

## OXYGEN CYCLE

As we all know, air is a mixture of gases. The air in the atmosphere is composed of different gases, namely nitrogen (78%), oxygen (21%), argon and other trace gases ((1%).

According to Earth's history, oxygen gas was first introduced by cyanobacteria through the process of photosynthesis. Earlier, around 4.6 billion years ago, there was no life on planet earth because the atmosphere was devoid of oxygen. Later, there was a gradual increase in the oxygen levels and by the Carboniferous Period-299 million years ago, oxygen reached the levels that were similar to today's estimates.

Today, oxygen is freely available in the air, and also dissolved in water. It is the second most abundant gas present in the atmosphere and also the most common element of the human body. It plays an essential role in most life forms on Earth and also serves as an essential element in biomolecules like proteins, and nucleic acids.

Oxygen cycle, along with the carbon cycle and nitrogen cycle plays an essential role in the existence of life on the earth. The oxygen cycle is a biological process which helps in maintaining the oxygen level by moving through three main spheres of the earth which are:

- Atmosphere
- Lithosphere
- Biosphere.

This biogeochemical cycle explains the movement of oxygen gas within the atmosphere, the ecosystem, biosphere and the lithosphere. The oxygen cycle is interconnected with the carbon cycle.

The atmosphere is the layer of gases presents above the earth's surface. The sum of all Earth's ecosystem makes a biosphere. Lithosphere, which is the solid outer section along with the Earth's crust and it is the largest reservoir of oxygen.

The steps involved in the oxygen cycle are:

Stage-1: All green plants during the process of photosynthesis, release oxygen back into the atmosphere as a by-product.

Stage-2: All aerobic organisms use free oxygen for respiration.

Stage-3: Animals exhale Carbon dioxide back into the atmosphere which is again used by the plants during photosynthesis. Now oxygen is balanced within the atmosphere.

The four main processes that use Atmospheric oxygen are:

Breathing – It is the physical process, through which all living organisms including plants, animals, and humans inhale oxygen from the outside environment into the cells of an organism and exhale carbon dioxide back into the atmosphere.

**Decomposition:** It is one of the natural and most important processes in the oxygen cycle and occurs when an organism dies. The dead animal or plants decay into the ground, and the organic matter along with the carbon, oxygen, water and other components are returned back into the soil and air. This process is carried out by the invertebrates including fungi, bacteria and some insects which are collectively called as the decomposers. The entire process requires oxygen and releases carbon dioxide.

Read more: [Decomposition](#)

**Combustion:** It is also one of the most important processes which occur when any of the organic materials including fossil fuels, plastics and wood, are burned in the presence of oxygen and releases carbon dioxide into the atmosphere.

**Rusting:** This process also requires oxygen. It is the formation of oxides which is also called oxidation. In this process, metals like iron or alloy rust when they are exposed to moisture and oxygen for an extended period of time and new compounds of oxides are formed by the combination of oxygen with the metal.

As we all know, Oxygen is one of the most essential components of the Earth's atmosphere. It is mainly required for:

- Breathing
- Combustion
- Supports aquatic life
- Decomposition of organic waste.

Oxygen is an important element required for life, however, it can be toxic to some anaerobic bacteria (especially obligate anaerobes).

The oxygen cycle is mainly involved in maintaining the level of oxygen in the atmosphere. The entire cycle can be summarized as, the oxygen cycle begins with the process of photosynthesis in the presence of sunlight, releases oxygen back into the atmosphere, which humans and animals breathe in oxygen and breathe out carbon dioxide, and again linking back to the plants. This also proves that both the oxygen and carbon cycle occur independently and are interconnected to each other.

### **CARBON CYCLE:**

Carbon cycle, in biology, circulation of carbon in various forms through nature. Carbon is a constituent of all organic compounds, many of which are essential to life on Earth. The source of the carbon found in living matter is carbon dioxide (CO<sub>2</sub>) in the air or dissolved in water. Algae and terrestrial green plants (producers) are the chief agents of carbon dioxide fixation through the process of photosynthesis, through which carbon dioxide and water are converted into simple carbohydrates. These compounds are used by the producers to carry on metabolism, the excess being stored as fats and polysaccharides. The stored products are then eaten by consumer organisms, from protozoans to man, which convert them into other forms. CO<sub>2</sub> is added directly to the atmosphere by animals and some other organisms as a by-product of respiration. The carbon present in

animal wastes and in the bodies of all organisms is released as  $\text{CO}_2$  by decay, or decomposer, organisms (chiefly bacteria and fungi) in a series of microbial transformations.

Carbon is transported in various forms through the atmosphere, the hydrosphere, and geologic formations. One of the primary pathways for the exchange of carbon dioxide ( $\text{CO}_2$ ) takes place between the atmosphere and the oceans; there a fraction of the  $\text{CO}_2$  combines with water, forming carbonic acid ( $\text{H}_2\text{CO}_3$ ) that subsequently loses hydrogen ions ( $\text{H}^+$ ) to form bicarbonate ( $\text{HCO}_3^-$ ) and carbonate ( $\text{CO}_3^{2-}$ ) ions. Mollusk shells or mineral precipitates that form by the reaction of calcium or other metal ions with carbonate may become buried in geologic strata and eventually release  $\text{CO}_2$  through volcanic outgassing. Carbon dioxide also exchanges through photosynthesis in plants and through respiration in animals. Dead and decaying organic matter may ferment and release  $\text{CO}_2$  or methane ( $\text{CH}_4$ ) or may be incorporated into sedimentary rock, where it is converted to fossil fuels. Burning of hydrocarbon fuels returns  $\text{CO}_2$  and water ( $\text{H}_2\text{O}$ ) to the atmosphere. The biological and anthropogenic pathways are much faster than the geochemical pathways and, consequently, have a greater impact on the composition and temperature of the atmosphere.

