Ecology

- **<u>Ecology</u>:** The interaction between organisms and their environment.
- **Abiotic:** non-living; wind, temperature
- Key elements of the environment:
  - Temperature
  - Water
  - Sunlight
  - Soil
- **Biotic**: The Living or once living factors. Think of the characteristics of life.

- **Environment**: This is the place where an organism lives and encompasses both the **abiotic** and the **biotic** factors, that effect a particular organism.

- **Habitat**: The place were you would most likely find an organism.
- Ex. Aspen Forest.
- **Niche:** The role an organism plays in the environment.
- The niche of an organism decides the type of habitat.

- **Ecosystem**: all of the Biotic and Abiotic factors that affect all of the organism in a particular area.

Four levels of understanding

Ecology

- **1st. level**: to understand an individual organism. What it eats what eats it were they live etc.
-
- **2nd level**: To know the Population of a specified organism.
-

- **3rd Level**: The numbers of different populations of that same organism. (Community)
- **4th Level**: The community and its physical environment. (Biomes and the Biosphere)

- **<u>Aquatic Biomes</u>**: 75% of the Earth is covered with water.
- About 95 of this water is from oceans and seas.

- **1. <u>Freshwater Biomes</u>** 5% of the water supply. Rivers, streams, glaciers, groundwater, and lakes.
- Good source of drinking water and food. Only .1% of this water is easily obtainable for consumption.
- <u>Glaciers hold most of the fresh water on the earth</u>.

2. **Marine Biomes**: 95 % of the water supply. Oceans & Seas

- **4** Zones to marine Biomes
- 1. Intertidal Zone: Most difficult zone for animals to live in.
- Organisms must be able to adapt to extreme changes daily.
- (Water, sunlight, and wave action.)

- 2. Neretic Zone: Extends from the low tide area to the open sea area. Seaweed such as brown kelp, animals like the lobsters crabs and many Species of fish etc are found here.

- 3. Open- sea Zone: Phytoplankton is found in great abundances.
- 80 to 90 % of earths photosynthetic activity takes place here.
- Animals :Whales dolphins, large fish, sea birds.
- Not enough food for too many animals

- 4. Deep-Sea Zone: High pressure, very cold, total darkness.
- Many strange looking animals.

- **Estuaries**: Boundary between freshwater and salt water.
- Swamps, salt marshes, mangroves lagoons and mouths of rivers.
- Supports a variety of organisms.
- Fish lay their eggs here, and many species of birds migrate here for the winter.This area is flushed out into the sea or ocean not a lot of dead material on the bottom.

Interactions Between Organisms

- **Symbiosis:** Relationships between organisms.
- **Commensalism:** When one organism is helped by another and the other organism receives nothing.
- **Amensalism**: This is when one species affects another adversely but remains unaffected

Commensalism

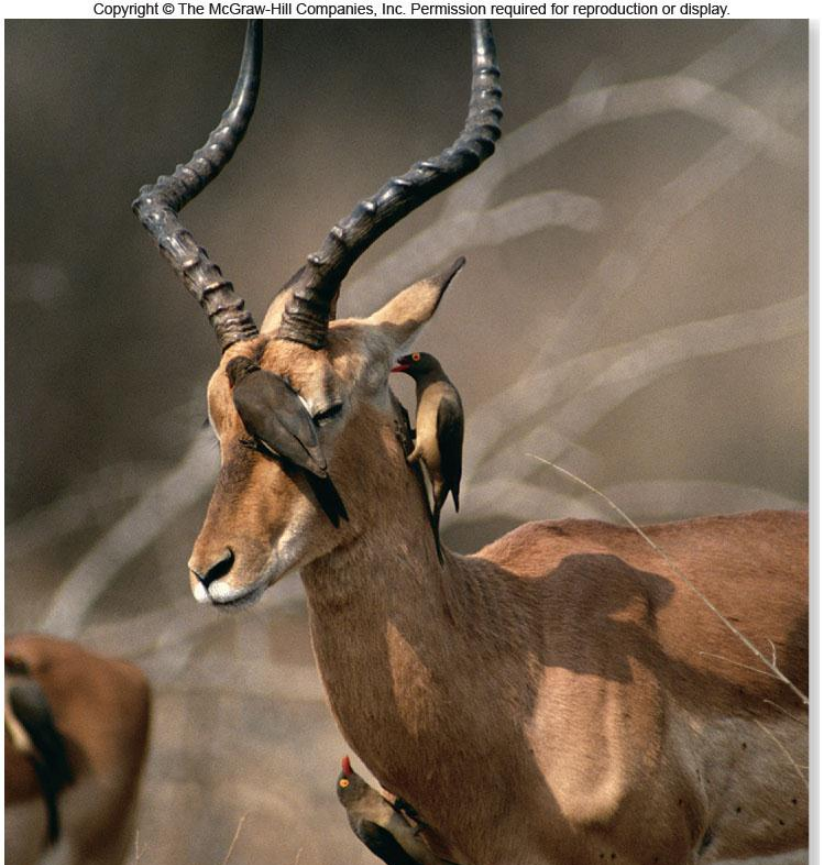
Commensalism benefits one species and is neutral to the other

- Spanish moss: an epiphyte hangs from trees

© Eastcott/Momatiuk/The Image Works

Species Interactions

- Oxpickers on an impala
- Is it commensalism, parasitism or mutualism ?



- **Amensalism**: This is when one species affects another adversely but remains unaffected
- **Mutualism** This is a relationship where both organisms benefit from each other.

Species Interactions

- Mutualism benefits both species
- Coevolution: flowering plants and insects
  - Ants and acacias
  - Acacias provide hollow thorns and food
  - Ants provide protection from herbivores

© Michael Fogden/DRK Photo

Species Interactions

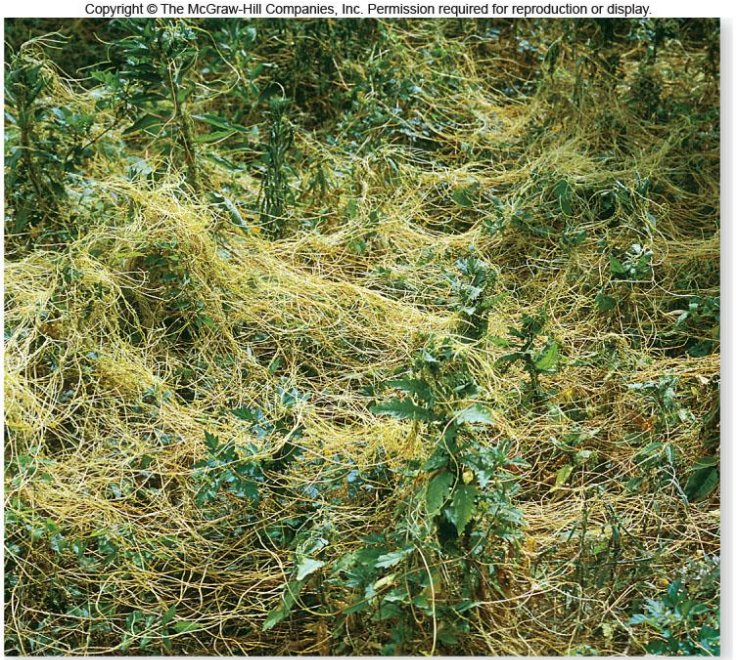
- Not all ant and acacia relationships are mutualism
- In Kenya, several species of ants live on acacias
  - One species clips the acacia branches to prevent other ants from living in the tree
  - Clipping branches sterilizes the tree
  - A parasitic relationship

- **Parasitism**: This is also a one-way relationship where one organism gains and the other losses.
-
- The parasite does not want to harm the host species only weaken it.

