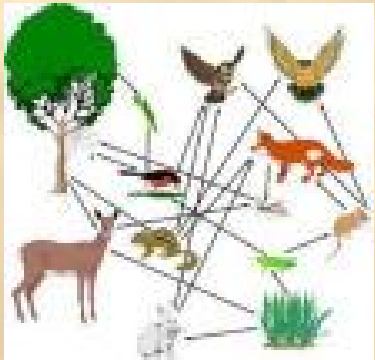
Ecosystems & Energy

Components

Energy Flow



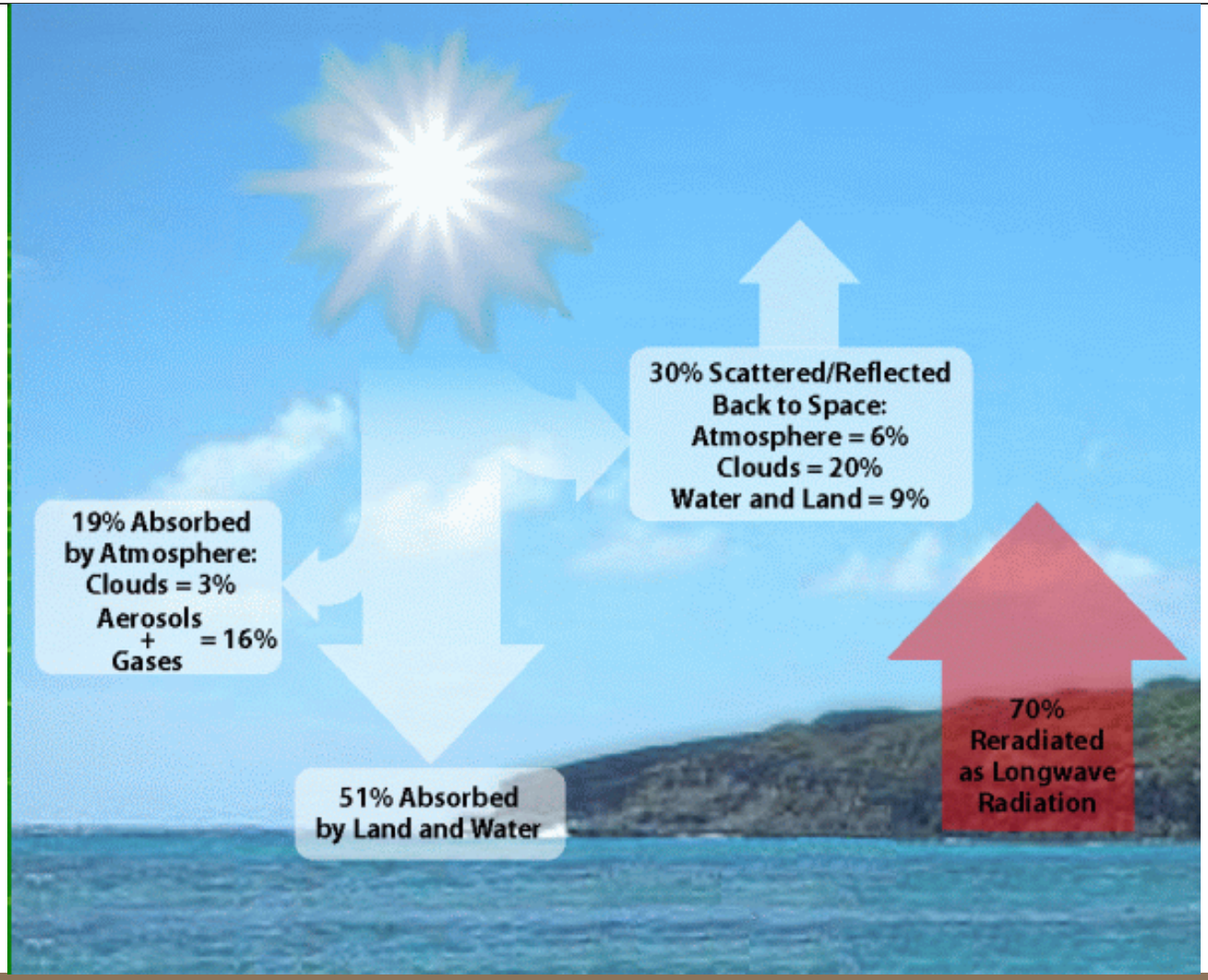
Life is sustained by:

- **One-way flow of energy**
- **Cycling** of matter & nutrients
- **Gravity**: holds planet's atmosphere

