ECOSYSTEMS

Follow along in chapter 54

*Means less important

How do ecosystems function?

- What is an ecosystem?
  - All living things in an area and their abiotic environment

- Ecosystem function can be easily summed up
  - Matter moves in cycles
  - Energy flows through the system

Ecosystems and Physical Laws

- The laws of physics and chemistry apply to ecosystems
  - Particularly in regard to the flow of energy
- Energy is conserved
  - But degraded to heat during ecosystem processes

Trophic Relationships

- Energy and nutrients pass from primary producers (autotrophs)
  - To primary consumers (herbivores) and then to secondary consumers (carnivores)

- Energy flows through an ecosystem
  - Entering as light and exiting as heat

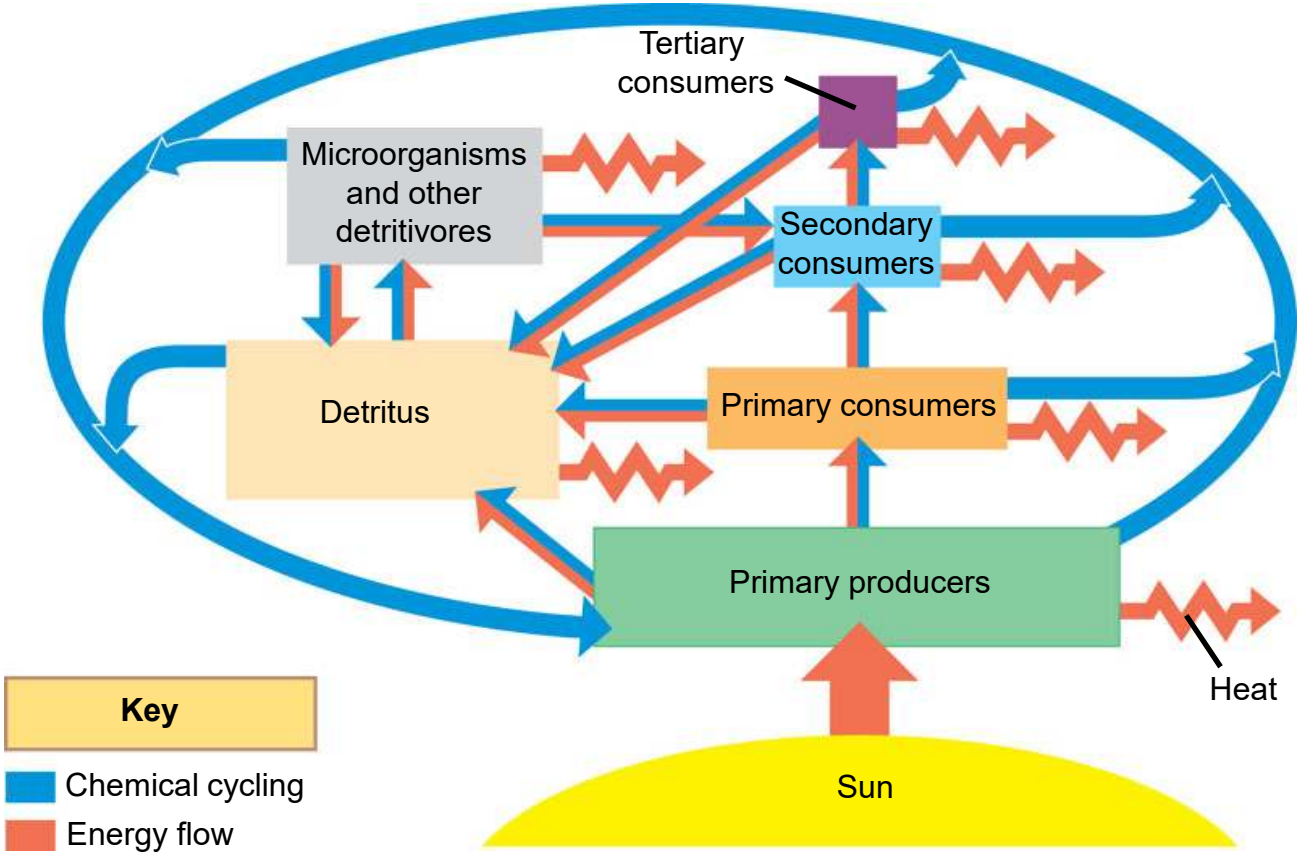


Figure 54.2

- Nutrients cycle within an ecosystem
  - Water
  - Carbon
  - Nitrogen
  - Phosphorous

*Decomposition

- Decomposition
  - Connects all trophic levels
  - Materials broken down and “recycled”

Ecosystem primary production

- What is primary production in an ecosystem?
  - The amount of light energy converted to chemical energy by autotrophs
  - The extent of photosynthetic production sets the limit for the energy budget of the entire ecosystem
  - Basically plants are the primary source for all the energy that exists in an ecosystem
    - They got the energy from the sun and no other organism is doing that

Gross and Net Primary Production

- Total primary production in an ecosystem is known as that ecosystem's gross primary production (GPP)
  - Not all of this production is stored as organic material (carbohydrates) in the growing plants
  - Why not? They use some of this energy themselves for growth

- Net primary production (NPP)
  - Is equal to GPP minus the energy used by the primary producers for respiration
- Only NPP is available to consumers

- Why is this important? There has to be enough NPP to support all the other species in an ecosystem

- *Different ecosystems vary considerably in their net primary production
  - And in their contribution to the total NPP on Earth

