Chapter 3
Ecosystem Ecology

Food Web:

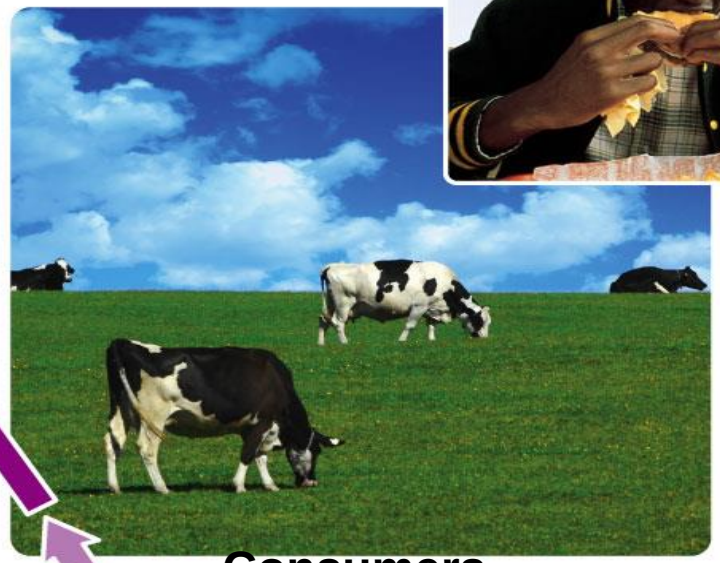
Solar energy

Producers

Consumers

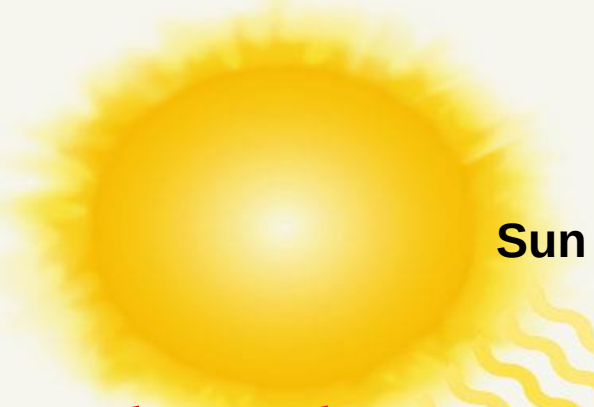
Decomposers

(ex. bacteria and fungi)



Decomposer
(FBI)

Consumers
(heterotrophic)



Sun

Producer
(photosynthetic, autotrophic organisms, plants)

Interdependence:
all organism are a part of a network that *depend on one another for energy* and raw material

10 benefits trees provide to society:

1. **Heat reduction:** Trees provide shade
2. **Air pollution reduction:** Trees absorb carbon and remove pollutants from the atmosphere.
3. **Energy emissions reduction:** Trees reduce energy costs by $4 billion a year (shade…air conditioning costs, reduce emissions)
4. **Water quality improvement:** Trees act as water filters
5. **Flooding reduction:** reducing runoff and erosion into streams (barriers).
6. **Noise reduction:** Trees can deflect sound
7. **Protection from UV radiation:** Trees absorb 96% of ultraviolet radiation
8. **Improved aesthetics**
9. **Improved human health:** studies have found connections between exposure to nature and better mental and physical health
10. **Wildlife habitat:** species rely on trees for shelter, food and nesting

