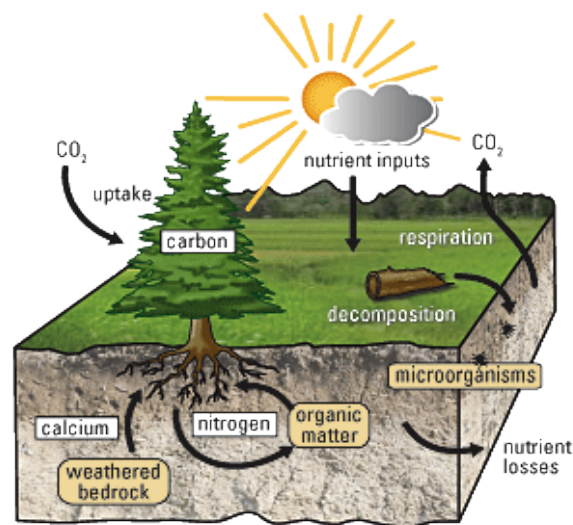


The Nutrient Cycle and Ecosystems

The nutrient cycle is a system where energy and matter are transferred between living organisms and non-living parts of the environment. This occurs as animals and plants consume nutrients found in the soil and organic matter, and these nutrients are then released back into the environment via death and decomposition. In forest environments, there is an exchange of nutrient elements among the soil, plants, animals, fungi and bacteria living there. Each of these cycles is fairly complex. The specific mineral cycles include: carbon, nitrogen, sulphur, and phosphorous. The water and oxygen cycles also factor in to create a total nutrient system.



In forest environments, the nutrient cycle involves animals, plants, fungi and bacteria living above- and below-ground, as well as mineral components in soil, dead leaves and wood, and water from rain and snowfall. Trees and other plants take up mineral and non-mineral nutrients from the soil through their roots.

The nutrients are stored in the leaves, flowers and other parts of plants. Arthropods (i.e., animals with no internal spine, a jointed body, and a hard shell covering) and earthworms, for example, break down decaying material that then mix with soil particles. Fungi can break apart some of the more complex compounds and break them down into smaller components. All of these organisms ultimately consume and respire much of the organic material back into carbon dioxide gas, which is why it disappears over time.

What Factors Influence the Nutrient Cycle?

The nutrient cycle is controlled by the climate, location, and living communities in forest ecosystems. The role of each factor varies in relation to the diversity of forest ecosystems around the world (e.g., boreal, temperate, tropical). In Canada, we see a range of diversity among our forests. Each forest type behaves uniquely and responds to environmental conditions differently, storing varying rates of carbon and producing different amounts of nutrient-rich litter. For example, in tropical forests, there is a low storage rate of carbon and a high amount of litter production, while in boreal forests, there is high carbon storage and low litter production.

What Disturbs the Nutrient Cycle?

Disturbances can be natural or man-made, prompting an addition or loss of nutrients. The results can have positive or negative impacts. Fire, harvesting, storms, pests or disease can all affect the nutrient cycle processes.

For example, after a fire, nutrients are redistributed in the forest due to the following:

1. Fire burns live and decomposing plant material.
2. Ash is distributed by the wind.
3. Water erodes the surface soil.
4. Liquid filters nutrients through and out of the soil.

The relative importance of these processes varies with each nutrient and is modified by differences in fire intensity, soil characteristics, landscape, climatic patterns, and living communities.

The Nitrogen Cycle

The two major nutrient cycles are nitrogen and carbon. The nitrogen cycle is a bit complex. Nitrogen from the atmosphere is converted into a form that living organisms can use, and then returned to the atmosphere. Nitrogen-fixing bacteria convert atmospheric nitrogen into ammonia, which is then converted to nitrite and nitrate by nitrifying bacteria. Plants absorb ammonium and nitrate through their roots, and animals obtain nitrogen when they consume plants or animals. More details about the process are given below; otherwise, scroll to the diagram further below.

