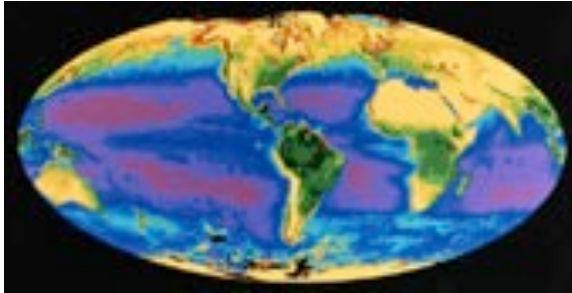
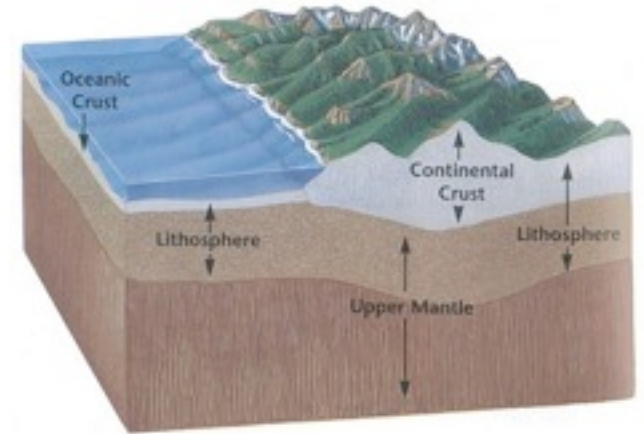


BIOGEOCHEMICAL CYCLES

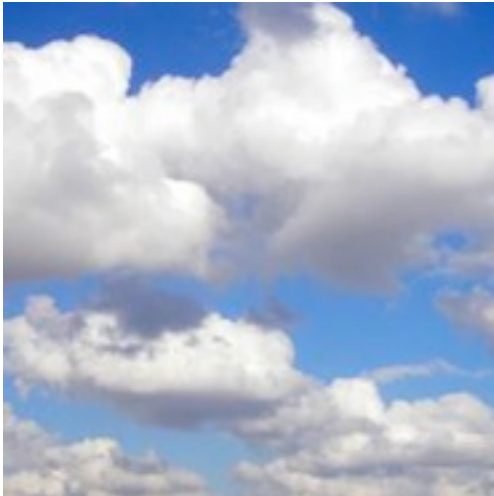
Biosphere



Lithosphere



Atmosphere



Hydrosphere



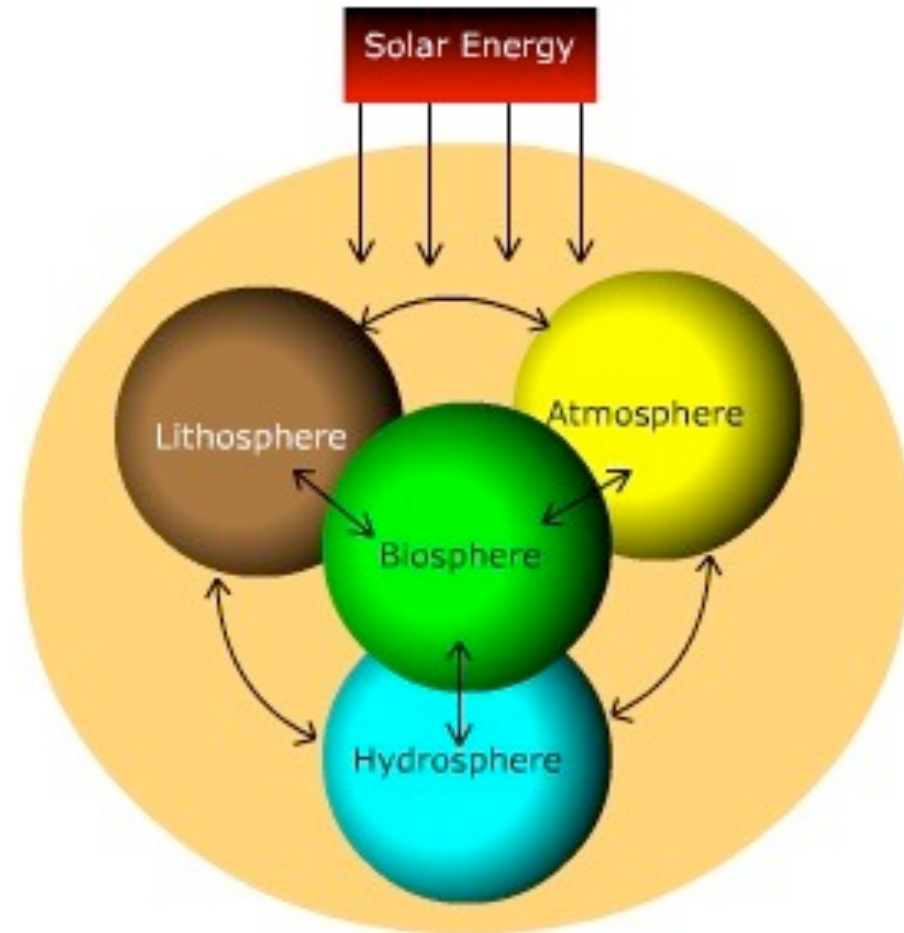
Reeda Hart

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What is a Biogeochemical Cycle?

- Earth is a closed system for matter, except for small amounts of cosmic debris that enter the Earth's atmosphere. This means that all the elements needed for the structure and chemical processes of life come from the elements that were present in the Earth's crust when it was formed billions of years ago. This matter, the building blocks of life, continually cycles through Earth's systems, the atmosphere, hydrosphere, biosphere, and lithosphere, on time scales that range from a few days to millions of years.





Biogeochemical



- Wow. Talk about a word that describes everything on Earth. The cycles we discuss will all fall into the big group of biogeochemical cycles. Let's break it down.

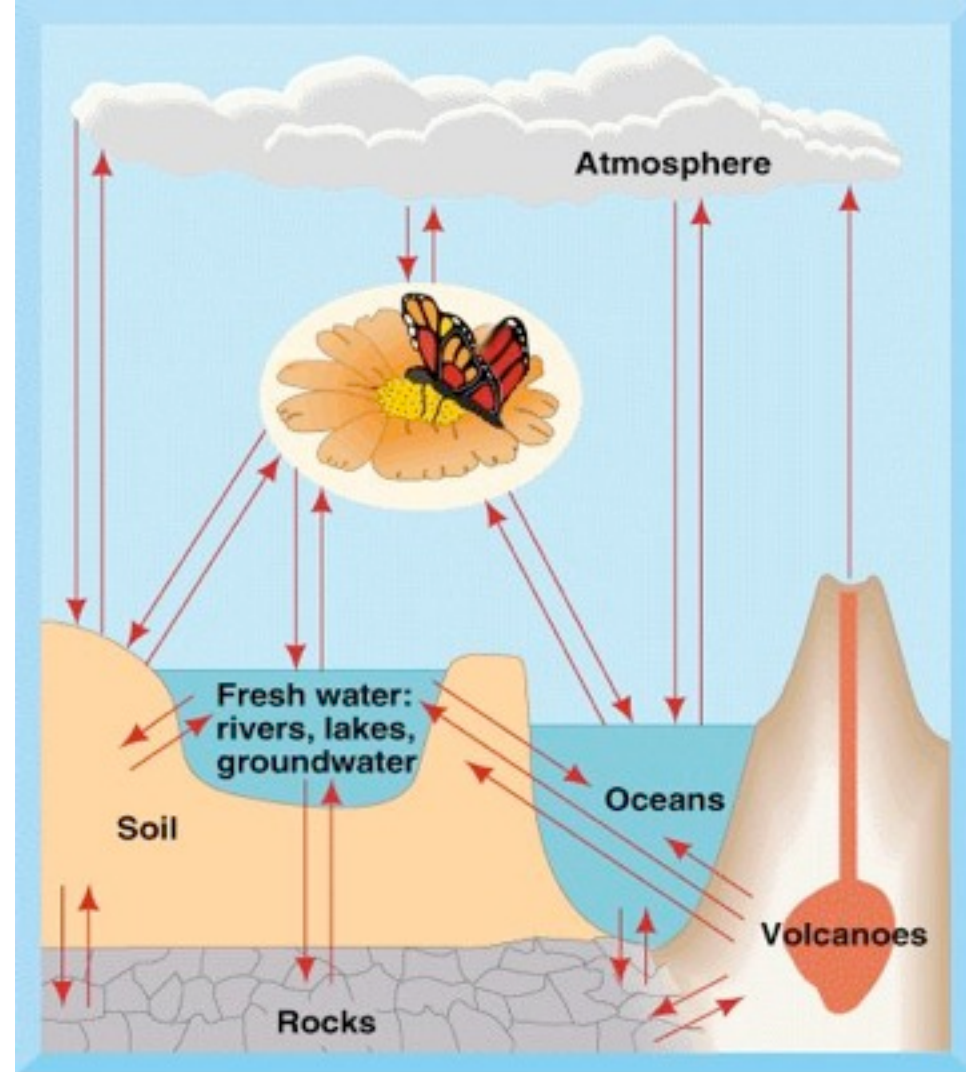
BIO: Biology. Life. Living things. These cycles all play a role in the lives of living things. The cycles might limit the organisms of Earth or they might happen along side, changing the environment.

