Reading

Forced Perspective: Week 7

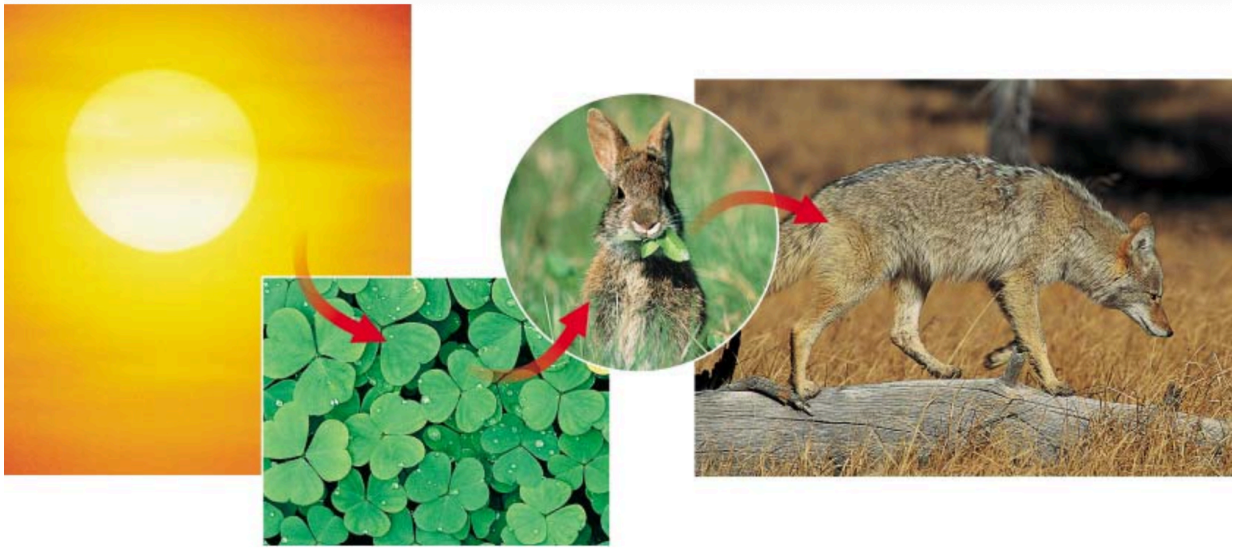
Just as a car cannot run without fuel, an organism cannot survive without a constant supply of energy. Where does an organism's energy come from? The answer to that question depends on the organism, but the ultimate source of energy for almost all organisms is the sun.

Life Depends on the Sun

Energy from the sun enters an ecosystem when a plant uses sunlight to make sugar molecules by a process called photosynthesis. During photosynthesis, plants, algae, and some bacteria capture solar energy. Solar energy drives a series of chemical reactions that require carbon dioxide and water. The result of photosynthesis is the production of sugar molecules known as carbohydrates. Carbohydrates are energy-rich molecules which organisms use to carry out daily activities. As organisms consume food and use energy from carbohydrates, the energy travels from one organism to another. Plants, such as sunflowers, produce carbohydrates in their leaves. When an animal eats a plant, some energy is transferred from the plant to the animal. Organisms use this energy to move, grow, and reproduce.

From Producers to Consumers

When a rabbit eats a clover plant, the rabbit gets energy from the carbohydrates the clover plant made through photosynthesis. If a coyote eats the rabbit, some of the energy is transferred from the rabbit to the coyote. In this example, the clover is the producer. A producer is an organism that makes its own food. Producers are also called autotrophs, self-feeders. Both the rabbit and the coyote are consumers, organisms that get their energy by eating other organisms. Consumers are also called heterotrophs, other-feeders. In the example shown, the clover, rabbit, and coyote get their energy from the sun. Some producers get energy directly from the sun by absorbing it through their leaves. Consumers get energy indirectly from the sun by eating producers or other consumers.



What Eats What

Table 1 classifies organisms by the source of their energy. Consumers that eat only producers are called herbivores, or plant eaters. Rabbits are herbivores and so are cows, sheep, deer, grasshoppers, and many other animals. Consumers, such as lions and hawks, that eat only other consumers are called carnivores, or flesh eaters. You already know that humans are consumers, but what kind of consumers are we? Because most humans eat both plants and animals, we are called omnivores, or eaters of all. Bears, pigs, and cockroaches are other examples of omnivores. Some consumers get their food by breaking down dead organisms and are called decomposers. Bacteria and fungi are examples of decomposers. The decomposers allow the nutrients in the rotting material to return to the soil, water, and air.

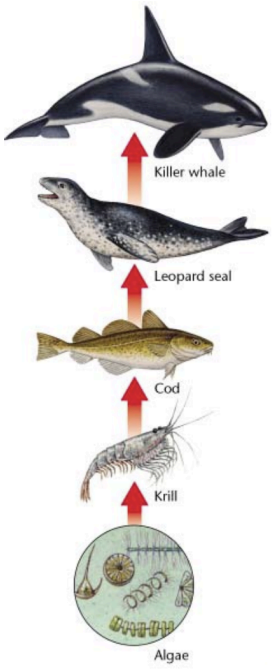
Table 1 ▼

What Eats What in an Ecosystem		
	Energy source	**Examples**
Producer	makes its own food through photosynthesis or chemical sources	grasses, ferns, cactuses, flowering plants, trees, algae, and some bacteria
Consumer	gets energy by eating producers or other consumers	mice, starfish, elephants, turtles, humans, and ants

