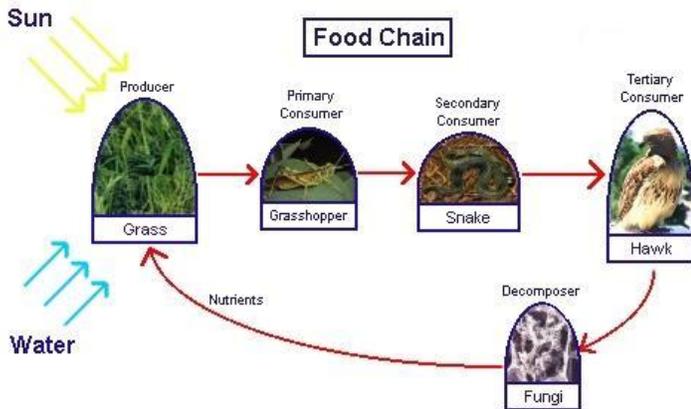


FOOD CHAINS, FOOD WEBS AND ECOLOGICAL PYRAMIDS

In an ecosystem, plants capture the sun's energy and use it to convert inorganic compounds into energy-rich organic compounds. This process of using the sun's energy to convert minerals (such as magnesium or nitrogen) in the soil into green leaves, or carrots, or strawberries, is called **photosynthesis**.

Photosynthesis is only the beginning of a chain of energy conversions. There are many types of animals that will eat the products of the photosynthesis process. Examples are deer eating shrub leaves, rabbits eating carrots, or worms eating grass. When these animals eat these plant products, food energy and organic compounds are transferred from the plants to the animals. These animals are in turn eaten by other animals, again transferring energy and organic compounds from one animal to another. Examples would be lions eating zebras, foxes eating rabbits, or birds eating worms.



This chain of energy transferring from one species to another can continue several more times, but it eventually ends. It ends with the dead animals that are broken down and used as food or nutrition by bacteria and fungi. As these organisms, referred to as decomposers, feed from the dead animals, they break down the complex organic compounds into simple nutrients. Decomposers play a very important role in this world because they take care of breaking down (cleaning) many dead material. There are more than 100,000 different types of decomposer organisms! These simpler nutrients are returned to the soil and can be used again by plants. The energy transformation chain starts all over again.

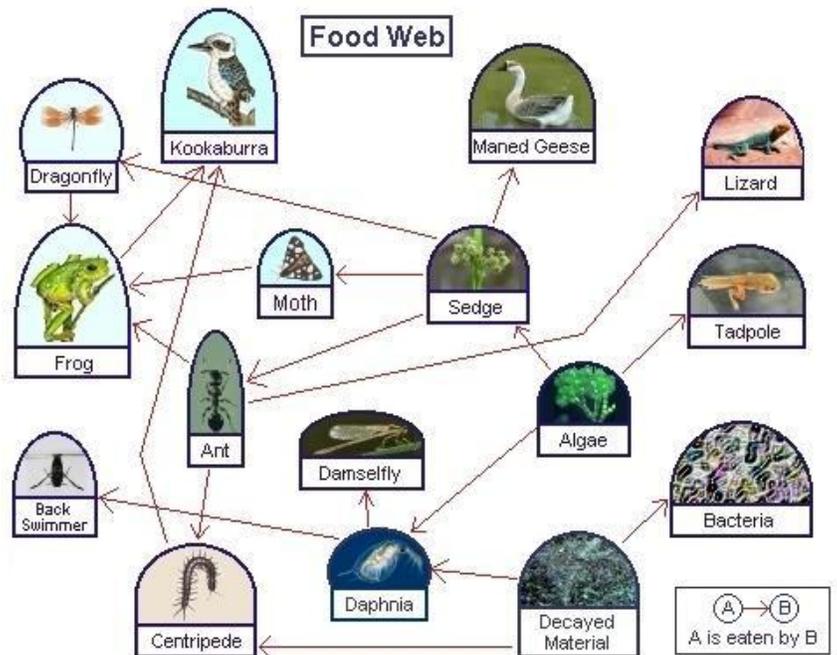
Producers: Organisms, such as plants, that produce their own food are called autotrophs. The autotrophs, as mentioned before, convert inorganic compounds into organic compounds. They are

called producers because all of the species of the ecosystem depend on them.