Species Interactions

- External parasites:
  - **Ectoparasites:** feed on exterior surface of an organism
  - **Parasitoids:** insects that lay eggs on living hosts
    - Wasp, whose larvae feed on the body of the host, killing it
- Parasitism benefits one species at the expense of another

Species Interactions



© David Moorhead

External parasite: the yellow vines are the flowering plant dodder, it is a parasite that obtains its food from the host plant it grows on

Species Interactions

Internal parasites

- **Endoparasites:** live inside the host
- Extreme specialization by the parasite as to which host it invades
- Structure of the parasite may be simplified because of where it lives in its host
- Many parasites have complex life cycles involving more than one host

Species Interactions

- *Dicrocoelium dendriticum* is a flatworm that lives in ants as an intermediate host with cattle as its definitive host
- To go from the ant to a cow it changes the behavior of the ant
- Causing the ant to climb to the top of a blade of grass to be eaten with the grass

Species Interactions

- **Keystone species:** species whose effects on the composition of communities are greater than one might expect based on their abundance
- Sea star predation on barnacles greatly alters the species richness of the marine community
- Keystone species can manipulate the environment in ways that create new habitats for other species

- **Predator/ Prey**: One Way relationship.
- This is a relationship where one of the organism gains all and the other losses.
- The predator needs the prey and the prey needs the predator .
- Why?

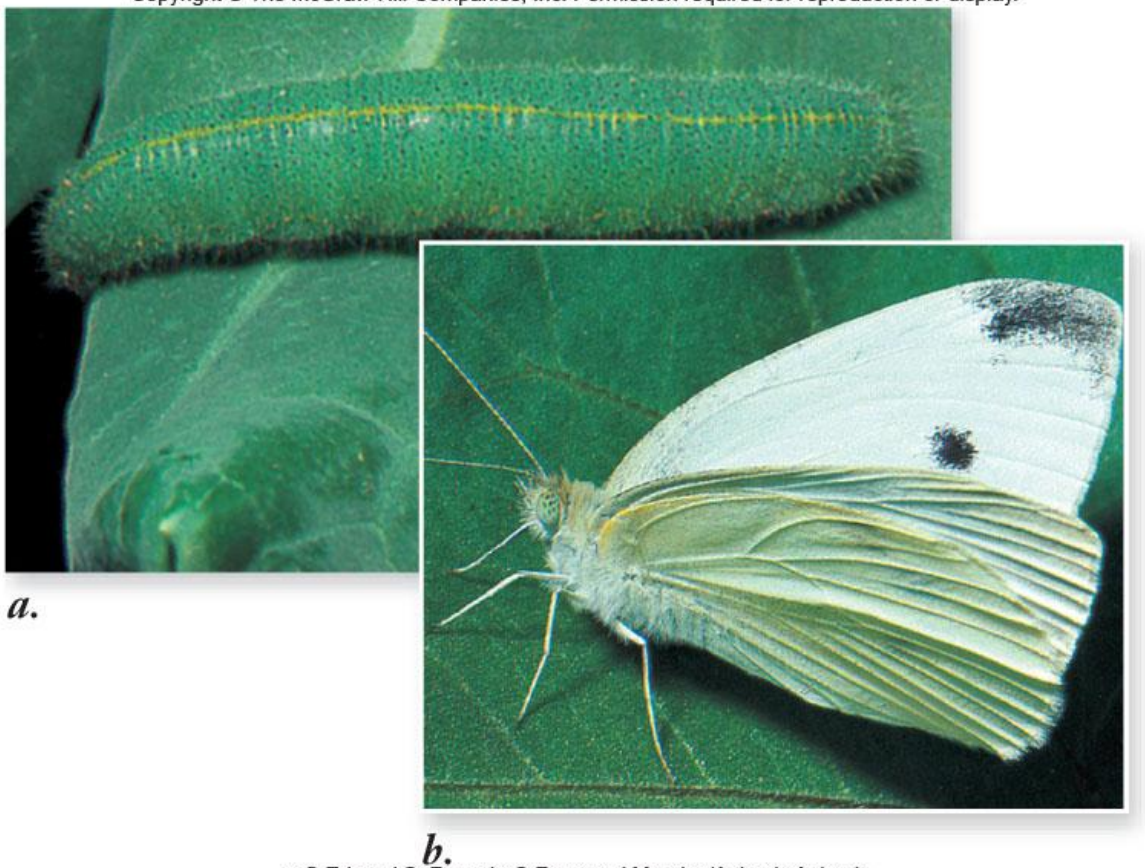
- 1. Predator thins out the herd or keeps the population in check.

- 2. Survival of the fittest.

Predator-Prey

- Plants adapt to predation (herbivory) by evolving mechanisms to defend themselves
  - Chemical defenses: secondary compounds
    - Oils, chemicals to attract predators to eat the herbivores, poison milky sap and others
  - Herbivores coevolve to continue eating the plants