GEO: Earth. Rocks. Land. This refers to the non-living processes at work. Oxygen cycles through many systems. It's in you and plants for the 'bio' part of the cycle. Oxygen might also wind up in rocks. The 'geo' part of its cycle.

CHEMICAL: Molecules. Reactions. Atoms. All cycles include these small pathways. Complete molecules are not always passed from one point to the next. Sometimes chemical reactions take place that changes the molecules and locations of the atoms. Think about oxidation as an example of the 'chemical' part of these pathways.

To sum it up, these pathways are all made of different biological, geological, and chemical processes that help make the world go 'round and life exist on Earth.

- As you can see, the elements cycle in either a gas cycle or a sedimentary cycle; some cycle as both a gas and sediment.

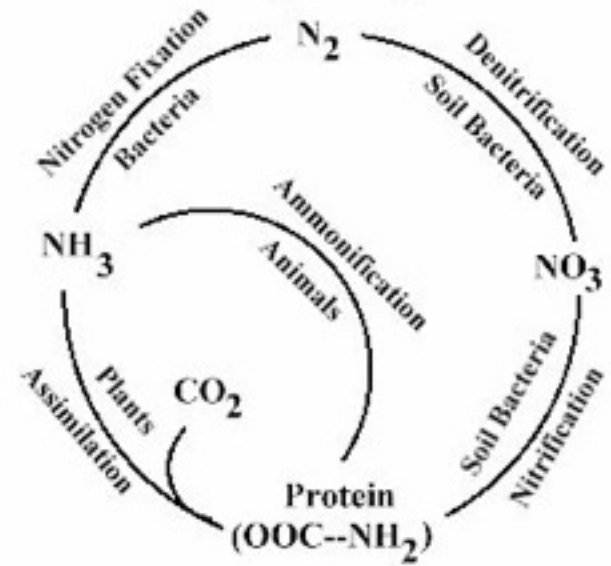


Generalized biogeochemical cycle. The major parts of the biosphere are connected by the flow of chemical elements and compounds. In many of these cycles, the biota plays an important role. Matter from the Earth's interior is released by volcanoes. The atmosphere exchanges some compounds and elements rapidly with the biota and oceans. Exchanges of materials between rocks, soils, and the oceans are generally slower by comparison.

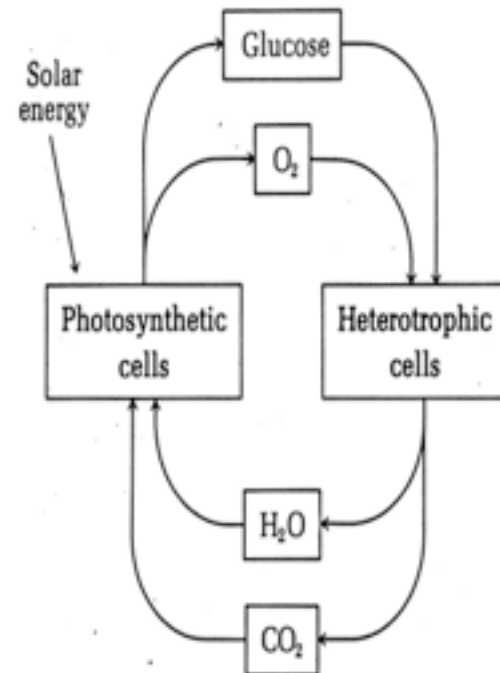
Gas Cycles

- Elements move through the atmosphere. Main reservoirs are the atmosphere and the ocean. Examples:

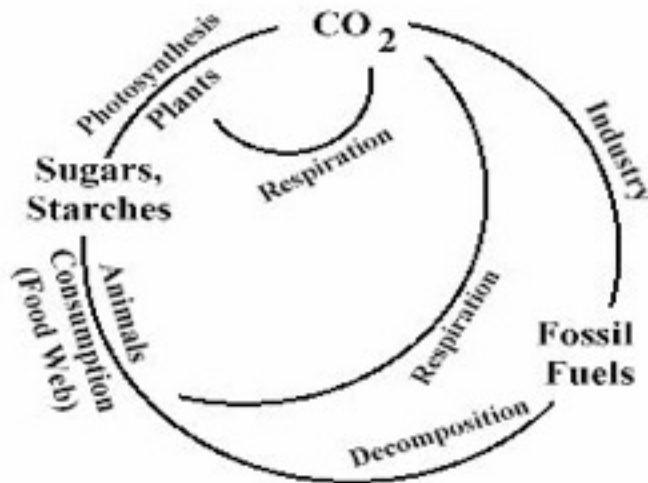
Nitrogen Cycle



Oxygen Cycle



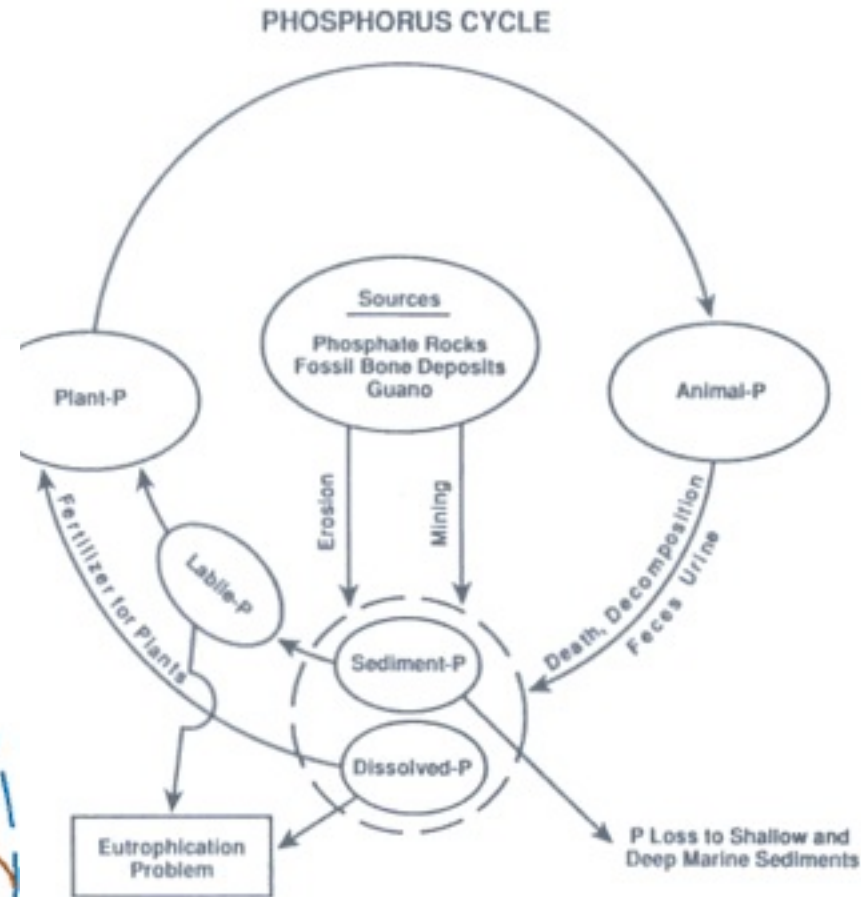
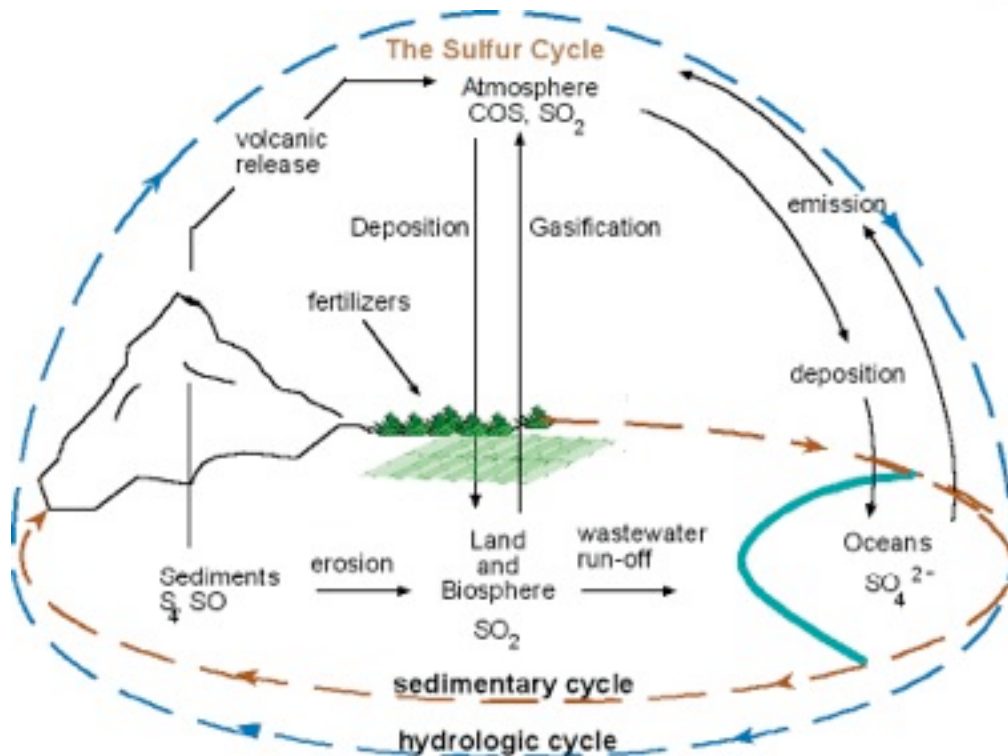
Carbon Cycle



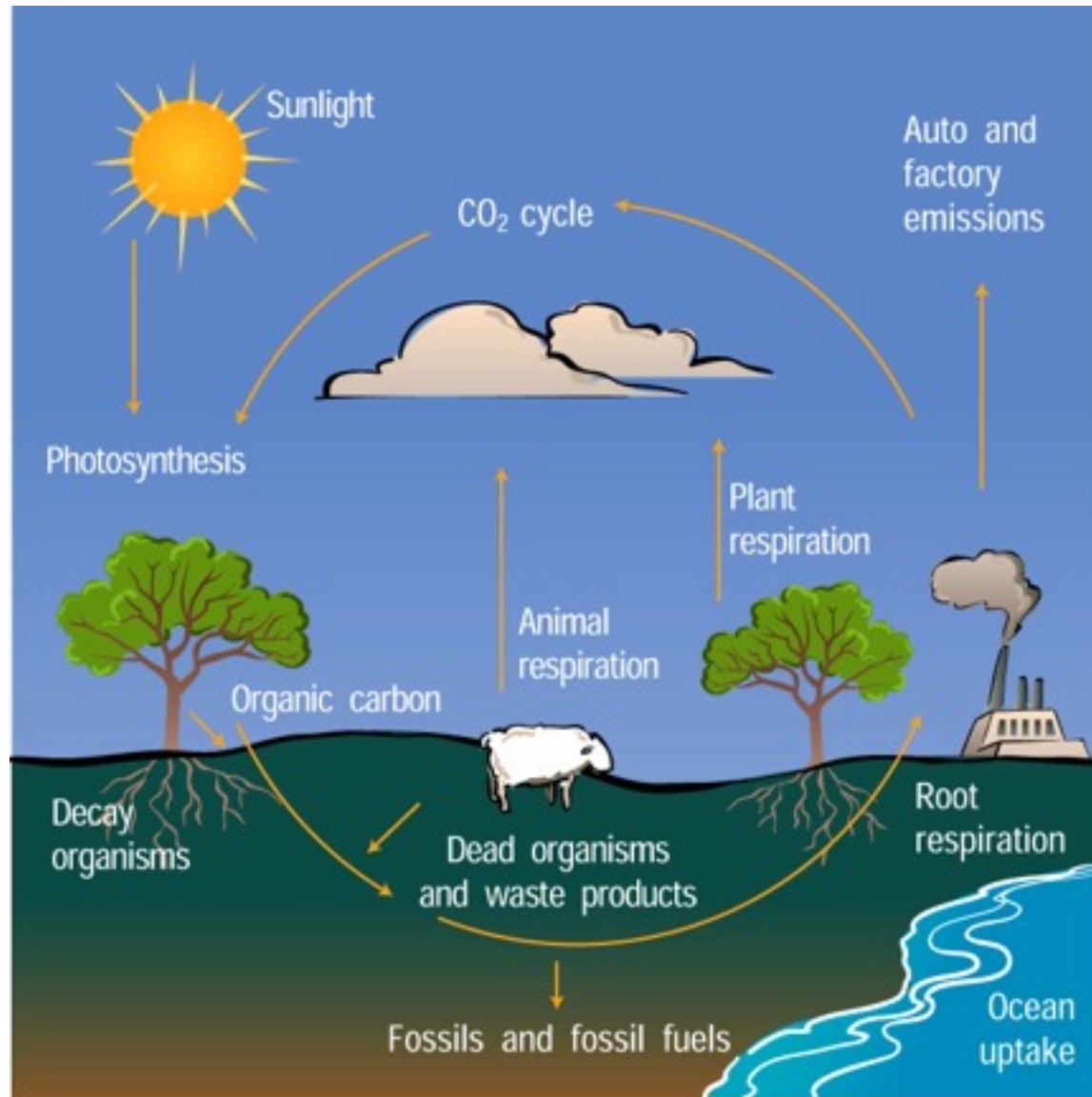
Sedimentary Cycles

- Elements move from land to water to sediment. Main reservoirs are the soil and sedimentary rocks.