Sun's Role

- Light, warmth, & energy for photosynthesis
- Powers cycling of matter
- Drives the climate and weather systems
- Most of light to earth is ultraviolet
  - ~28% reflected back into space by clouds, dust, and land
  - ~72% warms air & land, evaporates water, generates winds and global air & water currents
  - Only about .023% is used by plants for photosynthesis

Earth's Energy Budget



Nutrient Cycles
aka Biogeochemical Cycles

- Nutrient—any atom, ion or molecule an organism needs to live
  - Macronutrients: needed in large amounts; CHONPS & a few others
  - Micronutrients: needed in small or trace amounts
- Driven by the sun
- Main ones: hydrologic, nitrogen, carbon, phosphorus, & sulfur

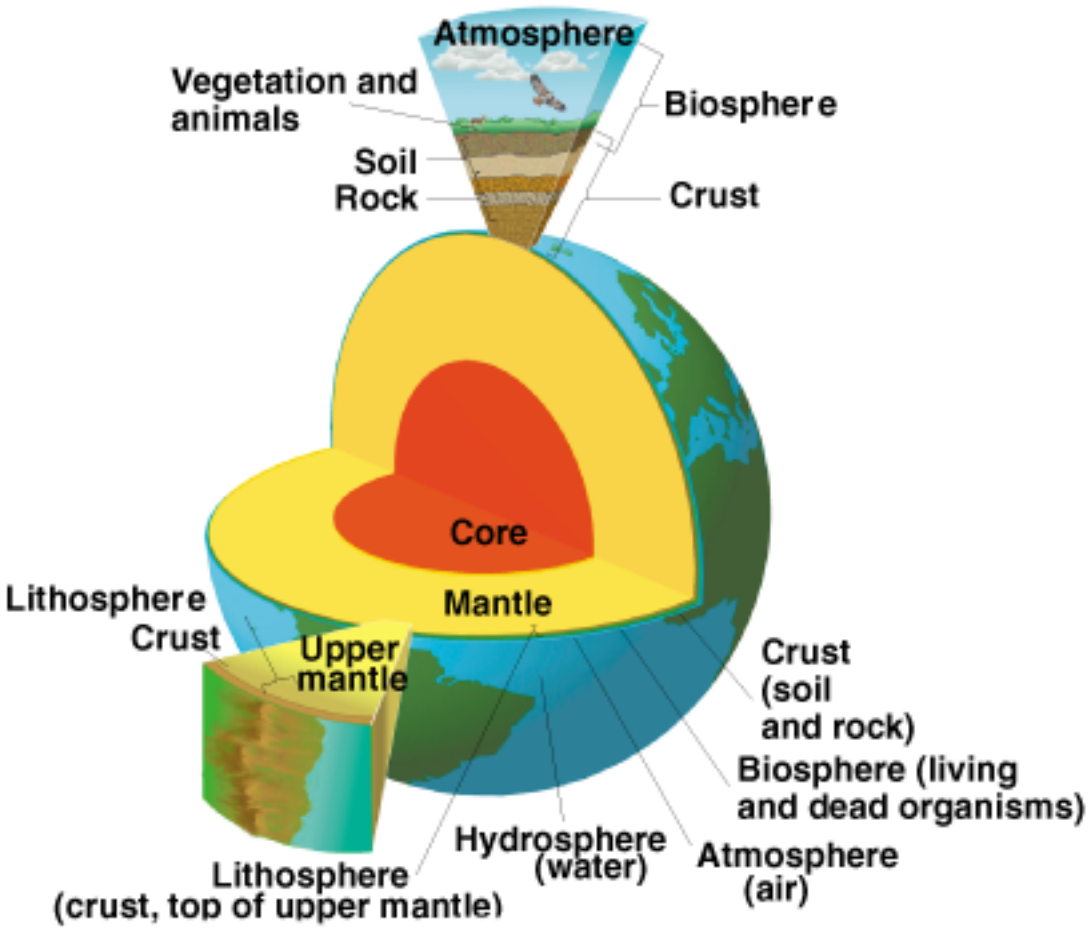
Types of Systems

- Earth = closed system
  - Receives energy from sun but loses no matter into space
  - Recycles nutrients
- Organisms = open systems
  - Exchange matter & energy between the system and the environment
  - Take in matter and energy, use it, & put waste back into environment

Ecology

- Study of the relationships between organisms and their environment
  a.k.a How organisms **interact** with their nonliving environment such as sunlight, temperature, moisture, nutrients, etc.

Ecology & the Spheres



Organisms

- Organism—any biological entity capable of replication/transferring is genetic material

  *Interest piece--Evolution: What is an Organism?

