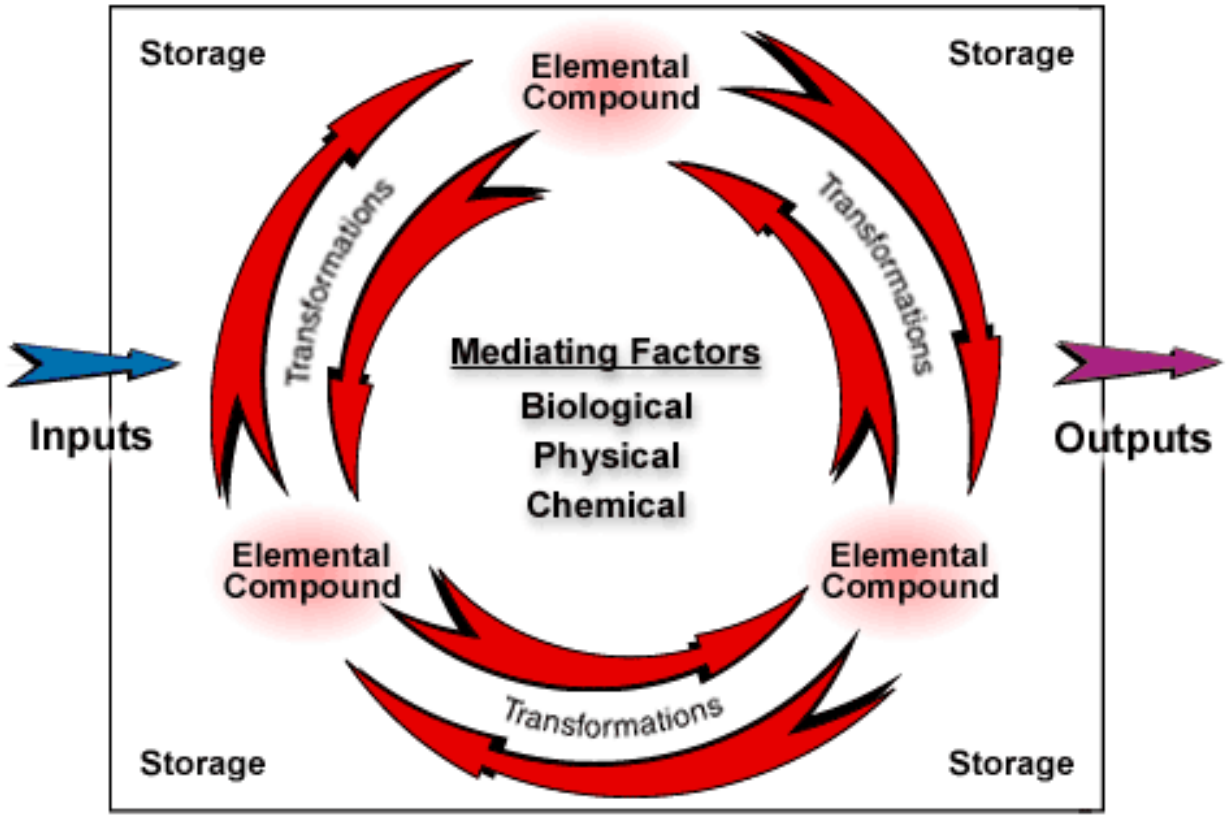
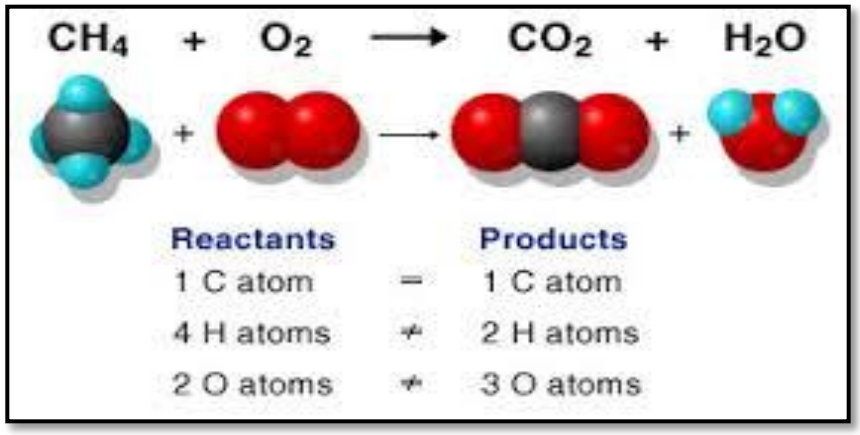
TEACHER BACKGROUND:
BIOGEOCHEMICAL CYCLES



Biogeochemical cycles are intricate processes that transfer, change and store chemicals in the geosphere, atmosphere, hydrosphere, and biosphere. The term biogeochemical cycles expresses the interactions among the ***organic (bio-)*** and ***inorganic (geo-)*** worlds, and focuses on the ***chemistry (chemical-)***, and ***movement (cycles)*** of chemical elements and compounds. In its simplest form, cycling describes the movement of elements through various forms and their return to their original state.

