# Biogeochemical Cycles

**Introduction**

- Pathways tracing the exchange and storage of chemical elements between living and non-living systems are called: **Biogeochemical cycles**.

These cycles occur in the:

**a.** atmosphere (air)

**b.** hydrosphere (water)

**c.** lithosphere (rocks/soil)

**d.** biosphere (life)

*Because of their different characteristics these each have different rates of storage.

**Biogeochemical Cycles & Life**

- Of the 103 known chemical elements, only 24 are needed by living organisms. These 24 are divided into 2 groups.

**Macronutrients**: 1° building blocks of organic compounds (C, H, N, O, P, S).

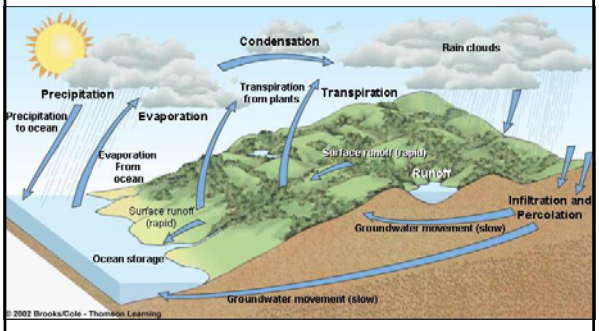
**Micronutrients**: required in minute amounts. (boron, copper, etc.)

- Chemical elements unavailable at the right time or in the proper conc. can be limiting factors.

**Limiting factors**: restrict or prevent the growth of an individual, population or species.

**Hydrologic Cycle**

- Transfer of water between oceans & atmosphere.

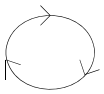



**Basic Concepts of Biogeochemical Cycling**

- Ecosystems have a critical limit of tolerance for certain chemical elements.

| Death | | | | Death |
|---|---|---|---|---|
| ← | [ | Tolerable | ] | → |
| Disease | Min. | | Max. | Disease |

•All chemical cycles begin with external input, then go into internal cycling, and end w/ external output.

**Inputs**
atmosphere, land →  → **Outputs** surroundings

internal cycling

•Human activities can damage the ability of ecosystems to serve as reservoirs of biologically essential chemicals and elements.

**The Carbon Cycle**

•Carbon is the structural foundation of all living things.

•C-cycle is linked to the H-cycle & $O_2$- cycle.

•In the gaseous phase C is primarily stored as $CO_2$.

•$CO_2$ exchanged between the atmosphere and large bodies of $H_2O$ by diffusion.

•Plants remove C from the atmosphere through photosynthesis.

$$CO_2 + H_2O \rightarrow O_2 + C_6H_{12}O_6$$

•Vegetation is a major storehouse for C in living tissue.

•C is returned to the atmosphere through
**a.** respiration
**b.** burning

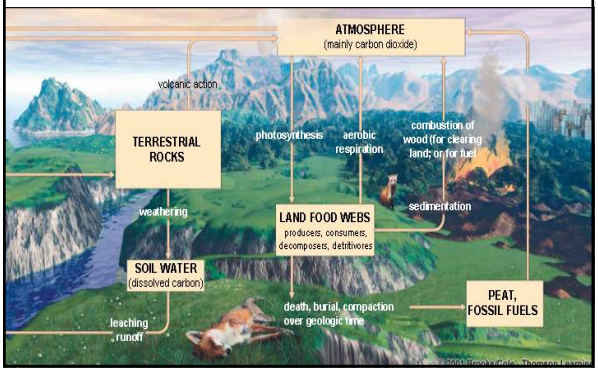
•C may enter the rock cycle as organic sediment solidifies.

•C-cycle is driven by photosynthesis & respiration.

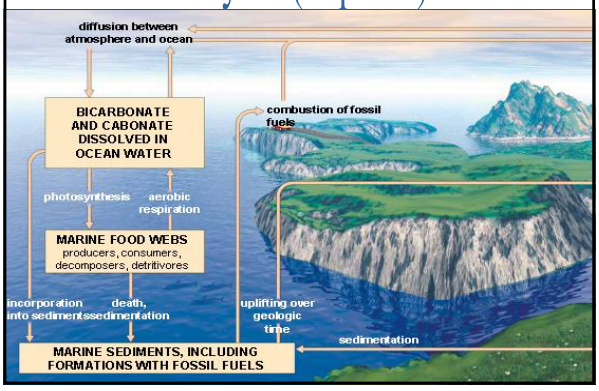
•C-cycle has historically maintained an equilibrium through C-storage in rocks, oceans, soils, & vegetation.

*Not all C released to the atmosphere remains there through the full cycle, it's not completely understood.

## The Carbon Cycle (Terrestrial)




## The Carbon Cycle (Aquatic)




**The Nitrogen Cycle**

•$N_2$ is made biologically available through a process called **<u>Nitrogen Fixation</u>**.

$N_2$ → ammonia, ammonium, nitrates, or nitrites

**Fixing Agents include:**

•Lightning

•Nitrogen-fixing bacteria live in symbiosis w/plants .

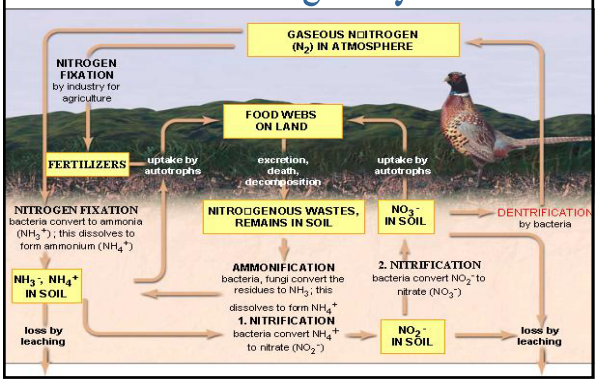
•Free living soil bacteria release fixed nitrogen to the atmosphere.

Ammonia → $N_2\uparrow$

•Fixed nitrogen is an important limiting nutrient (rice & beans).

•Through use of agriculture fertilizers and the release of $NO_X$ from combusted fossil fuels, humans have accelerated the cycle and caused pollution.

# The Nitrogen Cycle




**The Phosphorus Cycle**

•Lacks a major gaseous phase so its ART tends to be longer.

•Plant growth in many systems can be limited by the supply of phosphorus.

•Phosphate & phosphorus containing compounds are cycled through plants & animals to the oceans, or to the land via bird guano or slow uplifting sedimentary rocks.

•Phosphorus must me artificially supplied to agricultural systems and is mined by humans

•Mines can have a severe environmental impact.

# The Phosphorus Cycle