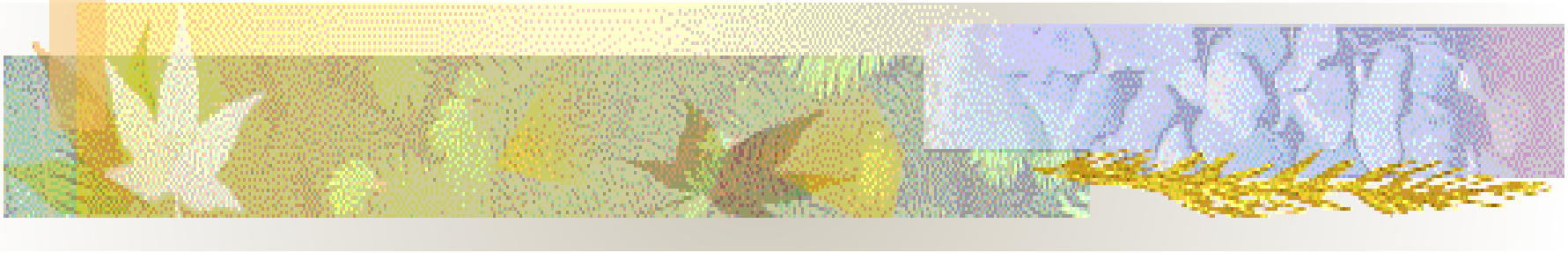
# Terrestrial Ecology Notes



# Chapter Overview Questions

- What is ecology?
- What basic processes keep us and other organisms alive?
- What are the major components of an ecosystem?
- What happens to energy in an ecosystem?
- What are soils and how are they formed?
- What happens to matter in an ecosystem?
- How do scientists study ecosystems?

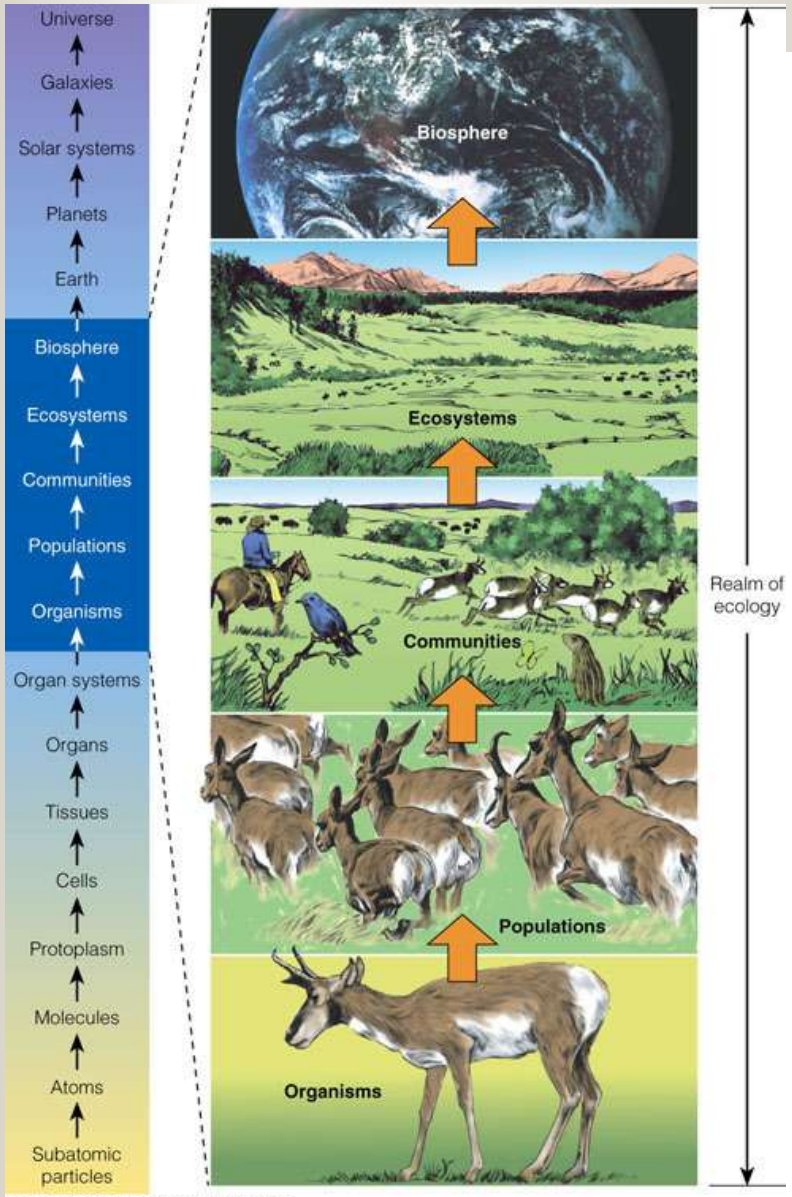
# Chapter Overview Questions

- What factors the earth's climate?
- How does climate determine where the earth's major biome's are found?
- What are the major types of desert biomes?
- What are the major types of grassland biomes?

# Chapter Overview Questions (cont'd)

- What are the major types of forest and mountain biomes?
- How have human activities affected the world's desert, grassland, forest, and mountain biomes?

# THE NATURE OF ECOLOGY




- Ecology is a study of connections in nature.
  - How organisms interact with one another and with their nonliving environment.

Figure 3-2

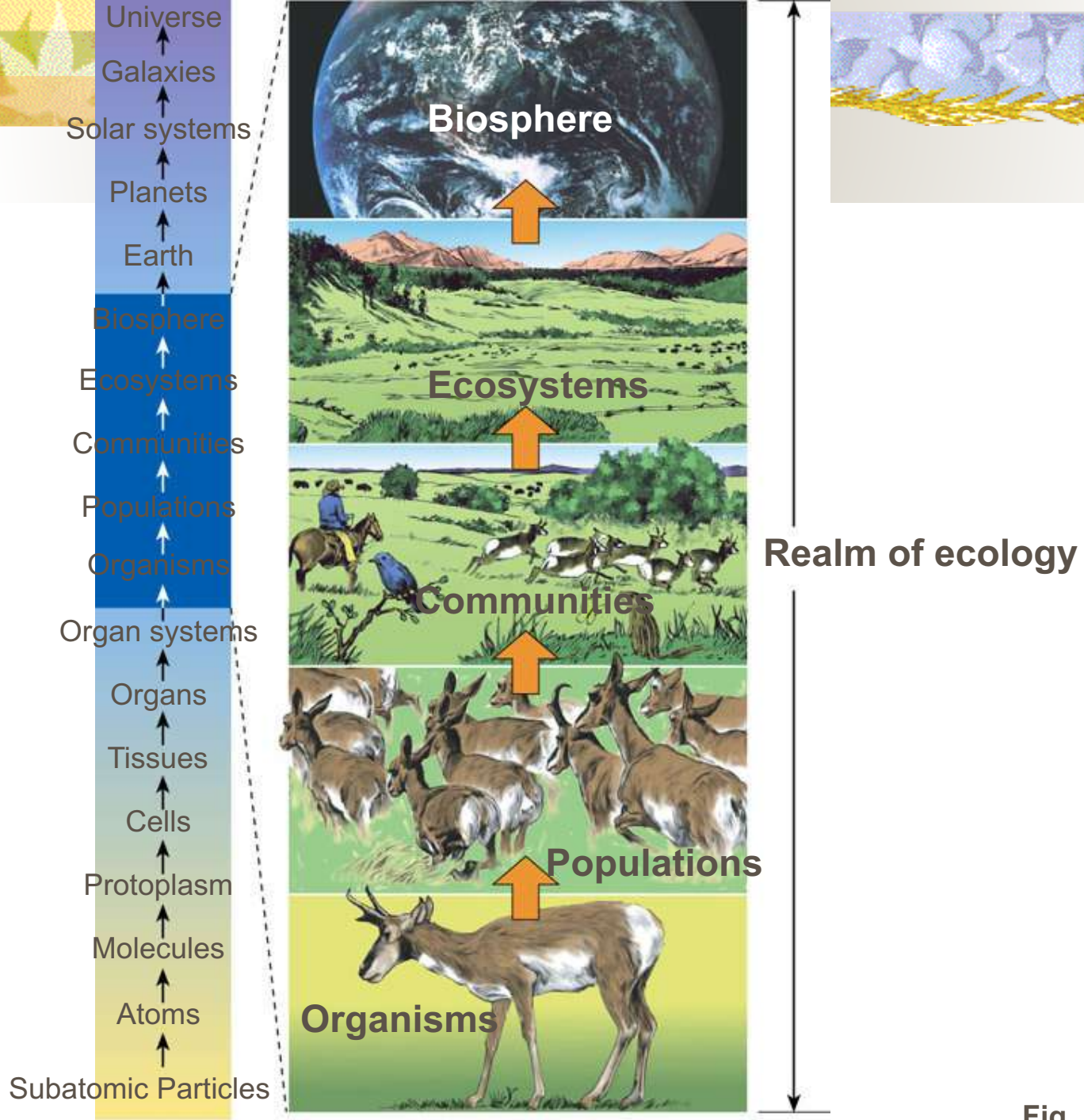





Fig. 3-2, p. 51

# Organisms and Species

- Organisms, the different forms of life on earth, can be classified into different species based on certain characteristics.

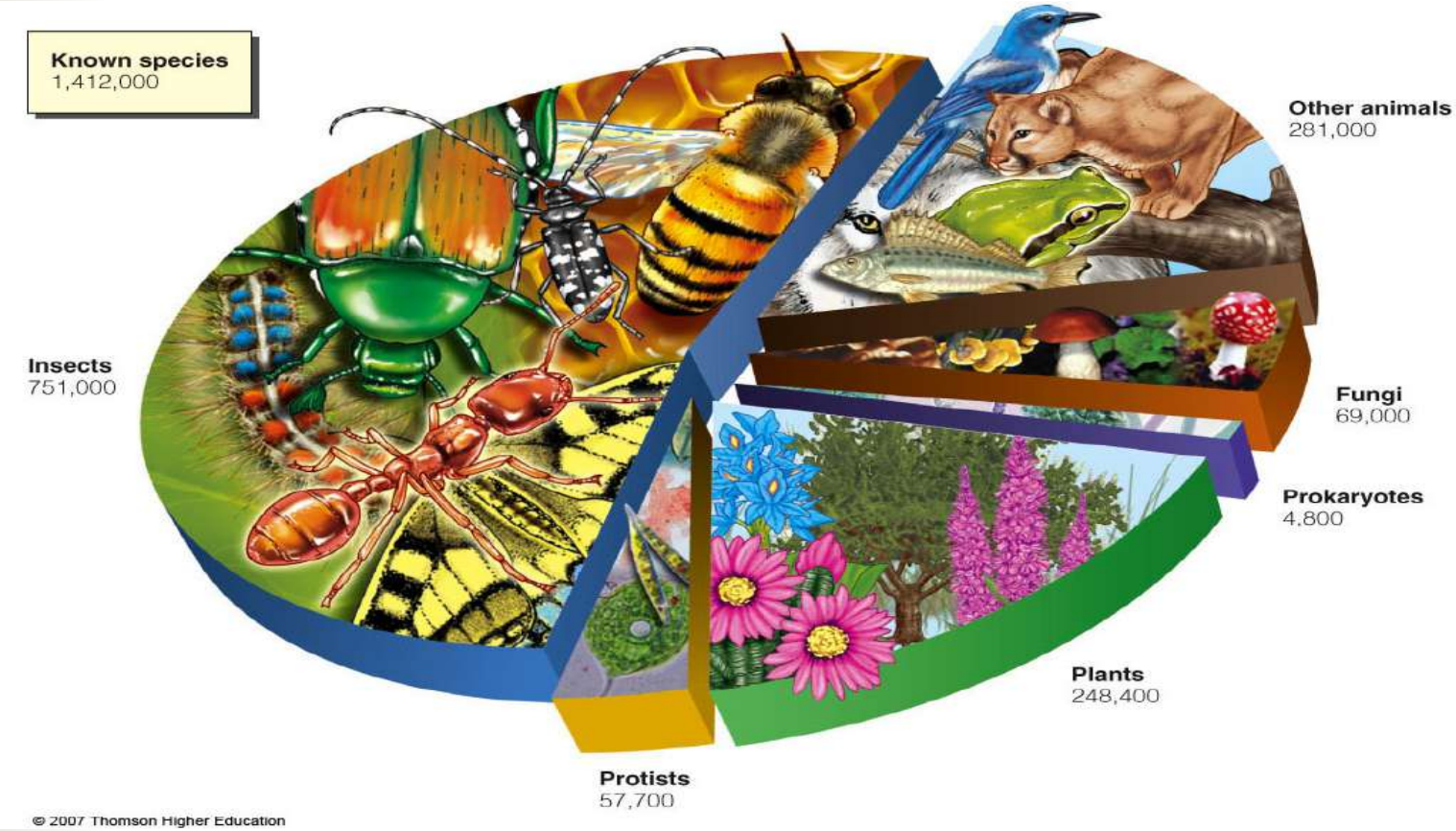



Figure 3-3

# Population

- A group of individual organisms of the same species living w/in a particular area.

# Community

- The population of all species living & interacting in an area.

# Ecosystem

- A community of different species interacting together & with the chemical & physical factors making up its non-living environment.

# Nonliving and Living Components of Ecosystems

- Ecosystems consist of nonliving (abiotic) and living (biotic) components.

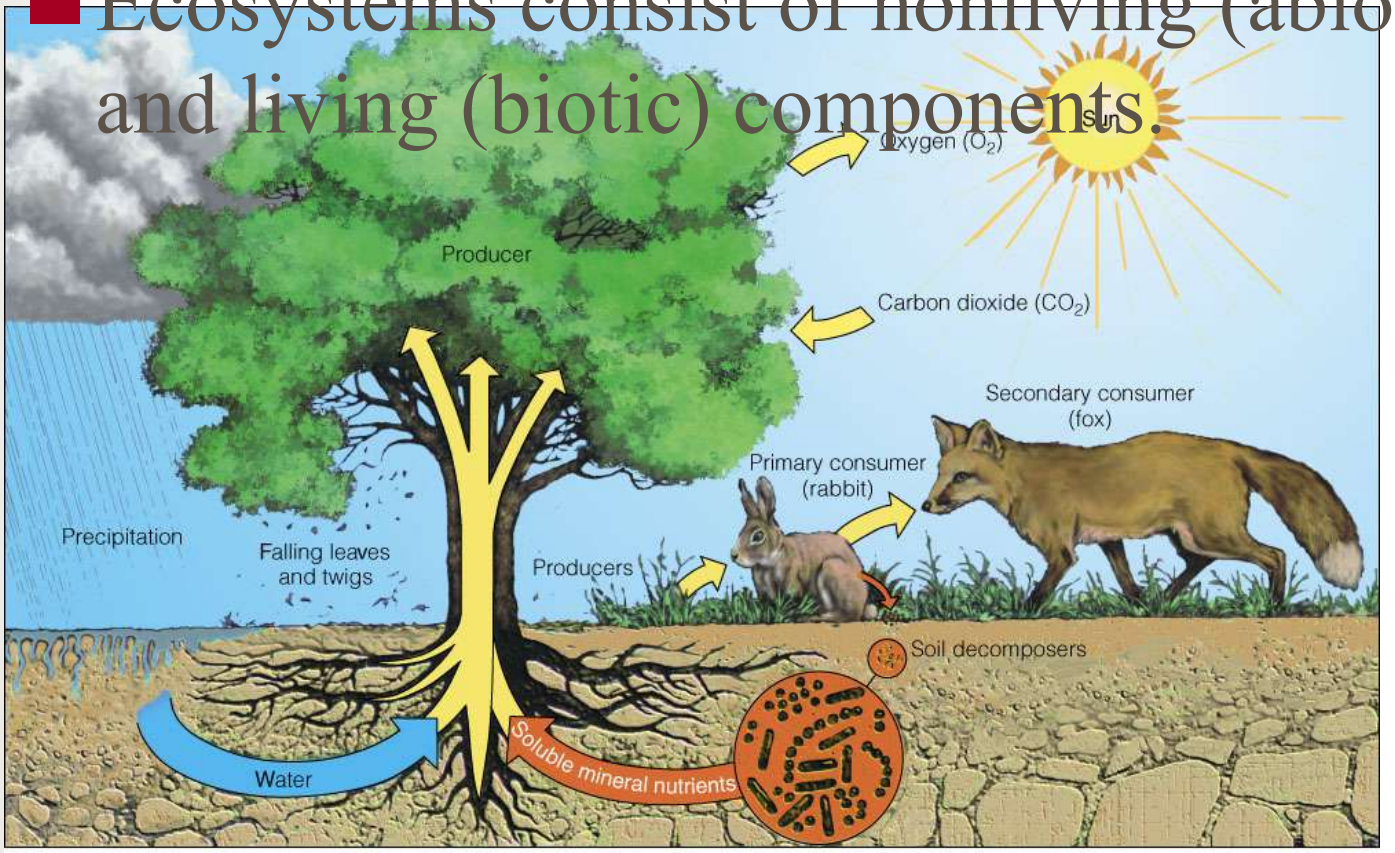
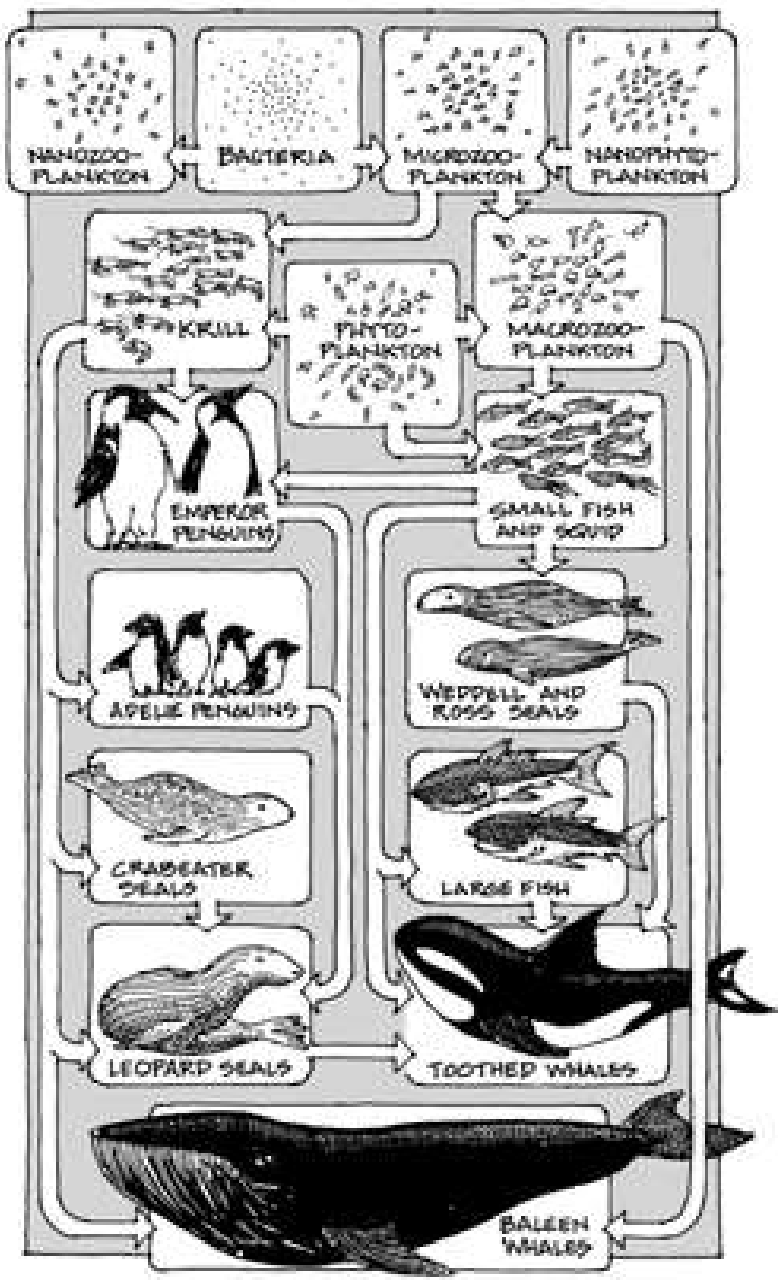





Figure 3-10

# Food Webs/Chains

- Purpose – determines how energy & nutrients move from one organism to another through the ecosystem
- Arrows – point from the producer to the consumer



