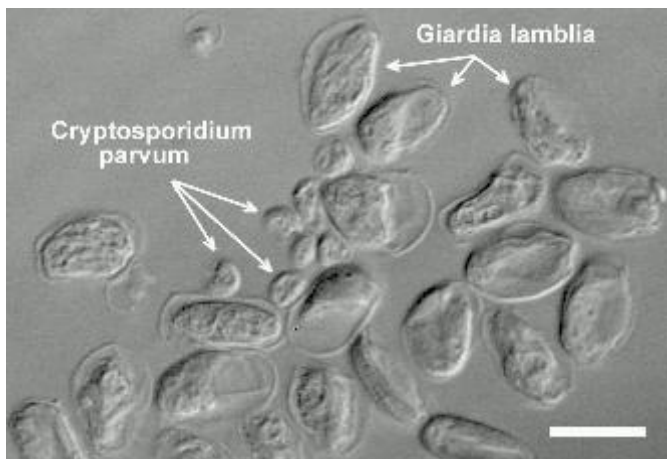


Image courtesy H.D.A. Lindquist, U.S.EPA

Multi-celled Organisms

Multi-celled, or multicellular, organisms may have many different kinds of cells. Each kind of cell has its own purpose and specialized parts that help the cell to carry out its function. Cells from multi-celled organisms cannot survive on their own. The cells must work together in order to get food and air and to help the organism reproduce.

Multi-celled organisms may be very small and made up of only a few cells, or very large and made up of trillions and trillions of

cells. All plants and animals are multi-celled organisms. Both the tiny mite shown below on the left and the algae shown below on the right are examples of multi-celled organisms.



Photo by Eric Erbe, colorization by Chris Pooley

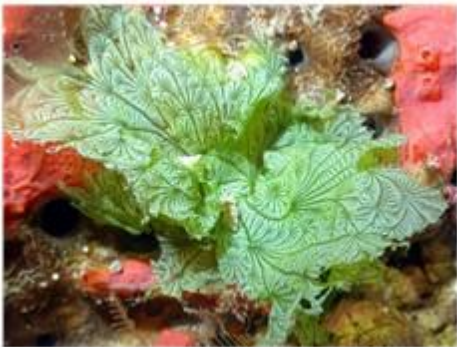


Image Courtesy of NOAA

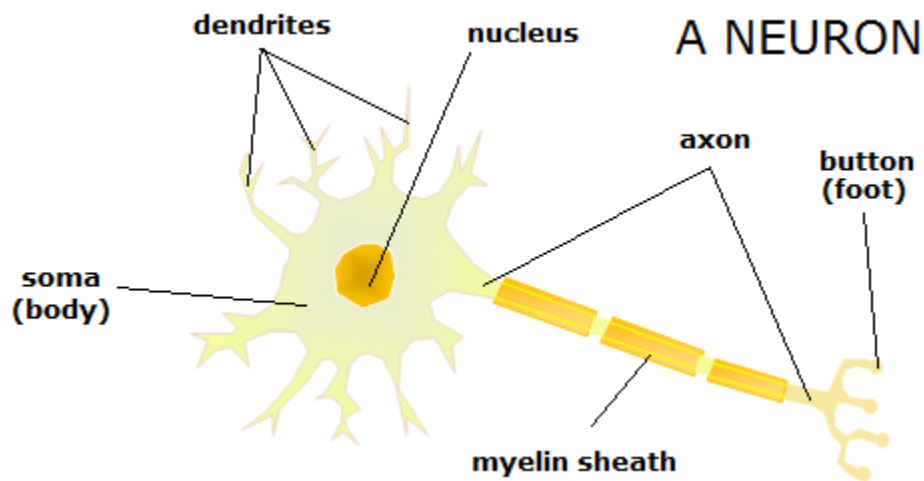
Cell Specialization

*In multicellular organisms, different cell types perform different necessary and specific functions for the survival of the organism. This is known as **cell specialization**.*

In complex, multicellular organisms, such as humans or other animals and plants, different cells are needed to perform different, specialized jobs for the organism.

