

## Ecological Systems

I. **Ecology** – The study of the interrelationships between organisms, and their environment.

- Studying ecological principles is essential for understanding how best to manage and conserve our natural resources, both renewable and nonrenewable.

A. **Biotic** – Living Organisms

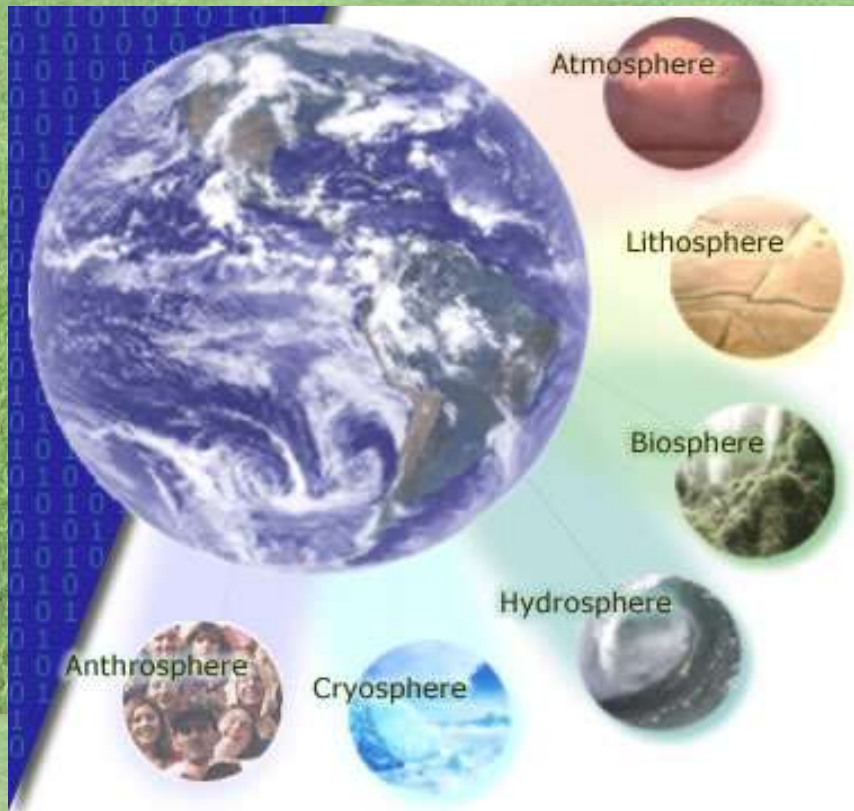
B. **Abiotic** – Non-living components

II. **Levels of Interrelationships**

A. **Ecosphere** (the big picture) – The thin envelope of life, and its physical environment that surrounds the earth.

Consists of the Atmosphere, Biosphere, Hydrosphere, and Lithosphere.





The ecosphere functions because of two fundamental processes:

1. Energy from the Sun - electromagnetic radiation, drives the climate, photosynthesis
2. Matter Recycling - biogeochemical cycles (Carbon, Nitrogen, Oxygen, Hydrologic, and Phosphorous)

**B. Population** - Groups of the same organism living in a specific area.



C. **Community** - All the living organisms in a specific area.

D. **Ecosystem (ecological system)** - The interactions of a community with the abiotic elements of a specific area.

1. **Aquatic Ecosystems** - Streams, Lakes, Ponds, Rivers, Oceans.

2. **Terrestrial Ecosystems (biomes)**

- a. **Tundra**: the Northern most limits of plant growth. Located in areas around the arctic circle southward to the coniferous forests. Tundra supports low growing mat-like vegetation. Long cold winters with barely any sunlight. Short summers with 24 hour periods of weak sunlight. Permafrost - continually frozen soil.





- b. **Grassland:** located in the mid-latitudes, with periodic drought and occasional fires that prevent tree growth.



- c. **Desert:** the harshest of all biomes. Maximum temperature of over 100 degrees F. Usually determined by minimum rainfall (less than 30 cm a year).





- d. **Savannah:** tropical or semi-tropical grassland. Located in the interiors of large continents like Africa and South America. Low amounts of rainfall. Supports large herds of herbivores.



- e. **Coniferous Forests:** higher latitudes, and high elevations. Evergreen trees. Harsh cold winter, and short hot summers. Thin acidic soils.





- f. **Deciduous Forests:** mid latitudes, sufficient moisture to support large trees. Long hot summers, cold winters. Thick, rich soils.



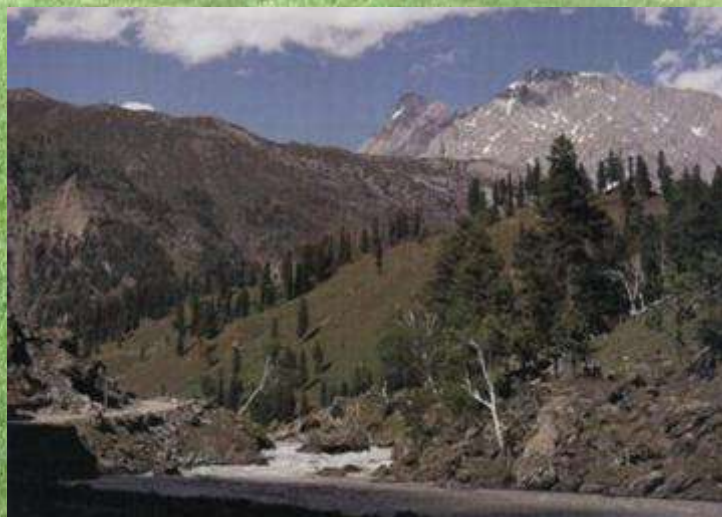
- g. **Tropical Forests:** rainforests, located near the equator. High average temperatures and



rainfall (over 250 cm per year). Long daylight, 11 - 12 hours. extremely diverse plants and animals.



