Matter Cycles

5.5

Food chains, food webs, and ecological pyramids show how energy moves in one direction in ecosystems. Matter also moves in ecosystems. What happens to matter—the leaves, roots, bones, hair, muscles, and every other part of an organism—in an ecosystem?

Earth is a closed system. A **closed system** is one in which no new matter can enter and no matter can leave. (On Earth, the only exception to this is when meteorites hit the surface of the planet.) The amounts of carbon, water, oxygen, hydrogen, and nitrogen on Earth are the same now as they were when dinosaurs were alive. However, organisms are continuously using these materials to stay alive. How do the amounts of matter on Earth remain the same over long periods of time? The answer is through recycling. Matter is taken up from the environment, used in life processes, and eventually returned to the environment where it can be used again. Ecologists call this repeating pattern a **cycle**.

closed system: a system in which the amount of matter remains constant over time

cycle: a pattern in nature that repeats over time

The Cleanup Squad

Detrivores and decomposers recycle in an ecosystem. They are essential to any ecosystem. As you have already learned, detrivores and decomposers eat the remains of dead plants and animals that scavengers and other consumers have left behind (Figure 1). Detrivores and decomposers also feed on animal wastes. Detrivores break up organic matter into smaller pieces. When decomposers feed, they break down these smaller pieces into simple substances such as minerals, nitrates, and phosphates. These substances are left in the soil as nutrients that plants can absorb. This is nature's way of recycling matter. Decomposers play a critical role in any ecosystem. They convert biotic elements, such as plant and animal matter, into abiotic elements, such as minerals. They allow matter to be recycled and reused by other organisms in the ecosystem.

LINKING TO LITERACY

Synthesizing Information

Synthesizing means to summarize what you read, reflect on your learning, and make connections with what you already know to form new opinions, apply your learning, or construct new ideas. Use the text on this and the next page to help you understand decomposers and detrivores.

Figure 1 (a) Scavengers like this turkey vulture feed on already dead animals and leave behind decaying matter. (b) Detrivores such as earthworms break down the organic matter into smaller pieces. (c) Decomposers like this fungus break down the remaining matter, releasing nutrients back into the ecosystem.

A composter is a perfect example of matter being recycled. Food and plant wastes are put into a container. Earthworms and other detrivores break down large pieces of decaying matter into smaller pieces. Bacteria, fungi, and other decomposers then further break down these pieces into nutrient particles. The final product is compost. Gardeners mix nutrient-rich compost into the existing soil. Garden plants then use these nutrients to grow.

To learn more about composting,
Go to Nelson Science

TRY THIS: Discovering Interactions in a Rotting Log

SKILLS MENU: performing, observing, analyzing

It generally takes 10 years for a rotting log (Figure 2) to break down completely into soil. In this activity, you will investigate the interactions in a rotting log that will cause it to decompose.

Equipment and Materials: rotting log; gloves; hand lens; forceps; water in a spray bottle; small shovel; plastic containers with lids; field guides (optional)

Figure 2 There are many hidden interactions happening within a rotting log.

1. Find a rotting log in your neighbourhood. It might be in a park or even on your school grounds.
2. Put on your gloves. Using the hand lens and forceps, carefully observe the log. Look for any signs of life. Use the spray bottle to keep the log moist. You may want to use field guides to identify what you see. Place any living things you find into plastic containers for temporary observation.
3. In your notebook, record any observations, along with any questions that arise from your investigation.
4. Return any organisms to where you found them on the log. Wash your hands when you are finished.

A. What evidence did you observe that indicates that the log is decomposing?

B. Is the rotting log an ecosystem? Use your evidence to explain.

Ecosystems Are Sustainable

Without scavengers, detrivores, and decomposers, Earth would be piled high with dead organisms. For example, the leaves that fall from trees would still be there in the spring, continuing to pile up year after year. With no new nutrients being added to the soil, plants would slowly starve and die. As a result, animals would also starve and die.

sustainable: something that can be maintained and used indefinitely

Healthy ecosystems are **sustainable**, which means that they can be maintained indefinitely. They can replenish resources by continuously recycling matter. For example, a bear catches a fish, eats most of it, and leaves the carcass to rot into the soil. The nutrients in the carcass are released by decomposers. Forest trees use these nutrients to grow and stay healthy. The healthy forest provides a home and food for the bear.

The Carbon Cycle

Carbon is found in many places on Earth. It is found in abiotic elements, such as coal, oil, and natural gas, and in the air as carbon dioxide. Carbon is also found in all living things.

Carbon has a predictable cycle (Figure 3). Plants use carbon dioxide in photosynthesis to produce sugars. When animals and other organisms break down these sugars to obtain energy, they produce water and carbon dioxide. Animals also release waste carbon dioxide when they exhale, or breathe out. When decomposers break down dead plants and animals, they too release carbon dioxide. All of the carbon dioxide released into the air by these processes is available to plants for photosynthesis. The cycle starts again.

