Life on Planet Earth

2.1

In our solar system, only a single planet—Earth—is teeming with millions of species. Earth is home to countless organisms and habitat types. A habitat is the place where an organism lives. Habitats may be terrestrial, on the land, or aquatic, in the water. In the oceans, life ranges from colourful fish on coral reefs to strange creatures living in the dark depths. On land, there are cacti and rattlesnakes in the arid deserts. Enormous trees swarm with insects in the tropical rainforests (Figure 1). Low-lying shrubs and herds of caribou abound in the frozen Arctic. What features of Earth permit such a diversity of life to exist?

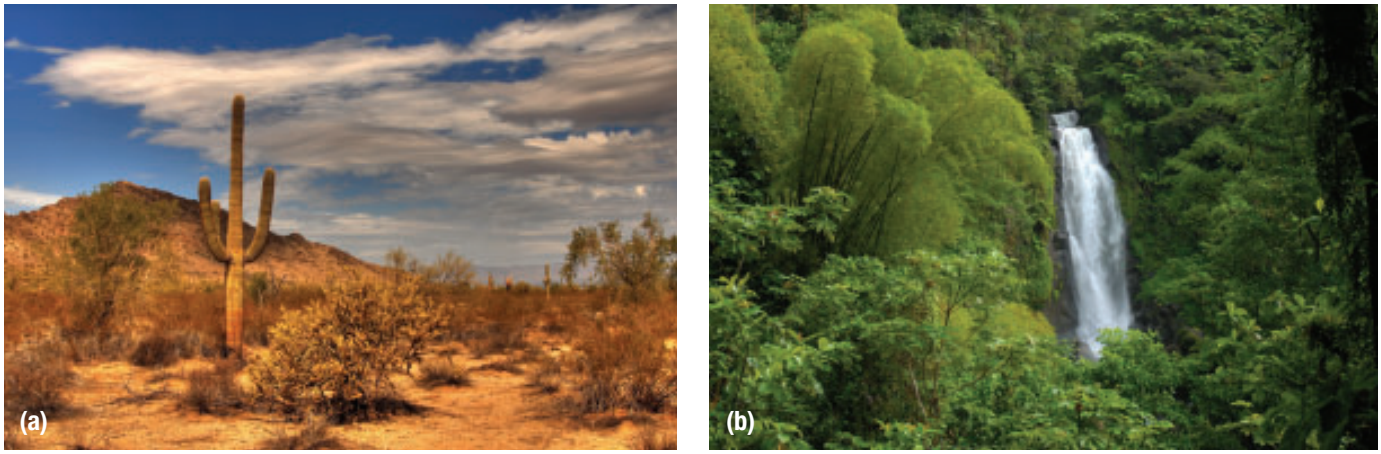

Figure 1 Earth is home to countless habitats, including (a) deserts and (b) tropical rainforests.

The Spheres of Earth

Earth is a medium-sized planet orbiting our Sun (a star) at a distance of approximately 150 000 000 km. Viewed from space, Earth appears as a pale blue dot (Figure 2). As you near Earth, you will notice it is surrounded by a thin gaseous layer swirling with clouds. Finally, you will be able to distinguish the oceans, land, and ice that cover Earth's surface.

Figure 2 Earth looks like a pale blue dot when viewed from space.

The Atmosphere, Lithosphere, and Hydrosphere

Earth's mass creates a force of gravity strong enough to hold gases near its surface. In contrast, the force of gravity of our Moon is not strong enough to hold gases. Earth's **atmosphere** is the layer of gases extending upward for hundreds of kilometres. It is made up of about 78 % nitrogen gas and 21 % oxygen gas. The remaining <1 % of the atmosphere includes argon, water vapour, carbon dioxide, and a variety of other gases.

atmosphere the layer of gases surrounding Earth

The atmosphere is critical to life on Earth. It acts like a blanket and moderates surface temperatures. The insulation prevents excessive heating during the day and cooling during the night. Without an atmosphere, Earth's surface temperature would drop from the 15 °C average it is now to approximately −18 °C. In addition, Earth's atmosphere blocks some incoming solar radiation, including most ultraviolet light, which is linked to skin cancer. Without the atmosphere, most of Earth's species would be unable to survive.

lithosphere Earth's solid outer layer

Scientists use a number of terms to describe Earth's key surface components. The **lithosphere** is the rocky outer shell of Earth. It consists of the rocks and minerals that make up the mountains, ocean floors, and the rest of Earth's solid landscape. The lithosphere ranges from about 50 to 150 km in thickness.

hydrosphere all of Earth's water in solid, liquid, and gas form

The **hydrosphere** consists of all the water on, above, and below Earth's surface. It includes oceans, lakes, ice, groundwater, and clouds. Nearly all the water on Earth (97 %) is contained in the oceans.

The Biosphere

biosphere the zone around Earth where life can exist

Scientists use the term **biosphere** to describe the locations in which life can exist within the lithosphere, atmosphere, and hydrosphere (Figure 3). Most of the easily observed life forms exist on land and in water, but micro-organisms exist several kilometres beneath Earth's surface.