Consumers: All the organisms that can not make their own food (and need producers) are called heterotrophs. In an ecosystem heterotrophs are called consumers because they depend on others. They obtain food by eating other organisms. There are different levels of consumers. Those that feed directly from producers, i.e. organisms that eat plant or plant products are called primary consumers. In the figure above the grasshopper is a primary consumer.

Organisms that feed on primary consumers are called secondary consumers. Those who feed on secondary consumers are tertiary consumers. In the figure above the snake acts as a secondary consumer and the hawk as a tertiary consumer. Some organisms, like the squirrel are at different levels. When the squirrel eats acorns or fruits (which are plant product), it is a primary consumer; however, when it eats insects or nesting birds, it is a tertiary consumer. Consumers are also classified depending on what they eat; they can be herbivores, carnivores, omnivores or scavengers.

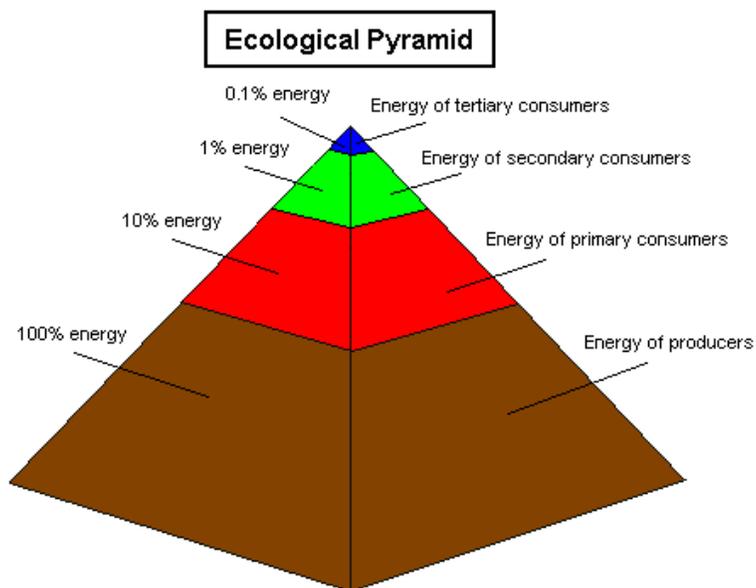
In looking at the previous picture, the concept of food chain looks very simple, but in reality it is more complex. Think about it. How many different animals eat grass? And from the Facts about Red-tailed Hawks page, how many different foods does the hawk eat? One doesn't find simple independent food chains in an ecosystem, but many interdependent and complex food chains that look more like a web and are therefore called food webs.



We described in the previous sections how energy and organic compounds are passed from one trophic level to the next. What was not mentioned is the efficiency of the transfer. In a highly efficient transfer almost all of the energy would be transferred -- 80% or more. In a low efficiency transfer very little energy would be transferred -- less than 20%. In a typical food chain, not all animals or plants are eaten by the next trophic level. In addition, there are portions or materials (such as beaks, shells, bones, etc.) that are also not eaten. That is why the transfer of matter and energy from one trophic level to the next is not an efficient one.

One way to calculate the energy transfer is by measuring or sizing the energy at one trophic level and then at the next. Calorie is a unit of measure used for energy. The energy transfer from one trophic level to the next is about 10%. For example, if there are 10,000 calories at one level, only 1,000 are transferred to the next. This 10% energy and material transfer rule can be depicted with an ecological pyramid that looks like the one below.

This pyramid helps one visualize the fact that in an ecological system there need to be many producing organisms at the bottom of the pyramid to be able to sustain just a couple of organisms at the top. In looking at the pyramid, can you guess how much larger the volume of each layer is as compared to the one just above it? Take a guess. It might not look like it but they are close to 10 times larger.

