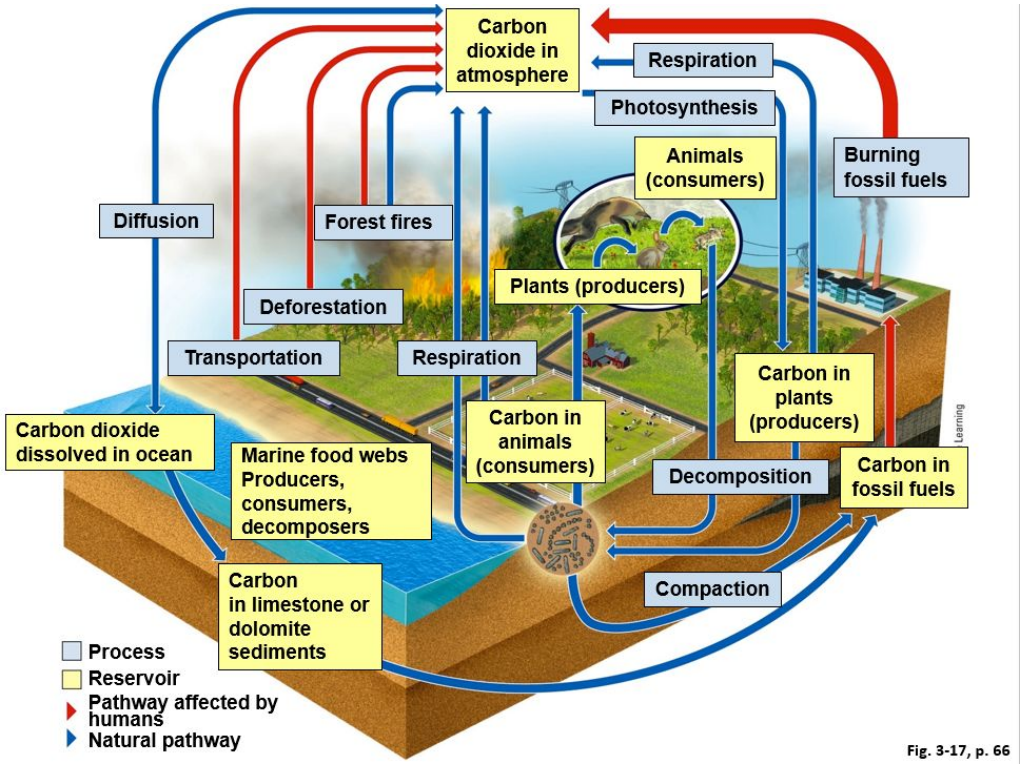
Biogeochemical Cycles Cheat Sheet

Carbon Cycle:



- Is an atmospheric cycle.
- Carbon is required for formation of organic compounds in living things.
- C in carbon dioxide in atmosphere and in water is moved to C in glucose by photosynthesis by producers.
- C in glucose is moved to C in carbon dioxide by cellular respiration.
- C in glucose is moved to C in organic molecules by synthesis reactions in living things.
- C in organic molecules is moved to C in carbon dioxide by combustion.
- C in organic molecules in organisms is moved to C in fossil fuels over millions of years by pressure, heat, and bacterial action.
- C in limestone ($CaCO_3$) is released slowly to C in carbon dioxide when exposed to oxygen and/or water.
- Largest reservoir of carbon - sedimentary rocks (limestone)
  Second largest reservoir of carbon - ocean (dissolved carbon dioxide), living things in ocean.
- In water:
  $CO_2 + H_2O \rightarrow HCO_3^-$ (bicarbonate ions) + CO_3^{2-} (carbonate ions)
  $Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3$ (calcium carbonate) in shells/skeletons of aquatic organisms
  $CaCO_3 \rightarrow$ buried, long period of time, pressure $\rightarrow$ limestone
- Human Impact:
  - Removal of vegetation reduces absorption of carbon dioxide for photosynthesis from atmosphere. Increases atmospheric CO_2.
  - Burning of fossil fuels increases atmospheric CO_2.
  - Increase in atmospheric CO_2 leads to increased Greenhouse Effect $\rightarrow$ Global Warming.

