

The Earth System

System Models



FIGURE 8: Model of the Earth system.



Explain Is Earth an open, closed, or isolated system? Explain.

To understand living things better, we can study the systems in which they exist. One of these systems is our home planet—Earth. The Earth system is all of the matter, energy, and processes within Earth's boundary. Earth is made up of smaller systems, such as the biosphere, where all living things exist and interact. The biosphere in turn includes many smaller subsystems of living things in both aquatic and land environments. Earth itself exists within larger systems, such as the solar system and the Milky Way galaxy.

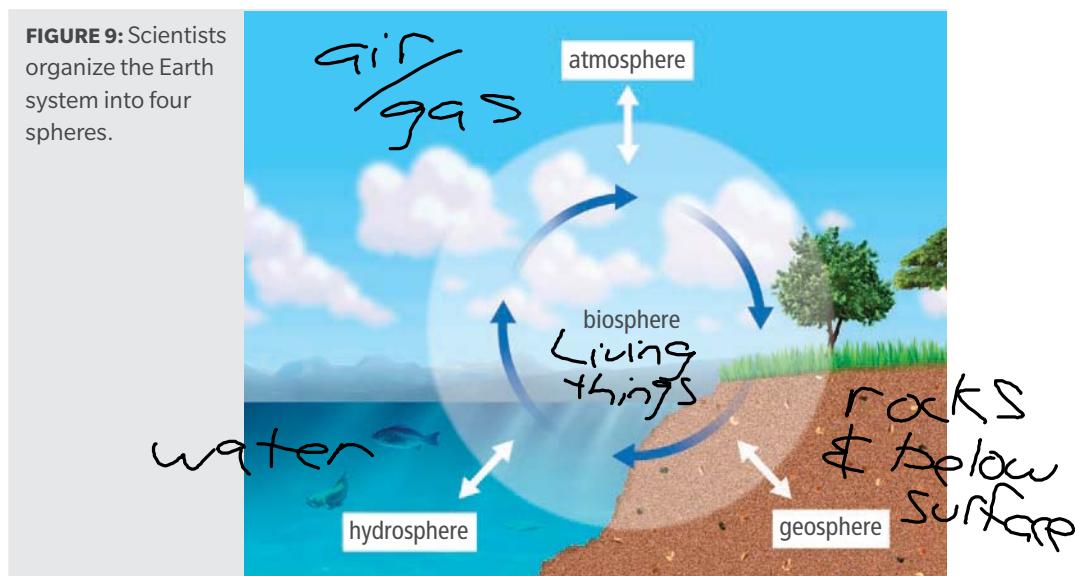
As Figure 8 shows, matter stays within the Earth system, but energy enters the system in the form of sunlight and exits in the form of heat. Within the system itself, light energy is converted into other forms of energy that drive transformations of matter from one form to another as it cycles through the system.

Organization of the Earth System

Scientists use a system model to better understand interactions within the Earth system. The system model, shown in Figure 9, organizes the Earth system into four interconnected systems, or spheres: geosphere, hydrosphere, biosphere, and atmosphere.

The geosphere is all the solid features of Earth's surface, such as mountains, continents, and the sea floor, as well as everything below Earth's surface. The hydrosphere is all of Earth's water, including water in the form of liquid water, ice, and water vapor. The biosphere is the area of Earth where life exists. The atmosphere is all of the air that envelops Earth's solid and liquid surface.

FIGURE 9: Scientists organize the Earth system into four spheres.

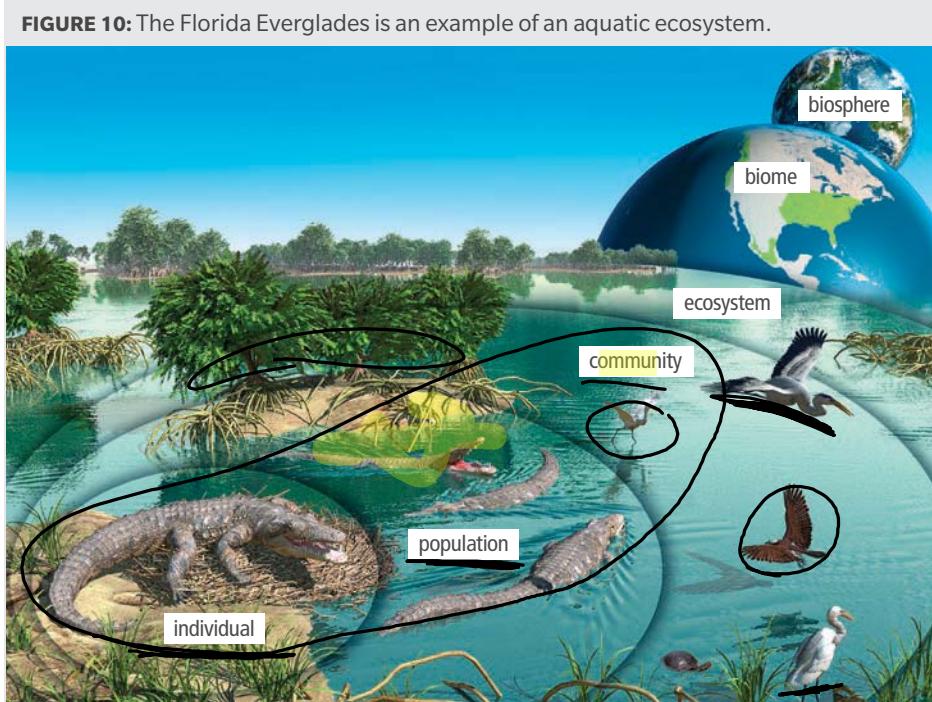


Explain This model shows the biosphere in the middle of the diagram with arrows connecting it to the other spheres. Why is the biosphere depicted this way?