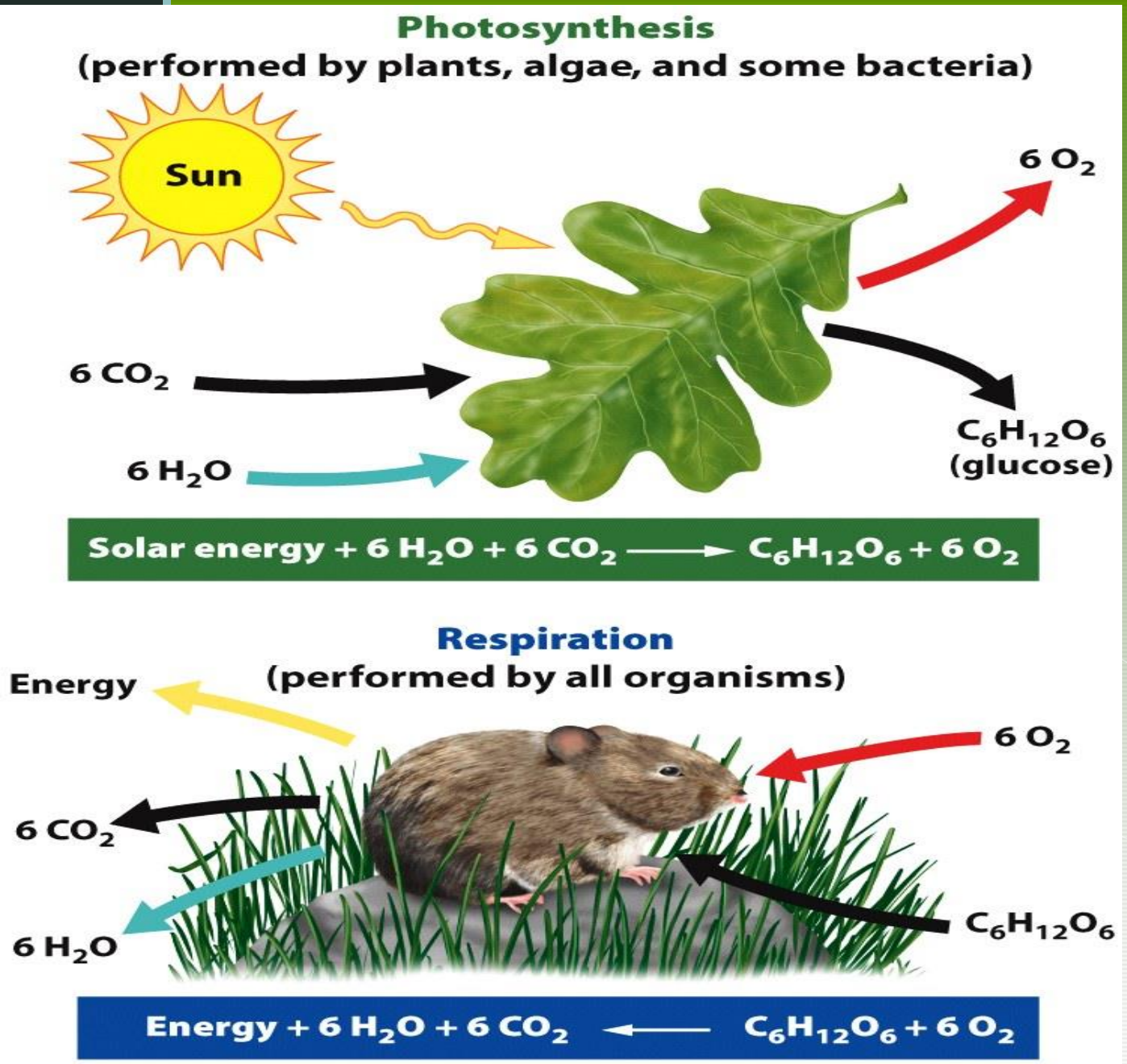


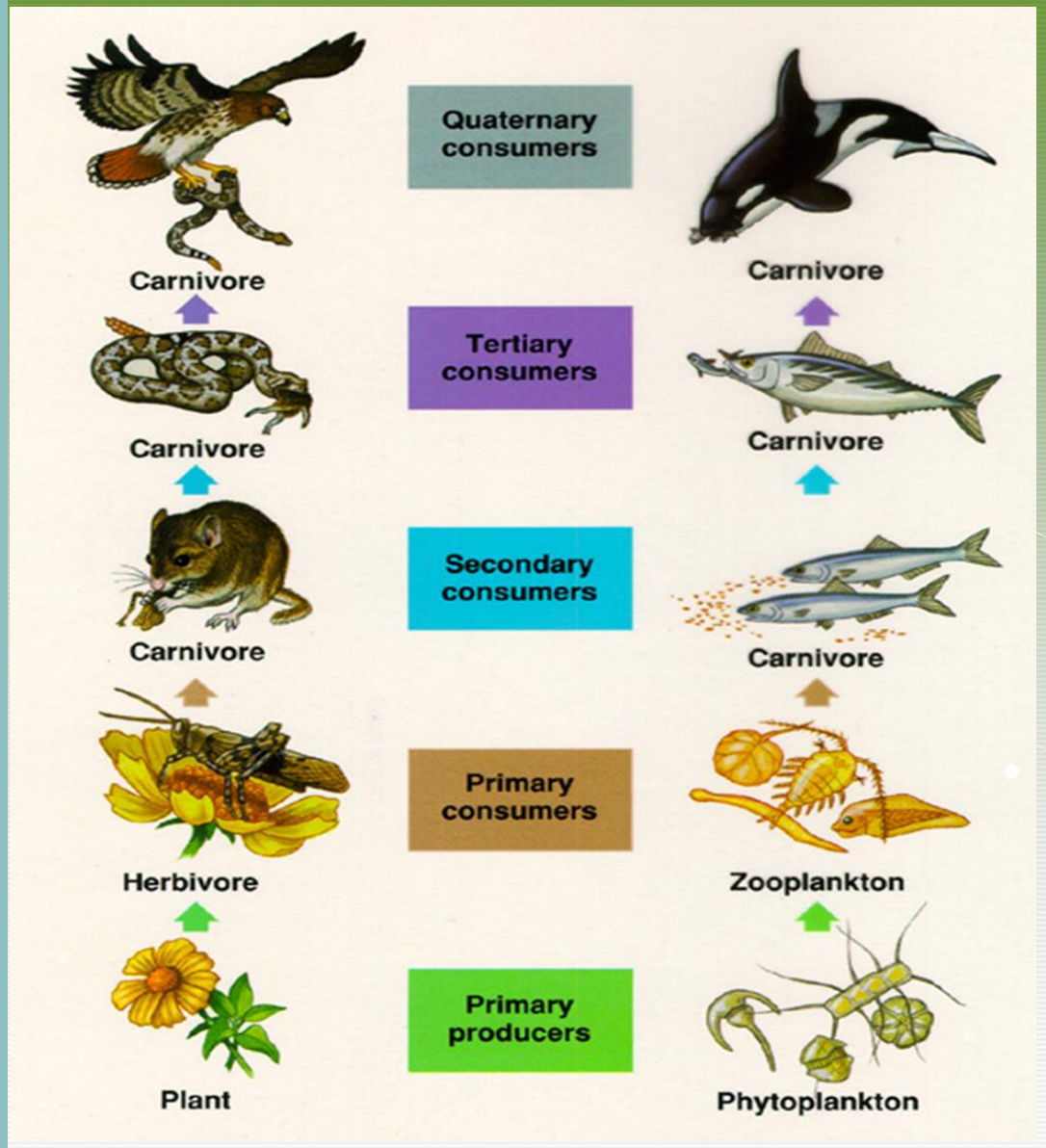
Figure 3.4
Environmental Science

Photosynthesis is the process in which producers use solar energy to convert "waste" to beneficial components to our atmosphere

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