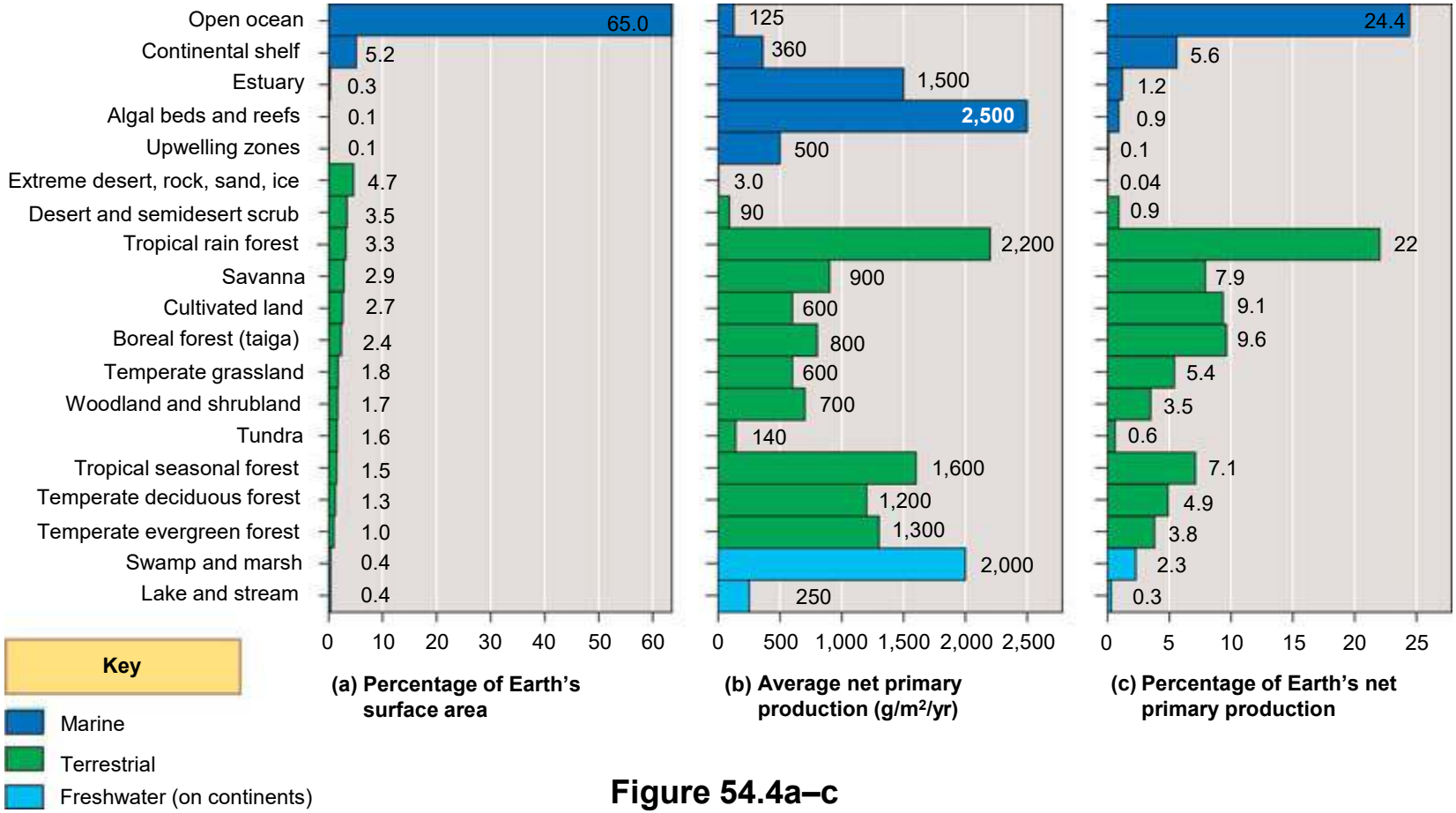


Figure 54.4a–c

- *A limiting nutrient is the element that must be added in order for production to increase
  - Nitrogen and phosphorous are common limiting nutrients

- The addition of large amounts of nutrients to lakes has a wide range of ecological impacts
  - Sewage and fertilizer run off leads to eutrophication
    - Excessive plant growth of plant life- can lead to fish species loss

Figure 54.7

Major big idea of this awesome powerpoint:

- **Energy transfer between trophic levels is usually less than 20% efficient**
  - **A good average estimate is 10%**

- The secondary production of an ecosystem is the amount of chemical energy in a consumers' food that is converted to their own new biomass
  - Basically if that energy is used by an organism to build up their biomass, then they have "stored" all that energy in themselves

