

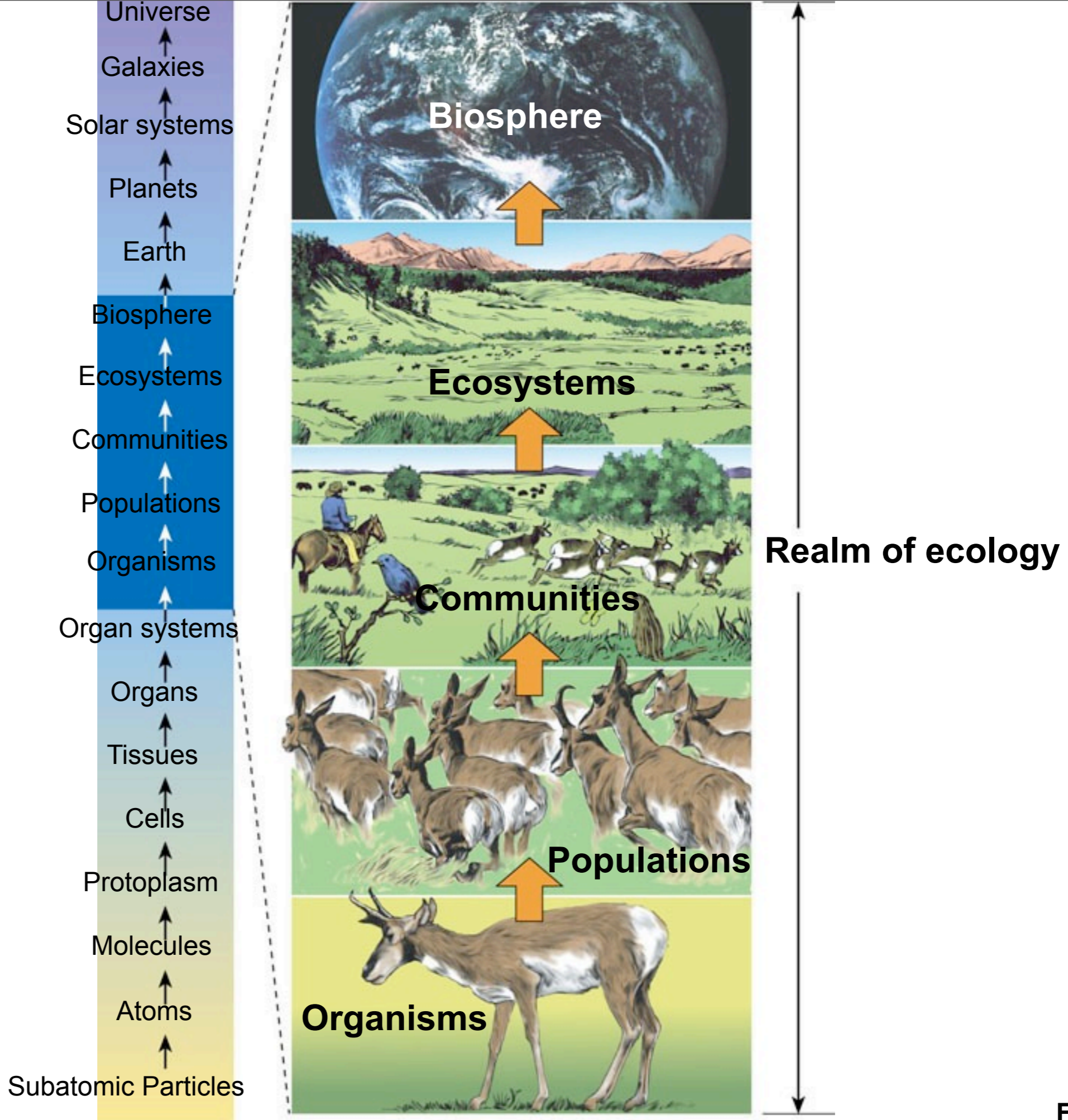


Chapter 3

Ecosystem Ecology

Populations, Communities, and Ecosystems

- Members of a species interact in groups called **populations**.
- Populations of different species living and interacting in an area form a **community**.
- A community interacting with its physical environment of matter and energy is an **ecosystem**.



Ecosystem Ecology Examines Interactions Between the Living and Non-Living World

- **Ecosystem-** A particular location on Earth distinguished by its particular mix of interacting biotic and abiotic components.
- **Ecology-** The study of connections and nature.
 - How organisms interact with one another and their nonliving environment.

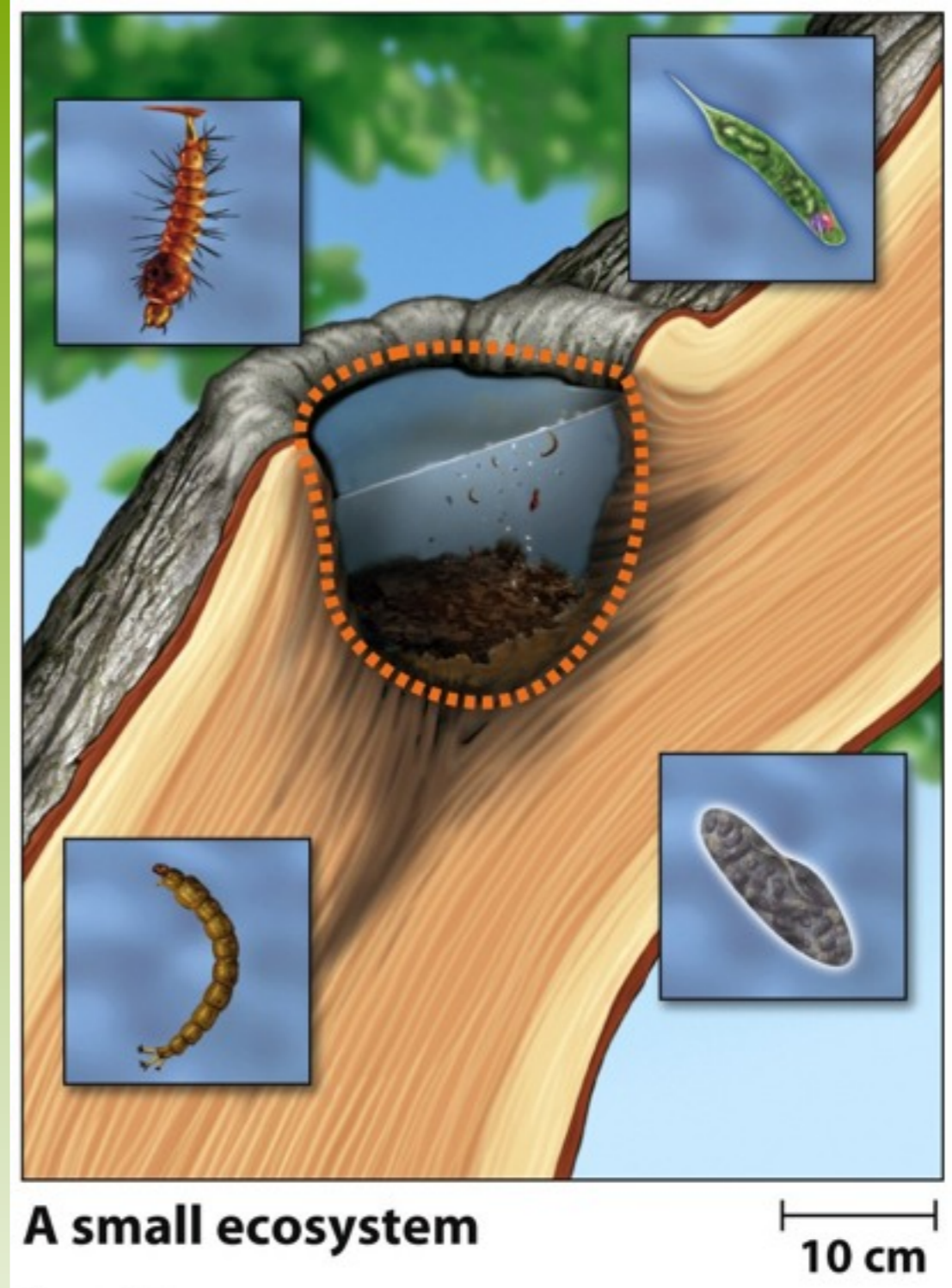
Ecosystem Boundaries

- Some ecosystems, such as a caves and lakes have very distinctive boundaries. However, in most ecosystems it is difficult to determine where one ecosystems stops and the next begins.

The Greater Yellowstone Ecosystem



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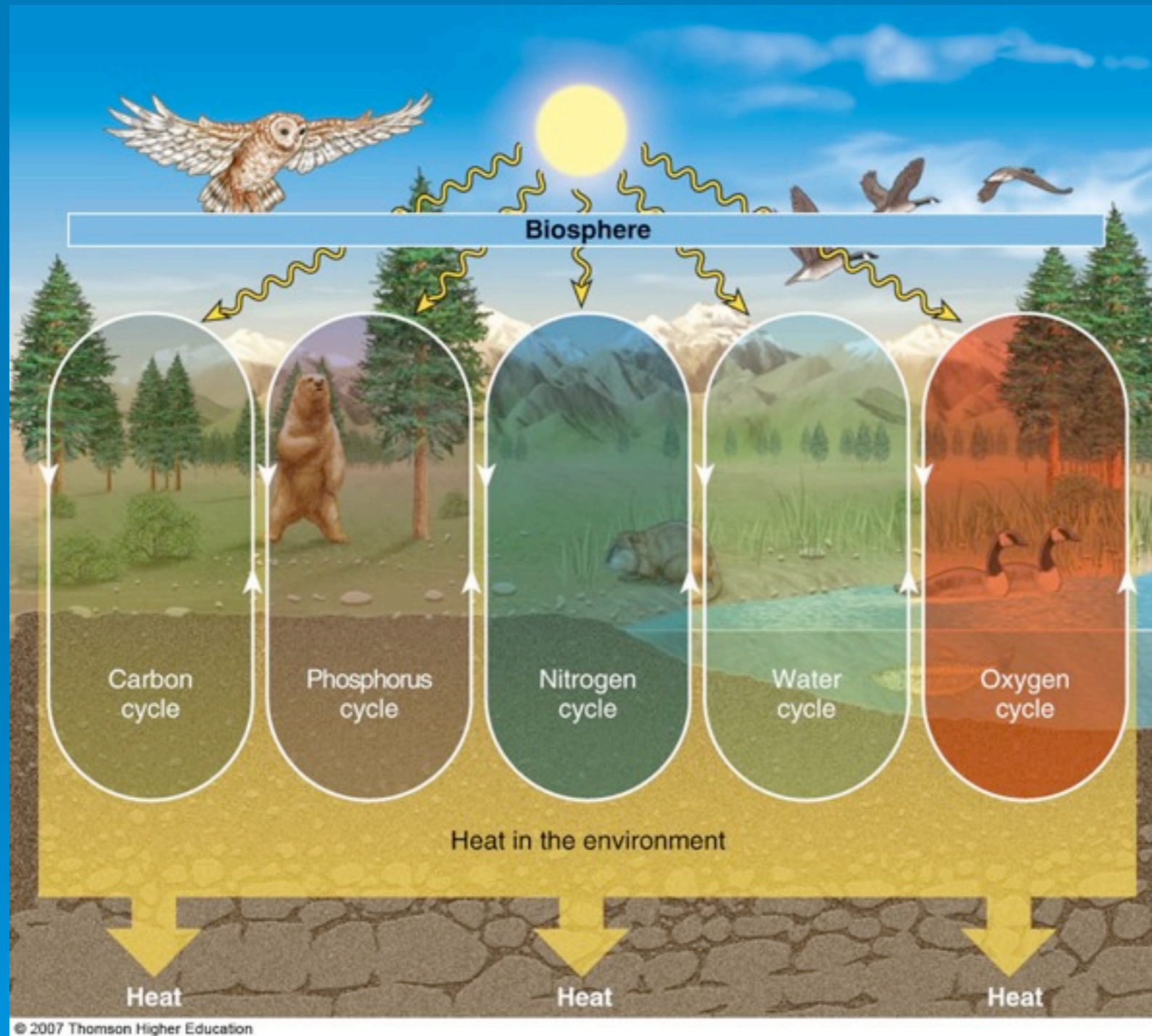
A small ecosystem

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Ecosystem Processes

- Even though it is helpful to distinguish between two different ecosystems, ecosystems interact with other ecosystems.

What Sustains Life on Earth?



- Solar energy, the cycling of matter, and gravity sustain the earth's life.

Figure 3-7

What Happens to Solar Energy Reaching the Earth?

- Solar energy flowing through the biosphere warms the atmosphere, evaporates and recycles water, generates winds and supports plant growth.