For example, the three diagrams below show three different types of human cells — a nerve cell (called a neuron), a red blood cell, and a muscle cell.

Neurons



The structure of a nerve cell allows it to more easily transmit nerve signals.

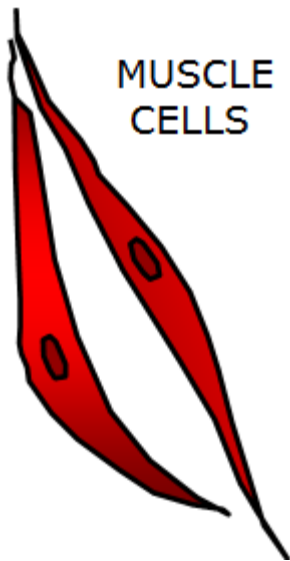
Red Blood Cells



RED BLOOD CELL

The red blood cell shown has a simple structure. Red blood cells carry oxygen to all parts of the body.

Muscle Cells



The muscle cell has a structure that allows it to relax or contract as needed.

Other Specialized Cell Types

Other types of specialized cells in the human body include bone cells, which provide stability and structure to the body; white blood cells, which fight disease in the body; and reproductive cells, which allow humans to pass their genes on to their children.

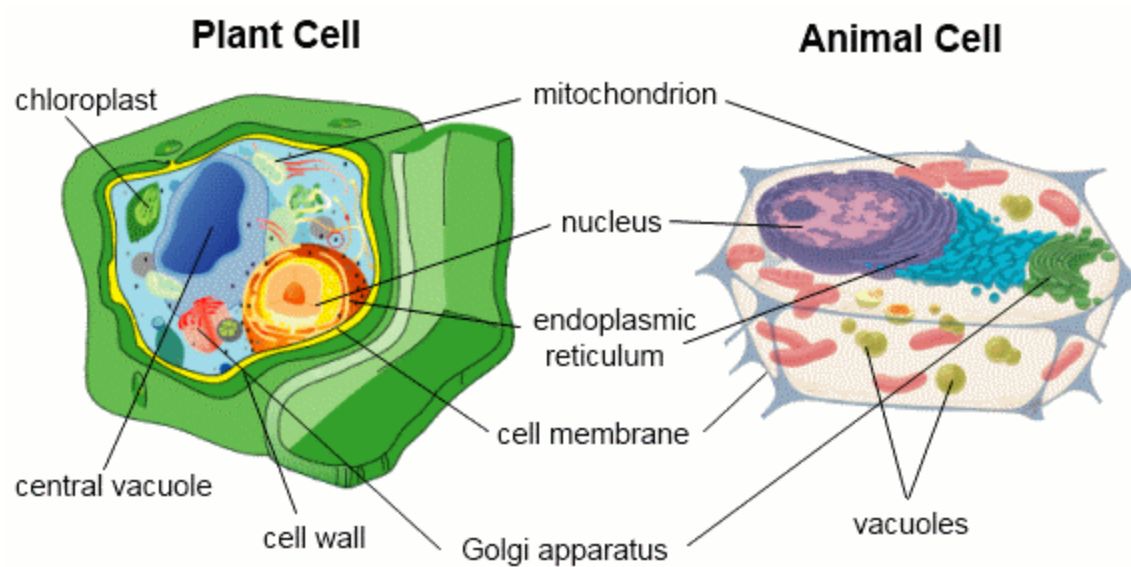
Cell Structure and Function

*All living organisms on Earth are made up of microscopic structures called **cells**. There are many types of cells, including plant cells and animal cells.*

Cell Organelles

Cells consist of smaller parts, called **organelles**. Organelles are like the "organs" of a cell; they are small structures that perform different functions that help cells survive.

Different kinds of cells can have different organelles. A plant cell and an animal cell are shown below. They have some of the same kinds of organelles, but the plant cell also has some organelles that the animal cell does not have.



Adapted from images courtesy of NIH and Wikipedia.

Plant and animal cells share many of the same organelles. The structures that can be found in both plant and animal cells are discussed in the list below.