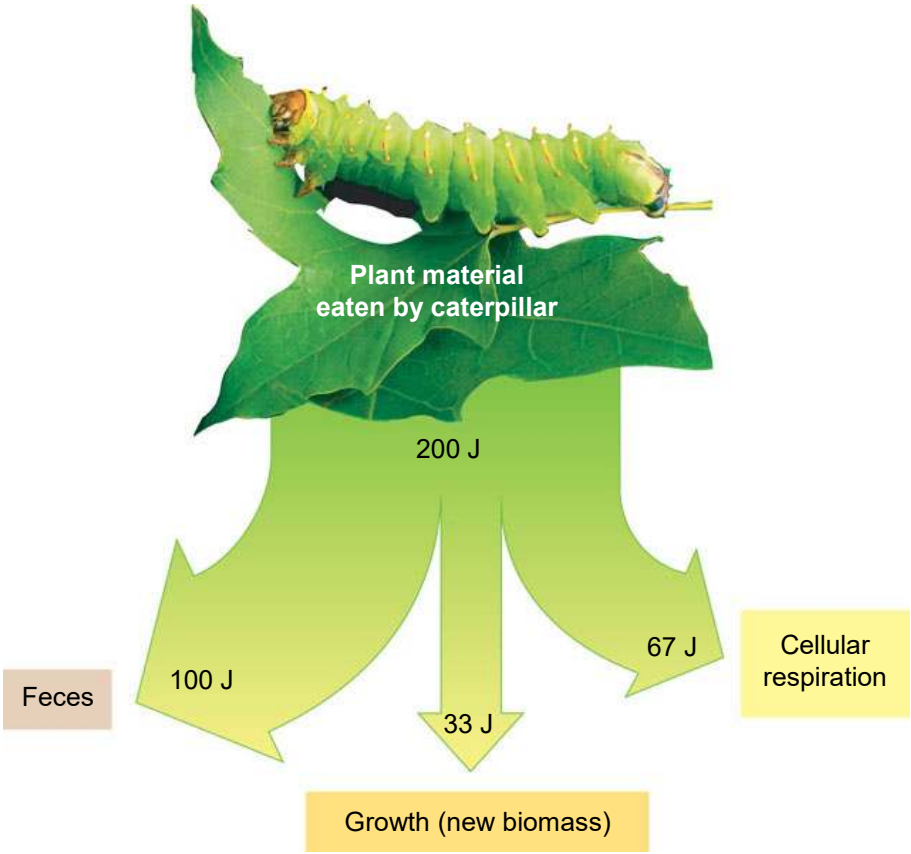
Major big idea of this awesome powerpoint:

- **Energy transfer between trophic levels is usually less than 20% efficient**
  - **A good average estimate is 10%**

- The secondary production of an ecosystem is the amount of chemical energy in consumers' food that is converted to their own new biomass during a given period of time

Production Efficiency

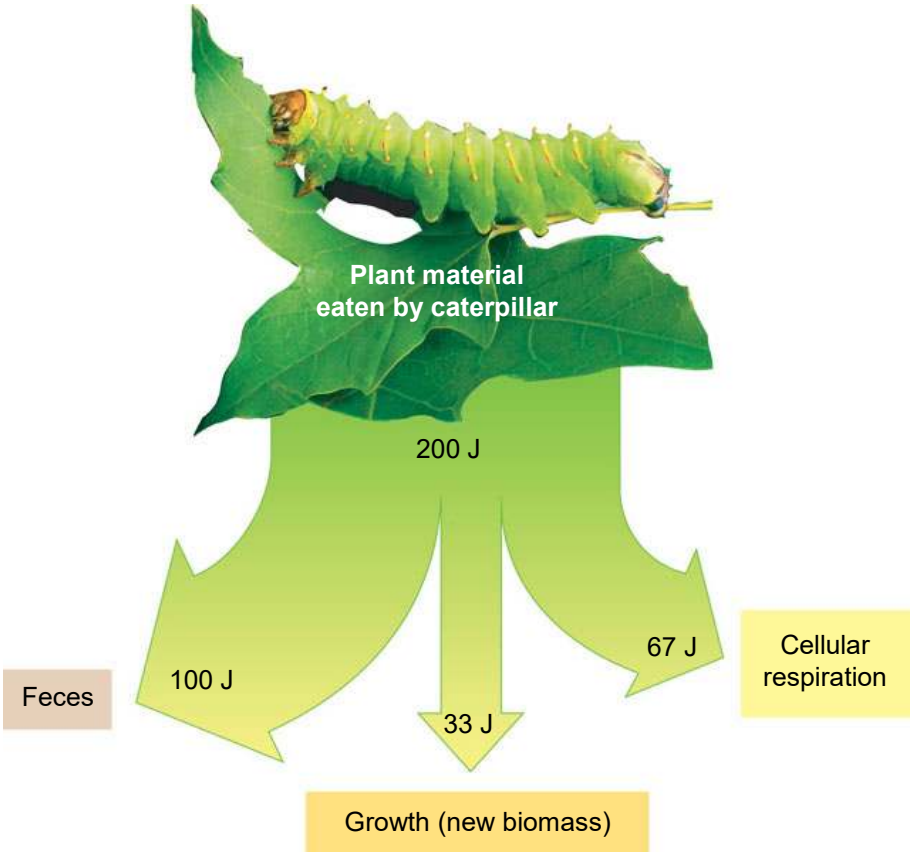
- When a caterpillar feeds on a plant leaf only about one-sixth of the energy in the leaf is used for secondary production
  - That's not very much. Where does the rest of the energy go?
    - Check out the picture
- So, what happens to all that stored energy when the caterpillar gets eaten?



Trophic Efficiency and Ecological Pyramids

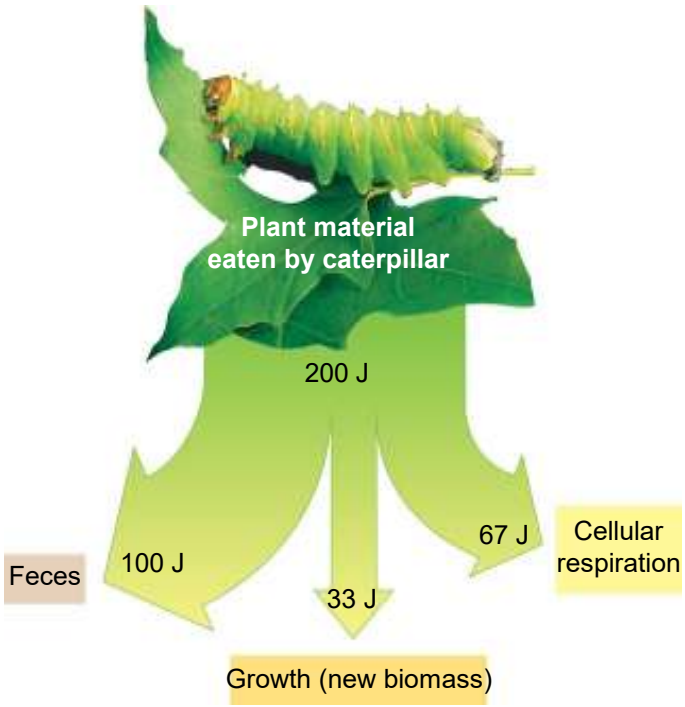
- It gets transferred to the organism that ate the caterpillar