Photosynthesis work antagonistically to cellular respiration (opposites)

Energy Flows through Ecosystems



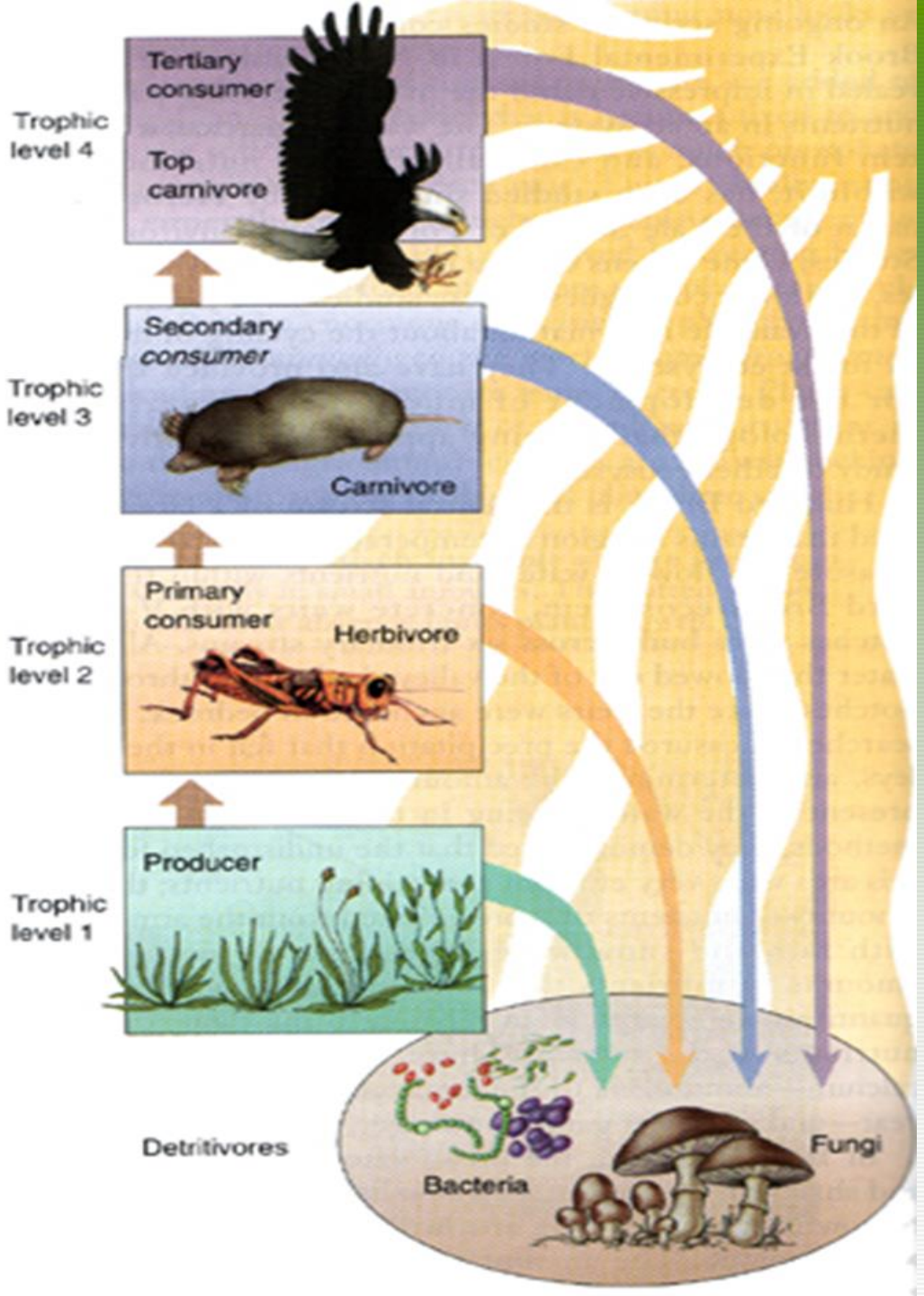
Tertiary/Quaternary Consumers (*carnivores*)- obtain energy by consuming other organisms - eat secondary consumers (meat).

