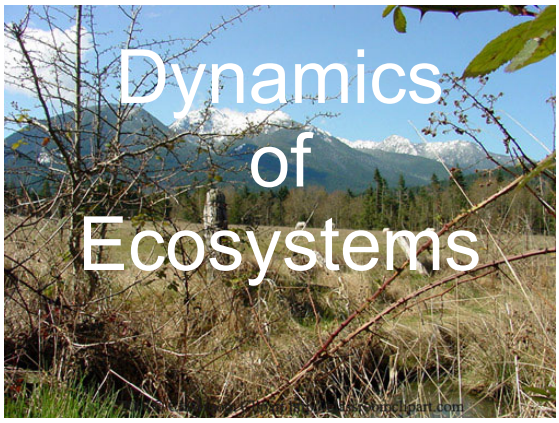


Ecology

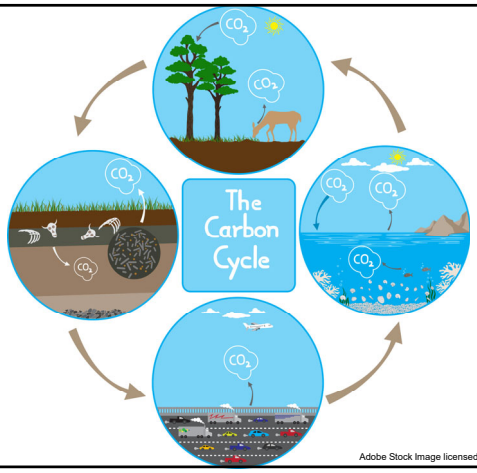
- the study of relationships between living organisms and between organisms and their environment

Definitions

- Species
  - a group of organisms that can interbreed and produce fertile offspring
- Habitat
  - the environment in which a species normally lives or the location of a living organism
- Population
  - a group of organisms of the same species who live in the same area at the same time

- Community
  - a group of populations living and interacting with each other in an area
- Ecosystem
  - a community and its abiotic environment
- Abiotic
  - non-living components of the environment
    - light, heat, minerals, air, water
- Biotic
  - living components of the environment

- All organisms in an ecosystem have a specific roll or trophic level
  - Autotroph (Producer)
    - Convert radiant energy into chemical energy using photosysthesis
  - Heterotroph (Consumer)
    - Cannot produce their own food
    - Get energy by eating other plants or animals
  - Detritivore
    - Ingests non-living matter (dead leaves, carcasses)
  - Saprotroph (Decomposer)
    - lives on or in non-living organic matter, secreting digestive enzymes into and absorbing the products of digestion



Carbon

- Carbon is such a crucial element to living organisms that it is part of the basic of the definition of a living thing

- Carbon is found in one of four 'pools'
  - Biosphere
    - All living organisms
  - Hydrosphere
    - Water
  - Atmosphere
    - carbon dioxide
  - Lithosphere
    - Rocks/Sediments as carbonates, fossil fuels
- Carbon is moved between these four pools by a variety of processes

Photosynthesis

- Occurs in all plants
- Converts carbon dioxide and water to carbohydrates (sugar) and oxygen
- $6CO_2 + 6 H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$

Cellular Respiration

- Occurs in all living cells
- Converts oxygen to carbon dioxide
- $6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O$ + energy

Feeding

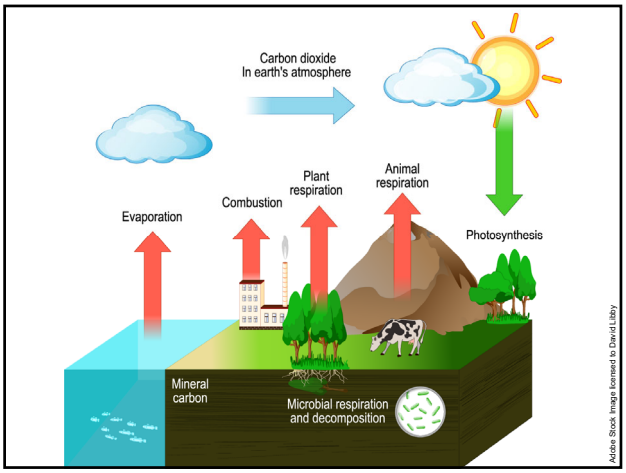
- One organism eats another
- The carbon of one organism is ingested by another