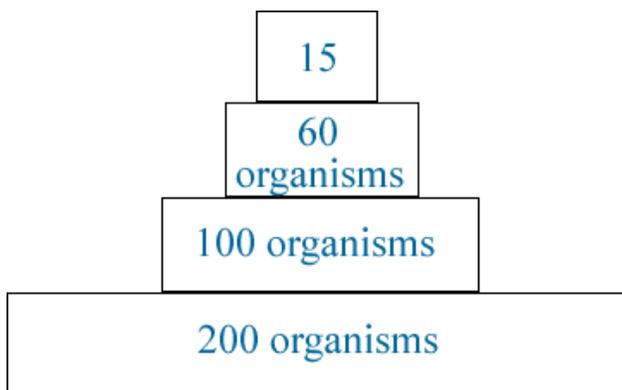


A basic pyramid shape often represents a typical food chain or food web. The pyramid represents the decrease in the amount of energy, the number of organisms and the biomass from the producer to the high - order consumer levels. The decrease in the numbers and in the biomass represent the fact that, due to energy loss, fewer organisms can be supported at each successive trophic level.

Pyramid of Energy

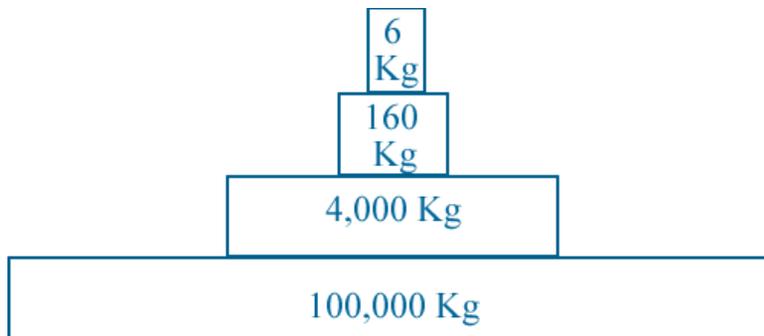
Energy is lost between each link in a food chain. Much of the potential energy at each level never reaches the next level. Where does the energy go as it moves through a food chain? Some of the energy that enters a food chain is used as each organism carries out its life functions (i.e. foraging, metabolic processes, reproduction, predator/prey behavior, etc.). Producers manufacture their own food source directly from sunlight by the process of photosynthesis. In order to carry out life functions, consumers acquire energy through the 'burning' or breaking down of food molecules they consume (eat). Thermal energy (heat) is produced as a result of the burning of these food molecules. More than half of the energy from each food molecule is lost as heat. Only about 10% - 20%

of energy at each trophic level is available to pass on to the next level. In other words, at each level there is only about 10% available energy to put on new biomass (growth).



Pyramid of Numbers

The loss of energy at each trophic level also explains why there are usually fewer organisms in each higher trophic level. The total number of plants in a particular area would generally be higher than the number of herbivores that the plants support and the number of herbivores would be higher than the number of higher order carnivores.



Pyramid of Biomass

Biomass is the total mass of dry organic matter per unit of area. Each higher trophic level contains less biomass than the previous trophic level. Therefore a drawing or graph that represents the amount of biomass at each trophic level would also produce the basic pyramid shape. Biomass is related to the abundance of organisms at each trophic level.

Human Impact on Food Chains and Webs

Humans have the ability to have a great impact on ecosystems. Living organisms are a significant portion of any ecosystem, therefore any activity that affects an ecosystem is also likely to affect the organisms within that ecosystem. If organisms are affected the food chains webs that the organisms are a part of will also feel the affects.

Ecological Pyramids Worksheet

1. Give three examples of food chains that exist in nature. _____

2. In a ecological pyramid, what happens to energy, biomass and # of species as you move up? **Why?**

3. What is biomass? _____

4. In an ecosystem, can there be more carnivores than herbivores? **Explain** why or why not?

5. What is the 10% rule? What is its significance? Why is energy lost?

6. Brainstorm to create a list of 4 human activities that interfere with ecosystems, food chains and food webs. For each explain how it happens, why we do it, and mention short and long-term effects.

7. Label the ecological pyramid below with the following words: producers, tertiary consumer, secondary consumer, autotroph, heterotroph, primary consumer, decomposers, hawk, grass, chicken, grasshopper. **Also** label and explain what happens to energy, biomass and number of organism.

8. Discuss what trophic level humans occupy on an ecological pyramid, and explain what happens to contaminants and environmental pollution (such as mercury) as you move down and up the ecological pyramid (what is this called?).

1. Look at the food web on the first page of the article. Who does the Maned Geese depend on for survival?

2. Using the same food web, which organism may not increase in population if all the frogs were removed from this ecosystem? _____

3. Using the same food web, which organisms would be affected if the algae were to overproduce? _____

4. Using the same food web, who eats the sedge? _____