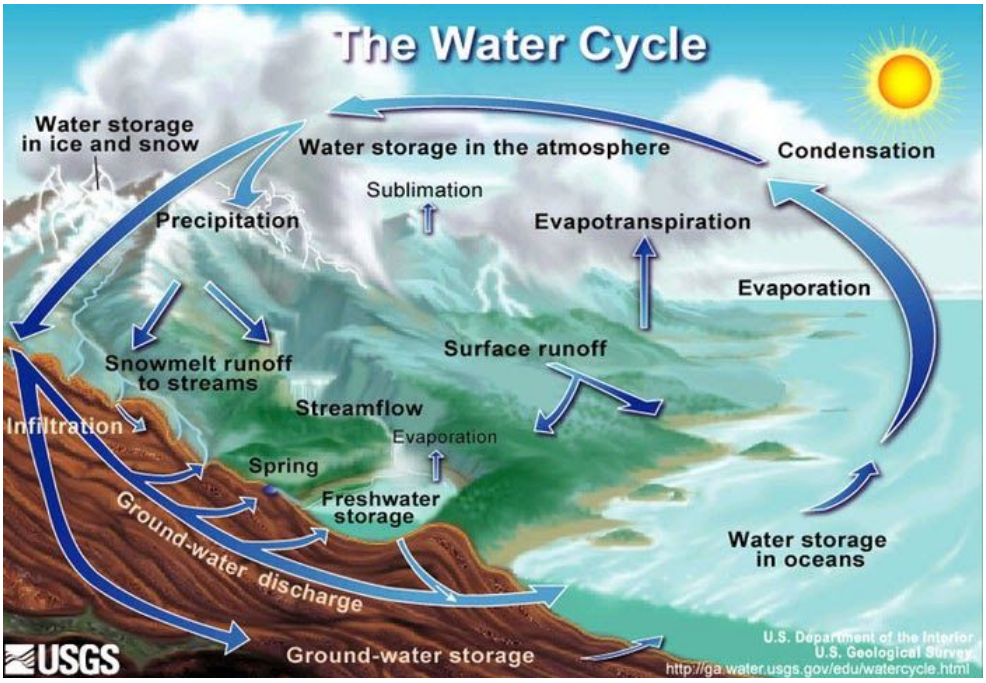
Water Cycle (also known as hydrologic cycle)

1. The cycle of processes by which water circulates between the earth's oceans, atmosphere, and land, involving precipitation as rain and snow, drainage in streams and rivers, and return to the atmosphere by evaporation and transpiration.
2. Driven by solar energy which evaporates water, and by gravity, which draws water back to Earth in the form of precipitation from water vapor in the atmosphere.
3. ¾ of the surface of Earth is covered in water, but only 1% of that can be used by humans and land animals
4. Human Impact:
    a. Unsustainable water usage
    b. Clearing vegetation to industrialize leads to increased runoff and reduced infiltration that recharges groundwater supplies. This can then increase soil erosion and the risk of flooding
    c. Draining wetlands for human purposes such as farming increases risk of flooding
    d. Pollution, including smog and improper waste disposal, can impact the water cycle by making acid rain



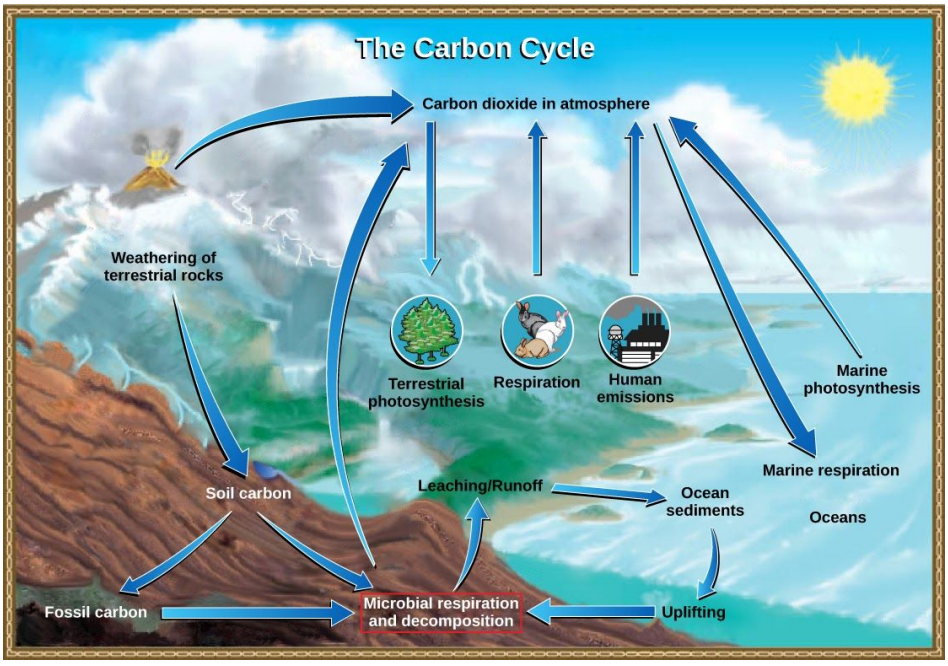
Carbon Cycle

1. Carbon is required for formation of organic compounds in living things.
2. Movement of carbon:
    a. In photosynthesis: The carbon in carbon dioxide in the atmosphere and in water transfers in glucose

