Food Webs

How do the grasshopper and the grass interact?

Grasshoppers don't just hop on the grass. They also eat the grass. Other organisms also eat the grass, and some animals even eat the grasshopper. These interactions can be visualized by drawing a food web.

Food Webs

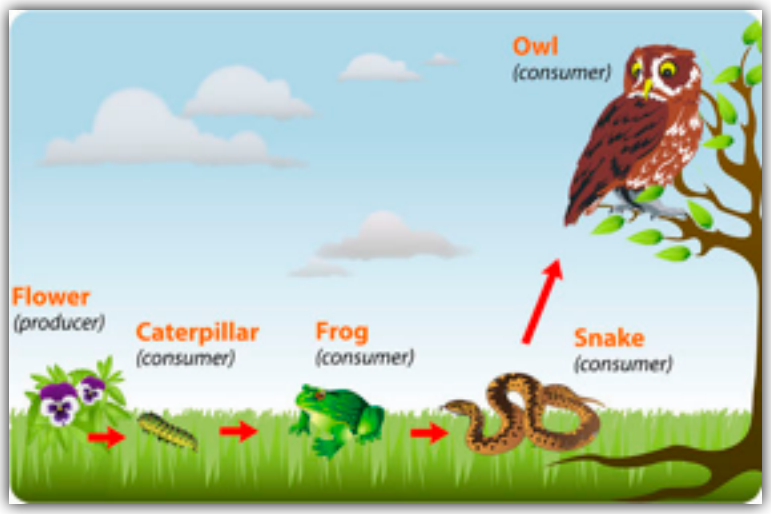
Energy must constantly flow through an ecosystem for the system to remain stable. What exactly does this mean? Essentially, it means that organisms must eat other organisms. **Food chains** (**Figure** below) show the eating patterns in an ecosystem. Food energy flows from one organism to another. Arrows are used to show the feeding relationship between the animals. The arrow points from the organism being eaten to the organism that eats it. For example, an arrow from leaves to a caterpillar shows that the caterpillar eats the leaves. Energy and nutrients are moving from the leaves to the caterpillar. Next, a frog might prey on the caterpillar, a snake may eat the frog, and then a hawk might eat the snake. The food chain would be:

leaves → caterpillar → frog → snake → hawk.

A food chain cannot continue to go on and on. For example the food chain could not be:

leaves → caterpillar → spider → frog → lizard → fox → hawk.

Food chains only have 4 or 5 total levels. Therefore, a chain has only 3 or 4 levels for energy transfer.



This food chain includes producers and consumers. What would you label each of the consumers?

In an ocean ecosystem, one possible food chain might look like this: phytoplankton → krill → fish → shark.

The **producers** are always at the beginning of the food chain, bringing energy into the ecosystem. Through photosynthesis, the producers create their own food in the form of glucose, but also create the food for the other organisms in the ecosystem. The **herbivores** come next, then the **carnivores**. When these **consumers** eat other organisms, they use the glucose in those organisms for energy. In this example, phytoplankton are eaten by krill, which are tiny, shrimp-like animals. The krill are eaten by fish, which are then eaten by sharks. In an ocean ecosystem, or in any ecosystem, the names for the various types of consumers remains the same - sharks are carnivores and fish that eat only phytoplankton or algae are herbivores. Can you think of any omnivorous fish?

Each organism can eat and be eaten by many different types of organisms, so simple food chains are rare in nature. There are also many different species of fish and sharks. So a food chain cannot end with a shark; it must end with a distinct species of shark. A food chain does not contain the general category of "fish," it will contain specific species of fish. In ecosystems, there are many food chains.

Since feeding relationships are so complicated, we can combine food chains together to create a more accurate flow of energy within an ecosystem. A **food web** (**Figure** below) shows the feeding relationships between many organisms in an ecosystem. If you expand our original example of a food chain, you could add deer that eat clover and foxes that hunt chipmunks. A food web shows many more arrows, but still shows the flow of energy. A complete food web may show hundreds of different feeding relationships.

- **Build A Food Web** at http://www.sciencesource2.ca/resources/SS_active_art/active_art/SEinteractive_gr09_ch01_pg31/index.html

Energy Pyramids

When an herbivore eats a plant, the **energy** in the plant tissues is used by the herbivore. But how much of that energy is transferred to the herbivore? Remember that plants are **producers**, bringing the energy into the ecosystem by converting sunlight into glucose. Does the plant use some of the energy for its own needs? Energy is the ability to do work, and the plant has plenty or "work" to do. So of course it needs and uses energy. It converts the glucose it makes into **ATP** through **cellular respiration** just like other organisms. After the plant uses the energy from glucose for its own needs, the excess energy is available to the organism that eats the plant.

The herbivore uses the energy from the plant to power its own life processes and to build more body tissues. However, only about 10% of the total energy from the plant gets stored in the herbivore's body as extra body tissue. The rest of the energy is used by the herbivore and released as heat. The next consumer on the food chain that eats the herbivore will only store about 10% of the total energy from the herbivore in its own body. This means the carnivore will store only about 1% of the total energy that was originally in the plant. In other words, only about 10% of energy of one step in a food chain is stored in the next step in the food chain. The majority of the energy is used by the organism or released to the environment.

Every time energy is transferred from one organism to another, there is a loss of energy. This loss of energy can be shown in an **energy pyramid**. An example of an energy pyramid is pictured below (**Figure** below). Since there is energy loss at each step in a food chain, it takes many producers to support just a few carnivores in a community.

Plants or other photosynthetic organisms are found on the first level, at the bottom of the pyramid. The next level will be the herbivores, and then the carnivores that eat the herbivores. The energy pyramid (**Figure** below) shows four levels of a food chain, from producers to carnivores. Because of the high rate of energy loss in food chains, there are usually only 4 or 5 levels in the food chain or energy pyramid. There just is not enough energy to support any additional levels.

Vocabulary

- **ATP**: Adenosine triphosphate; a molecule containing a large amount of energy that can be used for many metabolic processes in the cell.
- **autotroph**: Organism that produces complex organic compounds from simple inorganic molecules using a source of energy such as sunlight.
- **cellular respiration**: Process of breaking down glucose to obtain energy in the form of ATP.
- **energy**: Ability to do work.
- **energy pyramid**: Diagram showing how energy decreases from lower to higher trophic levels.
- **heterotroph**: Organism which obtains carbon from outside sources.
- **producer**: Organism that produces food (glucose) for itself and other organisms.
- **trophic level**: Feeding position in a food chain.

Summary

- As energy is transferred along a food chain, energy is lost as heat.
- Only about 10% of energy of one step in a food chain is stored in the next step in the food chain.

Practice

Use the resource below to answer the questions that follow.

- **Ecological Pyramids** at http://www.youtube.com/watch?v=NJplkrliUEg (4:03)

1. What are three types of ecological pyramids? How do their shapes compare?
2. Do you think it would be possible to construct a pyramid where the number of carnivores was more than the number of herbivores? Think carefully about the different possibilities.
3. Do you think it would be possible to construct a pyramid where the biomass of carnivores was more than the biomass of herbivores? How does this compare to a numbers pyramid.
4. What consumes energy at each trophic level? How does this contribute to energy loss between trophic levels?

5. What do you think you could learn about an ecosystem by comparing three different types of pyramids for an ecosystem? How is this information different than the information you could gain from looking at a single pyramid?

Review

1. When an herbivore eats a plant, what happens to 90% of the energy obtained from that plant?
2. In a forest community, caterpillars eat leaves, and birds eat caterpillars. Draw an energy pyramid using this information.