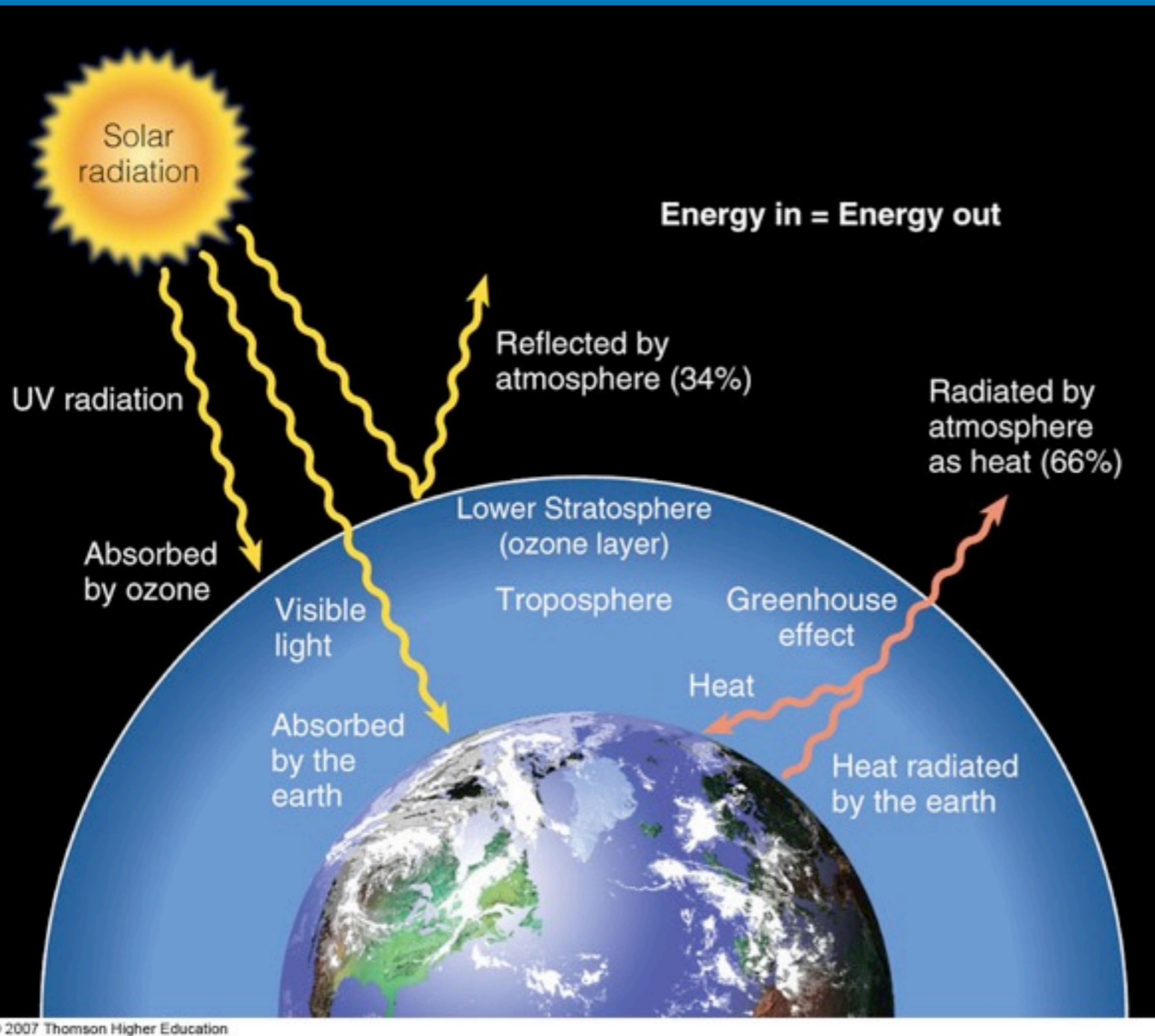
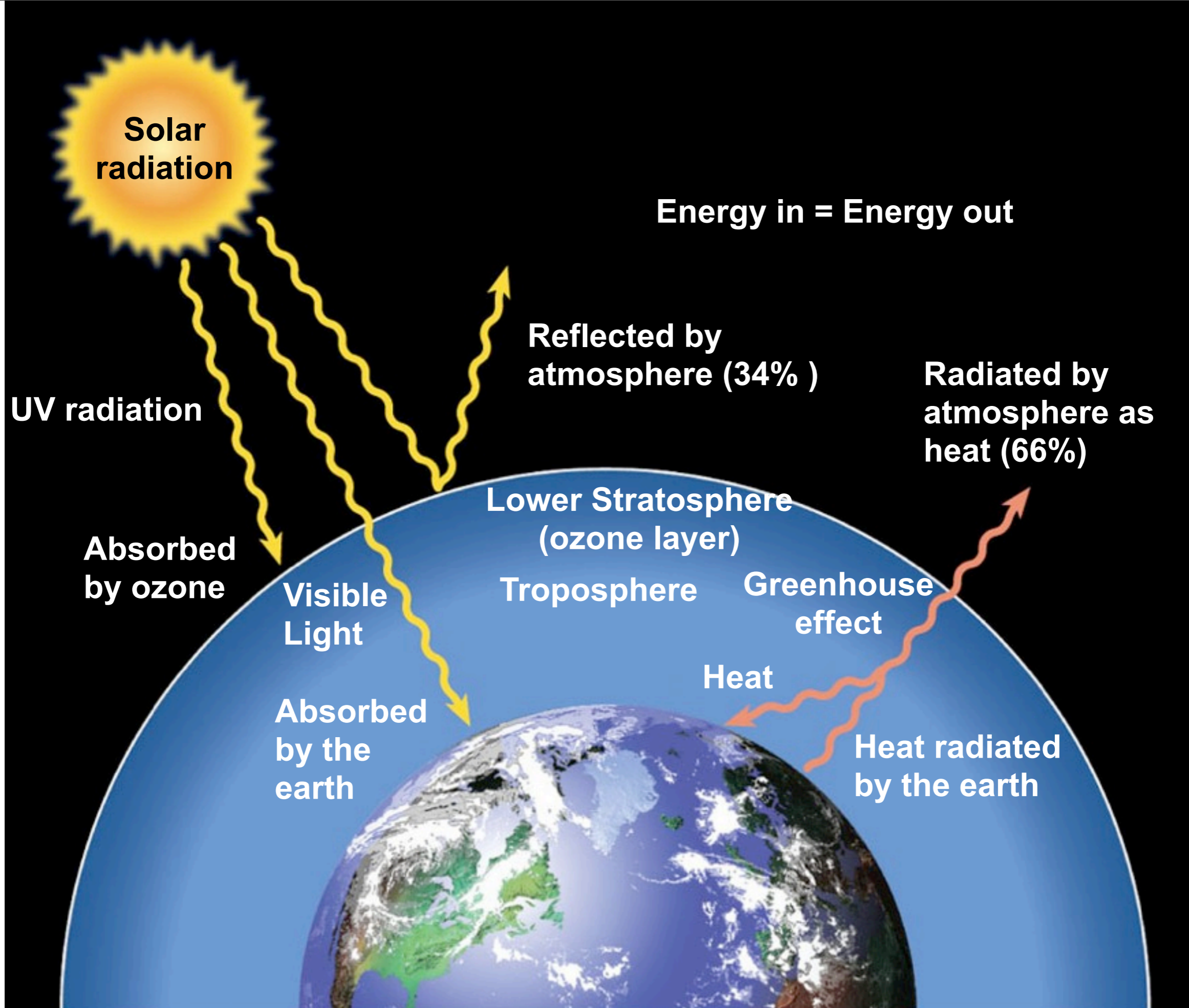
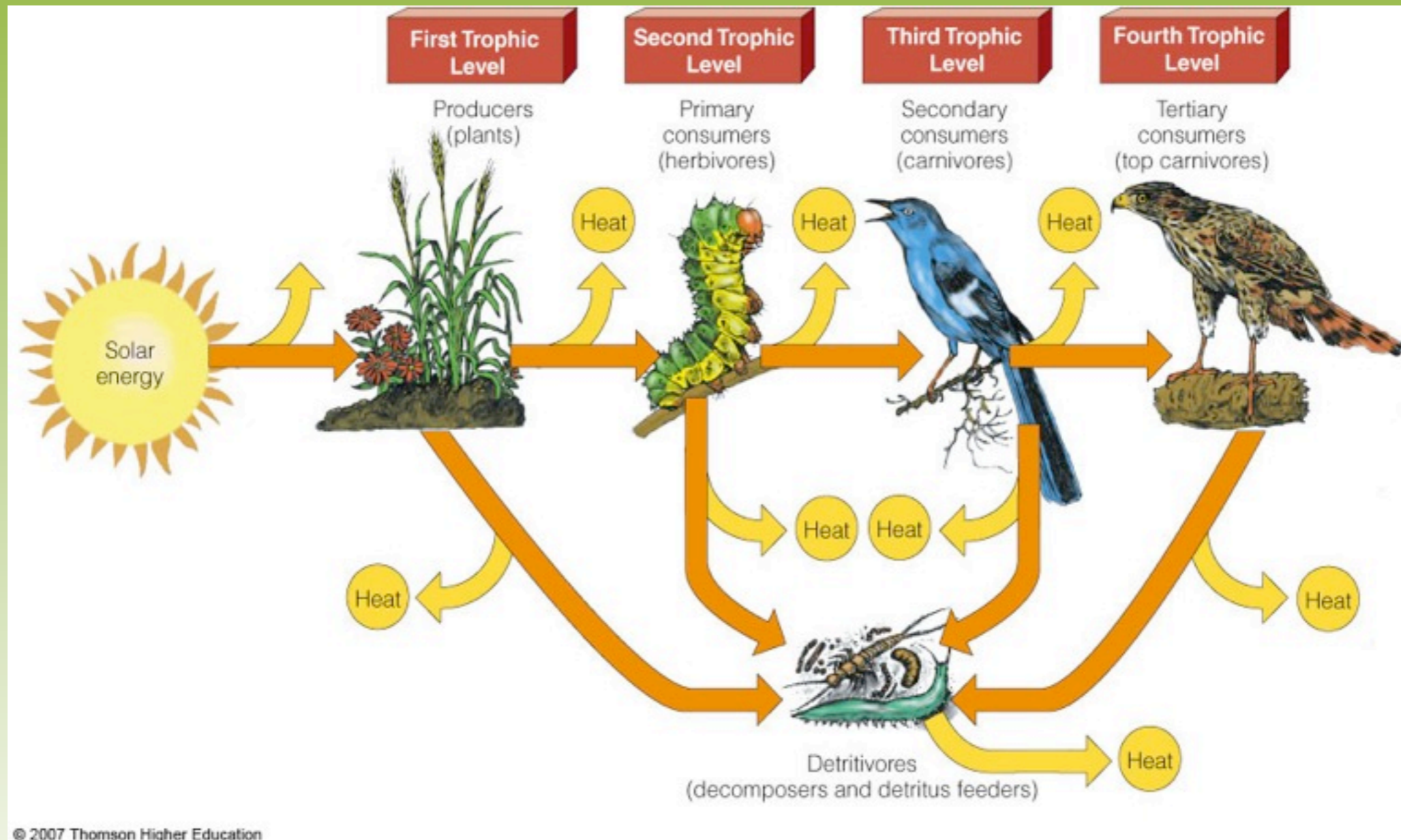


Figure 3-8

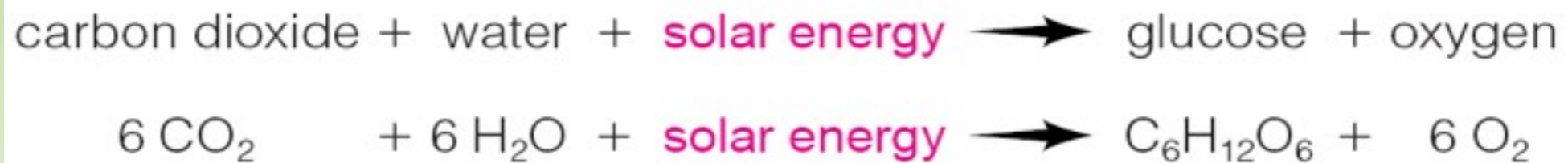


Energy Flows through Ecosystems



Photosynthesis and Respiration

- Producers (autotrophs) are able to use the sun's energy to produce usable energy through the process called **photosynthesis**.