    b. In cellular respiration: Carbon in glucose is transferred to carbon dioxide
    c. Carbon in glucose is transferred to organic molecules by synthesis reactions in living things.
3. Carbon in organic molecules is transferred to carbon dioxide by combustion.
4. Carbon in organic molecules in organisms is transferred to fossil fuels over millions of years by pressure, heat, and bacterial action.
5. Carbon in limestone (CaCO3) is released slowly to carbon dioxide when exposed to oxygen and/or water.
6. Largest reservoirs of carbon:
    a. sedimentary rocks (limestone)
    b. ocean (dissolved carbon dioxide), living things in the ocean.

Human Impact:

- Removal of vegetation reduces absorption carbon dioxide for photosynthesis from the atmosphere. Increases atmospheric CO2.
- Burning of fossil fuels increased atmospheric CO2.
- Increase in atmospheric CO2 leads to increased Greenhouse Effect → climate change



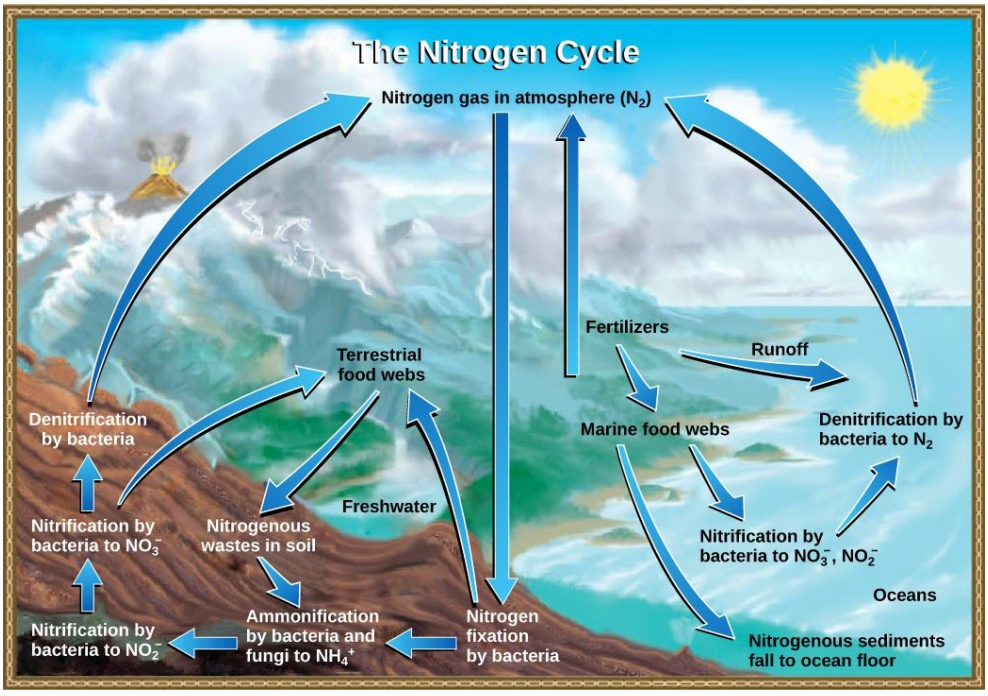
<u>Nitrogen Cycle</u>

1. Plants and animals cannot use free nitrogen gas in the atmosphere. They must have nitrogen in "fixed" form. Nitrogen is required for proteins, nucleic acids in living things.
2. Free N2 in atmosphere is "fixed" by nitrogen-fixing bacteria to NH3 (ammonia): N2 +3H22NH3
3. Nitrogen fixing bacteria live in nodules on the roots of leguminous plants (soybeans, peas, clover, and alfalfa.)
4. Water in the soil reacts with ammonia to form NH4+ (ammonium ion)

5. Another species of bacteria can perform nitrification once ammonium has formed: NH4+ NO2- (nitrite; toxic) NO3- (nitrate; plant nutrient)
6. Assimilation - absorption of ammonia, ammonium ion, nitrate for use by plants to make nucleic acids, proteins
7. Animals get fixed nitrogen by eating plants or other animals.
8. Plants and animals are broken down by still other bacteria that convert nitrogen-containing organic molecules in organisms to an inorganic form of nitrogen (ammonia or ammonium ion) = ammonification
9. Once this ammonia has formed, still another group of bacteria can perform Denitrification: NH3 or NH4+ NO2- and/or NO3- N2 and N2O (nitrous oxide)
10. Nitrogen is often a limiting factor in plant growth because ammonia, ammonium ion, nitrate are water-soluble: can be leached from soil.