Predator-Prey



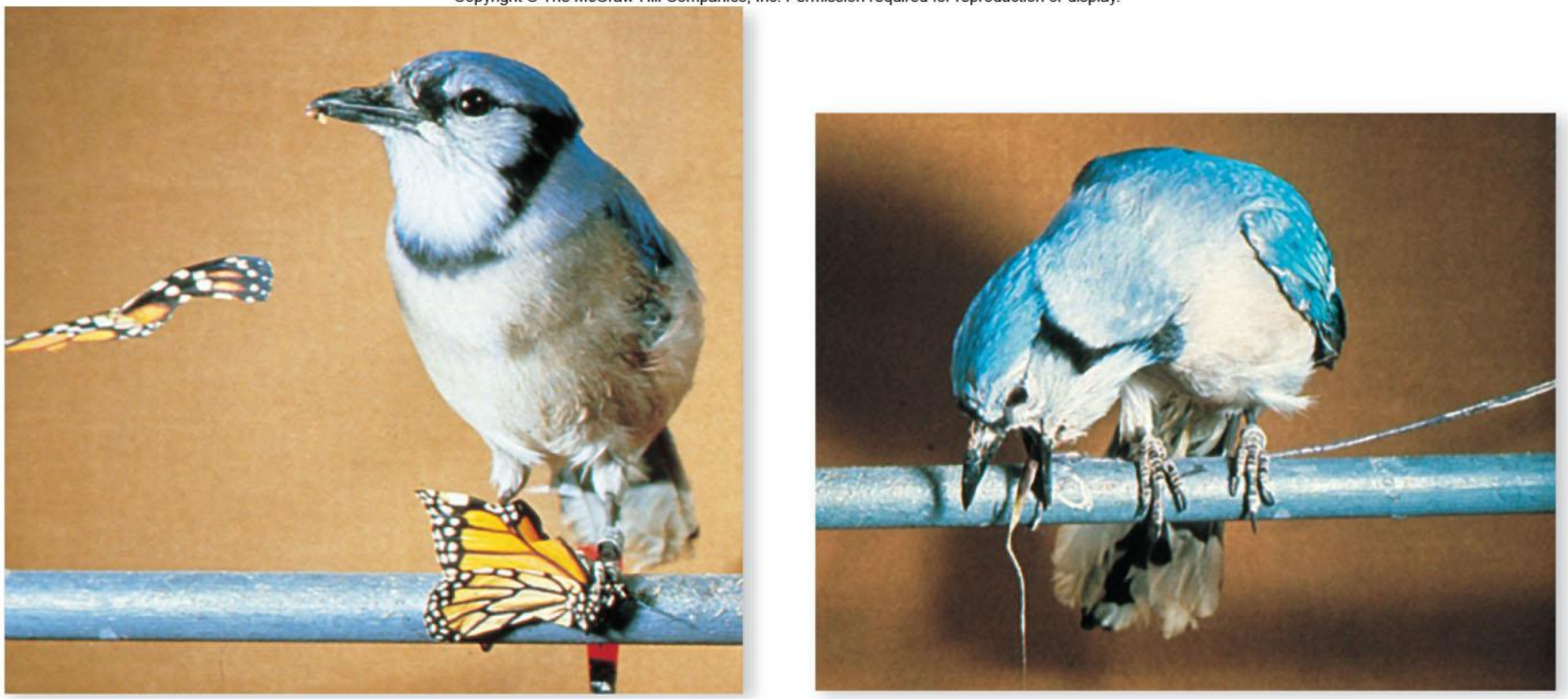
a: © Edward S. Ross; b: © Raymond Mendez/Animals Animals

Insect herbivores well suited to their plant hosts: cabbage butterfly

Predator-Prey

- Chemical defenses in animals
  - Monarch butterfly caterpillars feed on milkweed and dogbane families
  - Monarchs incorporate cardiac glycosides from the plants for protection from predation
  - Butterflies are eaten by birds, but the Monarch contains the chemical from the milkweed that make the birds sick

Predator-Prey

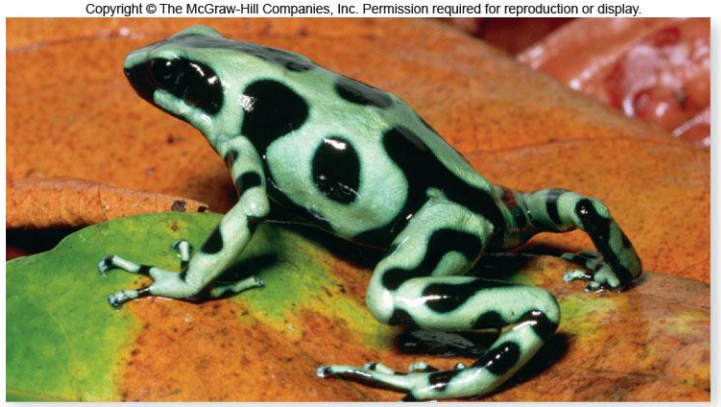


a. *b.*

Blue Jay learns not to eat Monarch butterflies

Predator-Prey

Poison-dart frogs of the family Dendrobatidae produce toxic alkaloids in the mucus that covers their brightly colored skin



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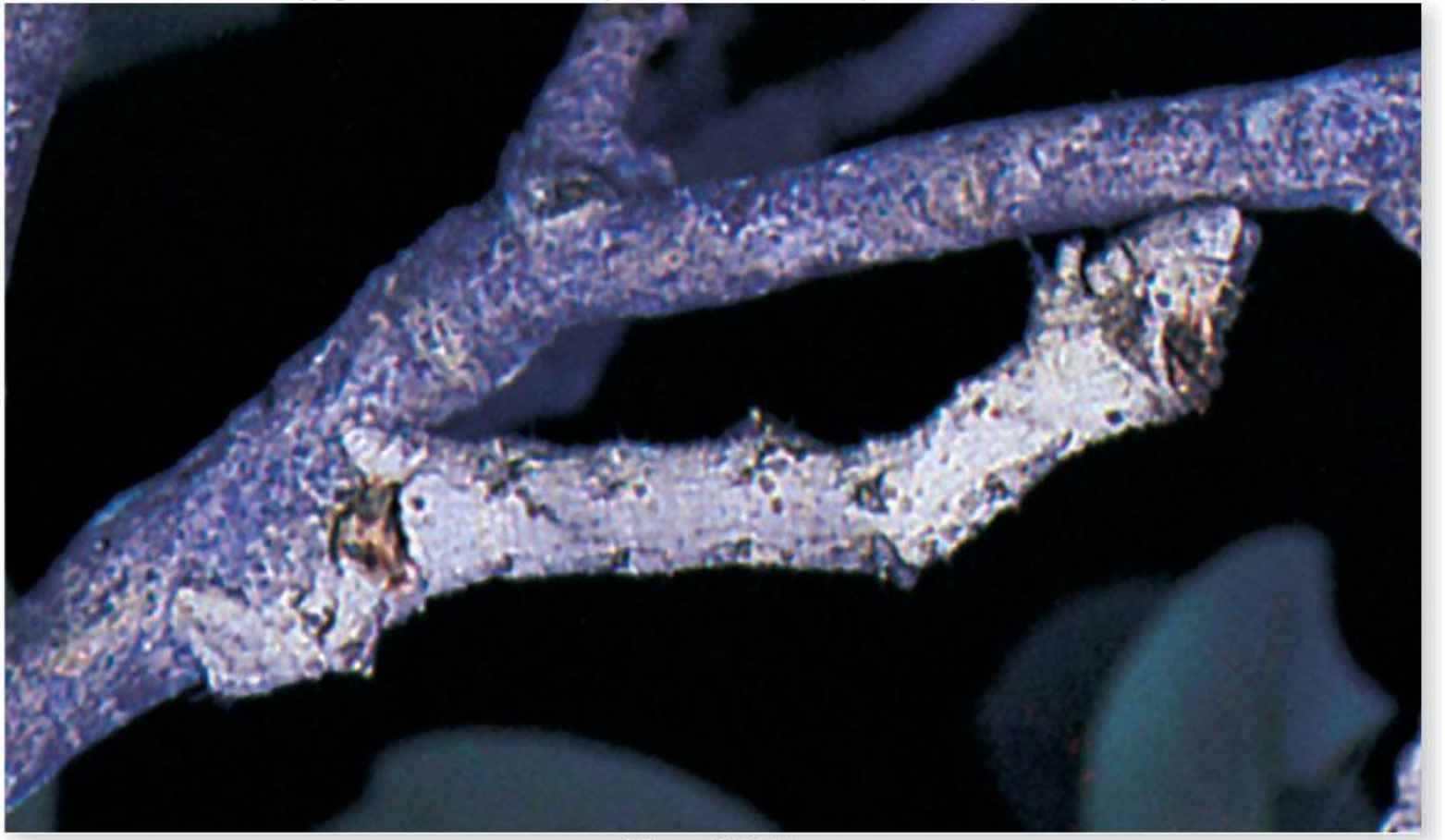
Predator-Prey

