3–3 Cycles of Matter

How does matter move among the living and nonliving parts of an ecosystem?

Recycling in the Biosphere

Energy and matter move through the biosphere very differently.

Unlike the one-way flow of energy, matter is recycled within and between ecosystems.

Elements, chemical compounds, and other forms of matter are passed from one organism to another and from one part of the biosphere to another through **biogeochemical cycles**.

Matter can cycle because biological systems do not use up matter, they **transform** it.

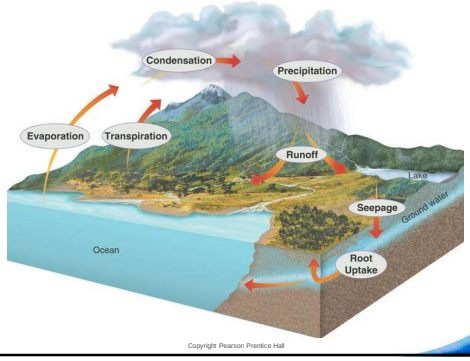
Matter is assembled into living tissue or passed out of the body as waste products.

The Water Cycle

All living things require water to survive.

active art click to start

Water moves between the ocean, atmosphere, and land.



Water molecules enter the atmosphere as water vapor, a gas, when they evaporate from the ocean or other bodies of water.

The process by which water changes from a liquid form to an atmospheric gas is called **evaporation**.

Water can also enter the atmosphere by evaporating from the leaves of plants in the process of **transpiration**.

Water vapor **condenses** into tiny droplets that form clouds.

The water returns to Earth's surface in the form of **precipitation**.

Water enters streams or **seeps** into soil where it enters plants through their roots **(uptake)**.

How are nutrients important in living systems?

Nutrient Cycles

All the chemical substances that an organism needs to sustain life are its **nutrients.**

Every living organism needs nutrients to build tissues and carry out essential life functions.

Similar to water, nutrients are passed between organisms and the environment through biogeochemical cycles.

Primary **producers**, such as plants, usually obtain nutrients from their environment.

Consumers obtain nutrients by eating other organisms.

movie click to start

The Carbon Cycle

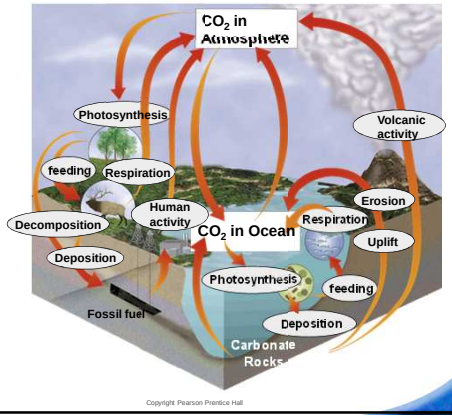
Carbon is a key ingredient of living tissue.

Biological processes, such as photosynthesis, respiration, and decomposition, take up and release carbon and oxygen.

Geochemical processes, such as erosion and volcanic activity, release carbon dioxide to the atmosphere and oceans.

Biogeochemical processes, such as the burial and decomposition of dead organisms and their conversion under pressure into coal and petroleum (fossil fuels), store carbon underground.

Human activities, such as mining, cutting and burning forests, and burning fossil fuels, release carbon dioxide into the atmosphere.



The Nitrogen Cycle

All organisms require nitrogen to make proteins.

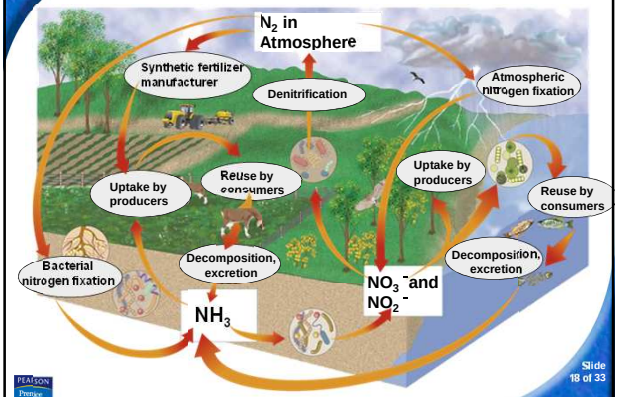
Although nitrogen gas is the most abundant form of nitrogen on Earth, only certain types of bacteria can use this form directly.

Such bacteria live in the soil and on the roots of plants called legumes. They convert nitrogen gas into ammonia in a process known as **nitrogen fixation.**

Other bacteria in the soil convert ammonia into nitrates and nitrites.

Once these products are available, producers can use them to make proteins.

Consumers then eat the producers and reuse the nitrogen to make their own proteins.



When organisms die, decomposers return nitrogen to the soil as ammonia.

The ammonia may be taken up again by producers.

Other soil bacteria convert nitrates into nitrogen gas in a process called **denitrification**.

This process releases nitrogen into the atmosphere once again.

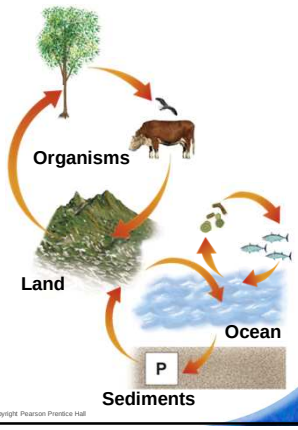
The Phosphorus Cycle

Phosphorus is essential to organisms because it helps forms important molecules like DNA and RNA.

Most phosphorus exists in the form of inorganic phosphate. Inorganic phosphate is released into the soil and water as sediments wear down.

Some phosphate stays on land and cycles between organisms and the soil. Plants bind the phosphates into organic compounds.

Organic phosphate moves through the food web and to the rest of the ecosystem.



Nutrient Limitation

The **primary productivity** of an ecosystem is the rate at which organic matter is created by producers.

One factor that controls the primary productivity of an ecosystem is the amount of available nutrients.

If a nutrient is in short supply, it will limit an organism's growth.

When an ecosystem is limited by a single nutrient that is scarce or cycles very slowly, this substance is called a **limiting nutrient**.

When an aquatic ecosystem receives a large input of a limiting nutrient—such as runoff from heavily fertilized fields—the result is often an immediate increase in the amount of algae and other producers.

This result is called an **algal bloom**.

Algal blooms can disrupt the equilibrium of an ecosystem.