Photosynthesis and Respiration

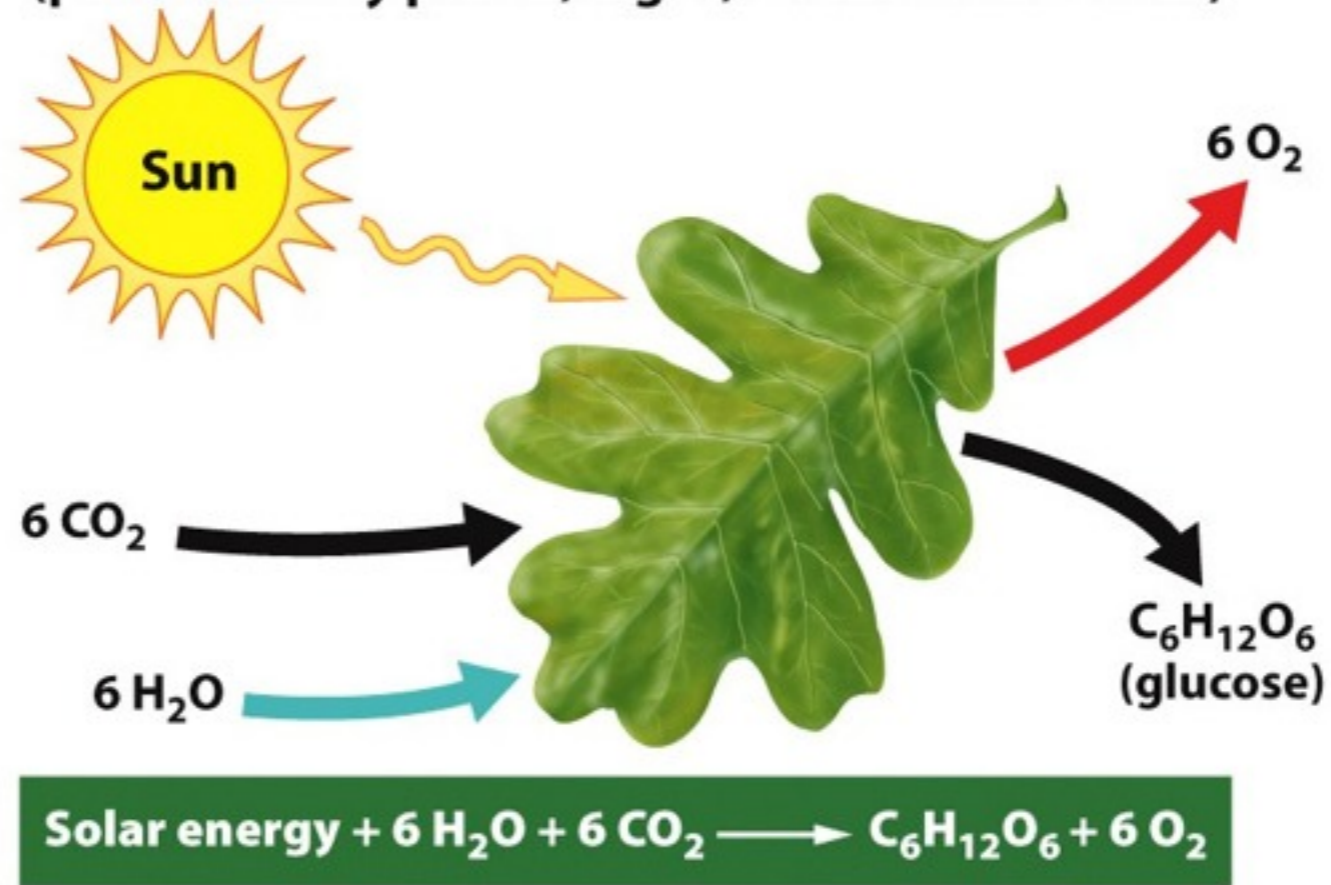
- **Cellular respiration** is the process by which other organisms gain energy from eating the tissues of producers.

glucose + oxygen \longrightarrow carbon dioxide + water + energy

$C_6H_{12}O_6 + 6 O_2 \longrightarrow 6 CO_2 + 6 H_2O + \text{energy}$

Photosynthesis

(performed by plants, algae, and some bacteria)



Respiration

(performed by all organisms)

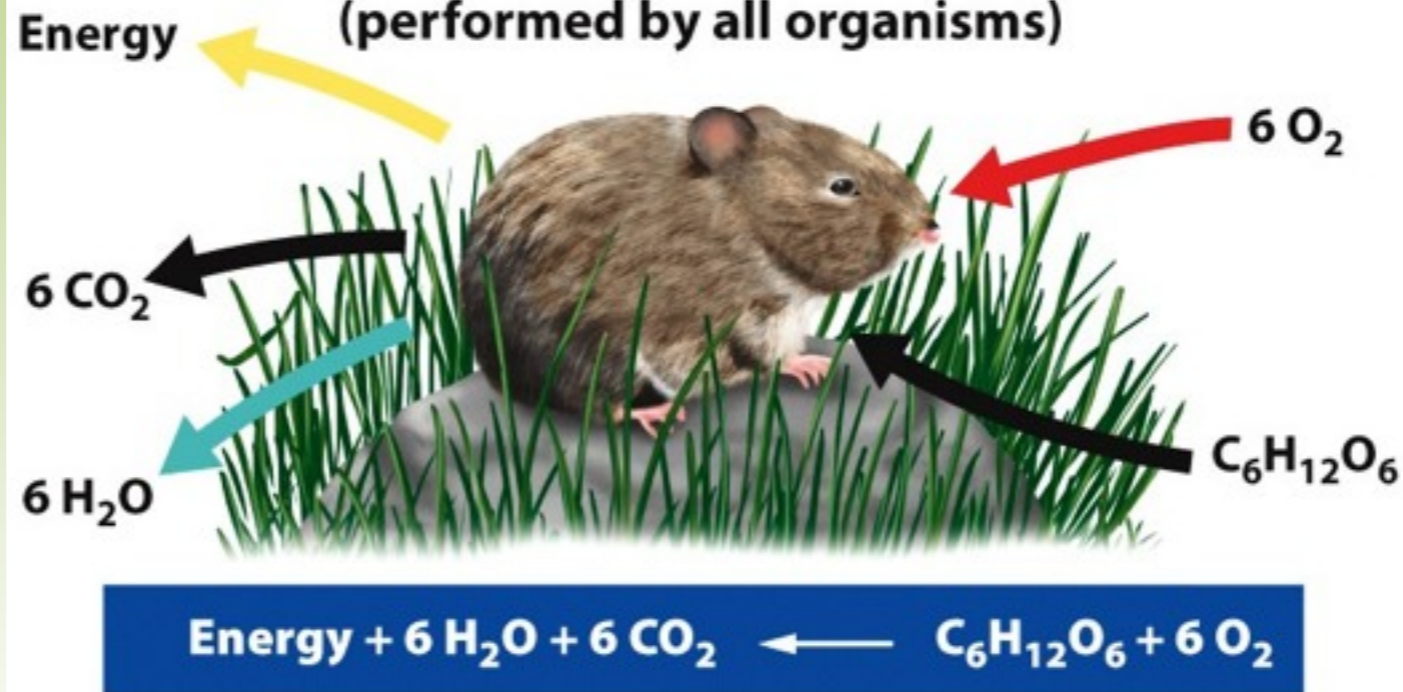


Figure 3.4

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Trophic Levels, Food Chains, and Food Webs

- **Consumers** (heterotrophs)- obtain energy by consuming other organisms.
- **Primary Consumers** (herbivores)- consume producers.
- **Secondary Consumers** (carnivores)- obtain their energy by eating primary consumers.
- **Tertiary Consumers** (carnivores)- eat secondary consumers.

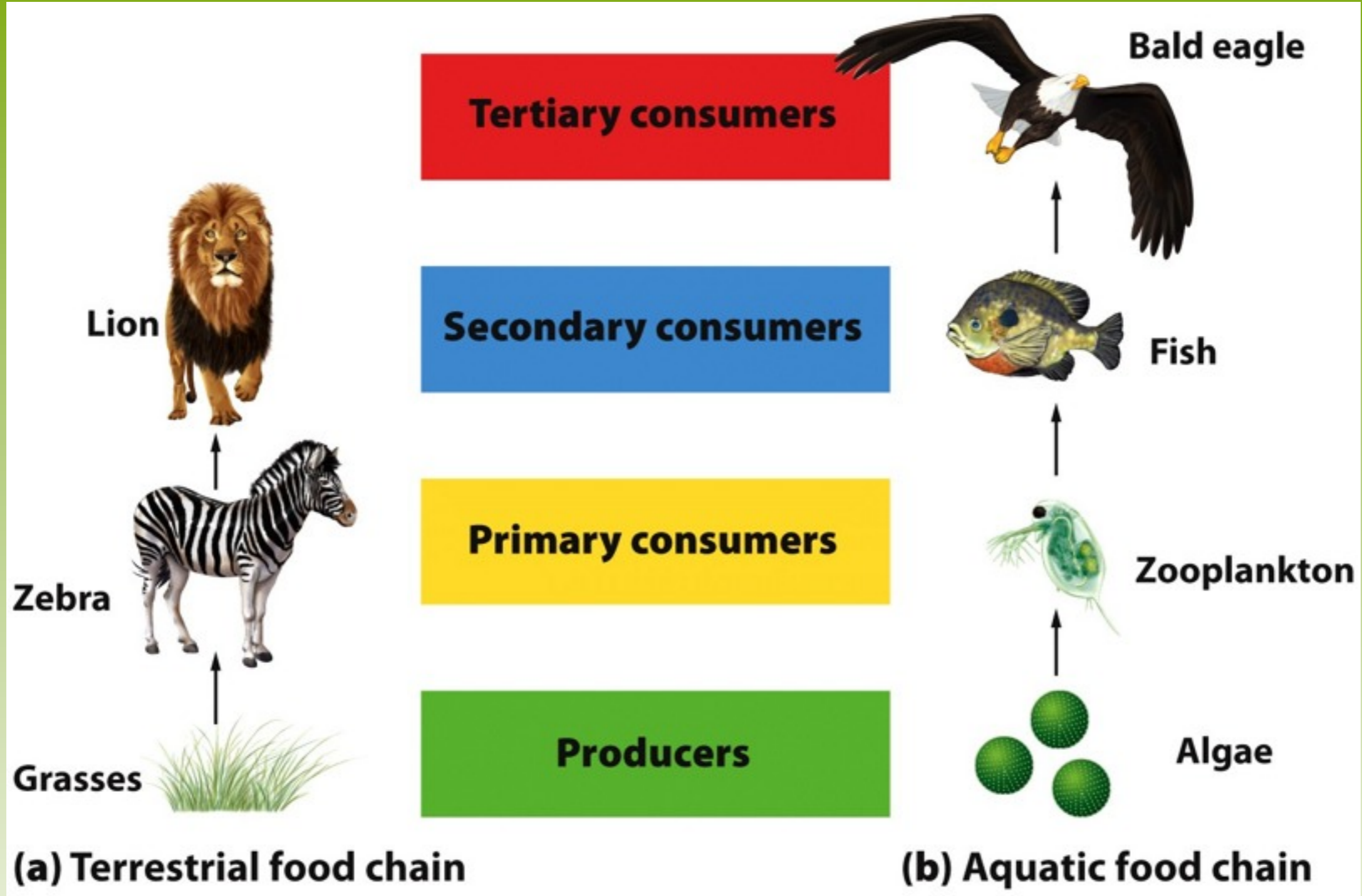


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- **Food Chain-** The sequence of consumption from producers through tertiary consumers.
- **Food Web-** A more realistic type of food chain that takes into account the complexity of nature.