- Defensive coloration
  - Insects and other animals that are poisonous use warning coloration
  - Organisms that lack specific chemical defenses are seldom brightly colored
  - Camouflage or cryptic coloration help nonpoisonous animals blend with their surroundings
  - Camouflaged animals do not usually live together in groups

Predator-Prey



© James L. Castner

Inchworm caterpillar closely resembles a twig

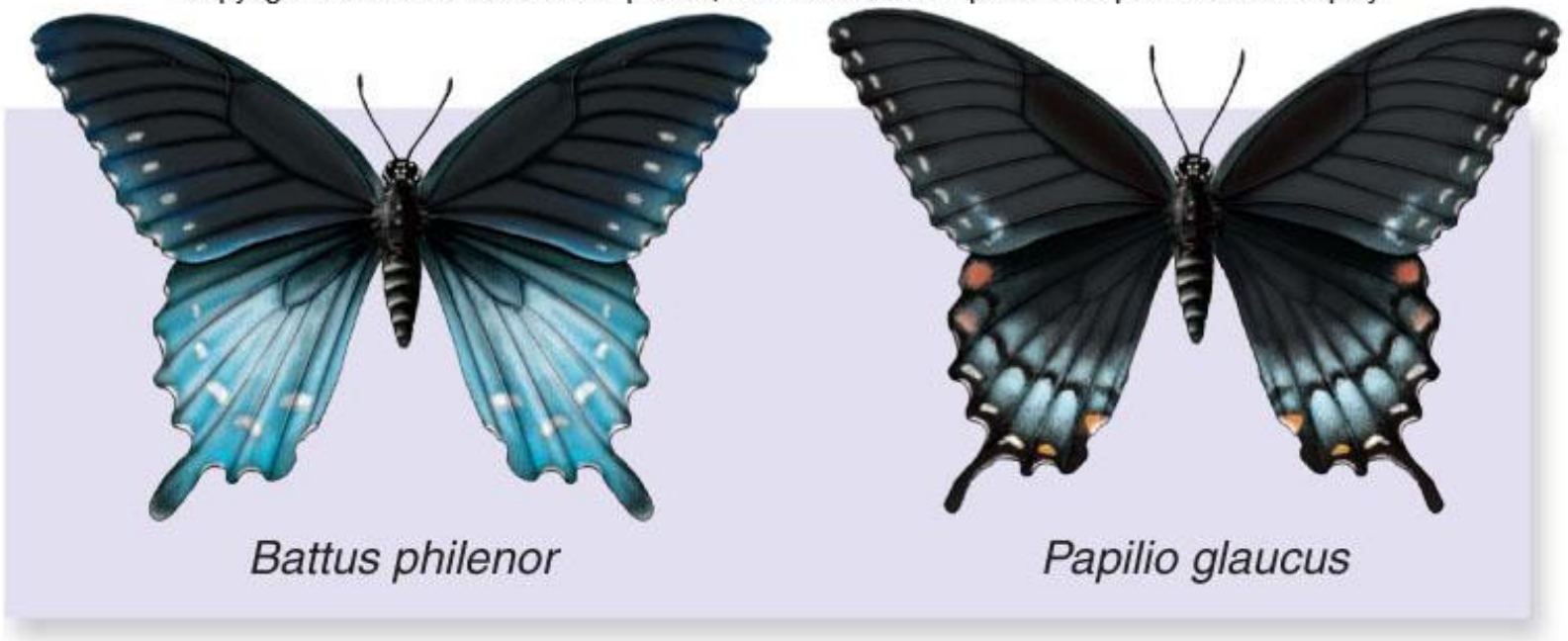
Predator-Prey

- Mimicry allows one species to capitalize on defensive strategies of another
  - Resemble distasteful species that exhibit warning coloration
  - Mimic gains an advantage by looking like the distasteful model
  - Batesian mimicry
  - Müllerian mimicry

Predator-Prey

- Batesian mimicry
  - Named for Henry Bates
  - Discovered palatable insects that resembled brightly colored, distasteful species
  - Mimics would be avoided by predators because they looked like distasteful species
  - Feed on plants with toxic chemicals

