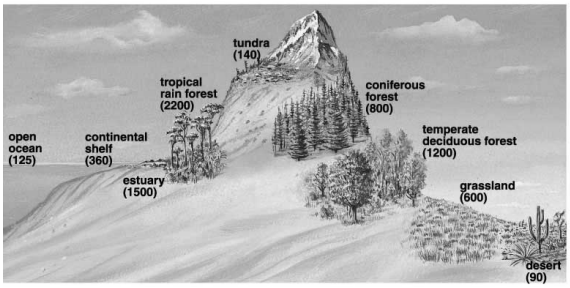
Chapter 28:

How Do Ecosystems Work?

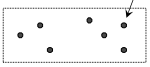


Introduction to Ecology

Ecology - Increasing Levels of Complexity:

Organism

Population: All members of a particular species living within a defined area



Community: All interacting populations of species within a defined area

Ecosystem: All living organisms and the non-living environment within a defined area

Energy (sunlight)

Energy (heat)

- One-way flow through system
- Needs constant replenishment

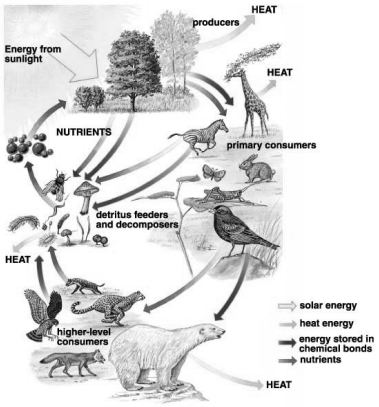
Life on Earth

Nutrients = chemical building blocks

- Constantly cycled & recycled

Nutrients

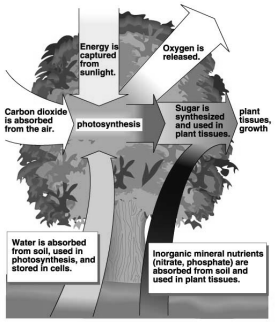
Nutrients



(Figure 28.1)

Energy Flow Through Communities:

- Energy enters communities through photosynthesis:



$$CO_2 + H_2O \xrightarrow{\text{Energy (Sunlight)}} C_6H_{12}O_6$$

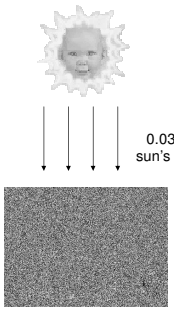
Carbon Dioxide + Water → Glucose

Producers / Autotrophs:

Organisms that produce food for themselves via photosynthesis (e.g. plants)

Energy Flow Through Communities:

- The amount of life an ecosystem can support is determined by the energy captured by the producers in the system.



Factors Affecting Productivity:

1. Nutrients / water available to producers
2. Sunlight available to producers
3. Temperature

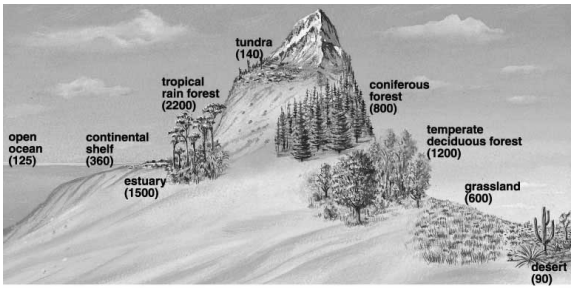
Biomass:

Dry weight of organic material
(weight / unit area / unit time)

Net Primary Productivity:

Energy available to other organisms from the producers
(calories / unit time)

Ecosystem Productivity:



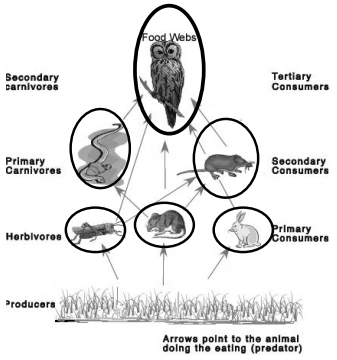
(Figure 28.3)

Energy Flow Through Communities:

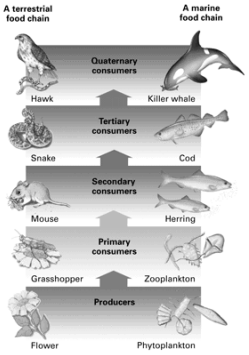
Consumers / Heterotrophs: Organisms which acquire energy by eating other organisms