- Eucaryotic—surrounded by membrane; have distinct nucleus; have internal organelles; all organisms except bacteria
- Procaryotic—surrounded by membrane; nave NO distinct nucleus; no internal body parts surrounded by membranes; bacteria

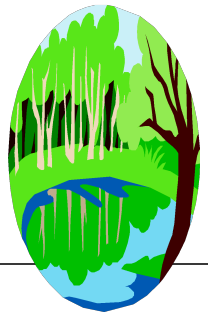
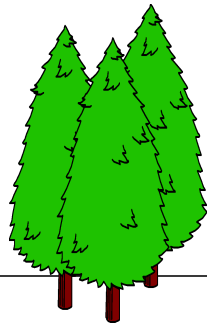
Species

- Species—group of organisms capable of interbreeding AND producing viable offspring
- Sexual vs. asexual reproduction
- Number of species on earth is not known
  - 5 million to 100 million maybe
- Wild species - found in natural habitat
- Domestic species - have been taken out of natural setting & therefore play a smaller role

Population

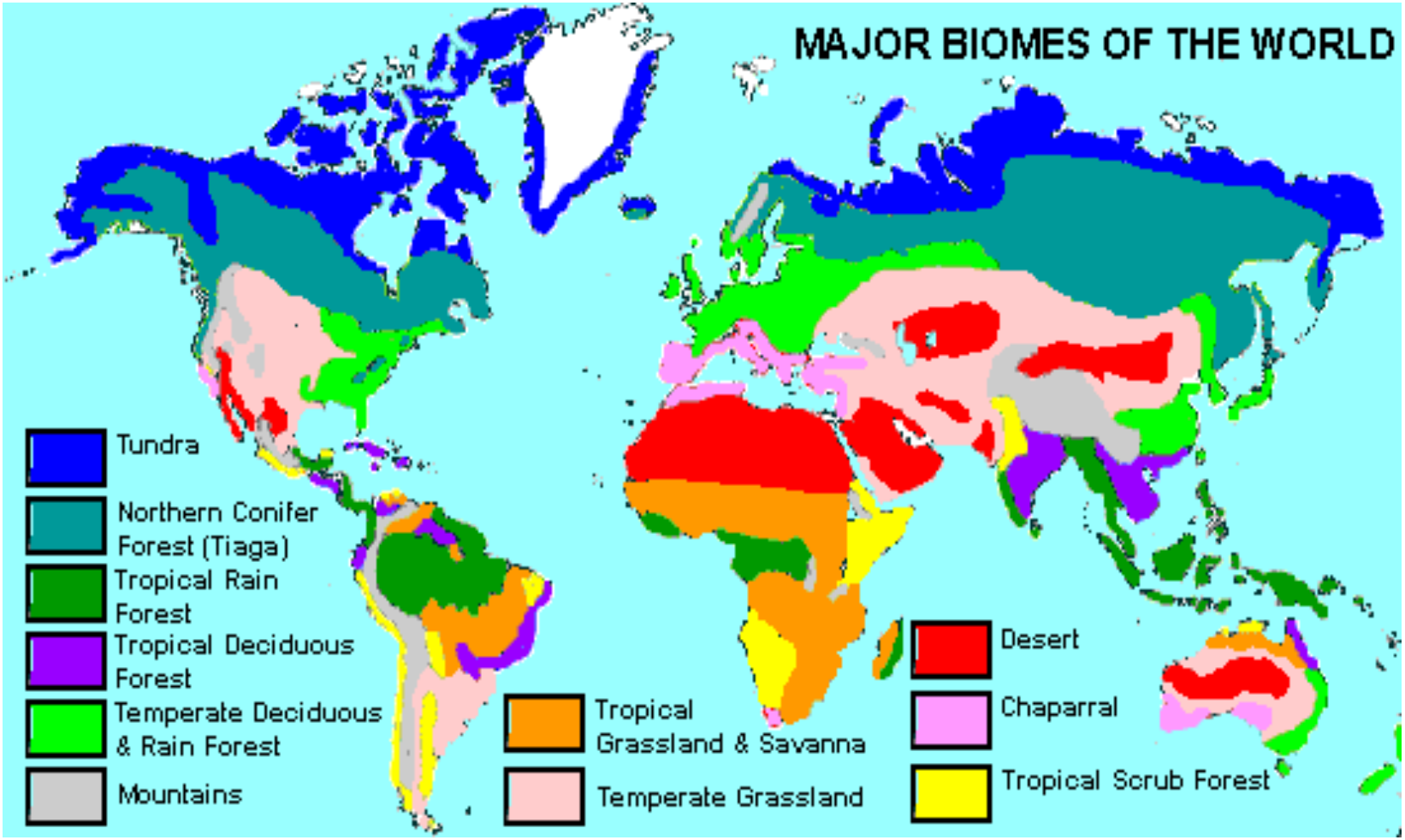
- A group of organisms of the same species in a given area at a given time
  - Can vary with:
    - Season
    - Time of day
    - Time of year
- Density = number of organisms ÷ area