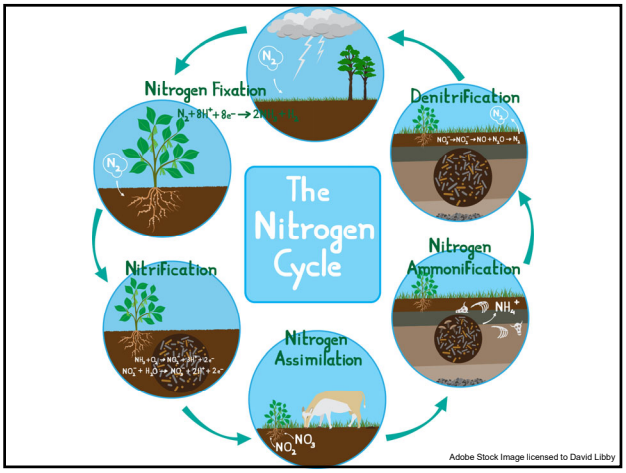
Fossilization

- Carbon as organic molecules becomes trapped in sediment as coal, gas and oil

Combustion

- Burning of any biotic organism





Nitrogen Fixation

- All life requires nitrogen compounds
  - proteins, nucleic acids
- Plants must have their nitrogen “fixed”
  - Taken from the air, which is 80% nitrogen, and combined with other elements to make compounds that plants can use
- Animals must get their nitrogen by eating plants or other animals that have fed on plants
- Nitrogen fixation occurs in the atmosphere and by way of specialized bacteria

Atmospheric Fixation

- lightning breaks apart the nitrogen molecules in the atmosphere
- the nitrogen atoms combine with oxygen from the air forming oxides
- these dissolve in rain, forming nitrates, that fall to the ground
- only 5-8% of the total nitrogen is fixed this way

Biological Fixation

- certain bacteria can fix nitrogen by producing ammonia (NH_3)
  - some live in a symbiotic relationship with plants
    - legumes (soybeans, alfalfa, beans, peas)
    - alders

Alfalfa
Patrick J. Alexander, hosted by the USDA-NRCS PLANTS Database

Gray Alder
Joe F. Duff, hosted by the USDA-NRCS PLANTS Database / USDA NRCS. 1992. *Western wetland flora: Field office guide to plant species*. West Region, Sacramento.

- some live free in the soil or water
  - cyanobacteria (blue-green algae)

cyanobacteria
blog.ucsusa.org

Industrial Fixation

- Artificial fertilizers can be made and used to enhance natural fixation processes
- High pressure and temperature is used to combine nitrogen gas with hydrogen to form ammonia (NH_3)
- This is usually processed further to make ammonium nitrate (NH_4NO_3) which is used in commercial fertilizer

Nitrification

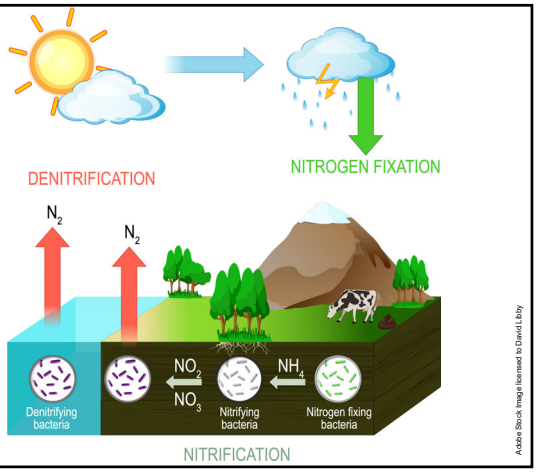
- Ammonia can be used directly by some plants as a source of nitrogen
- Most of the ammonia is converted to nitrates by nitrifying bacteria in a process called **nitrification**

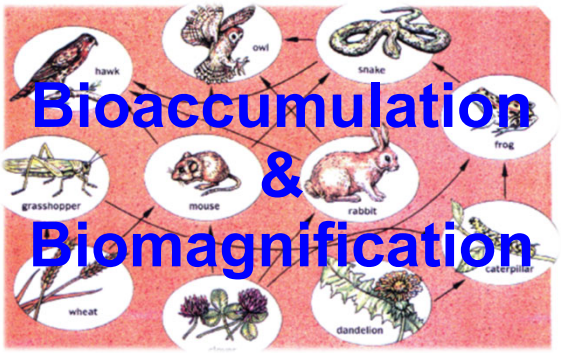
Denitrification

- **Denitrification** converts nitrates to nitrogen gas, thus replenishing the atmosphere
- Bacteria that use nitrogen instead of oxygen to live are responsible for the denitrification

Finishing the Cycle

- Nitrogen compounds that enter plants move through food chains and return to the soil and water through dead organisms and waste materials
- Decomposers break down the molecules in excretions and dead organisms into ammonia
- The nitrogen can then continue to be used without going back to the atmosphere





