

Chemical cycling: Biogeochemical cycles. A combination of geological and chemical processes drives these.

Elements taken up as molecules or ions. Plants take nitrogen as nitrates, while animals take it from the bodies of their prey. Some are turned into new molecules, some (like Carbon, oxygen, and hydrogen) are metabolized (used) for their chemical bond energy. But these elements reappear in metabolic wastes (feces, urine etc.), or through decay. **Decomposers** play a key role in this cycling.

Rates of nutrient cycling are often dependant or influenced by rates of decomposition, which are dependant on abiotic factors such as temperature, oxygen availability, and moisture.

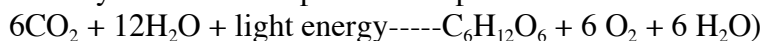
Elements accumulate in three major places in natural systems;

- In the **bodies** of living organisms
- In **exchange pools**: readily available water soluble reserves of a mineral nutrient, such as nitrates in soil water easily taken up by plants, or such as Carbon as Carbon Dioxide in air
- **Reservoirs**: harder to get to places such as bones of animals, shells etc. It takes longer for these sources of elements to be accessed (a good example is oil as a reservoir for Carbon. We have tapped this reservoir and have made it into an exchange pool – that's part of why Carbon is building up in the form of CO₂ – we are releasing it from a reservoir.

Water cycle: most occurs between sea and atmosphere. This is primarily a *physical* cycle, not a *chemical* one.

Carbon cycle:

Photosynthesis and respiration are part of it:



Link between atmosphere and terrestrial environment. High demand by plants recycles it fast. Atmospheric CO₂ varies by season

Carbon removal – eg build up of organic matter---coal/oil - carbonification

Aquatic environments: Carbon reacts with water and limestone.

Dissolved CO₂ reacts with water to form Carbonic acid: H₂CO₃, which reacts with limestone: CaCO₃, to form Bicarbonate (2 HCO₃⁻) and carbonate (2CO₃²⁻) ions:

Bicarbonates are a CO₂ reservoir

Ocean is an important buffer. Oceans are now acidifying due to excess CO₂ in the atmosphere.

Nitrogen cycle: bacteria are key here!

NO_3^- = nitrates (plants can use this)
 NH_4^+ = ammonium (plants can use this)
 NO_2^- = nitrites (some bacteria can use this)

Animals need organic forms of nitrogen (eg. amino acids)

Nitrogen is a principal constituent in nucleic acids, proteins, chlorophyll, etc. Largest reservoir is the atmosphere. We can't get it. Plants get it in the form of nitrate ions (NO_3^-) which are produced by soil and water bacteria (Nitrogen in the atmosphere is virtually inaccessible to most forms of life). Bacteria make it available through **nitrogen fixation** and **ammonification** (atmospheric Nitrogen is converted to an ionic form (NH_4^+), and **nitrification** (oxidative conversion of ammonium to nitrate). This allows for nitrogen in soil available to plants. Some settles directly into the soil through water or particulate (5-8%).

N_2 ----- NH_3 ammonia gas ----- NH_4^+ ammonium in soils

Decomposers convert organic nitrogen back to ammonium (NH_4^+): **ammonification**.

nitrification by bacteria:

NH_4^+ ammonium ----- NO_2^- nitrite ----- nitrate NO_3^- which can be assimilated by plants

Animals can only assimilate organic nitrogen by eating animals or plants.
Most nitrogen is cycled through decomposition and reassimilation

Phosphorous cycle

Nucleic acids, phospholipids, ATP..., bones and teeth – these are a few places we use it

Sedimentary cycle and animal/plant/soil cycle – can be a long cycle (time)

No atmospheric component. Made available primarily by

- Weathering of rocks
- Excretion and decomposition
- Humus and soil particles bind phosphates – recycling and availability is localized.
Limiting factor
- In ocean accumulates in sediments and make it back to earth through geologic processes