**THE ROLES MICROORGANISM PLAY IN NUTRIENT CYCLES**

**Roles of Fungi and Bacteria in Nutrient Cycling**

A nutrient cycle describes the movement and exchange of natural and synthetic matter back into the production of living systems. Food web pathways control the procedure which disintegrates organic matter into available nutrients. Organic matter is recycled in an ecosystem by decomposers. Decomposers are microorganisms such as bacteria and fungi that break down the raw material in the remains of plants and animals. As the decomposers prey on the dead elements, they break down the natural compounds right into simple nutrients. These nutrients are returned to the soil and could be reused again by living plants and transferred to animals when the plants are consumed as feed. Once this happens the energy supply chain starts once again.

Bacteria and fungi generate bio-synthetic catalysts called enzymes that digest the dead material. The absorbed product then offers a food source for other organisms in the soil which makes the role of a decomposer very important in an environment. Without them, organic matter would pile up on the ground as well as plants would certainly not get the required nutrients necessary for their survival. The decomposing nature of microorganisms enhances microbial activity in the soil resulting in greater biodiversity. Both fungi and bacteria are responsible for the disintegration of plant deposits as well as the release of plant nutrients. However, they have different functions in the recycling of nutrients because of their difference in mode of nutrition, the type of organisms they feed on and choice of habitat in the soil. Therefore, the equilibrium of fungus and bacterium in the soil is necessary for optimal performance.

1. **Roles of Fungi in Nutrient Recycling**.

Nutrient cycling involves the constant supply, capturing, replenishment and the distribution of carbon as well as minerals. Energy derived from carbon is the fundamental requirement for the vitality of ecological communities. Fungi benefit ecological communities using their huge vegetative part (mycelium) to facilitate nutrient capturing and productive collaborations with plants and animals for a sustainable ecosystem. The captured nutrients carbon and various other nutrients (e.g., phosphorus, nitrogen, sulfur, copper and so on) are released for consumption.

**Fungi Aids Decomposition of Organic Matter**

The fungus thrives well in a moist environment and could be discovered as single-celled organisms, like yeast, which is unseen to the naked eye, and as multiple-celled microorganisms, like mushrooms, which consists of branching filaments called "hyphae." Fungi are so extensive that they comprise a large percentage of the biomass in any ecosystem. Decomposition of complex organic materials, such as cellulose and lignin aids digestibility of the organic materials by invertebrates. Fungus release digestive minerals that are used to process complex organic substances into dissolved mineral compounds, such as carbonates, nitrates, and phosphates. Higher animals process feed inside their systems, fungi process feed outside of their "bodies" and subsequently take in the nutritional value into their cells.

**Symbiosis Role of Fungi**

Mycorrhizae fungi develops synergistic cooperations with plants through what is known as the "soil-borne root fungus" connected with plant roots. The plant nourishes the fungus and the fungus nourishes the plant as this is mutually beneficial because it facilitates the transfer of nutrients from the soil into plant roots, and the fungus is compensated by obtaining and utilizing CO2 released by algae during photosynthesis. Fungi store carbon in the soil and for that reason is not released as carbon dioxide. It is assumed that plants were the only resource of carbon for mycorrhizal fungi. Functional ecology reveals that mycorrhizal fungi can actively disintegrate organic carbon, and as a result play a much more substantial duty in loss of carbon as well as input from the soil than previously assumed. The association of fungus with algae referred to as lichens benefits cyanobacteria by giving shelter which then makes energy for lichens using photosynthesis.