Examples:

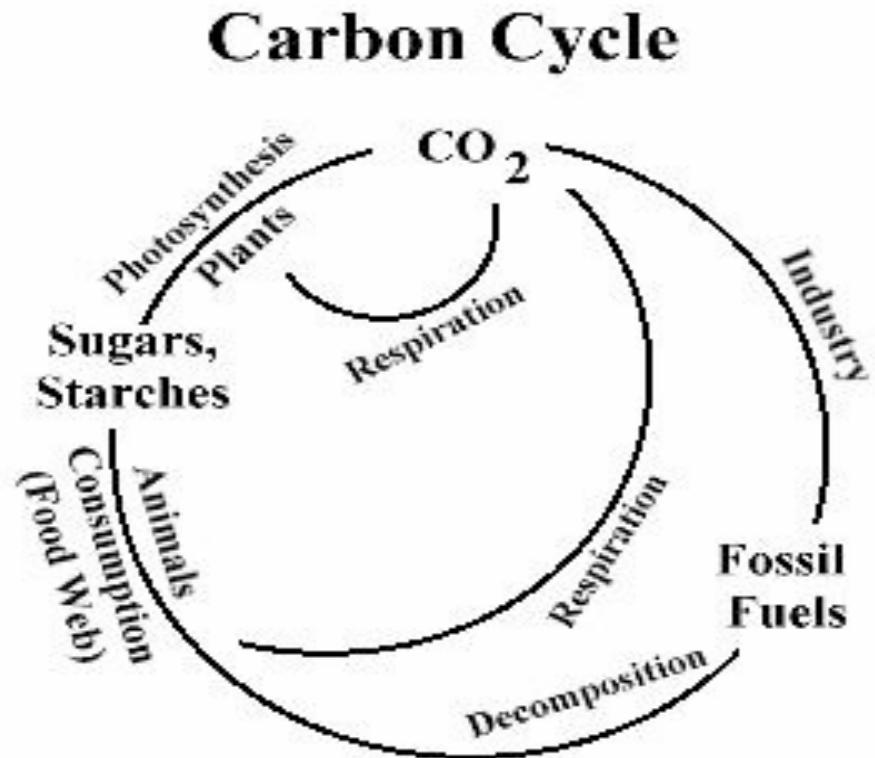


The Carbon Cycle

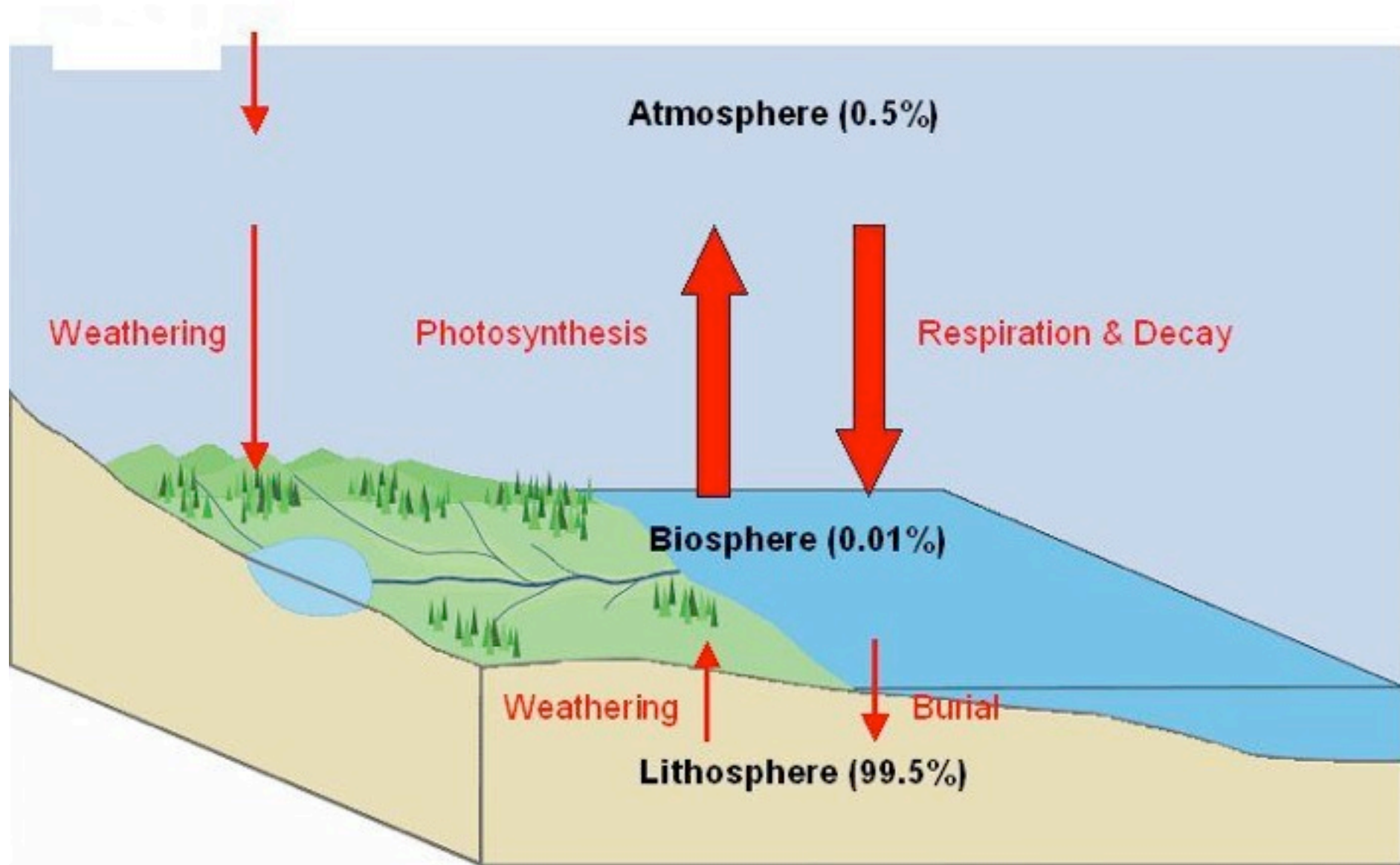


Key Aspects of the Carbon Cycle

- Carbon is the skeleton of all life.
- Carbon dioxide is a critical gas:
 - Taken up by plants in photosynthesis
 - Released by plants and animals in cell respiration
 - Released during decomposition (and fires)
 - Greenhouse gas (greenhouse effect – your car in the sun)