- h. **Mountain:** very similar to the tundra biome, located above the tree line.



- i. **Chaparral:** mid latitude coastlines where cool ocean currents influence cool rainy winters, and hot dry summers. California, Mediterranean,



west coast of South America. Low growing trees and shrubs.



## II. Energy Flow ~ the movement of energy through ecosystems

A. **What is energy?** The ability to perform work or cause change.

B. **Forms of energy:** Radiant(EM), chemical, electrical, mechanical, and thermal.

C. **Energy is governed by the laws of thermodynamics.**

1. **First Law** - Energy cannot be created nor destroyed, it just changes form.



2. **Second Law** - Whenever energy changes form, large amounts are lost as heat.

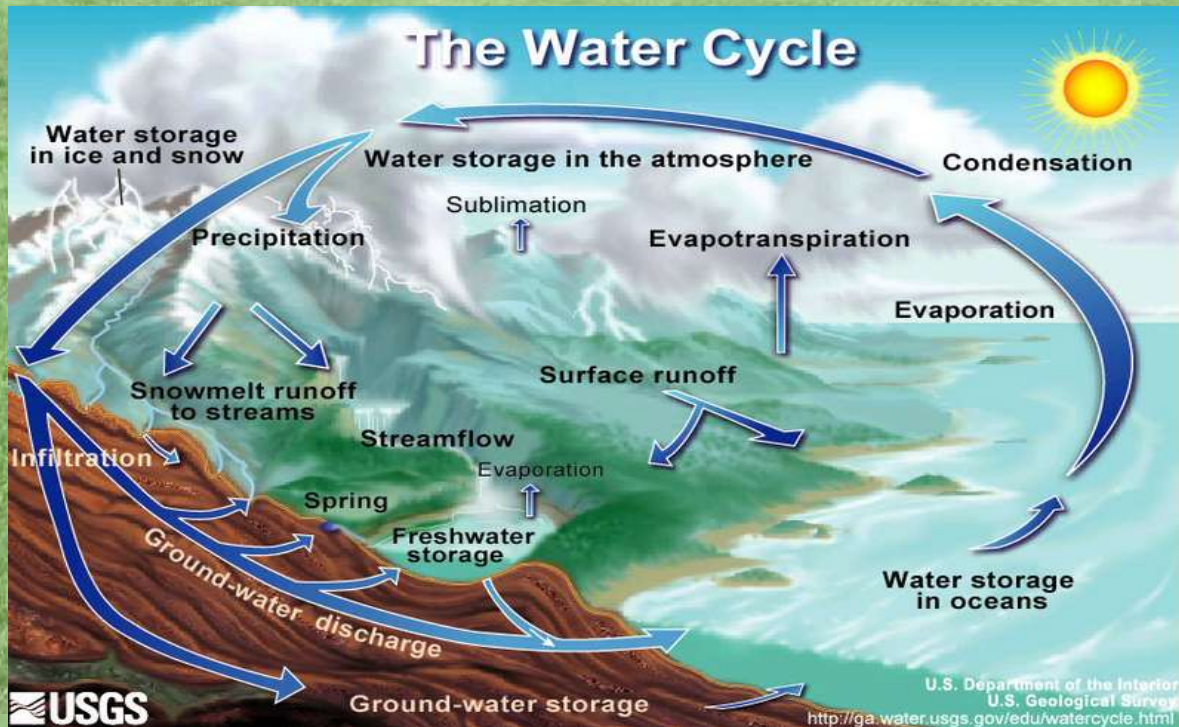
-**Entropy**: The degree of disorder. Organisms utilize energy in orderly forms to do work, this is low entropy. When energy is lost as heat, it becomes disordered, high entropy.

-Physicists define energy flow in the universe as moving from order to disorder.

IV. **Biogeochemical Cycles** - The movement of an element from the abiotic environment into living organisms, and then back into the abiotic environment.

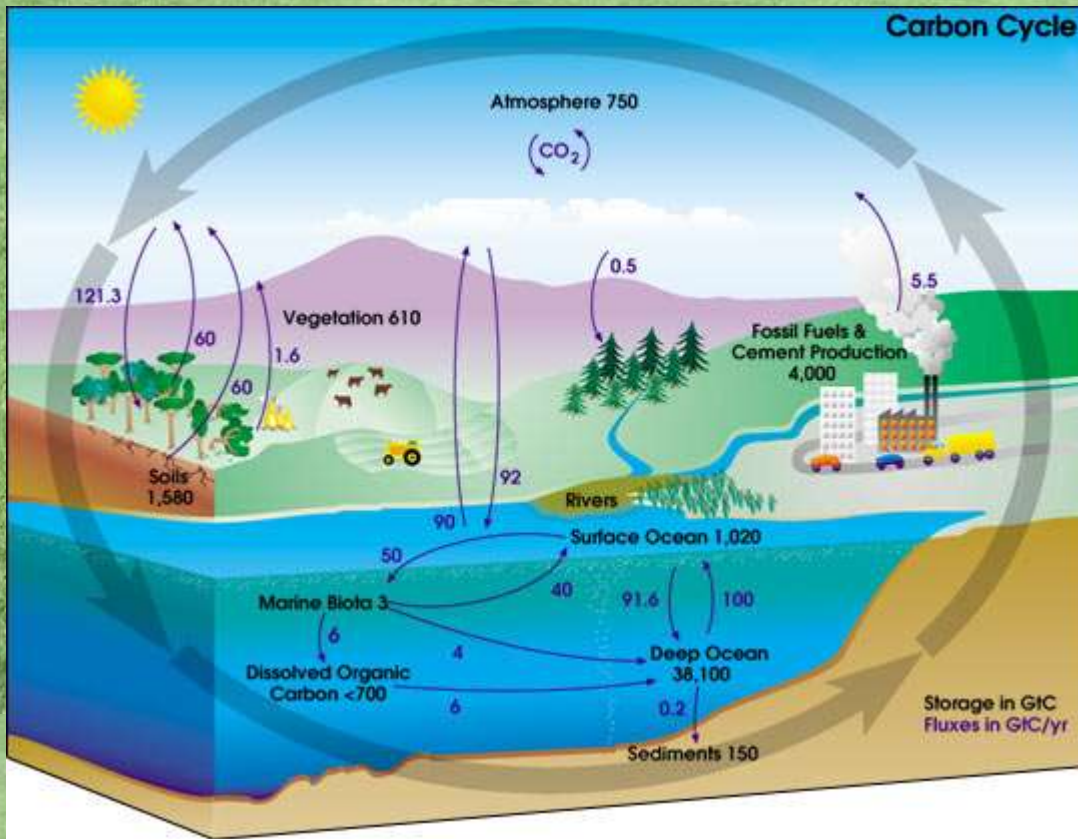
A. **Hydrologic Cycle** - water, oceans a huge reservoir