Carnivores	Tertiary Consumers	4th Trophic Level
↑		
Carnivores (Meat-eaters)	Secondary Consumers	3rd Trophic Level
↑		
Herbivores (Plant-eaters)	Primary Consumers	2nd Trophic Level
↑		
Light (energy) →	Primary Producers	1st Trophic Level ("Feeding level")

Examples of trophic levels



A more complicated example



Energy Flow Through Communities:

Biological Magnification:

Process where toxic substances accumulate in higher trophic levels

- not biodegradable
- fat soluble (stored in fat)

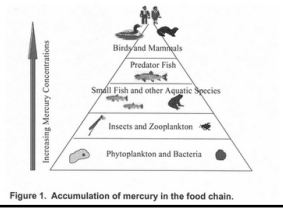
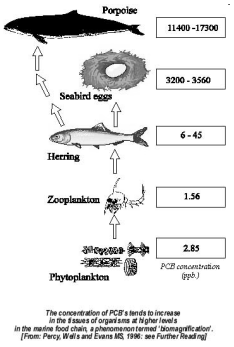
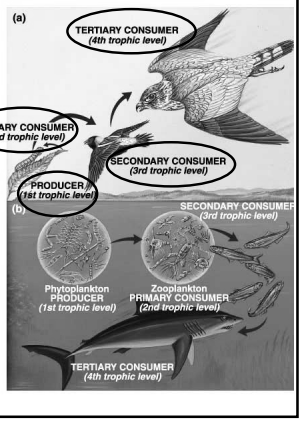


Figure 1. Accumulation of mercury in the food chain.



- Food Chain:
  - **A linear feeding relationship in a community**
  - **a single representative from each trophic level is used.**



Energy Flow Through Communities:

Omnivore ("eaters of all"):

Organisms that may interact at multiple trophic levels (e.g. bears)

Food Web:

A complex feeding relationship showing the various interactions between all organisms from all trophic levels in a community

Energy Flow Through Communities:

How are Nutrients Recycled Once Used?

Answer: Via Detritus Feeders & Decomposers

Detritus ("Debris") Feeders:

- Organisms that consume dead organic matter and excrete it in a further decomposed state
  - Protists, earthworms, vultures

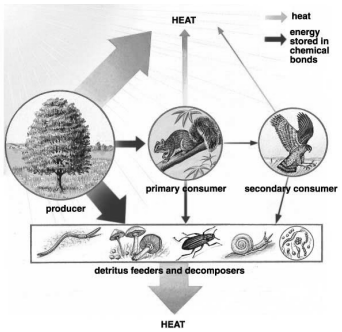
Decomposers:

- Organisms which digest food outside their bodies by secreting digesting enzymes into the environment
  - Fungi, bacteria

Although Critters are Small, Activity is Essential for Life

Energy Flow Through Communities:

Energy Transfer Through Tropic Levels is Inefficient:



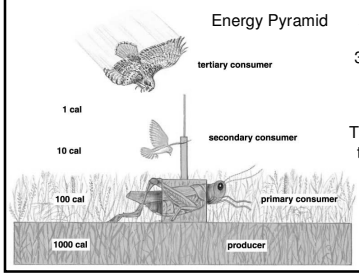
(Figure 28.6)

Energy Flow Through Communities:

Energy Transfer Through Tropic Levels is Inefficient:

10% Law: Energy transfer between trophic levels is approx. 10% efficient

Energy Pyramid



(Figure 28.7)

Results in:

1° Producers = most abundant

3° Consumers = least abundant

Human Implications:

The lower trophic level we utilize, the more food energy available

Do vegetarians have it right?

Nutrient Flow Through Communities:

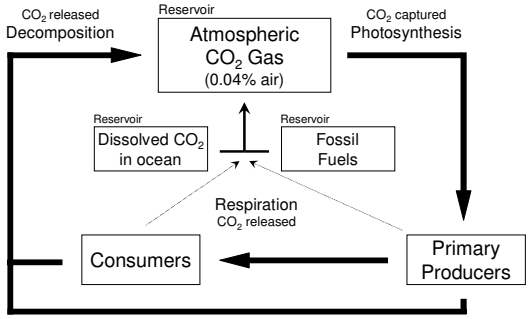
Nutrients: Elements / small molecules that form all the chemical building blocks of life