Habitat

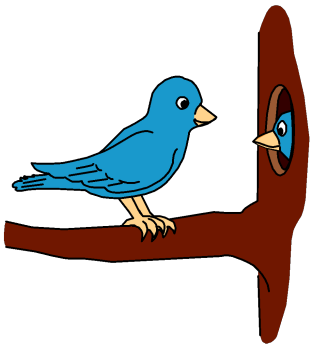
- Where an organism or population normally lives
- Provides the particular resources needed for that organism
- Part of biosphere
  - Subdivided into biomes based on climate & types of organisms (primarily vegetation)
  - Includes aquatic life zones (ocean, lakes, rivers, riparian zones, wetlands, etc.)
- Can be large or small (ex. Intestines of a cow vs. Atlantic Ocean)

Biomes


MAJOR BIOMES OF THE WORLD
Tundra
Northern Conifer Forest (Tiaga)
Tropical Rain Forest
Tropical Deciduous Forest
Temperate Deciduous & Rain Forest
Mountains
Tropical Grassland & Savanna
Temperate Grassland
Desert
Chaparral
Tropical Scrub Forest

Community

- Populations of all species in a particular place at a particular time.



Ecosystem

- Community of different species interacting with one another and their nonliving environments.
- Can be small or large
- All combined = biosphere
- Components:
  - Biotic—living
  - Abiotic—nonliving (water, nutrients, air, solar energy, etc.)