B. *Carbon Cycle* ~ respiration and photosynthesis, source = atmospheric carbon dioxide

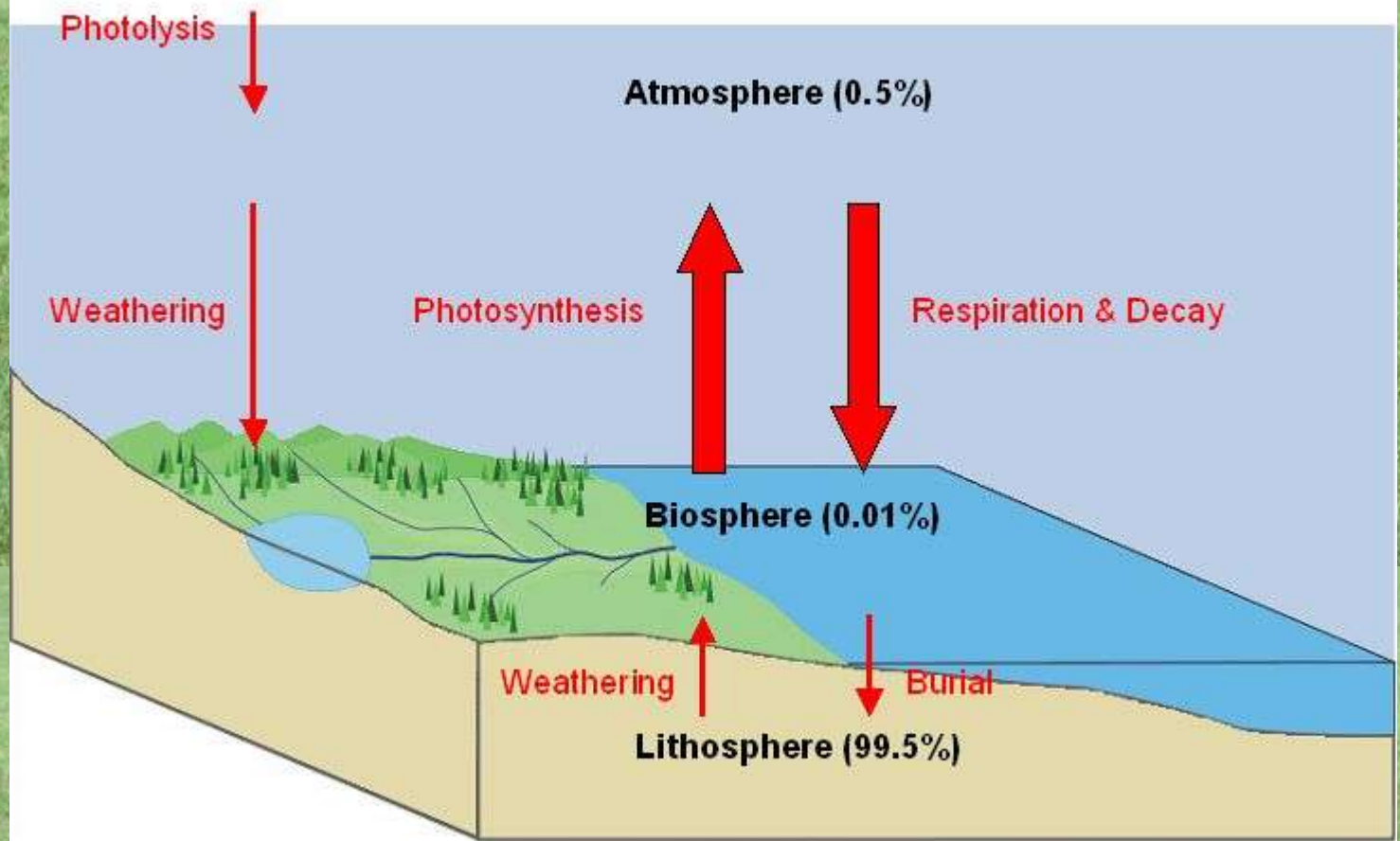




