



# Cycles & Patterns in the Biosphere

You will die but the carbon will not; its career does not end with you. It will return to the soil and there a plant may take it up again in time, sending it once more on a cycle of plant and animal life.

—Jacob Bronowski



# **Cycles and Patterns in the Biosphere**

- v The Impact of Plants and Animals on the Landscape
- v The Geographical Approach to the Study of Organisms
- v Biochemical Cycles
- v Food Chains
- v Natural Distributions
- v Environmental Relationships





- ❖ The Impact of Plants and Animals on the Landscape
  - Biosphere
  - Human Impacts Can Overwhelm the Biosphere



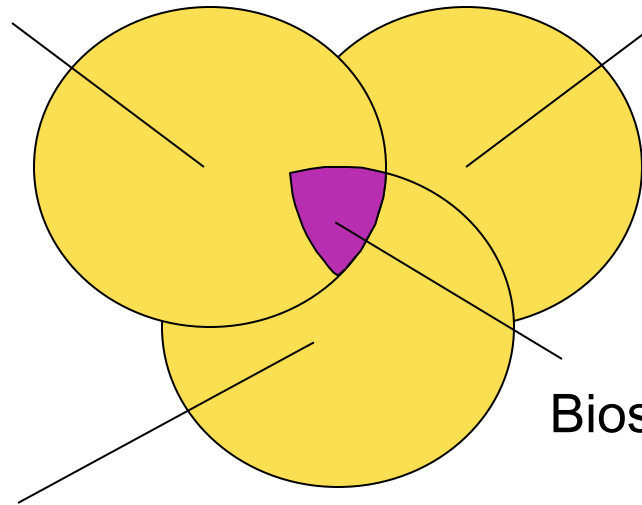
(b)



- Biosphere is still an integral part of the landscape

Hydrosphere: Ocean,  
freshwater & ice

Atmosphere  
(climate's domain)

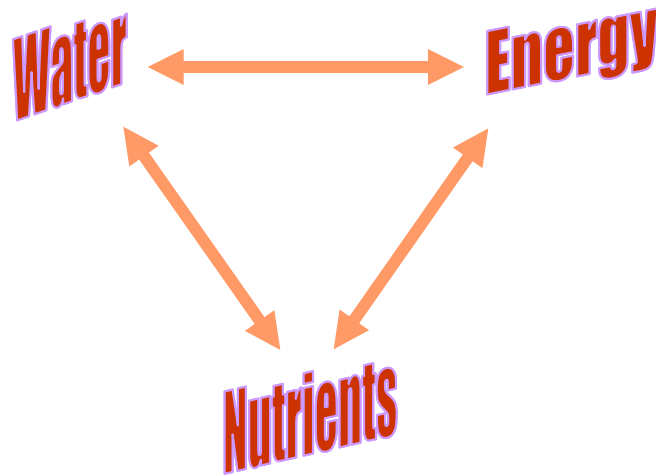


Biosphere: Plants & Animals

Lithosphere: Land surface



- Organisms survive in the biosphere through systemic flows of energy, water, and nutrients.
- These flows involve biochemical cycles





# The Geographical Approach to the Study of Organisms

- Geographical Viewpoint
  - Seeks to explain distributions of phenomena and how their spatial patterns change over time
- Biogeography
  - Study of plant and animal distributions and how their spatial patterns change over time



# Biochemical Cycles

- The Flow of Energy

Animation 

1. Net Primary Productivity
  2. Biological Productivity in Midlatitude Oceans
- Photosynthesis and Respiration

- Photosynthesis



- Respiration



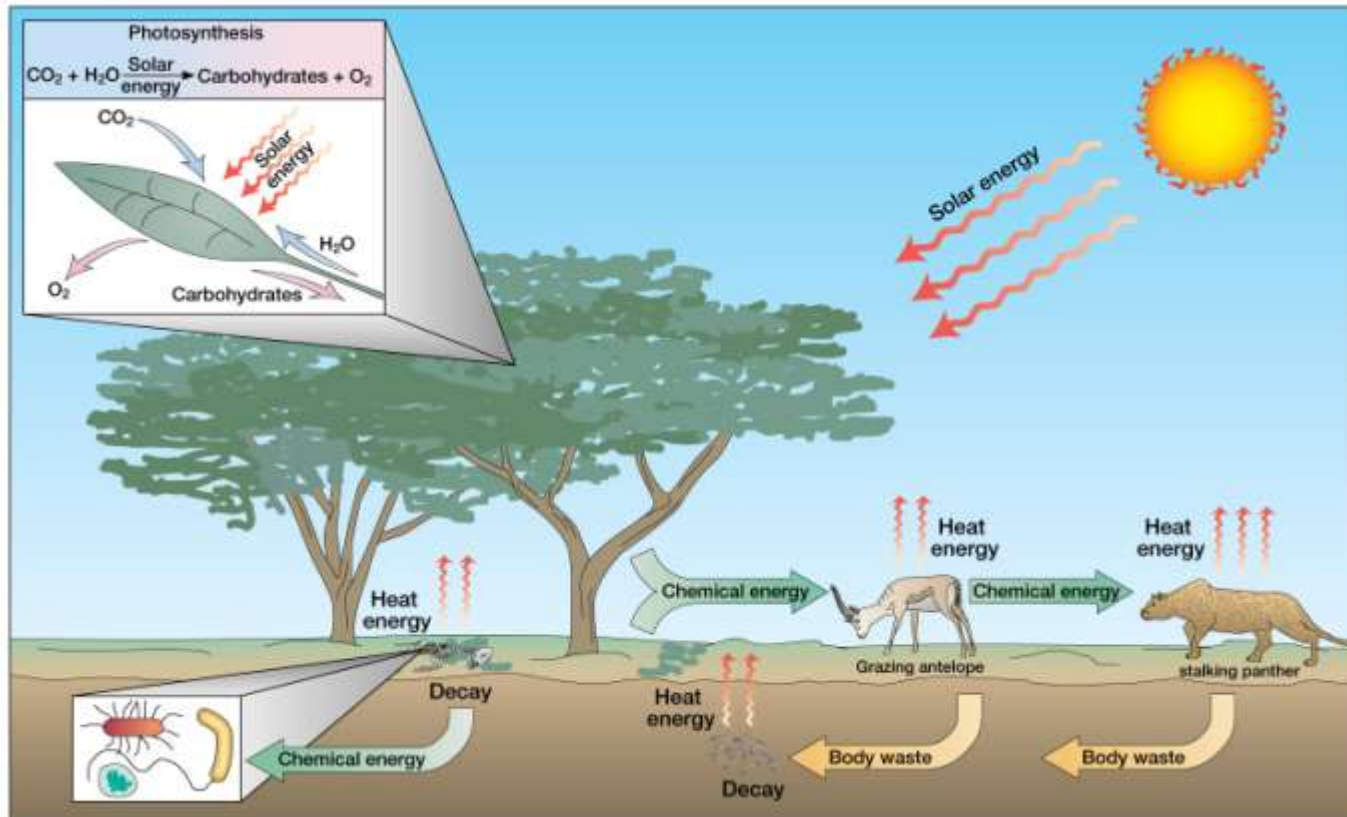
- Net Photosynthesis (e.g., gain/loss kg carbon<sup>-yr</sup>)