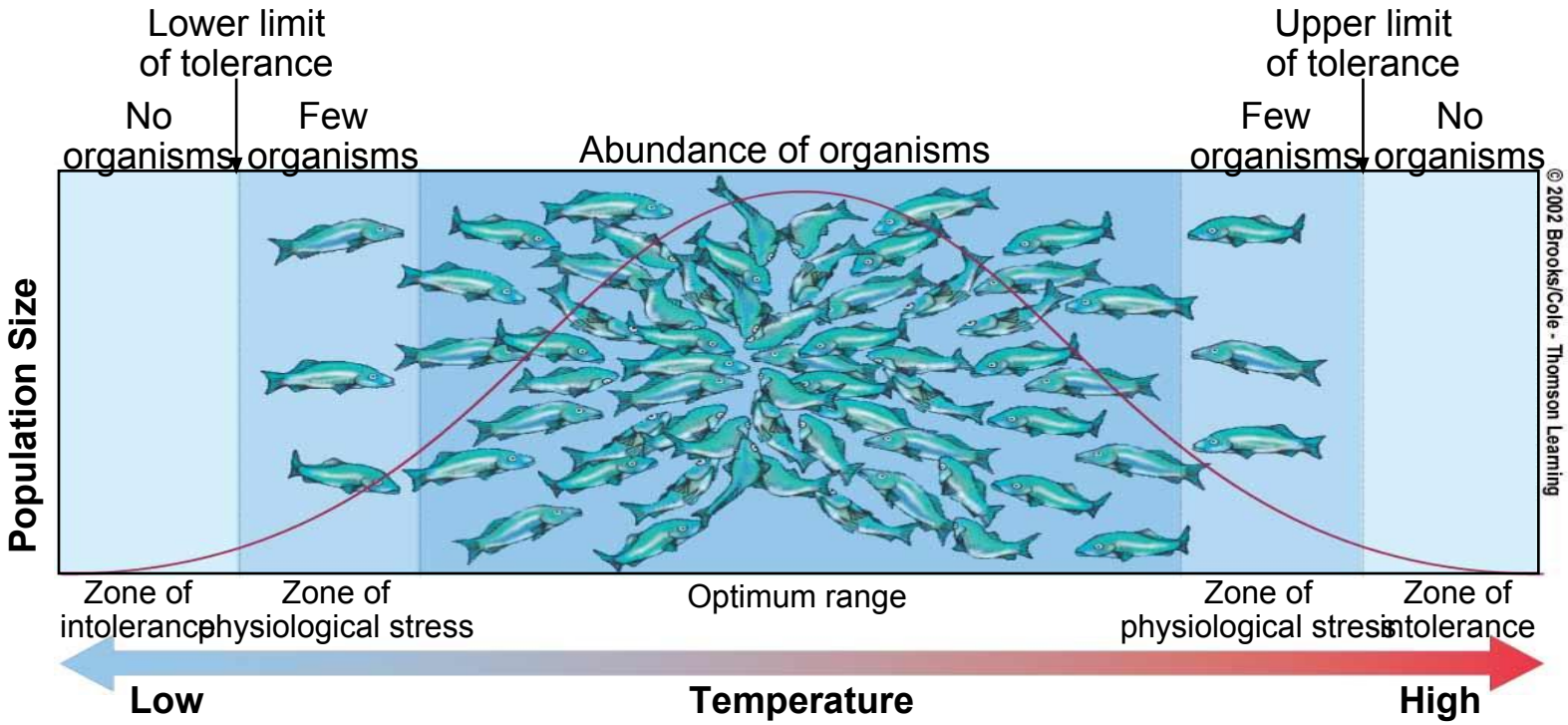
Abiotic Factors: Limiting Factors

- Any one factor that is responsible for regulating population growth
  - Light, water
  - In aquatic ecosystems
    - D.O.
    - Sunlight
    - Temperature

Populations: Range of Tolerance

- Ability to survive within variations of a physical or chemical environment
  - Individuals within a population may have differing ranges of tolerance
- Tolerance limit—point/level beyond which no member of a species is able to survive