- Trophic efficiency
  - Percentage of production transferred from one trophic level to the next
  - Usually ranges from 5% to 20%



Trophic Efficiency and Ecological Pyramids

- Trophic efficiency is really low because lots of energy gets used and lost every time something eats something else
  - Plants start will 100% of captured energy
  - Caterpillar gets 20% or less from the plant
  - Bird gets 20% or less from the caterpillar (4% of original)
  - Snake gets 20% or less from the bird (0.8% of original)



Pyramids of Production

- This loss of energy with each transfer in a food chain can be represented by a pyramid of net production
  - The higher the trophic level, the less energy available

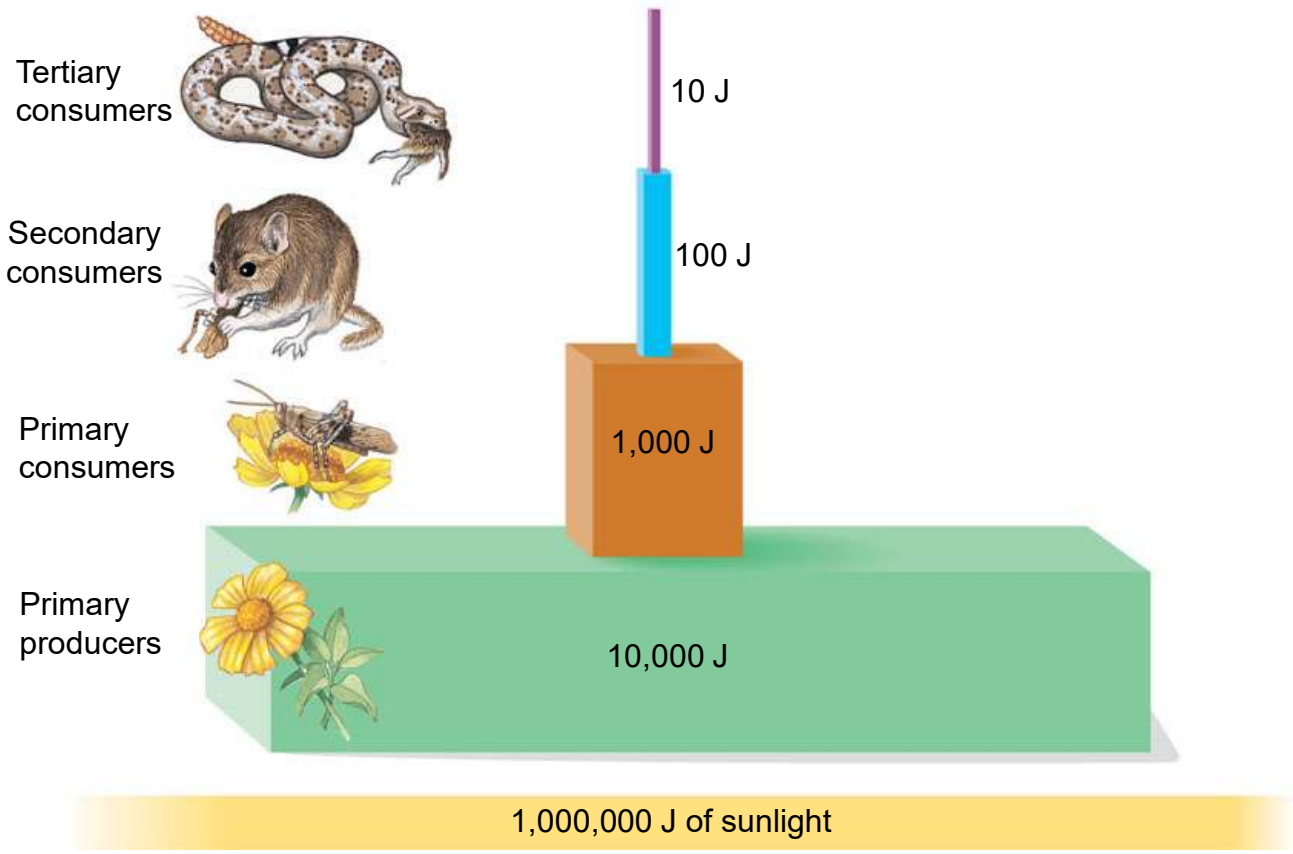
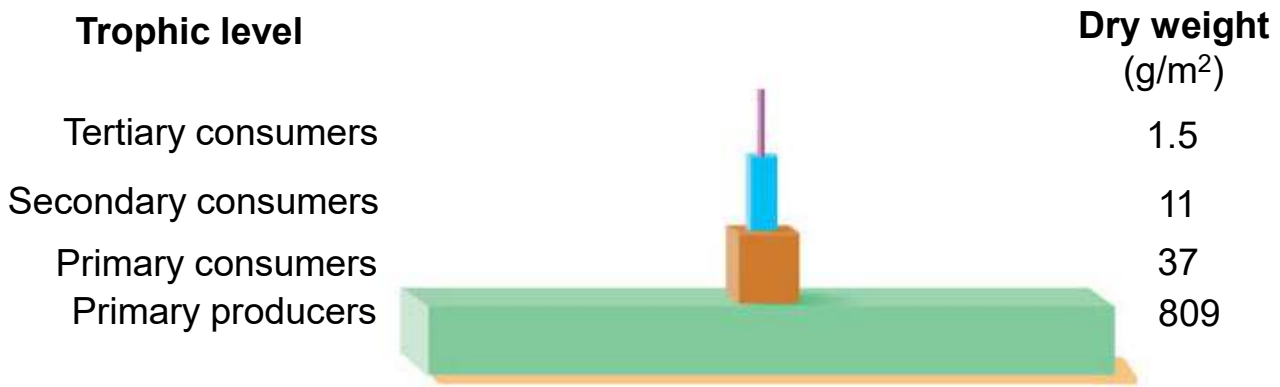