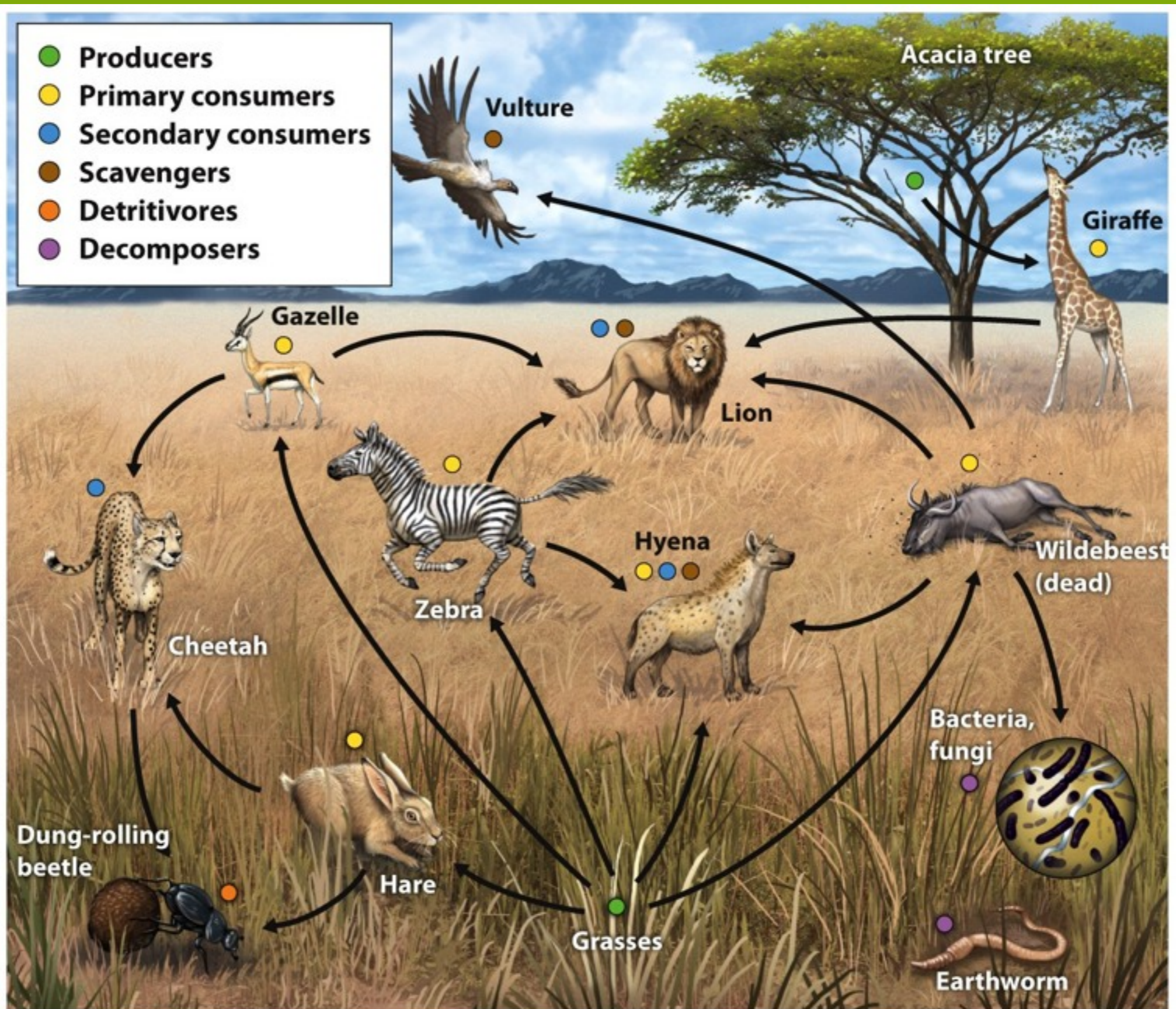
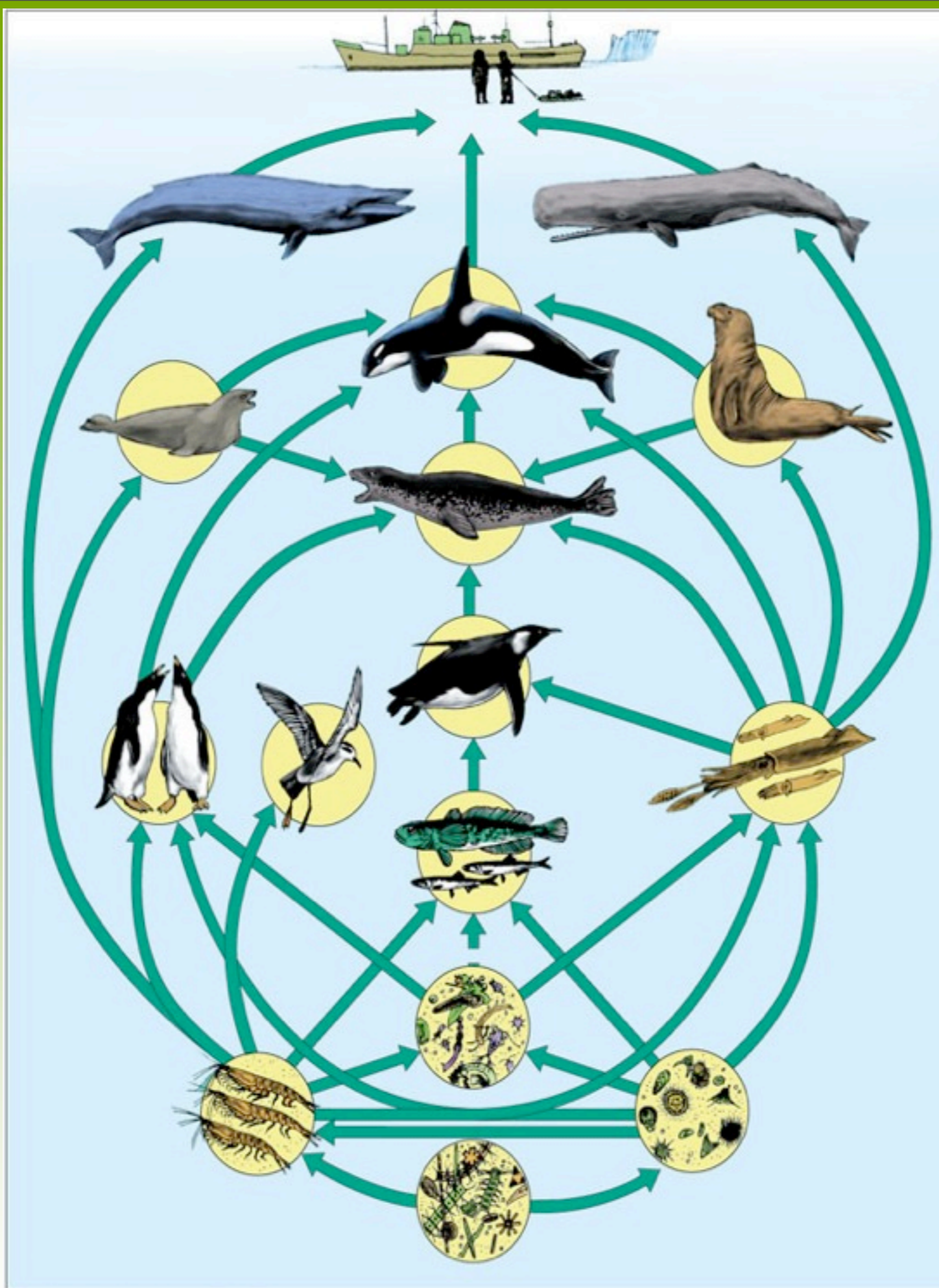


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Ecosystem Productivity

- **Gross primary productivity (GPP)**- The total amount of solar energy that the producers in an ecosystem capture via photosynthesis over a given amount of time.
- **Net primary productivity (NPP)**- The energy captured (GPP) minus the energy respired by producers.

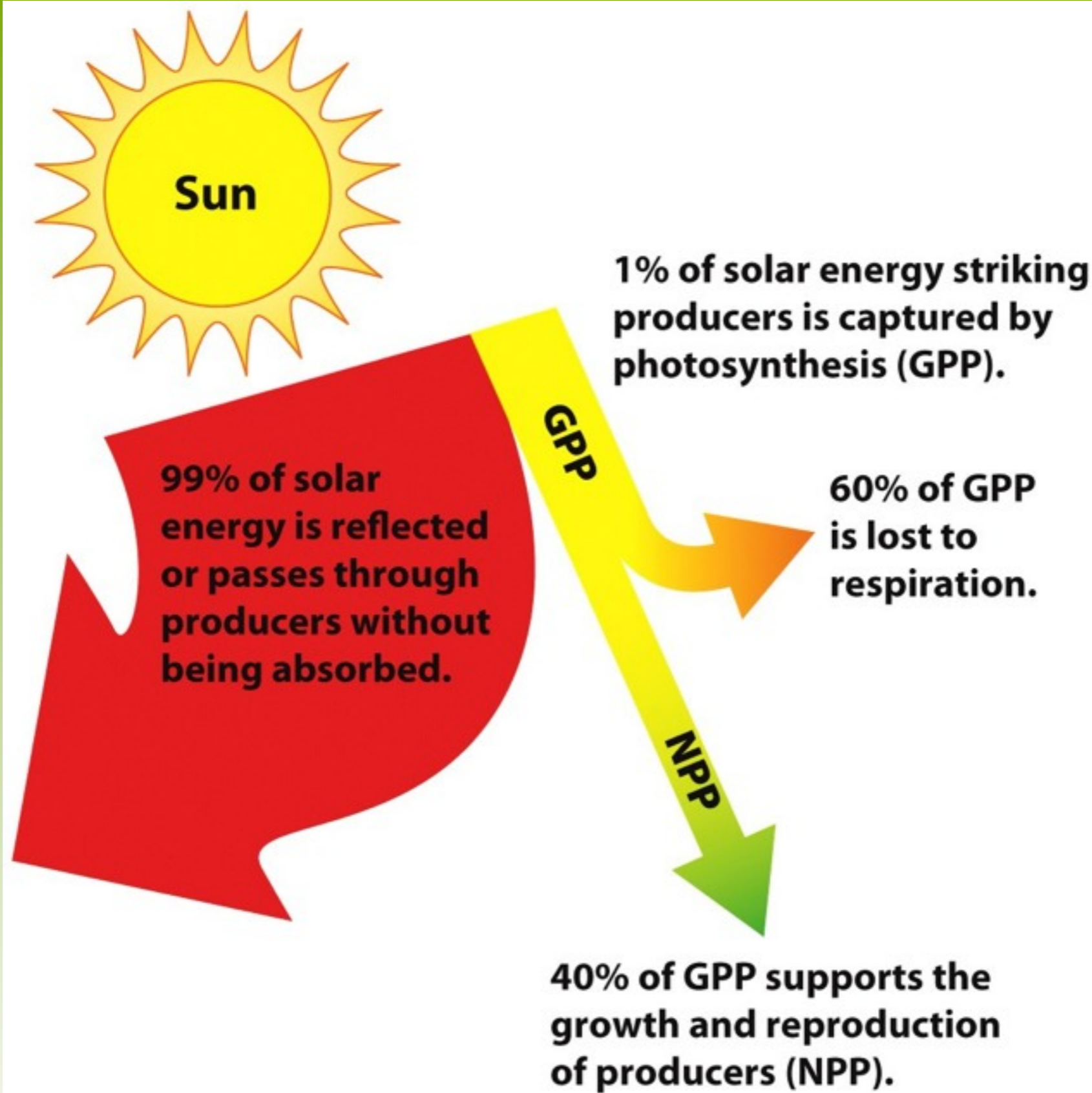
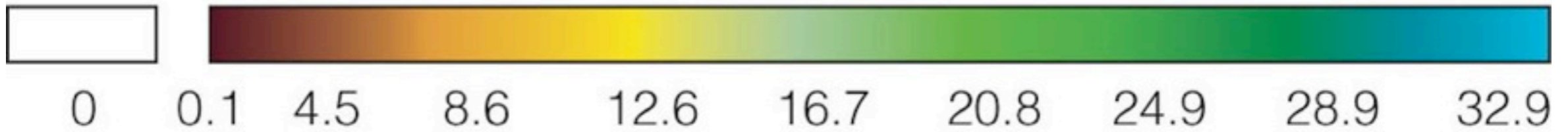
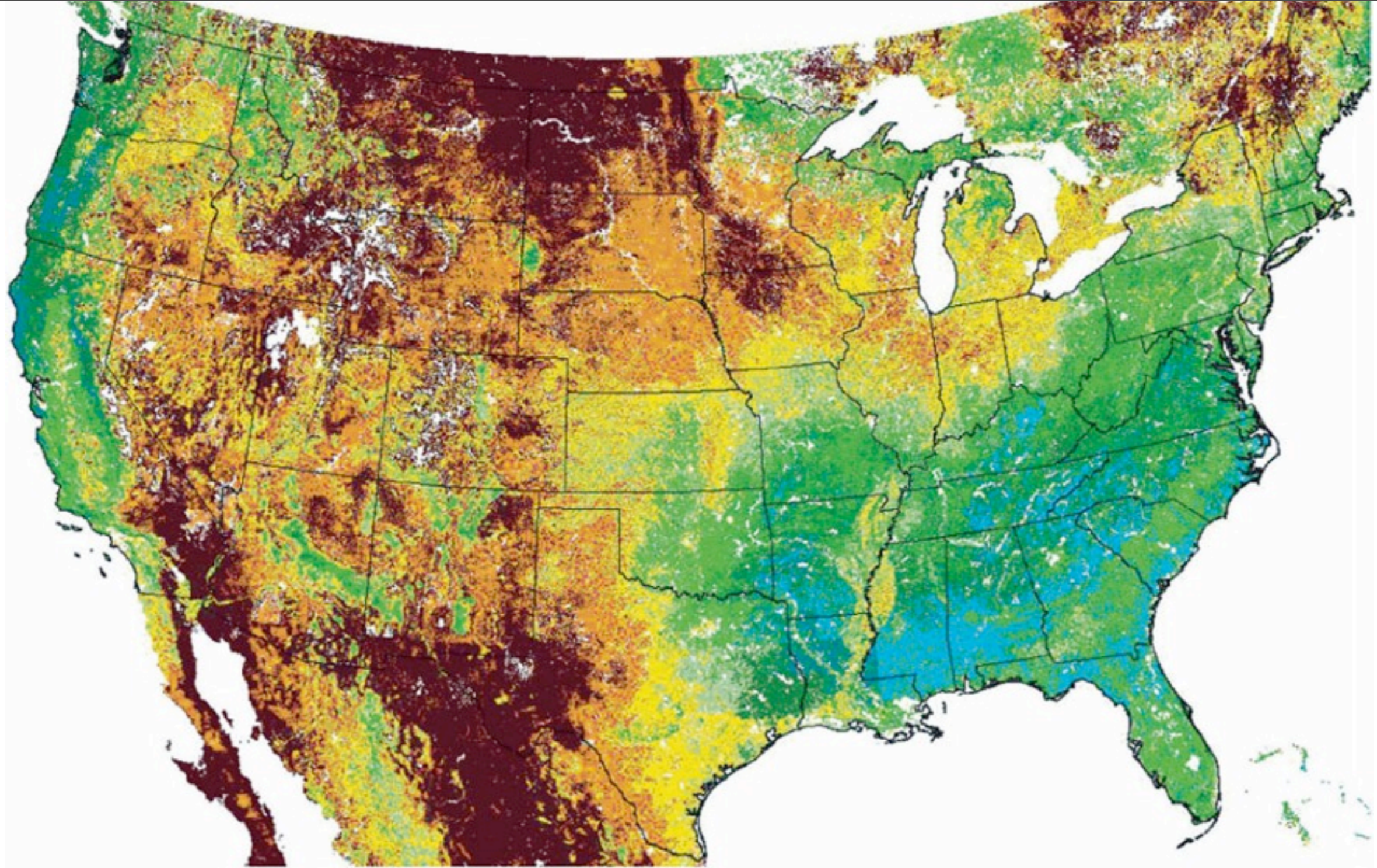


