

3.4 Cycles of Matter

Lesson Objectives

-  Describe how matter cycles among the living and nonliving parts of an ecosystem.
-  Describe how water cycles through the biosphere.
-  Explain why nutrients are important in living systems.
-  Describe how the availability of nutrients affects the productivity of ecosystems.

Lesson Summary

Recycling in the Biosphere Matter, unlike energy, is recycled within and between ecosystems. Elements pass from one organism to another and from one part of the biosphere to another through **biogeochemical cycles**, which are closed loops powered by the flow of energy.

The Water Cycle Water moves between the ocean, the atmosphere, and land.

- ▶ Evaporation is the process in which water changes from a liquid to a gas.
- ▶ Transpiration is the process in which water evaporates from the leaves of plants.

Nutrient Cycles The chemical substances that an organism needs to survive are called **nutrients**. Like water, nutrients pass through organisms and the environment.

- ▶ **Carbon Cycle:** Carbon is a key ingredient of all organic compounds. Processes involved in the carbon cycle include photosynthesis and human activities such as burning.
- ▶ **Nitrogen Cycle:** Nitrogen is needed by all organisms to build proteins. Processes involved in the nitrogen cycle include nitrogen fixation and denitrification.
 - In **nitrogen fixation**, certain bacteria convert nitrogen gas into ammonia.
 - In **denitrification**, other soil bacteria convert nitrogen compounds called nitrates back into nitrogen gas.
- ▶ **Phosphorus Cycle:** Phosphorus is needed for molecules such as DNA and RNA. Most of the phosphorus in the biosphere is stored in rocks and ocean sediments. Stored phosphorus is gradually released into water and soil, where it is used by organisms.

Nutrient Limitation A nutrient that, in short supply, can limit the productivity of an ecosystem is called a **limiting nutrient**.

Recycling in the Biosphere

For Questions 1–3, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- _____ 1. The four elements that make up over 95 percent of the body in most organisms are oxygen, sulfur, nitrogen, and hydrogen.
- _____ 2. Matter moves through an ecosystem in cycles.
- _____ 3. Chemical and physical processes include the formation of clouds and precipitation, “burning” food, and the flow of running water.

5. Explain why Earth is considered a closed system.

6. Give two ways building a new highway affect the cycles of matter?

The Water Cycle

7. What role do plants play in the water cycle?

Nutrient Cycles

9. Complete the chart about the carbon cycle.

Processes That Cause Carbon to Move into the Atmosphere		Processes That Cause Carbon to Move out of the Atmosphere	
Process	Description	Process	Description
Respiration		Photosynthesis	
	the release of CO ₂ and other gases into the atmosphere through vents in Earth's crust		

For Questions 10–12, write the letter of the correct answer on the line at the left.

- _____ 10. The carbon in coal, oil, and natural gas came from
- the combustion of fossil fuels.
 - the remains of dead organisms.
 - carbon-fixing bacteria in swamp soil.
 - carbon dioxide dissolved in ocean water.
- _____ 11. How does most of the carbon in an organism's body return to the environment after the organism dies?
- Decomposers break the body down into simpler compounds.
 - Heat from the sun causes the carbon in the body to evaporate.
 - Geological processes cause the body to turn into a fossil fuel.
 - Rainwater dissolves the carbon in the body and carries it to the ocean.
- _____ 12. Human processes mainly contribute to the
- release of carbon dioxide into the atmosphere.
 - decrease of the total amount of carbon found on Earth.
 - depletion of carbon dioxide reserves in the atmosphere.
 - increase in the amount of carbon contained in rock materials.

Write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

- _____ 13. Nitrogen, in the form of ammonia, nitrate, and nitrite, is found in the soil.
- _____ 14. Nitrogen fixation is the process in which certain bacteria convert nitrogen gas into nitrates.
- _____ 15. Denitrification is the process by which some soil bacteria convert nitrates into nitrogen gas.
- _____ 16. All organisms require nitrogen to make amino acids, which in turn are used to build carbohydrates.
- _____ 17. Phosphate is released as rocks and sediments wear down.
- _____ 18. Plants absorb phosphate from the soil or from water.
- _____ 19. Phosphorus is the most abundant gas in the atmosphere.
- _____ 20. Organic phosphate is taken up by producers during photosynthesis and released by cellular respiration.
- _____ 21. Phosphorus forms part of the important life-sustaining molecules such as DNA and RNA.
- _____ 22. Plants absorb phosphorus from the atmosphere or water.

23. List and describe the biological steps in the nitrogen cycle.

24. What is atmospheric nitrogen fixation, and how does it affect organisms?

25. How do humans add nitrogen to the biosphere?

26. Which parts of the phosphorus cycle are geological processes?