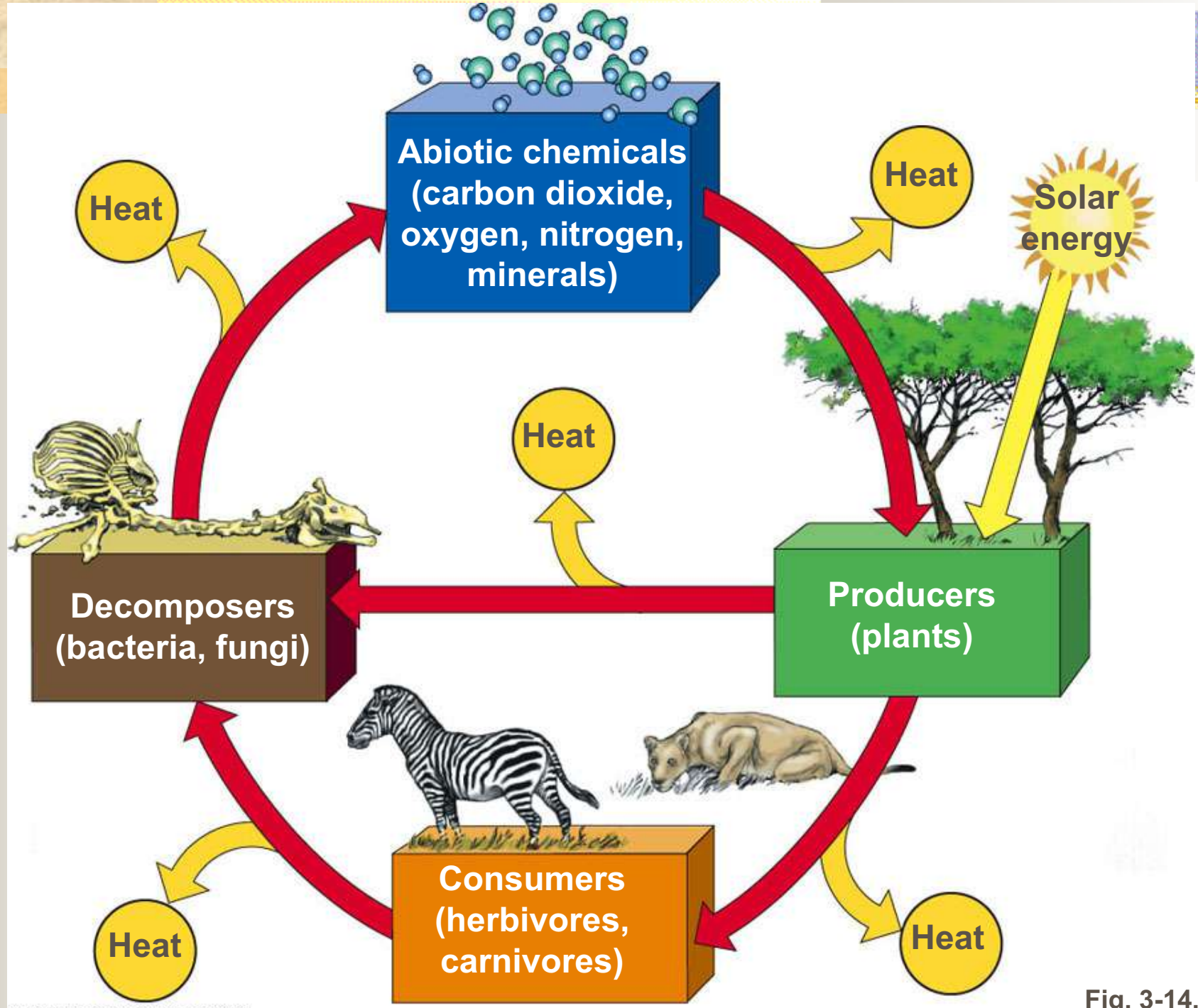





Fig. 3-14, p. 61

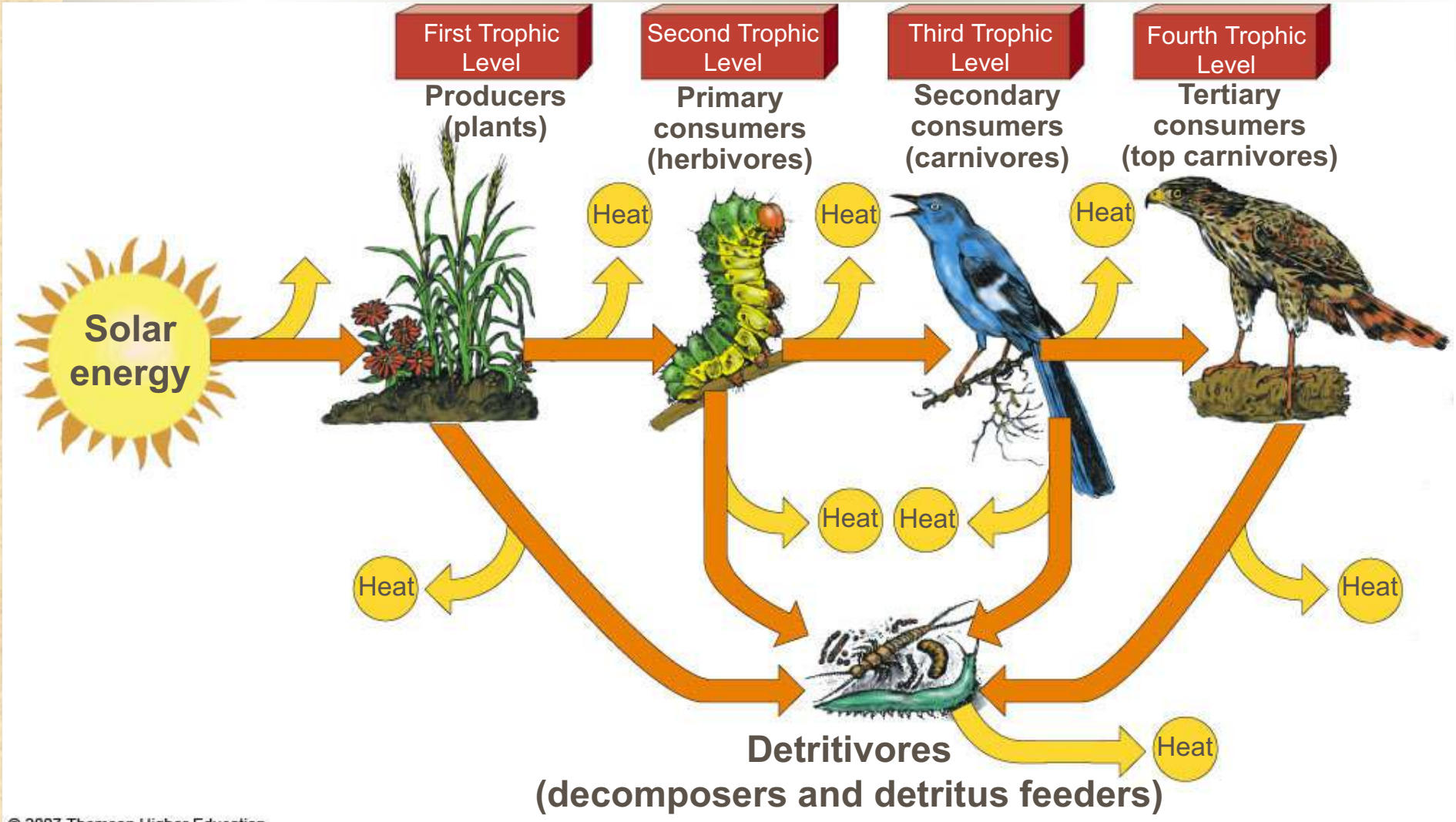

First Trophic Level
Second Trophic Level
Third Trophic Level
Fourth Trophic Level
Producers (plants)
Primary consumers (herbivores)
Secondary consumers (carnivores)
Tertiary consumers (top carnivores)
Solar energy
Heat
Heat
Heat
Heat
Heat
Heat
Heat
Detritivores (decomposers and detritus feeders)
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Fig. 3-17, p. 64

# Consumers: Eating and Recycling to Survive

- Consumers (heterotrophs) get their food by eating or breaking down all or parts of other organisms or their remains.
  - Herbivores
    - Primary consumers that eat producers
  - Carnivores
    - Primary consumers eat primary consumers
    - Third and higher level consumers: carnivores that eat carnivores.
  - Omnivores
    - Feed on both plant and animals.

# Producers

- An organism that uses solar energy (green plant) or chemical energy (some bacteria) to manufacture its food.

# Photosynthesis

## Producers: Basic Source of All Food

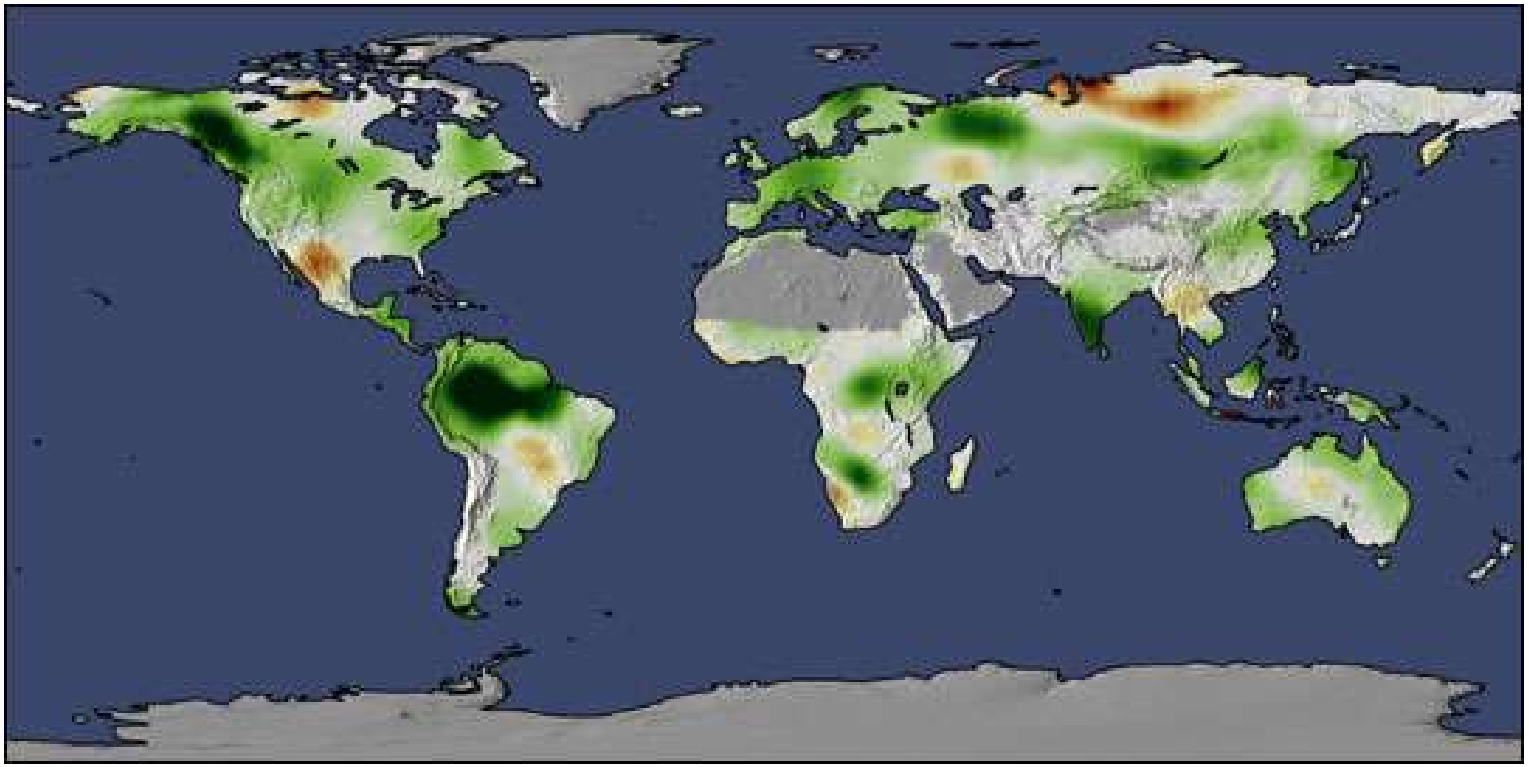
- The process in which glucose is synthesized by plants.
- Most producers capture sunlight to produce carbohydrates by photosynthesis:

carbon dioxide + water + solar energy → glucose + oxygen

$6\,CO_2 + 6\,H_2O + \text{solar energy} \rightarrow C_6H_{12}O_6 + 6\,O_2$

# Productivity

- The amount of increase in organic matter per unit of time.



# Primary Consumer (herbivore)

- An organism that feeds directly on all or parts of plants.

# Secondary Consumer (carnivore)

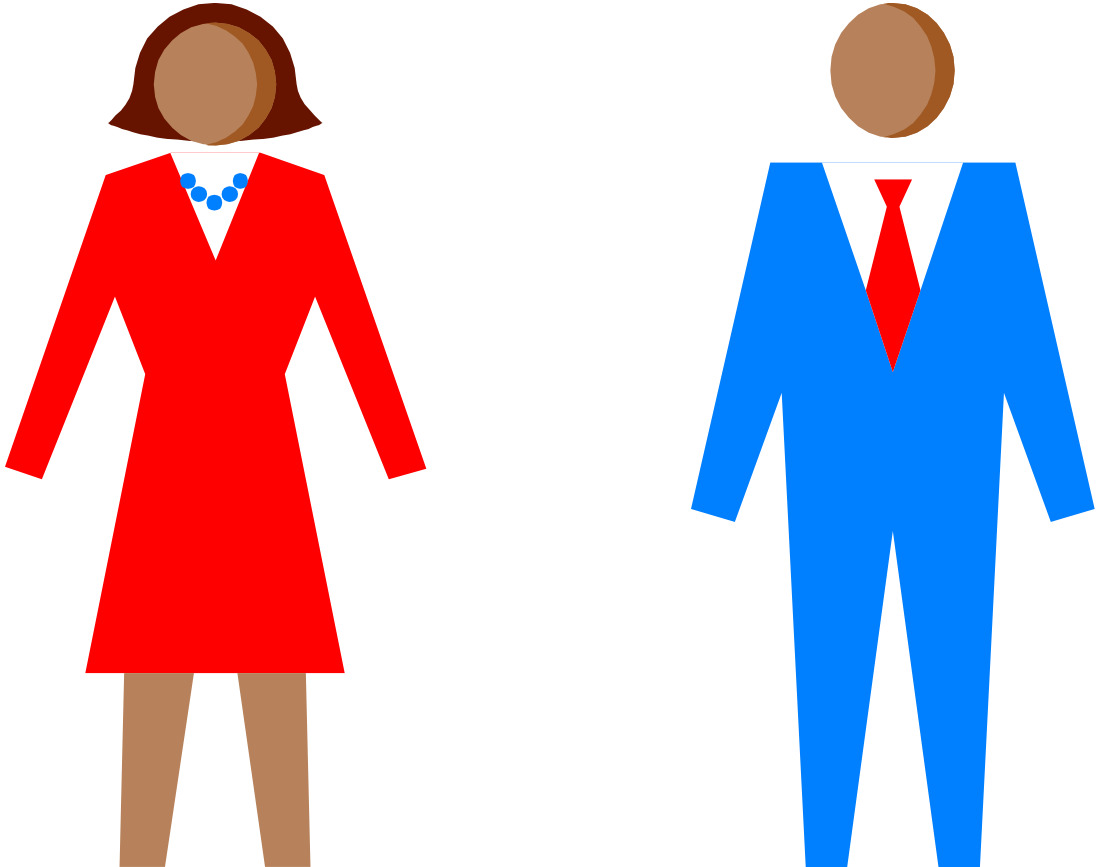
- An organisms that feeds only on primary consumers. Most are animals, but some are plants (Venus fly-trap).

# Tertiary Consumer (carnivore)

- Animals that feed on animal-eating animals. Ex. hawks, lions, bass, and sharks.

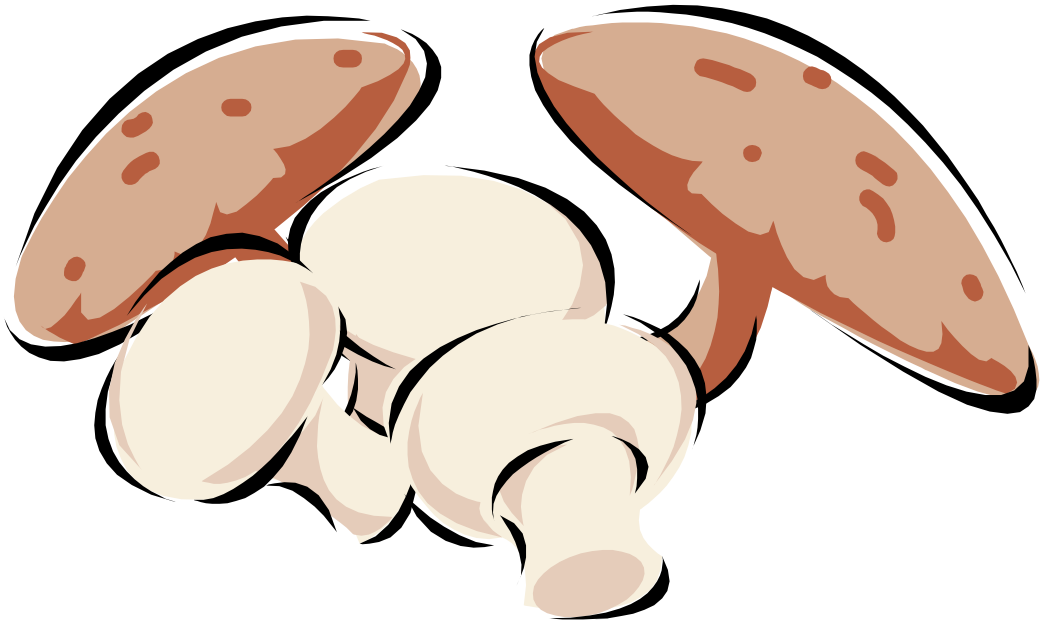
# Quaternary Consumer (carnivore)

- An animal that feeds on tertiary consumers. Ex. humans.

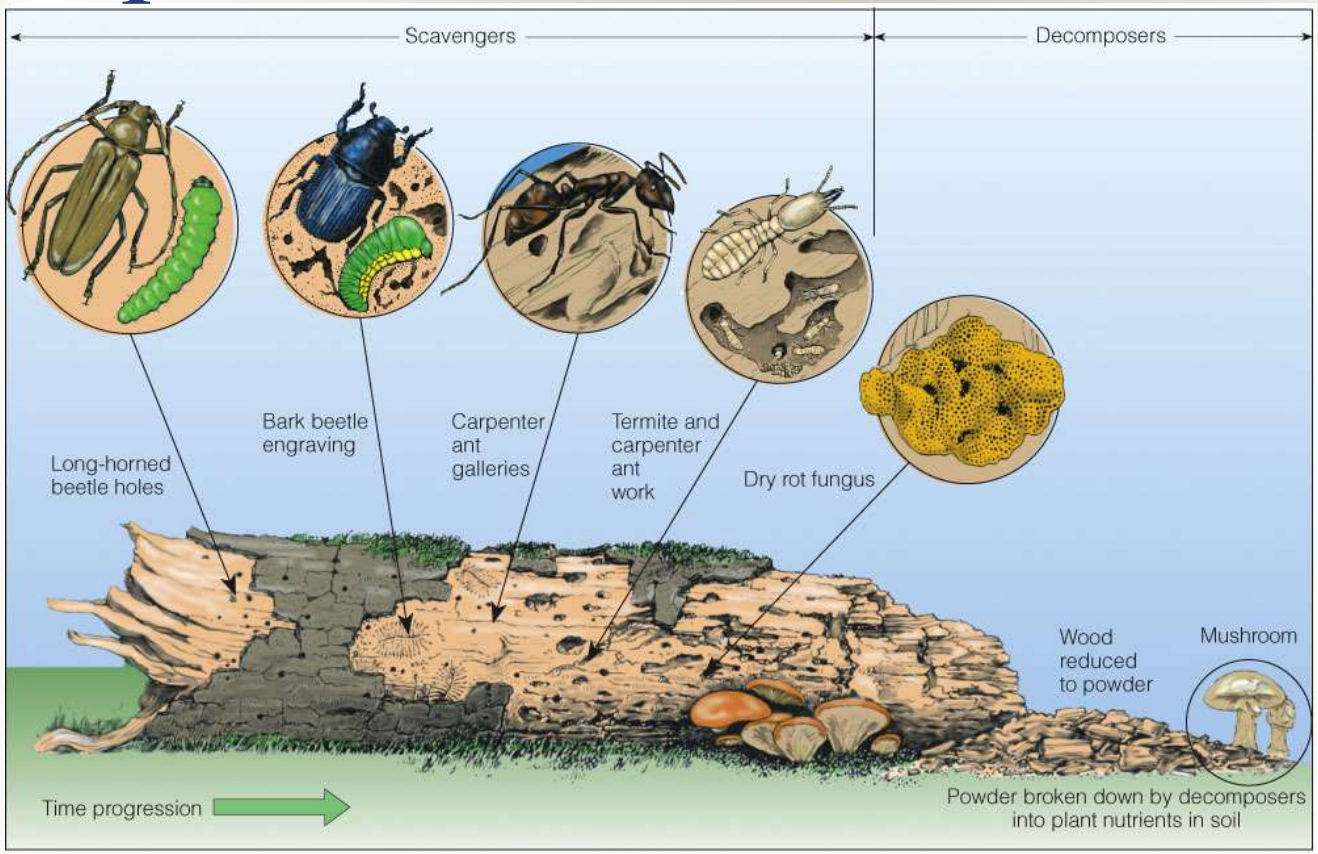


# Decomposer (scavenger, detritivore)

- An organism that digests parts of dead organisms, cast-off fragments, and wastes of living organisms.  Ex. bacteria and fungi.



