INQUIRY INVESTIGATIONS™ LAB

NAME

TEACHER

DATE

Unit 3 | Lab 9

Learning About Food Webs and Energy Pyramids

Objectives

- Build model food chains from different habitats
- Model food webs
- Model energy flow through trophic levels
- Investigate the roles of producers, consumers, scavengers, and decomposers in a food chain or web

Safety and Disposal

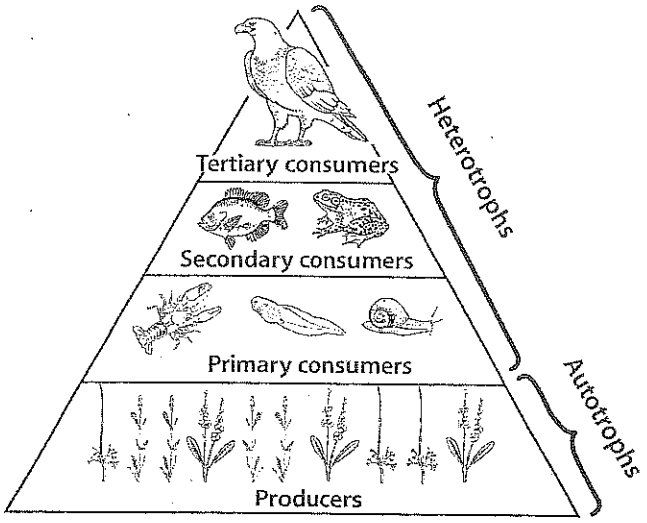
Follow proper lab safety protocols as directed by your teacher. Solid materials may be disposed of in the trash.

Background

Feeding Relationships

Within any **ecosystem**, there are many different types of organisms. Some organisms are able to get energy from food that they produce through photosynthesis, using energy in sunlight, carbon from carbon dioxide in the air, and water from soil. These organisms—plants, algae, and cyanobacteria—are known as **autotrophs**, which means that they are "self feeders." Other organisms rely on autotrophs for their energy. For example, cows eat grass. Many birds eat fruit and seeds. Manatees graze on marine algae and sea grasses. Because these animals cannot produce their own food, they are known as **heterotrophs**, or "other feeders." Not all heterotrophs eat autotrophs; some heterotrophic animals such as hawks and lions, eat other heterotrophs. One way to analyze the complex relationships that exist among organisms in an ecosystem is by observing their feeding relationships.

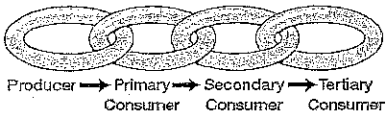
Ecologists are the scientists that study the interactions of organisms with each other and with their environment. One branch of the field of ecology deals with the study of **trophic levels** (relationships), that is, the types of food that each organism eats and how those organisms depend on each other. The word *trophic* means "to feed or to eat", and it forms part of the word root for the terms *autotroph* and *heterotroph*. Another set of terms that ecologists often use to describe trophic relationships between organisms is producer, consumer, scavenger, and decomposer.



Producers are always autotrophs. **Producers** form the base of any food or energy pyramid, or food chain or web. All consumers rely on the producers, either directly or indirectly, for their energy. **Consumer** organisms are those that feed either directly on the producers (these, such as cows, are called **herbivores**) or on other consumers (these are **carnivores**, such as sharks or your pet cat). Consumers can be broken down further into groups based on how far removed their food item is from the producers. For example, a primary consumer is an animal that feeds directly on plant material. A secondary consumer eats a primary consumer. A tertiary consumer eats the secondary consumer, and so on.

Food Chains

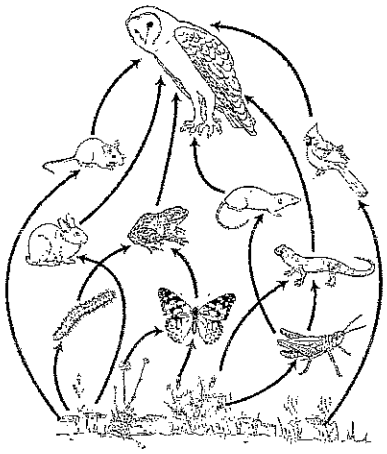
A **food chain** is formed by linking trophic levels together: producer ⟶ primary consumer ⟶ secondary consumer ⟶ tertiary consumer.