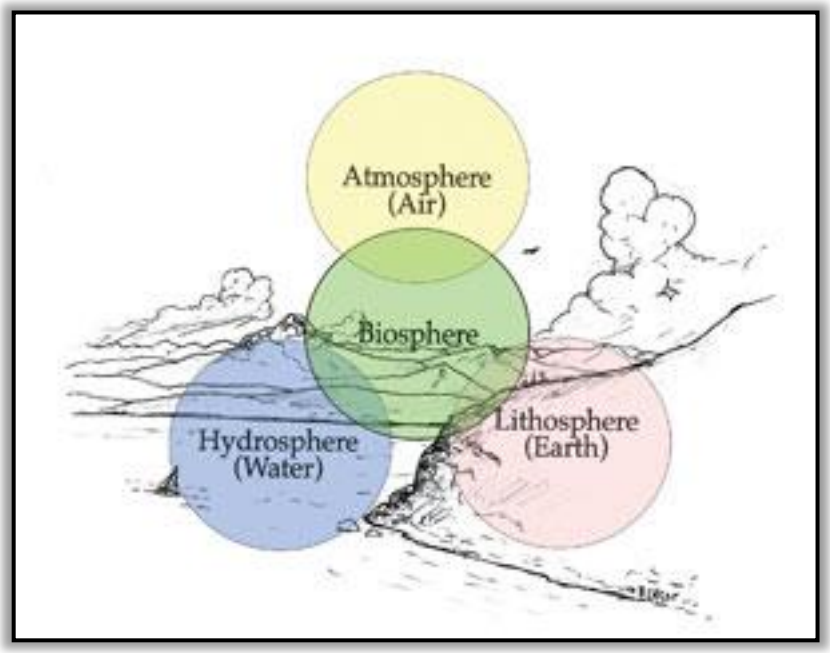
Separate biogeochemical cycles exist for each chemical element, such as the nitrogen (N), phosphorous (P), and carbon (C) cycles. However, through chemical transformations, elements combine to form compounds, and the biogeochemical cycle of each element must also be considered in relation to the biogeochemical cycles of other elements.

Elements and compounds exist in the gaseous, solid, and liquid phases and can be transformed from one phase to another. In studying biogeochemical cycles, it is important to express in a common unit the amount of each element in all its phases and all its chemical compounds. This allows for establishing an "accounting system" for each element and for consideration of the conservation of mass. The ***law of conservation of mass*** assumes that elements are neither created nor destroyed in the system.



A simple example of the law of conservation of mass

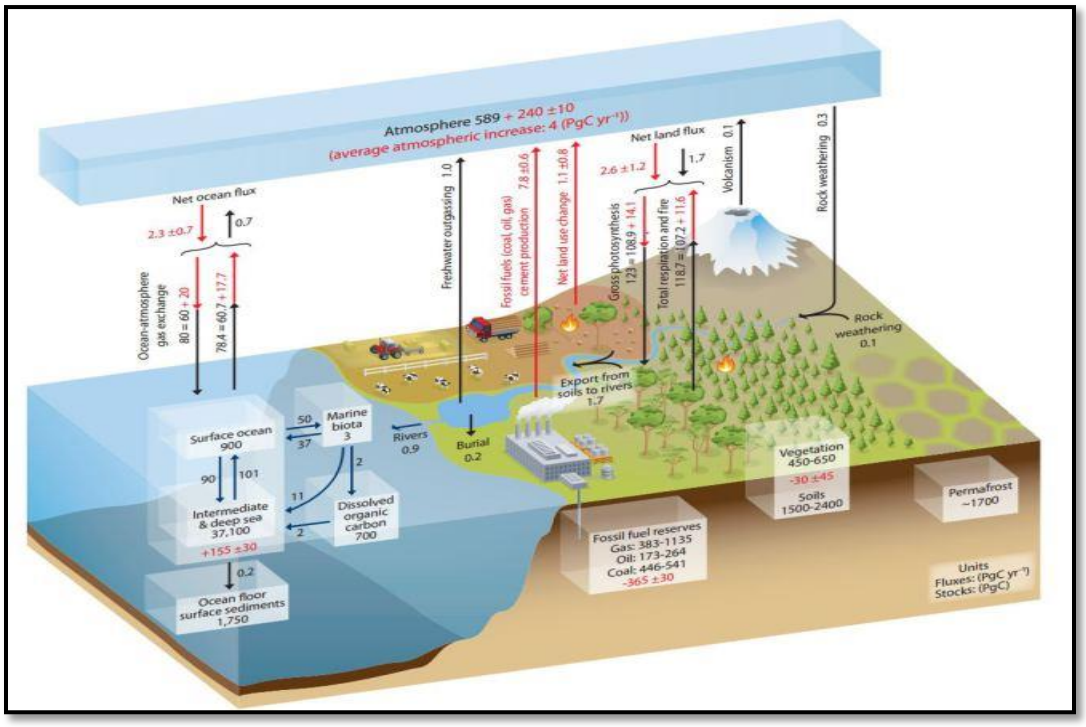
This assumption allows for conducting ***mass balance studies***. Mass balance studies track all chemical forms and physical phases of an element, accounting for storage, transport, and transformation of the element.