# Decomposers and Detrivores





- Decomposers: Recycle nutrients in ecosystems.
- Detrivores: Insects or other scavengers that feed on wastes or dead bodies.

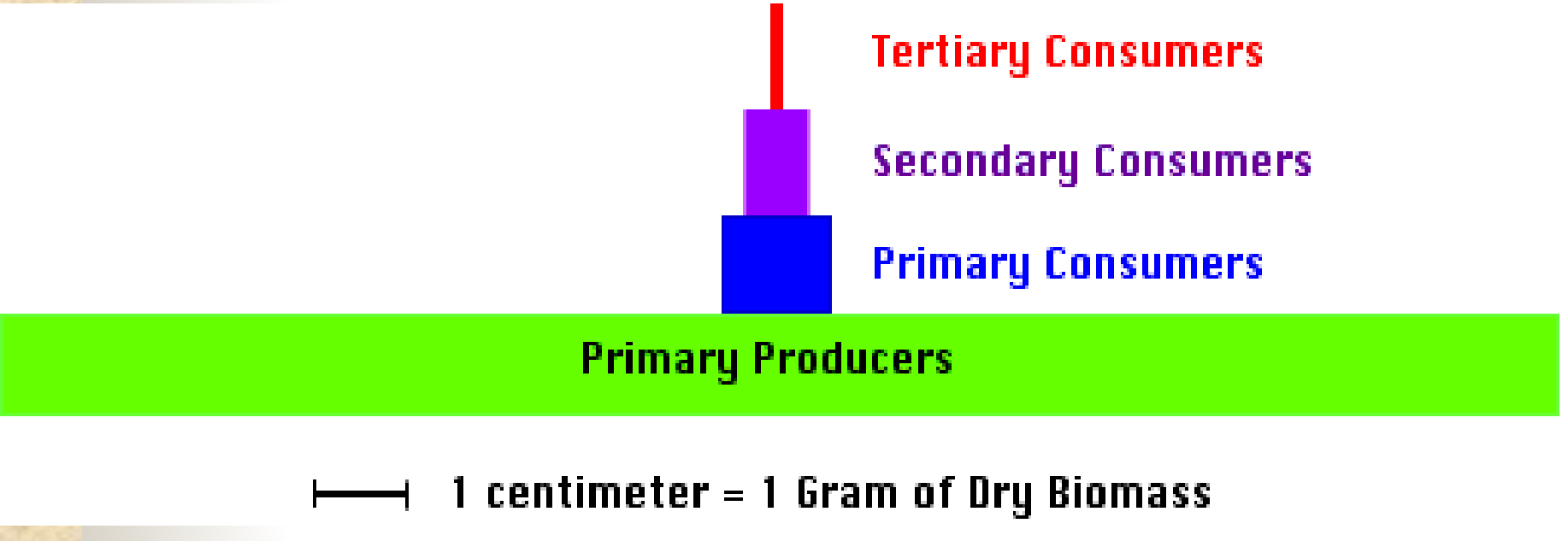
Figure 3-13

# Decomposition

- As plant or animal matter dies it will break down and return the chemicals back to the soil.
- This happens very quickly in tropical rainforest which results in low-nutrient soils.
- Grasslands have the deepest and most nutrient rich of all soils

# Structure

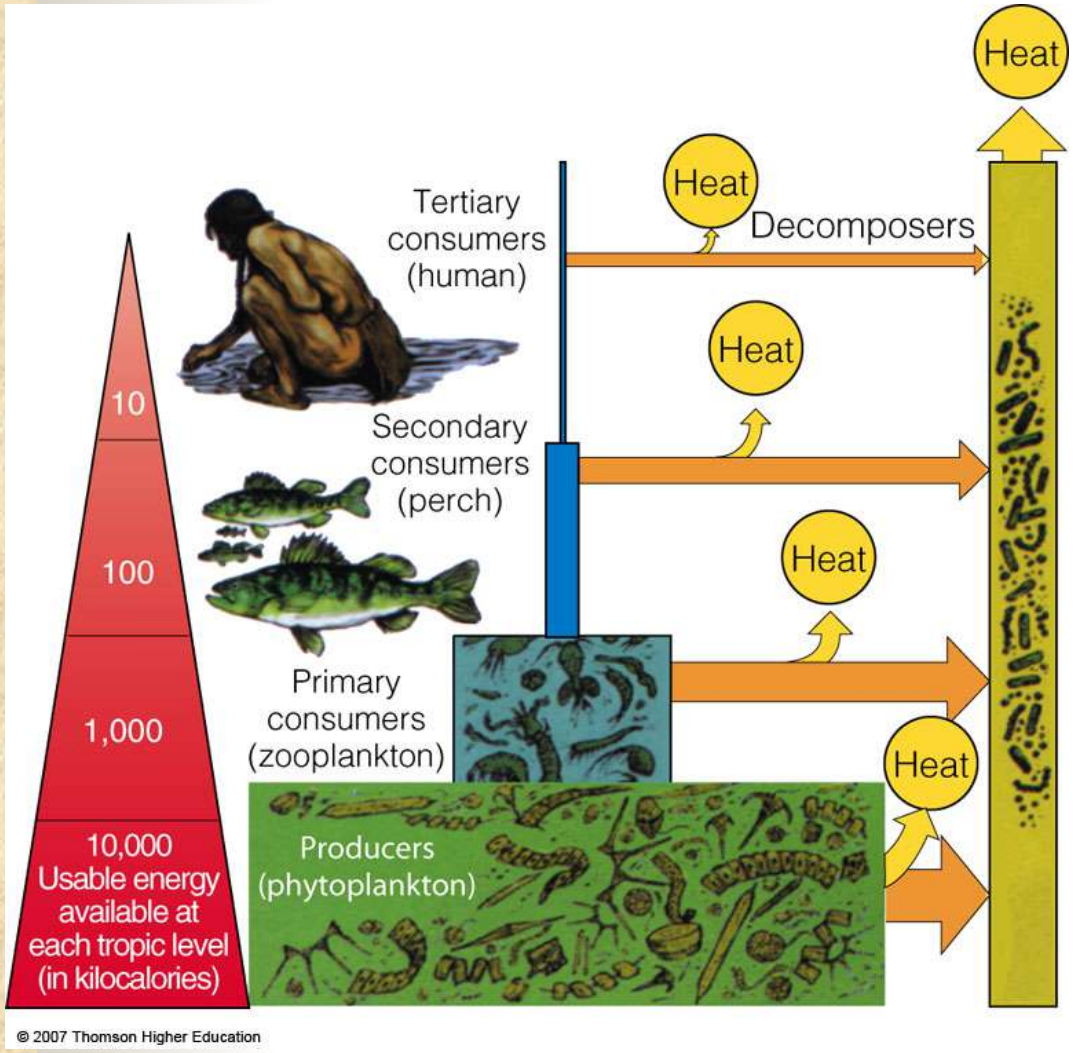
- Shows the decrease in usable energy available at each succeeding trophic level in a food chain or web.



# Energy Flow in an Ecosystem: Losing Energy in Food Chains and Webs

- In accordance with the 2nd law of thermodynamics, there is a decrease in the amount of energy available to each succeeding organism in a food chain or web.

# Energy Flow in an Ecosystem: Losing Energy in Food Chains and Webs





- ***Ecological efficiency***: percentage of useable energy transferred as biomass from one trophic level to the next.

Figure 3-19

# Relationship Between Biomass and Energy

- Biomass is dry weight & represents the chemical energy stored at each energy level.
- Water is neither a source of energy, nor has any nutritional value.

# 10% Rule

- We assume that 90% of the energy at each energy level is lost because the organism uses the energy. (heat)
- It is more efficient to eat lower on the energy pyramid.  You get more out of it!
- This is why top predators are few in number & vulnerable to extinction.

# Biomass

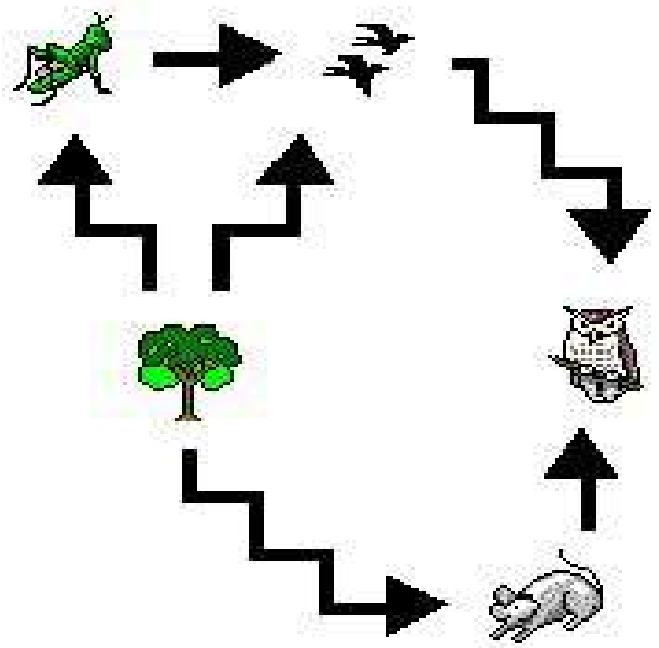
- The organic matter produced by plants; dry weight.
- Energy from wood, garbage & agricultural waste.
- Can be used for electrical energy!

# Energy Flow & Feeding Relationships

- Direction:

  grain → steer → human

- Measurement – samples are taken, dried, & weighed



# Tragedy of the Commons

- A common-property resource, which are owned by no one but are available to all users free of charge.
- Most are potentially renewable.
- Ex. Clean air, open ocean and its fish, migratory birds, Antarctica, the ozone, and space.

# Macronutrients

- Chemicals organisms need in large numbers to live, grow, and reproduce.
- Ex. carbon, oxygen, hydrogen, nitrogen, calcium, and iron.

# Micronutrients

- These are needed in small or even trace amounts.
- Ex. sodium, zinc copper, chlorine, and iodine.

# Carbon, Phosphorous, and Nitrogen Cycles

- The cyclic movement of chemicals (see overhead).
- Carbon cycle: pg 73-74
- Phosphorous cycle: pg 76
- Nitrogen cycle: pg 74-76
- Sulfur cycle:  pg 77-78

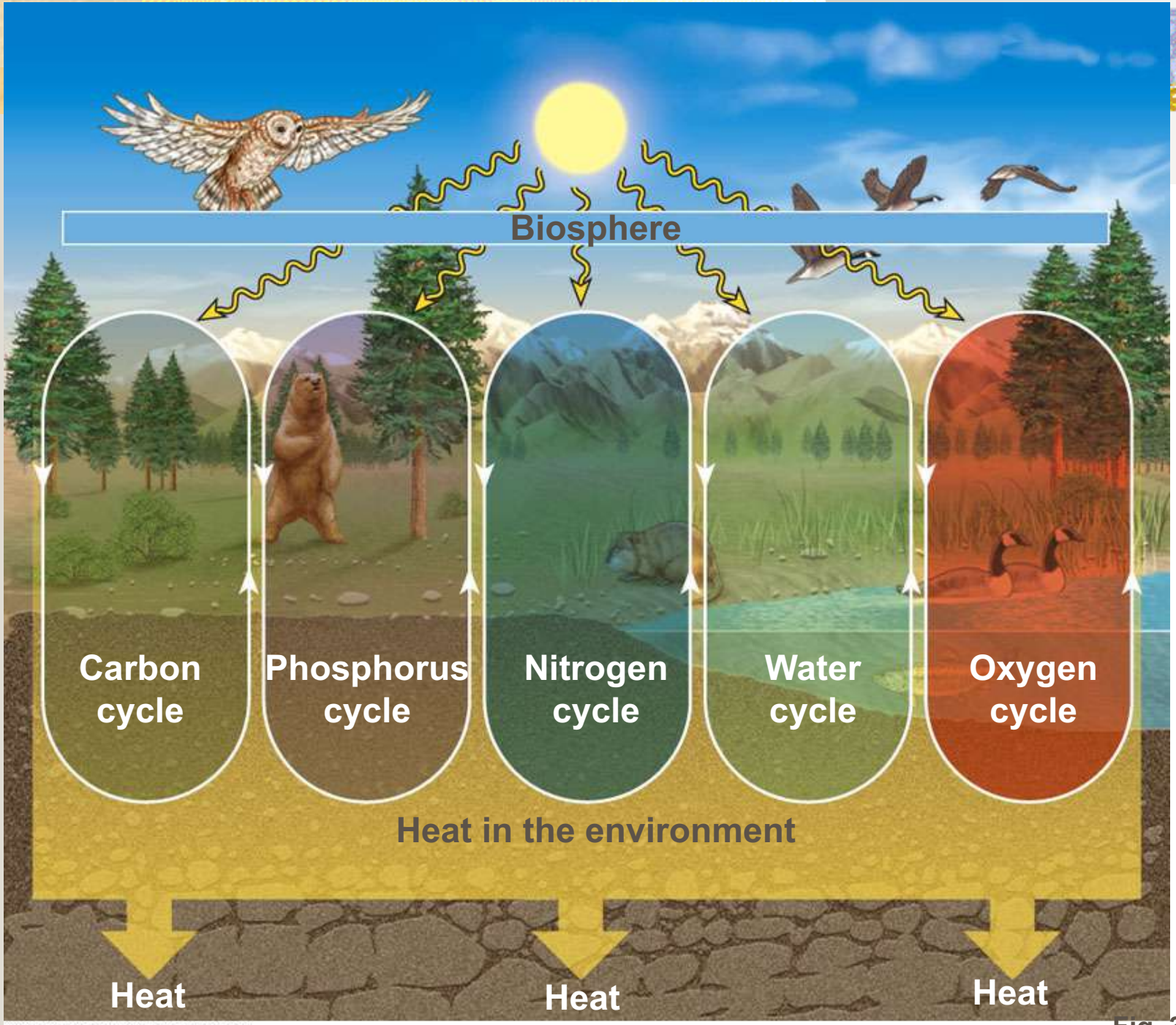
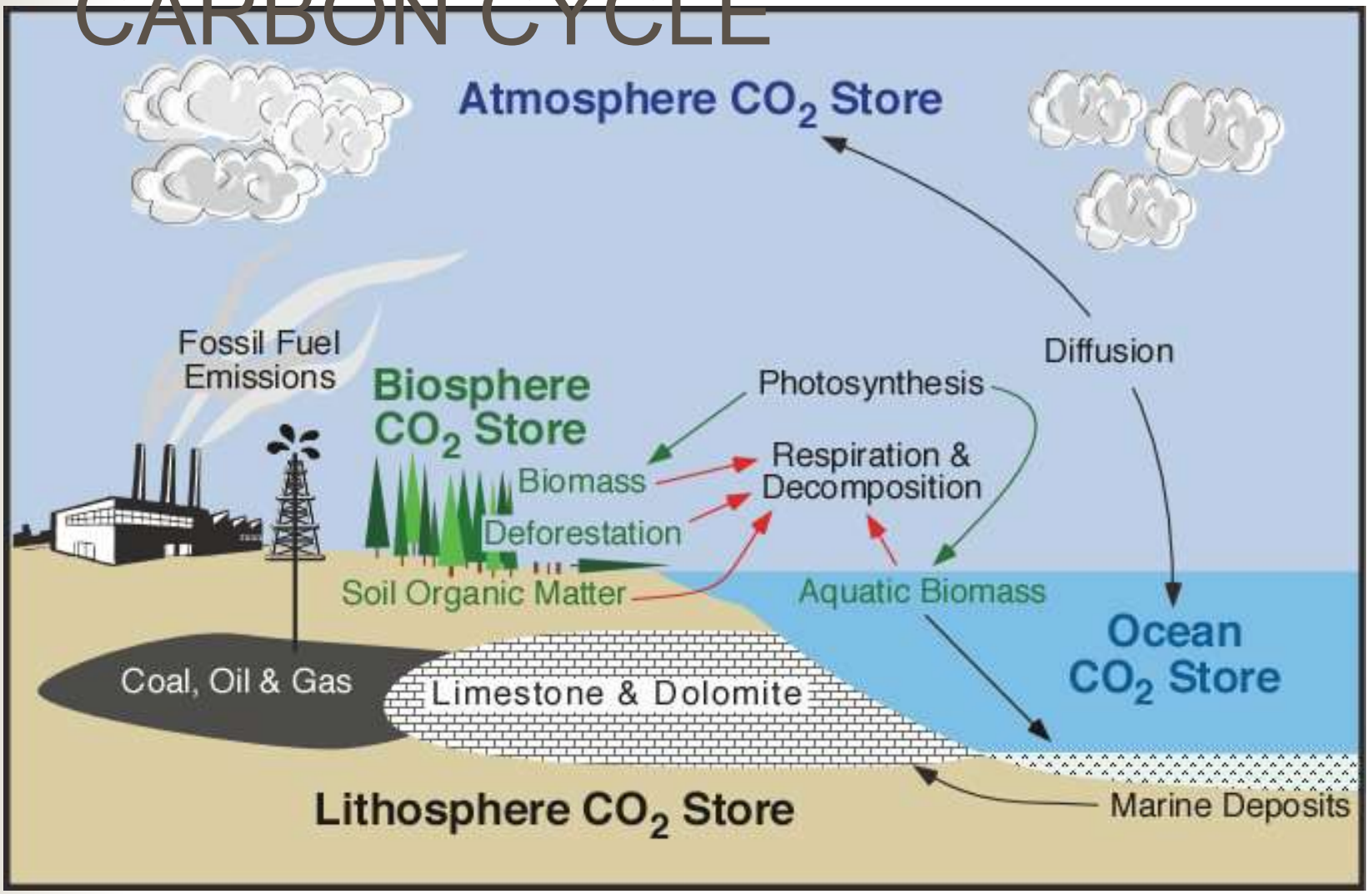





Fig. 3-7, p. 55

# CARBON CYCLE



# Effects of Human Activities on Carbon Cycle

- We alter the carbon cycle by adding excess $CO_2$ to the atmosphere through:
  - Burning fossil fuels.
  - Clearing vegetation faster than it is replaced.