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**Gross primary productivity
(grams of carbon per square meter)**

Fig. 3-20, p. 66

Terrestrial Ecosystems

Swamps and marshes

Tropical rain forest

Temperate forest

North. coniferous forest

Savanna

Agricultural land

Woodland and shrubland

Temperate grassland

Tundra (arctic and alpine)

Desert scrub

Extreme desert

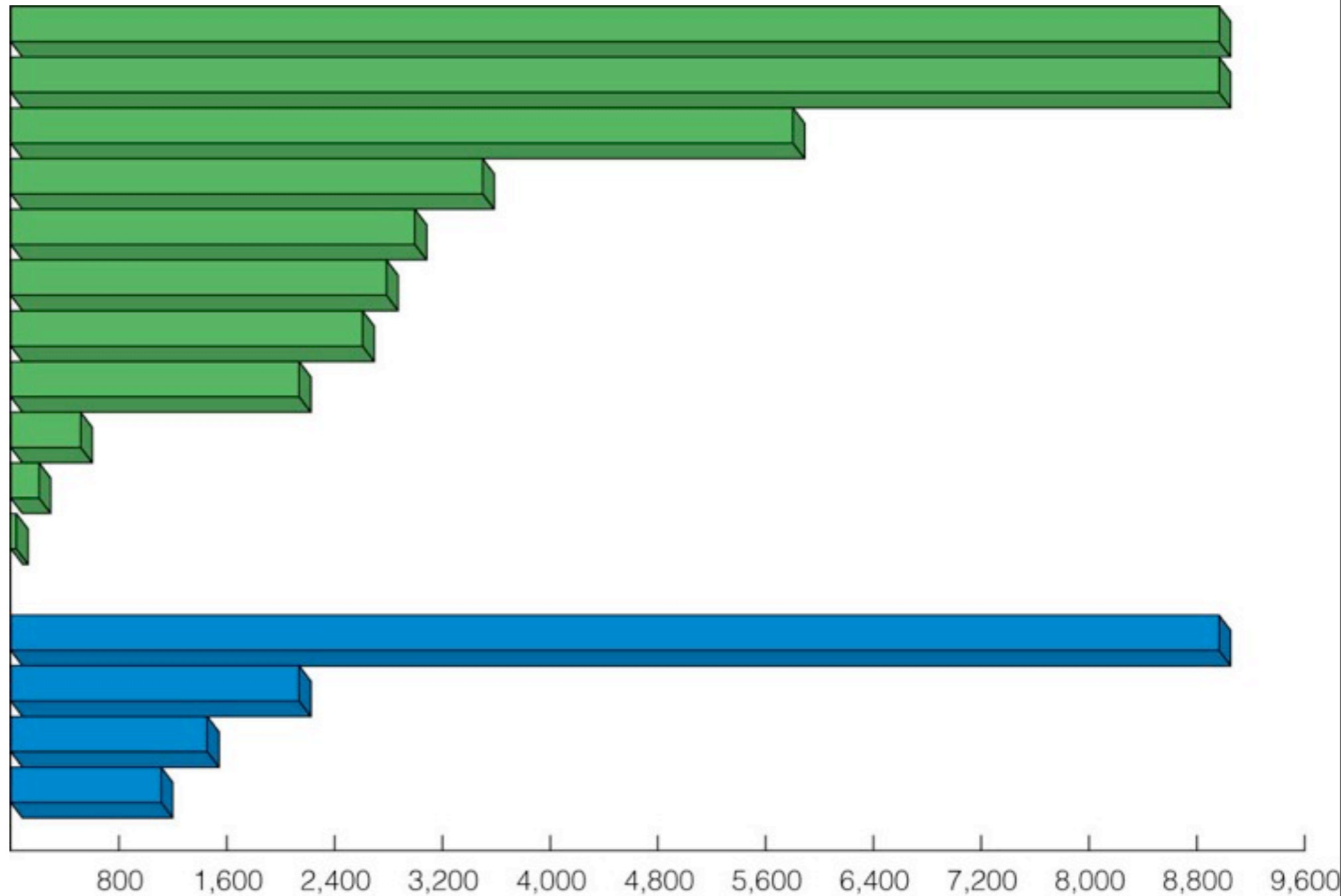
Aquatic Ecosystems

Estuaries

Lakes and streams

Continental shelf

Open ocean



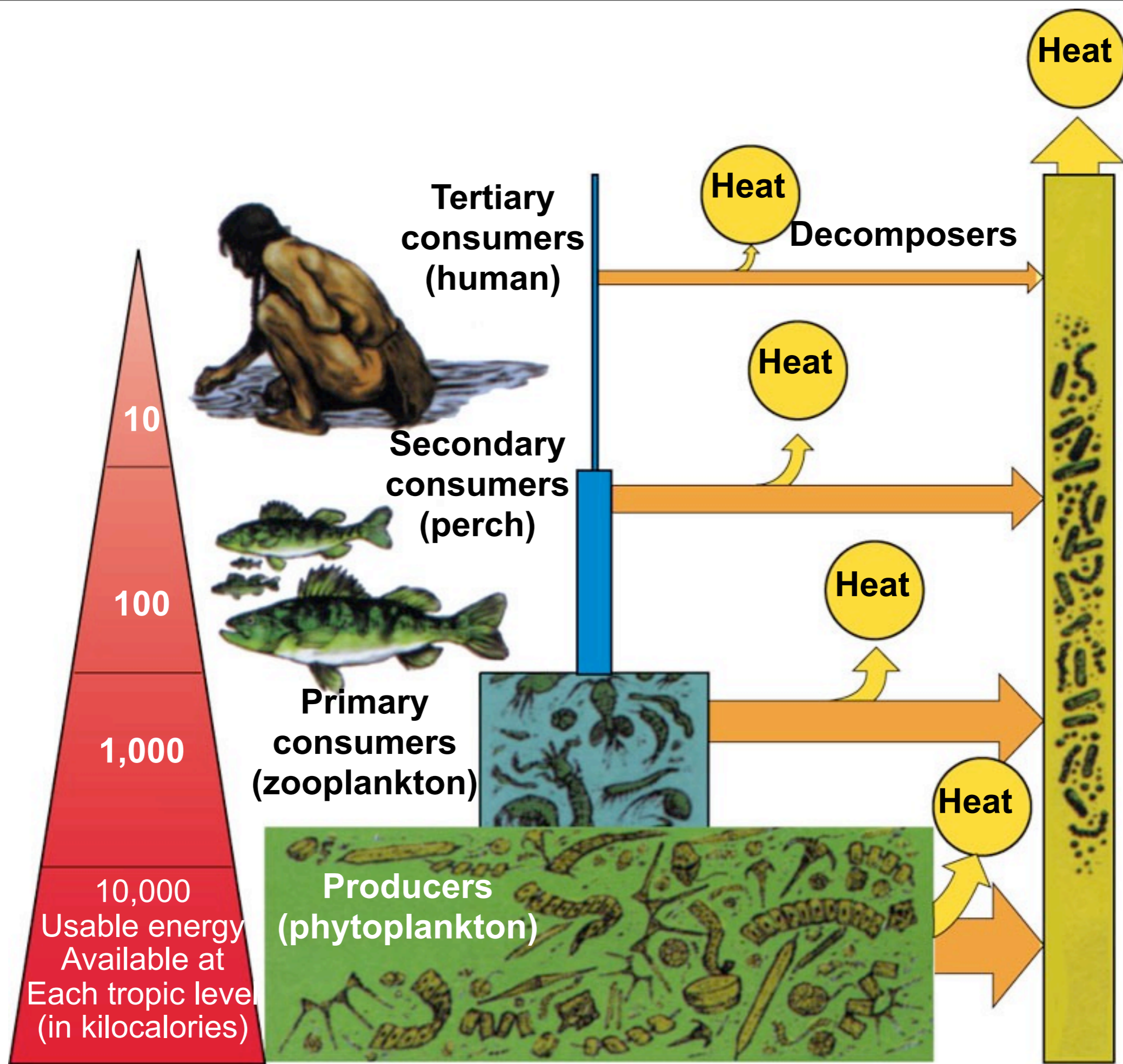
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Average net primary productivity (kcal/m² /yr)

Fig. 3-22, p. 67

Energy Transfer Efficiency and Trophic Pyramids

- **Biomass-** The energy in an ecosystem is measured in terms of biomass.
- **Standing crop-** The amount of biomass present in an ecosystem at a particular time.
- **Ecological efficiency-** The proportion of consumed energy that can be passed from one trophic level to another.
- **Trophic pyramid-** The representation of the distribution of biomass among trophic levels.



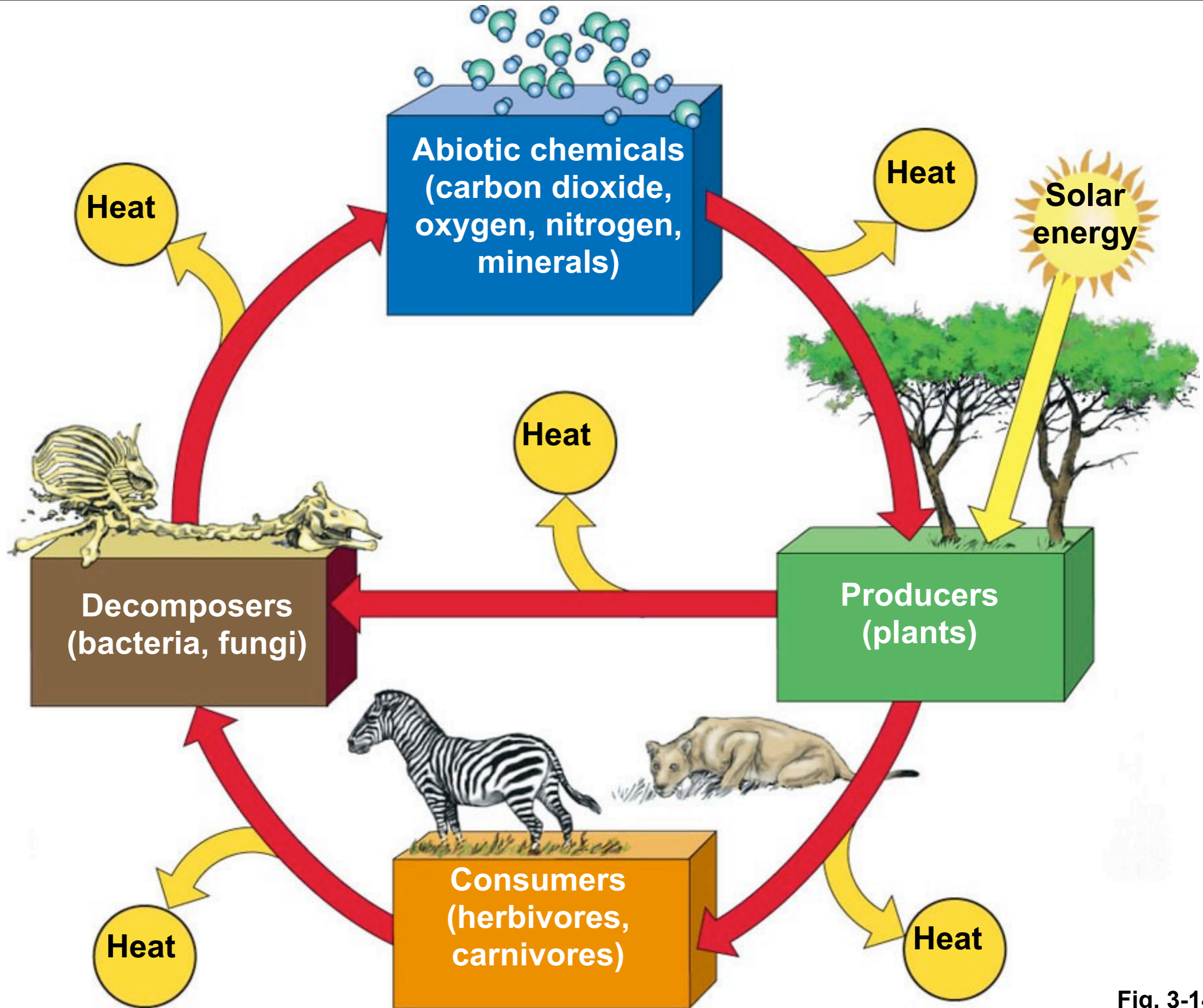


Fig. 3-14, p. 61

Matter cycles through the Biosphere

- **Biosphere-** The combination of all ecosystems on Earth.
- **Biogeochemical cycles-** The movement of matter within and between ecosystems involving biological, geologic and chemical processes.