Figure 54.11

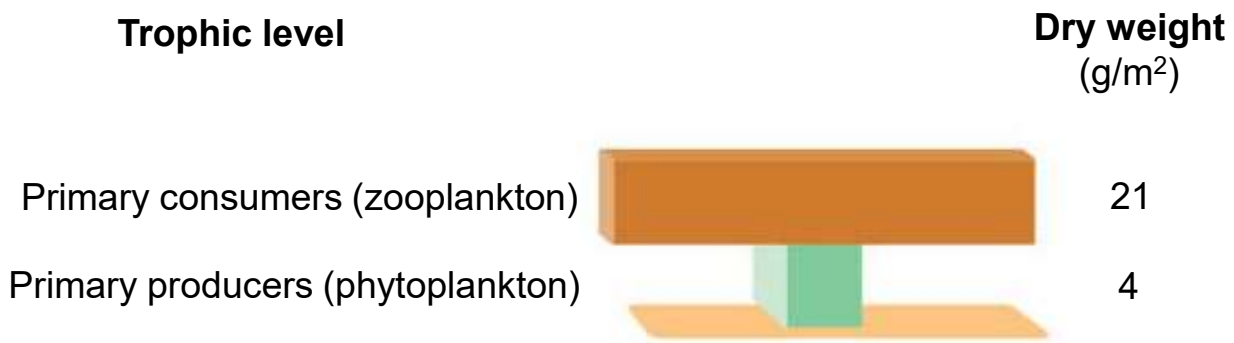
Pyramids of Biomass

- How does less energy at higher trophic levels affect an ecosystem?
  - Because there is less energy as you go up, there are fewer individuals in each higher trophic level
  - Fewer individuals = less matter
- A biomass pyramid shows this relationship
  - Amount of matter found in an individual or group of individuals



(a) Most biomass pyramids show a sharp decrease in biomass at successively higher trophic levels, as illustrated by data from a bog at Silver Springs, Florida.

- *Some aquatic ecosystems have inverted biomass pyramids



(b) In some aquatic ecosystems, such as the English Channel, a small standing crop of primary producers (phytoplankton) supports a larger standing crop of primary consumers (zooplankton).

Figire 54.12b

Pyramids of Numbers

- A pyramid of numbers represents the number of individual organisms in each trophic level