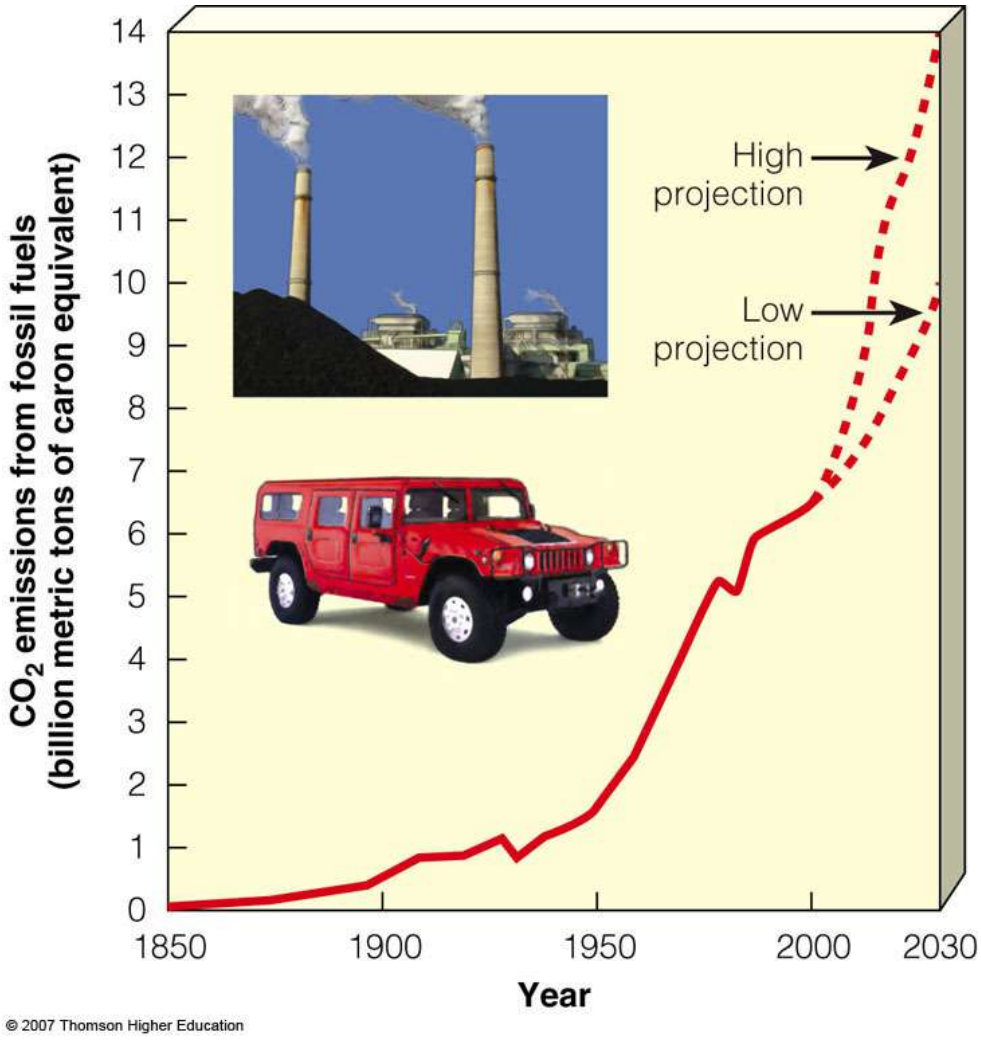
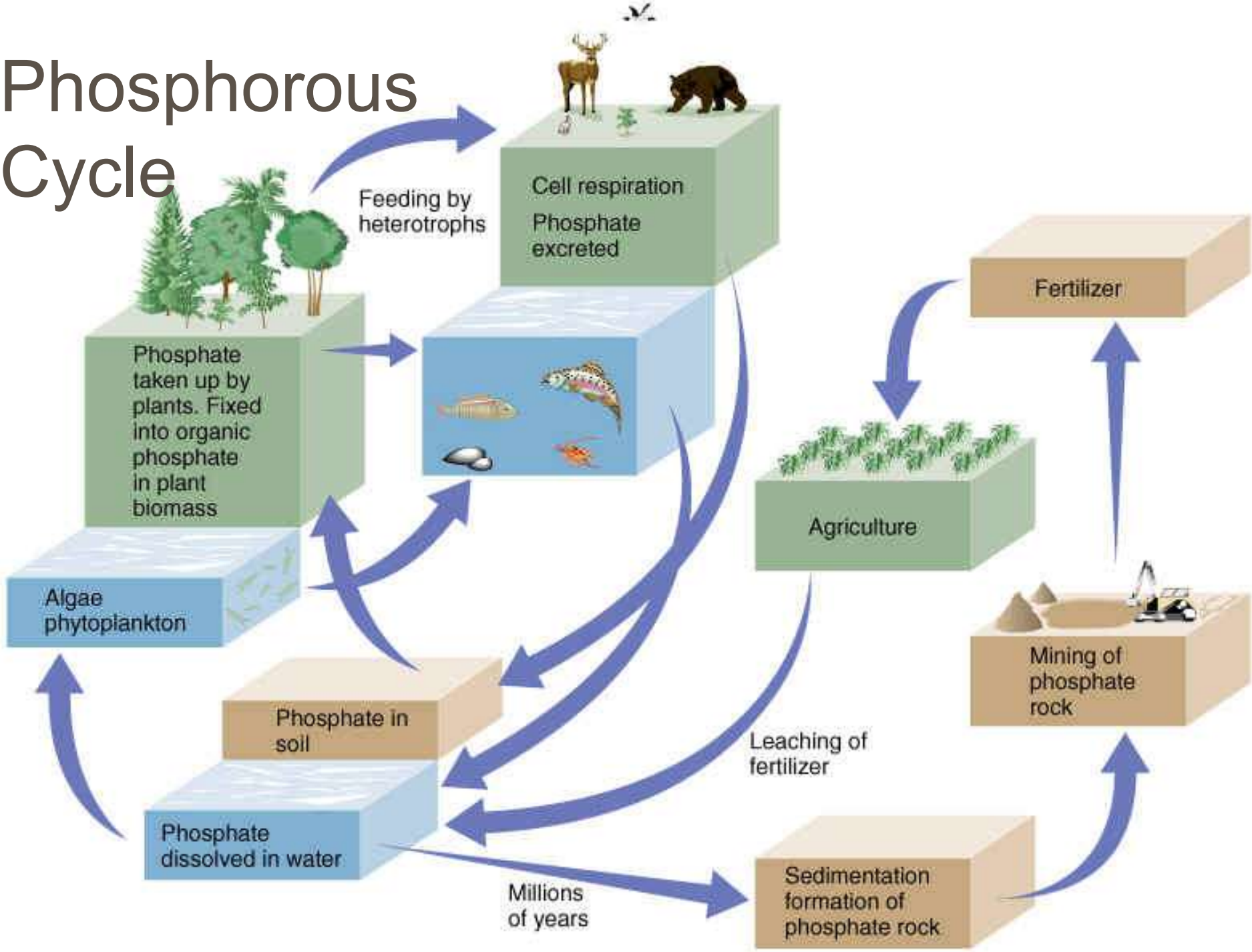





Figure 3-28

# Phosphorous Cycle



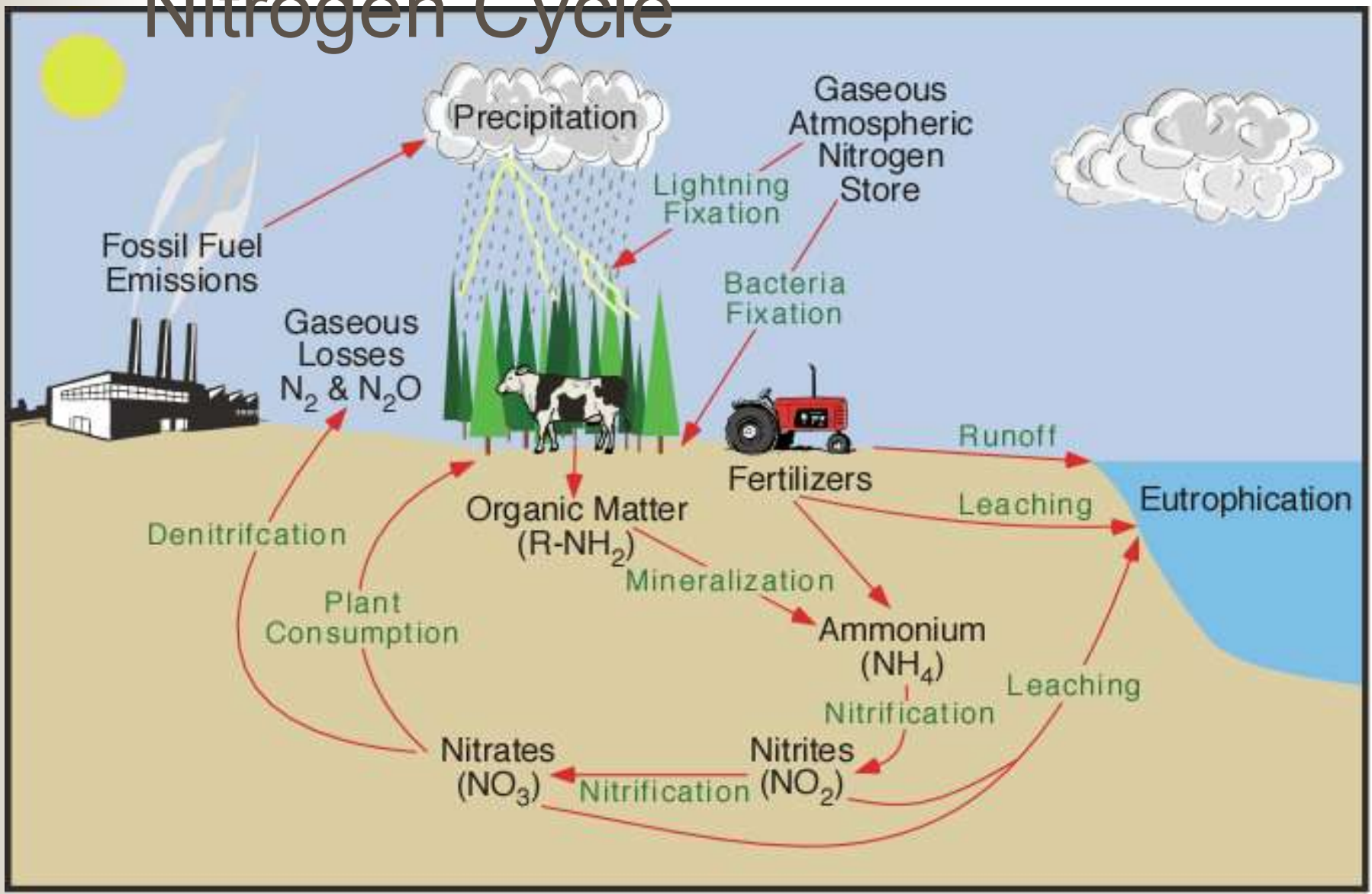
# Effects of Human Activities on the Phosphorous Cycle

- We remove large amounts of phosphate from the earth to make fertilizer.
- We reduce phosphorous in tropical soils by clearing forests.
- We add excess phosphates to aquatic systems from runoff of animal wastes and fertilizers.

# Phosphorus

- Bacteria are not as important in the phosphorus cycle as in the nitrogen cycle.
- Phosphorus is not usually found in the atmosphere or in a gas state only as dust.
- The phosphorus cycle is slow and phosphorus is usually found in rock formations and ocean sediments.
- Phosphorus is found in fertilizers because most soil is deficient in it and plants need it.
- Phosphorus is usually insoluble in water and is not found in most aquatic environments.

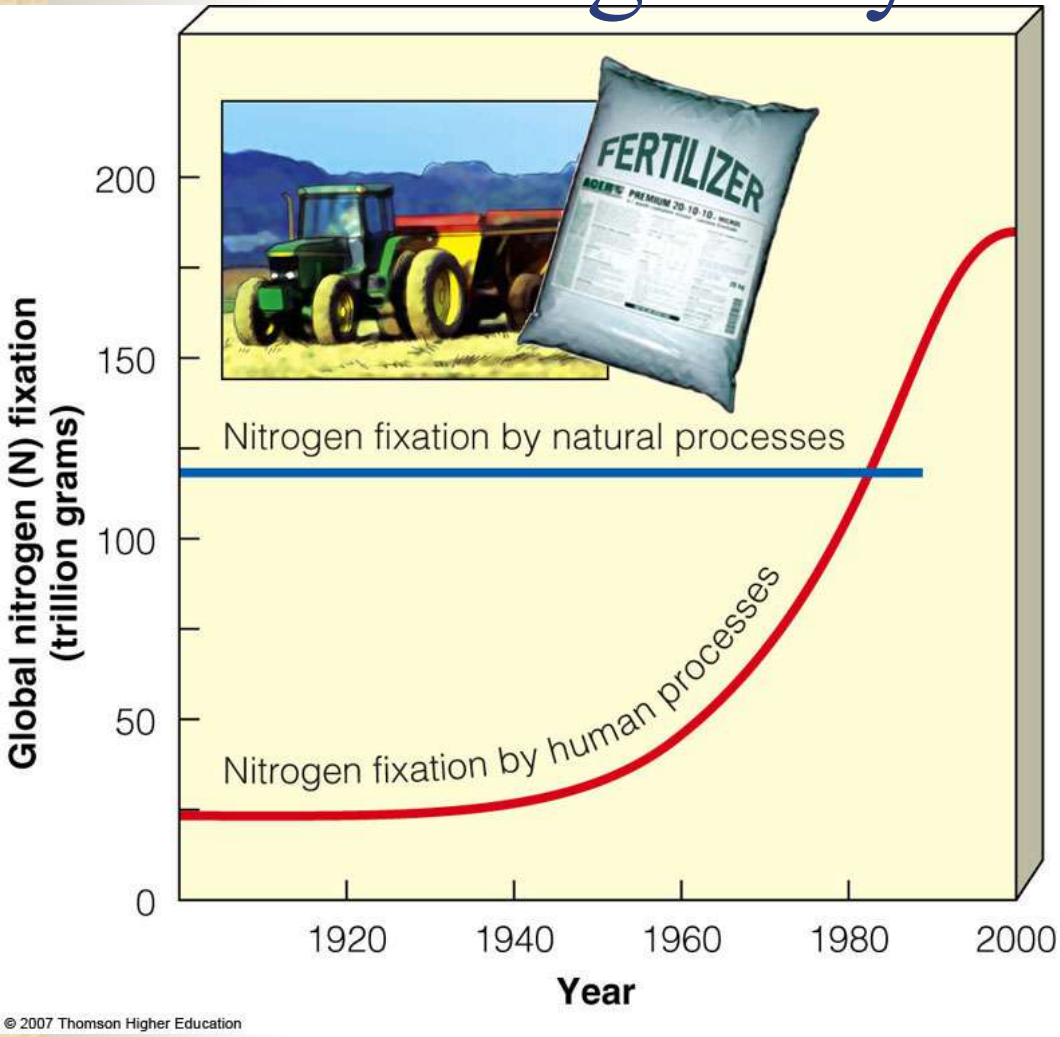
# Nitrogen Cycle



# Effects of Human Activities on the Nitrogen Cycle

- We alter the nitrogen cycle by:
  - Adding gases that contribute to acid rain.
  - Adding nitrous oxide to the atmosphere through farming practices which can warm the atmosphere and deplete ozone.
  - Contaminating ground water from nitrate ions in inorganic fertilizers.
  - Releasing nitrogen into the troposphere through deforestation.

# Effects of Human Activities on the Nitrogen Cycle





- Human activities such as production of fertilizers now fix more nitrogen than all natural sources combined.

Figure 3-30

# Nitrogen Fixation

- This is the first step of the nitrogen cycle where specialized bacteria convert gaseous nitrogen to ammonia that can be used by plants.  This is done by cyanobacteria or bacteria living in the nodules on the root of various plants.

# Nitrification

- Ammonia is converted to nitrite, then to nitrate

# Assimilation

- Plant roots absorb ammonium ions and nitrate ions for use in making molecules suc as DNA, amino acids and proteins.

# Ammonification

- After nitrogen has served its purpose in living organisms, decomposing bacteria convert the nitrogen-rich compounds, wastes, and dead bodies into simpler compounds such as ammonia.

# Denitrification

•Nitrate ions and nitrite ions are converted into nitrous oxide gas and nitrogen gas.
This happens when a soil nutrient is reduced and released into the atmosphere as a gas.

# The Sulfur Cycle

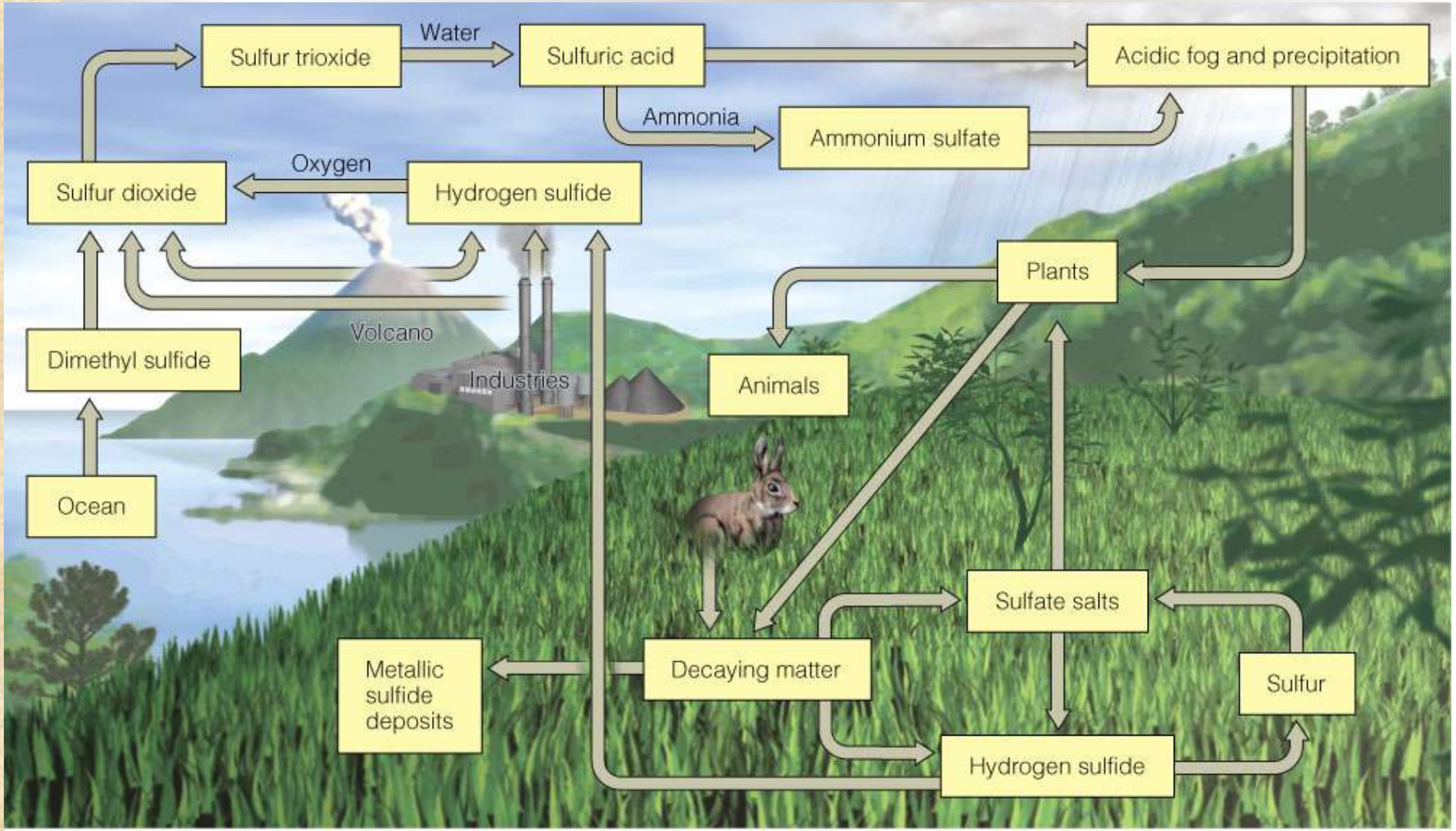





Figure 3-32

# Effects of Human Activities on the Sulfur Cycle

- We add sulfur dioxide to the atmosphere by:
  - Burning coal and oil
  - Refining sulfur containing petroleum.
  - Convert sulfur-containing metallic ores into free metals such as copper, lead, and zinc releasing sulfur dioxide into the environment.

# Species Diversity and Niche Structure: Different Species Playing Different Roles

- Biological communities differ in the types and numbers of species they contain and the ecological roles those species play.
  - ***Species diversity***: the number of different species it contains (***species richness***) combined with the abundance of individuals within each of those species (***species evenness***).

# Biodiversity

## Definition

- The many forms of life found on the Earth. "Wildness"
  - Genetic Diversity – the variety of genetic make-up w/in a single species
  - Species Diversity – the variety of species in different habitats on the Earth

# Importance

- It gives us food, wood, energy, free recycling, purification & natural pest control.

# Measurement

- Genetic tests, count/release, and tagging.

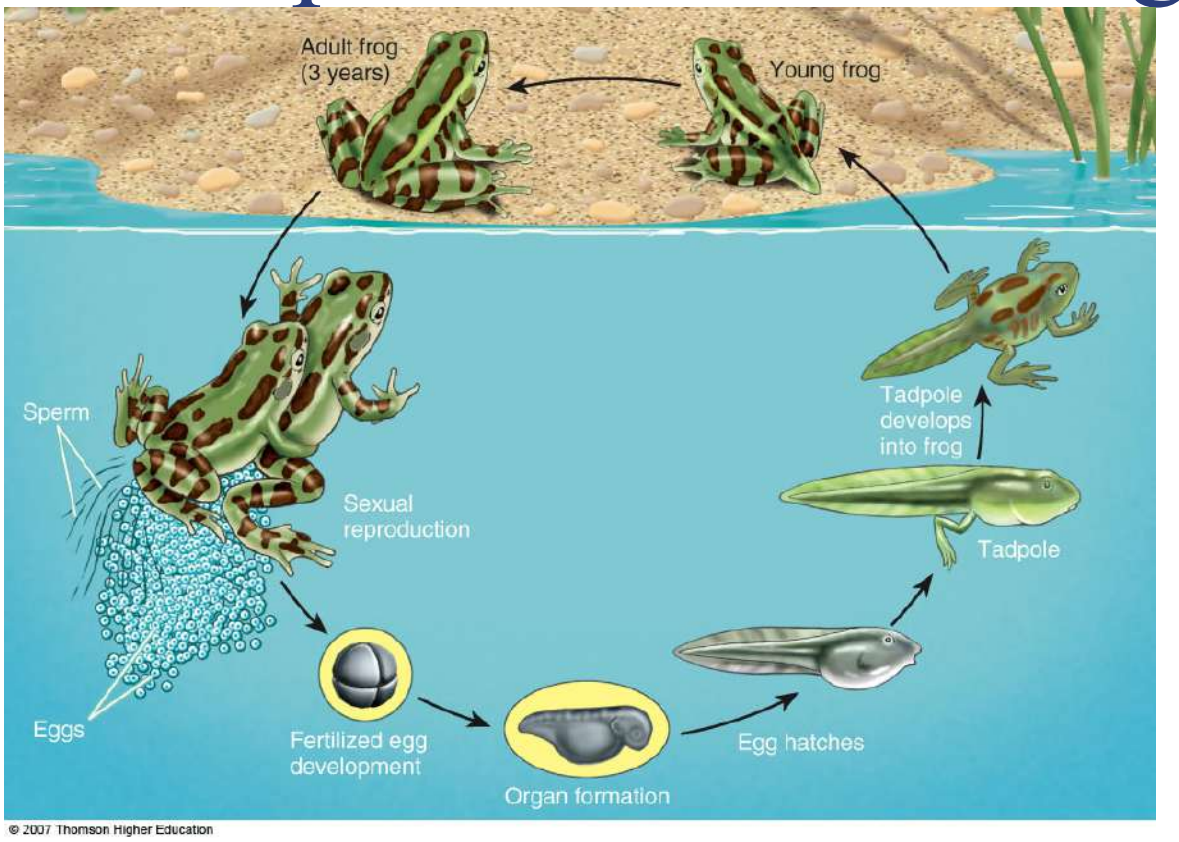
# The Gaia Hypothesis: Is the Earth Alive?