The Hydrologic Cycle

- The movement of water through the biosphere.

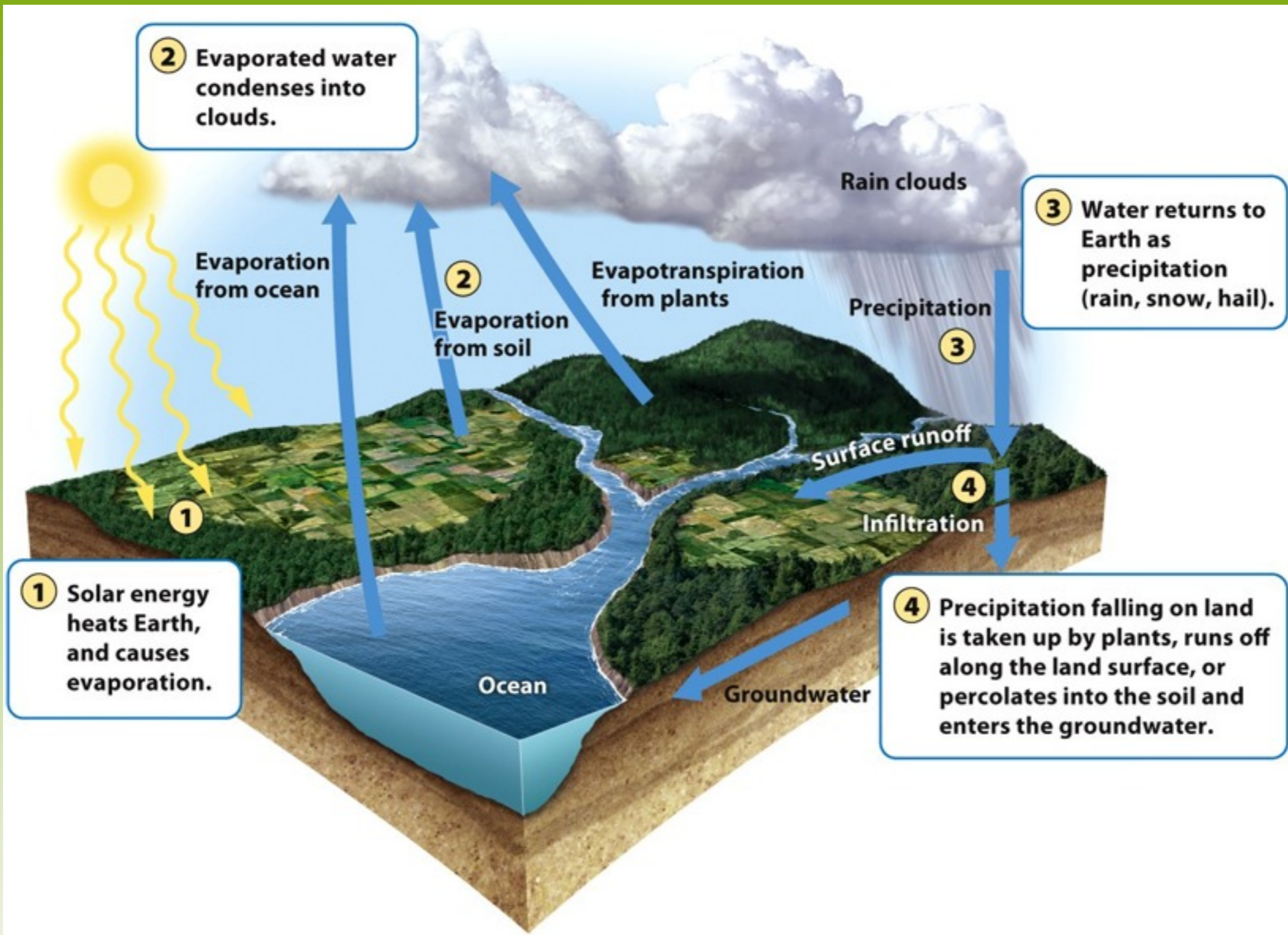


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The Hydrologic Cycle

- **Transpiration-** The process where plants release water from their leaves into the atmosphere.
- **Evapotranspiration-** The combined amount of evaporation and transpiration.
- **Runoff-** When water moves across the land surface into streams and rivers, eventually reaching the ocean.

The Carbon Cycle

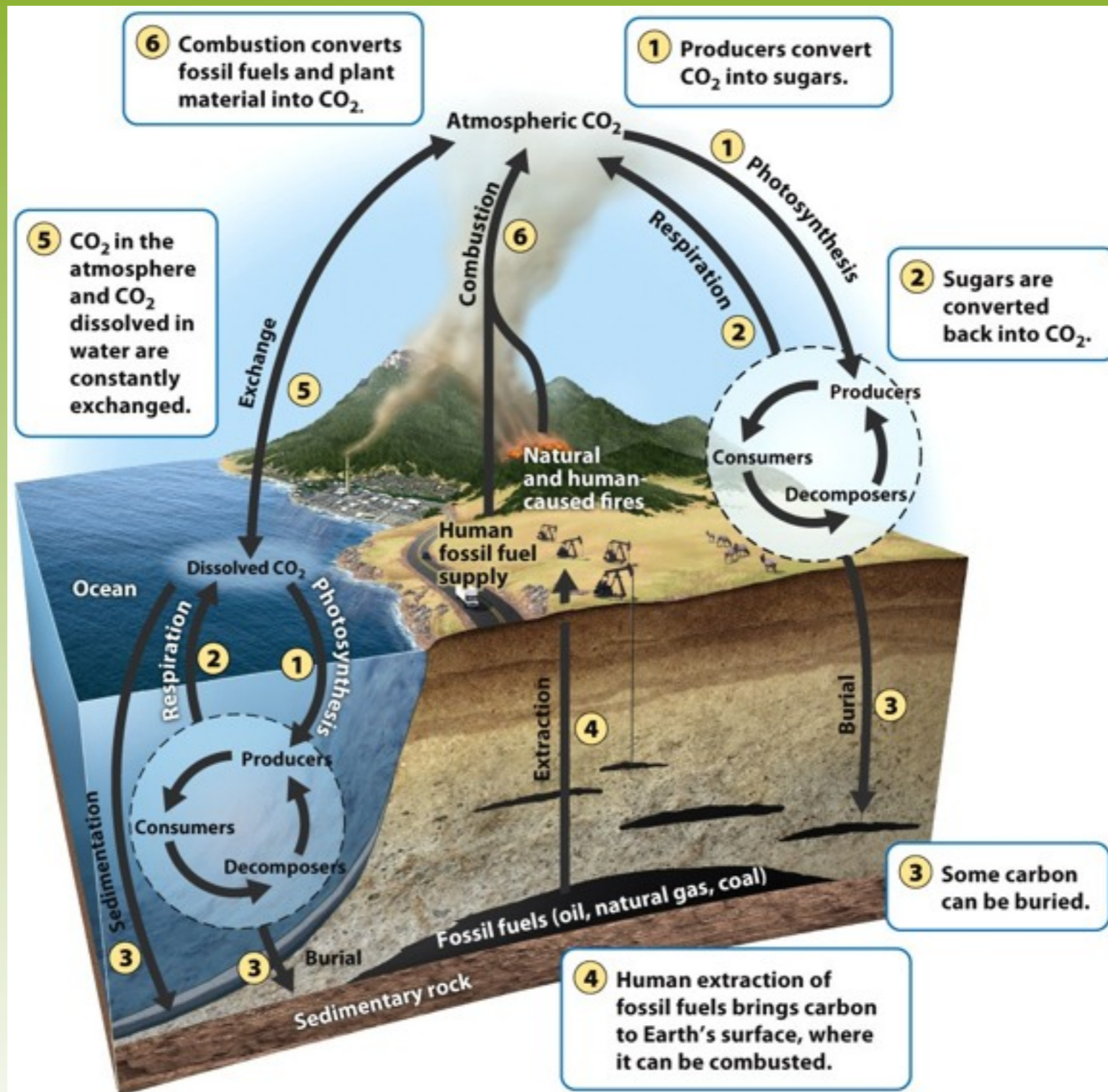
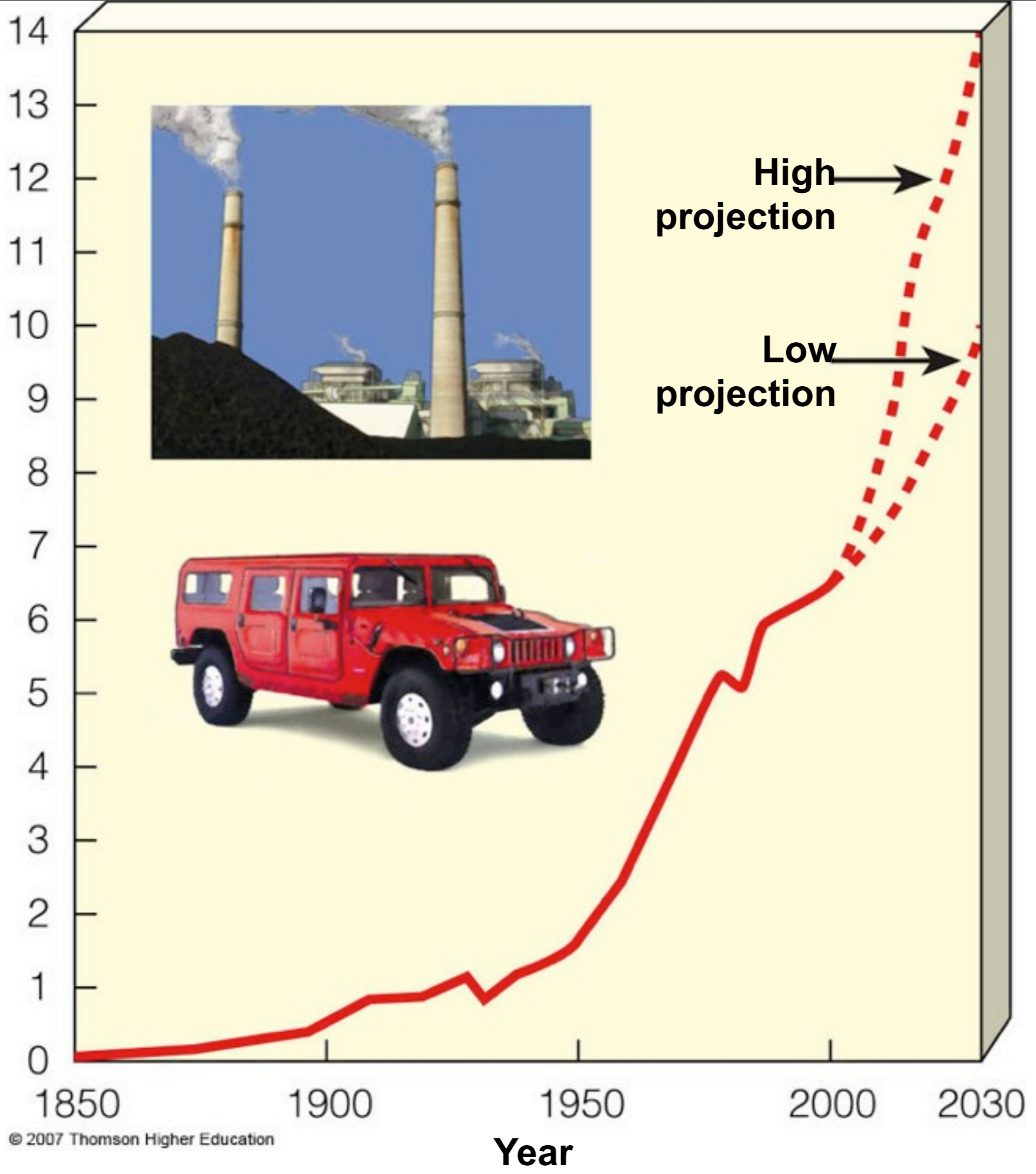


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**CO₂ emissions from fossil fuels
(billion metric tons of carbon equivalent)**