Organization of the Biosphere

Earth's biosphere is made up of ecosystems. An **ecosystem** includes all of the nonliving and living things, or **organisms**, in a given area. Nonliving things include the climate, soil, water, and rocks that organisms rely on for survival. The relationships among organisms can be further categorized. Organisms of the same species that live in the same area make up a population. The collection of the different populations in an area make up a community. Communities exist within larger systems called biomes. Biomes are major regional or global areas characterized by their climate and vegetation. Examples of biomes include deserts, tropical rain forests, tundra, and grasslands.

FIGURE 10: The Florida Everglades is an example of an aquatic ecosystem.



The living components in an ecosystem are called **biotic factors**. The nonliving components of ecosystems are **abiotic factors**. The biotic and abiotic components in an ecosystem interact and are interdependent.

FIGURE 11: Taiga is a biome characterized by long, cold winters and short, mild, and rainy summers.



Model Place these terms in order to illustrate the levels of scale from an organism to the solar system: *population, biosphere, solar system, ecosystem, organism, biome, Earth, community.*

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Hands-On Lab

Life Under a Microscope

Observe pond water under a microscope and determine whether items are living or nonliving based on their observable characteristics.

Model Identify the biotic and abiotic factors in Figure 11. Make a model to illustrate how these factors interact in this ecosystem.

Characteristics of Living Things

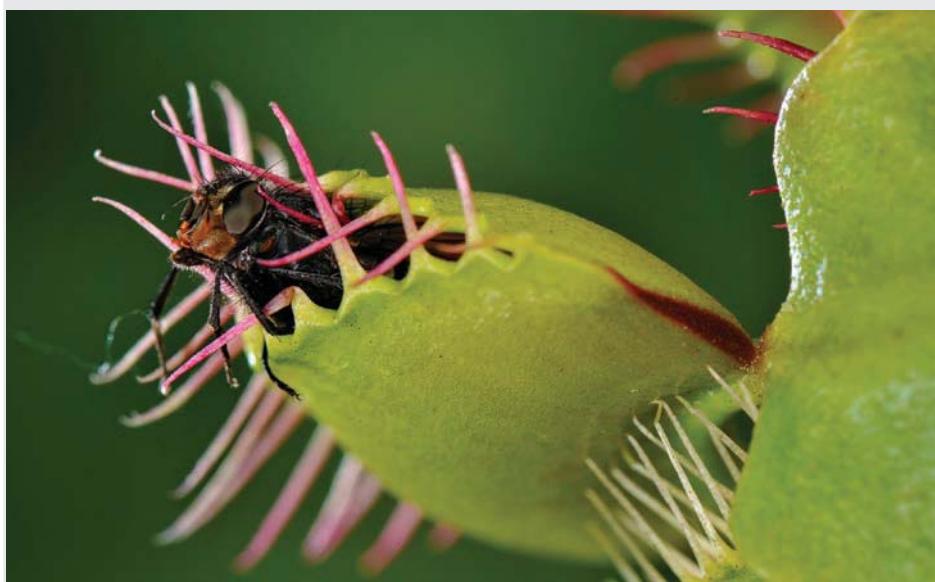
Scientists use a set of characteristics to define living things. In general, all living things are made up of one or more cells, require an energy source, grow and change over time, reproduce by making copies of themselves or by having offspring, and respond to changes in their environment. **Homeostasis** is the maintenance of constant internal conditions in an organism. Although temperature and other environmental conditions are always changing, the conditions inside organisms usually stay quite stable. Maintaining stable internal conditions is critical to an organism's survival.

Analyze Describe at least two biological systems. Explain how these systems are independent from and interconnected with each other.

FIGURE 12: Most plants get nitrogen from the soil.

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Venus flytraps grow in nitrogen-poor soil and must rely on the insects they catch as their source of nitrogen.



The Venus flytrap in Figure 12 is a living thing. It is a plant made up of individual cells that work together to perform the functions it needs to survive. It gets its energy from the sun and the nutrients it needs from the insects it digests. A Venus flytrap reproduces both sexually through pollination and asexually by spreading its rhizomes—rootlike stems—underground in the soil.

How scientists think about the characteristics of living things has undergone revision as new evidence comes to light. For example, there is disagreement about whether or not viruses are alive. Viruses do not maintain homeostasis and cannot reproduce without a host organism.

Another way to think about life is as an emergent property of a collection of certain nonliving things. As an example, proteins are chemical building blocks in all organisms, but proteins by themselves are nonliving things. However, proteins in combination with other molecules and a complex set of reactions make up living things. This argument applies to viruses, which are made only of a strand of genetic material surrounded by a protein coat. As a result, some scientists claim viruses are not living things, because they are not made of cells. However, there are some membrane-bound viruses. Are viruses living things or not? The debate continues.



Explain Record evidence for whether the robot at the beginning of this lesson meets the criteria for a living system. Which criteria does it meet, and which does it not? Does a robot have emergent properties? Explain your answer.