**2. Roles of Bacteria in Nutrient Recycling**

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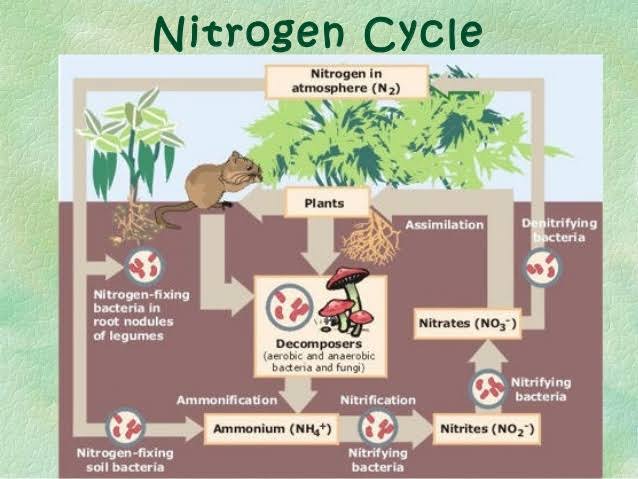
Bacterial microorganism groups form an essential component of the carbon and nitrogen cycles. Like plants, photoautotrophs as well as chemoautotrophs take carbon dioxide from the air and convert it into free carbon. Chemo-heterotrophs play an opposite role in the carbon cycle, releasing carbon dioxide into the system when they decompose raw material and which is also important in the nitrogen cycle since the extracellular digestion of organic matter transforms soluble nitrogen right into the environment, where it can be taken up by plants and nitrogen-fixing rhizobium which are a crucial component of the nitrogen cycle. Atmospheric nitrogen is ineffective to living organisms but often binds to hydrogen forming substances such as ammonia (NH3+) and ammonium (NH4+). However, a lot of plants could not utilize ammonia. Therefore, nitrifying microorganisms, transform ammonium ion into oxygen compounds such as nitrite (NO2-) and then to nitrate (NO3-), which assists plants in their growth and development. These rhizobia are fixed in the root nodules of legumes and supply the nitrates to the plant; animals eat up the plant to gain their energy as heterotrophs. Moreover, denitrifying bacteria transform nitrates back to pure nitrogen gas, as this process is catalyzed by facultative anaerobes.

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**NITROGEN CYCLE**

Nitrogen fixation describes the conversation of nitrogen into nitrate, a form that can be used by plants. This is carried out by volcanic action, lightning. Industrial activity and some bacteria. Nitrogen fixing bacteria can be found free in the soil or live in the root nodules of legumes (peas, beans, clover). The bacteria use the plant as carbohydrate source of energy, protection and shelter and the plant uses the nitrate produced by the bacterium.



**Figure 1: Nitrogen cycle**

**Nitrification:**

The ammonia is converted to nitrites and then to nitrates by nitrifying bacteria. Somr of nitrate formed in the soil is absorbed and assimilated by the plants.

**Denitrification:**

The conversion of nitrates to nitrogen gas. It is carried out by denitrifying bacteria in the soil. These bacteria are anaerobic and live in swampy soil or deep down in the soil (where water accumulates).

**ROLES OF MICROORGANISM IN THE NITROGEN CYCLE**

* Bacteria play a central role:

**Nitrogen-fixing bacteria**, which convert atmospheric nitrogen to nitrates.

**Bacteria of decay**, which convert decaying nitrogen waste to ammonia.

**Nitrifying bacteria**, which convert ammonia to nitrates/nitrites.

**Denitrifying bacteria,** which convert nitrates to nitrogen gas.

* Fungi, like bacteria, help to convert dead plants and animals and their wastes into ammonia in the soil.