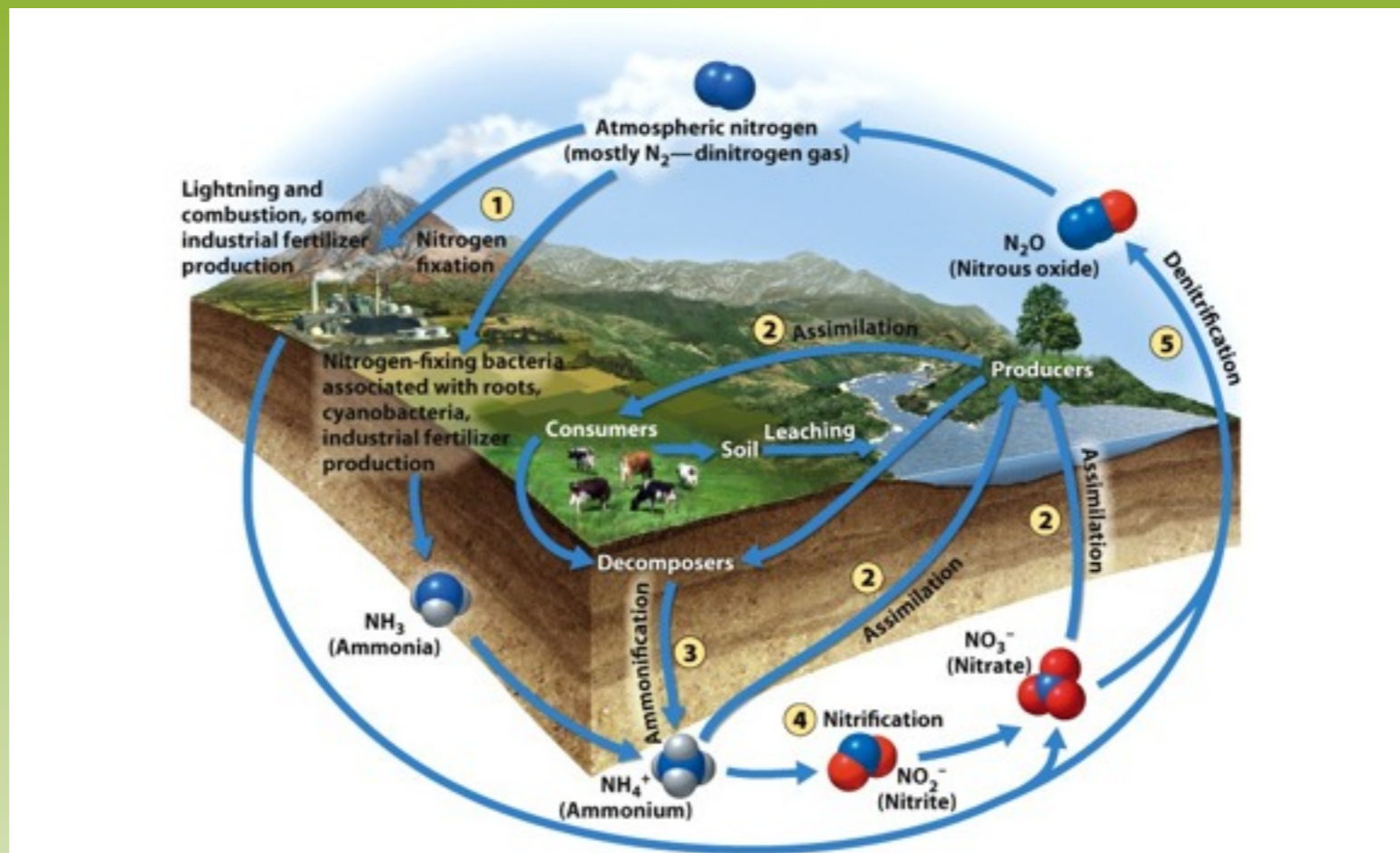


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Year

Fig. 3-28, p. 74

The Nitrogen Cycle







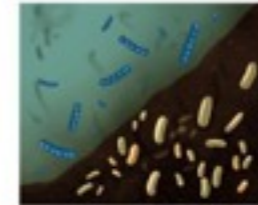
1 Nitrogen Fixation	2 Assimilation	3 Ammonification	4 Nitrification	5 Denitrification
Nitrogen fixation converts N_2 from the atmosphere. Biotic processes convert N_2 to ammonia (NH_3), whereas abiotic processes convert N_2 to nitrate (NO_3^-).	Producers take up either ammonium (NH_4^+) or nitrate (NO_3^-). Consumers assimilate nitrogen by eating producers.	Decomposers in soil and water break down biological nitrogen compounds into ammonium (NH_4^+).	Nitrifying bacteria convert ammonium (NH_4^+) into nitrite (NO_2^-) and then into nitrate (NO_3^-).	In a series of steps, denitrifying bacteria in oxygen-poor soil and stagnant water convert nitrate (NO_3^-) into nitrous oxide (N_2O) and eventually nitrogen gas (N_2).
				

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The Nitrogen Cycle: Bacteria in Action

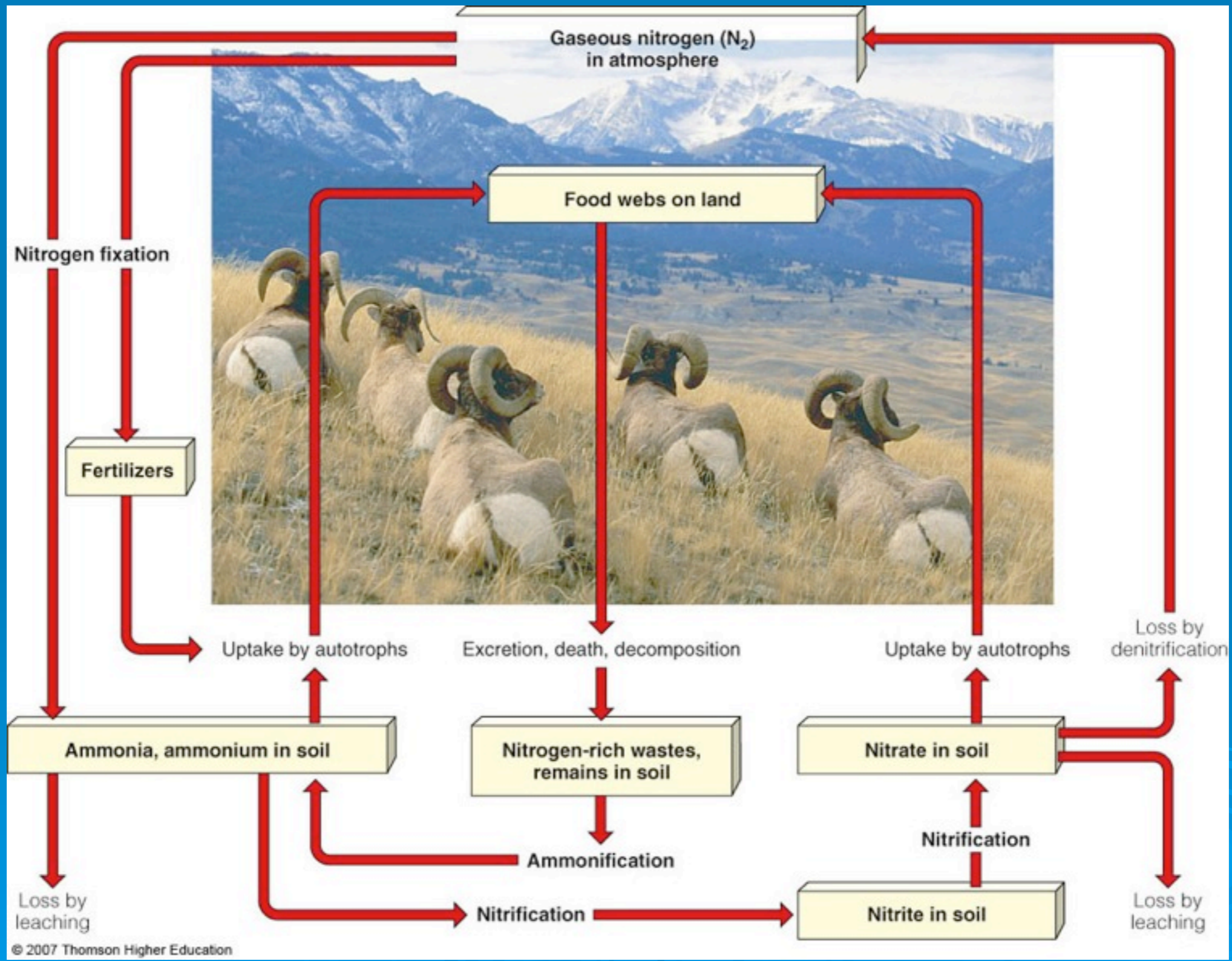


Figure 3-29

Global nitrogen (N) fixation
(trillion grams)