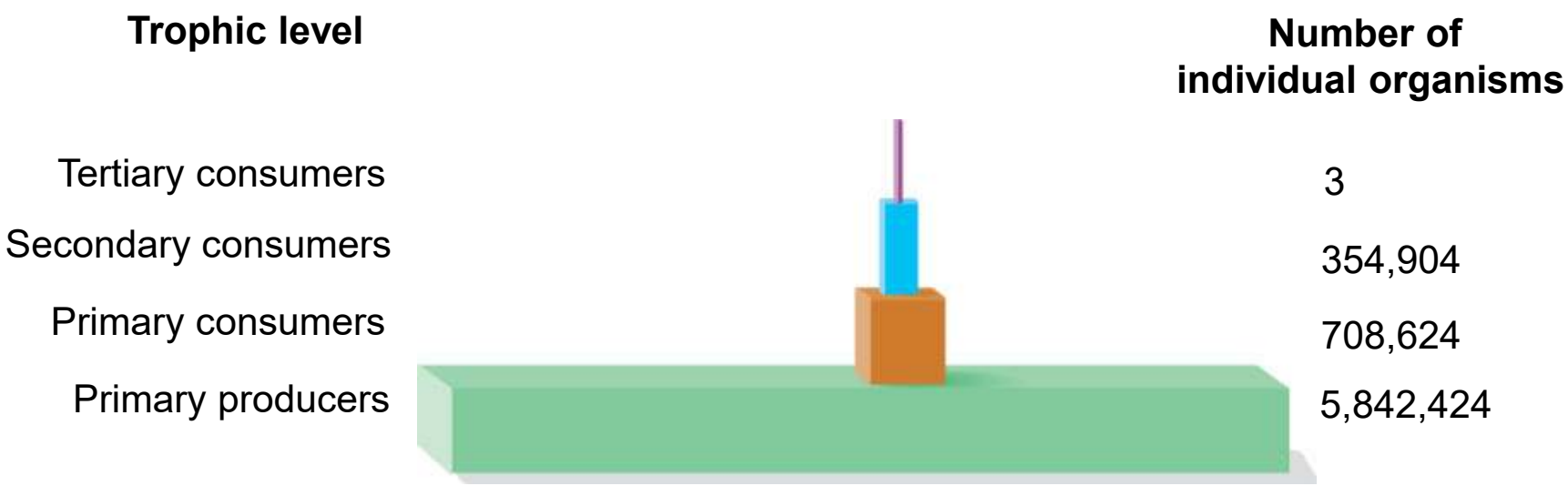
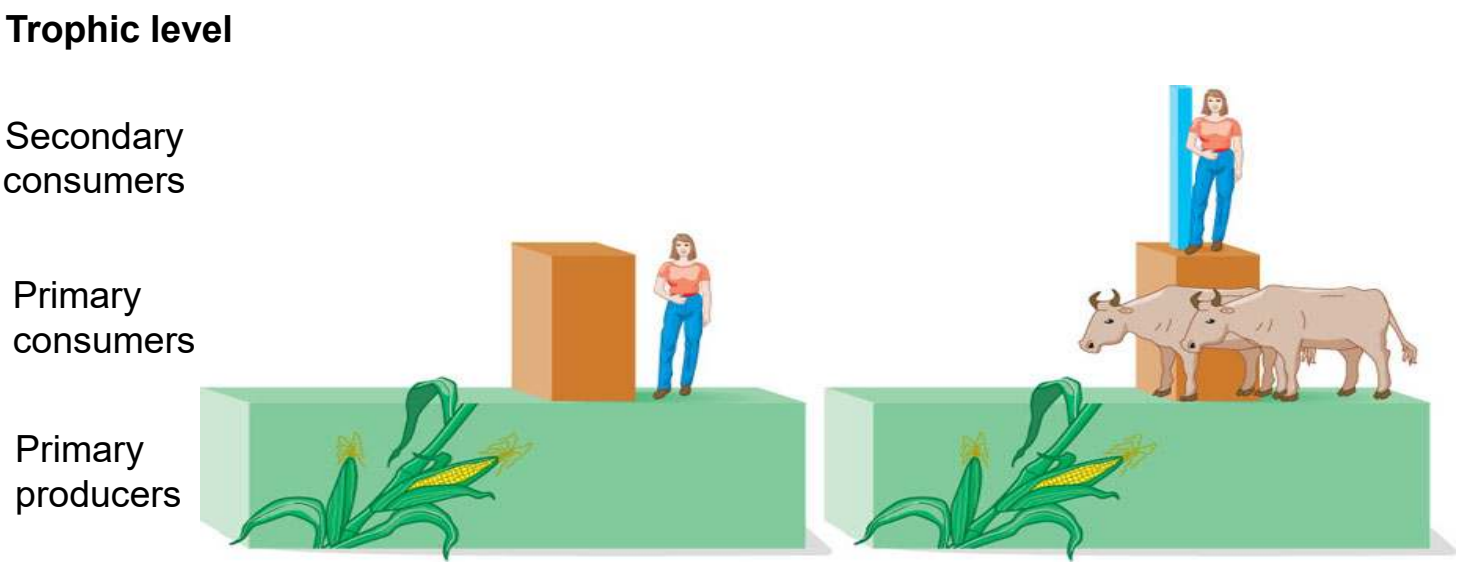


Figure 54.13

- The dynamics of energy flow through ecosystems have important implications for the human population
  - Eating meat is a relatively inefficient way of tapping photosynthetic production
    - Eating consumers = less available energy
- Worldwide agriculture could successfully feed many more people if humans all fed more efficiently, eating only plant material



Matter moves from organic to inorganic and back again

- Nutrients move between organic and inorganic parts of the ecosystem
- Life depends on the recycling of essential chemical elements
- Nutrient circuits that cycle matter through an ecosystem involve both biotic and abiotic components and are often called biogeochemical cycles

A General Model of Chemical Cycling

- All elements cycle between organic and inorganic reservoirs
- Elements exist as gaseous forms in the atmosphere and cycle globally
  - carbon, oxygen, sulfur, and nitrogen
- Less mobile elements cycle more in a local level
  - phosphorous, potassium, and calcium