### C. Oxygen Cycle ~ Respiration and Photosynthesis

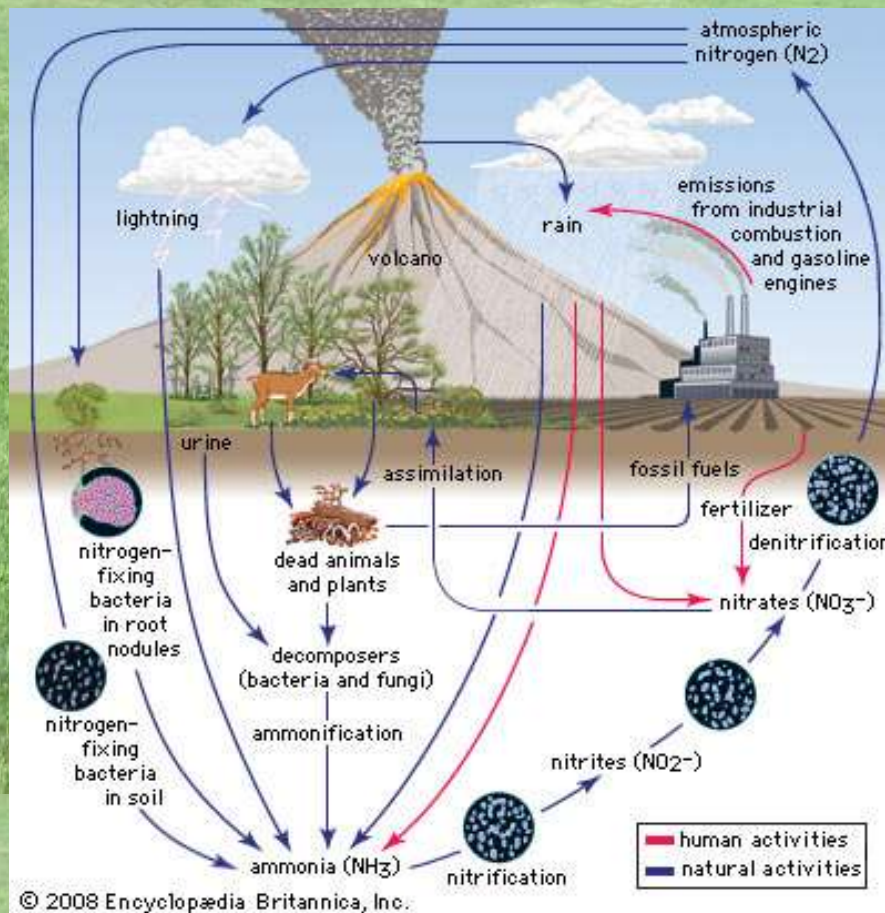
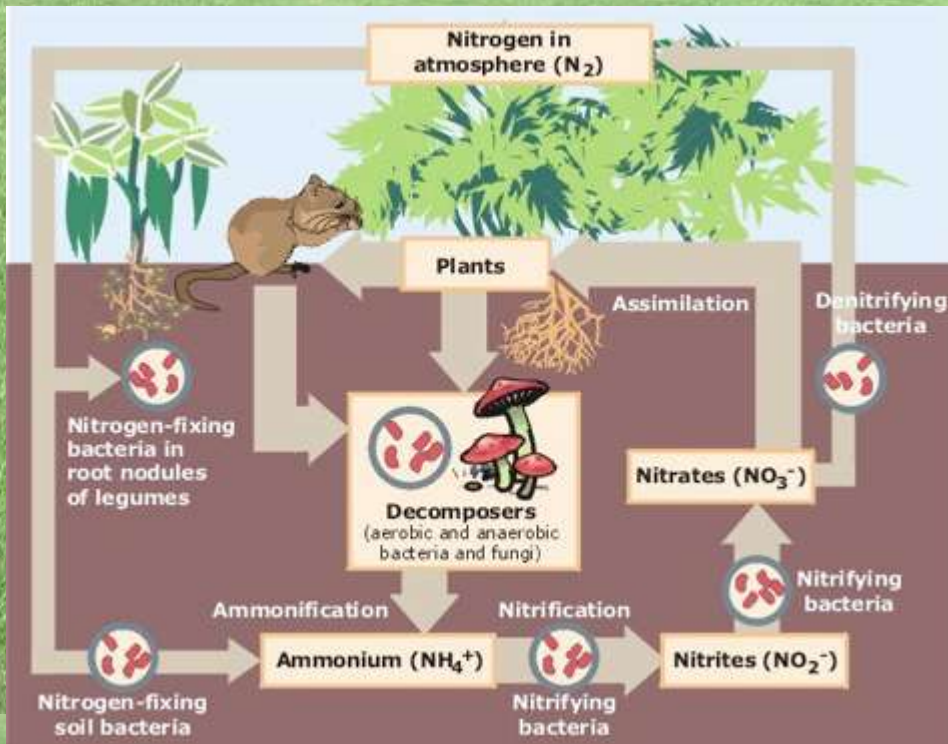