Secondary Consumers (*Omnivores*)- obtain their energy by eating primary consumers (meat or vegetation)

Primary Consumers (*herbivores*)- consume producers.

Producers (*autotrophs*) are able to use the suns energy to produce usable energy through the process called photosynthesis

- **Food Chain-** The *sequence* of consumption from producers through tertiary consumers.
- **Trophic levels** are successive levels of *organisms consuming one another.*



Food Web- A more realistic type of food chain that takes into account the complexity of nature

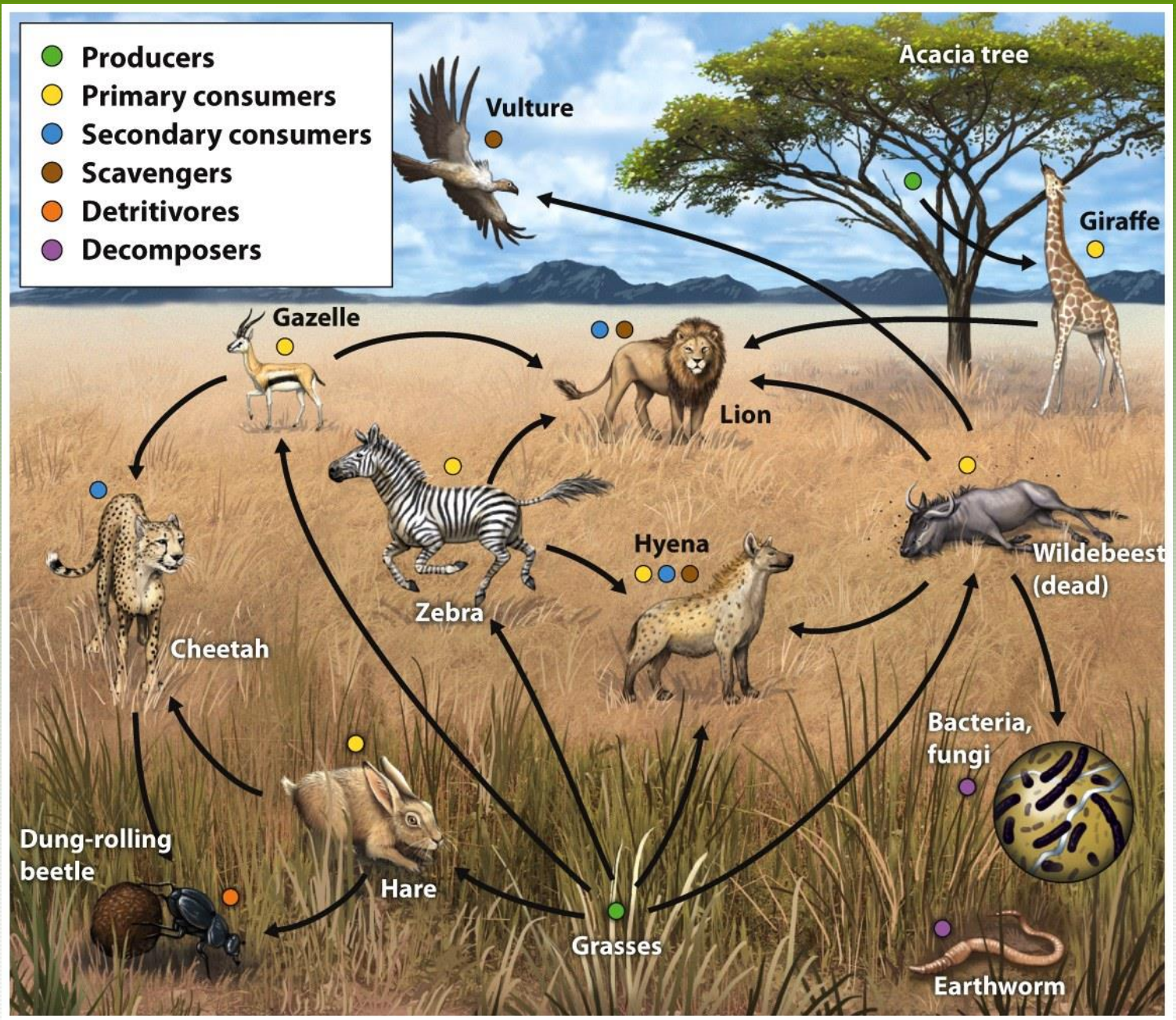


Figure 3.6
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- The interaction among organisms within or between overlapping niches can be characterized into *five types of relationships*:

- **Symbiosis relationship** refers to a close relationship in which one or both organisms obtain a benefit.
  - All relationships exhibit forms of symbiosis

- 1. **Competition** - individuals or populations compete for the same resource and can occur within or between species. Ex. A lion and hyenas compete for the same prey

- 2. **Predation** - one organism eats another organism to obtain nutrients. Ex. Prey vs. predator (owl eat mice)

- 3. **Commensalism** - one organism benefits while the other is neither helped nor harmed. Ex. barnacles that grow on whales and other marine animals.

