An introduction to nutrient cycles

Nutrient cycling

Carbohydrates can be produced using the carbon, hydrogen and oxygen in carbon dioxide and water during photosynthesis. But living organisms need a complex array of molecules to survive.

To be able to synthesise, all the other organic molecules, such as proteins (including enzymes), nucleotides (e.g. ATP), nucleic acids (e.g. DNA and RNA) and phospholipids (found in cell membranes) that are used by living organisms, plants also need nitrogen, sulfur and phosphorus. Plants need a supply of inorganic ions dissolved in soil water to be able to carry out the synthetic reactions needed.

They are able to remove these from the soil as inorganic ions, such as nitrate, sulfate and phosphate.

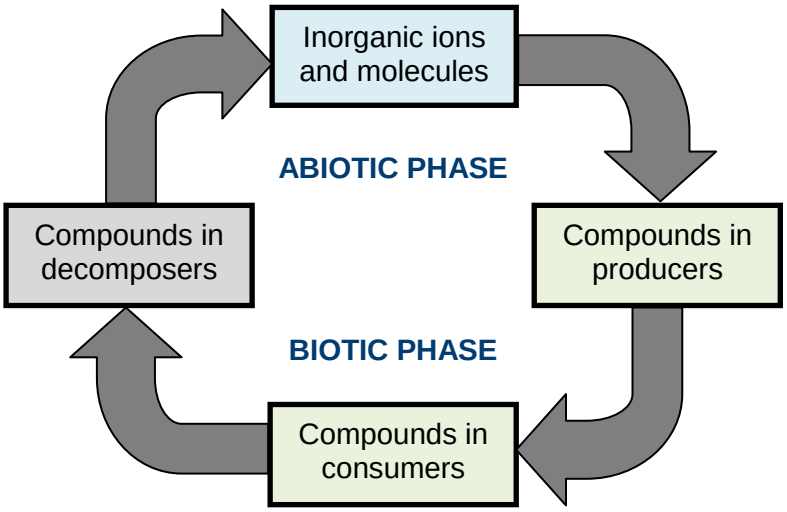

Figure 1 During cycling, they pass between living organisms (the biotic phase) and the environment (the abiotic phase).

Since elements used as nutrients are in finite supply, to support life on Earth, they must be constantly recycled.

Nutrients in the soil dissolve in rain water. This is known as leaching. Nutrients are washed into rivers and transported to the sea. They fall to ocean beds or are taken up by organisms whose dead remains fall to the sea floor. This is called sedimentation. Sediments may form rocks, locking up the nutrients for long periods of time. Eventually, through weathering, erosion and movements of Earth's crust, rocks form new soil.

Nutrient cycles and the atmosphere

Some cycles involve gases in the atmosphere. They transfer materials on a global scale. The gases carbon dioxide, nitrogen and sulfur dioxide are integral parts of the carbon, nitrogen and sulfur cycles respectively.

Carbon

Photosynthesis and respiration are opposing processes. In photosynthesis, energy from the Sun is used to synthesise organic compounds which are energy stores. Carbon dioxide is taken up by plants, photosynthesis takes place and one of the products, oxygen, is released into the atmosphere. The other product, glucose, is stored in plant cells.

During aerobic respiration, energy stored in organic compounds is released. Oxygen from the atmosphere is used up and produces carbon dioxide.

Around 100 billion tonnes of carbon dioxide is fixed in photosynthesis each year, with about 50 billion tonnes being returned through respiration by plants and animals and the remaining 50 billion tonnes through decomposition of dead remains.