Types of Consumers in an Ecosystem		
	Energy source	**Examples**
Herbivore	producers	cows, sheep, deer, and grasshoppers
Carnivore	other consumers	lions, hawks, snakes, spiders, sharks, alligators, and whales
Omnivore	both producers and consumers	bears, pigs, gorillas, rats, raccoons, cockroaches, some insects, and humans
Decomposer	breaks down dead organisms in an ecosystem and returns nutrients to soil, water, and air	fungi and bacteria

Energy Transfer

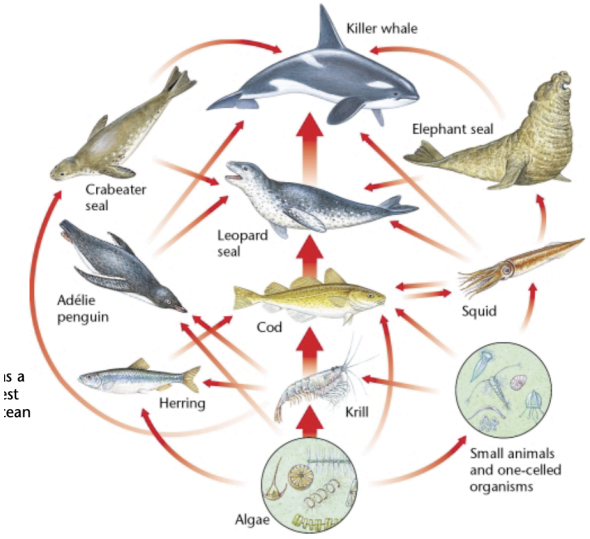
Each time one organism eats another organism, a transfer of energy occurs. We can trace the transfer of energy as it travels through an ecosystem by studying food chains, food webs, and trophic levels. Food chains, food webs, and trophic levels can tell us how energy is transferred as well as how much energy is transferred between organisms in an ecosystem. Studying the paths of energy between organisms can also tell us which organisms in an ecosystem depend on other organisms to survive.



Food Chains and Food Webs

A food chain is a sequence in which energy is transferred from one organism to the next as each organism eats another organism. The chart here shows a typical food chain in an ocean ecosystem. Algae are eaten by krill, which are eaten by cod. The cod are eaten by leopard seals, which are eaten by killer whales. Energy flow in an ecosystem is much more complicated than energy flow in a simple food chain. Ecosystems almost always contain many more species than a single food chain contains. In addition, most organisms, including humans, eat more than one

kind of food. So a food web, such as the one shown below, includes more organisms and multiple food chains linked together. A food web shows many feeding relationships that are possible in an ecosystem. Notice that the food chain is just one strand in the larger food web.

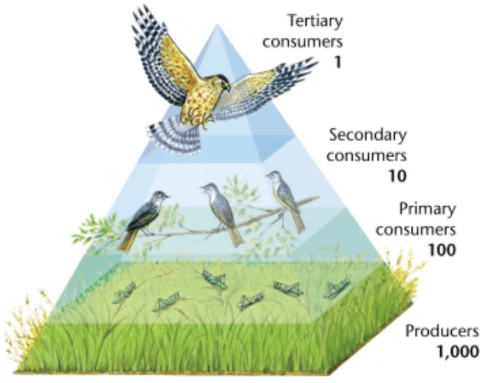


Trophic Levels

Each step in the transfer of energy through a food chain or food web in an ecosystem is known as a trophic level. In the example at left, the algae are in the bottom trophic level, the krill are in the next level, and so on. Each time energy is transferred from one organism to another, some of the energy is lost as heat and less energy is available to organisms at the next trophic level. Some of this energy is lost during cellular respiration. Organisms use much of the remaining energy to carry out the functions of living, such as producing new cells, regulating body temperature, and moving around. About 90 percent of the energy at each trophic level is used in these ways. The remaining 10 percent of the energy becomes part of the organism's body and is stored in its molecules. This 10 percent that is stored is all that is available to the next trophic level when one organism consumes another organism.

Energy Pyramids

One way to visualize the loss of energy from one trophic level to the next trophic level is to draw an energy pyramid like the one shown here. Each layer in the energy pyramid represents one trophic level. Producers form the base of the pyramid, the lowest trophic level, which contains the most energy. Herbivores contain less energy and make up the second level. Carnivores that feed on herbivores form the next level, and carnivores that feed on other carnivores make up the top level. Organisms in the upper trophic levels store less energy than both herbivores and producers. A pyramid is a good way to illustrate trophic levels because the pyramid becomes smaller toward the top, where less energy is available.



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How Energy Loss Affects an Ecosystem

The decreased amount of energy at each trophic level affects the organization of an ecosystem. First, the energy loss is usually due to a smaller number of organisms at the higher trophic levels. For example, zebras and other herbivores outnumber lions on the African savanna by about 1,000 to 1. In this example, there simply are not enough herbivores to support more carnivores. Second, the loss of energy from trophic level to trophic level limits the number of trophic levels in an ecosystem. Ecosystems rarely have more than four or five trophic levels because the ecosystem does not have enough energy left to support higher levels. For example, a lion typically needs up to 250 km2 of land to hunt for food. Therefore, an animal that feeds on lions would have to expend a lot of energy to harvest the small amount of energy available at the top trophic level. The organisms that do feed on organisms at the top trophic level are usually small, such as parasitic worms and fleas that require a very small amount of energy.

1. Draw a food chain and a food web for your organism. Label the organisms in both
2. Color code the organisms in your food chain and web to show which type of consumer/producer each is.
3. Describe how energy is transferred from the sun to producers and then to consumers in your food web.

Seminar

Discussion / Seminar Questions

For each question below, use specific examples when possible

1. Describe how energy is transferred from the sun to producers and then to consumers.
2. Describe one way in which consumers depend on producers.
3. Explain how energy transfer in a food web is more complex than energy transfer in a food chain.
4. Explain why an energy pyramid is a representation of trophic levels.