Populations: Range of Tolerance

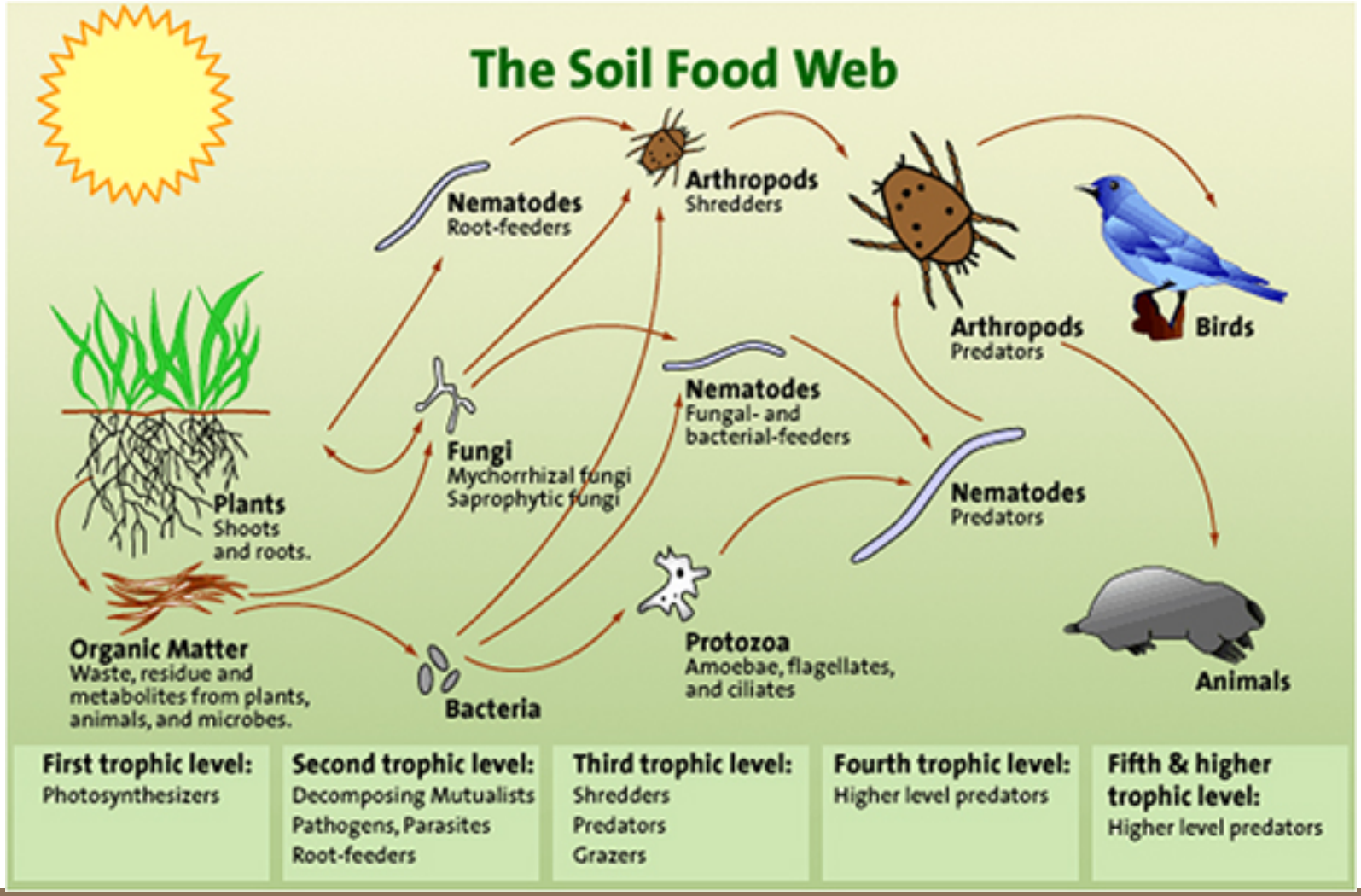


Energy Flow within an Ecosystem

- Moves from one trophic level to the next
  - Trophic Level—organism's position within food chain
  - Food chains combine to form food webs
- Unidirectional flow sun → organisms → environment → space

  high quality low quality heat

Food Web vs. Food Chain



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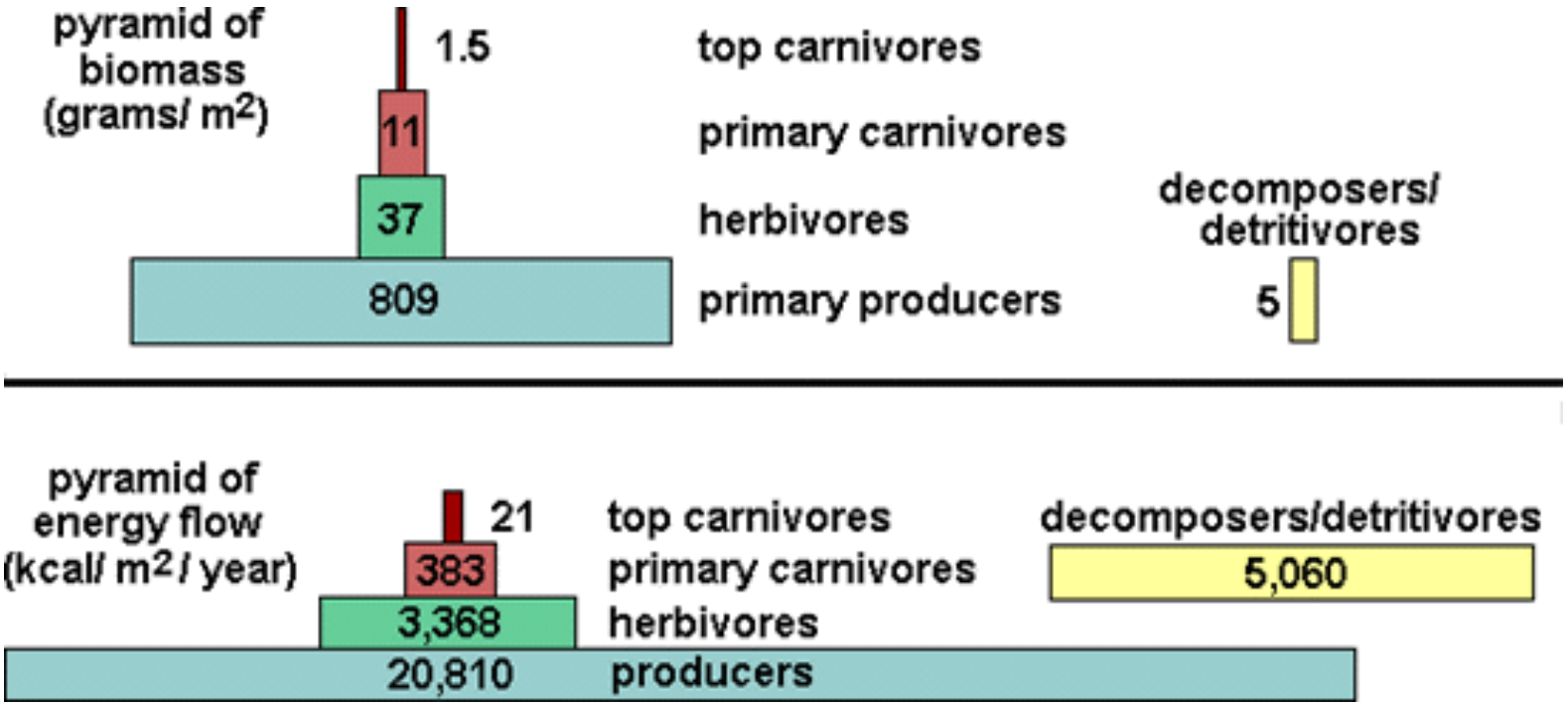