## – Net Primary Productivity

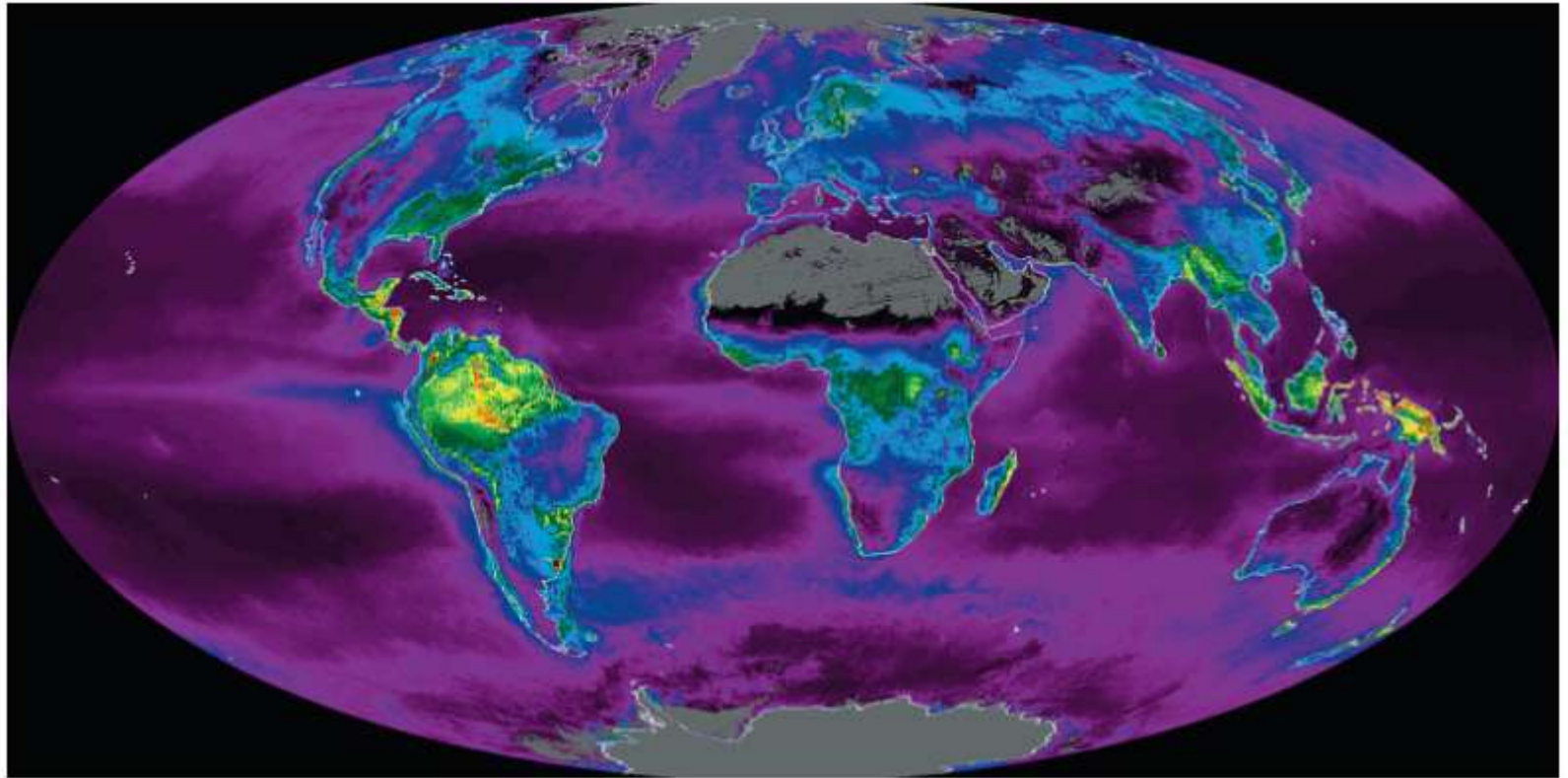
- Net photosynthesis  $\text{yr}^{-1} \text{ unit area}^{-1}$  (e.g.,  $\text{kg m}^{-2} \text{ yr}^{-1}$ )