Oxygen Cycle

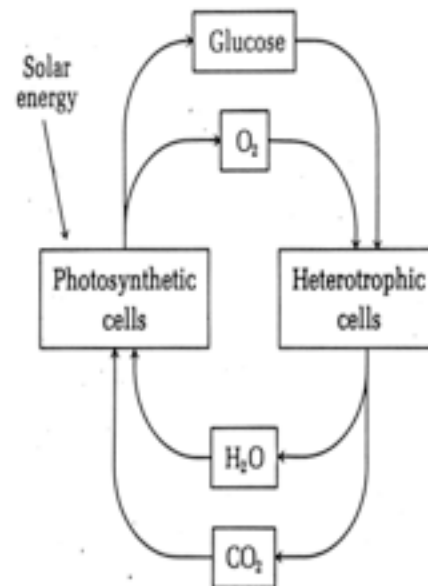


The Oxygen Cycle

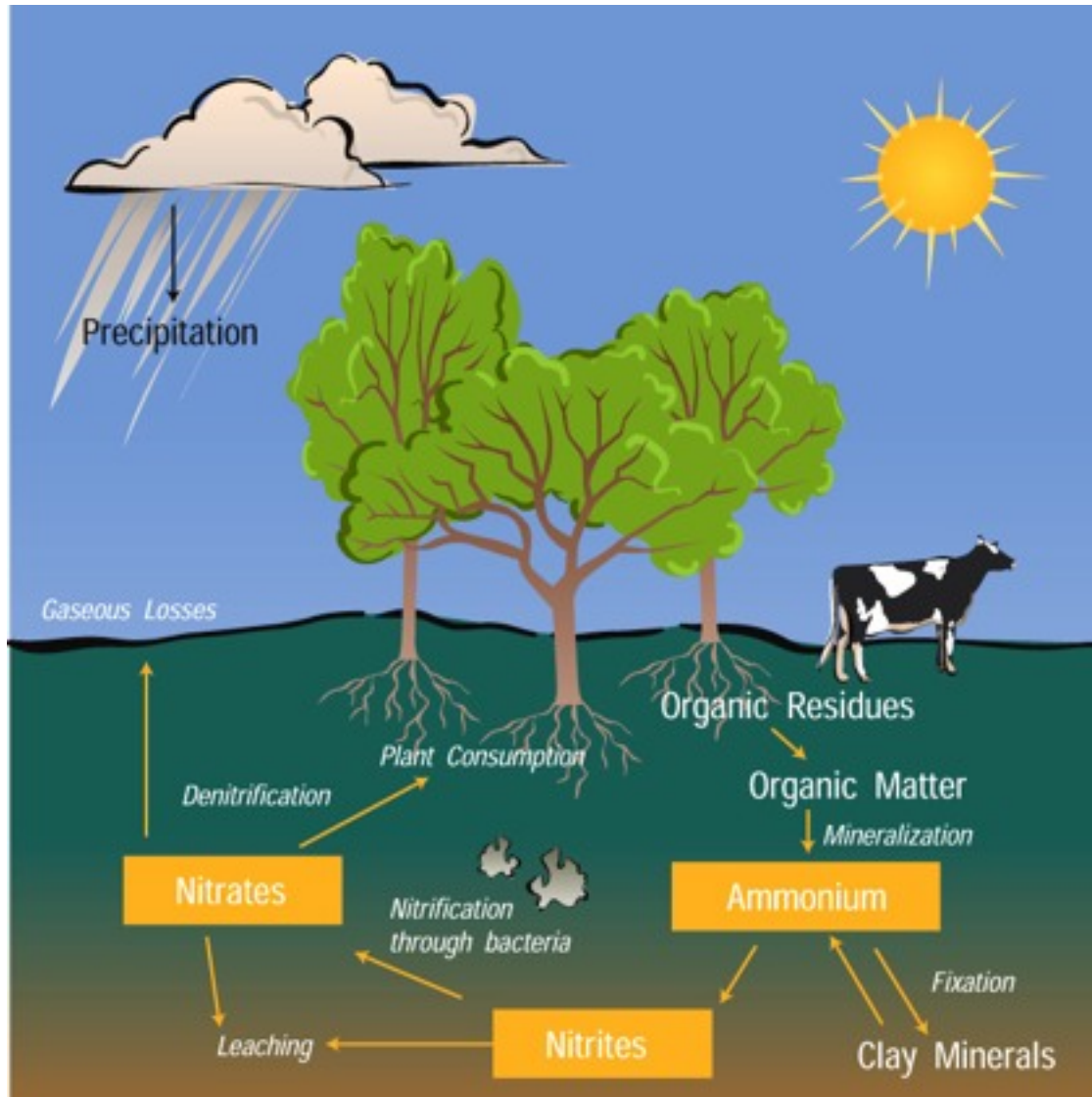
- By far the largest reservoir of Earth's oxygen is in the [minerals](#) of the [crust](#) and [mantle](#) (99.5%).
- Oxygen is also cycled between the biosphere and lithosphere. Marine organisms in the biosphere create [calcium carbonate](#) shell material (CaCO_3) that is rich in oxygen. When the organism dies its shell is deposited on the shallow sea floor and buried over time to create the [limestone](#) rock of the lithosphere. Weathering processes initiated by organisms can also free oxygen from the lithosphere. Plants and animals extract nutrient minerals from rocks and release oxygen in the process.

- Only a small portion has been released as free oxygen to the biosphere (0.01%) and atmosphere (0.36%).
- The main source of atmospheric oxygen is photosynthesis, which produces sugars and oxygen from carbon dioxide and water.