Energy Flow within an Ecosystem

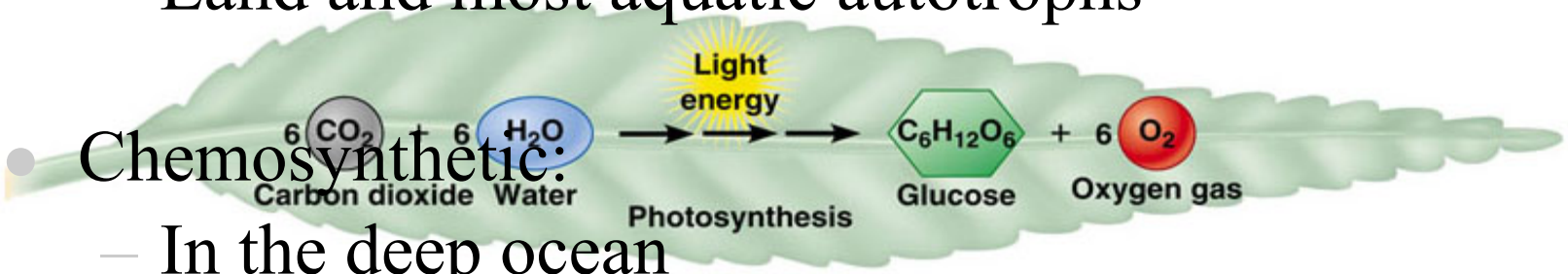
- Ecological Efficiency:
  - Percentage of usable biomass transferred from one trophic level to the next
  - On average, only ~10% (range of 2 - 40%)
- Cellular respiration at EVERY level
  - Conversion of potential energy (chemical) into kinetic energy (electrical/mechanical)

Respiration:

- Aerobic: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O + 38\ ATP$
- Anaerobic (aka fermentation)
  - Plants: $C_6H_{12}O_6 \rightarrow C_2H_5OH + 2\ CO_2 + 2\ ATP$ ethanol
  - Animals: $C_6H_{12}O_6 \rightarrow C_3H_6O_3 + 2\ ATP$ lactic acid
  - End products include CH_4, ethyl alcohol, acetic acid, and H_2S (hydrogen sulfide)

Role: Producers

- Trophic Level: autotrophs (1)
- Photosynthetic:
  - Land and most aquatic autotrophs



- Chemosynthetic:
  - In the deep ocean
  - Use heat energy from the thermal vents to convert dissolved hydrogen sulfide and carbon dioxide into organic nutrient molecules