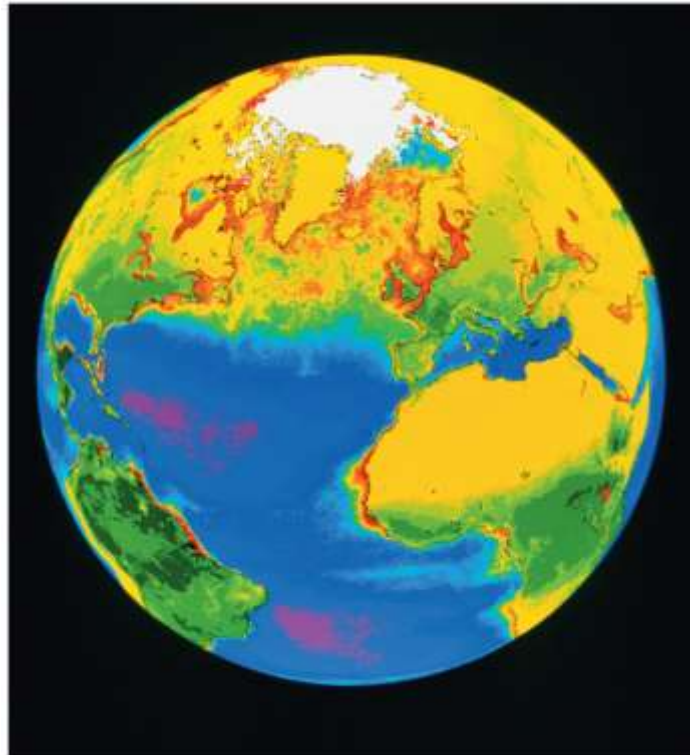
## Global Net Primary Productivity



Based on rate of plant absorption of carbon dioxide



## North Atlantic Ocean Net Primary Productivity



Based on density of chlorophyll



# Hydrologic Cycle

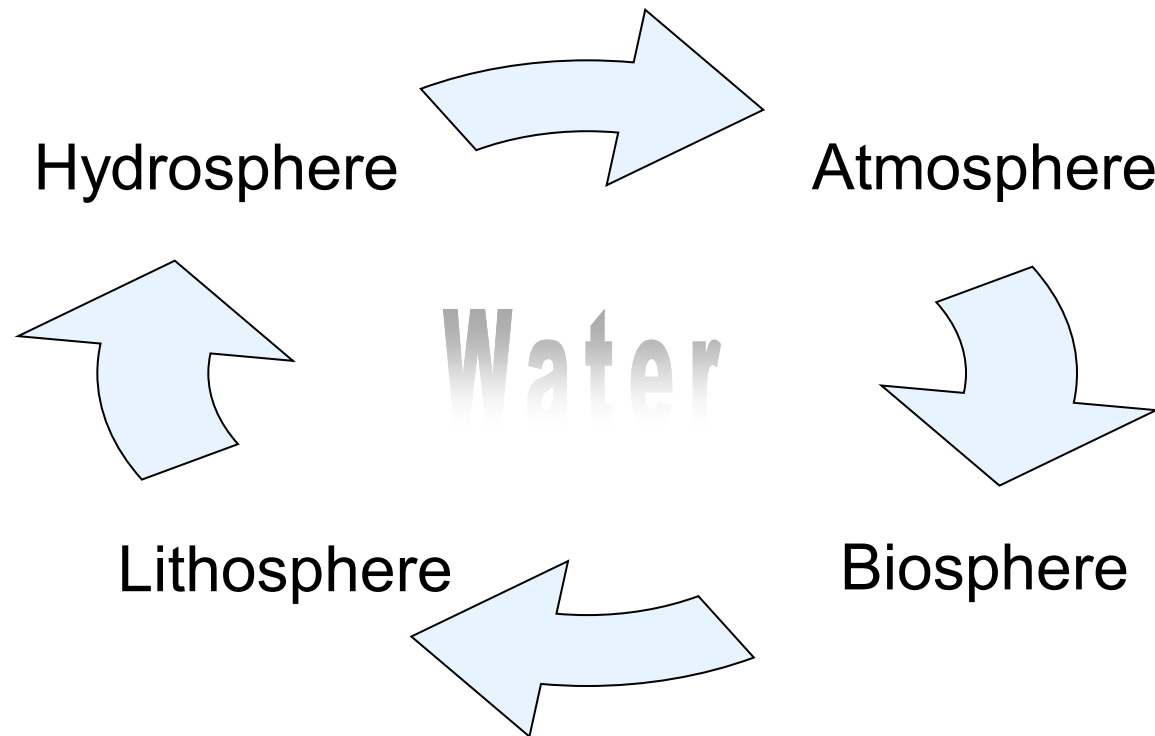
- H<sub>2</sub>O – most abundant substance of the biosphere
- Two locations
  - *In residence* in plant and animal tissues

Organism	Percentage Water In Body Mass
Human	65
Elephant	70
Earthworm	80
Ear of corn	70
Tomato	95



– Two locations (continued)