Predator-Prey

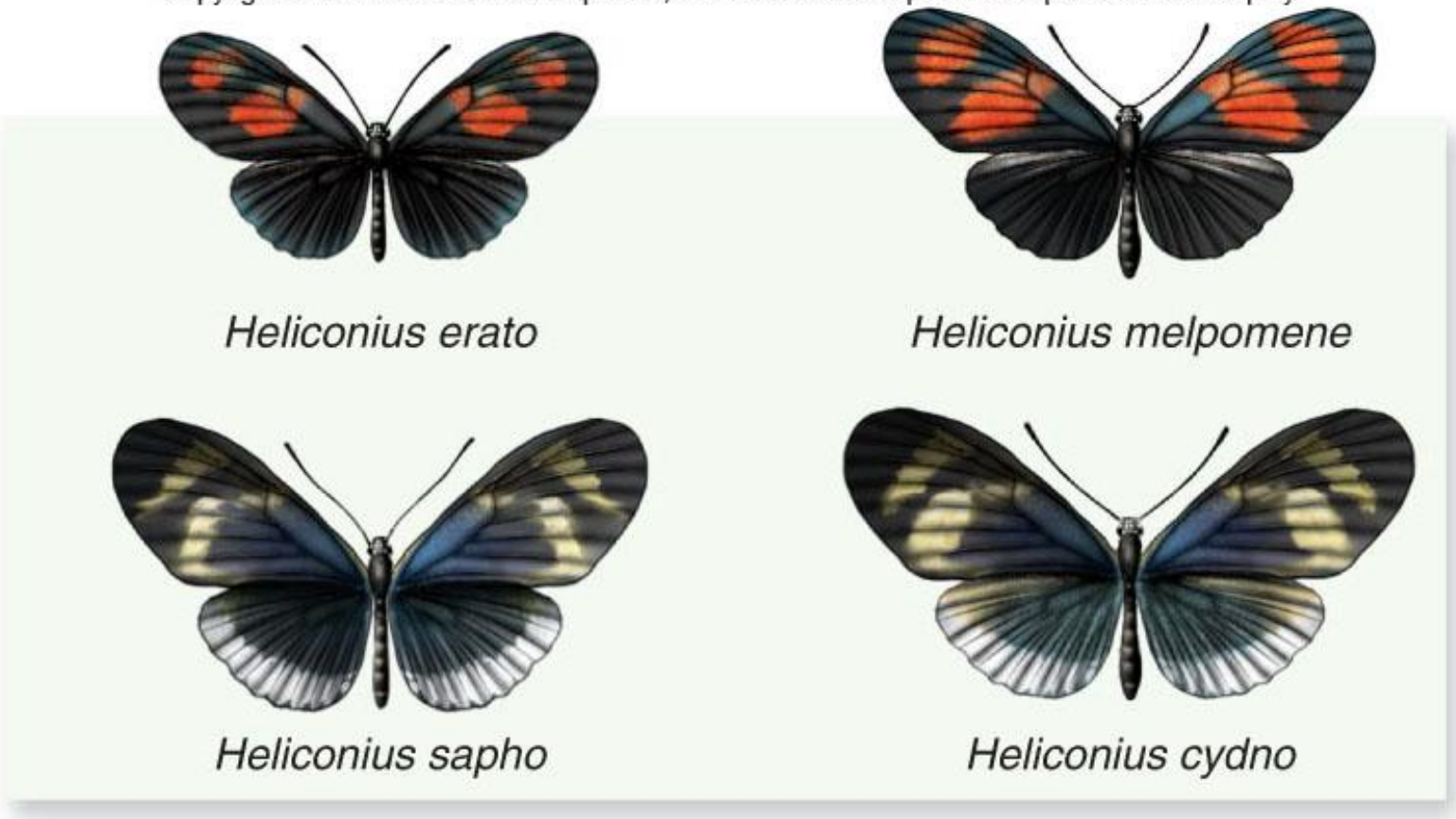


a. **Batesian mimicry:** Pipevine swallowtail butterfly (*Battus philenor*) is poisonous; Tiger swallowtail (*Papilio glaucus*) is a palatable mimic.

Predator-Prey

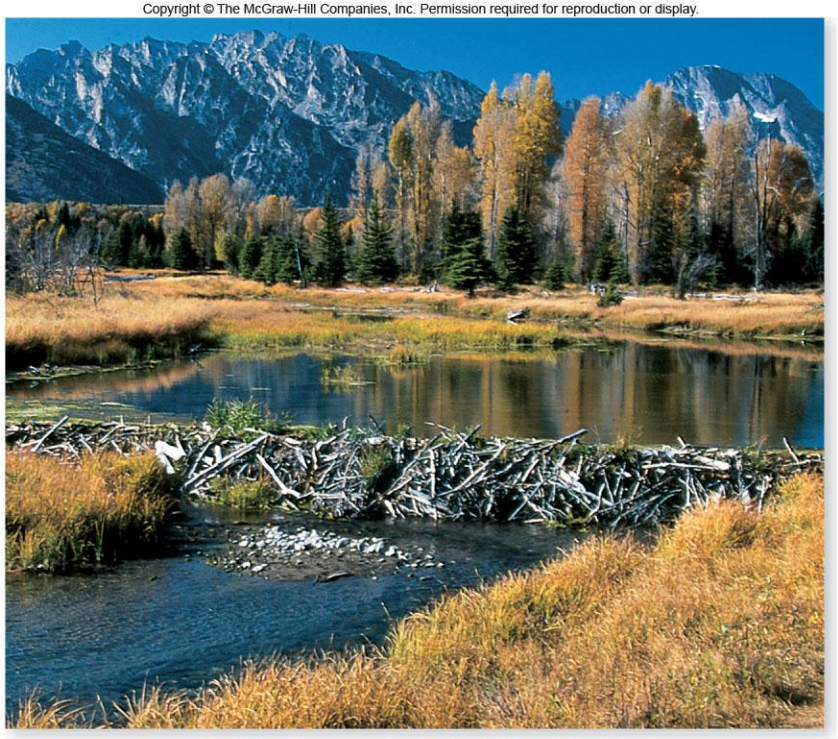
- Müllerian mimicry
  - Fritz Müller
  - Discovered that several unrelated but poisonous species come to resemble one another
  - Predator learns quickly to avoid them
  - Some predators evolve an innate avoidance
- Both mimic types must look and act like the dangerous model

Predator-Prey



b. **Müllerian mimicry:** Two pairs of mimics; all are distasteful.

Species Interactions



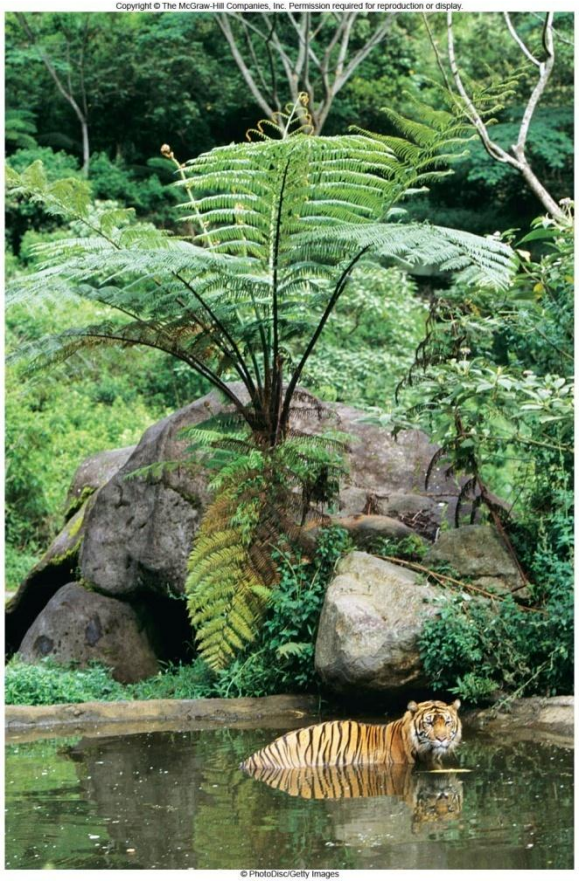
Beavers construct dams and transform flowing streams into ponds, creating new habitats for many plants and animals

Environmental Challenge

- **Homeostasis**: a steady-state internal environment regardless of external environment
- Beetle is catching water to help live in a dry environment