Rarely, a quaternary consumer may exist in an ecosystem, but most food chains stop at a tertiary or even a secondary consumer. Organisms responsible for clean-up duty are also necessary for a healthy, functioning ecosystem. These organisms are the scavengers and decomposers. **Scavengers** are consumers that eat dead plant and/or animal material whenever they come across them. They don't hunt or kill food organisms. An example of a scavenger is a turkey vulture. **Decomposers** break down the tissues of other organisms (living or nonliving). Decomposers absorb small nutrients into their cells from the breakdown products. Bacteria and fungi are important decomposers in all ecosystems.

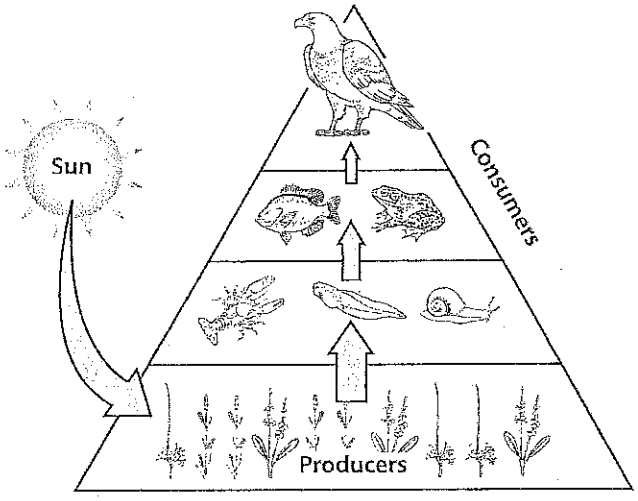
Food Webs

Most food chains do not accurately portray the trophic interactions in an ecosystem. In fact, ecologists usually study a more complex model of these interactions known as a food web. **Food webs** show how members of different food chains can interact with each other, forming a complicated web-like set of relationships. Food webs give ecologists a picture of how energy and materials move through a community.



Flow of Energy

Another aspect of trophic interactions in a food chain or web deals with the flow of energy from one organism to another. This is frequently described by ecologists as an **energy pyramid**. The wide base of the pyramid is formed by the producers. They use the energy in sunlight to make food. Most of the food that is produced by photosynthesis is used to run all of the activities and processes going on in the plant's cells, including energy for growth and reproduction. A small amount of food is stored in the cells of the plant.



Not all of the energy from sunlight is actually converted into food molecules. In fact, most of the sun's energy either doesn't reach Earth's surface or doesn't fall on areas where plants live. When a primary consumer eats a plant, it gets only a small fraction of the original sunlight energy that made it to Earth. A secondary consumer that eats the primary consumer gets an even smaller fraction of that original energy, because the primary consumer used most of the energy for its

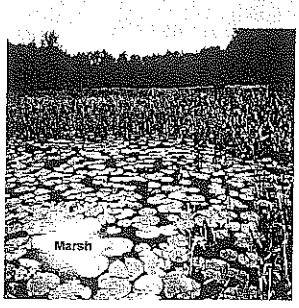
cellular activities rather than for making muscle tissue. This pattern of smaller and smaller energy returns continues as you progress up the trophic levels. For this reason, there are usually many fewer top level carnivores in an ecosystem than there are primary or secondary consumers. By the time the top level is reached, the supply of remaining energy has become quite small indeed.

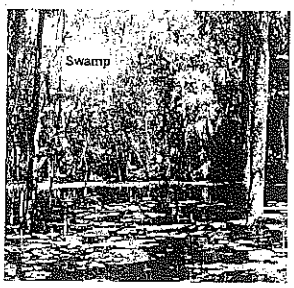
Biomes and Habitats

The number and types of producers and consumers available depend on geographical location and, sometimes, season. Earth is divided into major divisions called **biomes**. A biome can best be distinguished by its climate, fauna (animals), and flora (plants). Although there is some disagreement among scientists, most recognize five biomes: aquatic, desert, forest, grassland, and tundra.

Each biome may be further divided into different habitats. The place or environment where a plant or animal naturally or normally lives and grows is called a **habitat**. For example, the aquatic biome can be broken down into freshwater and marine regions. Freshwater regions have water that contains less than 1% salt. Ponds, lakes, streams, and rivers are familiar freshwater environments.