Phosphorus Cycle:

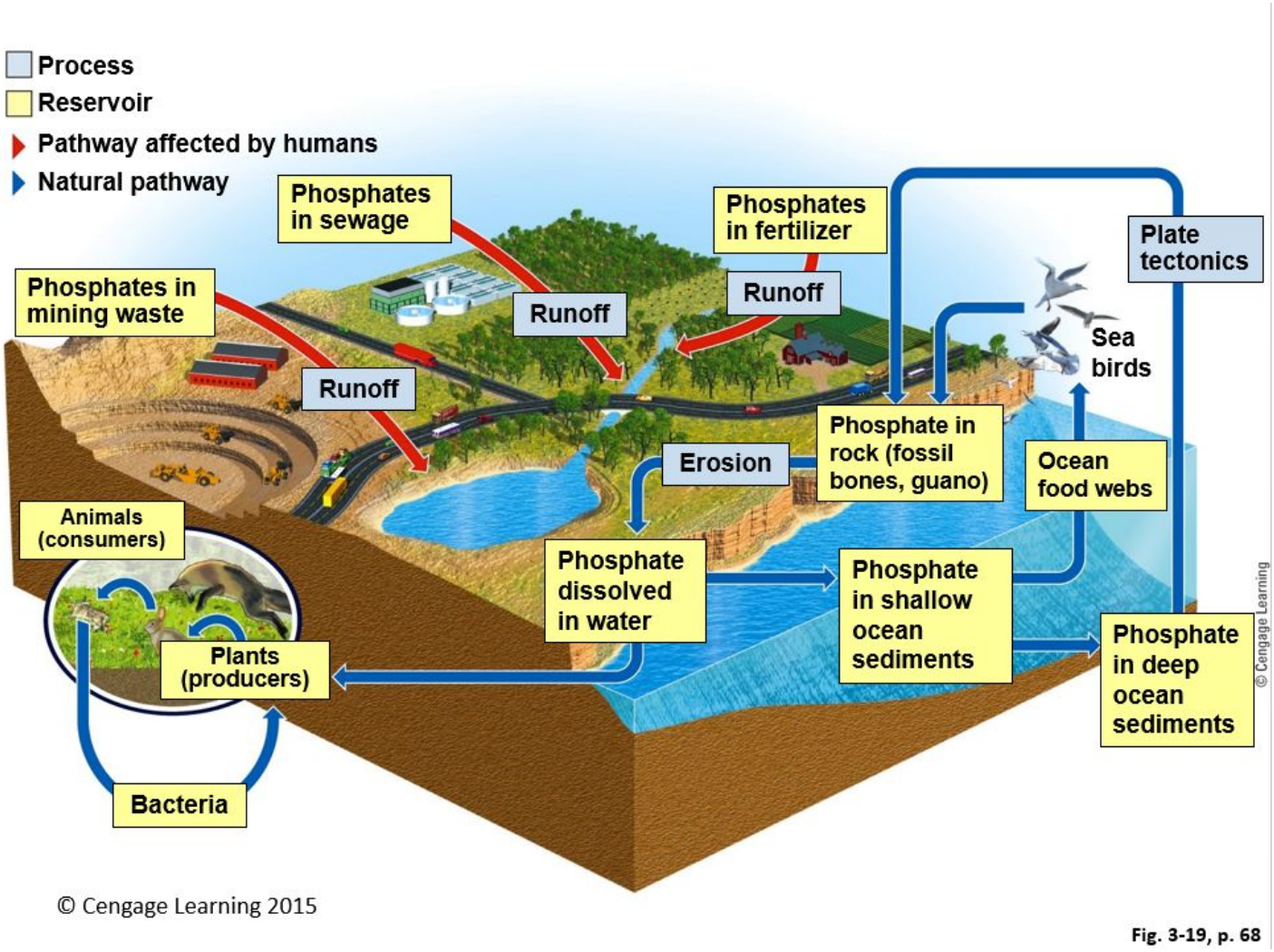


Fig. 3-19, p. 68

- Phosphorus is required in the form of phosphate ions for nucleic acids, ATP, phospholipids in cell membranes, bones, teeth, shells of animals.
- PO_4^{3-} = Phosphate
- Is a sedimentary cycle - does not include the atmosphere.
- Phosphate on land and in ocean sediment released by weathering into water and taken up by plants. Can be limiting factor for plant growth - is present in artificial fertilizer.
- Animals get phosphorus by eating plants or other animals.
- 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 to 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).