- *In transit* from one sphere to another

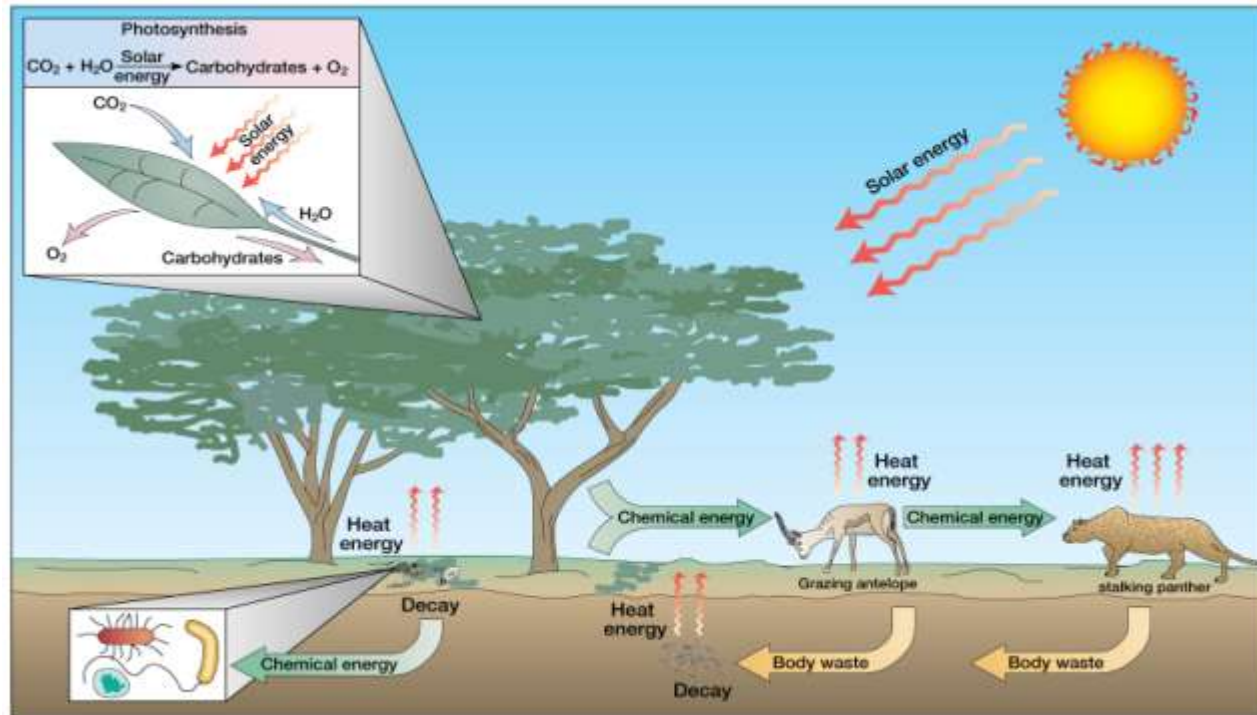






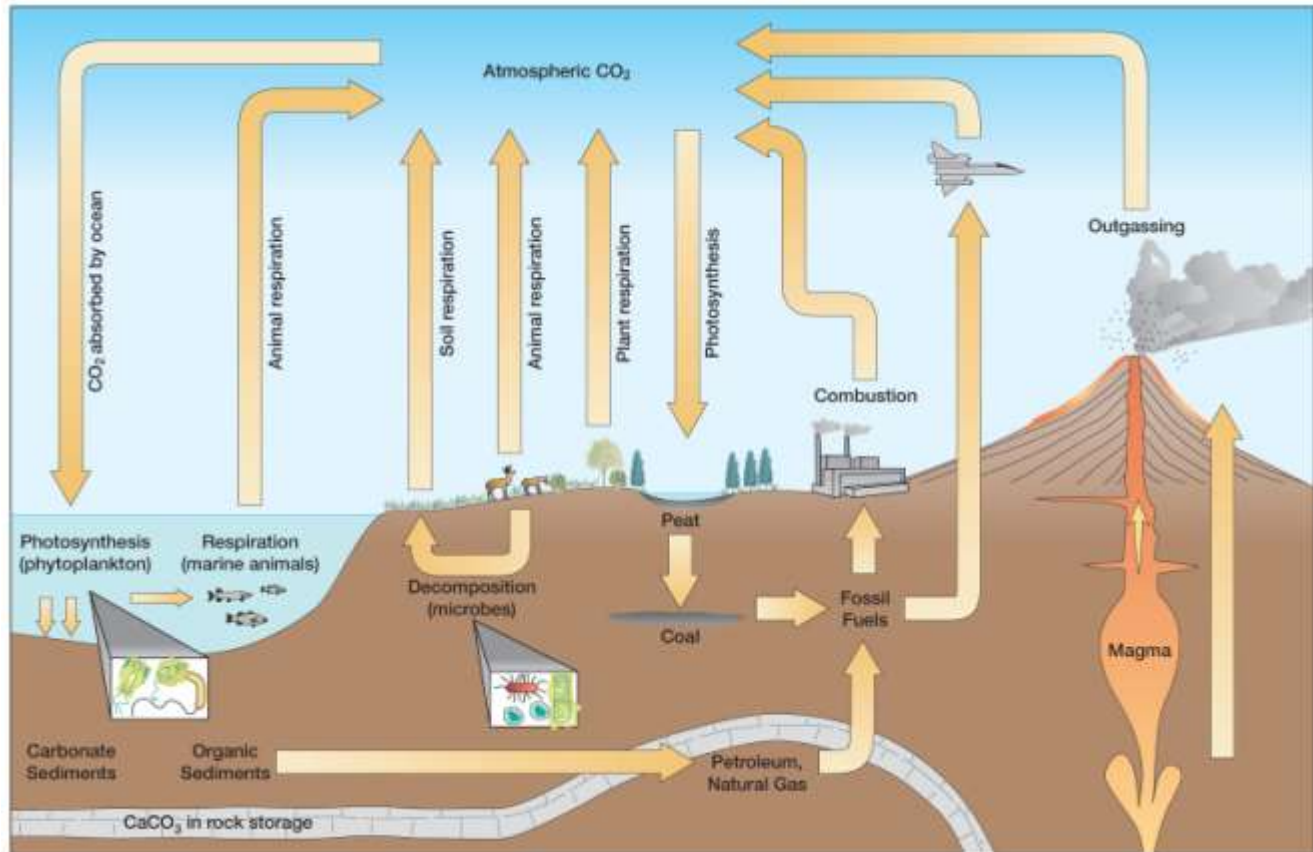
# Carbon Cycle

- Photosynthesis “pulls” atmospheric carbon into the biosphere.





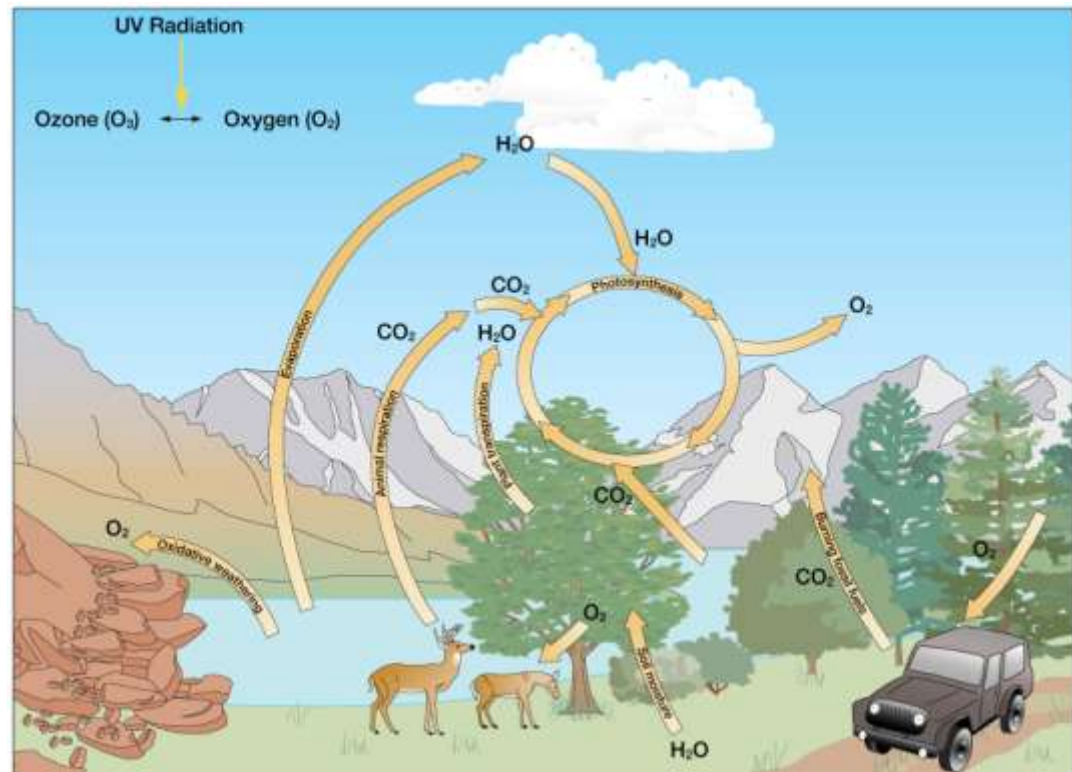
- Carbon moves constantly from the living system to organic reservoirs and back.





