Objective 3 Ecosystem and Interaction

Energy Transfer
1. Analyze the flow of matter and energy through different trophic levels and between organisms and the physical environment

Ecosystems
2. Interpret interactions among organisms exhibiting predation, parasitism, commensalisms and mutualism
3. Investigate and explain the interactions in an ecosystem including food chains, food webs, and food pyramids

ECOSYSTEMS
Biosphere = portion of earth inhabited by life. Includes all the planet's communities and ecosystems.
Environment includes biotic and abiotic factors. Questions about the relevant importance of various environmental variables are frequently at the heart of ecological studies.
Biotic = all organisms within an individual's environment.
Abiotic = temperature, light, water, nutrients etc...
Population = a group of individuals belonging to the same species inhabiting a particular geographical area.
Community = all organisms inhabiting a particular area.
Biosphere: Portion of the earth inhabited by life: sum of all ecosystems. This area is a relatively thin layer of seas, lakes, streams, land to soil depth of a few meters, and atmosphere to an altitude of a few kilometers.

Organisms in the biosphere are acted upon by abiotic factors (non-living).
1. Temperature: affects metabolism, range is between 0 degrees and 50 degrees centigrade.
2. Water: adaptations for water balance and conservation help determine a species' habitat range.
3. Light: Solar energy drives nearly all ecosystems. Availability of light can determine habitat. Aquatic environments, water selectively reflects and absorbs certain wavelengths; therefore, most photosynthesis occurs near the surface of the water. Animal and plant behavior is often sensitive to photoperiods.
4. Soil: Physical structure, pH, and mineral composition of soil limit distribution of plants and hence animals that feed on them.
5. Wind: amplifies the effects on temperature by increasing heat loss by evaporation and convection.

Principle of Allocation: Each organism has a limited, finite amount of total energy that can be allocated for growth, reproducing, obtaining nutrients, escaping predators and coping with environmental changes.
Species living in stable environments: Lead a good life in a small area.
Species living in unstable environments: Lead a rough life over a wider range.
FOOD CHAINS WEBS AND PYRAMIDS
The food chain consists of four main parts:

1. **The Sun**, which provides the energy for everything on the planet.
2. **Producers**: these include all green plants. These are also known as autotrophs, since they make their own food. Producers are able to harness the energy of the sun to make food. Ultimately, every (aerobic) organism is dependent on plants for oxygen (which is the waste product from photosynthesis) and food (which is produced in the form of glucose through photosynthesis). They make up the bulk of the food chain or web.
3. **Consumers**: In short, consumers are every organism that eats something else. They include *herbivores* (animals that eat plants), *carnivores* (animals that eat other animals), *parasites* (animals that live off of other organisms by harming it), and *scavengers* (animals that eat dead animal carcasses). Primary consumers are the herbivores, and are the second largest biomass in an ecosystem. The animals that eat the herbivores (carnivores) make up the third largest biomass, and are also known as secondary consumers. This continues with tertiary consumers, etc.
4. **Decomposers**: These are mainly bacteria and fungi that convert dead matter into gases such as carbon and nitrogen to be released back into the air, soil, or water. Fungi, and other organisms that break down dead organic matter are known as *saprophytes*. Even though most of us hate those mushrooms or molds, they actually play a very important role. Without decomposers, the earth would be covered in trash. Decomposers are necessary since they recycle the nutrients to be used again by producers.

**FOOD CHAINS, WEBS AND PYRAMIDS**

- **Autotrophs** – produce their own food (example: plants).
- **Herbivore** – plant eaters (example: deer).
- **Omnivore** – eats both plants and meat (example: bear).
- **Carnivore** – eats primary meat (example: coyote).
- **Decomposers** – breaks down dead tissue (example: bacteria).
- **Producer** - also known as autotrophs, produces its own food.
- **Primary, secondary, tertiary consumer** – a consumer is any animal that does not produce its own food; it is considered a primary, secondary or tertiary consumer depending on where it may be found in a food chain or food web. A primary consumer will feed on autotrophs, a secondary consumer will feed on primary consumers, and tertiary consumer will feed on secondary consumers.

A food chain is a possible route for the transfer of matter and energy (food) through an ecosystem from autotrophs through heterotrophs and decomposers.

Example of food chains:

- Producer $\rightarrow$ primary consumer $\rightarrow$ secondary consumer $\rightarrow$ tertiary consumer $\rightarrow$ decomposer
- Grass $\rightarrow$ rabbit $\rightarrow$ fox $\rightarrow$ decomposer (upon the death of the fox)

A food web shows all possible feeding relationships in a community at each trophic level; represents a network of interconnected food chains.

An example of a food web:

![Food Web Diagram]

The difference between a food chain and a food web is that a chain is a single strand of the different levels of energy transfer, where as a food web will show the many strands in a particular ecosystems such as a forest.
A food pyramid, or ecological pyramid, will show population sizes (amount of energy at that level) in an ecosystem. The pyramid most often decreases, as it gets farther up. In the example of the food web above, a food pyramid can be created with the clover, the worm, and the raccoon. There is a much larger abundance of clover than the other two; they will be on the bottom of the pyramid. The worm will be the next step with a smaller number than clover, but larger number of raccoon. The raccoon will be on the top of the pyramid with the smallest number. The pyramid will look like this:

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Raccoon
  Worm
  Clover
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This table shows the relational biomass of each of the major groups in the food chain:

<table>
<thead>
<tr>
<th>Tertiary Consumers</th>
<th>Secondary Consumers</th>
<th>Primary Consumers</th>
<th>Producers</th>
</tr>
</thead>
</table>

Biomass is organic material which has stored sunlight in the form of chemical energy.