Biogeochemical Cycles

- The water cycle and the carbon cycle

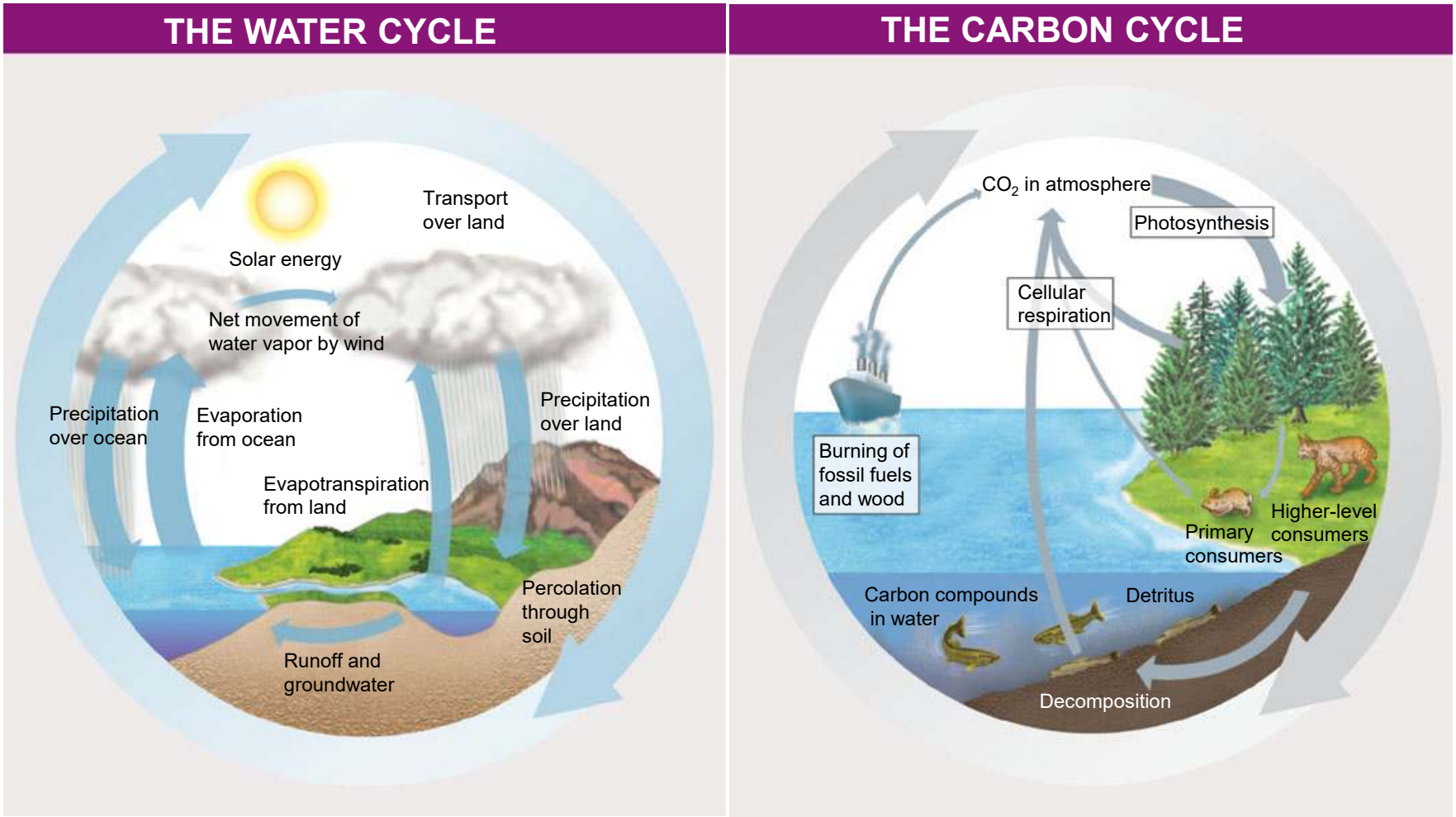
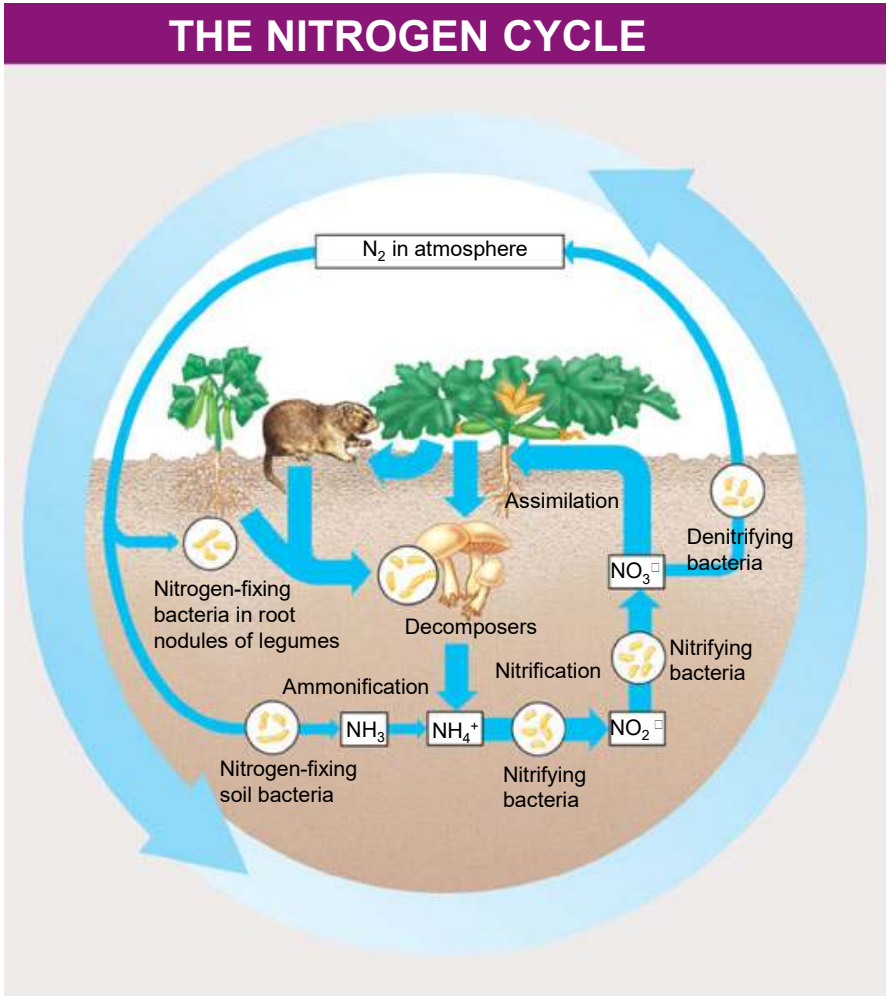


Figure 54.17

- Water moves in a global cycle
  - Driven by solar energy
- The carbon cycle works based on the reciprocal processes of photosynthesis and cellular respiration