- Some have proposed that the earth's various forms of life control or at least influence its chemical cycles and other earth-sustaining processes.
  - The strong Gaia hypothesis: life controls the earth's life-sustaining processes.
  - The weak Gaia hypothesis: life influences the earth's life-sustaining processes.

# Indicator Species: Biological Smoke Alarms

- Species that serve as early warnings of damage to a community or an ecosystem.
  - Presence or absence of trout species because they are sensitive to temperature and oxygen levels.

# Case Study:
# Why are Amphibians Vanishing?




- Frogs serve as indicator species because different parts of their life cycles can be easily disturbed.

Figure 7-3

# Case Study:
# Why are Amphibians Vanishing?

- Habitat loss and fragmentation.
- Prolonged drought.
- Pollution.
- Increases in ultraviolet radiation.
- Parasites.
- Viral and Fungal diseases.
- Overhunting.
- Natural immigration or deliberate introduction of nonnative predators and competitors.

# Keystone Species: Major Players



- Keystone species help determine the types and numbers of other species in a community thereby helping to sustain it.

Figures 7-4 and 7-5

# Foundation Species: Other Major Players

- Expansion of keystone species category.
- Foundation species can create and enhance habitats that can benefit other species in a community.
  - Elephants push over, break, or uproot trees, creating forest openings promoting grass growth for other species to utilize.

# Habitat

- The place where an organism or a population lives.

# Habitat Needs

- Cover – shelter; trees, shrubs, etc.
- Water
- Nutrients

# Niche

- The total way of life or role of a species in an ecosystem.
- All the physical, chemical, and biological conditions a species needs to live & reproduce in an ecosystem.

# Description

- Two kinds of organisms, such as lions and zebras, are said to have a predator-prey relationship.

# Predator

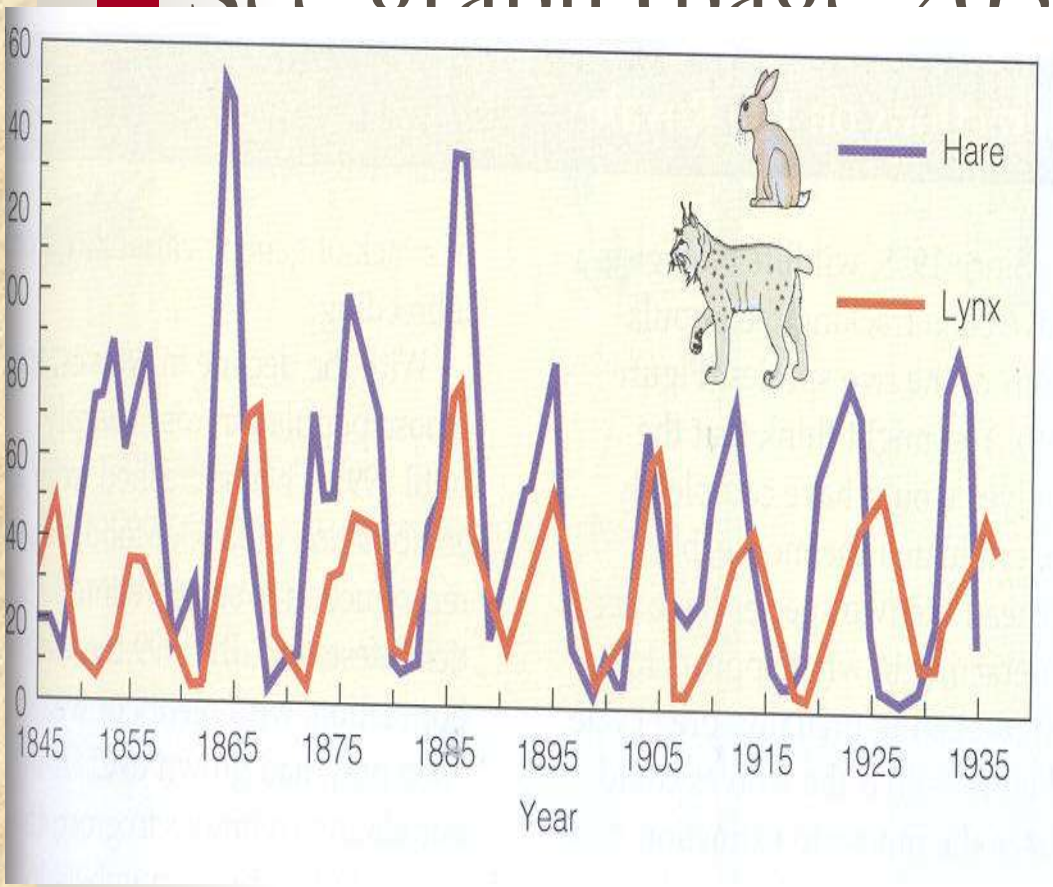
- An organisms that captures & feeds on parts or all of another animal.

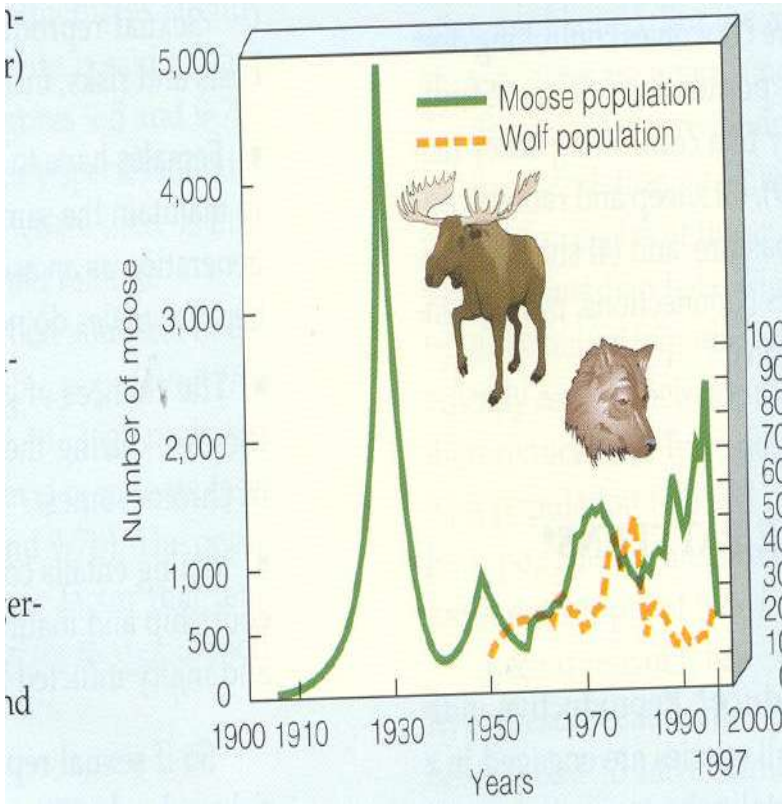
# Prey

- An organisms that is captured & serves as a source of food for another animal.

# Cycle

- See graph (page 203 and 204)



# Importance in Population Control

- Predators usually kill the sick, weak or aged.
- This helps to let the rest of the prey have greater access to the available food supply.
- It also improves the genetic stock.

# SPECIES INTERACTIONS: COMPETITION AND PREDATION

- Species can interact through competition, predation, parasitism, mutualism, and commensalism.
- Some species evolve adaptations that allow them to reduce or avoid competition for resources with other species (resource partitioning).

# Symbiosis

- Parasitism –when 1 species (parasite) feeds on part of another species (host) by living on or in it for a large portion of host's life.
- Commensalism – benefits one species but doesn't harm or help the other
- Mutualism – both species benefit

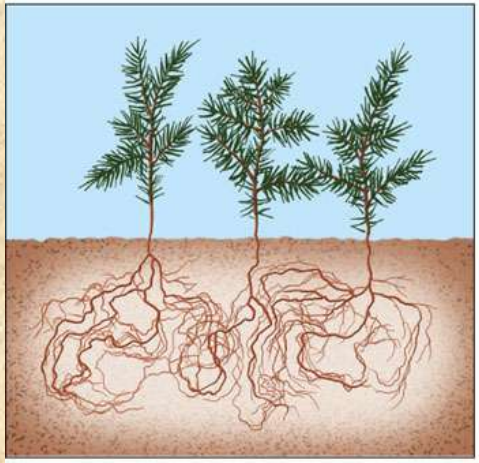
# Parasites: Sponging Off of Others

- Although parasites can harm their hosts, they can promote community biodiversity.
  - Some parasites live in host (micororganisms, tapeworms).
  - Some parasites live outside host (fleas, ticks, mistletoe plants, sea lampreys).
  - Some have little contact with host (dump-nesting birds like cowbirds, some duck species)

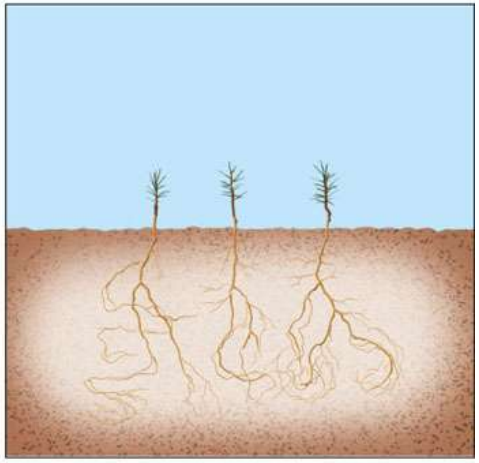
# Mutualism: Win-Win Relationship

(a) Oxpeckers and black rhinoceros

(b) Clownfish and sea anemone



(c) Mycorrhizal fungi on juniper seedlings in normal soil



(d) Lack of mycorrhizal fungi on juniper seedlings in sterilized soil



- Two species can interact in ways that benefit both of them.

Figure 7-9



(a) Oxpeckers and black rhinoceros

Fig. 7-9a, p. 154

# Commensalism: Using without Harming



- Some species interact in a way that helps one species but has little or no effect on the other.

Figure 7-10

# Population

- A group of individual organisms of the same species living w/in a particular area.

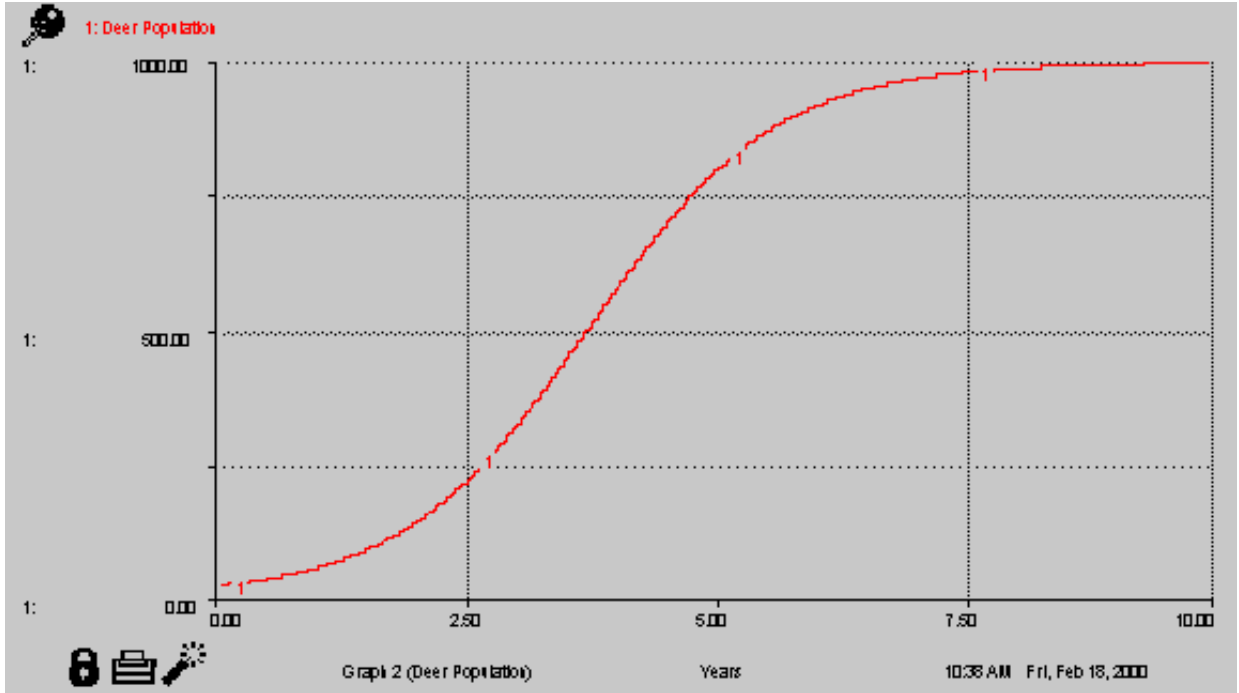
# Carrying Capacity

- The maximum population of a particular species that a given habitat can support over time.

# Population Growth Cycle

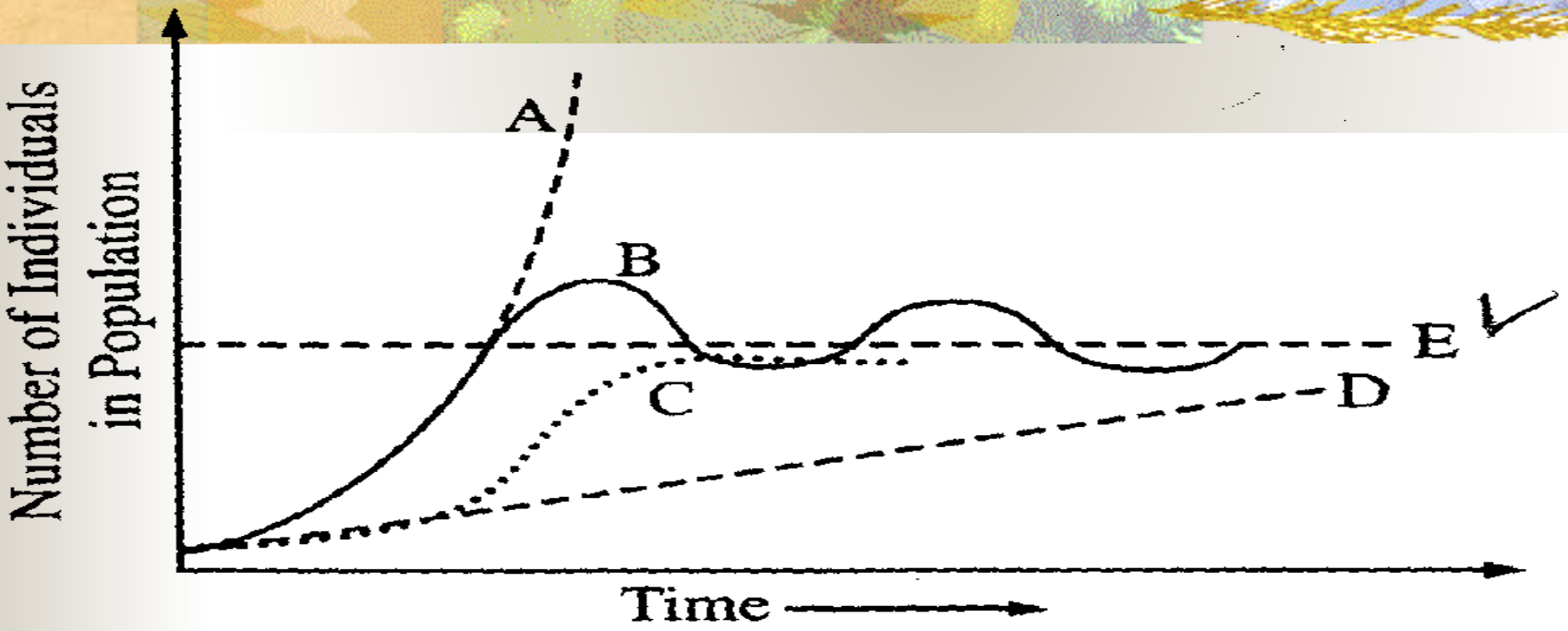
## Limited Resources

- A population can grow until competition for limited resources increases & the carrying capacity (C.C.) is reached.



# Typical Phases

- 1. The population overshoots the C.C.
- 2. This is because of a reproductive time lag (the period required for the birth rate to fall & the death rate to rise).
- 3. The population has a dieback or crashes.
- 4. The carrying capacity is reached.




A: Represents the biotic potential of the species

B: Shows how the population overshoots the carrying capacity

C: Represents the logistic growth

D: Represents linear growth

E: Carrying capacity- the maximum number of individuals that can be supported by a particular ecosystem.