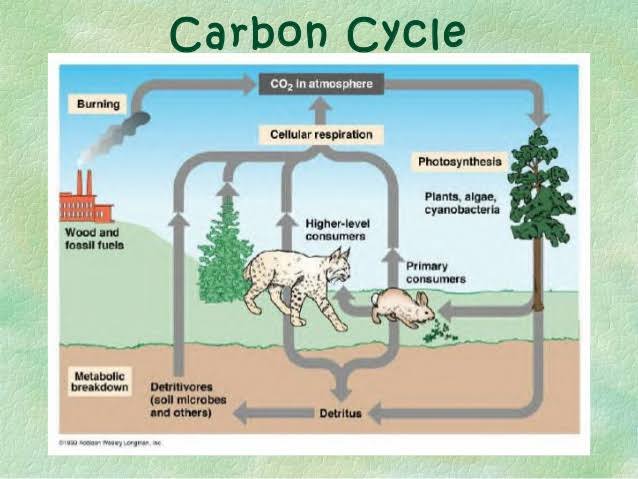
**CARBON CYCLE**

The carbon cycle in microorganism is part of a larger cycling of carbon that occurs on the global scale. The actions of microorganism help extract carbon from non-living sources and make the carbon available to living organisms (including themselves). The cycling of carbon by microorganism, including a variety of bacteria and fungi, occurs in aquatic habitats. Even relatively oxygen-free zones such as in the deep mud of lakes, ponds and other water bodies can be regions where the anaerobic conversion of carbon takes place.

Much of the carbon that enters the carbon cycle of microorganism is carbon dioxide. This form of carbon exists as a gas in the atmosphere and can be dissolved in water. The atmospheric can be converted to organic material in the process of photosynthesis. Photosynthetic algae are important microorganism in this regard. As well, chemoautotrophs, primarily bacteria and archae are capable of carbon dioxide conversion. In both systems the carbon dioxide is converted to chains that are comprised of sugar that have the structure CH2O.

The carbon available in the carbohydrate sugar molecules is cycled further by microorganism in a series of reaction that form the tricarboxylic acid or TCA cycle. In anaerobic environment, microorganisms can cycle the carbon compounds to yield energy in a process known as fermentation.

Carbon dioxide can also be converted to methane. This occurs in anaerobic environment, such as deep compacted mud, and is accomplished by bacteria called methanogenic bacteria. To complete the recycling pattern another group of methane bacteria called methane-oxidizing bacteria or methanotrophs (literally methane eaters) can convert methane to carbon dioxide. Other microorganism are able to participate in the recycling of carbon. For example the green and purple sulphur bacteria are able to use the energy they gain from the degradation of a compound called hydrogen sulphide to degrade carbon compounds. Others bacteria such as Thiobacillus ferrooxidans uses the energy gained from the removal of an electron from iron-containing compounds to convert carbon. The anaerobic degradation of carbon is done only by microorganisms. This degradation is a collaborative effort involving numerous bacteria. Example of the bacteria include Bacteroides succinogenes, clostridium butyricum, and syntrophomonas sp.



**Figure 2: Carbon cycle**

**WATER CYCLE**

Water is a good example of a molecule that is cycled within an ecosystem, which is recycled through the water cycle. Water undergoes evaporation, condensation, and falls back to earth as rain (or other forms of precipitation) this typifies the cycling that is observed for all of the principle elements of line Roles of Fungi and Bacteria in Nutrient Cycling

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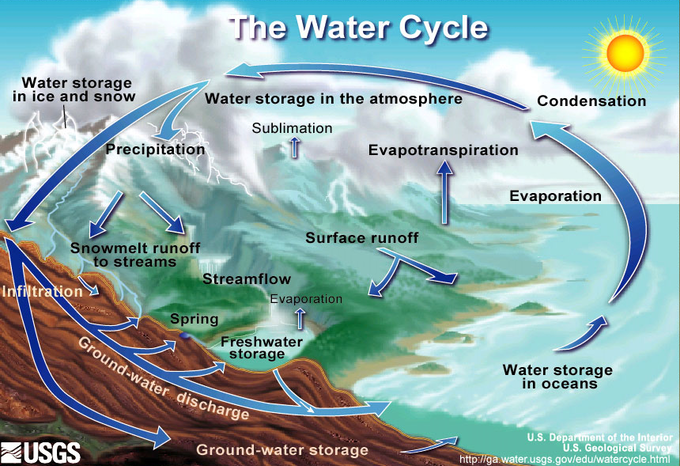
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**FIGURE 3: Water cycle**

**FUNGI AND FOOD CHAIN**

The food chain begins with primary producers, such as green plants, that get energy from the sun and convert it to food through photosynthesis. Primary consumers, or herbivores, eat plants, secondary consumers eat primary consumers, and even tertiary or quaternary consumers enter the food chain. At the end of the chain, fungi and other decomposers take care of the “waste” in the food chain by consuming dead plants or animals. Decomposers complete the food chain cycle, and when nutrients return to the soil, a new food chain begins.