Nitrogen Cycle:

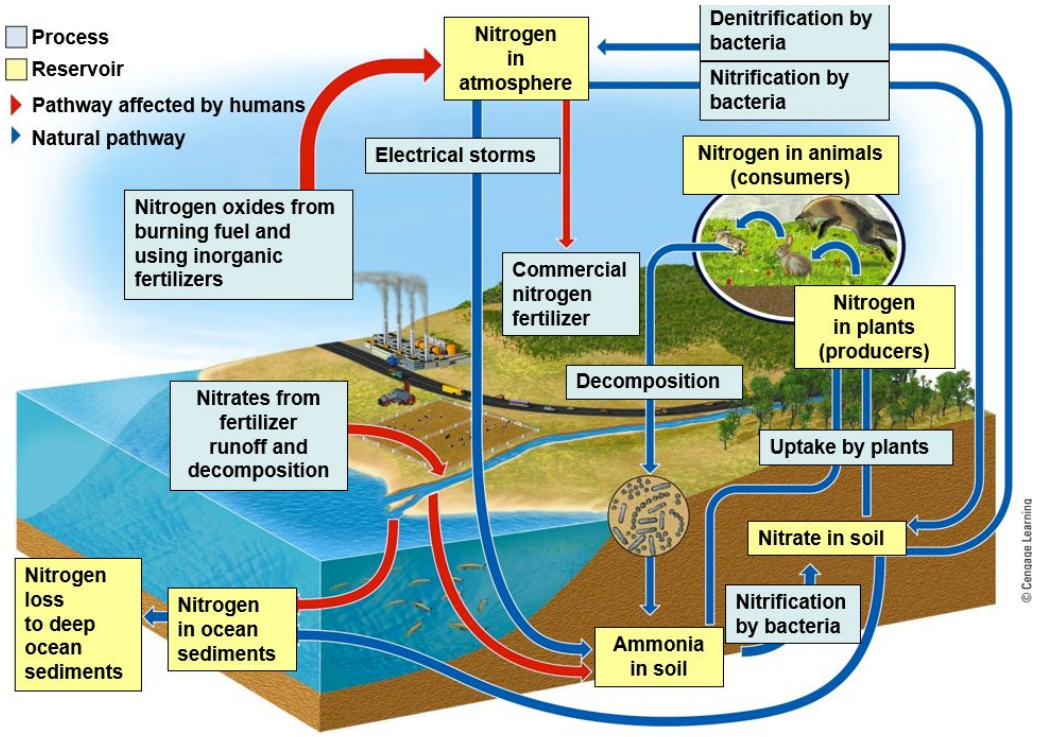


Fig. 3-18, p. 67

- Is an atmospheric cycle.
- 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.
- Free N_2 in atmosphere is "fixed" by nitrogen-fixing bacteria to NH_3 (ammonia):
  $N_2 + 3H_2 \rightarrow 2NH_3$
- Nitrogen fixing bacteria live in nodules on the roots of leguminous plants (soybeans, peas, clover, and alfalfa.)
- Water in the soil reacts with ammonia to form NH_4^+ (ammonium ion)
- Another species of bacteria can perform nitrification once ammonium has formed:
  $NH_4^+ \rightarrow NO_2^-$ (nitrite; toxic) $\rightarrow NO_3^-$ (nitrate; plant nutrient)
- Assimilation - absorption of ammonia, ammonium ion, nitrate for use by plants to make nucleic acids, proteins
- Animals get fixed nitrogen by eating plants or other animals.
- 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
- Once this ammonia has formed, still another group of bacteria can perform denitrification:
  NH_3 or $NH_4^+ \rightarrow NO_2^-$ and/or $NO_3^- \rightarrow N_2$ and N_2O (nitrous oxide)

- Nitrogen is often limiting factor in plant growth because ammonia, ammonium ion, nitrate are water-soluble: can be leached from soil.
- Human Intervention:
  - In the atmosphere:
    $N_2 + O_2 \rightarrow 2NO$ (nitric oxide) produced when burning fuel or forests.
    (Heat combines N_2 and O_2 present in atmosphere)
    $NO + O_2 \rightarrow NO_2$ (nitrogen dioxide gas)
    $NO_2 + H_2O \rightarrow HNO_3$ (nitric acid - dissolved in water causes acid deposition)
  - N_2O (nitrous oxide) released from decomposition of fertilize and waste.
  - Excess nitrogen added to aquatic systems by runoff of artificial fertilizer, farm waste, discharge of sewage. This stimulates growth of algae. Breakdown of algae by aerobic decomposers depletes water of oxygen.

