

Nutrient Cycles in Ecosystems

Textbook pages 68–91

Before You Read

Like other organisms, your body relies on nutrients to stay healthy. Based on your current understanding, create a definition of what you think a nutrient is. Write your definition in the lines below.



Mark the Text

Check for Understanding
As you read this section, be sure to reread any parts you do not understand. Highlight any sentences that help you improve your understanding.



Reading Check

1. Name the three main nutrient cycles.

How are nutrients cycled in the biosphere?

Nutrients are chemicals required for plant and animal growth and other life processes. They are constantly recycled within Earth's biosphere. Nutrients spend different amounts of time in **stores** within the atmosphere, oceans, and land. Nutrients are stored for short periods of time in short-term stores, such as living organisms and the atmosphere. Nutrients can also be incorporated into longer-term stores, such as Earth's crust. **Nutrient cycles** describe the flow of nutrients in and out of stores as a result of biotic and abiotic processes. Without human interference, nutrient cycles are almost perfectly balanced. There are three main cycles that move nutrients through terrestrial and aquatic ecosystems:

1. the **carbon cycle**
2. the **nitrogen cycle**
3. the **phosphorus cycle** ✓

How does the carbon cycle work?

Carbon is an essential component of cells and life-sustaining chemical reactions. Carbon is cycled through living and decaying organisms, the atmosphere, bodies of water, and soil and rock. Carbon moves between stores via six main processes:

1. **Photosynthesis**: **Photosynthesis** is a chemical reaction that converts solar energy and atmospheric carbon dioxide gas (CO₂) into chemical energy.
2. **Cellular respiration**: During **cellular respiration**, plants and animals obtain energy by converting carbohydrates and oxygen (O₂) into carbon dioxide and water.

continued

- 3. **Decomposition:** Decomposers release carbon dioxide into the atmosphere through the **decomposition** of carbon-rich organic matter in soil.
- 4. **Ocean processes:** Dissolved carbon dioxide is stored in oceans. Marine organisms store carbon-rich **carbonate** (CO_3^{2-}) in their shells, which eventually form sedimentary rock.
- 5. Volcanic eruptions
- 6. Forest fires

How do human activities affect the carbon cycle?

Human activities, such as fossil fuel combustion and land clearance, quickly introduce carbon into the atmosphere from longer-term stores. These actions increase the levels of carbon dioxide, a greenhouse gas that contributes to global climate change.

How does the nitrogen cycle work?

Nitrogen is an important component of DNA and proteins. Most nitrogen is stored in the atmosphere, where it exists as nitrogen gas (N_2). It is also stored in bodies of water, living organisms, and decaying organic matter. Most organisms cannot use atmospheric nitrogen gas. The nitrogen cycle involves four processes, three of which make nitrogen available to plants and animals.

- 1. **Nitrogen fixation:** Nitrogen gas is converted into nitrate (NO_3^-) and ammonium (NH_4^+), compounds that are usable by plants. Nitrogen fixation occurs mainly through nitrogen-fixing bacteria, and when lightning strikes in the atmosphere.
- 2. **Nitrification:** Ammonium is converted into nitrate and nitrite (NO_2^-) through the work of **nitrifying bacteria**.
- 3. **Uptake:** Useable forms of nitrogen are taken up by plant roots and incorporated into plant proteins. When herbivores and omnivores eat plants, they incorporate nitrogen into their own tissues.
- 4. **Denitrification:** **Denitrifying bacteria** convert nitrate back into atmospheric nitrogen.

How do human activities affect the nitrogen cycle?

Fossil fuel combustion and burning organic matter release nitrogen into the atmosphere, where it forms acid rain. Chemical fertilizers also contain nitrogen, which escapes into the atmosphere or **leaches** into lakes and streams. High levels of nitrogen cause **eutrophication** (too many nutrients) and increased algal growth in aquatic ecosystems, depriving aquatic organisms of sunlight and oxygen.

How does the phosphorus cycle work?

Phosphorus carries energy to cells. It is found in phosphate (PO_4^{3-}) rock and sediments on the ocean floor. **Weathering**—through **chemical** or **physical** means—breaks down rock, releasing phosphate into the soil from longer-term stores. Organisms take up phosphorus. When they die, decomposers return phosphorus to the soil. Excess phosphorus settles on floors of lakes and oceans, eventually forming sedimentary rock. It remains trapped for millions of years until it is exposed through **geologic uplift** or mountain building.

How do human activities affect the phosphorus cycle?

