16.4D: The Phosphorus Cycle

Phosphorus, important for creating nucleotides and ATP, is assimilated by plants, then released through decomposition when they die.

Learning Objectives

• Explain the phosphorous cycle

Key Points

• Phosphorous is important for the production of ATP and nucleotides.
• Inorganic phosphorous is found in the soil or water. Plants and algae assimilate inorganic phosphorus into their cells, and transfer it to other animals that consume them.
• When organisms die, their phosphorous is released by decomposer bacteria.
• Aquatic phosphorous follows a seasonal cycle, inorganic phosphorous peaks in the spring causing rapid algae and plant growth, and then declines. As plants die, it is re-released into the water.
• Phosphorous based fertilizers can cause excessive algae growth in aquatic systems, which can have negative impacts on the environment.

Key Terms

• **hypertrophication**: the ecosystem response to the addition of artificial or natural substances, such as nitrates and phosphates, through fertilizers or sewage, to an aquatic system. This response is usually an increase in primary production.
Phosphorus is an important element for living things because it is necessary for nucleotides and ATP. Plants assimilate phosphorous from the environment and then convert it from inorganic phosphorous to organic phosphorous. Phosphorus can be transferred to other organisms when they consume the plants and algae. Animals either release phosphorous through urination or defecation, when they die and are broken down by bacteria. The organic phosphorous is released and converted back into inorganic phosphorous through decomposition. The phosphorous cycle differs from other nutrient cycles, because it never passes through a gaseous phase like the nitrogen or carbon cycles.

Figure: The aquatic phosphorous cycle: Phosphorous is converted between its organic and inorganic forms. Plants convert phosphorous to its organic form, and bacteria convert it back to the inorganic form through decomposition.

Phosphorous levels follow a seasonal pattern in aquatic ecosystems. In the spring, inorganic phosphorous is released from the sediment by convection currents in the warming water. When phosphorous levels are high, algae and plants reproduce rapidly. Much of the phosphorous is then converted to organic phosphorous, and primary productivity then declines. Later in the summer, the plants and algae begin to die off, and bacteria decompose them, and inorganic phosphorus is released back into the ecosystem. As phosphorous levels begin to increase at the end of the summer, primary plants and algae begin to rapidly grow again.

The phosphorous cycle is affected by human activities. Although phosphorous is normally a limiting nutrient, most agricultural fertilizers contain phosphorous. Run-off and drainage from farms can flood aquatic ecosystems with excess phosphorus. Artificial phosphorous can cause over growth of algae and plants in aquatic ecosystems. When the excess plant material is broken down, the decomposing bacteria can use up all the oxygen in the water causing dead zones. Most bodies of water gradually become more productive over time through the slow, natural accumulation of nutrients in a process called eutrophication. However, overgrowth of algae due to phosphorous fertilizer is called "cultural eutrophication" or "hypertrophication," and is generally negative for ecosystems.
Figure: **Hypertrophication on the Potomac River**: The bright green color of the water is the result of algae blooms in response to the addition of phosphorous based fertilizers.