- Macronutrients: Nutrients required in large quantities
  - ❖ carbon, nitrogen, oxygen, hydrogen
  - ❖ phosphorus, sulfur, calcium
  - ❖ water
- Micronutrients: Nutrients required in small quantities
  - ❖ iron, zinc, iodine

Nutrient Cycles: Pathway nutrients follow from communities to the environment and back to communities

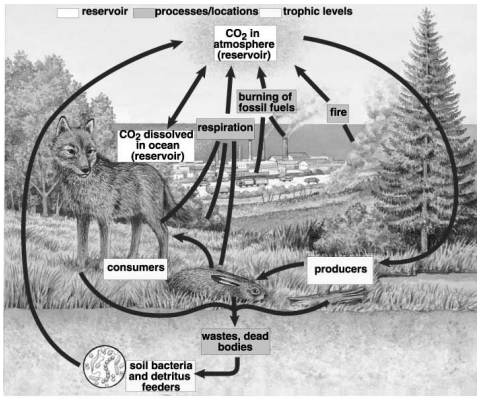
- Reservoirs: Storage sites of nutrients (usually abiotic)

Carbon Cycle (Importance = organic molecules):

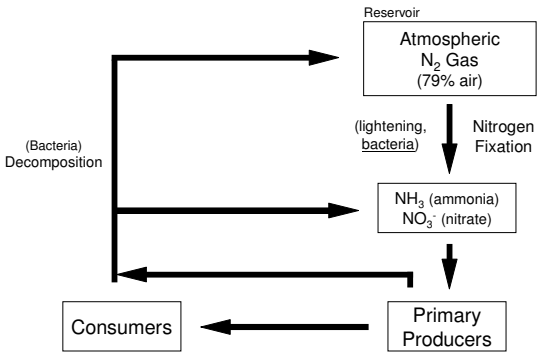


Fossil Fuels: Coal, oil & natural gas

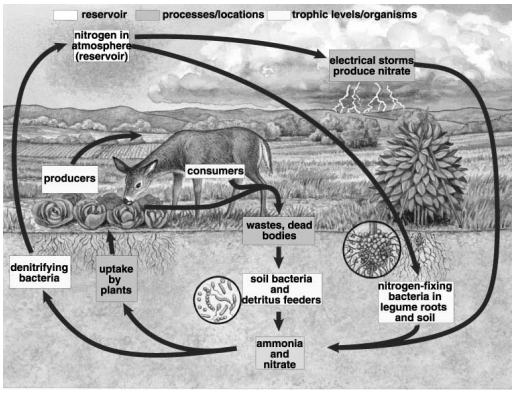
Carbon: (Figure 28.8)



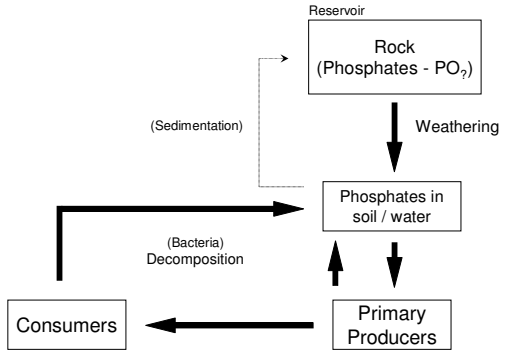
Nitrogen Cycle (Importance = proteins, vitamins, DNA):



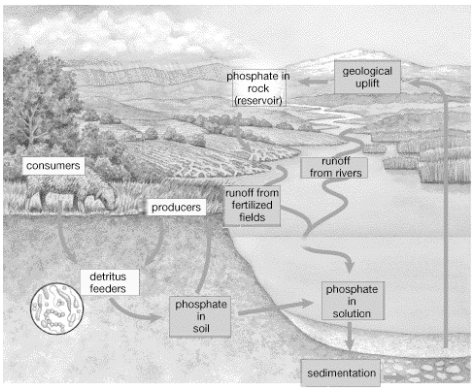
Nitrogen: (Figure 28.9)



Phosphorus Cycle (Importance = ATP - energy molecule of cell):