Dynamics of Ecosystems

Chapter 57



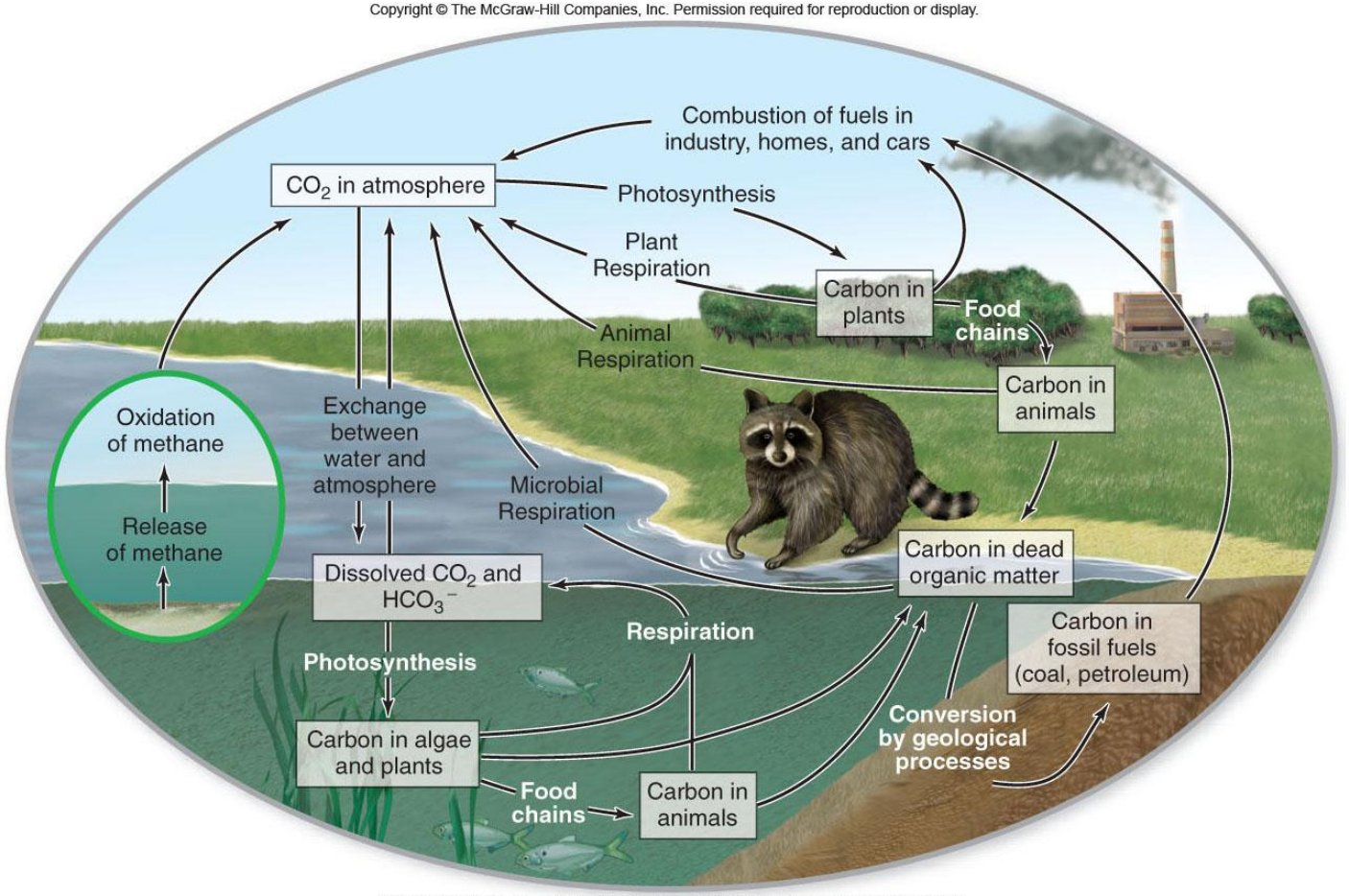
Biogeochemical Cycles

- **Ecosystem:** includes all the organisms that live in a particular place, plus the abiotic environment in which they live and interact
- Biological processing of matter: cycling of atoms in the environment and in living organisms
- **Biogeochemical cycles:** chemicals moving through ecosystems; biotic and abiotic

Biogeochemical Cycles

- Carbon is a major constituent of the bodies of organisms:
  - ~20% of weight of human body is carbon
  - Makes up 0.03% volume of the atmosphere; 750 billion metric tons

The carbon cycle



Data in: Begon, M., J.L. Harper, and C.R. Townsend, Ecology, 3/e, Blackwell Science 1996, page 715. Original Source: Whittaker, R. H.Communities and Ecosystems, 2/e Macmillan, London,1975.

The carbon cycle

- **Carbon fixation:** metabolic reactions that make nongaseous compounds from gaseous ones
- In aquatic systems inorganic carbon is present in water as dissolved CO_2 and as HCO_3^- ions
- CO_2 is used by algae and aquatic plants for photosynthesis

The carbon cycle

- Methane producers
  - Microbes that break down organic compounds by anaerobic cellular respiration provide an additional dimension to the carbon cycle
  - **Methanogens:** produce methane (CH_4)
  - Wetland ecosystems are a source of CH_4
  - CH_4 is oxidized to CO_2, but can remain as CH_4 for a long time

The carbon cycle

- Over time, globally, the carbon cycle may proceed faster in one direction
- This can cause large consequences if continued for many years
- Earth's present preserves of coal, and other fossil fuels were built up over geological time
- Human burning of fossil fuels is creating large imbalances in the carbon cycle
- The concentration of CO_2 in the atmosphere is going up year by year