**Importance and Roles of Decomposers**

The organisms that occupy the [decomposer](https://biologydictionary.net/decomposer/) level of a biome are essential to life on Earth. They break down dead [plant](https://biologydictionary.net/plant/) and animal matter so the nutrients in them are recycled back into the [ecosystem](https://biologydictionary.net/ecosystem/) to be used again.

[Fungi](https://biologydictionary.net/fungi/) are the main decomposers in many ecosystems, particularly in forests. One of their main functions is to help release nitrogen and phosphorous from dead decaying matter. They do this through a series of specialized proteins and enzymes in their [cell](https://biologydictionary.net/cell/) walls and [hyphae](https://biologydictionary.net/hyphae/) (root-like filaments). Fungi are particularly suited to penetrating large pieces of decaying matter like wood with their hyphae and breaking it down with lignin-digesting enzymes. [Bacteria](https://biologydictionary.net/bacteria/) are also key organisms at the decomposer level.

There are other organisms in nature such as earthworms, some insects, sea cucumbers and woodlice that also break down decaying material, but they need to ingest it first unlike fungi that use chemical and biological processes. These organisms are called detritivores.

**Nutrient Recycling**

In food chains, fungi act as decomposers, also called saprotrophs, which recycle nutrients in an ecosystem. Without fungi, forest floors would be covered in plant debris and animal carcasses; similarly other ecosystems would have a vast amount of waste piled up. Fungi break down plant components like lignin and cellulose, so they are particularly important in woody ecosystems. They also break down surface waste and release nitrogen back into the soil in the form of ammonium nitrate, a nutrient that plants need for survival.

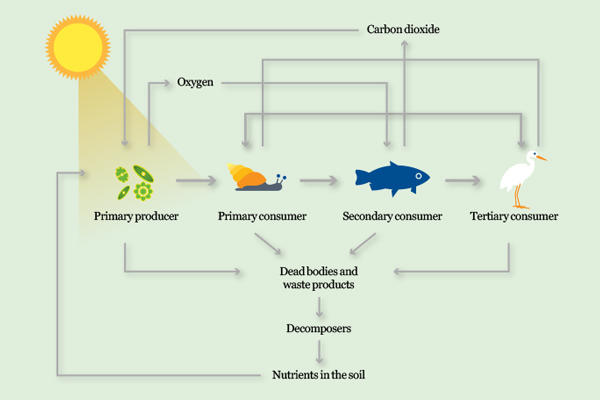
**Symbiotic Relationships**

Without fungi, nutrients in the soil would be used up, and plants would not have food and couldn’t survive. If plants don’t survive, the animals that depend on plants for food would also suffer, and the whole food chain would collapse. Since transferring nutrients from fungi to the soil is such an integral part of the food chain, some organisms team up with fungi to form symbiotic relationships. Mycorrhiza, for example, is a symbiotic relationship in which fungi live in plant roots; the plant provides the fungi with carbohydrates, and the fungi in return transfer nutrients like phosphorus to the plant.

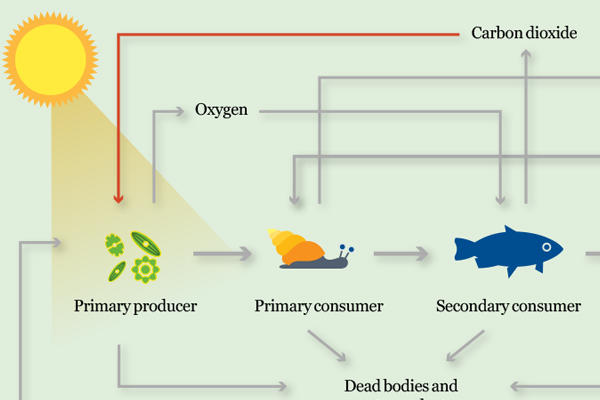
**Detrimental Effects of Fungi**

While most fungi aid the function of the ecosystem and contribute positively to the food chain, some fungi are harmful and destroy crops or other plant life. Fungi can spread on tree bark, for example, and decay the plant material; as large areas of dead tissue spread on the tree, nutrient supply is cut off, and the tree dies. Still other fungi produce toxins that are deadly to animals, including humans.

