

Levels of Organization of Living Things

Living things are highly organized and structured. The **atom** is the smallest and most fundamental unit of matter. It consists of a nucleus surrounded by electrons. Atoms form molecules. A **molecule** is a chemical structure consisting of at least two atoms held together by a chemical bond. Many biologically important molecules are macromolecules. A **macromolecule** is a large molecule that is typically formed by combining smaller molecules. For example, nucleotides are small molecules linked together to form the macromolecule, DNA (deoxyribonucleic acid) (Figure 1.11). DNA contains the instructions necessary for cells and organisms to maintain homeostasis.



Figure 1.11 A molecule, like this large DNA molecule, is composed of atoms. (credit: "Brian0918"/[Wikimedia Commons](#))

CONCEPTS IN ACTION- To see an animation of this DNA molecule, click [here](#).



Some cells contain collections of macromolecules surrounded by membranes; these are called organelles. **Organelles** are small structures that exist within cells and perform specialized functions. For example, in some cells, DNA is enclosed within a membrane-bound organelle called the nucleus (plural: nuclei). All living things are made of cells; the **cell** is the smallest fundamental unit found in living organisms. Cells exhibit all of the properties of life discussed above. Viruses are often not considered living because they are not made of cells, nor are they capable of reproducing on their own. To make new viruses, they must invade and take over a living cell.

Some **organisms** consist of a single cell, while others are multicellular. In most multicellular organisms, cells combine to make **tissues**, which are groups of similar cells carrying out the same function. **Organs** are collections of tissues grouped based on 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. For example, vertebrate animals have many organ systems, such as the circulatory system that transports blood throughout the body; it includes organs such as the heart and blood vessels. **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.

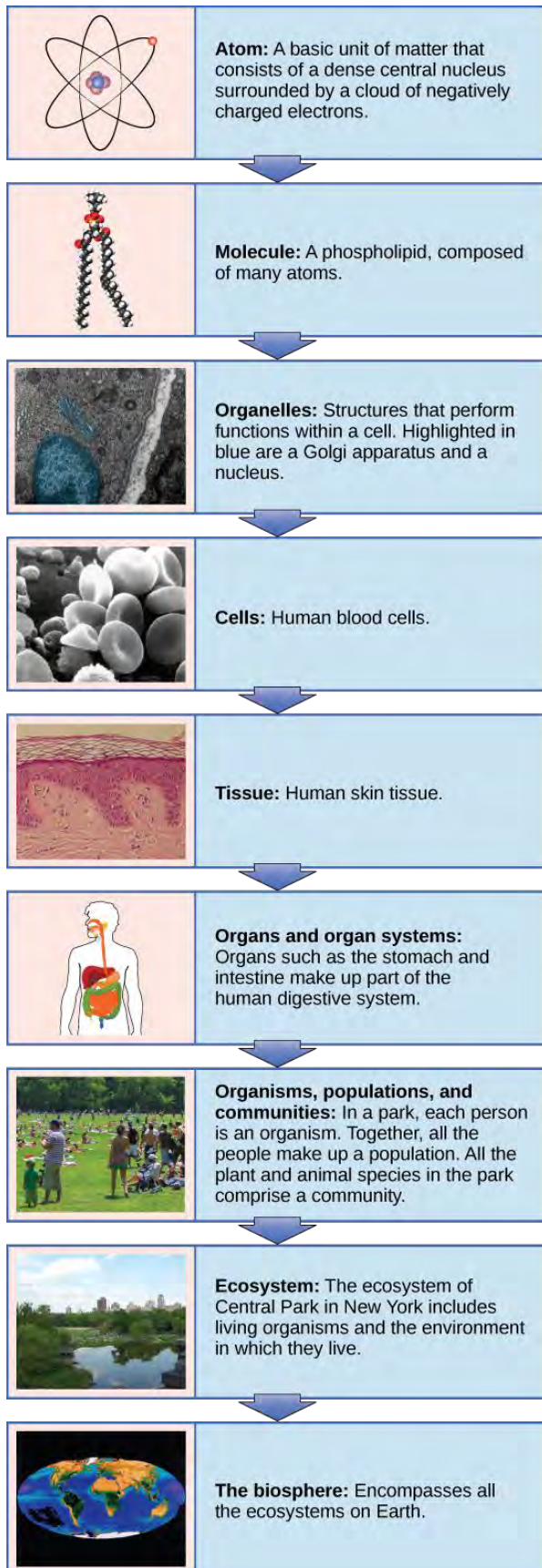


Figure 1.12 From an atom to the entire Earth, biology examines all aspects of life. (credit "molecule": modification of work by Jane Whitney; credit "organelles": modification of work by Louisa Howard; credit "cells": modification of work by Bruce Wetzel, Harry Schaefer, National Cancer Institute; credit "tissue": modification of work by "Kilbad"/Wikimedia Commons; credit "organs": modification of work by Mariana Ruiz Villareal, Joaquim Alves Gaspar; credit "organisms": modification of work by Peter Dutton; credit "ecosystem": modification of work by "gigi4791"/Flickr; credit "biosphere": modification of work by NASA/ Concepts of Biology OpenStax)

All the individuals living within a specific area are collectively called a **population**. For example, a forest may include many white pine trees. All these pine trees represent the population of white pine trees in this forest. Different populations may live in the same area. The forest with the pine trees includes populations of flowering plants, insects, and microbial populations. A **community** is the set of populations inhabiting a particular area. For instance, all 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, or non-living, parts of that environment, such as nitrogen in the soil or rainwater. At the highest level of organization (Figure 1.12), the **biosphere** is the collection of all ecosystems on planet Earth. It includes land, water, and portions of the atmosphere.

Check your knowledge

Which of the following statements is false?

- a. Tissues exist within organs which exist within organ systems.
- b. Communities exist within populations which exist within ecosystems.
- c. Organelles exist within cells which exist within tissues.
- d. Communities exist within ecosystems which exist in the biosphere.

Answer: (b)

The Diversity of Life

The science of biology is very broad because there is a tremendous diversity of life on Earth. The source of this diversity is evolution. **Evolution** is the process of genetic change in a population. Evolution helps explain how new species can arise from older species. Speciation events can occur when individuals within a population are separated and begin to change or evolve independently of one another. If the individuals change to the point where they can no longer interbreed, a speciation event has occurred, and species diversity has increased. Evolution will be discussed in much greater detail in chapter 11.

In the 18th century, a Swedish scientist named Carl Linnaeus first proposed organizing living organisms into a hierarchical taxonomy. In this system, species that are most similar to each other are put together within a grouping known as a genus. Furthermore, similar genera (the plural of genus) are put together within a family. This grouping continues until all organisms are collected together into groups at the highest level. The current taxonomic system now has eight levels in its hierarchy, from lowest to highest, they are species, genus, family, order, class, phylum, kingdom, and domain (Figure 1.13).