## Oxygen Cycle Reservoirs & Flux



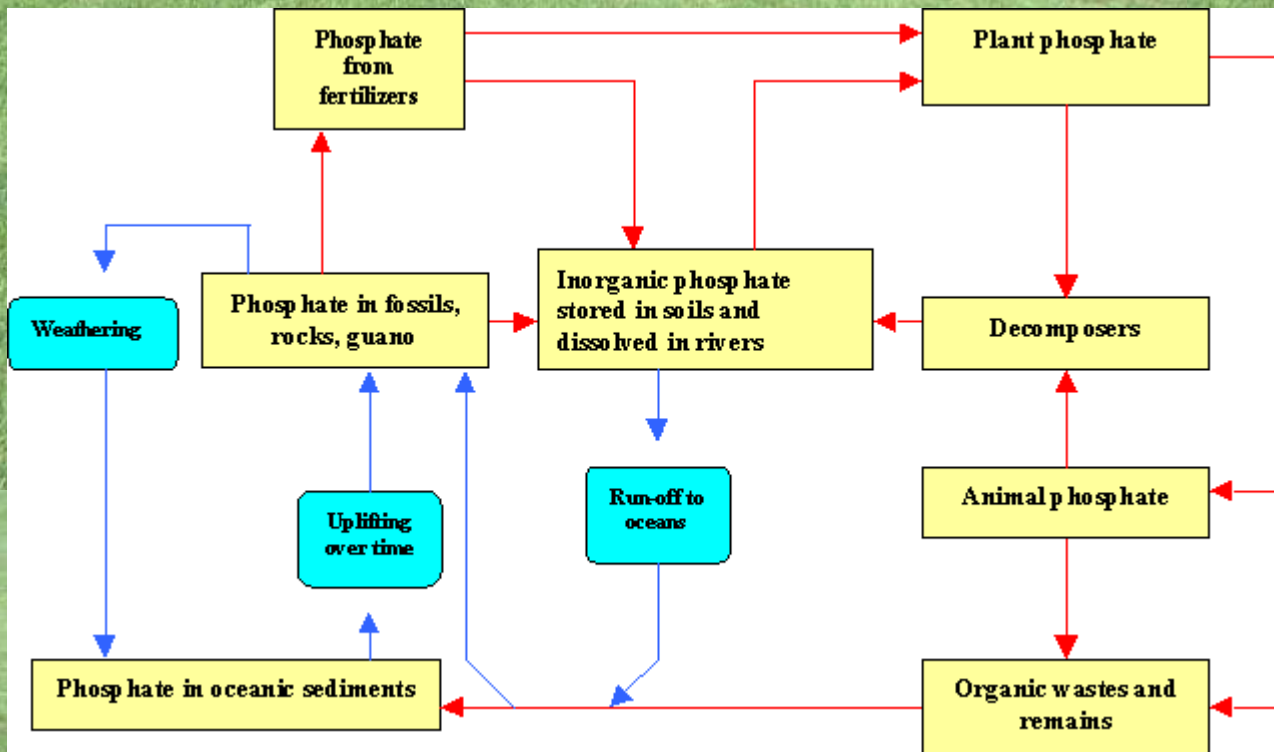
D. *Nitrogen Cycle* – proteins, DNA, source = atmospheric nitrogen fixed by soil microbes







## E. Phosphorus Cycle - ATP Molecule, phosphorus containing rocks

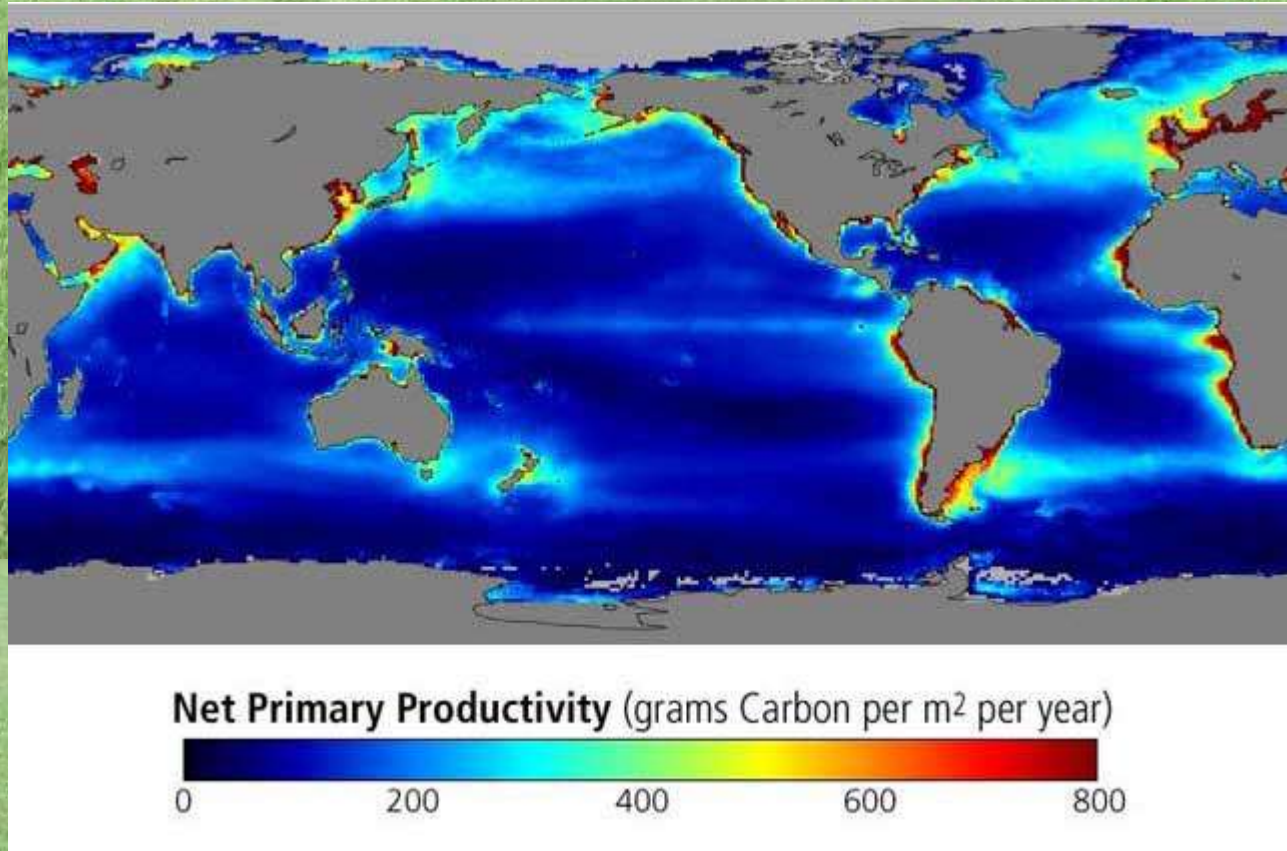


## V. Primary Production - the total amount of biomass produced by photosynthesis

- Biomass - the total dry weight of an organism.
- Primary production forms the food base for an ecosystem.
- Gross Productivity & Net Productivity



## Ocean Productivity



VI. **Food Chains** - the flow of energy and nutrients from one organism to another by means of a series of eating processes.

