

**Lecture 4**  
**Biogeochemical Cycles**  
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- ▶ **Lecture topics:**
- ▶ **Biogeochemical**
- ▶ **The most well-known and important biogeochemical cycles**

The ways in which an element, in some cases, a compound such as water moves between its various living and nonliving forms and locations is called a biogeochemical cycle. This name reflects the importance of chemistry and geology as well as biology in helping us understand these cycles.

**Biogeochemical:**

is a pathway by which a chemical substance moves through biotic (biosphere) and abiotic (lithosphere, atmosphere, and hydrosphere) compartments of Earth. The set of changes that occur to the chemical that brings it back to the starting point, which can be repeated. Ecological systems have many biogeochemical cycles operating as a part of the system, for example the water cycle, the carbon cycle, the nitrogen cycle, etc. All chemical elements occurring in organisms are part of biogeochemical cycles. In addition to being a part of living organisms, these chemical elements also cycle through abiotic factors of ecosystems such as water (hydrosphere), land (lithosphere), and/or the air (atmosphere). The living factors of the planet can be referred to collectively as the biosphere. All the nutrients such as carbon, nitrogen, oxygen, phosphorus, and sulfur-used in ecosystems by living organisms are a part of a closed system; therefore, these chemicals are recycled instead of being lost and replenished constantly such as in an open system.

## **Which biogeochemical cycles are key to life?**

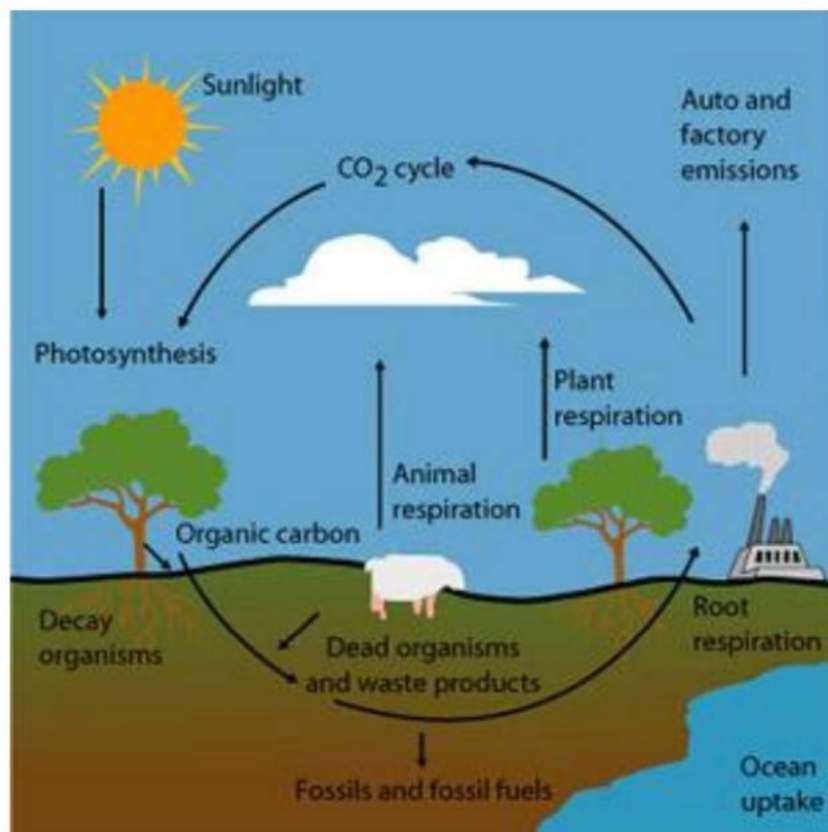
Water makes up more than half of our bodies, but humans cannot live by water alone. Instead, there are some other chemical elements that keep our bodies running and are part of biogeochemical cycles: carbon (C), hydrogen (H), nitrogen (N), oxygen (O), phosphorous (P) and sulfur (S). These are the building blocks of life, and are used for essential processes, such as metabolism, the formation of amino acids, cell respiration and the building of tissues. These cycles don't happen in isolation, and the water cycle is a particularly important driver of other biogeochemical cycles. For example, the movement of water is critical for the leaching of nitrogen and phosphate into rivers, lakes.

### **The most well-known and important biogeochemical cycles are:**

#### **Carbon Cycle:**

The carbon cycle is the biogeochemical cycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of the Earth. Carbon is the backbone of life on Earth. We are made of carbon, we eat carbon, and our civilizations, our economies, our homes, our means of transport are built on carbon. Carbon is found in the atmosphere in the form of carbon dioxide (CO<sub>2</sub>), as it is found in the compounds that form the bodies of wild and marine biology and their structures, and in the soil within the organic matter and humus, and in the hydrosphere as (CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>) dissolved in water

Also, it is found in the lithosphere of limestone ( $\text{CaCO}_3$ ) and dolomite  $\text{CaMg}(\text{CO}_3)_2$  and fossil fuels (coal, oil, and natural gas) and that carbon is contained within the organic matter (organic carbon) and within the inorganic material (non organic carbon). The carbon cycle begins with taking green plants (products) carbon dioxide from the atmosphere in the process of photosynthesis to produce organic compounds and in the plant also breathing is done, that results in  $\text{CO}_2$  gas which returns to the atmosphere, and then is used in the building process Photosynthesis so that the cycle is completed by returning to the plant.



**Fig (1): Carbon Cycle**

The carbon cycle is closely related to CO<sub>2</sub>. The carbon cycle often follows more complex paths; After the carbon gained by the plant turns into organic materials, the animals (consumables) feed on it, the process of digesting, absorbing and representing the organic materials contributes to building animal tissues. Accordingly, the carbon atoms in the plant become part of the composition of the cells of the animal's body that feed on them. Carbon can be returned to the atmosphere through the breathing process, resulting in carbon dioxide. And the remaining carbon in the cells and tissues of the consuming living organisms loses part of it through its secretions and excreta. After its death, carbon devolves into the organic matter from which it can return to the atmosphere due to the processes of aerobic decomposition by microorganisms. This process is called a rapid carbon cycle. There is a portion of organic carbon that does not pass cycles of this type and quickly, as it can track a longer pathway; In marine animals, carbon is included in the formation of solid parts, such as the shells of mollusks, in the form of calcium carbonate. After long periods of time, carbon deposits in the limestone rocks of the marine sediments of these shells. A large portion of CO<sub>2</sub> dissolves in sea, ocean and lake waters, which can lead to sedimentation of limestone, carbon fixation. These rocks are subjected to chemical weathering processes, which leads to the return of a portion of the installed carbon to the atmosphere in the form of CO<sub>2</sub>. This is called a slow carbon cycle.