- The nitrogen cycle and the phosphorous cycle



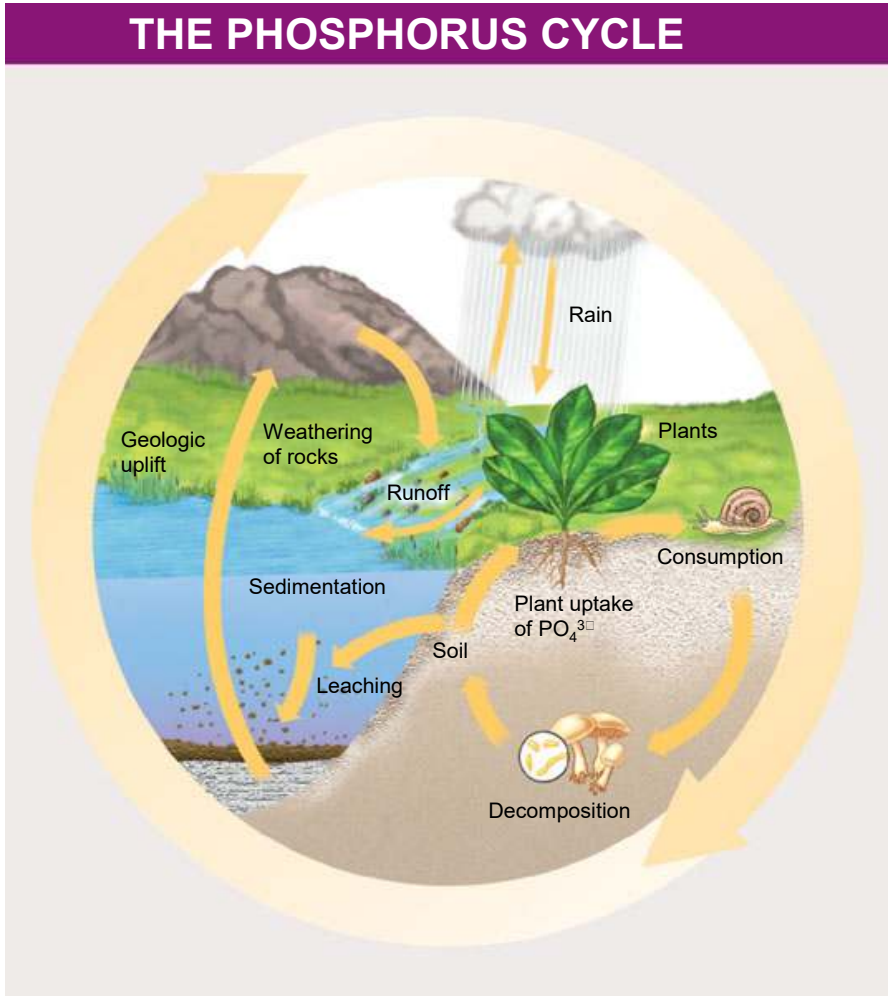


Figure 54.17

- Most of the nitrogen cycling in natural ecosystems involves local cycles between organisms and soil or water

- The phosphorus cycle is relatively localized

Decomposition and Nutrient Cycling Rates

- Decomposers (detritivores) play a key role in the general pattern of chemical cycling
- The rates at which nutrients cycle in different ecosystems are extremely variable, mostly due to differences in rates of decomposition

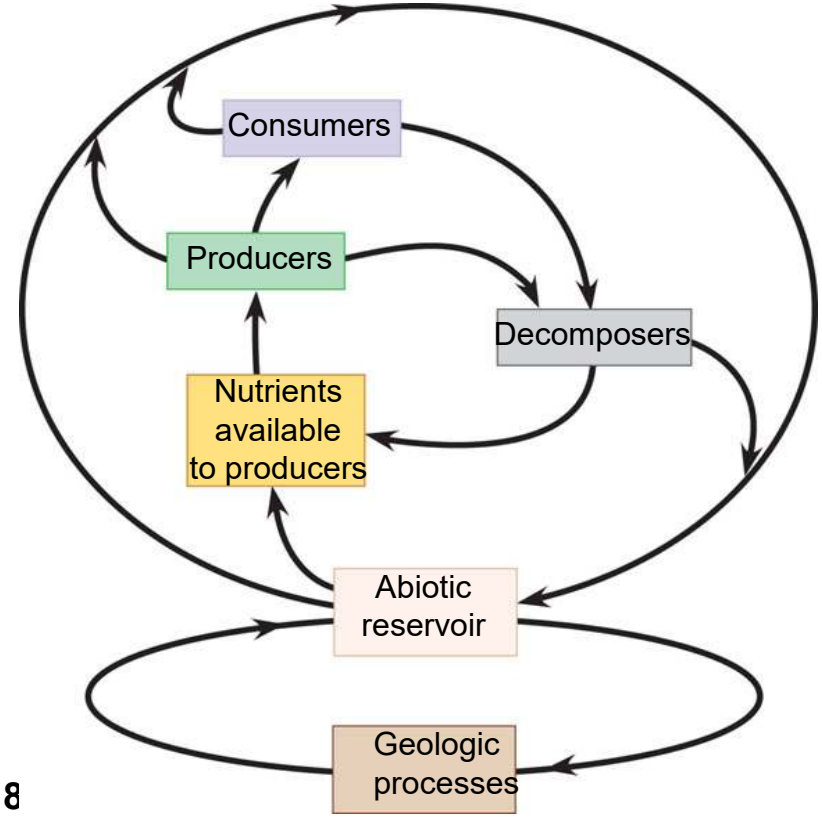


Figure 54.18

Humans can mess up ecosystems

- Check out 55.1 in your book and see some specific ways that people make ecosystems unstable
  - Just read the headings