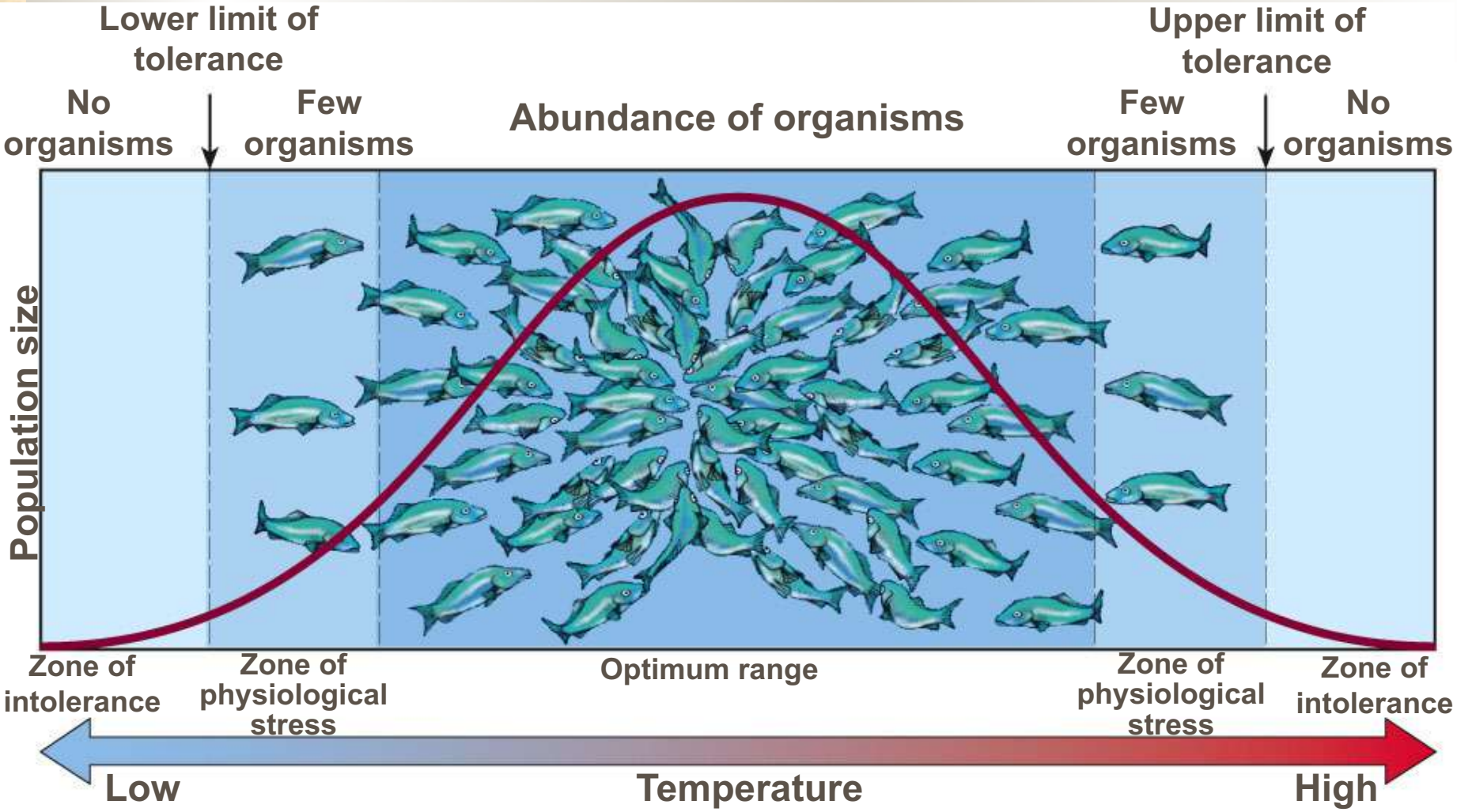




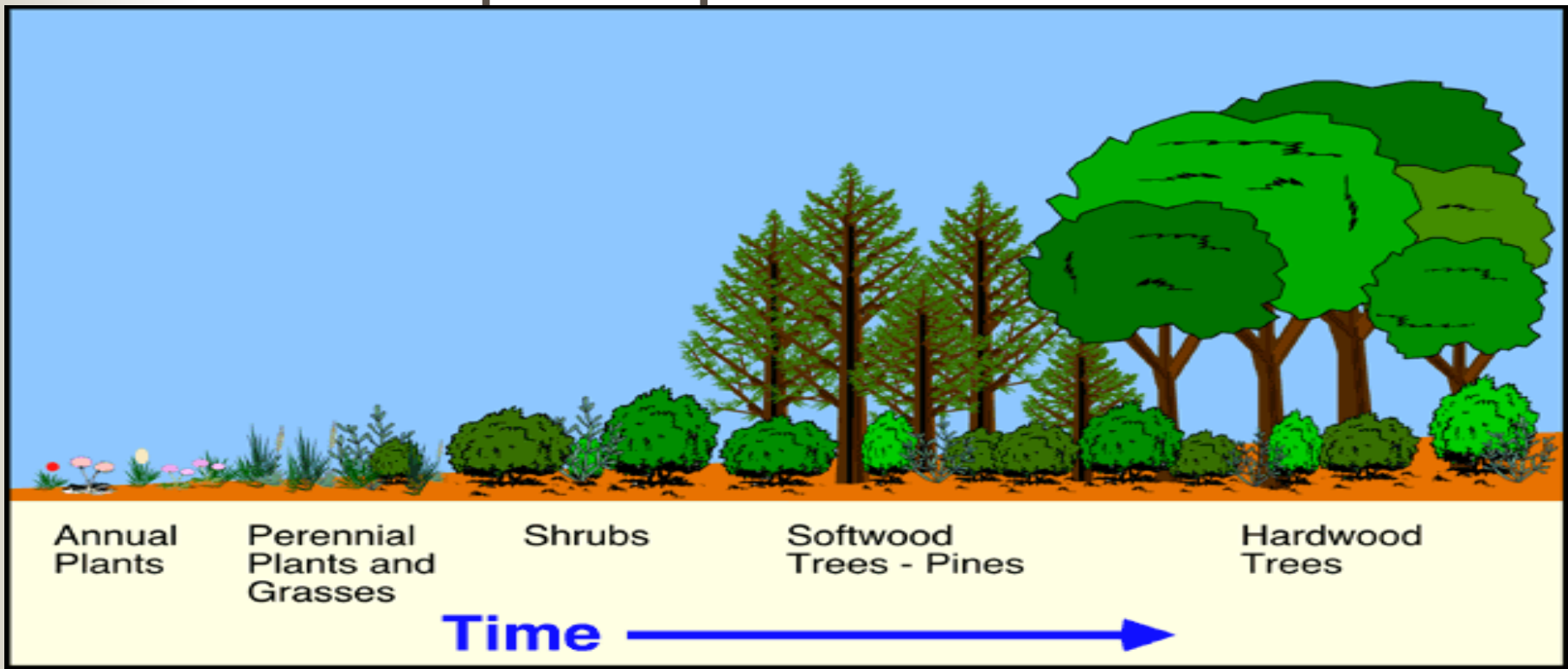

Fig. 3-11, p. 58

# Relationship to Human Population Growth

- Infectious disease can control humans. Ex. the Bubonic plague.

# Succession Definition

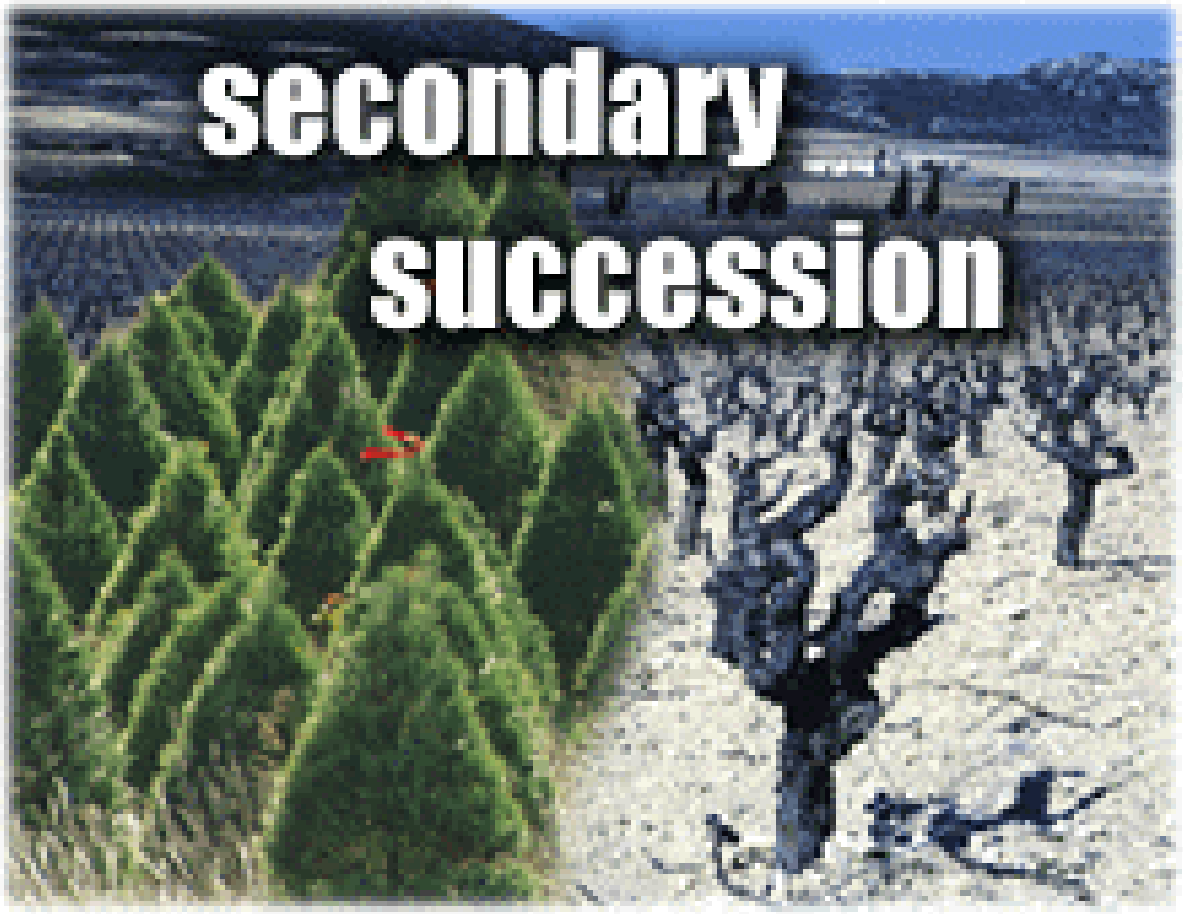
- The process where plants & animals of a particular area are replaced by other more complex species over time.



# Primary vs. Secondary

- Primary begins with a lifeless area where there is no soil (ex. bare rock). Soil formation begins with lichens or moss

Secondary begins in an area where the natural community has been disturbed, removed, or destroyed, but soil or bottom sediments remain.



# Pioneer Communities

- Lichens and moss.

# Climax Communities

- The area dominated by a few, long-lived plant species.

# Stages

- Land – rock → lichen → small shrubs → large shrubs → small trees → large trees

Water – bare bottom → small/few underwater vegetation → temporary pond and prairie → forest and swamp

# Biomes

- The most important factors in a biome are temperature and precipitation.
- Biomes tend to converge around latitude lines on the globe.

# CLIMATE: A BRIEF INTRODUCTION

- Weather is a local area's short-term physical conditions such as temperature and precipitation.
- Climate is a region's average weather conditions over a long time.
  - Latitude and elevation help determine climate.

# Earth's Current Climate Zones

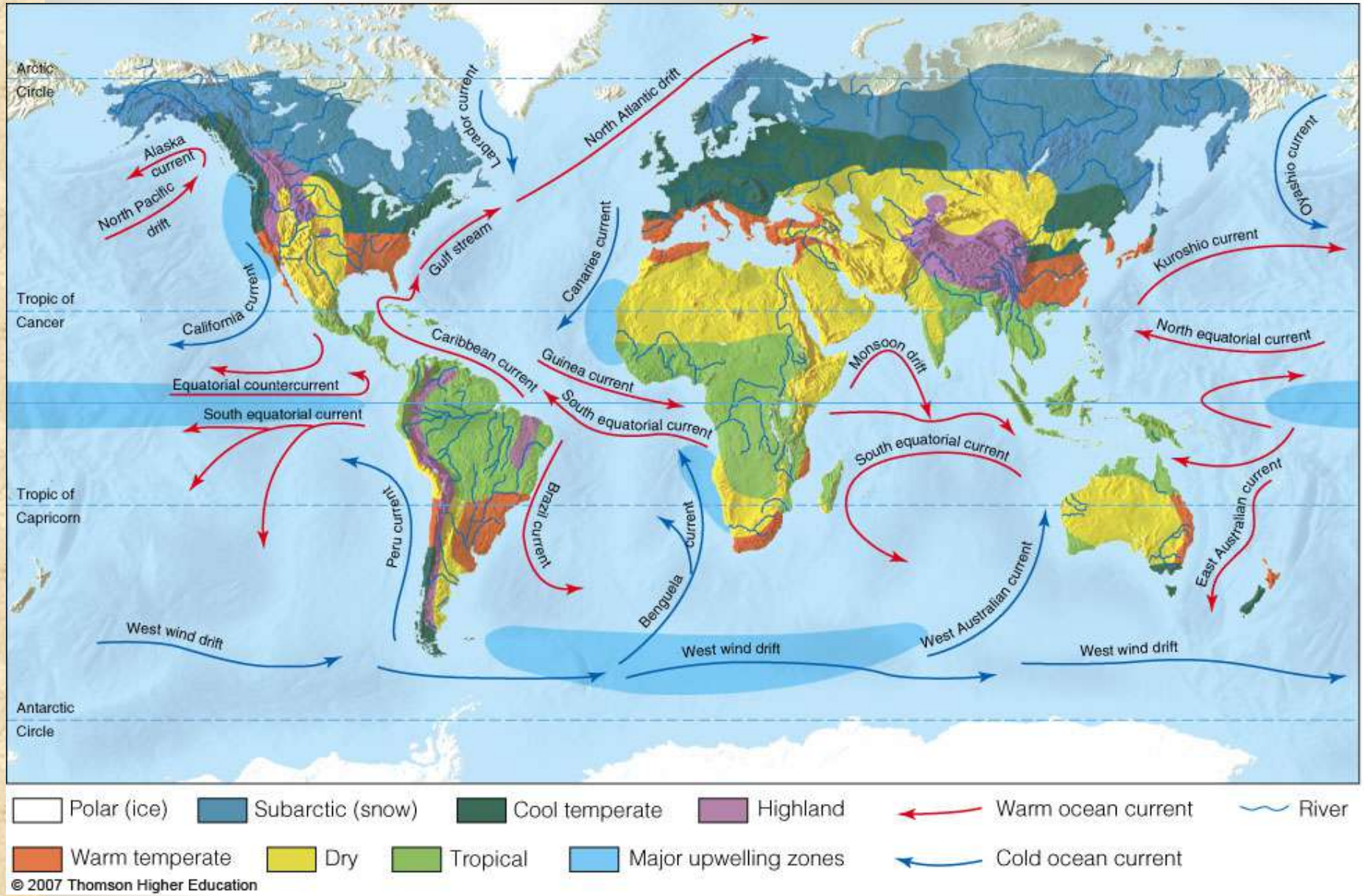





Figure 5-2

# BIOMES: CLIMATE AND LIFE ON LAND

- Different climates lead to different communities of organisms, especially vegetation.
  - Biomes – large terrestrial regions characterized by similar climate, soil, plants, and animals.
  - Each biome contains many ecosystems whose communities have adapted to differences in climate, soil, and other environmental factors.

# BIOMES: CLIMATE AND LIFE ON LAND

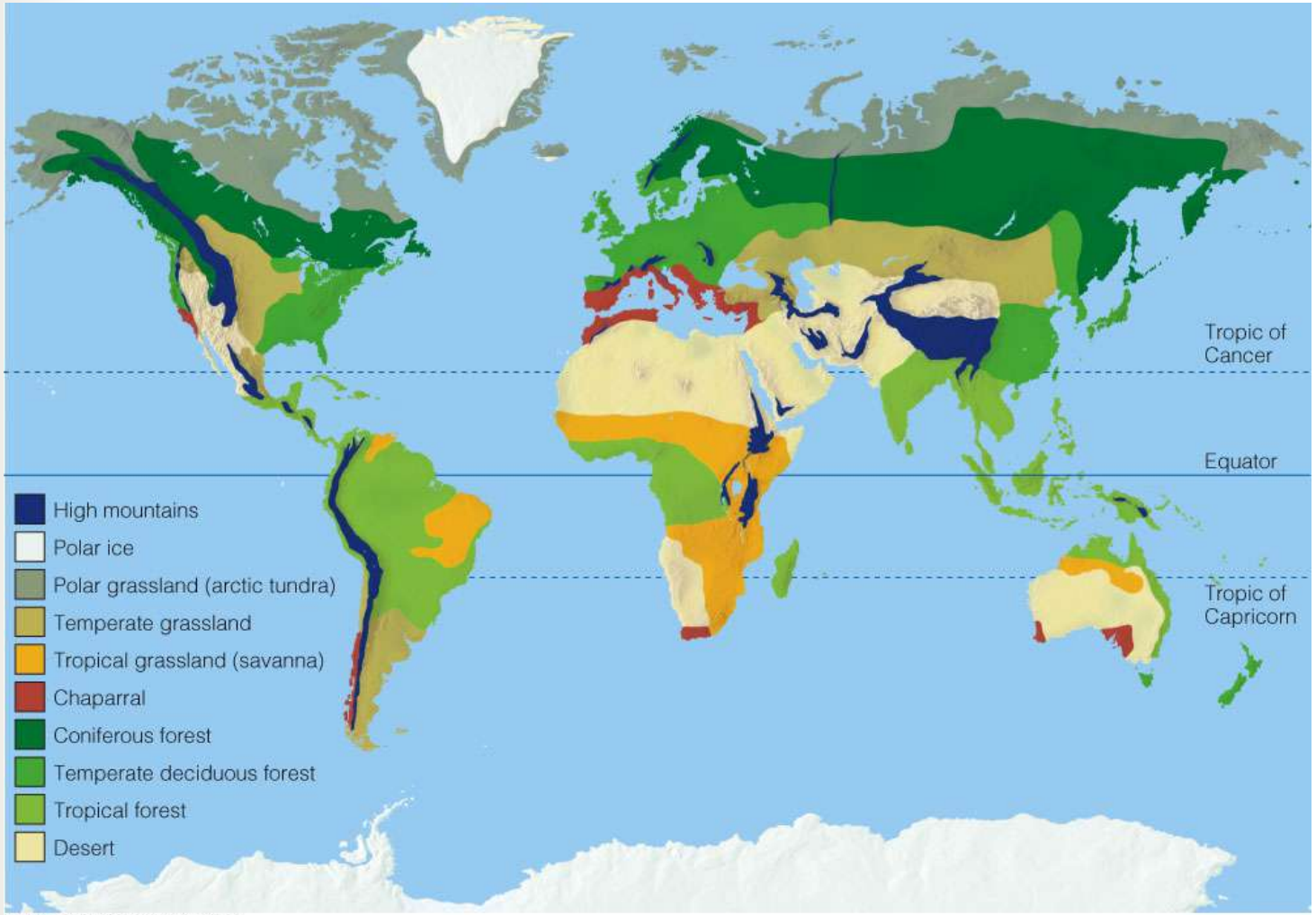
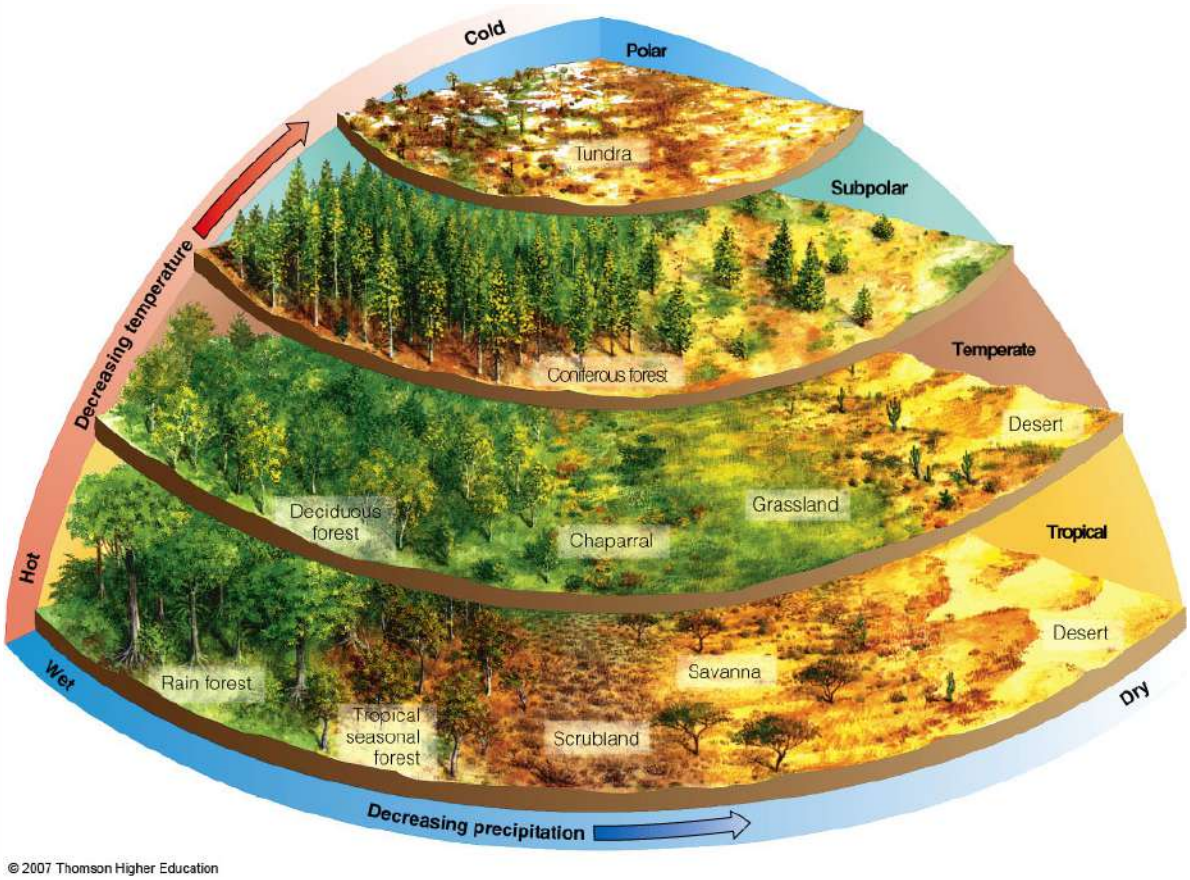





Figure 5-9

# BIOMES: CLIMATE AND LIFE ON LAND



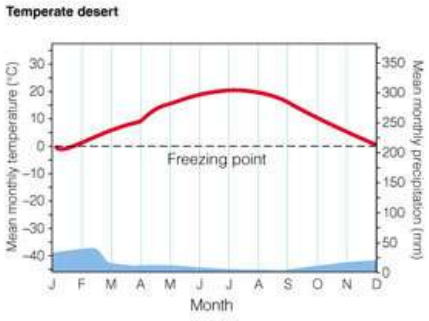

- Biome type is determined by precipitation, temperature and soil type

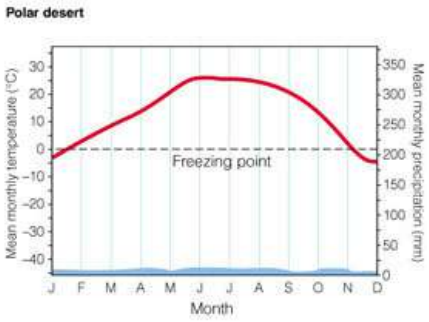
Figure 5-10

# Desert

- The evaporation is greater than the precipitation (usually less than 25 cm). Covers 30% of the earth

# DESERT BIOMES



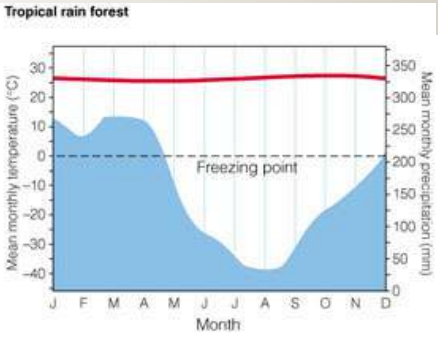

- Variations in annual temperature (red) and precipitation (blue) in tropical, temperate and cold deserts.

