Levels of Organization

The living world consists of all biotic and abiotic factors that affect life within it. Living things are part of a whole that organize themselves in several levels proceeding from the very small (simple) to the very large (complex), these levels of organization include:

Organization at cellular level

1. Molecules

Molecules consist of several atoms of different elements that joined together into complex cluster known as ***macromolecules*** (biological molecules) including carbohydrates, lipids, proteins, and nucleic acids (DNA & RNA).

2. Organelles

They are tiny compartments within cell assembled from complex of biological molecules which are responsible for specific function in the cell (e.g. nucleus, ribosome, mitochondria, etc.).

3. Cells

They are the smallest unit of life that has all the characteristics of living things (organisms).

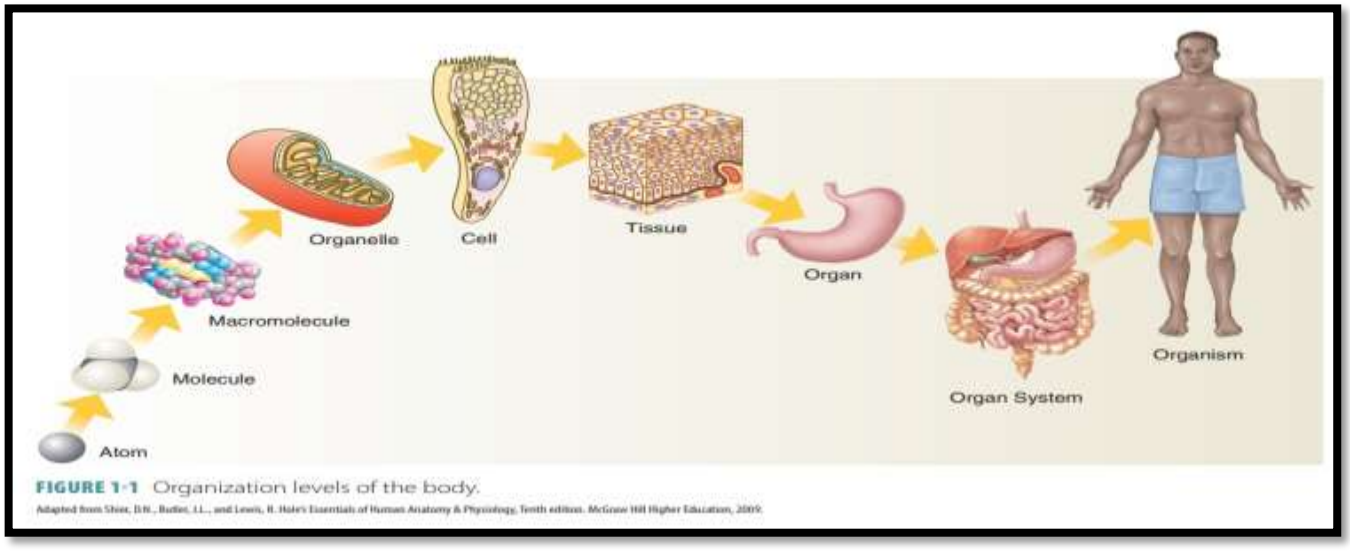


FIGURE 1-1 Organization levels of the body.

Organization at organism level

Organism is a specific **species** of plant, animal, bacteria, fungus or other living thing that lives in a specific area. There are two types of organisms:

Unicellular organisms which are composed of single cell such as Bacteria, Amoeba, Paramecium, etc.

Multi-cellular organisms have several types of cells located in different parts of the living organism that carry out specific functions such as animals & plants. Therefore, cells are organized into three levels of complexity:

1. Tissues

They are groups of similar cells that act as a functional unit such as nervous tissue which composed of specialized cells called nerve cells (neurons) and able to carry signals & impulses from one place to another within organism.

2. Organs

Organ is a set of tissues connected that carry out a specific function for a living thing (an example of an organ may include the heart, the lung, the brain, etc.)