* The diagram illustrates the important role that microbes i.e. algae, cyanobacteria and the decomposers, play as primary producers and in the cycling of nutrients.

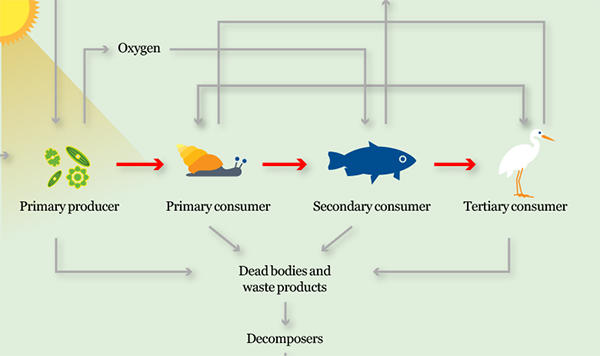


**Step 1: Photosynthesis**



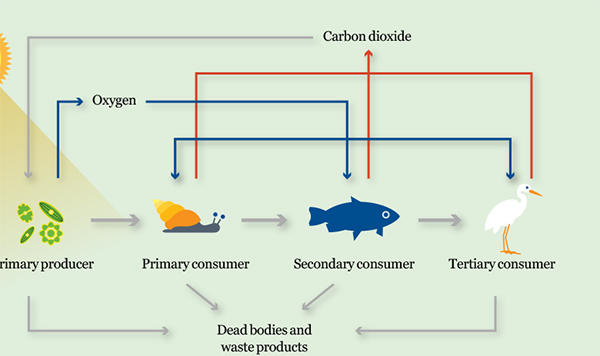
Photosynthetic organisms like algae, cyanobacteria and plants are capable of using light energy which is trapped by chlorophyll, to convert carbon dioxide and water into oxygen and glucose (food). This process is called photosynthesis.

### **Step 2: Primary producers**



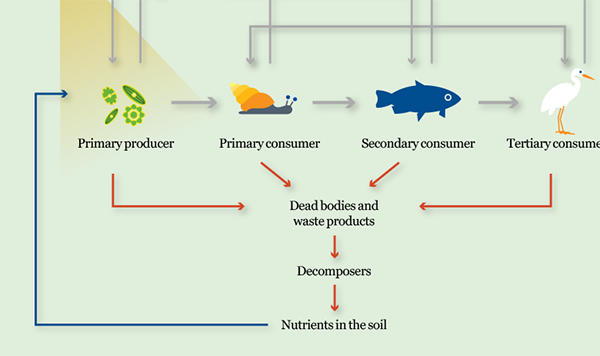
Organisms that make their own food are called primary producers and are always at the start of the food chain. Animals and micro-organisms like fungi and bacteria get energy and nutrients by eating other plants, animals and microbes.

**Step 3: Aerobic respiration**



Organisms release energy from food (glucose), as well as carbon dioxide and water in the process of aerobic respiration. This energy is used to do the work needed to keep cells and organisms alive. Aerobic respiration requires oxygen.

**Step 4: Decomposition**



The decomposers (fungi and soil bacteria) obtain their energy and nutrients from the dead bodies and waste products of other organisms. As dead bodies and waste products break down, they release essential nutrients into the soil.

Green algae and cyanobacteria are found at the beginning of the food chain. They are known as primary producers because they make their own food.

* The Nitrogen Cycle.” Khan Academy, Khan Academy, www.khanacademy.org/science/biology/ecology/biogeochemical-cycles/a/the-nitrogen-cycle. “Carbon Cycle.” Ignicoccus Hospitalis - Microbewiki, microbewiki.kenyon.edu/index.php/Carbon\_cycle.

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