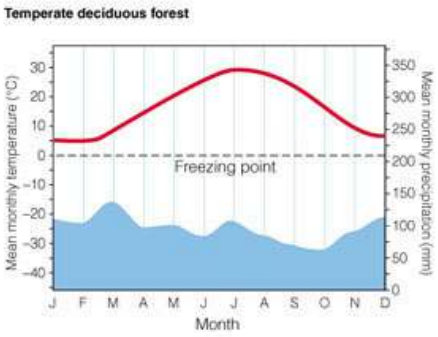
Figure 5-12

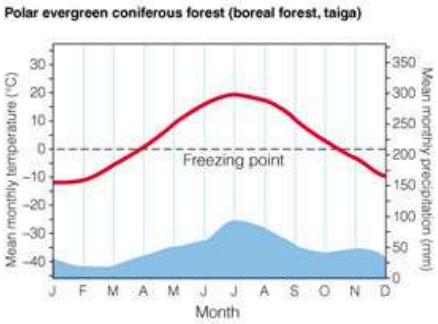
# FOREST BIOMES

- Forests have enough precipitation to support stands of trees and are found in tropical, temperate, and polar regions.

# FOREST BIOMES



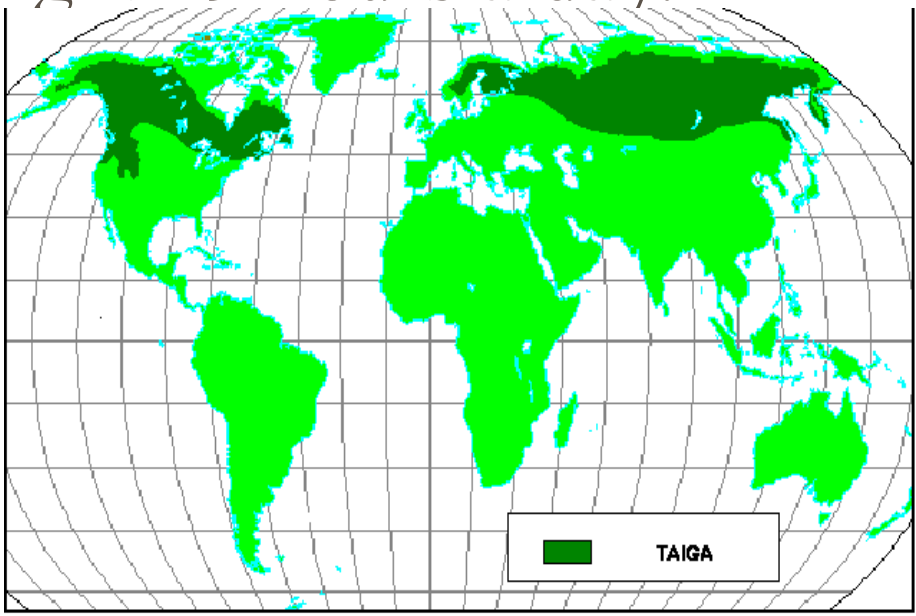



- Variations in annual temperature (red) and precipitation (blue) in tropical, temperate, and polar forests.

Figure 5-19

# Taiga (evergreen coniferous forest)

- Just south of the tundra (northern part of N. America), it covers 11% of earth's land. Its winters are long, dry & cold. Some places have sunlight 6 to 8 hours a day. The summers are short and mild, w/ sunlight 19 hours a day.



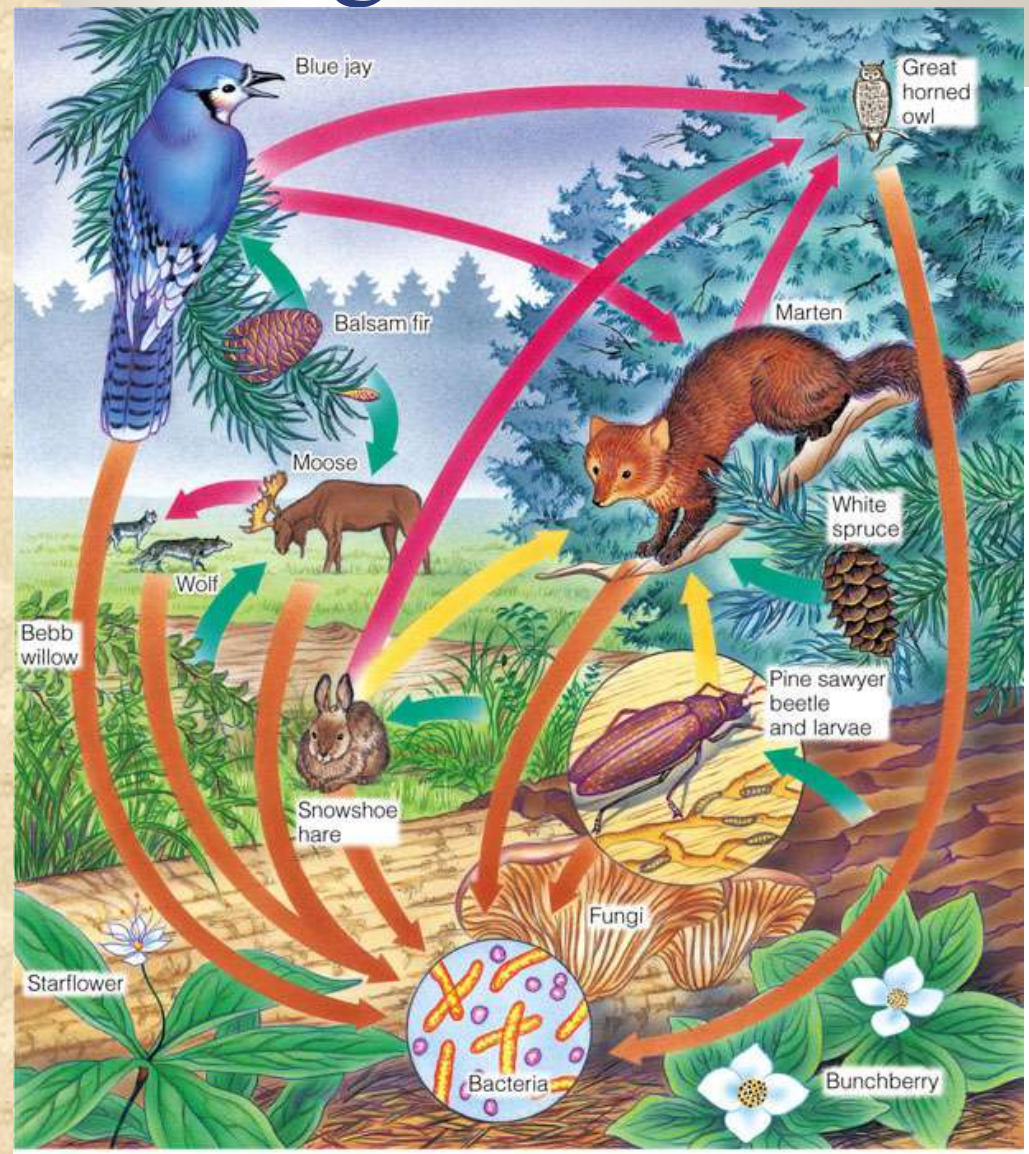
# MOUNTAIN BIOMES (Taiga)



- High-elevation islands of biodiversity
- Often have snow-covered peaks that reflect solar radiation and gradually release water to lower-elevation streams

Figure 5-25

# Evergreen Coniferous Forests



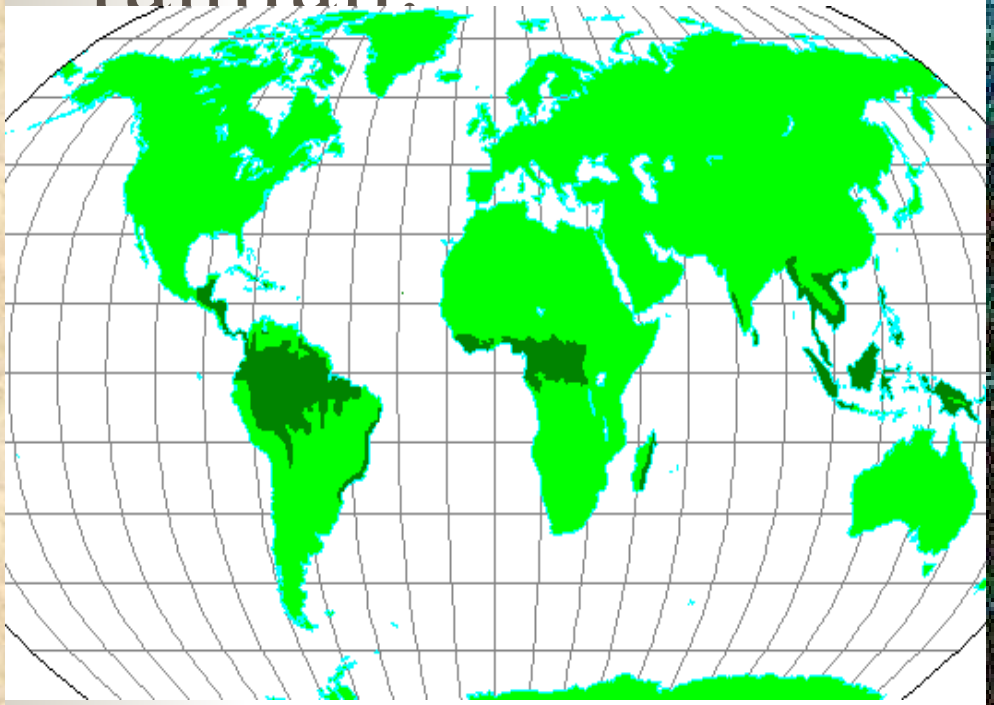



- Consist mostly of cone-bearing evergreen trees that keep their needles year-round to help the trees survive long and cold winters.

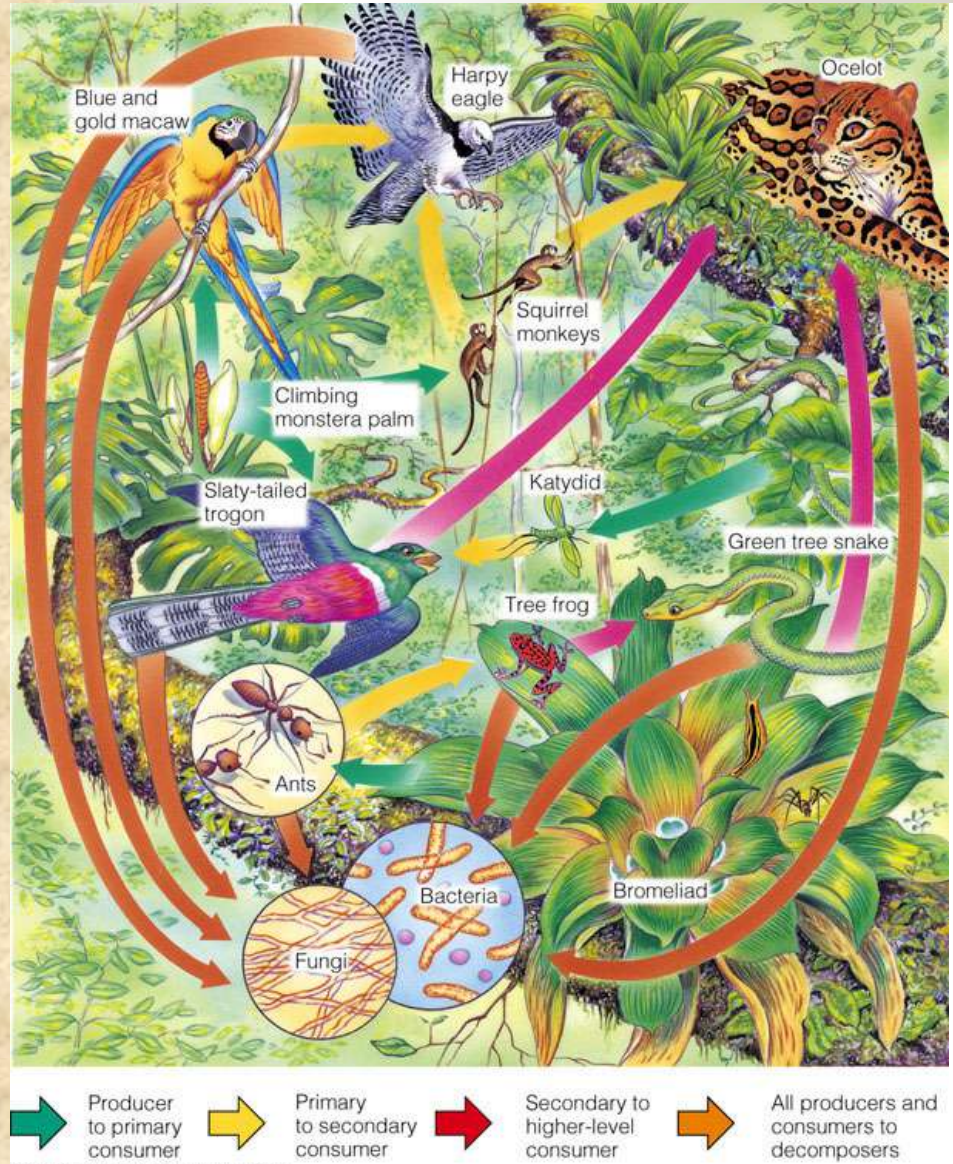
Figure 5-23

# Tropical Rainforest

- Near the equator. It has warm temperatures, high humidity & heavy rainfall.



# Tropical Rain Forest

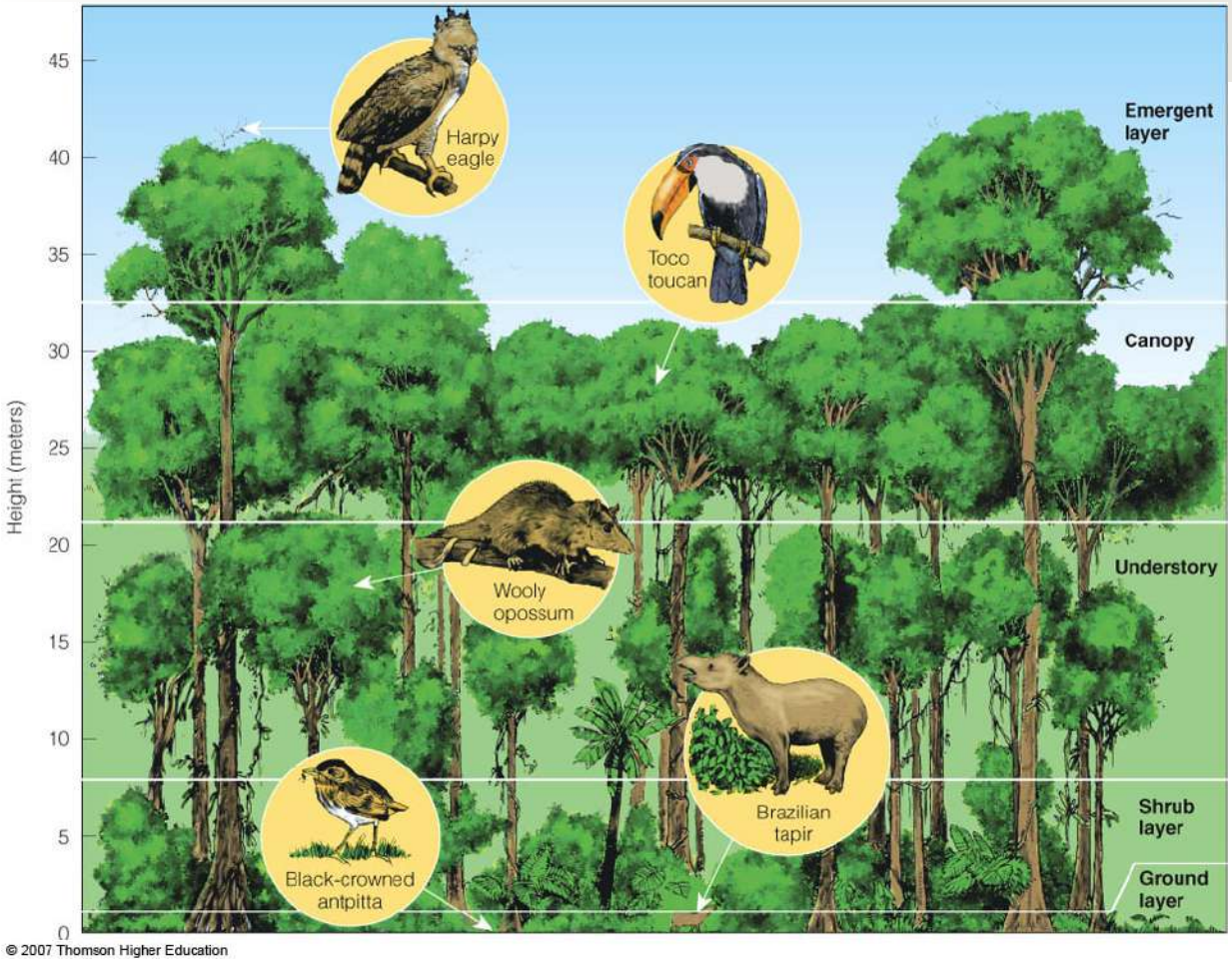





- Tropical rain forests have heavy rainfall and a rich diversity of species.
  - Found near the equator.
  - Have year-round uniformity warm temperatures and high humidity.

Figure 5-20

# Tropical Rain Forest




- Filling such niches enables species to avoid or minimize competition and coexist

Figure 5-21

# Temperate Rain Forests

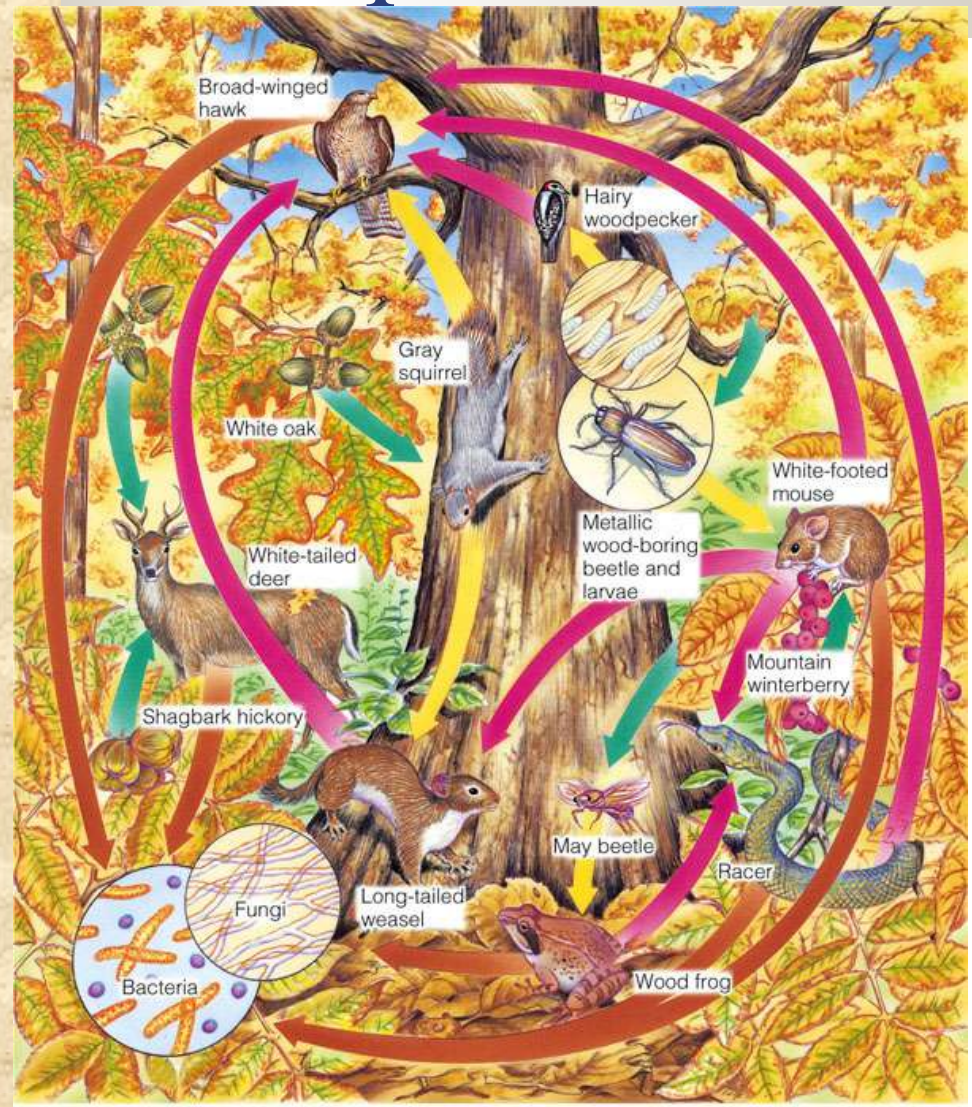

- Coastal areas support huge cone-bearing evergreen trees such as redwoods and Douglas fir in a cool moist environment.