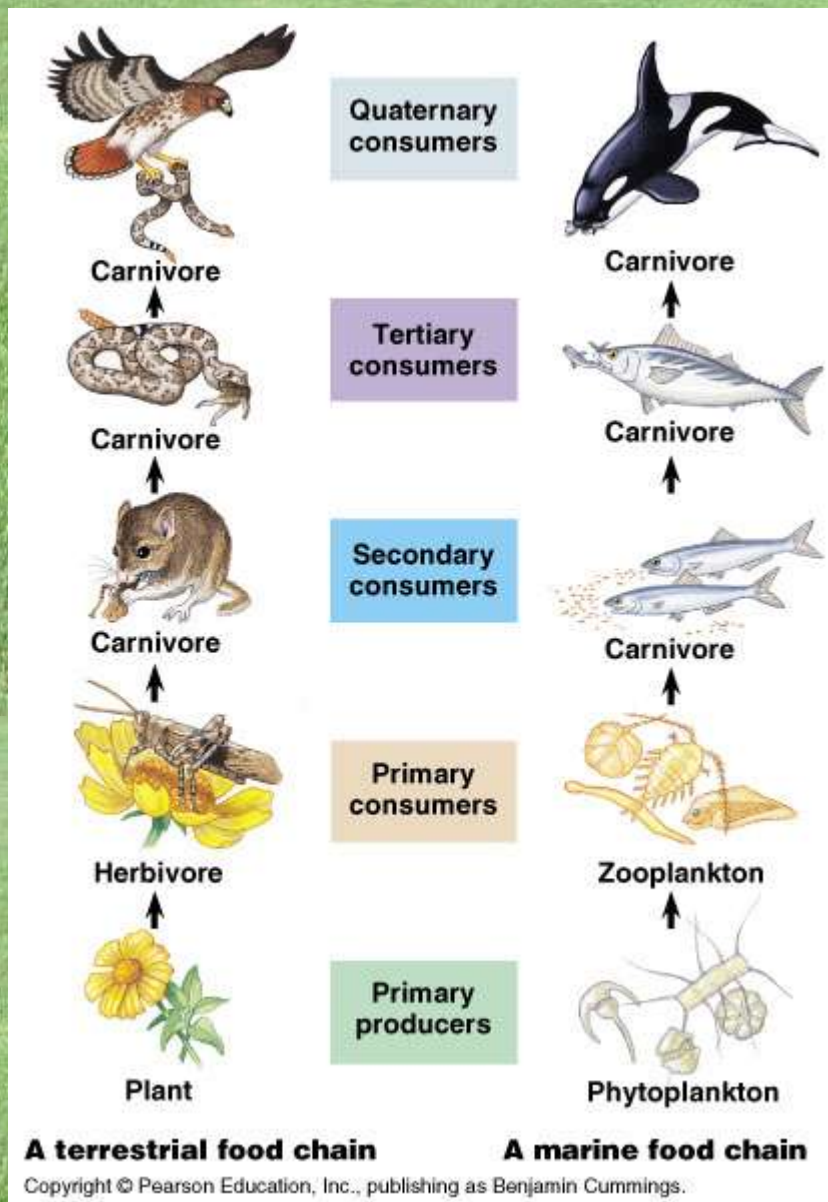
### A. Aquatic and Terrestrial Food Chains

1. **Producers** - Plants, phytoplankton (Autotrophs = "self feeding")



2. **Primary Consumers** - Organisms who eat the producers. (Heterotrophs = "other feeders or herbivores)
3. **Secondary, Tertiary, and Quaternary Consumers** - Carnivores or Omnivores who eat the herbivores.
4. **Detritivores** - "waste eaters" Decomposers of dead organisms and waste materials.





## VII. Food Webs ~ interrelated food chains.

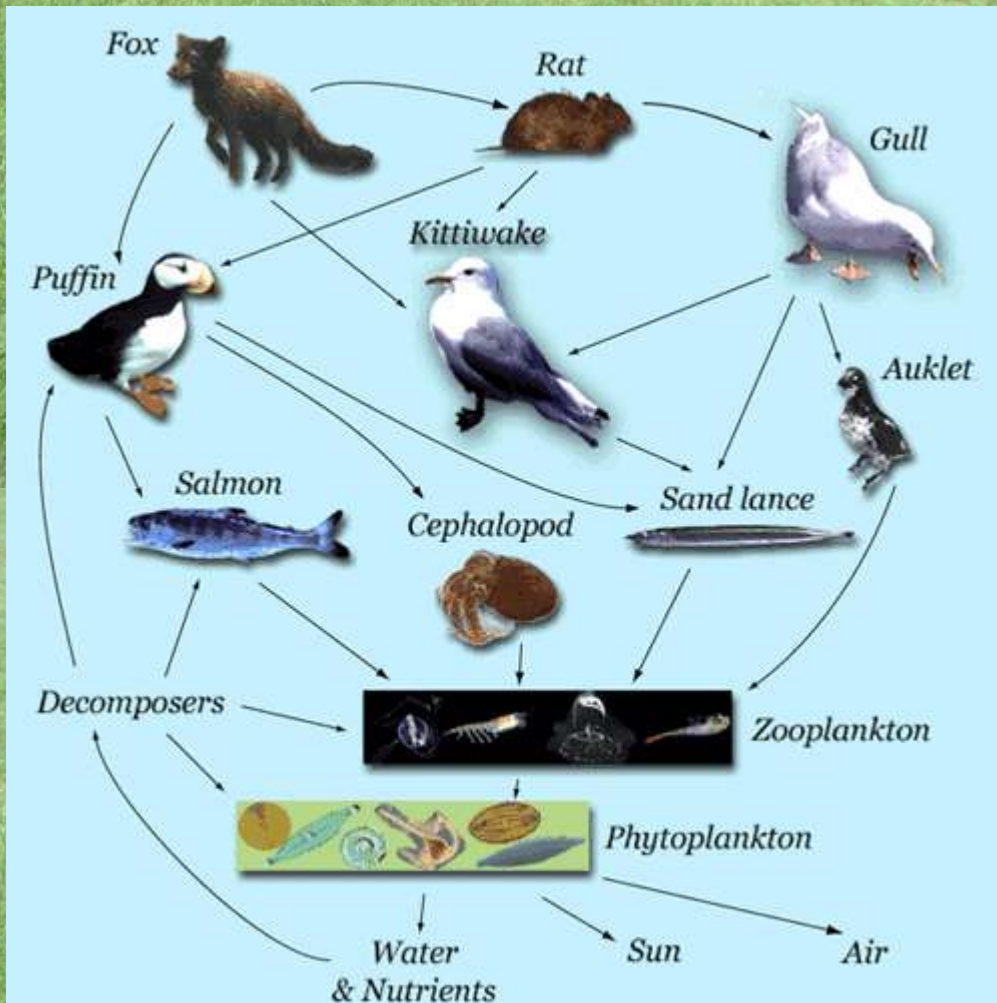
### A. Trophic Levels - "feeding" levels.