- 4. **Mutualism** - both species benefit. Ex. Anaerobic bacterium and our digestive system

- 5. **Parasitism** - one organism benefits and the other organism is harmed, but not always killed. Ex. Ticks, leeches, fleas

Ecosystem Productivity

- **Amt. of energy available in an ecosystem determines how much life can be supported (varies from ecosystem to the next)**

- **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. (how much energy (from sun) are all the plants in an ecosystem creating in sugar from photosynthesis)

  - **Net primary productivity** (*NPP*)- The energy captured (GPP) minus the energy respired by producers. (establishes the RATE at which living mass is produced over time)

Person eating:

GPP **total amount of energy (food Calories) you eat, but your body needs to use those Calories in order to maintain your daily life (breathing, digesting, maintain body temp, cellular repair, etc…cellular respiration) the left over after those daily life processes is stored as biomass in your body = *NPP***

NPP = GPP – respiration by producers

Take home salary
What you put as your **biomass (amt of vegetation)** after conducting cellular respiration
(less NPP…less vegetation)

Salary
All food (energy) taken in

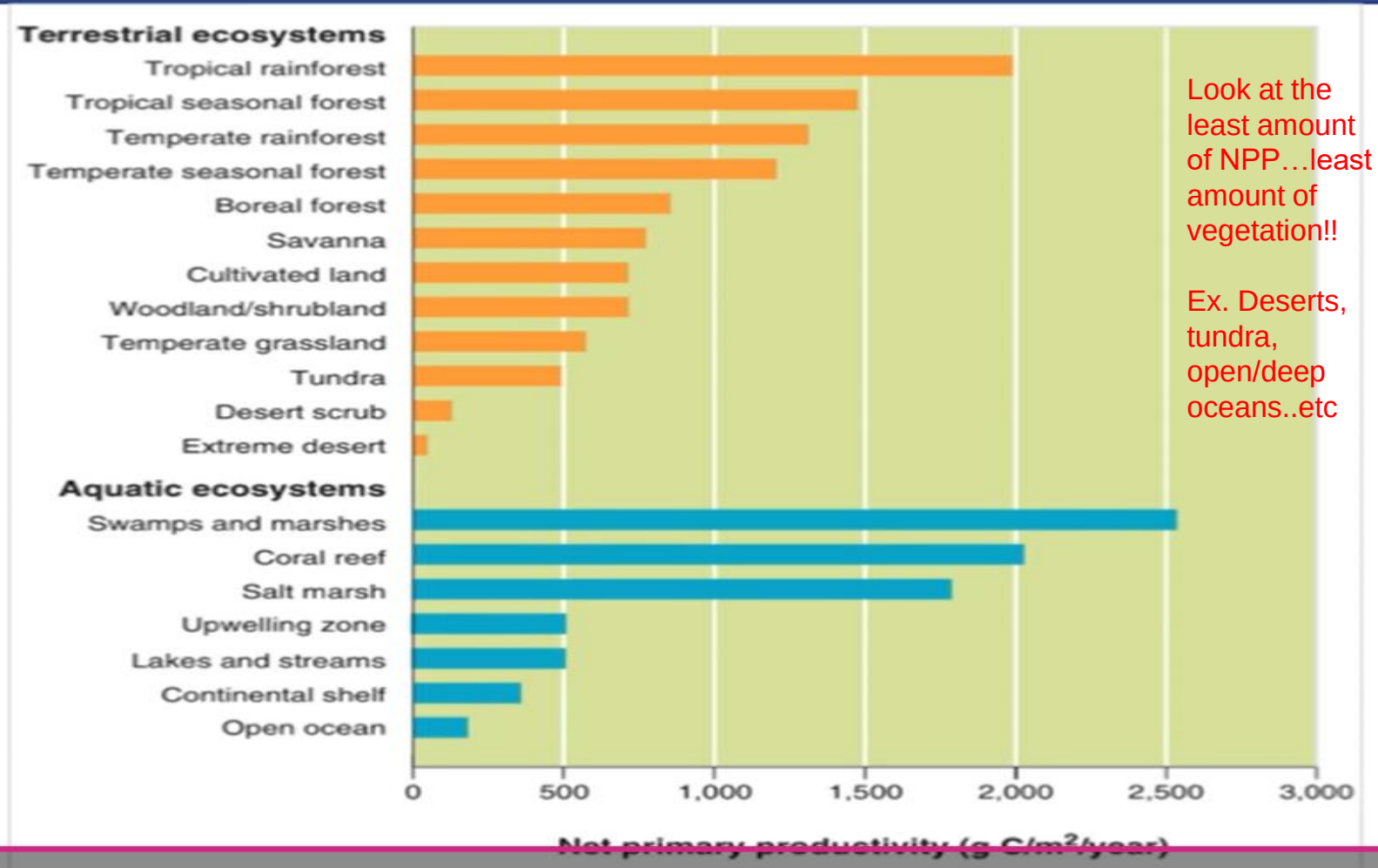
The organism "burning" the calories to maintain daily life processes (cellular respiration)