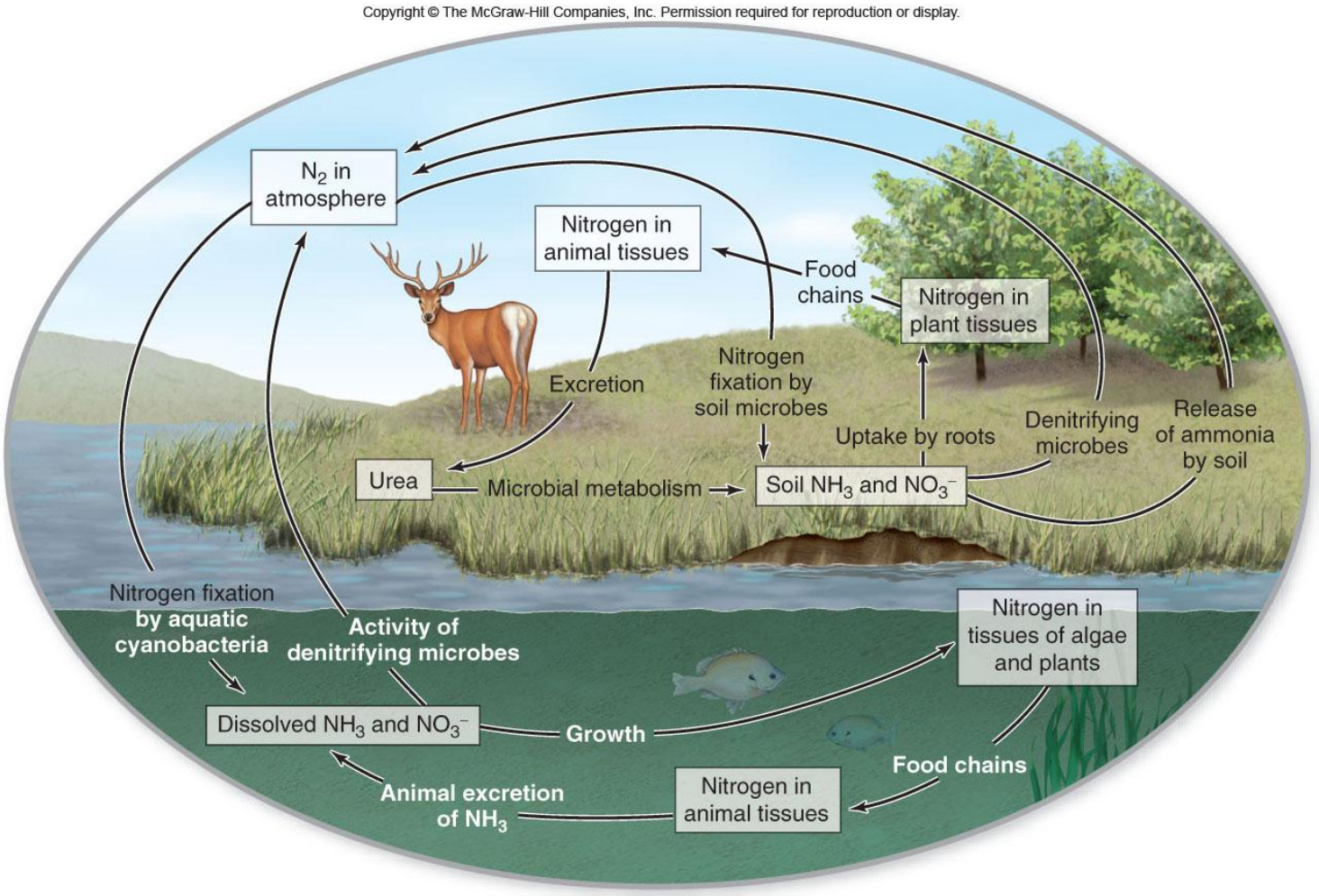
Nitrogen Cycle

- Nitrogen Cycle
  - Nitrogen is a component of all proteins and nucleic acids
  - Usually the element in shortest supply
  - Atmosphere is 78% nitrogen
  - Availability
    - Most plants and animals can not use N_2 (gas)
    - Use instead NH_3, and NO_3^-
- Nitrite / nitrogen should be below 90mg/l
- Nitrate levels below 10 mg / l

Nitrogen Cycle

- **Nitrogen N_2, Ammonium NH_3, Nitrites NO_2 and Nitrates NO_3:** Can cause a variety of problems.
- Brown blood disease in fish.
- Methemoglobin: destroys the ability for hemoglobin to transport Oxygen.
- Methemoglobinemia or “Blue Baby.” nitrite levels over 1 mg/l

Nitrogen Cycle



Biogeochemical Cycles

- **Nitrogen fixation:** synthesis of nitrogen containing compounds from N_2
  - Nitrification: N_2 --> NH_3 --> NO_3^-
  - Denitrification: NO_3^- --> N_2
  - Both processes are carried out by microbes: free or living on plant roots
  - Nitrogenous wastes and fertilizer use radically alter the global nitrogen cycle
  - Humans have doubled the rate of transfer of N_2 in usable forms into soils and water

Steps to the Nitrogen Cycle

- The Nitrogen Cycle is an 8 step process that begins with free nitrogen in the atmosphere and ends with Free nitrogen in the atmosphere. However the final step could be missed if nitrogen compounds are returned to the soil by bacteria

1.Nitrogen is placed in the atmosphere very often by **lightning** as well as by **Denitrofication**

2. **Nitrogen** is carried to the soil by precipitation.

3. Nitrogen Fixation:

- These bacteria live in the roots of plants called legumes.
- They place nitrogen in the soil so plants can use it.
- Convert it from Nitrogen to Nitrite to Nitrate

4. Plants absorb the compounds and convert to plant Proteins.

5. Plants are eaten by animals and animals convert these to animal proteins.

- Or plant dies and material is decomposed or denitrified.
- **6**. Animal dies or makes waste or is eaten by another animal
- and material is decomposed or denitrified

- **7**. Denitrofication: Bacteria breakdown organic material to release free nitrogen into the air.
-
- **8**. Free Nitrogen into air.

Phosphorus cycle

- Phosphorus cycle
  - Phosphorus is required by all organisms
    - Occurs in nucleic acids, membranes, ATP
  - No significant gas form
  - Exists as PO_4^{3-} in ecosystems
  - Plants and algae use free inorganic phosphorus, animals eat plants to obtain their phosphorus

Phosphorus cycle

- **Total $P0_4$** should not exceed 0.1 mg/L in in streams that do not directly empty into a lake or reservoir.
- Can get into our water supplied from fertilizers. (Minnesota has a law that states no phosphates in lawn fertilizers.)
- Total Phosphates **should not be exceed** 0.05 mg/L in a stream at a point where it enters a lake or reservoir.
- **Animal wastes**: Essential in metabolism so it is present in animal waste.
- Barnyards feedlots, hog and dairy farms.

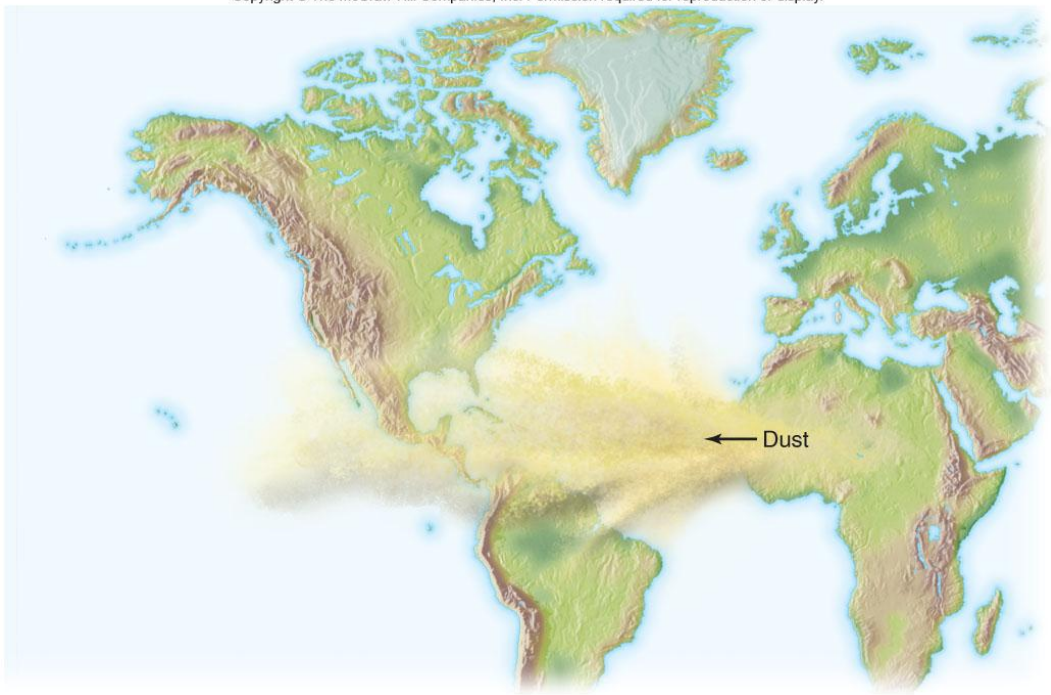
Phosphorus cycle

- **Paved Surfaces**: Development will expose and release phosphorous through soil erosion. If wetlands are drained phosphorous that was buried can be exposed also with no area to act as a filter.
- **Forest fires**: Causes soil erosion thus releasing Phosphorous.