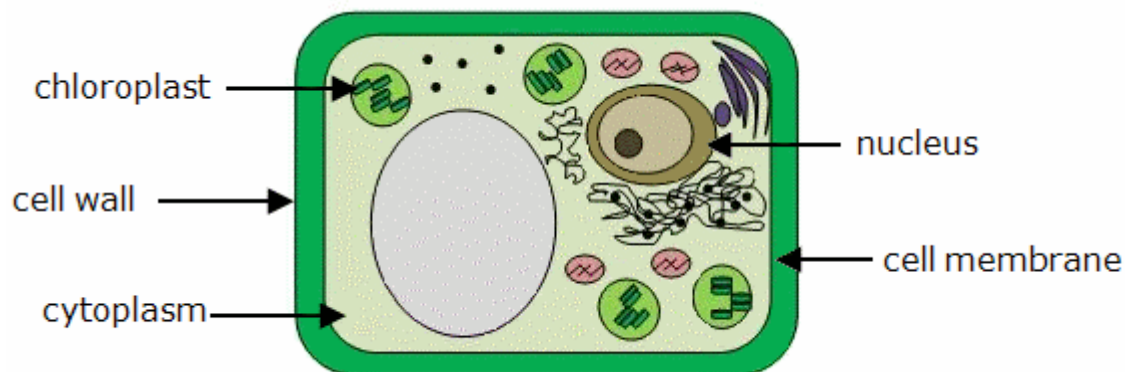
- The **cytoplasm** is the suspension fluid that contains all of the organelles of the cell located between the nucleus and the cell membrane, as well as the support structures that help give the cell its shape. It is also the site of most of the chemical reactions that take place in the cell.
- The **cell membrane** (or plasma membrane) acts as a boundary layer around the cytoplasm that separates a cell from its outside environment. In addition to being able to recognize chemical signals, the cell membrane is selectively permeable to chemicals,

and it controls which substances enter and leave the cell. Nutrients first enter the cell through the cell membrane.

- A **vacuole** stores water and ingested food in a fluid sack and helps remove waste from the cell. While both plant and animal cells can have vacuoles, the vacuoles found in animal cells are very small, while plant cells have one large, central vacuole. The central vacuole in plants produces turgor pressure against the cell wall for cellular support.
- The **nucleus** is the control center of the cell. It contains *chromosomes*. The information in the chromosomes control cell metabolism and heredity.
- The **ribosomes** are organelles that participate in the production of proteins.
- The **mitochondria** take in nutrients, break them down, and create energy for the cell.

Plant vs. Animal Cells

While plant and animal cells share many organelles, there are a few organelles that are specific to plant cells. These organelles include the cell wall and chloroplasts.



- The **cell wall** provides protection from physical injury and, with the vacuole, it provides structural support. It is made mostly of a structural material called *cellulose*, which makes plant cells more rigid than animal cells.
- The **chloroplasts** are the food producers in a plant cell. These small green organelles contain a substance called *chlorophyll* to trap energy from the Sun during photosynthesis.

Cell Functions

Cells perform many of the functions that are needed to sustain life. These functions include:

- growth and repair
- taking in nutrients
- producing energy
- disposing of wastes

Cells of multicellular organisms are responsible for the organisms' **growth**. Cells must multiply as the organism grows. This is because the size of individual cells does not change very much. When an organism needs to grow bigger, it must make more cells. The body of a multicellular organism can also **repair** itself by using cell division to make more cells.

Cells must **take in nutrients** in order to perform life processes. The cell membrane of a cell allows the cell to take in nutrients (or food molecules) while keeping out things that are bad for the cell. Plant cells that contain chloroplasts can also make their own food by using energy from the Sun.

Cells use the nutrients that they acquire to **produce energy**. The mitochondria found in both plant and animal cells use nutrients to make a substance called ATP. Cells then use ATP as their main source of energy.

After a cell has acquired and used nutrients for cellular processes, the cell must be able to **dispose of waste materials**. During waste removal, the cell membrane works with other cell organelles to move waste products from an area of higher concentration (inside the cell) to an area of lower concentration (outside the cell).

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