Commercial fertilizers and phosphate-containing detergents enter waterways and contribute additional phosphate to the phosphorus cycle. Slash-and-burn forest clearance reduces phosphate levels, as phosphate in trees enters soil as ash. It leaches out of the soil and settles on lake and ocean bottoms, unavailable to organisms. ✓

✓ Reading Check

1. List a human activity that can cause changes to a nutrient cycle.

Use with textbook pages 68–87.

Nutrient cycles

Answer the questions below.

1. Where are nutrients accumulated or stored for short or long periods?

2. Name a biotic process and an abiotic process that allow nutrients to flow in and out of stores.

3. Photosynthesis is an important process in which carbon and oxygen are cycled through ecosystems. Describe this process.

4. Cellular respiration is the process in which plants and animals make use of stored energy and release carbon dioxide back into the atmosphere. Describe this process.

5. How is decomposition related to the carbon cycle?

6. What is nitrogen fixation?

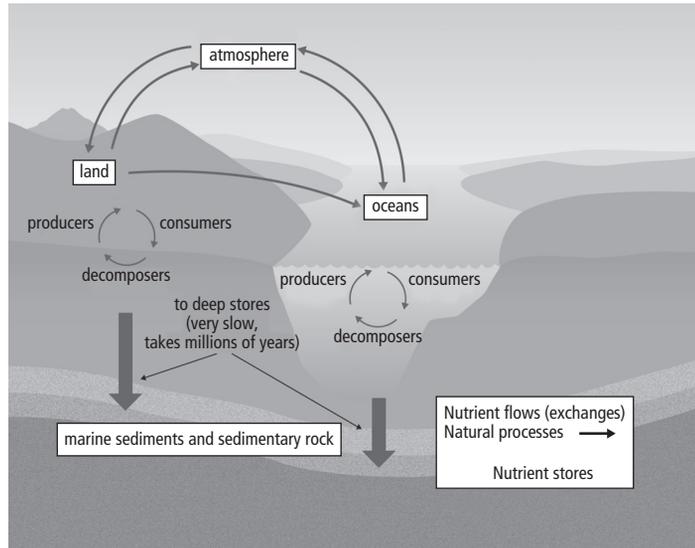
7. What is denitrification?

8. What is eutrophication?

Use with textbook pages 69–70, 86–87.

The cycling of nutrients in the biosphere

Use the general model of a nutrient cycle to answer the questions below.



1. This diagram illustrates the general model of a nutrient cycle. What types of human activities can affect a nutrient cycle?

2. How do these human activities affect a nutrient cycle?

3. On the diagram above, add terms and arrows that could represent the effects of human activity on a nutrient cycle.

4. How do changes in nutrient cycles affect biodiversity?

5. Reflect on your local community. Discuss a human activity that is affecting your local ecosystem.

Name _____

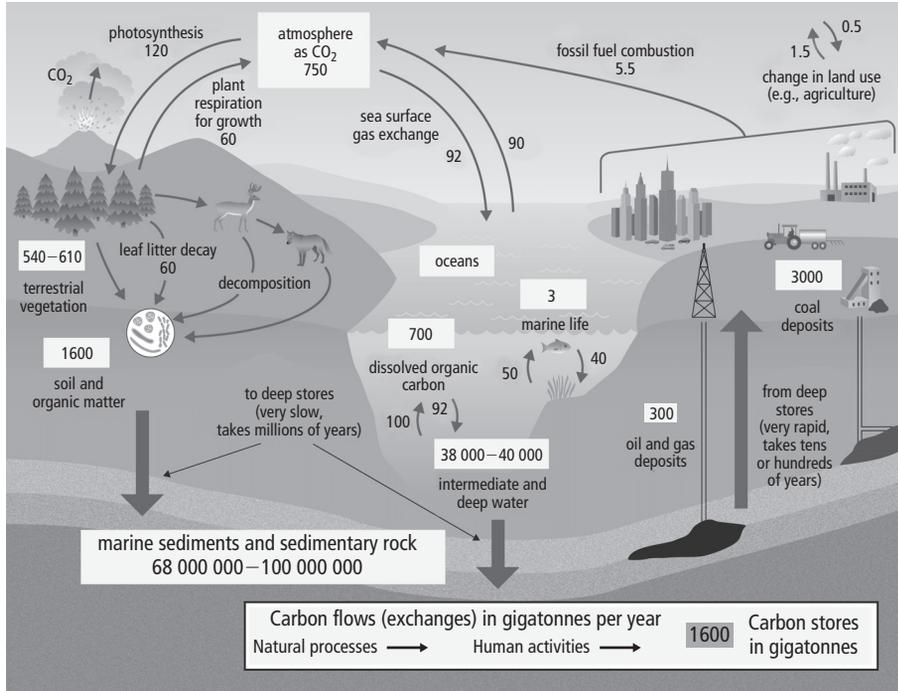
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Use with textbook pages 71–87.