Hydrologic Cycle (water cycle:

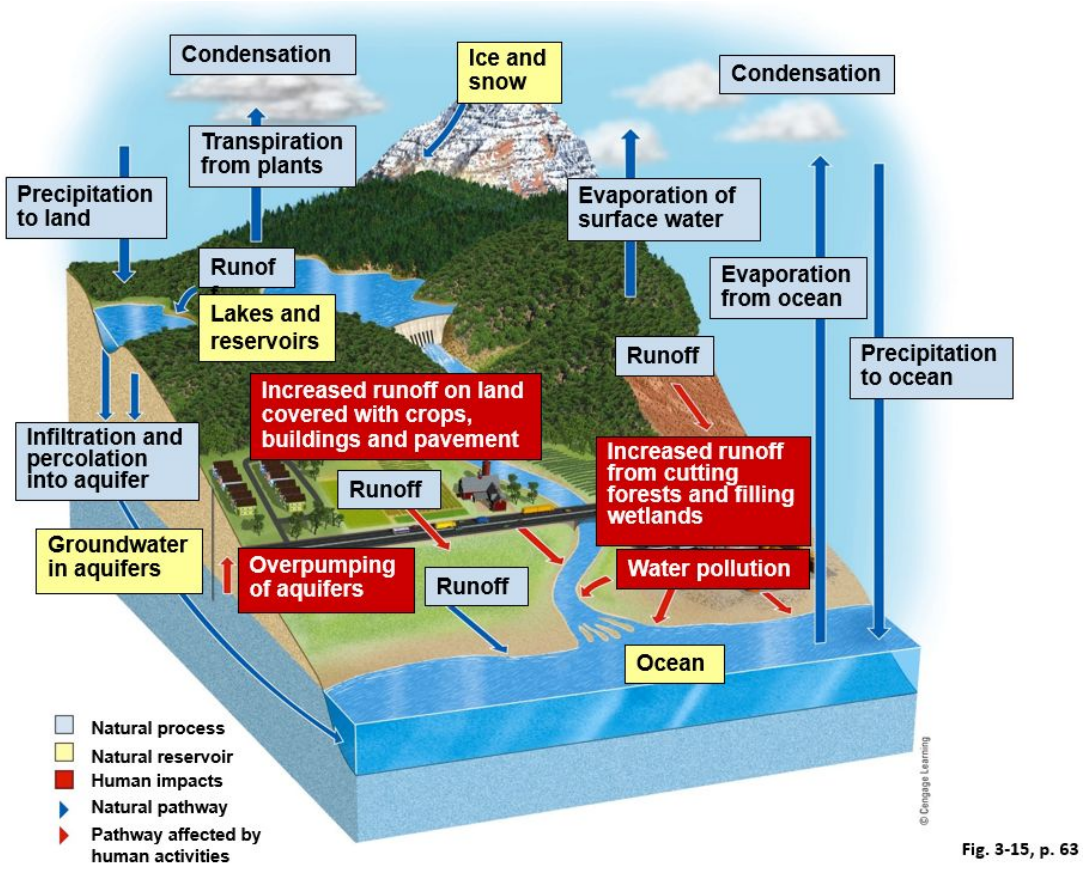


Fig. 3-15, p. 63

- Is an atmospheric cycle
- Collects, purifies, and distributes the earth's fixed supply of water
- Powered by the sun
- Evaporation- conversion of water from liquid to vapor from the earth's oceans, lakes, rivers, soils into the atmosphere
- Precipitation- water in the atmosphere condenses into droplets
- Transpiration- over land 90% of the water goes into the atm. Evaporates from the surfaces of plants
- Surface runoff- water flows into streams then into lakes and oceans, it evaporates and repeats the cycle
- Glaciers- precipitation is converted to ice that is stored for long periods of time
- Aquifers- precipitation sinks through soil and permeable rock to underground- stored as groundwater
- Small amount of water ends up in the living components of ecosystems - some water absorbed by plants combines with carbon dioxide during photosynthesis to produce high energy organic compounds - consumers break the compounds down which release the water back into the environment
- Human interventions
    - Withdraw large quantities of of freshwater from rivers, lakes, and aquifers, sometimes faster than we can replace it
    - We clear vegetation from land for agriculture, mining, road building, and other activities - this increases runoff and reduces infiltration that would normally recharge the groundwater
    - We drain and fill wetlands for farming and urban development