Phosphorus Cycle

- **Limiting nutrient:** weak link in an ecosystem; shortest supply relative to the needs of organisms
- Iron is the limiting nutrient for algal populations
- **Nitrogen and phosphorus** can also be limiting nutrients for both terrestrial and aquatic ecosystems

Biogeochemical Cycles



Every year millions of metric tons of iron-rich dust is carried by the trade winds, from the Sahara Desert, across the globe to as far as the Pacific Ocean

Flow of Energy in Ecosystems

- Energy is never recycled
- Energy exists as;
  - Light
  - Chemical-bond energy
  - Motion
  - Heat
- **First Law of Thermodynamics:** energy is neither created nor destroyed; it changes forms

Flow of Energy in Ecosystems
Food Chains and Food Webs

- Organisms cannot convert heat to any of the other forms of energy
- Second Law of Thermodynamics: whenever organisms use chemical-bond or light energy some is converted to heat (entropy)
- Earth functions as an open system for energy
- Sun our major source of energy

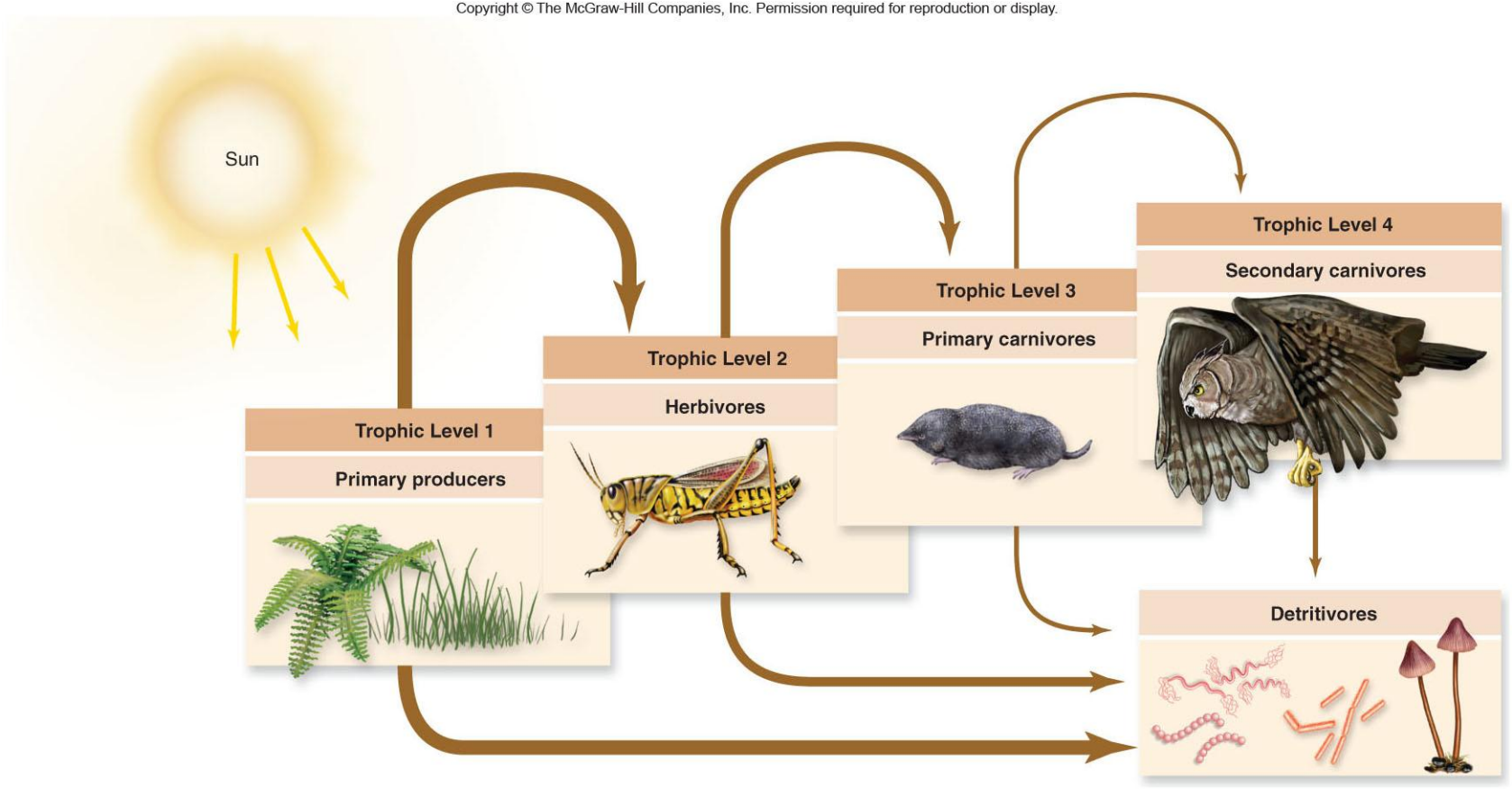
Energy Flow

- **Trophic levels:** which level an organism "feeds" at
- **Autotrophs:** "self-feeders" synthesize the organic compounds of their bodies from inorganic precursors
  - **Photoautotrophs:** light as energy source
  - **Chemoautotrophs:** energy from inorganic oxidation reactions
    - prokaryotic

Energy Flow

- **Heterotrophs:** cannot synthesize organic compounds from inorganic precursors;
  - animals that eat plants and other animals;
  - fungi that use dead and decaying matter (detritivores)

Trophic levels within an ecosystem



Trophic Levels

- **<u>Types of Aquatic Food Chains:</u>**
- All food chains need to begin with photosynthesis so that food substances can be made and Oxygen can be used for respiration.
- In **Standing Water** systems Photosynthesis from producers is the most common way to create Oxygen. (Plants and Algae)
- In **Fluvial Systems** most Oxygen is put into the water though aeration.
- (Some producers like blue-green algae, green algae, diatoms, and mosses that are attached to rocks make oxygen.) Water is moving to fast for rooted plants.

Trophic Levels

- **Autotrophic Food Chain**: Self Feeding Food Chain
- Algae ----- Snails ------- Fish ------ Otter
-
- **Detritus Food Chains:** Dead organic material enters from the surrounding environment into the water.
- Grass clippings------ Scavengers----- Carnivore
-
- **Heterotrophic Food Chain:** Small animals that are not aquatic enter the water supply.
- Insect falls in the water------ fish------ Otter

Biomes

- **Biomes:** a major type of ecosystem on land
- Each biome has a characteristic appearance
  - Defined largely by sets of regional climatic conditions
- Biomes are named according to their vegetational structures
- Eight principle biomes