UNIT:
C/m^2/year = amt. of Carbon per m^2 area of (land/forest) per year (timeline)

Ex. Ecosystem #1:What is the NPP of a forest with a GPP of 2.5kg C/m^2/year and a cellular respiration rate of 1.5kg C/m^2/year?

Primary Productivity

Example



Look at the least amount of NPP…least amount of vegetation!!

Ex. Deserts, tundra, open/deep oceans..etc

Total amount of solar energy that reaches the producers is only 1%, converted into chemical energy. Most of the solar energy is lost from the ecosystem as heat that returns to the atmosphere.

Out of the 1%, 60% used to fuel the producers respiration.

40% can be used to support the producers growth & development

Measuring NPP is used to measure the change in an ecosystem. New system is more or less productive from previous system.

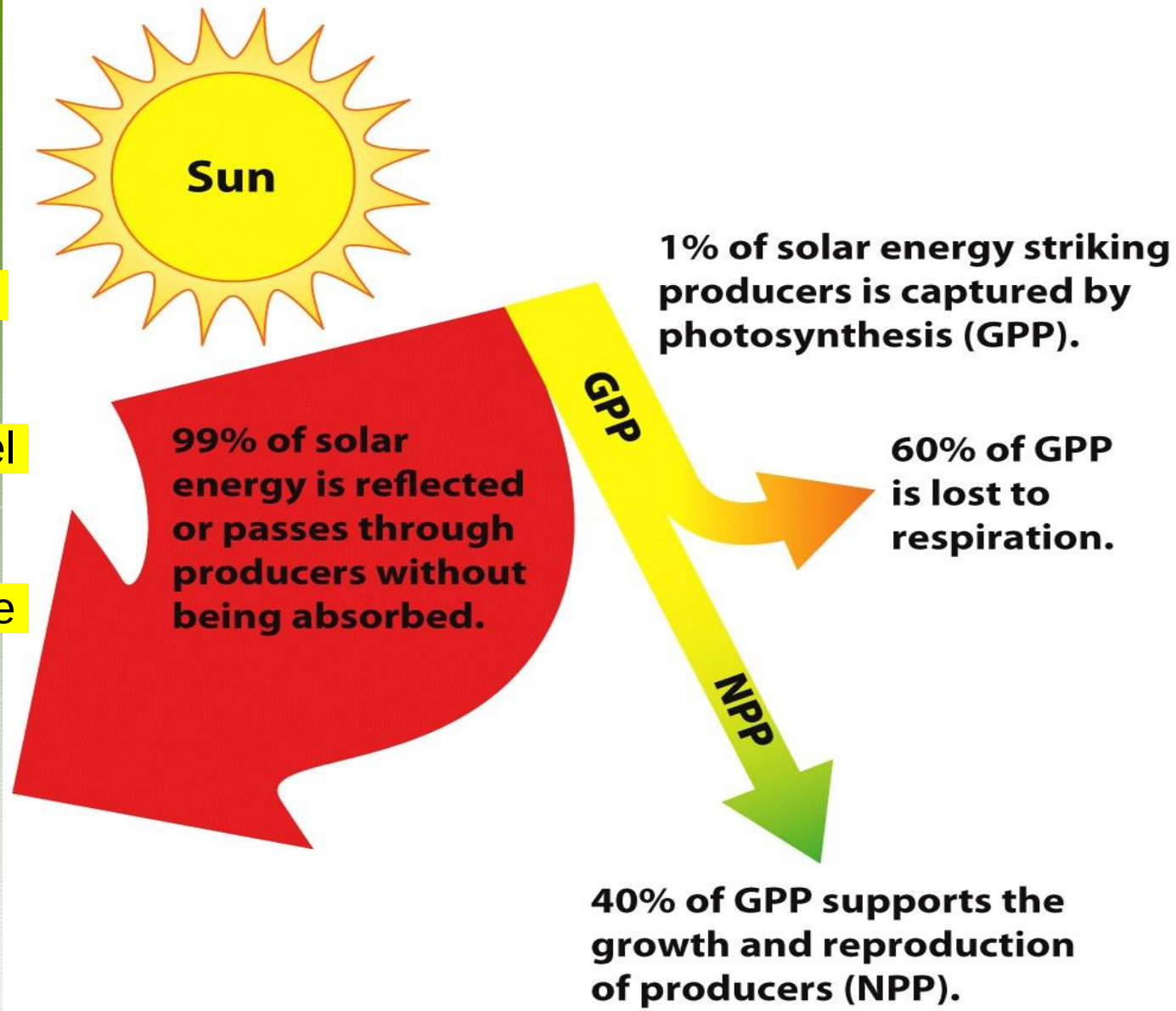


Figure 3.7
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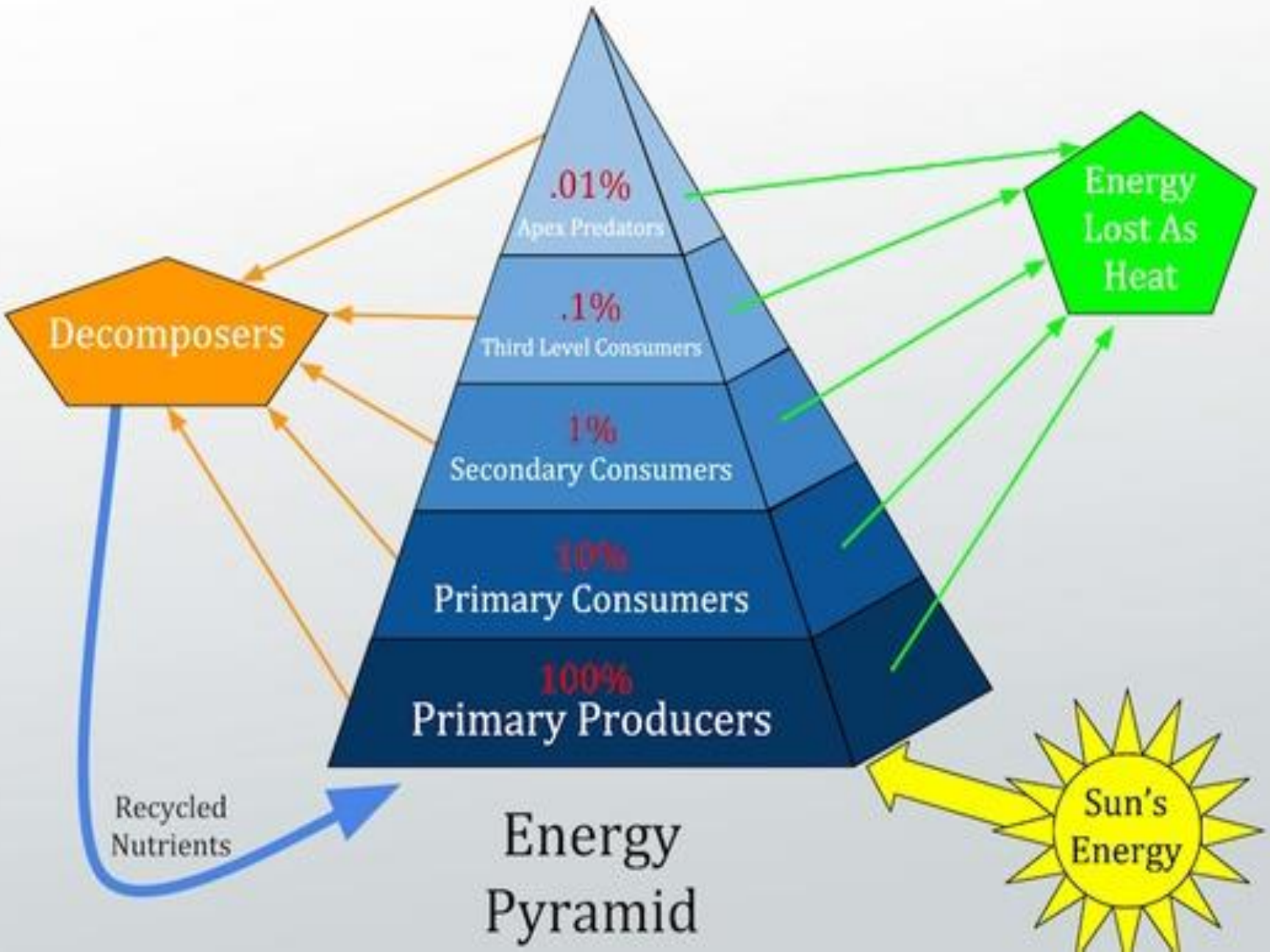
Energy Flow and the 10% Rule

- **Ecological efficiency-** The proportion of consumed energy that can be passed from one trophic level to another. (fairly low)
- **Trophic pyramid-** The representation of the distribution of biomass among trophic levels.
- ***total biomass available at a given trophic level, **only about 10% can be converted into energy** at the next higher tropic level **(divided by 10 as you go up the food pyramid – useable energy)**
- Most energy (and biomass) is found at the producer trophic level and DECREASE as we move up the food pyramid. (determines the population sizes for the various species)

ENERGY PYRAMIDS AND FOOD CHAINS



Ecosystems respond to disturbance

- **Disturbance-** An event caused by physical, chemical or biological agents that results in changes in population size or community composition.
- **Natural disturbances** include hurricanes, ice storms, tsunamis, tornadoes, volcanic eruptions, forest fires...etc
- **Anthropogenic disturbances** include human settlement, clear-cutting, agriculture, air pollution, mining...etc
- How an ecosystem can resist the impact or recover (affects on the flow of energy and matter)

Figure 3.15a
Environmental Science

Before Hurricane Katrina 2001

2 days after Hurricane Katrina 2005

Figure 3.15b
Environmental Science

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.