The carbon, nitrogen, and phosphorus cycles

The carbon cycle

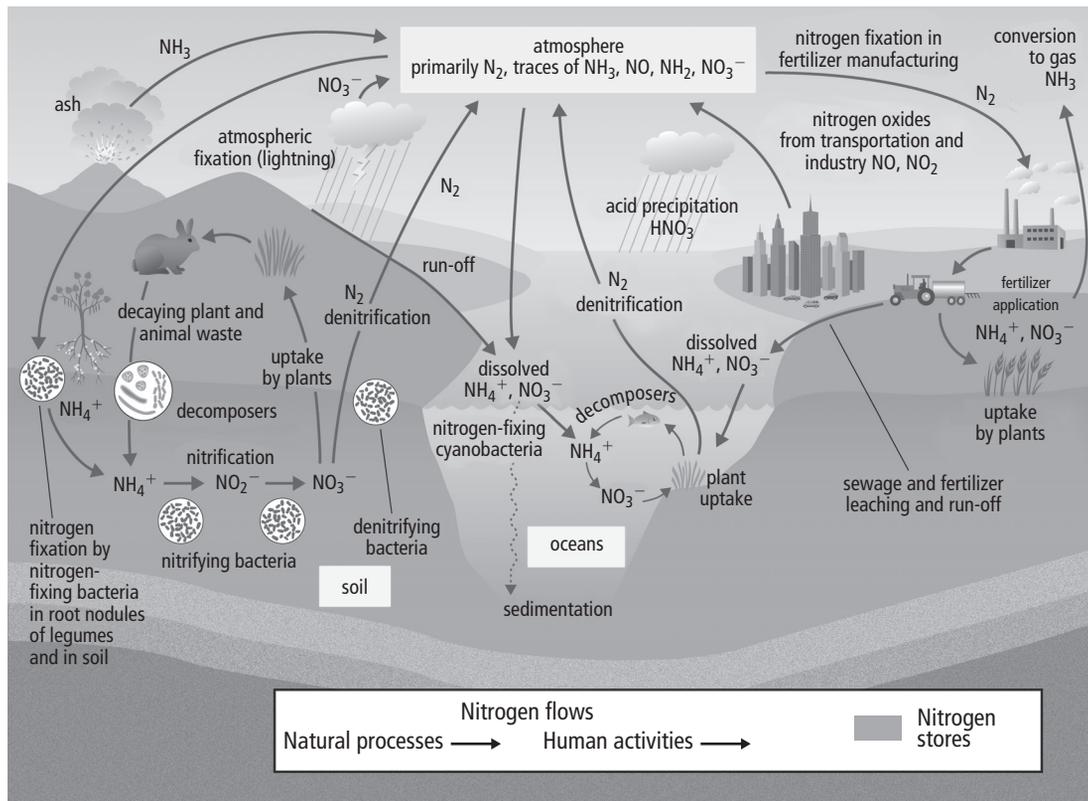
Use the nutrient cycle below to answer the questions in the chart that follows.



<p>Why is the carbon cycle important?</p>	<p>_____</p> <p>_____</p>
<p>How is carbon stored?</p>	<p>_____</p> <p>_____</p>
<p>How is carbon cycled?</p>	<p>_____</p> <p>_____</p>
<p>Name several human activities that affect the carbon cycle.</p>	<p>_____</p> <p>_____</p>