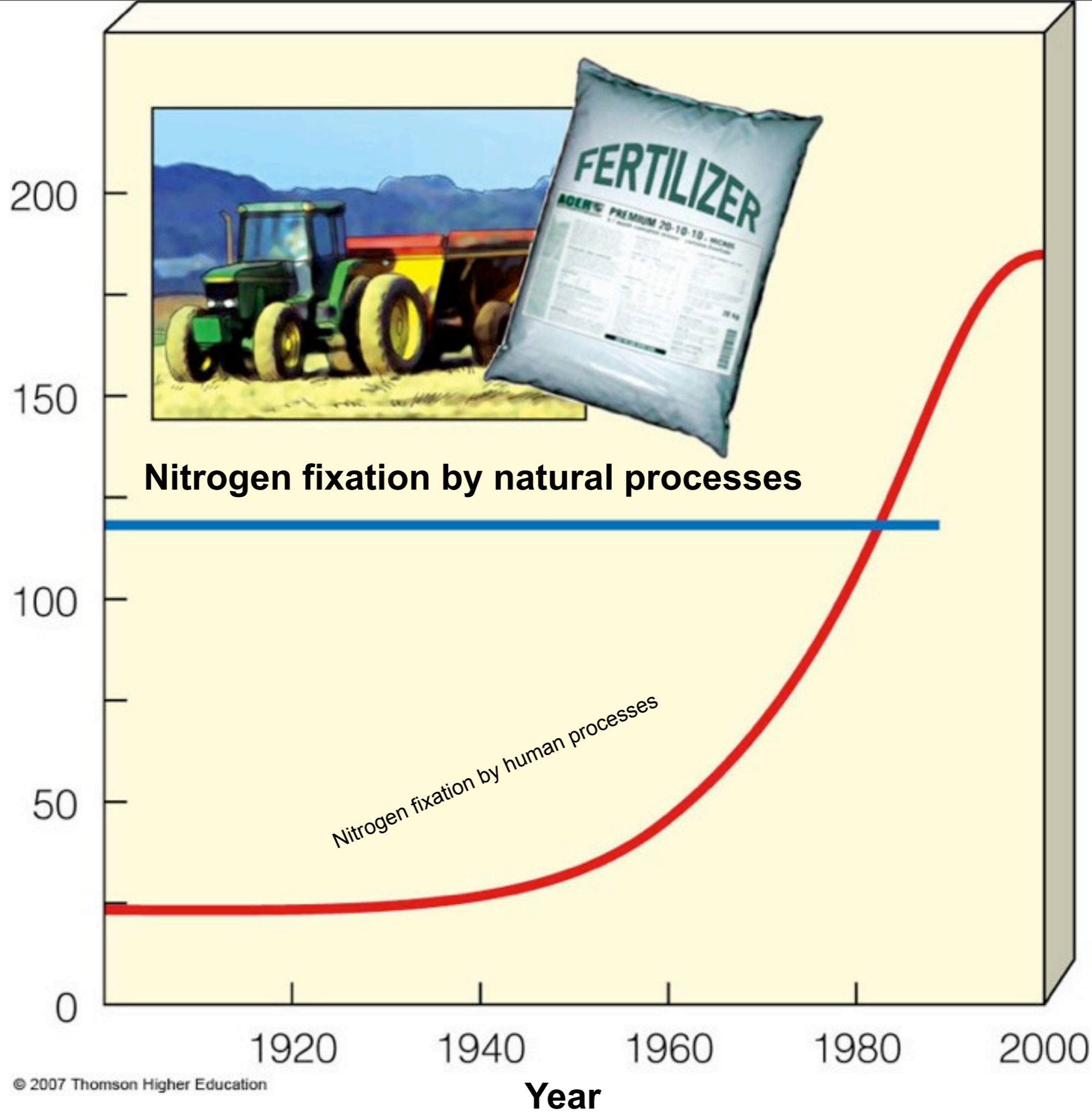


Fig. 3-30, p. 76

The Phosphorus Cycle

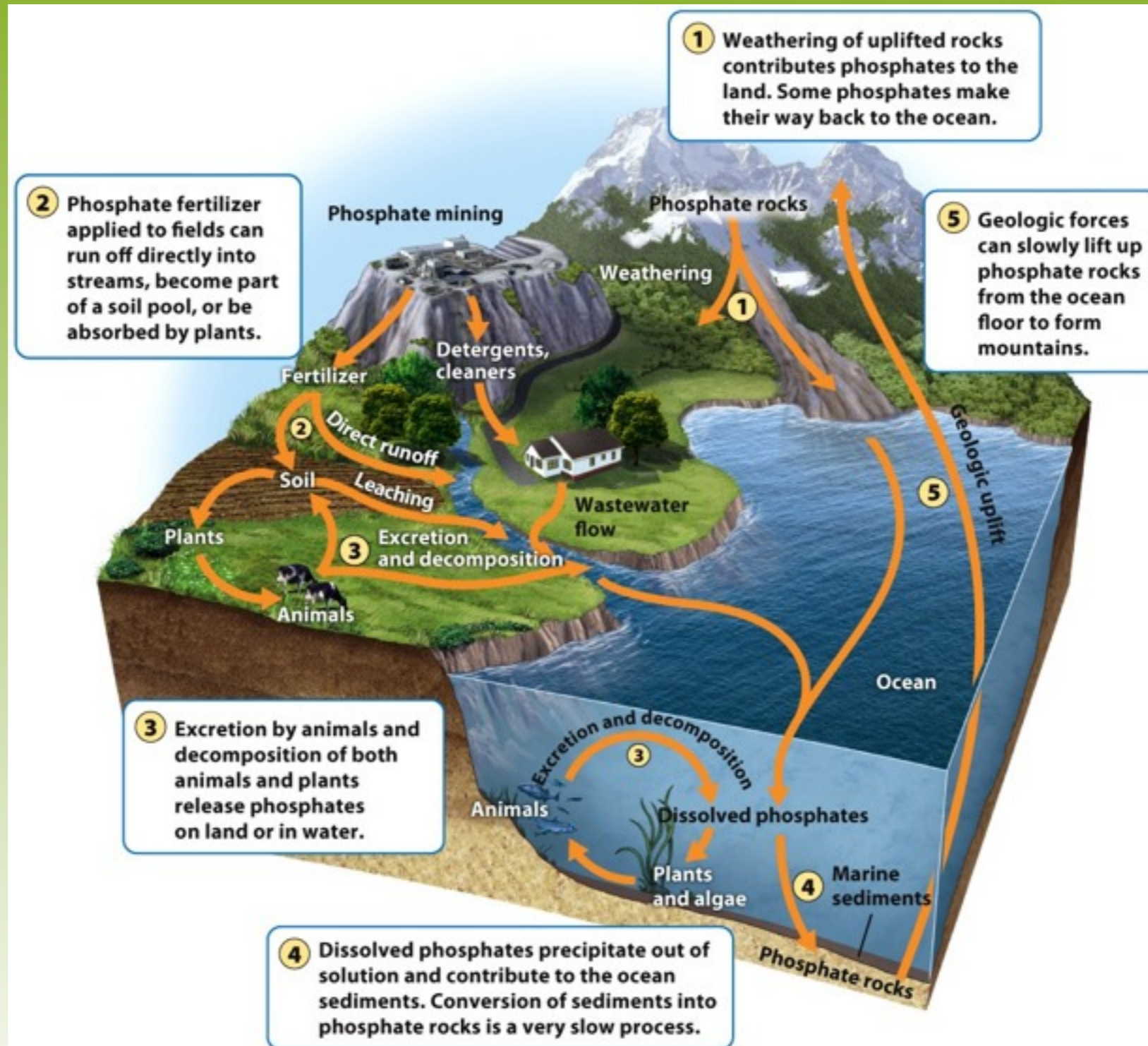
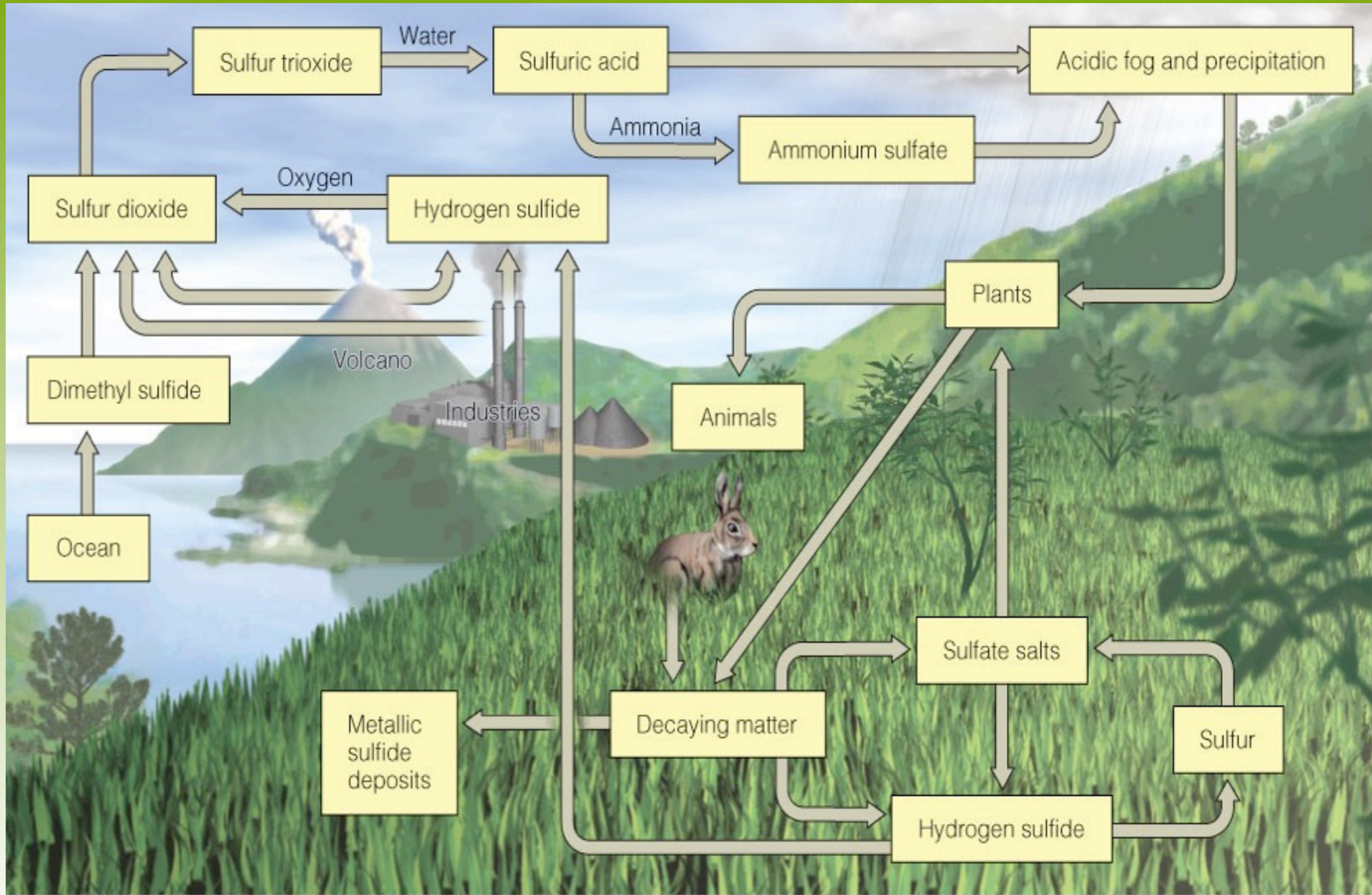


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Ecosystems respond to disturbances

- **Disturbance-** An event caused by physical, chemical or biological agents that results in changes in population size or community composition.
- Can be beneficial or harmful to an ecosystem.



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Figure 3.15b
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Watershed Studies

- Watershed- All of the land in a given landscape that drains into a particular stream, river, lake or wetland.



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Resistance versus Resilience

- **Resistance-** A measure of how much a disturbance can affect its flows of energy and matter.
- **Resilience-** The rate at which an ecosystem returns to its original state after a disturbance.
- **Restoration ecology-** A new scientific discipline that is interested in restoring damaged ecosystems.

The Intermediate Disturbance Hypothesis

- The intermediate disturbance hypothesis states that ecosystems experiencing intermediate levels of disturbance are more diverse than those with high or low disturbance levels.

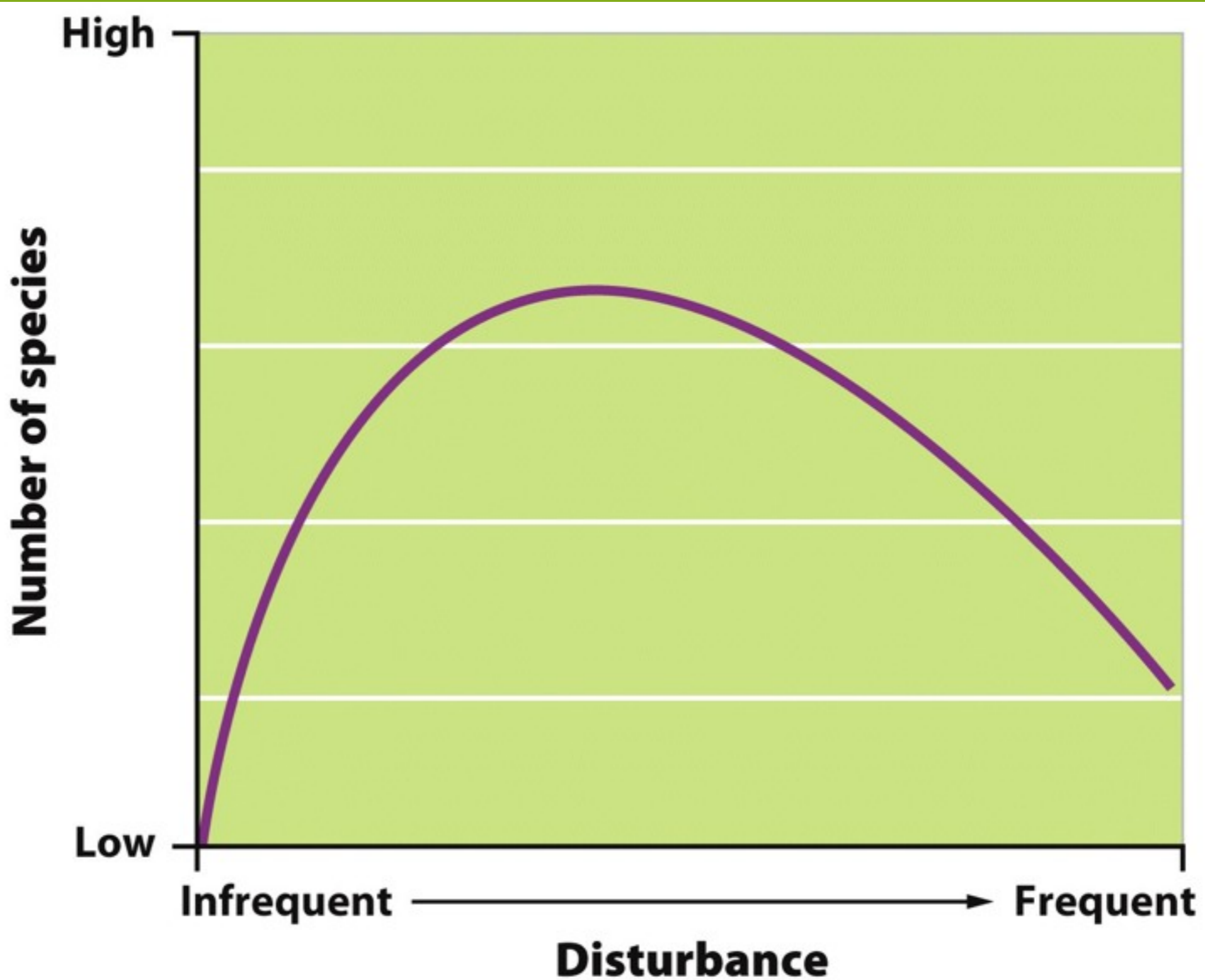


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Ecosystems Provide Valuable Services

Ecosystem services

Provisioning services, e.g.

- Food
- Freshwater
- Wood and fiber
- Fuel

Cultural services, e.g.

- Aesthetic
- Spiritual
- Educational
- Recreational

Regulatory services, e.g.

- Climate regulation
- Flood regulation
- Disease regulation
- Water purification

Supporting services, e.g.

- Nutrient cycling
- Soil formation
- Primary production

FIGURE 1: Ecosystem services can be divided into four main categories: provisioning, cultural, regulatory and supporting services (MA 2005). The management of agroecosystems has tended to focus on provisioning services, often to the detriment of other types of services. Ultimately, if supporting services (which operate on a much longer time scale) and regulatory services are degraded, food security will be reduced.

Instrumental Values of Ecosystems

- **Provisions-** Goods that humans can use directly.
- **Regulating services-** The service provided by natural systems that helps regulate environmental conditions.
- **Support systems-** The support services that natural ecosystems provide such as pollination, natural filters and pest control.
- **Resilience-** Resilience of an ecosystem ensures that it will continue to provide benefits to humans. This greatly depends on species diversity.
- **Cultural services-** Ecosystems provide cultural or