SCIENCE

BIOGEOCHEMICAL CYCLE (OXYGEN CYCLE, CARBON CYCLE, NITROGEN CYCLE)

OXYGEN CYCLE

The cyclic flow of oxygen in biosphere between its abiotic (soil, air and water) and biotic (plants and animals) components is called oxygen cycle.

Oxygen forms about 21% of the atmospheric gases. About 0.7% of oxygen is found dissolved in water while most of the oxygen occurs in combined state as oxides of metals, carbonate, sulphate, nitrate and other compounds. Oxygen also occurs in gases like CO₂, SO₂ and NO₂.

The oxygen cycle comprises the following processes:



The common storehouse of oxygen is atmosphere.

(i) Respiration: All living organisms like plants, animals and decomposers, take atmospheric oxygen and utilize it for respiration. During respiration, oxygen is used for oxidation of glucose. Carbon dioxide and water are formed while enormous amount of energy is released. Glucose + Oxygen ® Carbon dioxide + Water + Energy

(ii) Combustion: Burning of fossil fuels in homes, industry and automobiles utilizes oxygen and releases CO₂ in the atmosphere.

(iii) Atmospheric fixation of nitrogen: In the presence of lightning and other high energy sources, atmospheric nitrogen combines with atmospheric oxygen to produce nitrogen oxides.

(iv) Decomposition and decay: Oxygen is utilized in the decay and decomposition of dead organisms. On the contrary, oxygen is returned to the biosphere by the process of photosynthesis. In fact, green plants are a major source of oxygen in the atmosphere. During photosynthesis, plants take in carbon dioxide along with water and releases oxygen as a by product.

CARBON CYCLE

The cyclic flow of carbon in biosphere between its abiotic (soil, air and water) and biotic (plants and animals) components is called **carbon cycle**.

In the abiotic environment, carbon is present in four forms:

- (i) As CO₂ in the atmosphere.
- (ii) As dissolved CO₂ or carbonic acid and bicarbonates in water (oceans).
- (iii) As fossil fuels such as coal, petroleum and natural gas
- (iv) As carbonates in the rocks

The carbon cycle comprises the following processes: The basic movement of carbon is from the atmosphere.

- (i) Photosynthesis: Terrestrial and aquatic plants utilizes CO₂ for photosynthesis. During photosynthesis, the inorganic form of carbon is converted into organic matter in the presence of sunlight and chlorophyll. The CO₂ is thus fixed and assimilated by plants.
- (ii) Passage to other organisms: CO₂ fixed by plants becomes available to herbivores as organic food. From herbivores, it passes to carnivores. The animals use these carbon compounds in the synthesis of their own organic substances.
- (iii) Fossil fuels: At times, large scale upheavals trap a large number of organisms inside earth. The heat, pressure and chemical changes convert them into fossil fuels like coal, petroleum and gas.

Carbon dioxide is returned to the biosphere in five ways:

- (i) Respiration: Respiration is a metabolic process reverse of photosynthesis. During the process, the food is oxidized to liberate energy and CO₂ and water. Thus, CO₂ is produced, which passes back into the environment.
- (ii) Decomposition: After death of plants and animals, the decomposers (such as bacteria and fungi) break down the remaining dead organic matter and releases the left over carbon back into the atmosphere.





(iii) Combustion: Fossil fuels such as coal, petroleum and natural gas on burning releases CO₂ and carbon monoxide into the atmosphere.

Fossil fuel is a product of complete or partial decomposition of plants and animals as a result of exposure to heat and pressure in the earth's crust over million of years ago.

- (iv) Weathering of rocks: Weathering of carbonate containing rocks releases CO₂ into air. It occurs through the action of soil microorganisms, plant roots and acid rain.
- (v) By volcanic eruption: Volcanic eruptions also release carbon dioxide into the atmosphere.

NITROGEN CYCLE

The source of nitrogen is atmosphere which contains 78 per cent of nitrogen in the form of gas. Nitrogen is thus an essential nutrient for all life forms. Nitrogen-cycle in the biosphere involves the following important steps.



(i) Nitrogen fixation:

The process is converting atmospheric nitrogen into nitrates which are soluble in water. This is done by various N₂ fixing bacteria e.g., Rhizobium, blue green algae and bacterium azatobactor. Other than these bacteria, the only other manner in which the nitrogen molecule is converted to nitrates and nitrites is by a physical process. During lightning, the high temperature and pressure created in the air convert nitrogen into oxides of nitrogen which dissolve in water to give nitric and nitrous acids and fall on land along with rain which is then utilised.

- (ii) Ammonification : It is the process of decomposing complex, dead organic matter into ammonia. This is done by micro-organisms living in the soil e.g., decay bacteria and fungi.
- (iii) Nitrification : It is the process of conversion of ammonia into nitrites and then into nitrates. This is done by nitrifying bacteria e.g., Nitrosomonas and Nitrobacter.

(iv) Denitrification : It is the process of reducing nitrates present in the soil to release nitrogen gas back into atmosphere e.g., Pseudomonas.

Thus, there is a nitrogen cycle in nature in which nitrogen passes from its elemental form in the atmosphere into simple molecules in the soil and water, which gets converted into more complex molecules in living beings and back again to the simple nitrogen molecule in the atmosphere.

Do you know?

Some bacteria can fix the atmospheric nitrogen in plants while living symbiotically with it. e.g., **Rhizobium leguminosarum** (a bacteria) form some special structures called root nodules on the roots of legume (pulse) plants, and fixes nitrogen for them.

Some other bacteria like Azotobacter can fix N₂ directly (non-symbiotically) in soil.