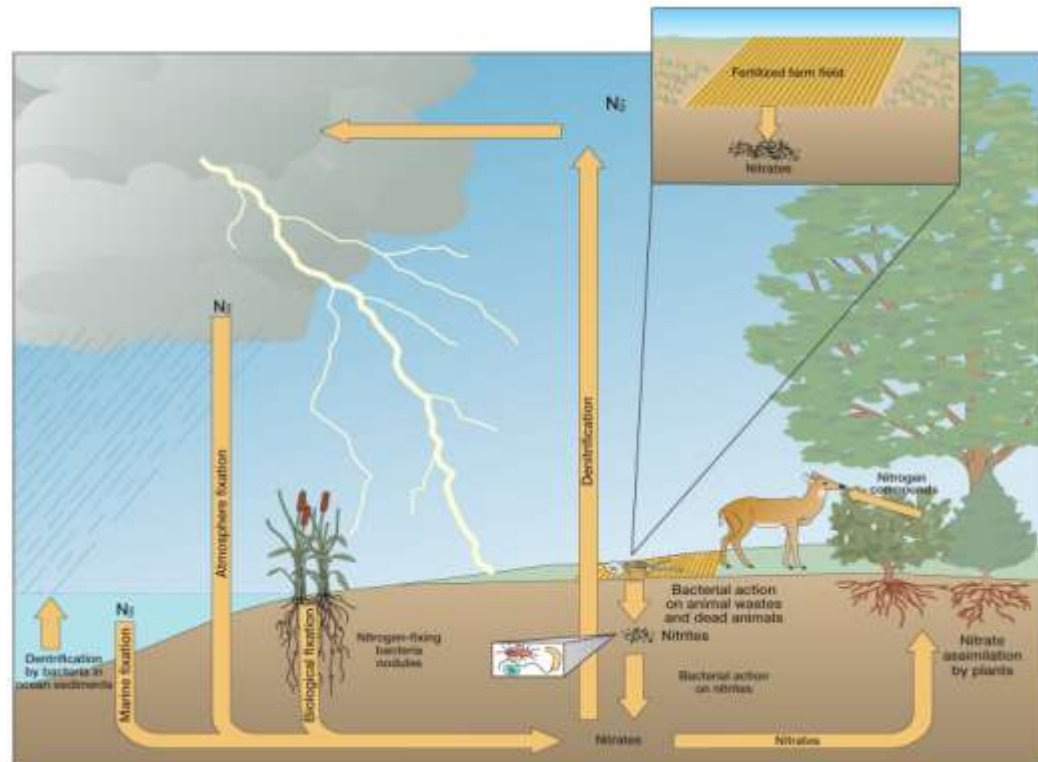
# Oxygen Cycle

- $O_2$  is mainly a byproduct of photosynthesis
- Other sources...





- Nitrogen Cycle
  - $N_2$  – Atmospheric nitrogen (78% of air)
  - Nitrogen fixation
- Other Mineral Cycles
  - Trace minerals (e.g., phosphorous, sulfur and calcium)