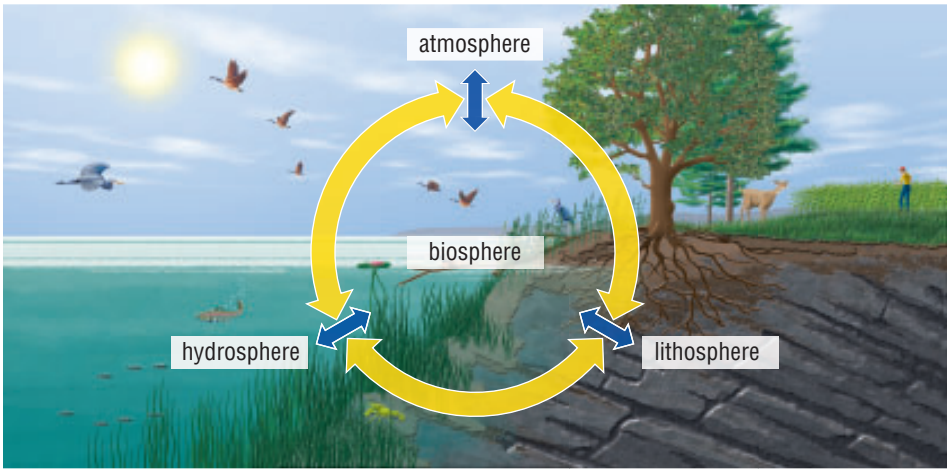

Figure 3 Earth's biosphere is found in regions of the atmosphere, lithosphere, and hydrosphere.

LEARNING TIP

It's All Greek to Me

Many scientific terms are derived from Greek. *Lithos* means stone, *atmos* means vapour, *hydro* means water, *bio* means life, and *sphere* means ball.

Earth is very large (about 12 700 km in diameter), but the biosphere is very thin by comparison. All conditions required for life must be met and maintained within this thin layer of ground, water, and lower atmosphere.

All living things need space, water, and nutrients to survive. However, the supply of these resources is limited. Ultimately, the availability of resources places a limit on the number of individuals of a species that can survive. All life on Earth is vying for access to these precious resources. The struggle for resources is discussed in Section 2.7.

The Gaia Hypothesis

READING TIP

Text-to-Text Connections

Brainstorm text-to-text connections by jotting down everything that comes to mind when you think about the selection and texts you have read. You can use a Venn diagram to list similarities and differences between the selection and other texts.

In the 1960s, scientist James Lovelock advanced the Gaia hypothesis. He proposed that Earth, through interactions among the biosphere, lithosphere, atmosphere, and hydrosphere, behaved like a living organism. Lovelock's hypothesis suggested that Earth was capable of responding to changes in its environment (such as incoming sunlight) and maintaining relatively consistent internal conditions over long periods of time—just like a living cell.

The Gaia hypothesis is not widely accepted as a rigorous scientific concept. However, many people feel that thinking of Earth as a living thing may encourage and promote a more caring attitude toward our planet and the life it supports.

TRY THIS A SCALE MODEL OF PLANET EARTH

SKILLS: Analyzing, Communicating

SKILLS HANDBOOK 5.A.1.

To appreciate how the lithosphere, atmosphere, and hydrosphere compare to the overall size of Earth, it is useful to consider a scale model of Earth. The diameter of Earth at the equator is approximately 12 700 km. Imagine a model of Earth with a diameter of 1 m, like a very large beach ball. Each distance of 1 mm on the model of Earth would represent a distance of 12.7 km on the true Earth. In this activity, you will create a scale model to compare the size of Earth's components.

1. Draw a table similar to Table 1 and fill in the missing values. For example, the thickest portion of the lithosphere at 150 km would be equivalent to $\frac{150}{12.7}$ or 12.8 mm on our model. T/I C

MATH TIP

To keep the model consistent, divide every value by the same number. Therefore, 1 mm always equals 12.7 km.

A. Did the model distances surprise you? Which model distances, if any, were less than you had expected? Which, if any, were greater? A

B. Based on the same scale, the volume of Earth would be 520 L, but the volume of all the world's oceans would be only 640 mL. This is not enough to fill two pop cans. If this is the case, why do you think Earth is often referred to as the watery planet? A

Table 1

Feature measurement	Actual distance	Model distance
thickest portion of lithosphere	150 km	12.8 mm
distance between Toronto and Thunder Bay	1380 km	
average ocean depth	3.7 km	
maximum ocean depth	10.9 km	
height of Mount Everest	8.4 km	
average thickness of Antarctic ice	1.6 km	
thickness of lower atmosphere	20 km	

C. In our Earth model, all life would exist within 1 mm of the surface. Given this information, would it surprise you to learn that many scientists consider the ocean, atmosphere, and biosphere to be very vulnerable to pollution and other forms of damage? A

IN SUMMARY

- Earth's atmosphere is made up of about 78 % nitrogen gas, 21 % oxygen gas, and other gases.
- The atmosphere moderates surface temperatures and blocks some incoming solar radiation.
- The lithosphere is Earth's solid outer shell.
- The hydrosphere is Earth's water in all its forms.
- The biosphere is the area where life can exist within the lithosphere, atmosphere, and hydrosphere.
- The Gaia hypothesis proposes that Earth behaves like a living organism.

CHECK YOUR LEARNING

1. Explain how Earth's mass is related to its ability to have an atmosphere. K/U
2. In what way does the presence of an atmosphere enhance conditions for life on Earth's surface? K/U
3. Define each of the following terms: lithosphere, atmosphere, hydrosphere, and biosphere. K/U
4. Describe the ways in which Earth's "spheres" overlap each other. K/U C
5. If Earth is so large, why do scientists consider the biosphere to be fragile? Explain. K/U A
6. It can be difficult to appreciate the relationships of large objects such as Earth. How does using a scale model make these relationships easier to understand? T/I C
7. What surprised you most about the physical makeup of Earth's spheres and the relationships among them? C