Nitrogen Fixation

Although there is plenty of nitrogen gas (N_2) in the atmosphere, it requires significant amounts of energy to break the bond between the two nitrogen atoms. This means that plants cannot absorb it directly from the atmosphere for use in making proteins. However, nitrogen is taken from the air and converted into nitrate ions, which are easier to absorb. This can happen in two ways:

- By nitrogen-fixing bacteria, which are present in the root nodules of leguminous plants (e.g., beans, clover, peas). They take nitrogen gas from the air and change it into nitrates in the soil.
- Lightning can split the bond between the two atoms in N_2 gas. This turns them into nitrous oxides (e.g. N_2O and NO_2) that eventually leach into the soil.

Absorption of Nitrates by Plants

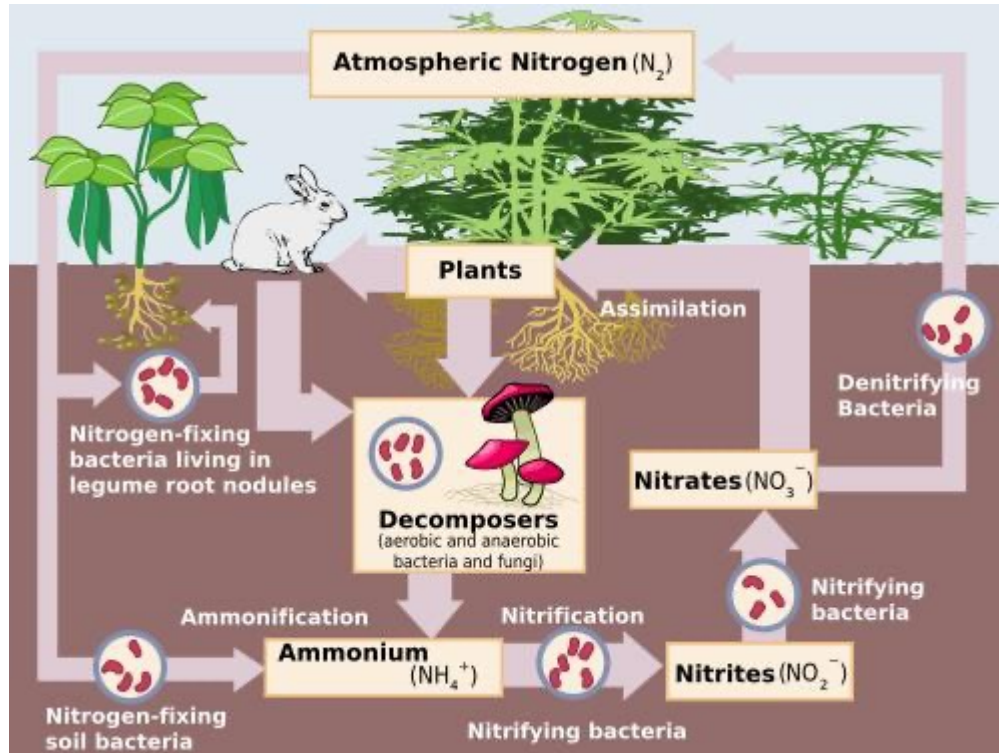
Plants absorb the nitrates from the soil and convert them into proteins and other essential compounds. When animals eat plants or other animals, they take in nitrogen from the consumed proteins. These proteins are then used to build their tissues.

Waste and Death

Decomposers break down animal waste (urine and feces), and dead remains. This returns nitrogen to the soil as ammonium ions. Nitrifying bacteria can convert the ammonium ions into nitrates, which plants can absorb.

Release of Nitrogen back into the Atmosphere

Anaerobic bacteria, known as denitrifying bacteria, are found in low-oxygen regions of soil. The bacteria break down nitrates and convert them back to nitrogen gas, which returns to the air.



The Nitrogen Cycle

The Carbon Cycle

In the food chain, plants move carbon from the atmosphere into the biosphere through photosynthesis. They use energy from the sun to chemically combine carbon dioxide with hydrogen and oxygen from water to create sugar molecules. Respiration, excretion, and decomposition release the carbon back into the atmosphere or soil, continuing the cycle. The oceans contribute a lot of carbon to the overall cycle.