3. Systems

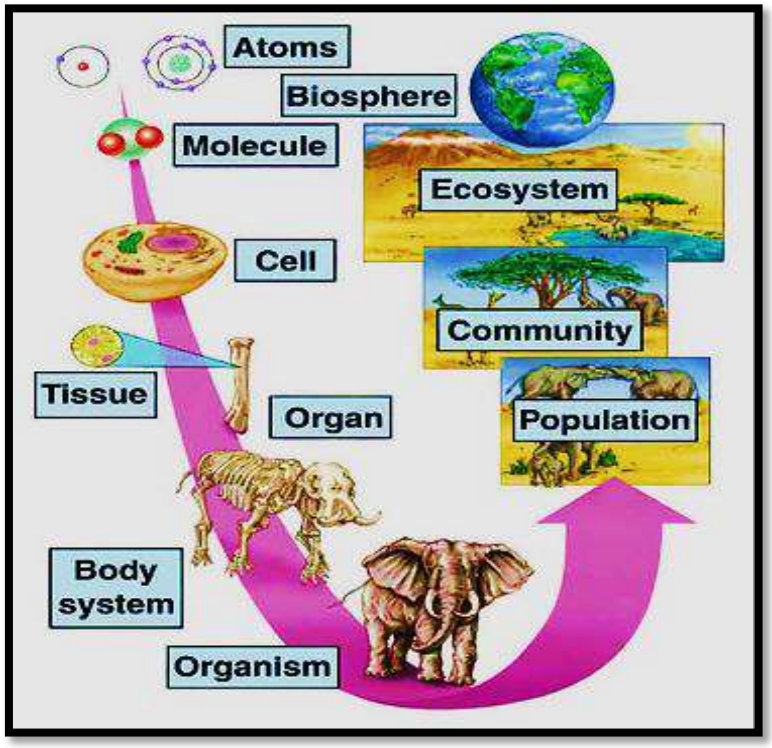
The system is a set of organs inside an organism that carry out a specific function (digestion, circulation, respiration, etc.).

Organization at population level

Organisms are organized into several higher hierarchical levels within the living world:

1. Population

Population is a group of organisms of the same ***species*** that live in the same place at the same time. The members of certain species are similar in appearance and able to interbreed. For example, several deer may belong to a population and can interact with other deer in the same area.



2. Community

Community consists of all populations of different species living together in one place (Gees may share their pond with ducks, fish, and many kinds of insects) all interact with each other in a single pond.

3. Biome = Ecosystem

It is the community and its non-living surrounding that may be separated by living or non-living matter (mountain or other boundaries) such as Deserts, oceans, and forests. A deer, rabbit, and all the plant populations that live in a grasslands area and the lake, air, and rocks are part of an ecosystem.

4. Biosphere

It is the part of the Earth that contains all ecosystems.

The cell

Animals, plants, fungi, and Protists are all made up of at least one eukaryotic cell. In contrast, bacteria and Archaea are made up of a single prokaryotic cell.

All cells are surrounded by a cell membrane (also called a plasma membrane). The cell membrane is the boundary that separates the inside of the cell from the outside. The plasma membrane encloses all the cell components, which are suspended in a gel-like fluid called the cytoplasm. The cytoplasm is the location of the organelles.

There are two basic types of cells

1- **Prokaryotes** (all bacteria are prokaryotes.)

2- **Eukaryotes**

The differences between prokaryotic and eukaryotic cells are as below.

Prokaryotic cell	Eukaryotic cell
1- Single-celled.	1- Can either be single-celled or multi- celled.
2- Size of the cell is generally small	2- Size of cell is generally large
3- Nucleus is absent (Nuclear region or nucleoid is not surrounded by a nuclear membrane) and DNA travels openly around the cell.	3- Nucleus is present (Nuclear material is surrounded by a nuclear membrane within containing its DNA).
4- Nucleolus is absent.	4- Nucleolus is present.
5- It contains single chromosome.	5- It contains more than one
6- Cell division takes place by fission or budding (no mitosis) another copy by dividing.	6- Can reproduce in one of several ways (Ex. meiosis, mitosis).

Animal cell shapes.

The basic shape of eukaryotic cell is spherical but the shape of cell is ultimately determined by the specified function of the cell. Thus, the shape of the cell may be variable (frequently changing its shape) or fixed. Variable or irregular shape occurs in amoeba and white blood cells or leucocytes. In fact, leucocytes are spherical in the circulating blood, but in other conditions they may produce pseudopodia and become irregular in shape.

Cell size.

Some animal cells are visible to the naked eye. Most cells, however, are visible only with a microscope, since they are only a few micrometers in diameter. A micrometer (μm) is one thousand of a millimeter. The size of cells varies from the very small cells of bacteria (0.2 to 5.0 μm) to the very large eggs of the ostrich (18 cm).

Animal cell structure

Animal cells have a variety of different organelles that work together to allow the cell to perform its functions. There are lots of different animal cells that each carry out specialized functions. Therefore, not every animal cell has all types of organelles, but in general, animal cells contain most (if not all) of the following organelles. Additionally, some organelles will be highly abundant in certain cells and not others.

