1.2B: Levels of Organization of Living Things

Learning Objectives

- Describe the biological levels of organization from the smallest to highest level

Living things are highly organized and structured, following a hierarchy that can be examined on a scale from small to large. The atom is the smallest and most fundamental unit of matter. It consists of a nucleus surrounded by electrons. Atoms form molecules which are chemical structures consisting of at least two atoms held together by one or more chemical bonds. Many molecules that are biologically important are macromolecules, large molecules that are typically formed by polymerization (a polymer is a large molecule that is made by combining smaller units called monomers, which are simpler than macromolecules). An example of a macromolecule is deoxyribonucleic acid (DNA), which contains the instructions for the structure and functioning of all living organisms.
Figure \(\PageIndex{1}\): DNA. All molecules, including this DNA molecule, are composed of atoms.

From Organelles to Biospheres

Macromolecules can form aggregates within a cell that are surrounded by membranes; these are called organelles. Organelles are small structures that exist within cells. Examples of these include: mitochondria and chloroplasts, which carry out indispensable functions. Mitochondria produce energy to power the cell while chloroplasts enable green plants to utilize the energy in sunlight to make sugars. All living things are made of cells, and the cell itself is the smallest fundamental unit of structure and function in living organisms. (This requirement is why viruses are not considered living: they are not made of cells. To make new viruses, they have to invade and hijack the reproductive mechanism of a living cell; only then can they obtain the materials they need to reproduce. ) Some organisms consist of a single cell and others are multicellular. Cells are classified as prokaryotic or eukaryotic. Prokaryotes are single-celled or colonial organisms that do not have membrane-bound nuclei; in contrast, the cells of eukaryotes do have membrane-bound organelles and a membrane-bound nucleus.

In larger organisms, cells combine to make tissues, which are groups of similar cells carrying out similar or related functions. Organs are collections of tissues grouped together performing a common function. Organs are present not
only in animals but also in plants. An organ system is a higher level of organization that consists of functionally related organs. Mammals have many organ systems. For instance, the circulatory system transports blood through the body and to and from the lungs; it includes organs such as the heart and blood vessels. Furthermore, organisms are individual living entities. For example, each tree in a forest is an organism. Single-celled prokaryotes and single-celled eukaryotes are also considered organisms and are typically referred to as microorganisms.

All the individuals of a species living within a specific area are collectively called a population. For example, a forest may include many pine trees. All of these pine trees represent the population of pine trees in this forest. Different populations may live in the same specific area. For example, the forest with the pine trees includes populations of flowering plants and also insects and microbial populations. A community is the sum of populations inhabiting a particular area. For instance, all of the trees, flowers, insects, and other populations in a forest form the forest’s community. The forest itself is an ecosystem. An ecosystem consists of all the living things in a particular area together with the abiotic, non-living parts of that environment such as nitrogen in the soil or rain water. At the highest level of organization, the biosphere is the collection of all ecosystems, and it represents the zones of life on earth. It includes land, water, and even the atmosphere to a certain extent. Taken together, all of these levels comprise the biological levels of organization, which range from organelles to the biosphere.
Organelles: The nucleus, dyed blue in these onion cells, is an example of an organelle.

Cells: Human blood cells.

Tissues: Human skin tissue.

Organs and Organ Systems: Organs, such as the stomach and intestine, make up the human digestive system.

Organisms, Populations, and Communities: In a forest, each pine tree is an organism. Together, all the pine trees make up a population. All the plant and animal species in the forest comprise a community.

Ecosystems: This coastal ecosystem in the southeastern United States includes living organisms and the environment in which they live.

The Biosphere: Encompasses all the ecosystems on Earth.
Figure \(\PageIndex{1}\): **Biological Levels of Organization**: The biological levels of organization of living things follow a hierarchy, such as the one shown. From a single organelle to the entire biosphere, living organisms are part of a highly structured hierarchy.

## Key Points

- The atom is the smallest and most fundamental unit of matter. The bonding of at least two atoms or more form molecules.
- The simplest level of organization for living things is a single organelle, which is composed of aggregates of macromolecules.
- The highest level of organization for living things is the biosphere; it encompasses all other levels.
- The biological levels of organization of living things arranged from the simplest to most complex are: organelle, cells, tissues, organs, organ systems, organisms, populations, communities, ecosystem, and biosphere.

## Key Terms

- **molecule**: The smallest particle of a specific compound that retains the chemical properties of that compound; two or more atoms held together by chemical bonds.
- **macromolecule**: A very large molecule, especially used in reference to large biological polymers (e.g. nucleic acids and proteins).
- **polymerization**: The chemical process, normally with the aid of a catalyst, to form a polymer by bonding together multiple identical units (monomers).