Oxygen Cycle

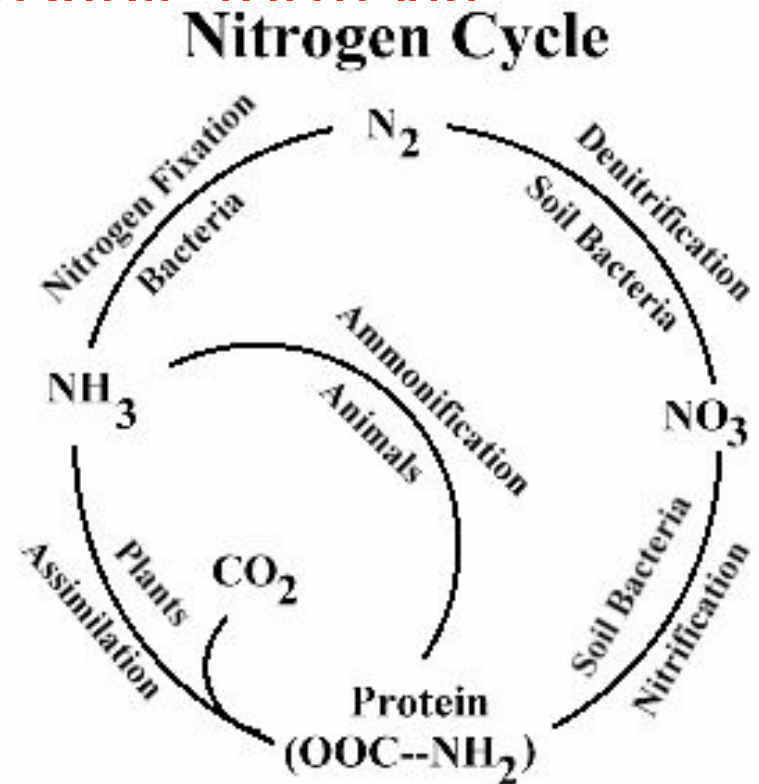


The Nitrogen Cycle

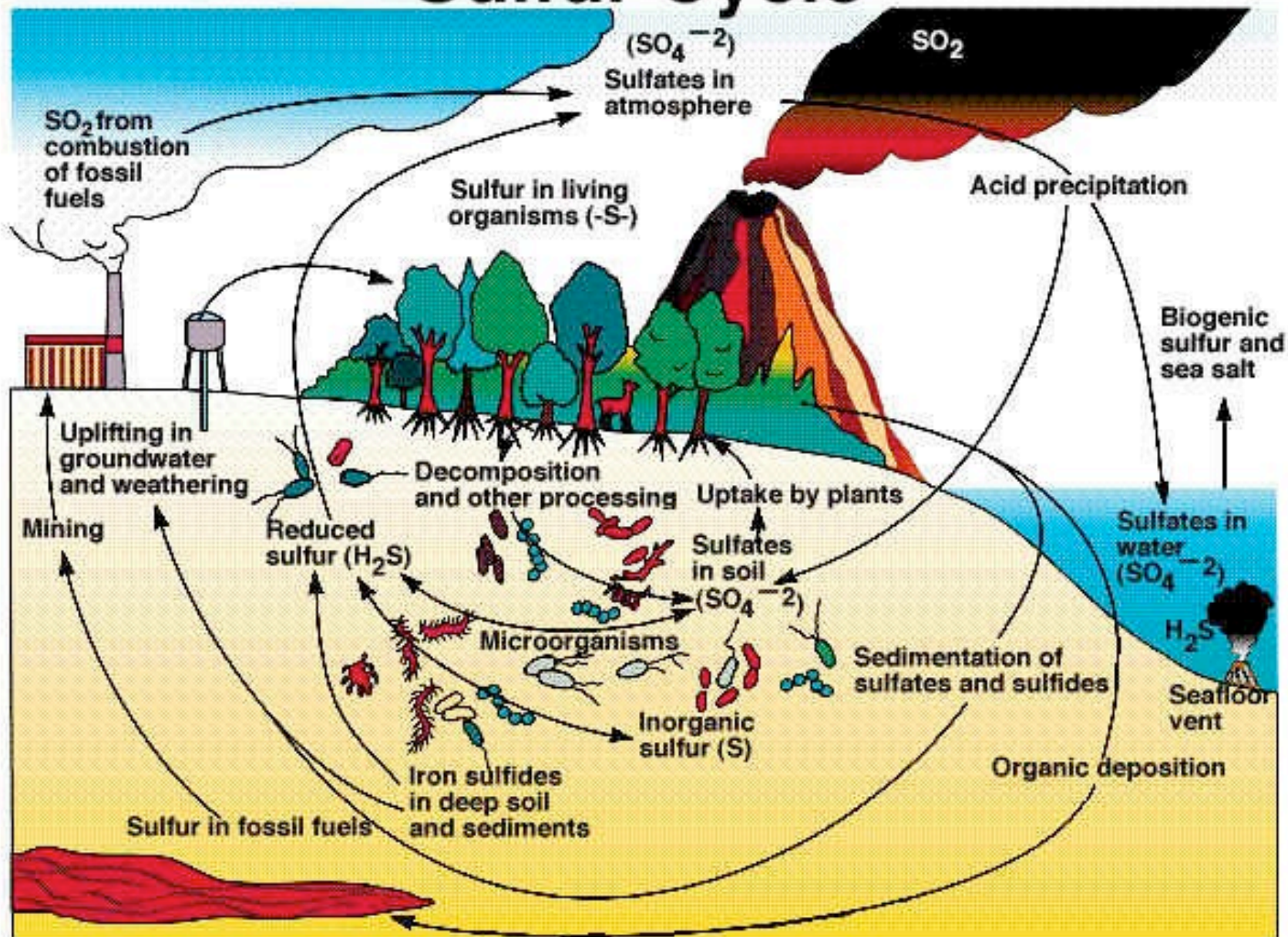


Nitrogen Cycle: Key Points

- Nitrogen is in the atmosphere as N_2 (78%)
- N_2 is an inert gas and cannot be used by plants or animals
- N_2 can be converted to a usable form via
 - Lightening
 - N-fixing plants and cyanobacteria
 - Industrial process
- Nitrogen limits plant