Elements and compounds are stored in major ***reservoirs*** - the atmosphere, hydrosphere, lithosphere, and biosphere. The reservoirs are also interconnected, such that the output from one reservoir can become the input to another.

Movements of elements and compounds within each reservoir and among reservoirs are called ***fluxes***. Thus, interactions among the atmosphere, surface waters, ground waters, soils, plants, trees, and sediments must be considered in biogeochemical cycles. Water (H_2O) is an important agent for transporting and transforming chemicals and the hydrologic cycle is an important factor in biogeochemical cycles.

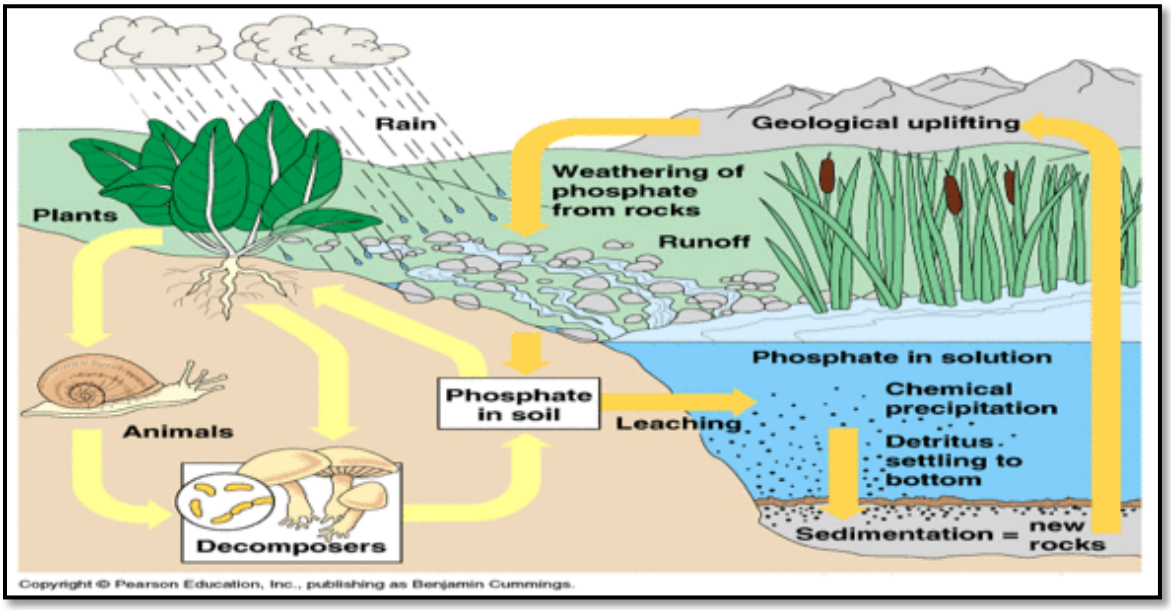
Diagram of Carbon Fluxes 2013 (Note: the diagram shows carbon fluxes, not CO_2



fluxes. To convert to the more commonly-cited CO_2 figure, multiple the these numbers by 3.67, which represents the weight of a CO_2 molecule compared to a molecule of C)

Biogeochemical cycles can be classed as ***gaseous,*** in which the reservoir is the air or the oceans (via evaporation), and ***sedimentary***, in which the reservoir is the Earth's crust. Gaseous cycles include those of nitrogen, oxygen, carbon, and water; sedimentary cycles include those of iron, calcium, phosphorus, and other more earthbound elements.

In a sedimentary cycle elements move from land to water to sediment. Main reservoirs are the soil and sedimentary rocks. Each cycle basically has a solution phase and a rock phase. Weathering releases minerals from the Earth's crust in the form of ***salts***, some of which dissolve in water, pass through a series of organisms, and ultimately reach the deep seas, where they settle out of circulation indefinitely. Other salts deposit out as sediment and rock in shallow seas, eventually to be weathered and recycled.



Simple diagram of the transferring of phosphorus

For example, phosphorus (P) enters the biosphere almost entirely from the soil through absorption by plant roots. Weathering of rocks containing phosphate minerals results in the relatively small pool of inorganic phosphorus available for use by organisms. In most soils the major amount of phosphorus absorbed by plants comes from organic molecules that undergo decomposition releasing phosphorus in plant-available inorganic forms.

In a gas cycle, elements move through the atmosphere and the main reservoirs are the atmosphere and the ocean. The cycling of oxygen, nitrogen, water vapor, and carbon dioxide, as well as the trace gases—methane, ammonia, various oxides of nitrogen and sulfur, and non-methane hydrocarbons—between the atmosphere and the biosphere results in relatively constant proportions of these compounds in the atmosphere over time. Without the continuous generation of these gases by the biosphere,

they would quickly disappear from the atmosphere.

Plants and some animals obtain their nutrient needs from solutions in the environment. Other animals acquire the bulk of their needs from the plants and animals that they consume. After the death of an organism, the elements fixed in its body are returned to the environment through the action of decay organisms and become available to other living organisms again.