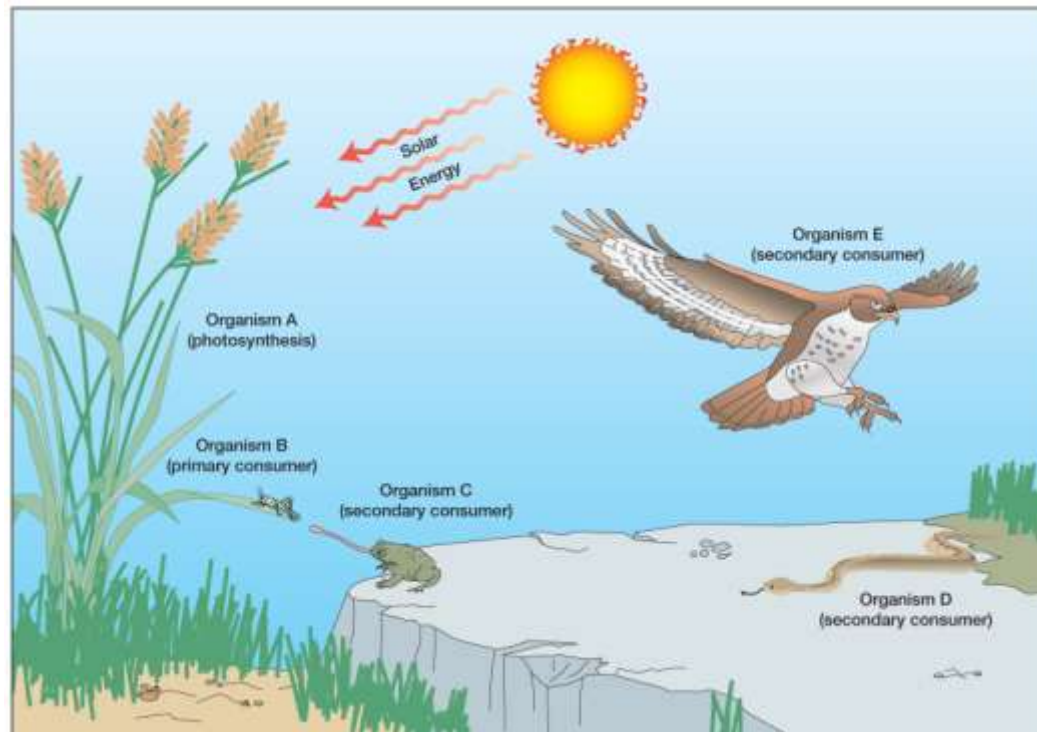






# Food Chains

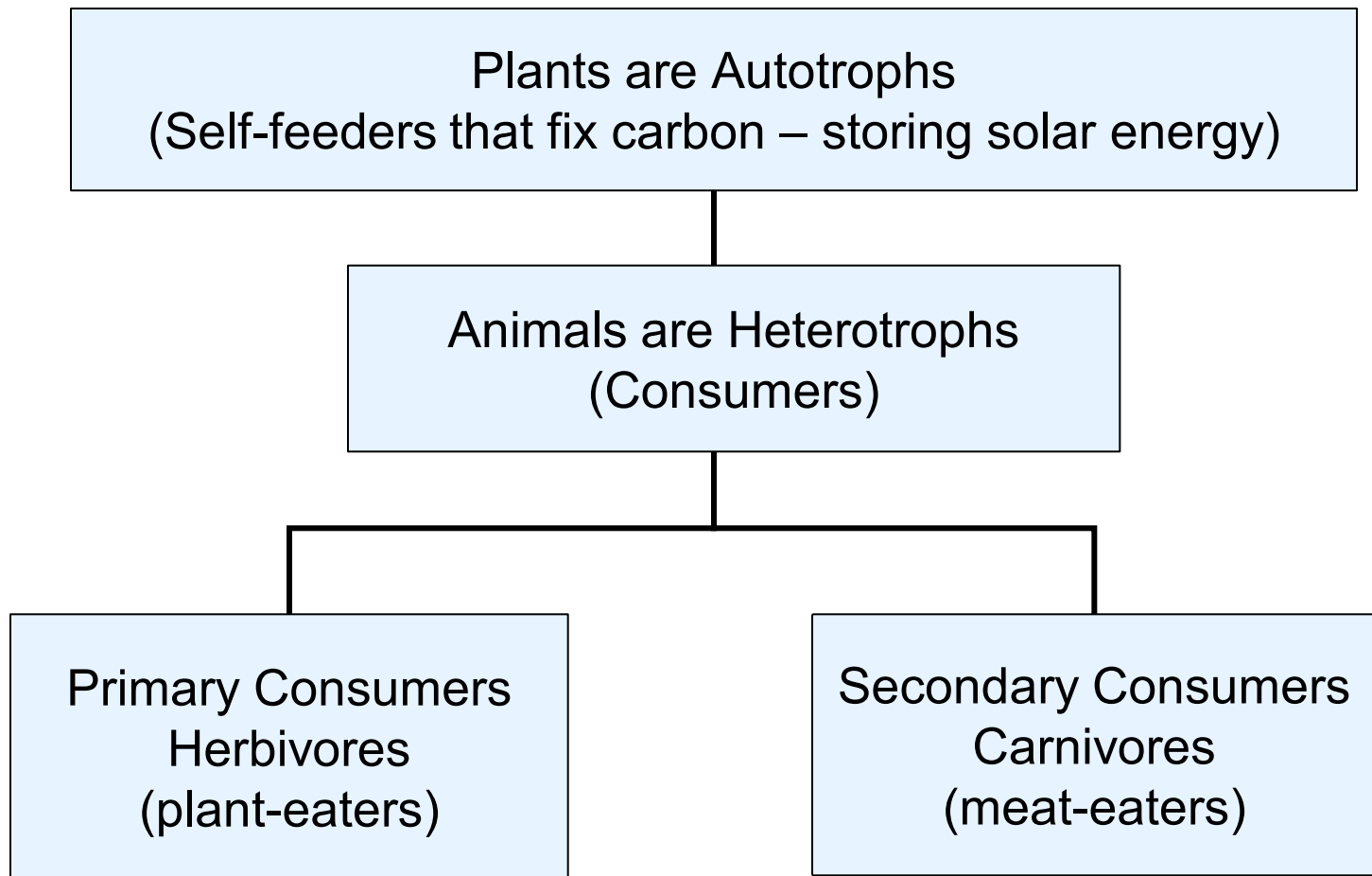
- Pathways of energy, water and nutrients on which organisms depend for their survival.