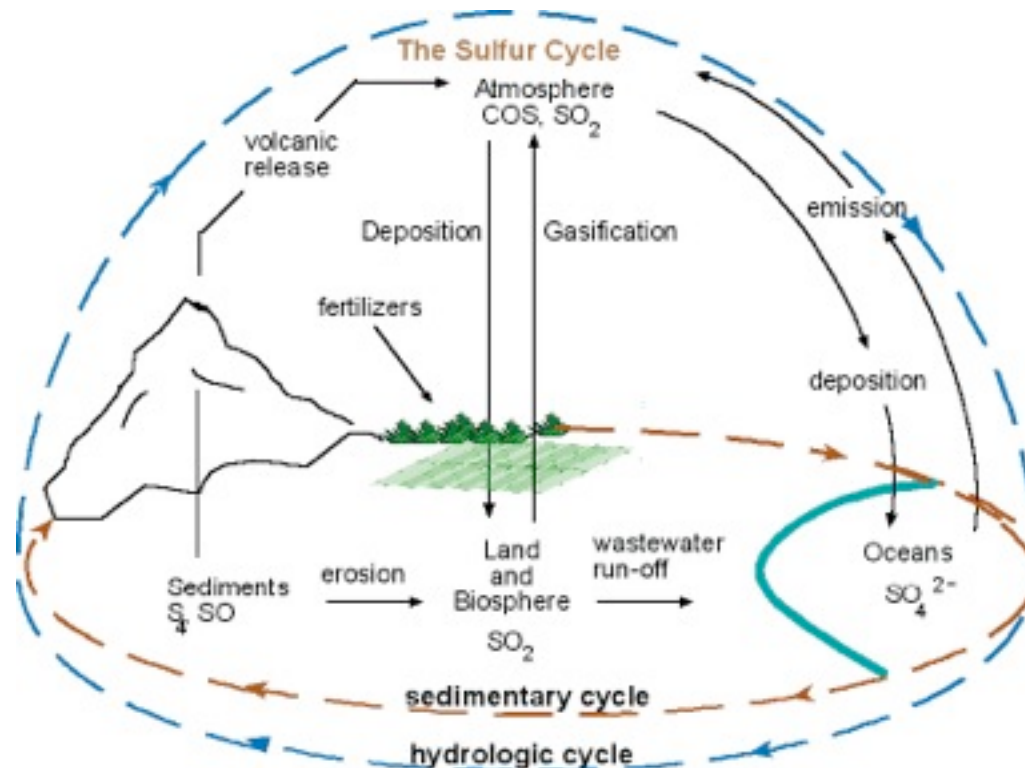


Sulfur Cycle

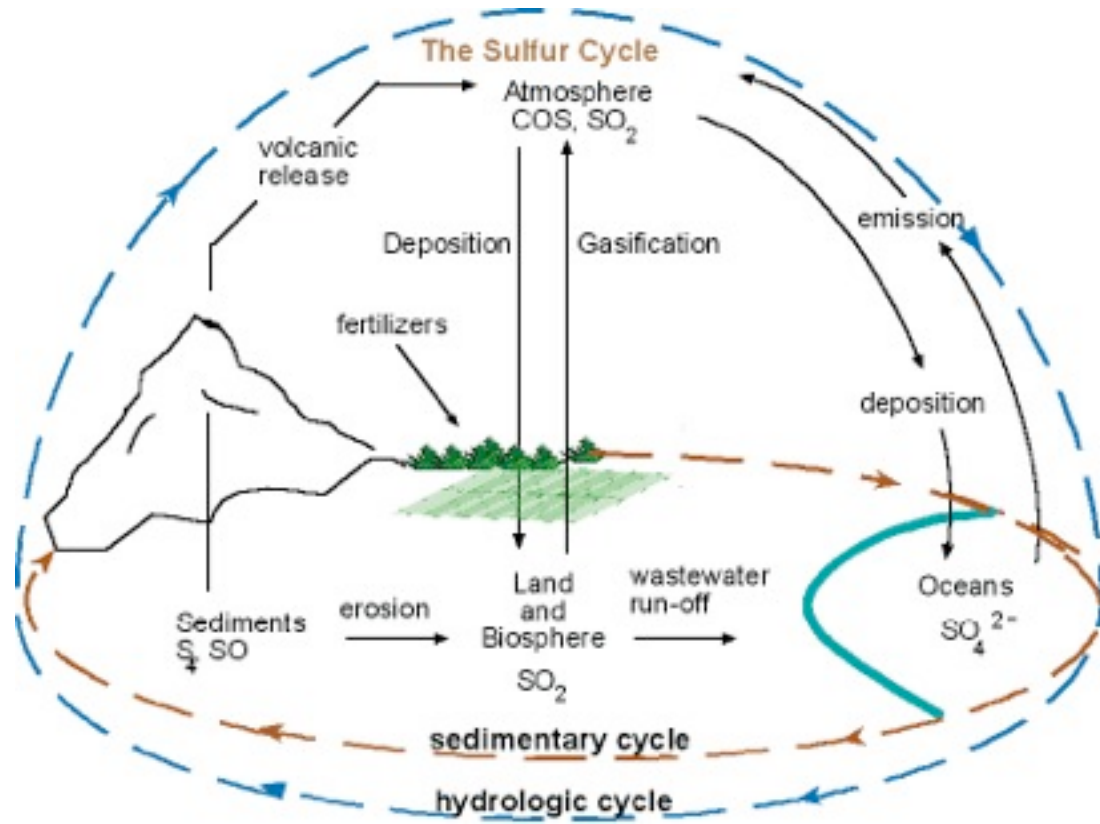


The Sulfur Cycle

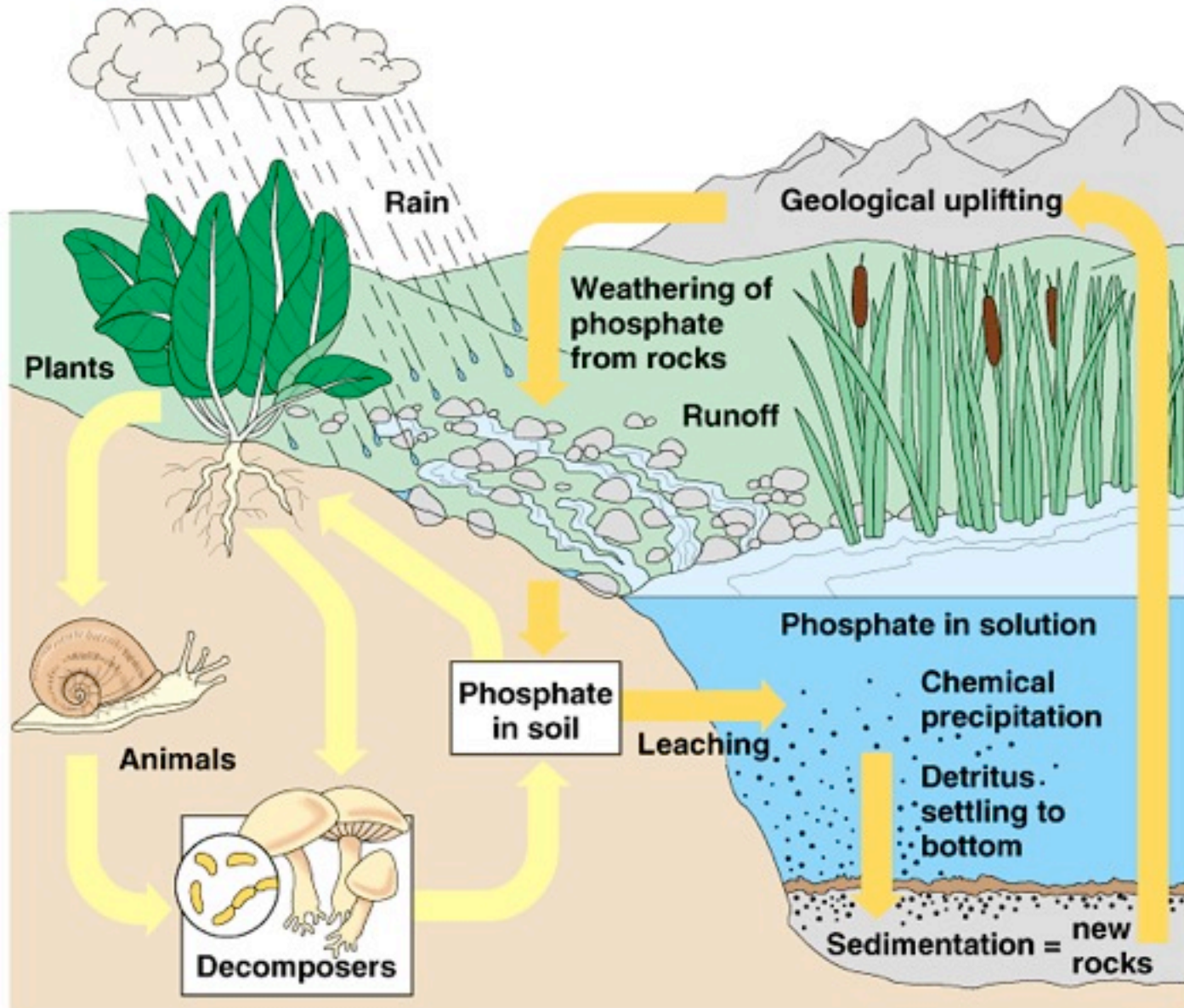
- Cycles in both a gas and sedimentary cycle.
- The source of Sulfur is the lithosphere, the earth's crust.
- Sulfur (S) enters the atmosphere as hydrogen sulfide (H₂S) during fossil fuel combustion, volcanic eruptions, gas exchange at ocean surfaces, and decomposition.



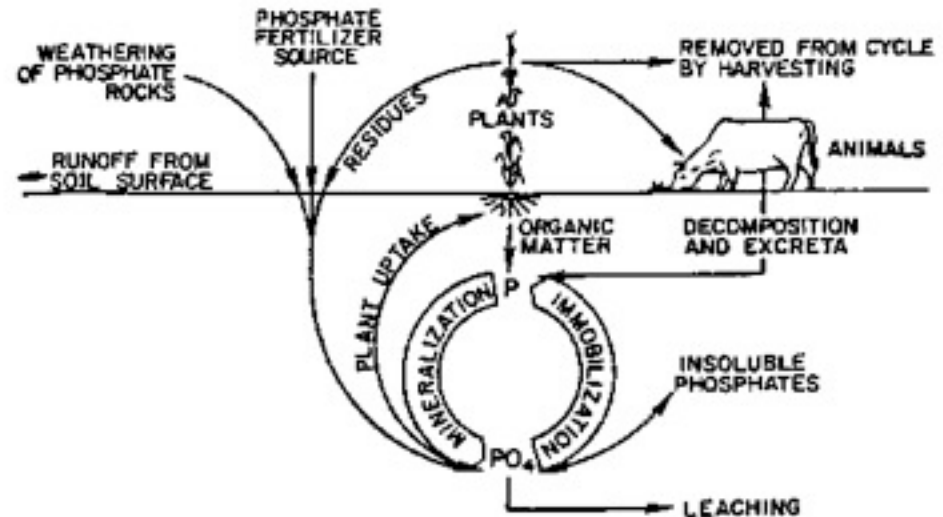
- H₂S is immediately oxidized to sulfur dioxide (SO₂)
- SO₂ and water vapor makes H₂SO₄ (a weak sulfuric acid), which is then carried to Earth in rainfall.
- Sulfur in soluble form is taken up by plant roots and incorporated into amino acids such as cysteine. It then travels through the food chain and is eventually released through decomposition.