Species diversity is highest at intermediate levels of disturbances. Species at both extreme can persist.

Rare disturbances *favor best competitors,* outcompetes other species.

Frequent disturbances *eliminates most species* expect those that have evolved to live under conditions

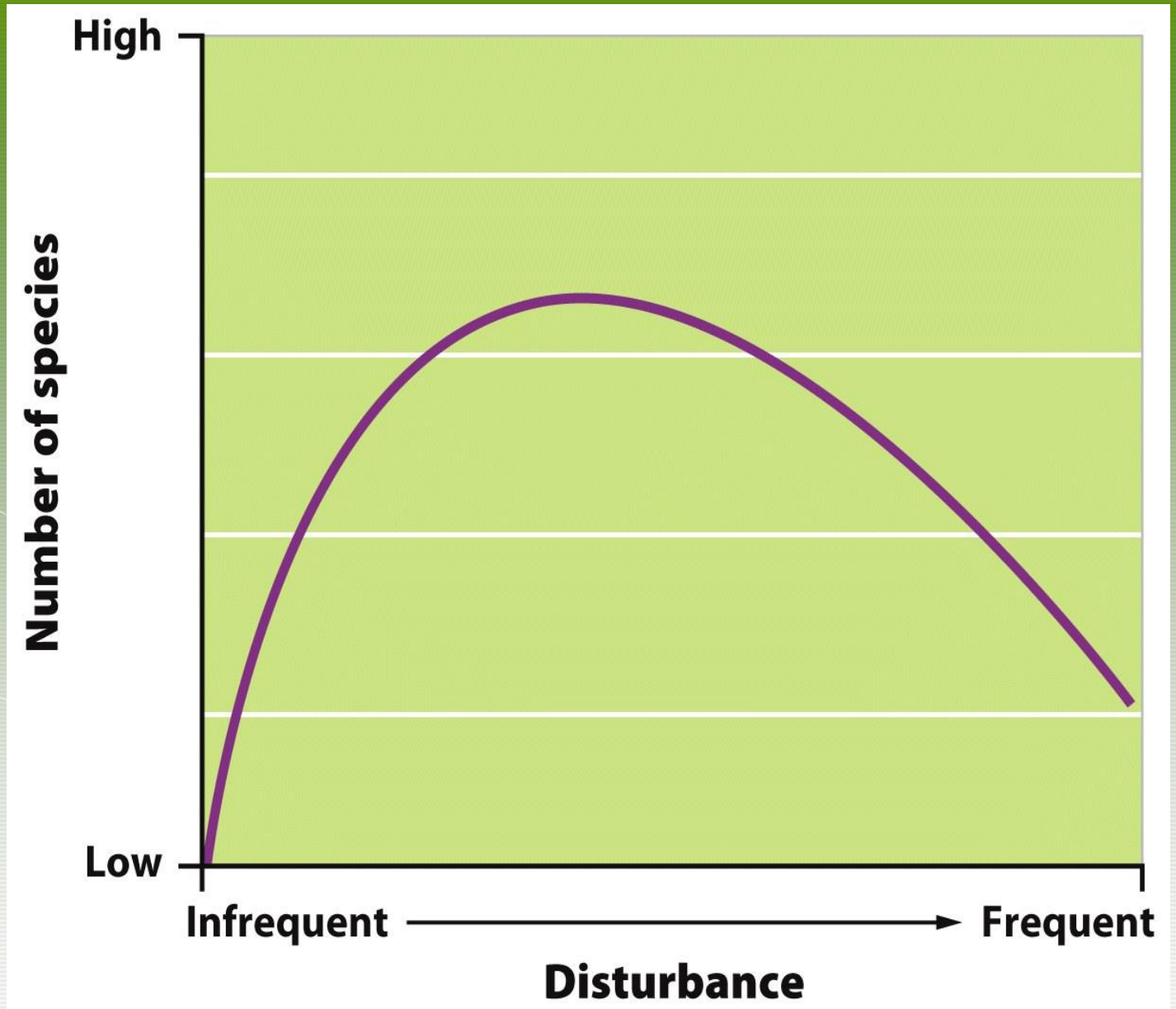


Figure 3.19
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Instrumental Values of Ecosystems
(values directed to humans vs. nature)

- **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.

Cultural services- Ecosystems provide cultural or aesthetic benefits to many people.

Intrinsic value – species' worth independent of any benefit it may provide to humans. *Morals values of an animal's life*