A simple food chain

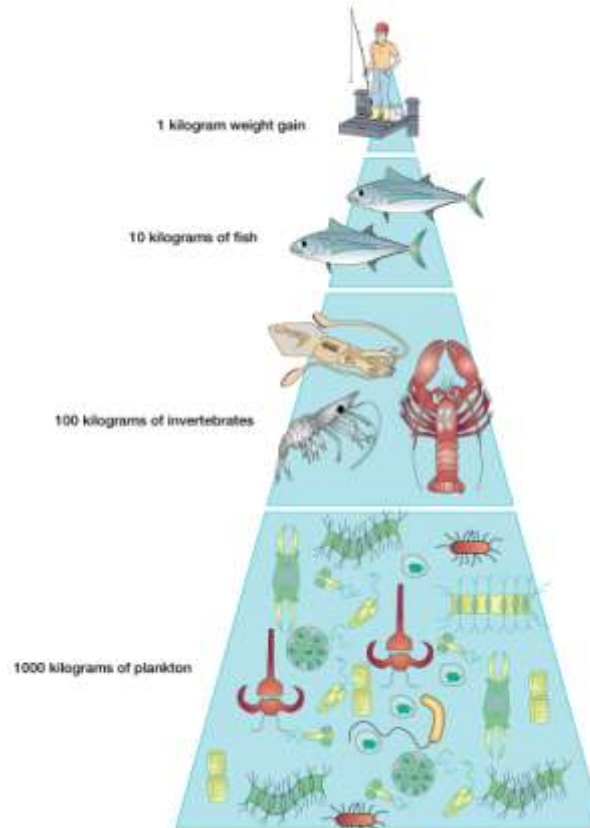


# Fundamental Units of a Food Chain

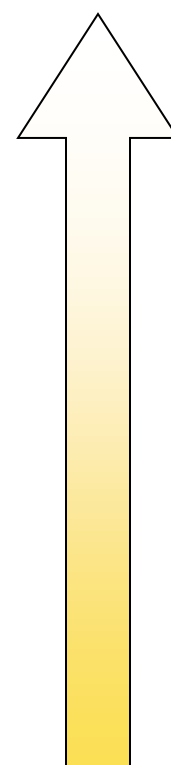




# Food Pyramid



Few Secondary Consumers



— Decrease in number of consumers —

Many primary consumers



Large predators are at top of the pyramid



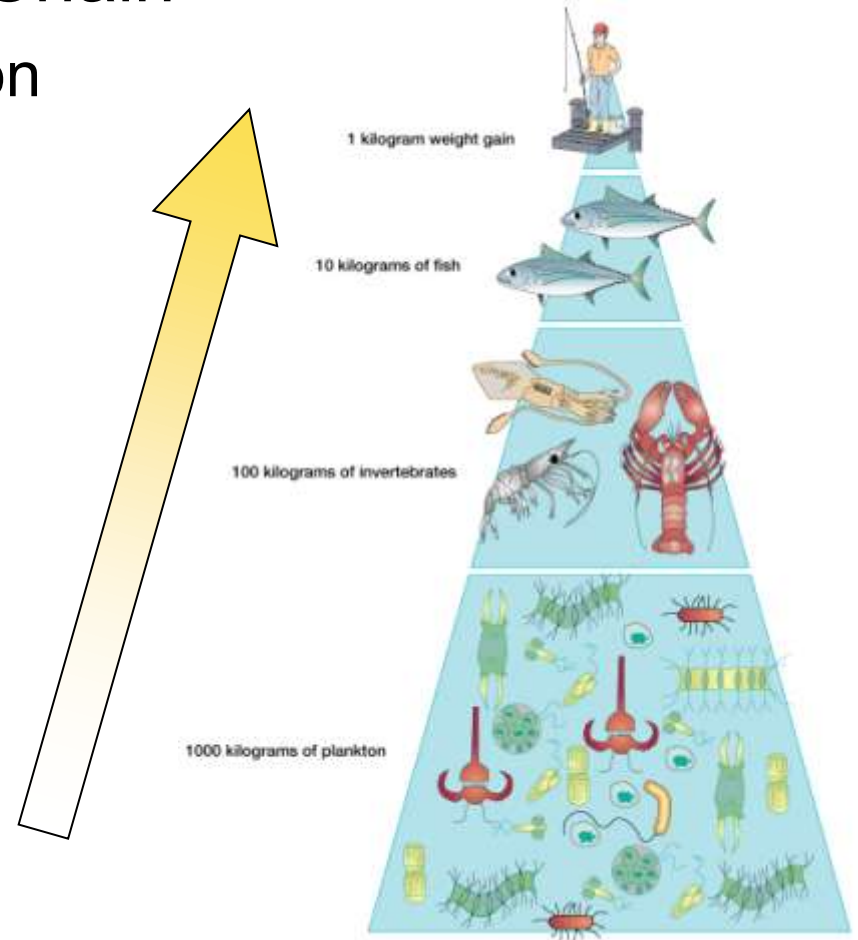
A lynx pouncing on a snowshoe hare





# Pollutants in the Food Chain

## – Biological amplification





# Natural Distributions

- Evolutionary Development
  - Darwinian theory of natural selection
  - Influence of Plate Tectonics
    - Acacia species – widespread distribution before the Pangaea break-up



Acacias are widespread in tropics today



Eucalyptus – Did not exist on Pangaea.



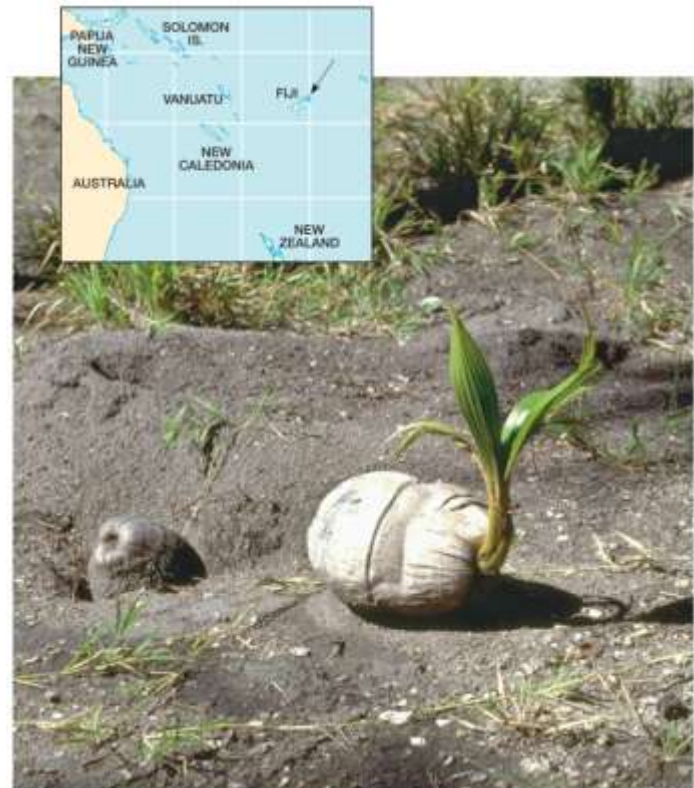
Eucalyptus species developed in geographical isolation in Australia, after the Pangaea break-up.



## Migration/Dispersal

- Plants disperse seeds via wind, water, and animals.

Example: Coconuts







- Animals migrate via legs, wings, fins, etc.

Example: Cattle egrets



(b)



# Reproductive Success

- Reproductive success allows one competing population to flourish while another languishes.