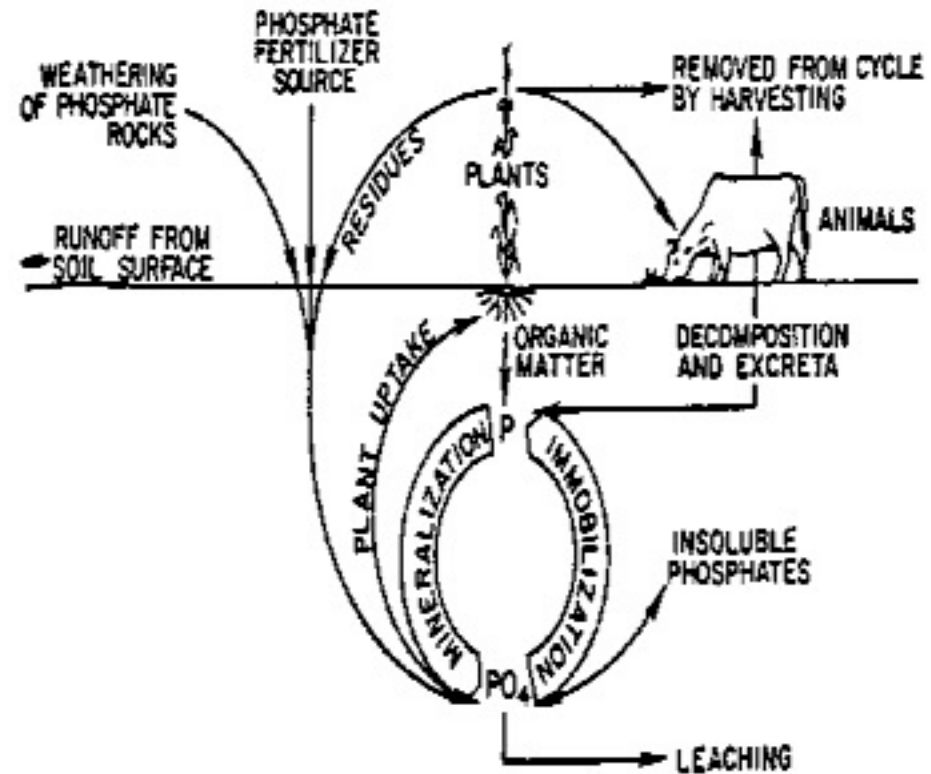
The Phosphorus Cycle



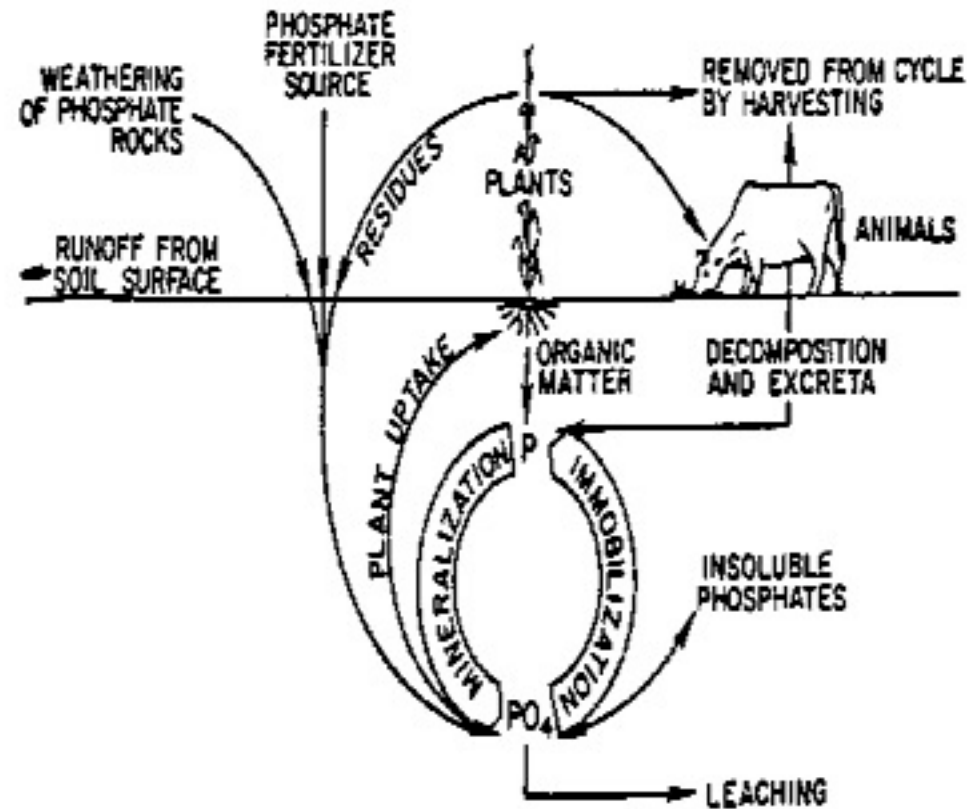
- Phosphorus forms part of the phospholipids in cell membranes, makes up the "backbone" of DNA and RNA along with sugar, and provides energy for cells as ATP.
- Animals excrete phosphorus in waste.
- Decomposers release phosphorus from decaying plants and animals, returning the phosphorus to the soil where it can be taken up by plants. The plants, in turn, are consumed by animals, completing the cycle.



- The sedimentary part of the cycle takes place in geologic time, as phosphorus in the ocean accumulates in sediment to become rock. Eventually those rocks may be uplifted and release phosphorus due to weathering, reintroducing phosphorus to the local ecosystem. However, on the "human" time scale, once phosphorus enters the sedimentary part of the cycle, it is essentially lost to organisms.

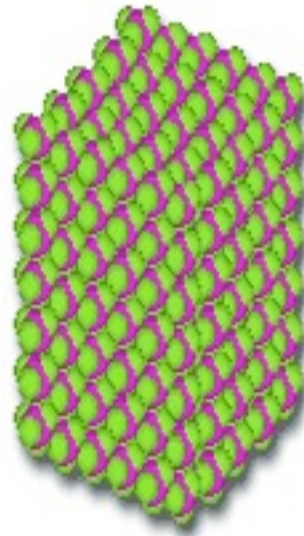


- Phosphorus in the soil occurs as phosphate. Phosphate can be leached out of soil by rain, where it may flow into groundwater. Increased erosion of a stream bank can also result in increased phosphate loss. When phosphates accumulate in lakes, rivers, and the ocean, algal blooms and red tides occur.

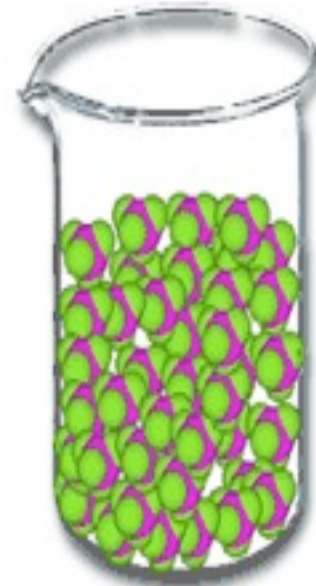


How fast do they cycle?

- How fast substances cycle depends on its chemical reactivity and whether or not it can be found in a gaseous state. A gaseous phase allows molecules to be transported quickly. Phosphorous has no gaseous phase and is relatively unreactive, so it moves very slowly through its cycle. Phosphorus is stored in large amounts in sediment in the oceans or in the Earth's crust and is recycled back to the surface only over very long periods of time through upwelling of ocean waters or



Solid



Liquid



Gas

How do humans interrupt these cycles?

- Biogeochemical cycles are subject to disturbance by human activities. Humans accelerate natural biogeochemical cycles when elements are extracted from their reservoirs, or sources, and deposited back into the environment. For example, humans have significantly altered the carbon cycle by extracting and combusting billions of tons of hydrocarbons in fossil that were buried deep in the Earth's crust, in addition to clearing vegetation that stores carbon.
- In addition to carbon cycle, humans have altered the nitrogen and phosphorus cycles by adding these elements to croplands as fertilizers, which has contributed to over-fertilization of aquatic ecosystems when excess amounts are carried by runoff into local waterways.

Investigate human impact!