**INTERACTIONS AMONG ORGANISMS**

Any relationship in which there is a close and permanent association between organisms of different species is **symbiosis**, or “living together”. There are several types of symbiosis. They are **predation**, **parasitism**, **commensalism**, and **mutualism**.

1. **Predation** is a relationship in which one organism preys on another as a source of food. An example of predation is an owl hunting a field mouse.
2. **Parasitism** is a relationship in which one organism derives benefit at the expense of the other. An example of parasitism is a tapeworm living in the intestines of dogs. The tapeworm takes nourishment from the dog in which it lives.
3. **Commensalism** is a relationship in which one organism derives benefit with neither benefit nor harm to the other. An example of a commensal relationship would be that of a sea anemone and the clown fish. The clown fish is covered in a secretion that makes it immune to a sea anemone’s attack. The clown fish can find protection within the anemone, while bringing the anemone no benefit or harm.
4. **Mutualism** is a relationship in which both organisms benefit from each other. An example of a mutualistic relationship is that of the ant and the acacia tree. The ant protects the tree from herbivores from eating the tree as well as clearing vegetation away from the tree that may compete for resources. The tree provides a home for the ants.
Flow of Energy and Matter

Water Cycle

Water is constantly moving in a cycle through organisms and the environment. Find the arrows in Figure 10-2 that show water evaporating from the lake and ocean. Evaporation is the process by which water changes from a liquid to a gas. The energy to drive this process comes from the sun. Notice in the diagram that as the water evaporates, it forms clouds. This water returns to the surface of Earth when precipitation—rain, sleet, hail, or snow—falls from the clouds. On land much of the water is heated by the sun, and it reenters the atmosphere through evaporation.

Some precipitation seeps into the soil and becomes part of the ground water, which is retained beneath the surface of Earth. Water also runs across the surface of Earth as runoff, which empties into lakes and other bodies of water. As water seeps into the land, some is taken up by the roots of plants. After passing through a plant, water moves into the atmosphere through the process of transpiration, the evaporation of water from the leaves of plants.

Plants also use water in photosynthesis, breaking it down into new combinations that create sugar and oxygen. Animals that eat the sugar and breathe the oxygen recombine those materials to make water as one product of respiration. Then the animals release the new water back into the environment.
**Carbon cycle**

If you could look at the organic molecules that make up living things, you'd find something similar in all of them—they all contain carbon. It's also found in the oceans, the air, and certain types of rock. In the air, carbon is present in the form of carbon dioxide. In the ocean, carbon dioxide is dissolved in water.

Carbon cycles through living organisms and the nonliving environment. Recall that plants use carbon dioxide along with water to build organic molecules during photosynthesis. The carbon atoms in these organic molecules may return to the pool of carbon dioxide in the air in several ways. Follow the processes in Figure 10-3 as you read about each.

**Respiration.** During cellular respiration, organisms use oxygen to release energy from carbon-containing organic molecules. Carbon dioxide is a product of this process, and it is released into the air.

**Combustion.** Carbon also returns to the air during combustion—when materials burn. Large amounts of carbon may be tied up in the wood of trees for hundreds of years. When the wood is burned—as a source of heat or during forest fires, for example—the carbon is released. Some carbon remains locked away for millions of years in the form of fossil fuels—coal, oil, and natural gas. Fossil fuels form after the remains of organisms become buried by sediments. When fossil fuels burn, carbon is released.

**Erosion.** Many marine organisms contain carbon in their calcium carbonate shells. As these organisms die, their shells form sediments on the bottom of the ocean. Over millions of years, these sediments form limestone, which also contains carbon atoms. Like the carbon in the tissues of trees, the carbon in limestone may be tied up for many years. During erosion, the limestone may become exposed and undergo chemical changes that return carbon to the atmosphere.

![Carbon cycle diagram](image-url)
Nitrogen cycle

The atmosphere around you contains about 79 percent nitrogen gas. Organisms need this important element to make amino acids, which in turn are used to build proteins. But most organisms can't use nitrogen in the form it takes in the atmosphere. Only certain types of bacteria can use this form directly. Those bacteria live in the soil and in swellings on the roots of plants called legumes—beans and peas. The bacteria bind nitrogen atoms to hydrogen atoms to form ammonia, NH₃, in a process known as nitrogen fixation. Other bacteria in the soil convert ammonia into nitrates and nitrites during nitrification. Producers can take these substances in and use them to make proteins. Consumers use these proteins to make new proteins.

You can see in Figure 10-4 that when organisms die, decomposers return nitrogen to the soil as ammonia. Bacteria may again change the ammonia into nitrates and nitrites, or other bacteria may convert it into nitrogen gas in a process called denitrification.