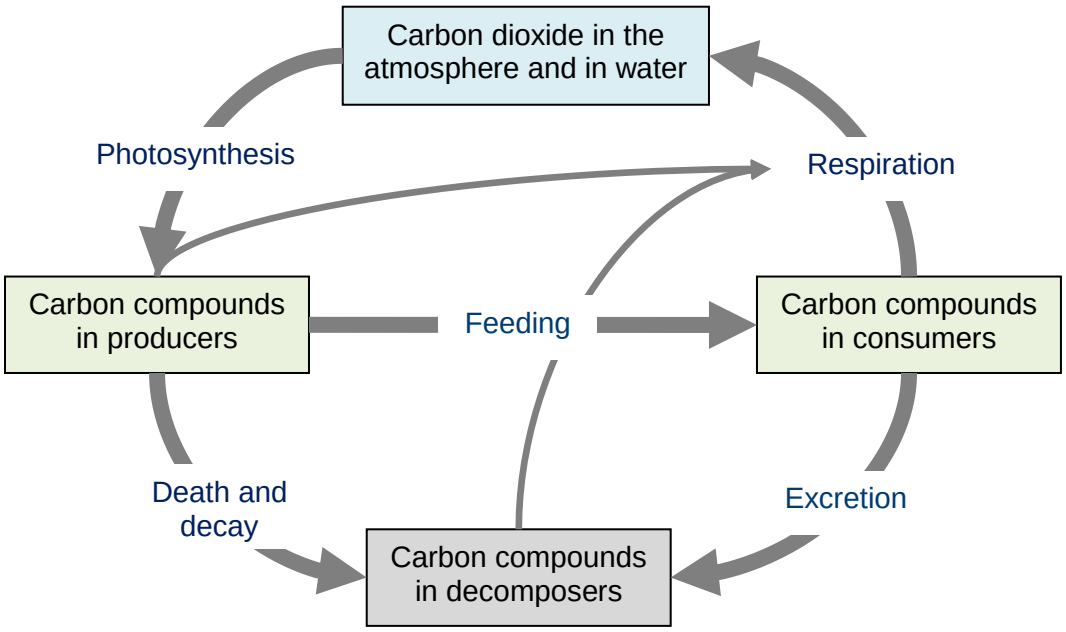

Figure 2 Core processes in the carbon cycle.

Nitrogen

Nitrogen is an essential element in proteins and nucleic acids. Plants obtain nitrogen from the soil in the form of nitrates and are able to use this to convert carbohydrates formed in photosynthesis into nitrogen-containing organic compounds.

The soil supply of nitrate must therefore be maintained through recycling of the nitrates. This occurs through the process of decay by certain fungi and bacteria that release ammonia, and through nitrification, in which certain bacteria convert ammonia to nitrites and then nitrates.

Some atmospheric nitrogen is also made available for plants like peas and beans, which have nitrogen fixing bacteria in nodules in their roots.

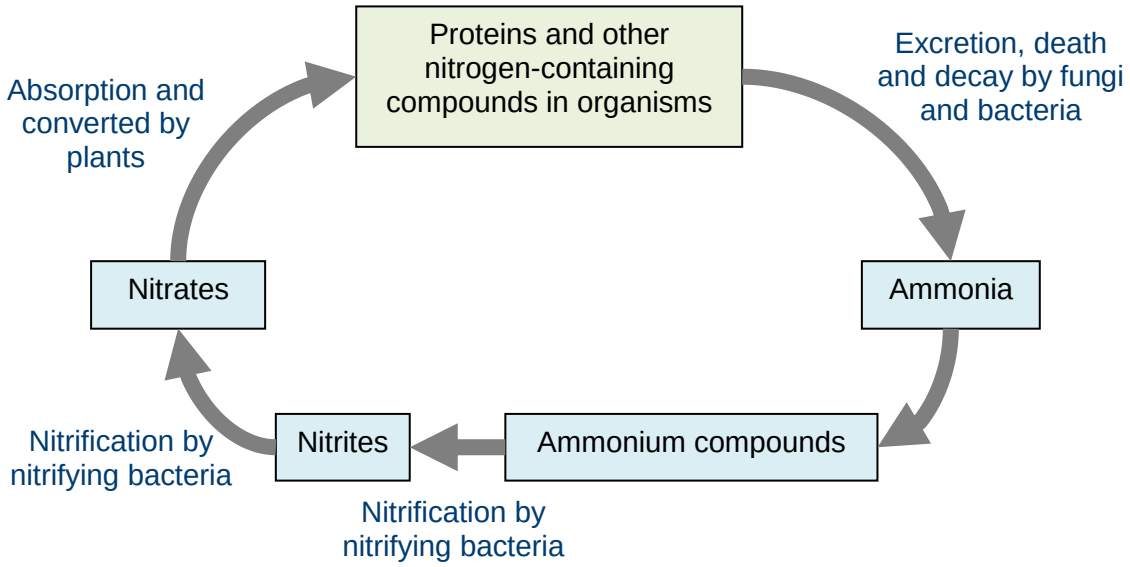

Figure 3 Core processes in the nitrogen cycle.