Figure 5-24

# Temperate Deciduous Forest

- It has moderate temperatures, long, warm summers, cold winters &lots of rain. Trees include oaks, hickory, maple, and beech.

# Temperate Deciduous Forest






- Most of the trees survive winter by dropping their leaves, which decay and produce a nutrient-rich soil.

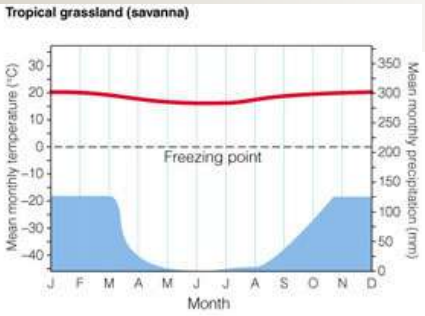
Figure 5-22

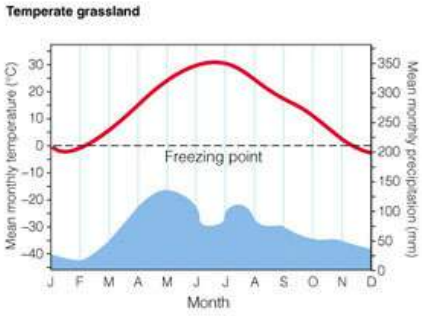
# Grassland

- The rainfall is erratic & fires are common. It has & shrubs that are good for grazing animals.

# GRASSLANDS AND CHAPARRAL BIOMES

- Variations in annual temperature (red) and precipitation (blue).



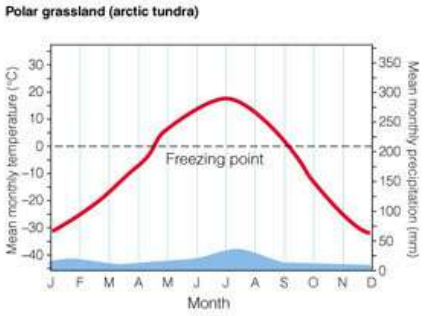
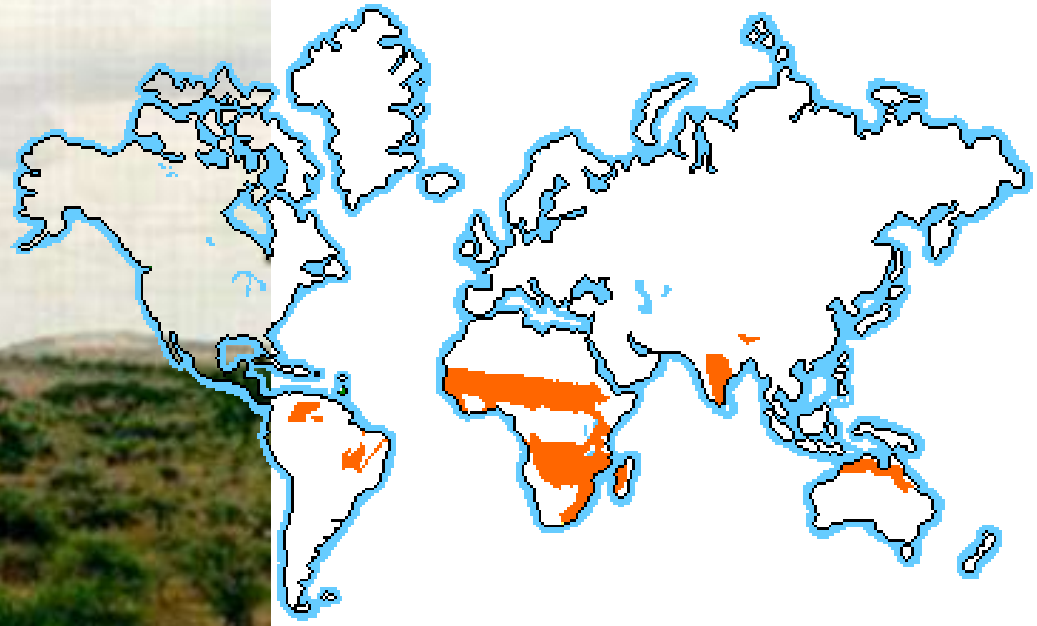






Figure 5-14

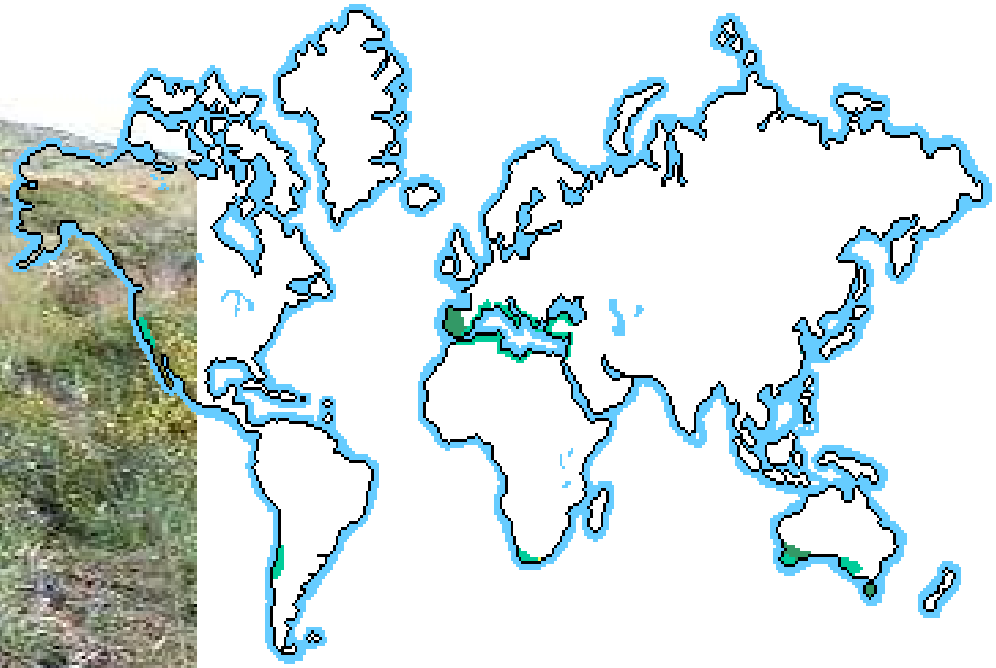
# Savanna

- The tropical & subtropical grassland. It is warm all year long with alternating wet & dry seasons.

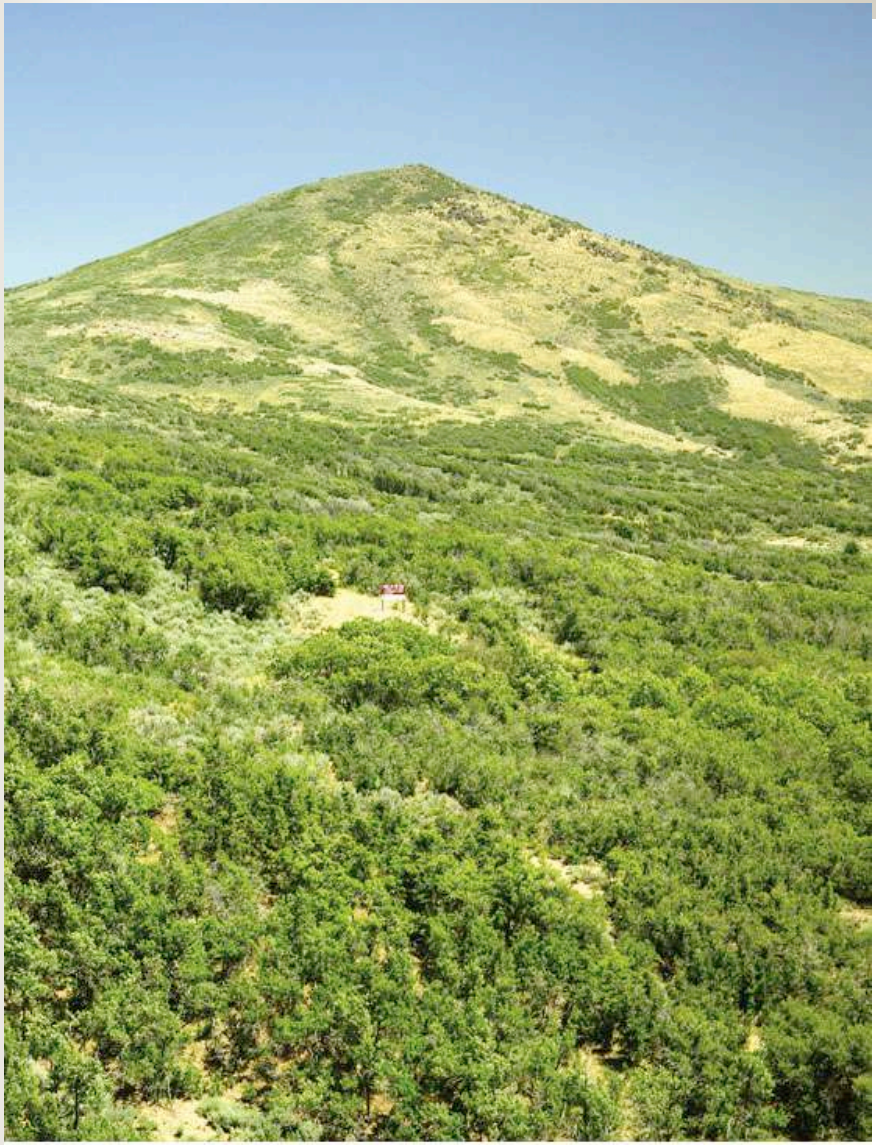


# Chaparral (temperate grassland)

- These are coastal areas. Winters are mild & wet, w/ summers being long, hot, & dry.



# Chaparral

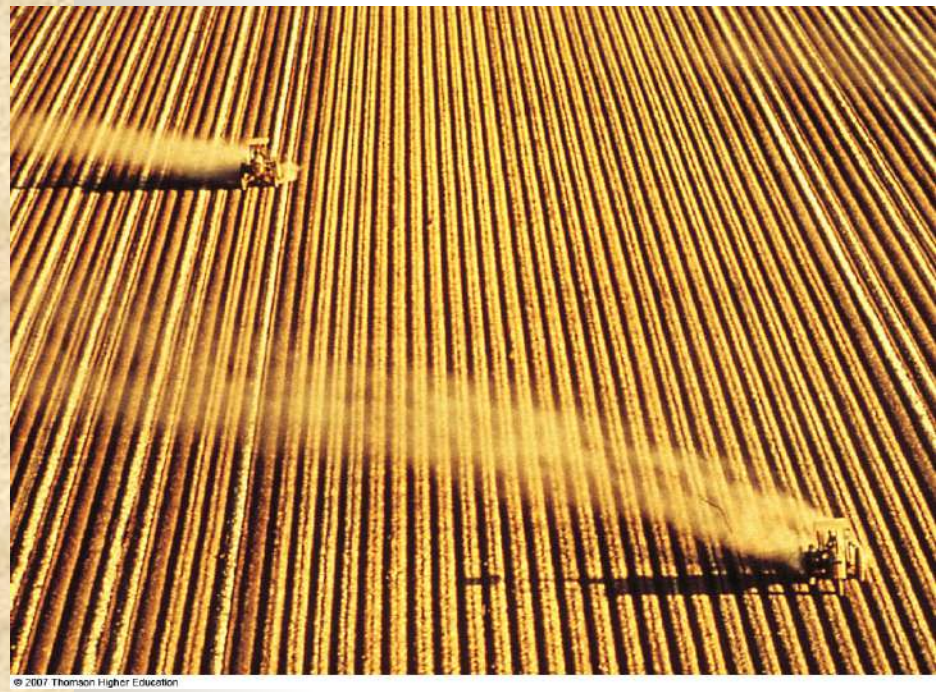




- Chaparral has a moderate climate but its dense thickets of spiny shrubs are subject to periodic fires.

Figure 5-18

# Temperate Grasslands



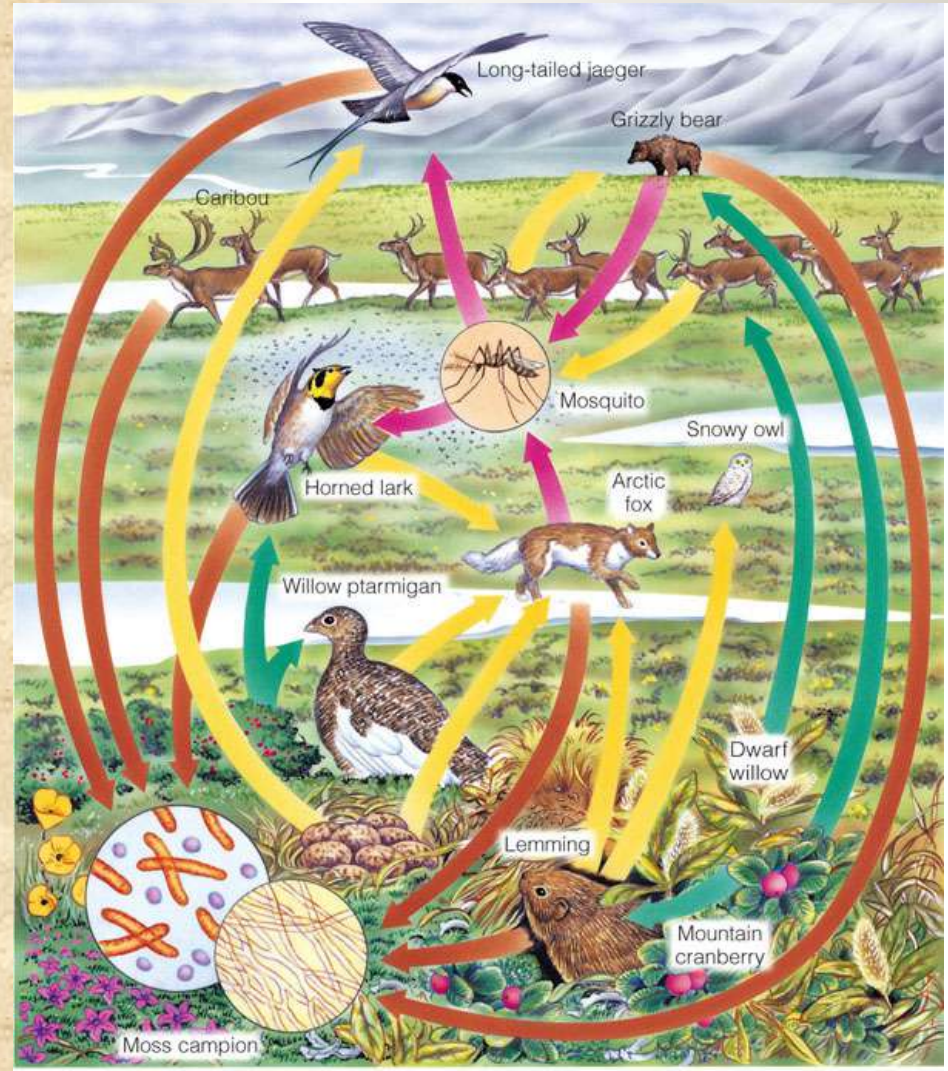

- The cold winters and hot dry summers have deep and fertile soil that make them ideal for growing crops and grazing cattle.

Figure 5-15

# Tundra (polar grasslands)

- Covers 10% of earth's land. Most of the year, these treeless plains are bitterly cold with ice & snow. It has a 6 to 8 week summer w/ sunlight nearly 24 hours a day.

# Polar Grasslands






- Polar grasslands are covered with ice and snow except during a brief summer.

Figure 5-17

# Relation to Biomes and Biodiversity

- Ecosystems are constantly changing in response to changing environmental conditions.

# HUMAN IMPACTS ON TERRESTRIAL BIOMES

- Human activities have damaged or disturbed more than half of the world's terrestrial ecosystems.
- Humans have had a number of specific harmful effects on the world's deserts, grasslands, forests, and mountains.

# Natural Capital Degradation

## Desert

Large desert cities

Soil destruction by off-road vehicles

Soil salinization from irrigation

Depletion of groundwater

Land disturbance and pollution from mineral extraction



Fig. 5-26, p. 123

# Natural Capital Degradation

## Grasslands

Conversion to cropland

Release of $CO_2$ to atmosphere from grassland burning

Overgrazing by livestock

Oil production and off-road vehicles in arctic tundra



Fig. 5-27, p. 123

# Natural Capital Degradation

## Forests

Clearing for agriculture, livestock grazing, timber, and urban development

Conversion of diverse forests to tree plantations

Damage from off-road vehicles

Pollution of forest streams



Fig. 5-28, p. 124

# Natural Capital Degradation

## Mountains

- Agriculture
- Timber extraction
- Mineral extraction
- Hydroelectric dams and reservoirs
- Increasing tourism
- Urban air pollution
- Increased ultraviolet radiation from ozone depletion
- Soil damage from off-road vehicles



Fig. 5-29, p. 124

# Development

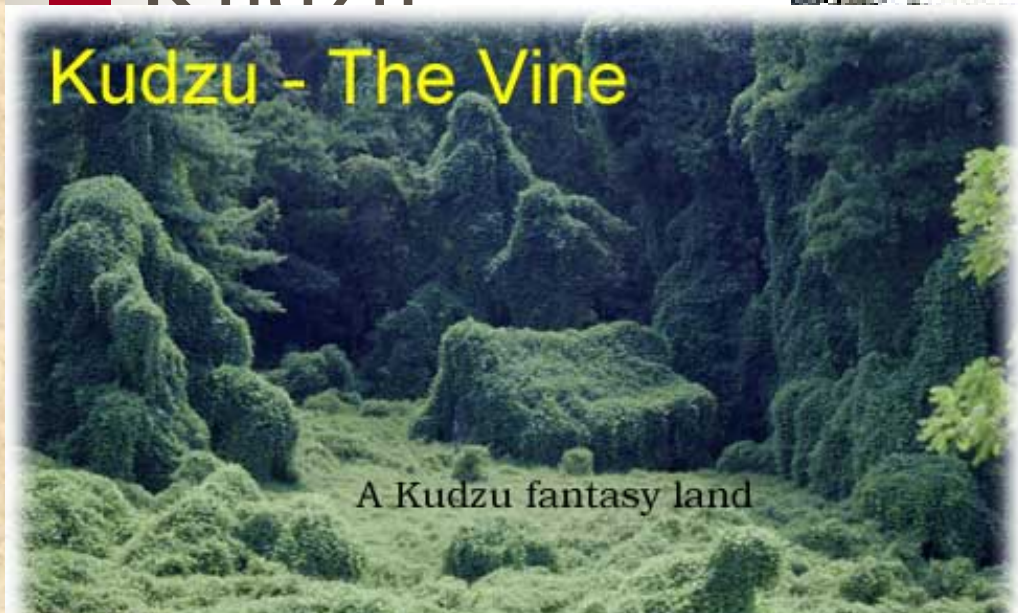
- (habitat destruction) Humans eliminate some wildlife habitats.

# TYPES OF SPECIES

- Native, nonnative, indicator, keystone, and foundation species play different ecological roles in communities.
  - Native: those that normally live and thrive in a particular community.
  - Nonnative species: those that migrate, deliberately or accidentally introduced into a community.

# Importation of Species

- Ex. The Chinese chestnut had a fungus that spread & virtually eliminated the American chestnut.
- Kudzu




# Introduced (invasive) species

- They displace native species
- They lower biodiversity
- The can adapt very quickly to local habitats
- They contribute to habitat fragmentation
- They can reproduce very quickly

# Hunting

- Over-hunting/hunting of top predators for big game.

# Pollution

- CFC's, $CO_2$, oil spills.

# Habitat Restoration

- Trying to rebuild what was ruined.

# Reclamation

- Returning vegetation to an area that has been mined or disturbed by human use.
- This can be done by re-planting, cleaning up pollution, regulations (laws) or any other activity designed to “fix” a destroyed area.

# Agriculture

- Cut/burn techniques & the loss of habitat.