LINKING TO LITERACY

Reading a Diagram

Diagrams help you understand what is written in the text. Figures 3 and 4 (on the next page) are described in words. As you read, move back and forth between the text and the diagram to help you understand the ideas.

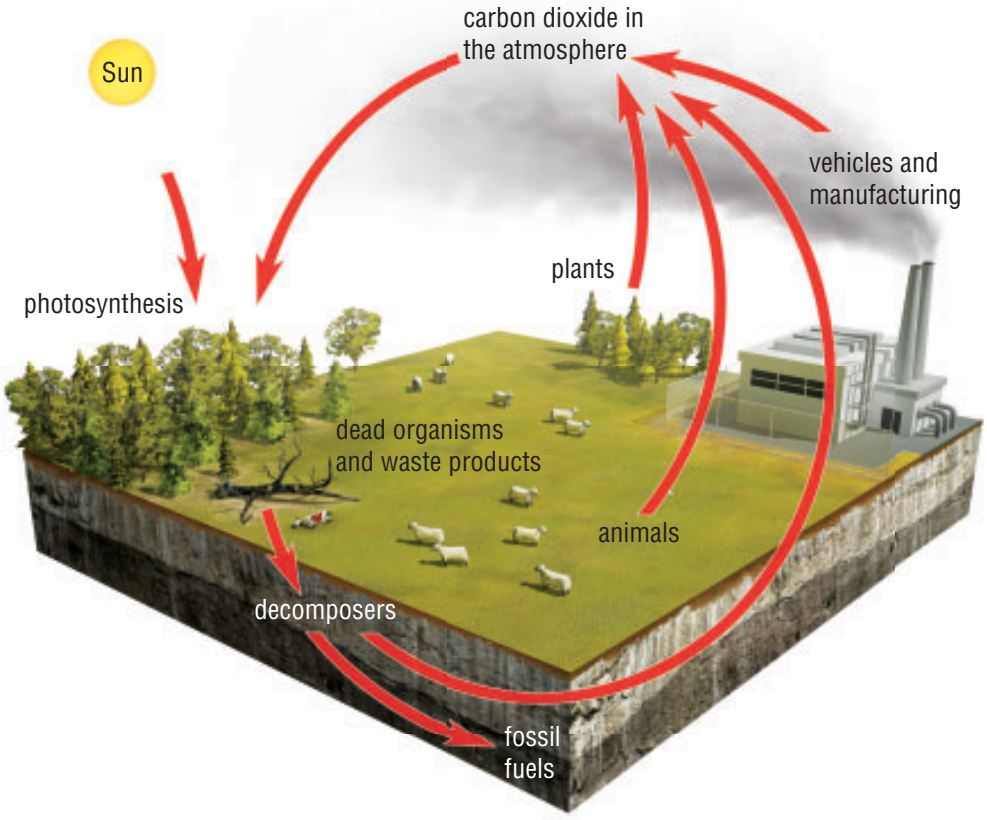

Figure 3 The carbon cycle

Carbon in dead plants that are buried in soil may not decompose completely. This organic matter remains underground for millions of years where it undergoes chemical changes to form fossil fuels such as coal, oil, and natural gas. When humans burn fossil fuels, most of the carbon quickly enters the atmosphere as carbon dioxide. Carbon dioxide is a gas that stays in Earth's atmosphere and absorbs the energy radiated by Earth and the Sun. This contributes to the warming of Earth's surface. Gases that trap energy in Earth's atmosphere are known as greenhouse gases. Earth would be a frozen world without greenhouse gases. However, humans have burned so much fossil fuel that there is about 30 % more carbon dioxide in the air today than there was 150 years ago.

All this extra carbon dioxide in the atmosphere has affected where organisms can live. Some locations are now too warm to meet the ideal temperature ranges of the organisms. These temperature changes have become a growing concern for society.

The Water Cycle

Water keeps all living things alive. Most living things are made largely of water. Water also moves in a cycle.

evaporation: the process in which a substance changes state from liquid to gas

The water cycle begins with evaporation (Figure 4). **Evaporation** is the change in state of a substance from liquid to gas. As the Sun's energy warms up oceans, lakes, and rivers, some of the water evaporates to form water vapour. Large amounts of water vapour also escape from plant leaves. The water vapour rises in the atmosphere, contracting as it cools to form tiny water droplets. The change of state from a gas to a liquid is called **condensation**. The tiny water droplets that result from the condensation of water vapour form clouds. As more and more droplets condense, they fall back to Earth as rain or snow, also called **precipitation**. Precipitation can run off of the surface of Earth and into bodies of water. Precipitation may also seep into the ground and remain trapped there for years as groundwater. Groundwater also eventually seeps into large bodies of water. At any stage in the cycle, the water may evaporate back into the atmosphere. Nature recycles water so that it can be used again and again!