Part of the organic carbon—the remains of organisms—has accumulated in Earth's crust as fossil fuels (e.g., coal, gas, and petroleum), limestone, and coral. The carbon of fossil fuels, removed from the cycle in prehistoric time, is now being released in vast amounts as  $\text{CO}_2$  through industrial and agricultural processes, much of it quickly passing into the oceans and there being “fixed” as carbonates. If oxygen is scarce (as in sewage, marshes, and swamps), some carbon is released as methane gas.

### **NITROGEN CYCLE:**

The nitrogen cycle represents one of the most important nutrient cycles found in terrestrial ecosystems (Figure 9s-1). Nitrogen is used by living organisms to produce a number of complex organic molecules like amino acids, proteins, and nucleic acids. The store of nitrogen found in the atmosphere, where it exists as a gas (mainly  $\text{N}_2$ ), plays an important role for life. This store is about one million times larger than the total nitrogen contained in living organisms. Other major stores of nitrogen include organic matter in soil and the oceans. Despite its abundance in the atmosphere, nitrogen is often the most limiting nutrient for plant growth. This problem occurs because most plants can only take up nitrogen in two solid forms: ammonium ion ( $\text{NH}_4^+$ ) and the ion nitrate ( $\text{NO}_3^-$ ). Most plants obtain the nitrogen they need as inorganic nitrate from the soil solution. Ammonium is used less by plants for uptake because in large concentrations it is extremely toxic. Animals receive the required nitrogen they need for metabolism, growth, and reproduction by the consumption of living or dead organic matter containing molecules composed partially of nitrogen.

In most ecosystems nitrogen is primarily stored in living and dead organic matter. This organic nitrogen is converted into inorganic forms when it re-enters the biogeochemical cycle via decomposition. Decomposers, found in the upper soil layer, chemically modify the nitrogen found in organic

matter from ammonia ( $\text{NH}_3$ ) to ammonium salts ( $\text{NH}_4^+$ ). This process is known as mineralization and it is carried out by a variety of bacteria, actinomycetes, and fungi.

Nitrogen in the form of ammonium can be absorbed onto the surfaces of clay particles in the soil. The ion of ammonium has a positive molecular charge is normally held by soil colloids. This process is sometimes called *micelle fixation* (see Figure 9s-1). Ammonium is released from the colloids by way of cation exchange. When released, most of the ammonium is often chemically altered by a specific type of autotrophic bacteria (bacteria that belong to the genus *Nitrosomonas*) into nitrite ( $\text{NO}_2^-$ ). Further modification by another type of bacteria (belonging to the genus *Nitrobacter*) converts the nitrite to nitrate ( $\text{NO}_3^-$ ). Both of these processes involve chemical oxidation and are known as nitrification. However, nitrate is very soluble and it is easily lost from the soil system by leaching. Some of this leached nitrate flows through the hydrologic system until it reaches the oceans where it can be returned to the atmosphere by denitrification. Denitrification is also common in anaerobic soils and is carried out by heterotrophic bacteria. The process of denitrification involves the metabolic reduction of nitrate ( $\text{NO}_3^-$ ) into nitrogen ( $\text{N}_2$ ) or nitrous oxide ( $\text{N}_2\text{O}$ ) gas. Both of these gases then diffuse into the atmosphere.

Almost all of the nitrogen found in any terrestrial ecosystem originally came from the atmosphere. Significant amounts enter the soil in rainfall or through the effects of lightning. The majority, however, is biochemically fixed within the soil by specialized micro-organisms like bacteria, actinomycetes, and cyanobacteria. Members of the bean family (legumes) and some other kinds of plants form mutualistic symbiotic relationships with nitrogen fixing bacteria. In exchange for some nitrogen, the bacteria receive from the plants carbohydrates and special structures (nodules) in roots where they can exist in a moist environment. Scientists estimate that biological fixation globally adds approximately 140 million metric tons of nitrogen to ecosystems every year.

The activities of humans have severely altered the nitrogen cycle. Some of the major processes involved in this alteration include:

- The application of nitrogen fertilizers to crops has caused increased rates of denitrification and leaching of nitrate into groundwater. The additional nitrogen entering the groundwater system eventually flows into streams, rivers, lakes, and estuaries. In these systems, the added nitrogen can lead to eutrophication.
- Increased deposition of nitrogen from atmospheric sources because of fossil fuel combustion and forest burning. Both of these processes release a variety of solid forms of nitrogen through combustion.
- Livestock ranching. Livestock release a large amounts of ammonia into the environment from their wastes. This nitrogen enters the soil system and then the hydrologic system through leaching, groundwater flow, and runoff.
- Sewage waste and septic tank leaching.