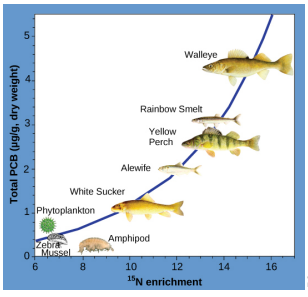
Bioaccumulation & Biomagnification

Bioaccumulation

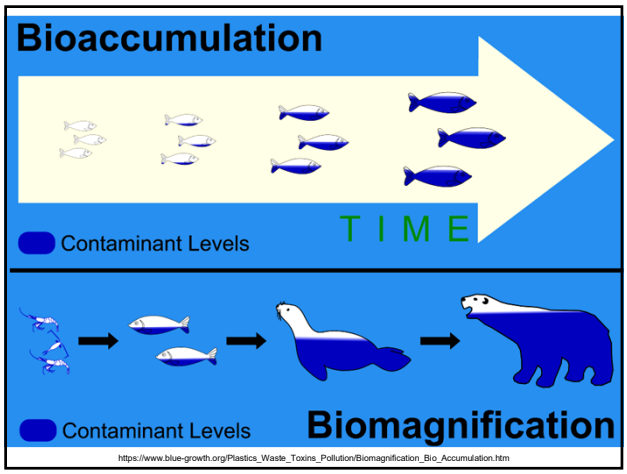
- increase in concentration of a pollutant from the environment in the first organism in a food chain
  - the pollutant is stored in the organism rather than being expelled as waste

Biomagnification

- increase in concentration of a pollutant from one link in a food chain



courses.lumenlearning.com/boundless-biology/chapter/energy-flow-through-ecosystems/



- For bioaccumulation and biomagnification to occur, a substance must be:
  - Long-lived
    - stays in the environment more than 15 years before it breaks down
  - Mobile
    - if it stays in one place it can be easily contained
  - Soluble in fats
    - it is absorbed and retained by animals

- For a substance to be harmful it must be biologically active
  - it must be harmful to organism

Examples

DDT (dichloro, diphenyl trichloroethane)

- Insecticide
- Used extensively in the western world to eliminate the mosquito that carries the malaria parasite
- Demonized by environmentalists
  - Claimed to cause harm to Bald Eagles
    - This was shown to be false
- Banned from use in 1972
  - Still carries the myth that it is hazardous

PCBs (polychlorinated biphenyls)

- Used as coolant in transformers, sealing and caulking compounds, inks and paint additives
- Can cause a severe form of acne (chloracne), swelling of the upper eyelids, discoloring of the nails and skin, numbness in the arms and/or legs, weakness, muscle spasms, chronic bronchitis, and problems related to the nervous system

PAH (polynuclear aromatic hydrocarbons)

- Naturally occurring component of petroleum products
- Possible carcinogen

Heavy Metals

- A group of metals and metalloids that have relatively high density
  - Pb, As, Hg, Cd, Zn, Ag, Cu, Fe, Cr, Ni, Pd, Pt, …
- Natural and anthropogenic sources
- Wide variety of commercial uses
  - Lead: storage batteries, ammunition, radiation shielding
  - Copper: wiring, water pipes
  - Iron: main component of steel
  - Chromium: component of stainless steel

- Many are nutritionally essential for humans
  - Copper: red blood cell production, neuron signaling, immunity
  - Chromium: maintain normal blood sugar levels
  - Iron: helps make hemoglobin, making amino acids
  - Magnesium: builds bones and teeth
  - Zinc: helps blood clot, bolsters immune system
- Overexposure can affect the nervous system

Cyanide

- Naturally found in small amounts in some foods
  - almonds, soy, spinach, apple seeds, cherry pits
- Naturally found in dangerous amounts in peach and apricot pits
- Used for making paper, textiles, plastics
- Used in electroplating, metal cleaning, removing gold from its ore
- Used for exterminating pests and vermin
- Survivors of serious cyanide poisoning may develop heart, brain and nerve damage

Selenium

- Trace element naturally present in many foods
  - Brazil nuts, yellowfin tuna, halibut, shrimp, ham, turkey, chicken, beef, eggs, spinach
- Nutritionally essential for humans
  - plays critical roles in reproduction, thyroid hormone metabolism, DNA synthesis, and protection from oxidative damage and infection
- Too much selenium can result in hair and nail loss, nausea, diarrhea, skin rashes, mottled teeth, fatigue, irritability, and nervous system abnormalities