The nitrogen cycle

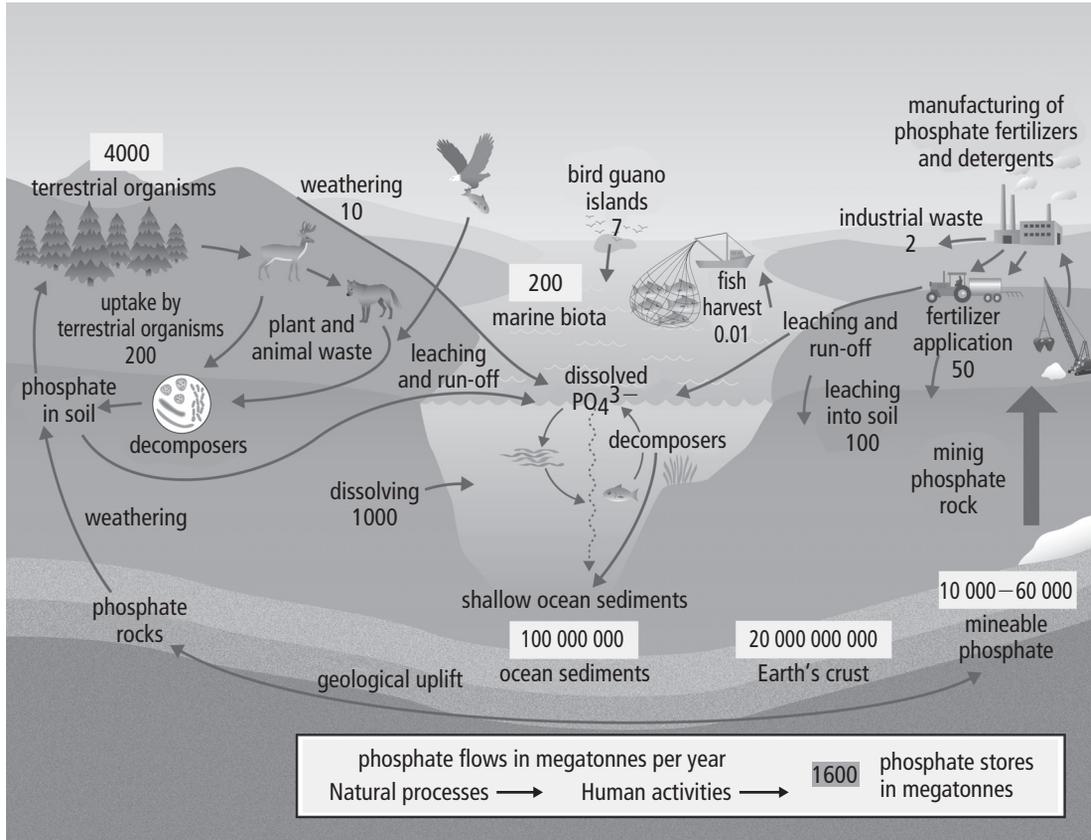
Use the nutrient cycle below to answer the questions that follow.



<p>Why is the nitrogen cycle important?</p>	<p>_____</p> <p>_____</p>
<p>How is nitrogen stored?</p>	<p>_____</p> <p>_____</p>
<p>How is nitrogen cycled?</p>	<p>_____</p> <p>_____</p>
<p>Name several human activities that affect the nitrogen cycle.</p>	<p>_____</p> <p>_____</p>

The phosphorus cycle

Use the nutrient cycle below to answer the questions that follow.



<p>Why is the phosphorus cycle important?</p>	<p>_____</p> <p>_____</p>
<p>How is phosphorus stored?</p>	<p>_____</p> <p>_____</p>
<p>How is phosphorus cycled?</p>	<p>_____</p> <p>_____</p>
<p>Name several human activities that affect the phosphorus cycle.</p>	<p>_____</p> <p>_____</p>

Nutrient cycles in ecosystems

Use with textbook pages 68–87.

Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.	
Term	Descriptor
1. _____ cellular respiration	A. the process in which nitrogen is released into the atmosphere
2. _____ denitrification	B. substances, such as nitrogen and phosphorus, that are required by plants and animals for energy, growth, development, repair, and maintenance
3. _____ nitrification	C. the process in which rock is broken into smaller fragments
4. _____ nutrients	D. a process in which carbon dioxide enters plants and reacts with water in the presence of sunlight to produce carbohydrates and oxygen
5. _____ photosynthesis	E. the process in which ammonium is converted into nitrate
6. _____ sedimentation	F. the process in which plants and animals release carbon dioxide back into the atmosphere by converting carbohydrates and oxygen into carbon dioxide and water.
7. _____ weathering	G. the process in which soil particles and decaying organic matter accumulate in layer on the ground or at the bottom of large bodies of water

Circle the letter of the best answer.

8. In the carbon cycle, where are the highest stores of carbon found?
- A.** terrestrial vegetation
 - B.** marine sediments and sedimentary rocks
 - C.** oil and gas deposits
 - D.** soil and organic matter
9. Calcium carbonate is a structural component of:
- A.** marine organisms
 - B.** terrestrial organisms
 - C.** algae
 - D.** volcanic ash
10. Which of the following is not stored in the atmosphere as a gas?
- A.** carbon
 - B.** oxygen
 - C.** nitrogen
 - D.** phosphorus
11. Nitrogen fixation results in:
- A.** ammonium being converted into nitrates
 - B.** nitrates being consumed by bacteria
 - C.** nitrogen gas being converted into nitrate or ammonium
 - D.** ammonia being converted into carbohydrates
12. Lightning provides energy that:
- A.** absorbs energy into land masses
 - B.** fixes nitrogen in the atmosphere
 - C.** fixes carbon dioxide in the atmosphere
 - D.** releases nitrogen into the soil