Example: American bison

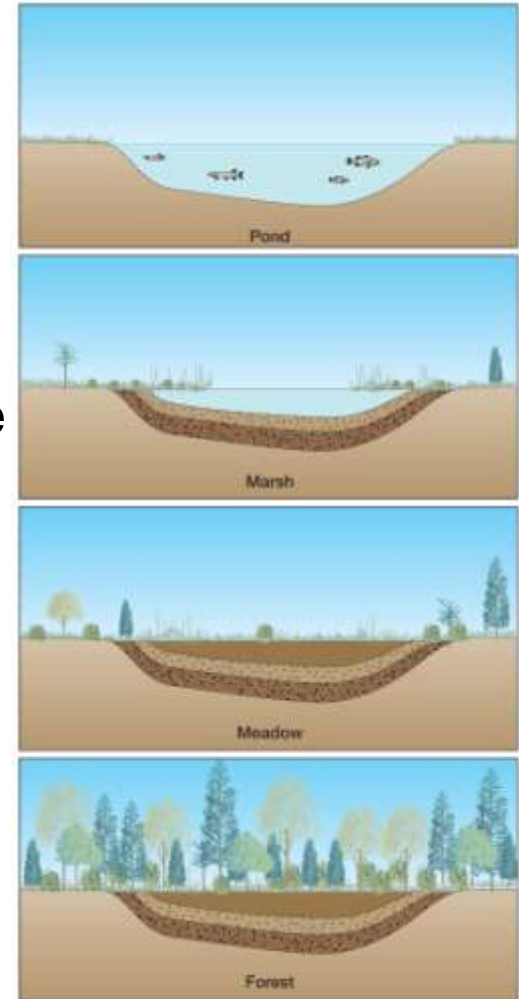




# Extinction

- Plant succession. One type of vegetation is replaced by another naturally

Example: Infilling of a small lake

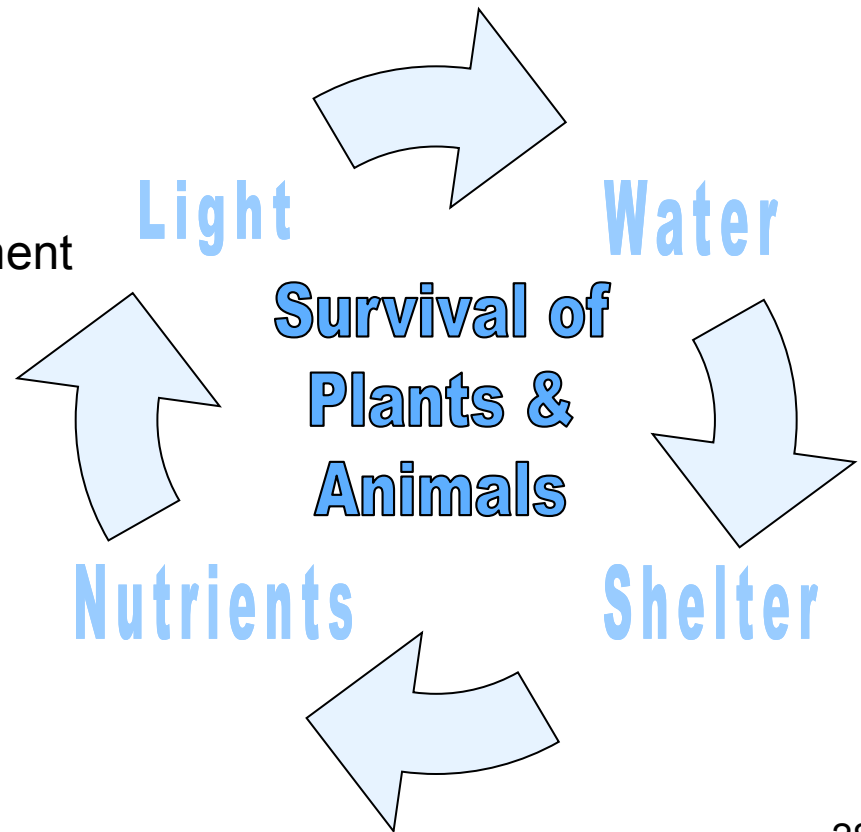




# Environmental Relationships

- Plants and animals compete with one another for natural resources in a dynamic environment.

Limiting factors of the environment



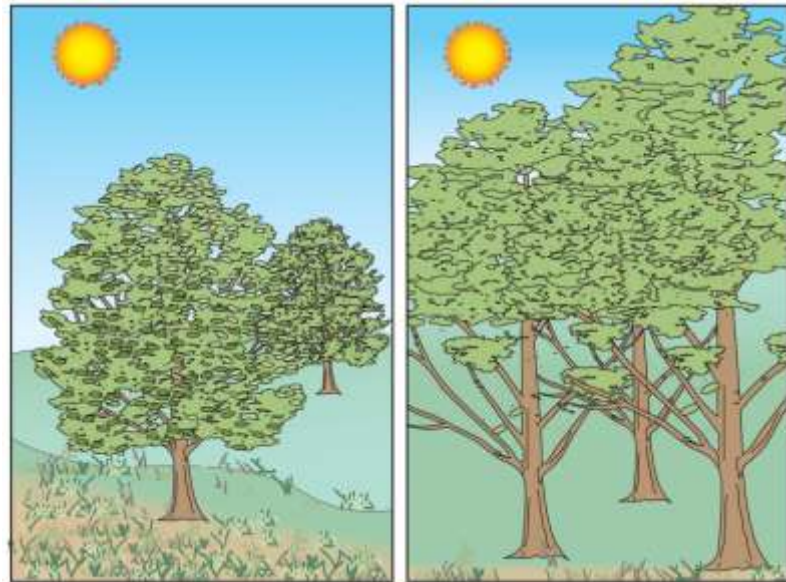




# The Influence of Climate

## – Light

- Plant shape
- Photoperiodism



Effect of light on tree shape



## Moisture

- Effect of moisture supply on plant adaptations.





## Temperature

- Plant tolerances to cold
- Animal tolerances to cold

## Wind

- Animal body heat loss
- Plant desiccation or wind shear



Desiccation and wind-shear effect on trees in a timberline zone



## Topographic Influences

- Steepness of slopes
- Orientation of slopes in regards to sunlight
- Porosity of soil on slopes

## Wildfire impacts



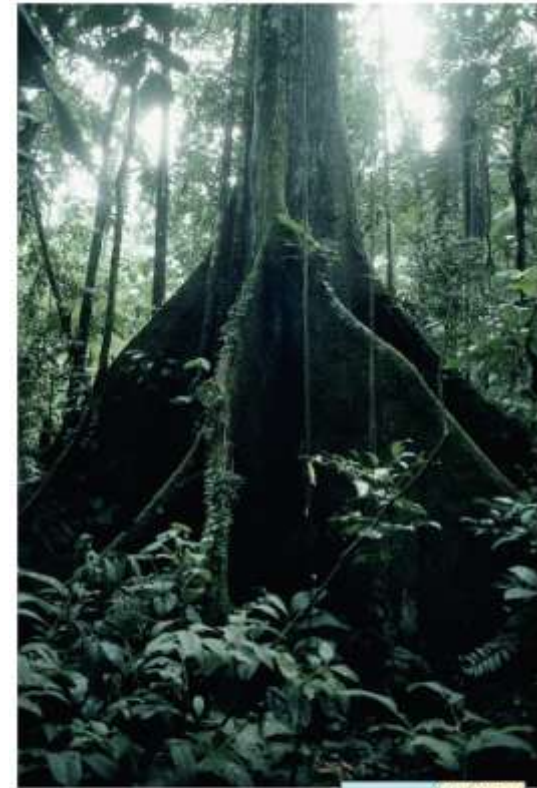




## Environmental Correlations: Example of Selva

- Climate – Af
- Flora – Tropical rainforest
- Fauna – Flyers, crawlers, creepers, and climbers
- Soil – Laterization
- Hydrography: Abundance of runoff, heavy sediment loads in rivers

Tropical rainforest scene in Ecuador





# Summary

- The biosphere consists of all plant and animal life forms on Earth. It overlaps with the other three environmental spheres.
- All life forms depend on three ingredients: solar energy, water and nutrients. These ingredients are unevenly distributed on Earth's surface.
- The three ingredients continuously cycle through the biosphere, as organisms absorb and return them to the other three spheres.



## Summary

- The most prominent geochemical cycles involve water, carbon, oxygen and nitrogen.
- Floral-faunal relationships can be described as a food chain or food pyramid.
- Plants are the “self-feeders”; they are the first link in the food chain and at the bottom of the food pyramid.
- Animals are either primary or secondary consumers of energy stored by plants.



## Summary

- Factors in the environment that determine the survival of plants and animals are limiting factors. The main limiting factors are light, water, shelter and nutrients.
- Climate is the main influence on how the limiting factors vary from place to place on Earth, but soils, topography and wildfires also influence local plant and animal distributions.