condensation: the change in state of a substance from gas to liquid

precipitation: water in the liquid or solid state that falls to Earth

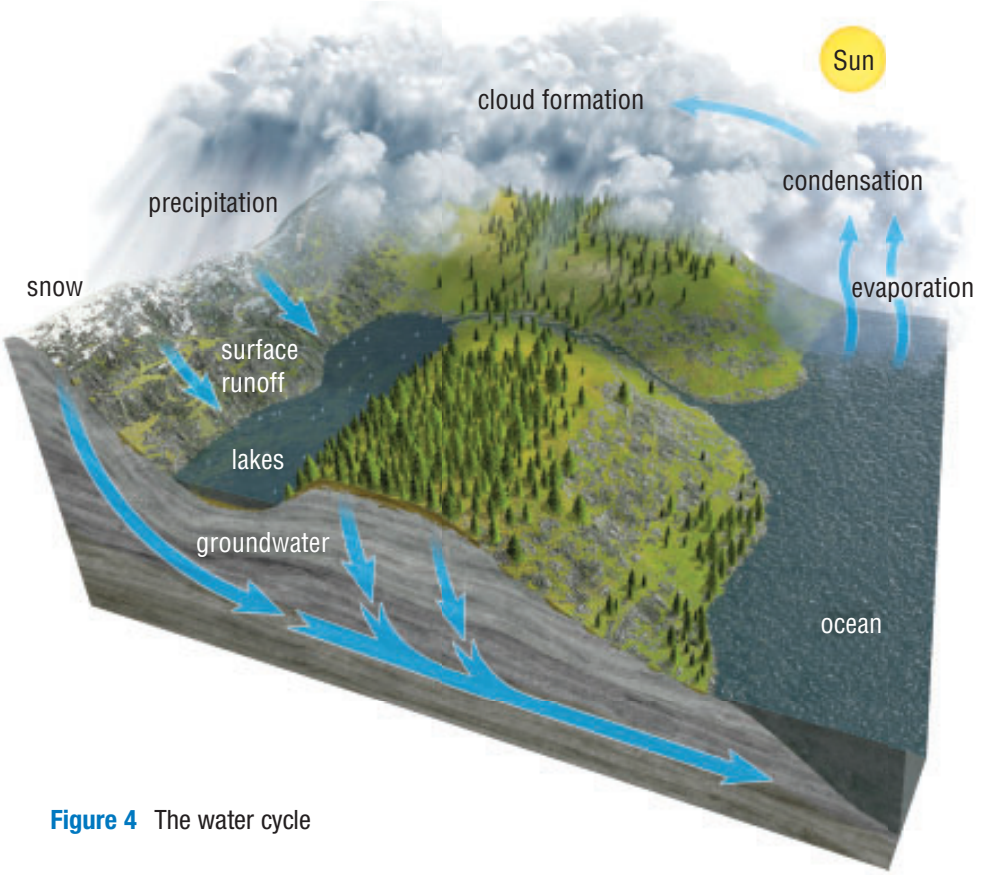

Figure 4 The water cycle

We all need clean fresh water to survive, but the supply of fresh water on Earth is limited. Agriculture and industry use large amounts of fresh water to irrigate crops and for industrial processes. Humans use water faster than it can be replenished by the water cycle because the demand has increased with the growth of the human population. Also, pollutants from agriculture, mine tailings, and other industrial processes can seep into local groundwater and make it unsafe to drink (Figure 5). We have to use water more carefully and protect it from pollution. This is the only way to ensure a supply of clean fresh drinking water in the future.

To learn more about the water cycle,
Go to Nelson Science

Figure 5 Smoke and steam are released from this paper mill near an Ontario lake. Pollutants that enter the water from industrial plants such as this are cycled through ecosystems and affect organisms.

In the same way that changes in food chains can affect an entire food web, changes to one of nature's cycles can affect other cycles. For example, Earth's temperature increases when more carbon enters the atmosphere. This can affect the water cycle. Higher temperatures affect precipitation patterns and the amount of water humans take from lakes and groundwater sources. It is important to think about the effects that different cycles in nature can have on each other.

Unit Task When you complete the Unit Task, think about whether your plan for naturalizing your area is sustainable.

CHECK YOUR LEARNING

1. What is a cycle?
2. Explain how detrivores and decomposers recycle matter.
3. What is meant by the statement "Ecosystems are sustainable"?
4. In your own words, describe the carbon cycle.
5. In your own words, describe the water cycle.
6. Describe some of the ways that the supply of fresh water on Earth is at risk.