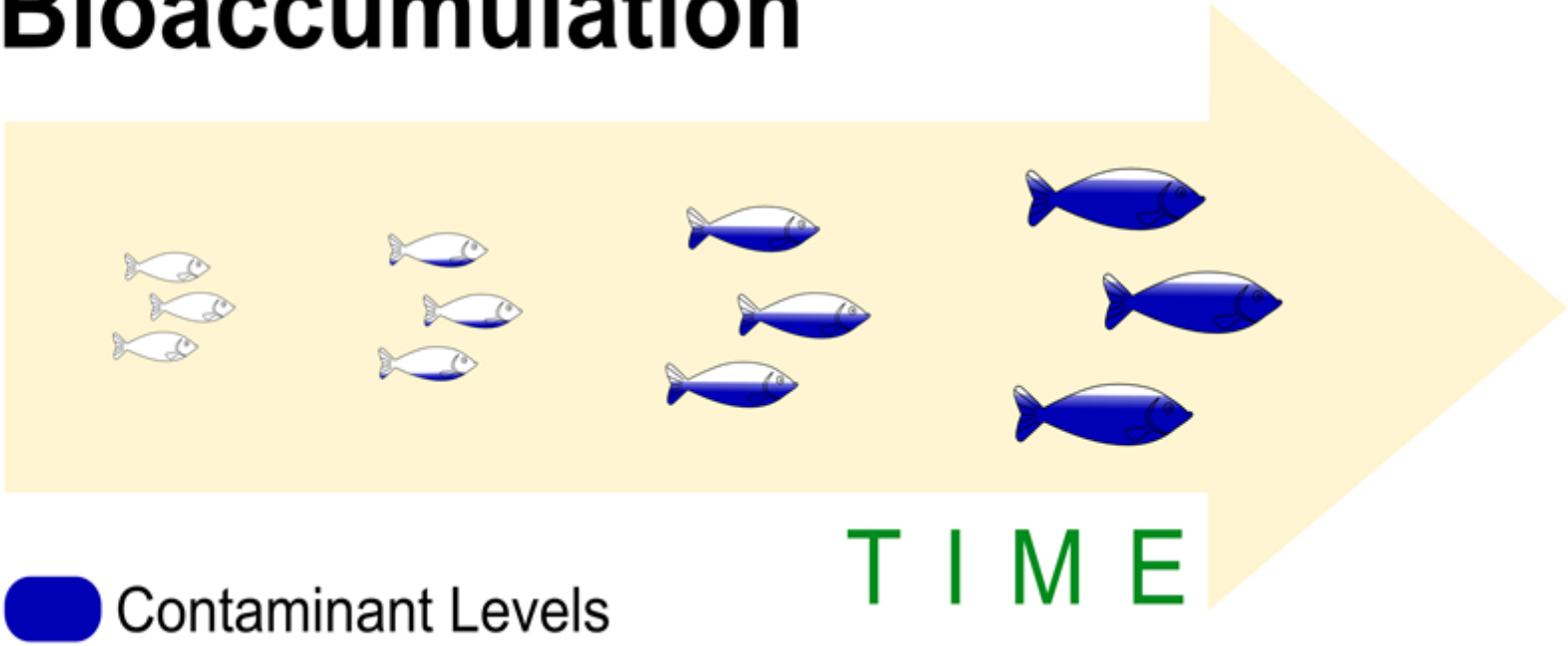
Role: Carnivores/Omnivores

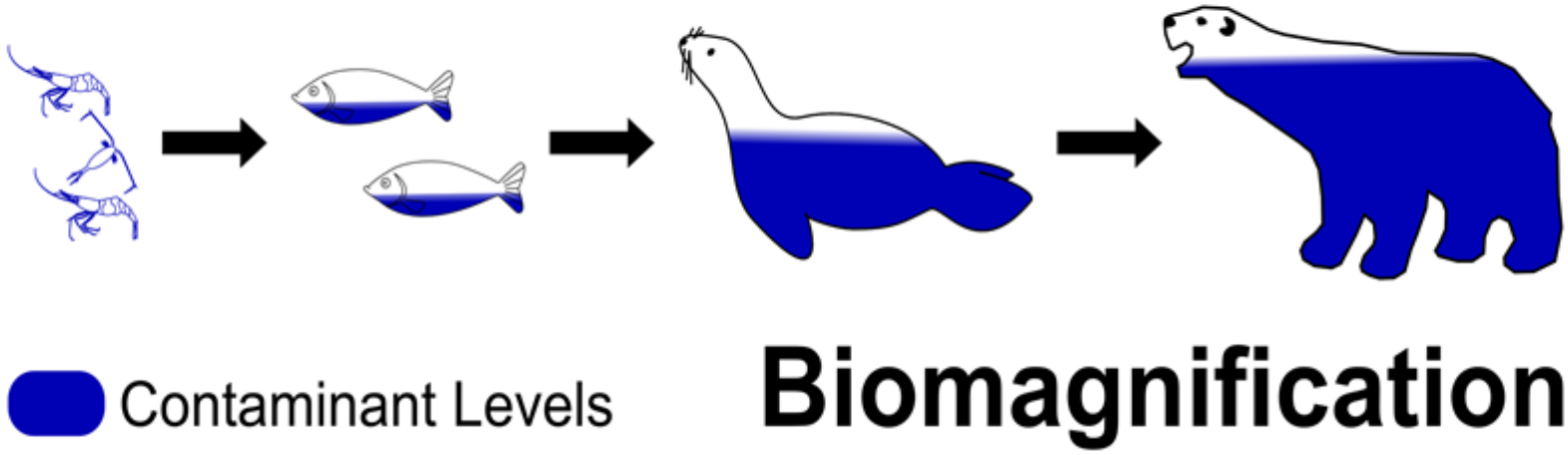
- Trophic Level:
  - Primary Consumer (2)
  - Secondary Consumer (3)
  - Tertiary Consumer (4)
- Rarely get higher than 4 trophic levels (ecological efficiency)

Role: Decomposers

- Obtain energy via decaying organisms
- Often the end of transfer of energy between organisms; return nutrients back to environment
- 2 groups
  - Fungi—actually decompose the organisms and absorb the nutrients
  - Detritivores—consume the decaying material

Bioaccumulation





Biomagnification