- **Producer** = First trophic level

- **Primary Consumers** = Second trophic level.

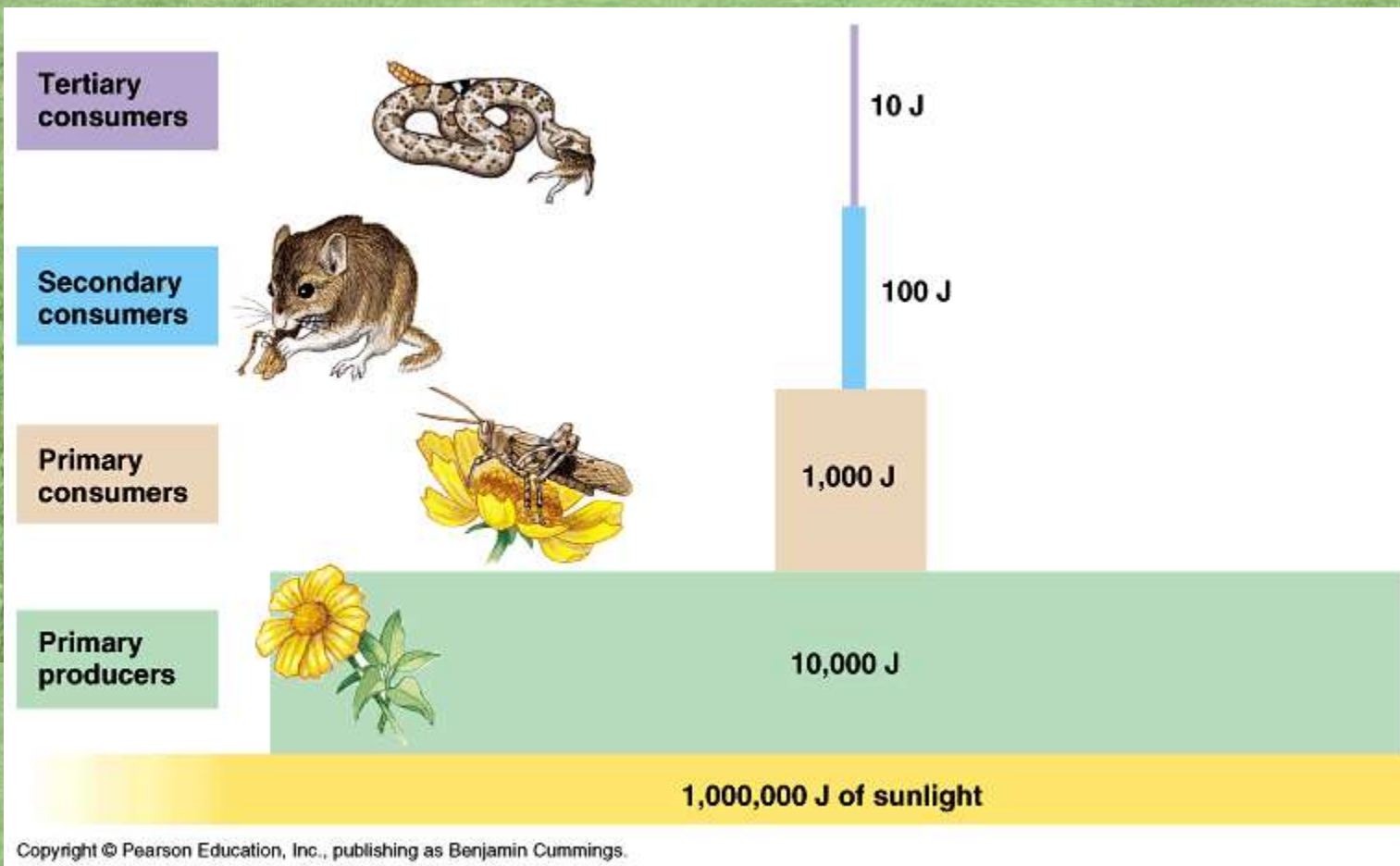


- Secondary Consumers = Third trophic level etc.



B. **Energy Pyramid** - A pyramid that represents the energy contained and transferred between each trophic levels. Measured in calories. Also called a food pyramid or pyramid of numbers.