Human Intervention:

- In the atmosphere:
    - N2 + O2 2NO (nitric oxide) produced when burning fuel or forests. (Heat combines N2 and O2 present in atmosphere)
    - NO + O2 NO2 (nitrogen dioxide gas)
    - NO2 + H2OHNO3 (nitric acid - dissolved in water causes acid deposition)
- N2O(nitrous oxide)released from decomposition of fertilize and waste.
- Excess nitrogen added to aquatic systems by runoff artificial fertilizer, farm waste, discharge of sewage → stimulates growth of algae → Breakdown of algae by aerobic decomposers depletes water of oxygen.

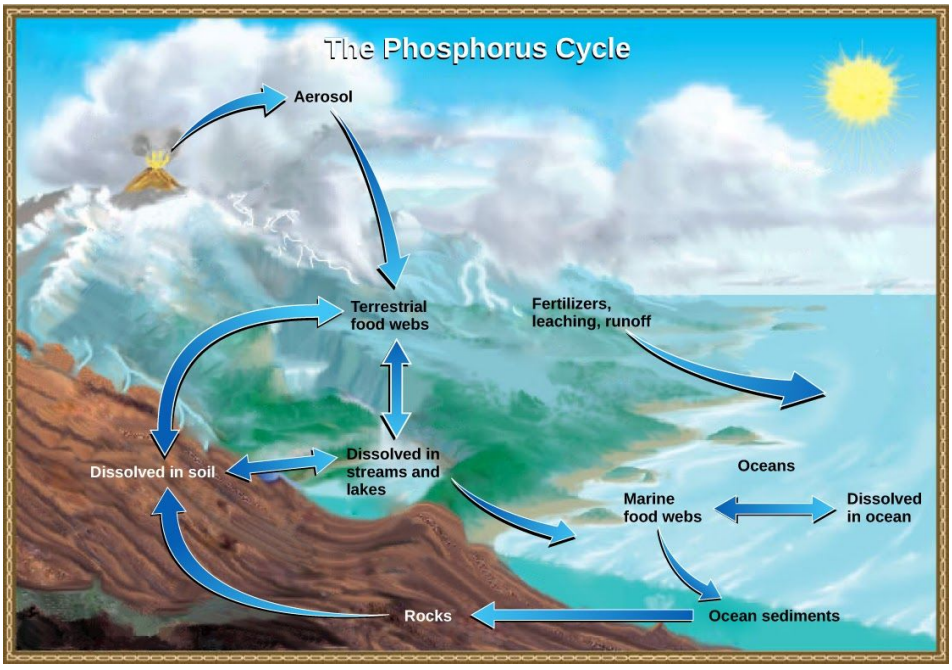


<u>Phosphorus Cycle</u>

1. Phosphorus is required in the form of phosphate ions for nucleic acids, ATP, phospholipids in cell membranes, bones, teeth, shells of animals.
2. PO43- = Phosphate
3. Is a sedimentary cycle - does not include the atmosphere.
4. Phosphate on land and in ocean sediment released by weathering into water and taken up by plants. Can be a limiting factor for plant growth - is present in artificial fertilizer.
5. Animals get phosphorus by eating plants or other animals.
6. Decomposition changes organic molecules with phosphorus back into phosphate which dissolves in water which returns the phosphorus to ocean sediment or deposited as rocks.

Human intervention:

- Mining of phosphate for fertilizers and soap causes disruption of ecosystems.
- Removal of phosphorus from ecosystems by cutting down of vegetation (most Of phosphorus is taken up as biomass)
- Excessive phosphate in runoff from fertilizer, discharge of sewage, farm waste causes growth of algae, etc. (same problem as nitrogen).



<u>Sulfur cycle</u>

1. Sulfur is an essential element for the macromolecules of living things and is involved in the formulation of proteins
2. Is an atmospheric cycle
3. H2S (hydrogen sulfide) and SO2 (sulfur dioxide) are released into the atmosphere from natural(volcanoes) and non-natural sources.
    a. H2S + O2SO2
    b. SO2 + O2 SO3 (sulfur trioxide)

c. SO_2 + $H_2OH_2SO_4$ (sulfuric acid) → acid deposition, sulfur returned to water and soil, taken up by plants, animals.

Human intervention:

- Sulfur-containing coal, when burned, releases SO_2 .
- Other Industrial Processes.