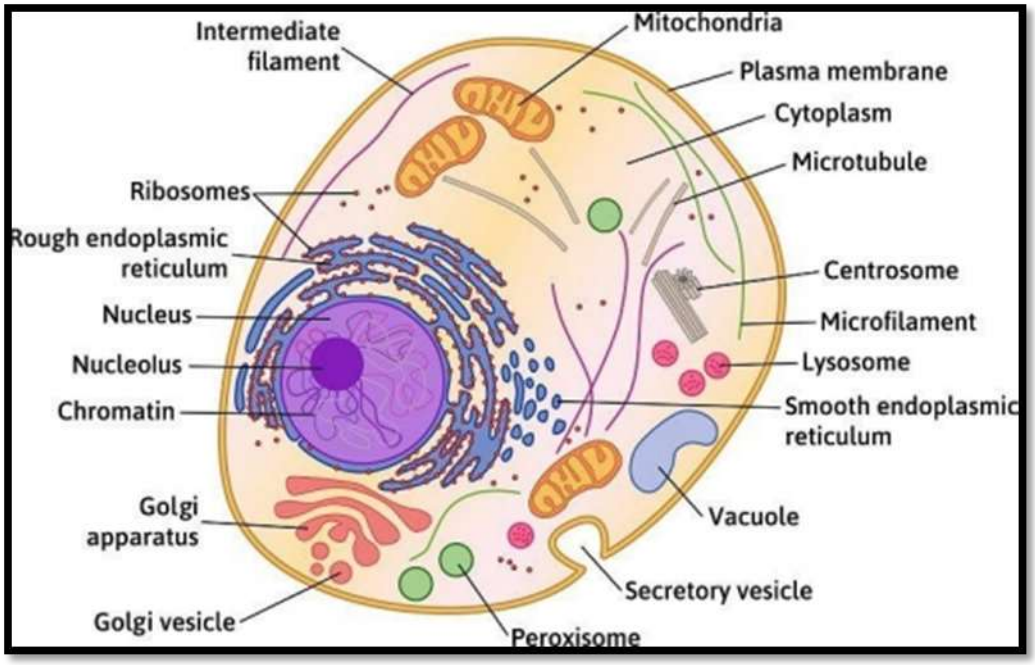


Diagram of a typical animal cell

The animal cell involves:

1- Nucleus.

The nucleus contains all the genetic material in a cell. This genetic information is called deoxyribonucleic acid (DNA). DNA contains all the instructions for making proteins, which control all of the body's activities. The nucleus is surrounded by a nuclear envelope (also called the nuclear membrane), which separates it from the rest of the cell. The nuclear envelope also contains pores to allow certain materials to pass in and out. The nucleus regulates the growth and division of the cell.

As well as all the genetic material, there is also a sub-section of the nucleus called the nucleolus. The nucleolus is the site of ribosome synthesis.

2- Ribosome's

Ribosomes are organelles found in both prokaryotic and eukaryotic cells that synthesize all the proteins in the cell. In animal cells, ribosome's can be found freely in a cell's cytoplasm or attached to the endoplasmic reticulum.

3- Endoplasmic Reticulum

The endoplasmic reticulum (ER) is a network of flattened membrane-bound sacs that are involved in the production, processing and transport of proteins that have been synthesized by ribosomes.

There are two kinds of endoplasmic reticulum: **smooth** and **rough**. The rough ER has ribosomes attached to the surface of the sacs. Smooth ER does not have ribosome's attached and has functions in storage, synthesizing lipids and removing toxic substances.

4- Golgi Apparatus

The Golgi apparatus also called the Golgi complex or Golgi body, receives proteins from the ER and folds, sorts and packages these proteins into vesicles.

5- Lysosomes

Lysosomes are a type of vesicle. Vesicles are spheres surrounded by a membrane that excludes their contents from the rest of the cytoplasm. Vesicles are used extensively within the cell for metabolism and transport of large molecules that cannot cross membrane unaided. Lysosomes contain digestive enzymes; these enzymes can break down large molecules like organelles, carbohydrates, lipids and proteins into smaller units so that the cell can reuse them.

6- Mitochondria

Mitochondria are the energy-producing organelles." The process of cellular respiration occurs in the mitochondria. During this process, sugars and fats are broken down through a series of chemical reactions, releasing energy in the form of adenosine triphosphate (ATP).

7- Cytoplasm

The cytosol is the gel-like liquid contained within cells. The cytosol and all the organelles within it – except for the nucleus – are collectively referred to as the cell's cytoplasm. This cytosol consists primarily of water, but also contains ions, proteins, and small molecules. The pH is generally neutral, around 7.

8- Cytoskeleton

The cytoskeleton is a network of filaments and tubules found throughout the cytoplasm of the cell. It has many functions:

1- Gives the cell shape and provides a mechanical support to allow cells to move and divide.

2- Provides strength

3- Stabilizes tissues and anchors organelles within the cell

4- Has a role in cell signaling

There are three types of cytoskeletal filaments: microfilaments, microtubules and intermediate filaments.

9- Cell Membrane

The cell membrane surrounds the entire cell and separates its components from the outer environment. The cell membrane is a double layer made up of phospholipids (called the phospholipids bilayer). The cell membrane is selectively permeable, meaning it only allows certain molecules to enter and exit. Oxygen and carbon dioxide pass through easily, while larger or charged molecules must go through special channels, bind to receptors or be engulfed.