## VIII. Ecosystem Function

A. **Biodiversity** – the variety of living things within an ecosystem.

High biodiversity = healthy ecosystem (polyculture)

Low Biodiversity = potentially unhealthy (monoculture)



B. **Limiting Factor** - an abiotic factor that limits the growth of a population.

C. **Habitat** - an organisms specific food, water, shelter, and space requirements.

1. **Niche** - The habitat of an organism, and the functional role it plays in an ecosystem.

#### D. **Species Interactions**

1. **Symbiosis** - two or more species interact with one or more benefiting
2. **Mutualism** - two species interact, and both benefit (insects get food, plants get pollinated)
3. **Commensalism** - two species interact, one benefits, the other is neither helped or harmed (moss on a tree).
4. **Parasitism** - one species benefits from and harms the other (ticks).



5. Competition - two or more species struggle for the same resource.
6. Predation - one species consumes the other.

X. **Biological Succession** - the gradual replacement of one community of organisms by another in an orderly, predictable manner.

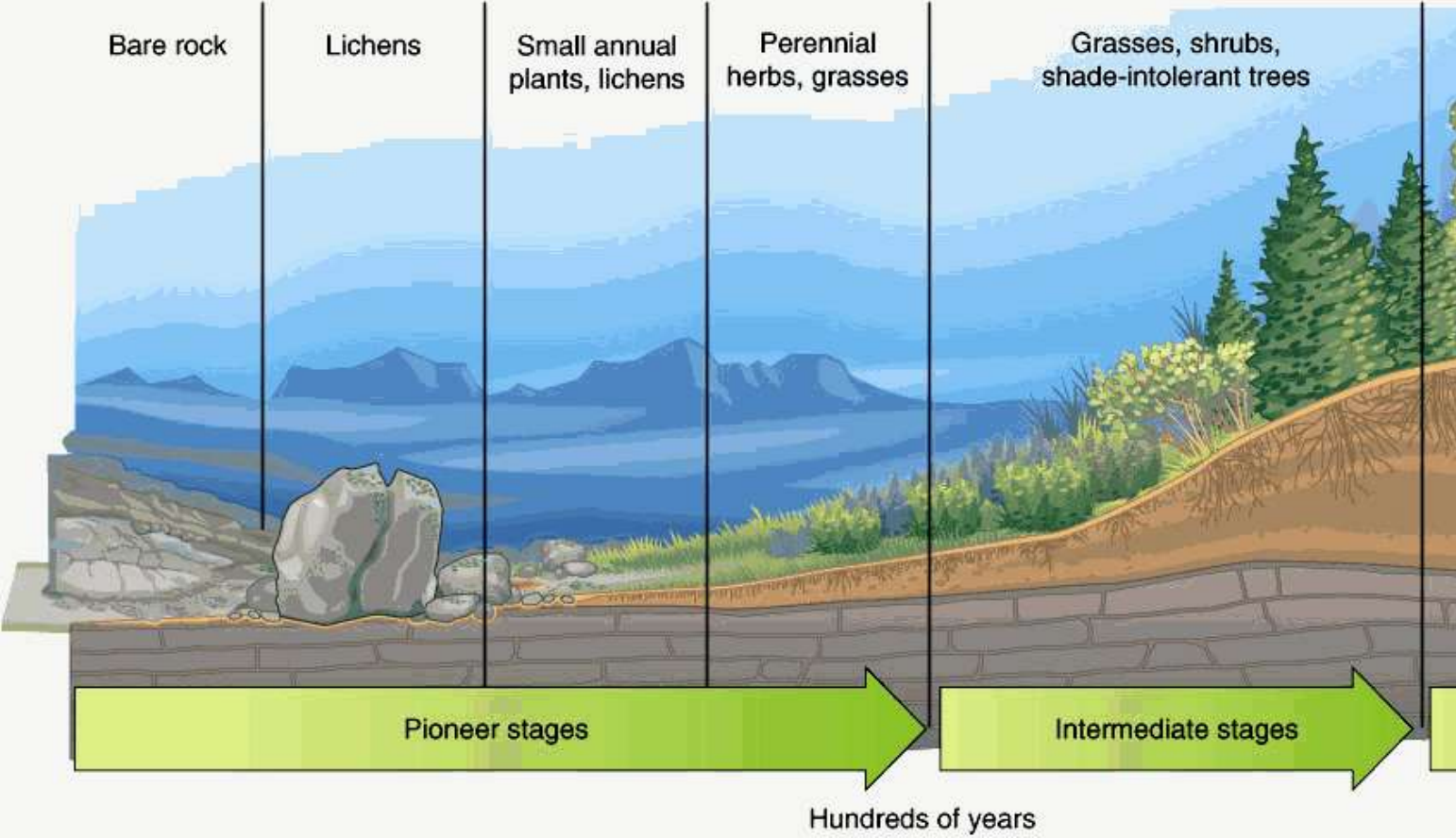
A. **Primary Succession** - succession occurring in an area where life does not exist (volcanic eruptions, exposed sandbars, retreating glaciers.)

1. **Pioneer Community** - rapid population growth, hardy species (Lichen, Microorganisms)

B. **Secondary Succession** - succession occurring in an area where living things have occupied (fallow farm fields, clear-cut forests, drained wetlands, forest fires)

1. **Climax Community** - as succession proceeds, a stable, resilient ecosystem develops with a high amount of diversity.









**Old field**



Disturbance ends, site is invaded by short-lived weedy species.



**Pioneering species**



Weedy species replaced by longer-lived herbaceous species and grasses.



**Early successional community**



Shrubs and short-lived trees begin to invade.



**Mid-successional community**



Short-lived tree species mature; long-lived trees begin to invade.



**Late-successional community**



Long-lived tree species mature.



**Climax community**