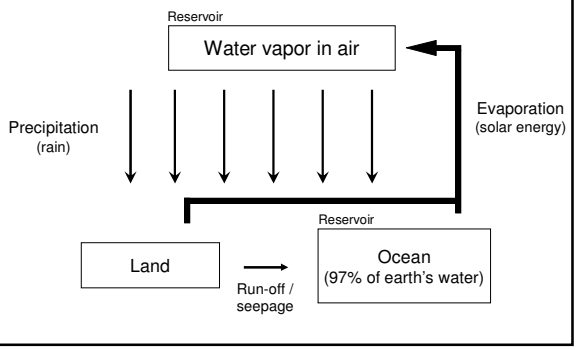


Phosphorus: (Figure 28.10)

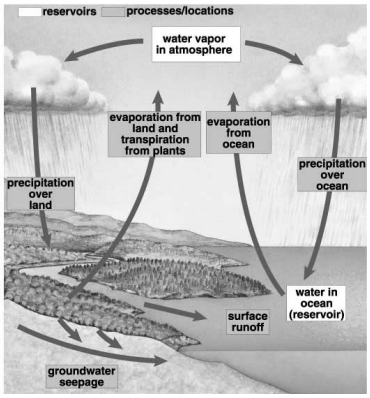


Water (Hydrologic) Cycle (Importance = Necessary for life):

- Water remains chemically unchanged throughout cycle



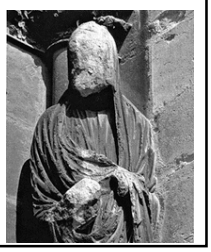
Water: (Figure 28.11)



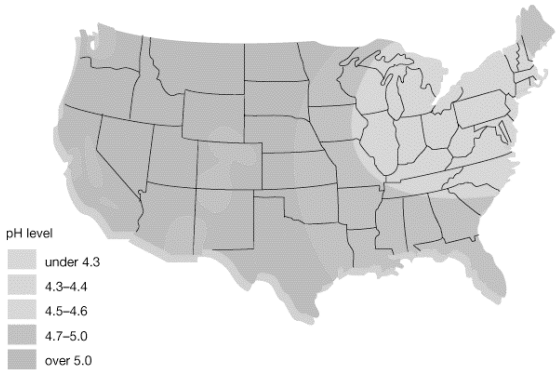
How Humans Seem to Muck Up the System:

1) Acid Deposition ("acid rain"):
   - Acidification of water due to excess nitrogen and sulfur in the atmosphere (e.g. power plants, vehicles)
     - Sulfuric acid / nitric acid (corrosive)

Fossil Fuel Burning



Acid Rain:

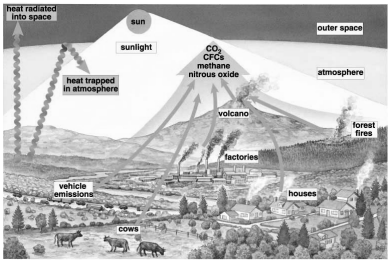


How Humans Seem to Muck Up the System:

2) Global Warming:

- Gradual increase in ambient temperature due to increased CO_2 levels in atmosphere

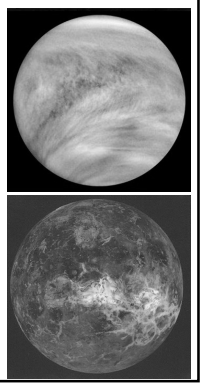
Fossil Fuel Burning



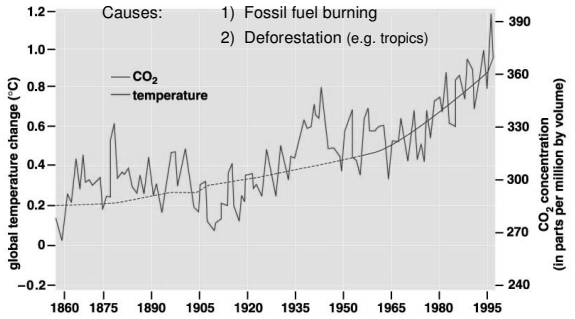
Greenhouse Effect:
Gases trap sun's energy in atmosphere as heat
(normal process)

Greenhouse effect on another planet

- Venus
  - ❖Earth's sister planet
    - ➢Similar in size and mass
  - ❖Clouds of carbon dioxide & sulfuric acid
    - ➢The dense clouds prompted the idea that it rained constantly on Venus
  - ❖Russian probes discovered that it was mostly volcanic



(Figure 28.16)



Potential Consequences:

1) Rising sea levels
2) Weather pattern shifts
3) Ecosystem shifts