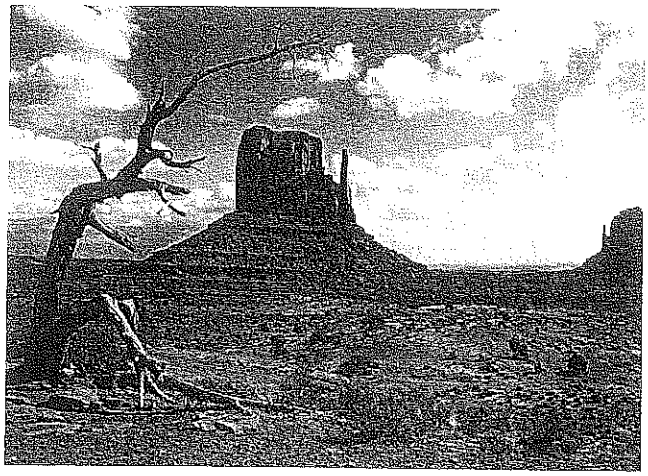
Wetlands are aquatic areas that support plants and animals. Marshes, swamps, and bogs are considered to be wetlands. The Everglades, in the southern part of Florida, is a wetland. Wetlands contain the highest diversity of plant and animal species of all regions. Producers include cypress, gum, water lilies, cattails, and sedges. Consumers include many types of amphibians, reptiles, insects, birds and mammals. Some wetlands contain brackish water, which is moderately salty. These wetlands are not considered to be true freshwater regions.





The marine regions cover about 75% of Earth's surface. They include oceans, coral reefs, and estuaries. Oceans have separate regions called zones. There are four zones: intertidal, pelagic, benthic, and abyssal. Each zone contains a diversity of species, depending on the amount of salt, amount of available sunlight, mineral content, and the rate of flow of the water.

The second major biome is the desert, which covers about 20% of Earth's surface. Deserts are dry areas where there is less than 50 cm of rainfall each year. Deserts may be hot and dry, semiarid, coastal, or cold. Hot and dry deserts have extremes in temperature due to the low humidity. When it does rain, the rain is concentrated in short bursts followed by long periods with no rainfall. The soil is coarse and rocky. There are few plants (mostly cactus and other succulents), and the consumers are limited to small, water-efficient species such as insects, small birds, and rats.



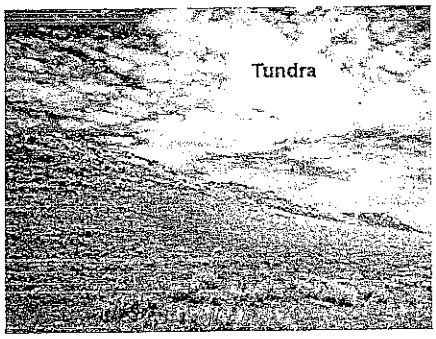
Semi-arid deserts may have up to 4 cm of rainfall a year. They experience fewer extremes in temperature, contain sand and other fine-textured loose soils, and support plants such as mesquite, bur sage, cat claw, and white thorn. Insects, lizards, snakes, owls, rabbits, and skunks make their home in this habitat. Coastal deserts are typically more moist (up to 37 cm of rainfall per year). The soil is porous with good drainage that supports plants with larger root systems and supports a wider diversity of plants and animals. Coyotes, badgers, toads, eagles, lizards, and snakes are found there. Cold deserts have the highest amount of rainfall (up to 46 cm), due to the large amount of snow and rain that falls throughout the long, cold winter. These deserts are usually found at high elevations or low latitudes. The soil is heavy and frequently salty. Plants are small and widely scattered. Small populations of jack rabbits, kangaroo rats, kangaroo mice, and small burrowing squirrels live there.

Forests are the third major biome. **Forests** occupy about 30% of Earth's land area. There are three major types of forest. They are classified by latitude and include the tropical rainforest, the temperate deciduous forest, and the taiga (boreal forest). The tropical rainforest occurs near the equator (23.5 degrees N latitude to 23.5 degrees S latitude); has about 12 hours of sunlight per day year round; is warm and humid; and receives more than 200 cm of rainfall per year (usually every day). The soil is acidic and is poor in nutrients. Large trees with deep roots compete for sunlight. The canopy is continuous and thick, so little light reaches the ground. Orchids, bromeliads, vines, mosses, fungi, and ferns thrive there. Many species of birds, bats, small mammals, and insects populate tropical rain forests.

Tropical Rain Forest

Temperate forests are found in the temperate zone. Rainfall is plentiful (75–150 cm per year), and the soil is fertile. Broadleaf (deciduous) trees and shrubs abound. Many species of mammals, insects, birds, and amphibians thrive in this habitat. The taiga or boreal forest is cold. Most of the precipitation falls as snow (40–100 cm per year). The soil is thin, acidic, and contains few nutrients. The taiga is an evergreen forest. Only hardy species of birds and mammals survive there.

The **tundra** is the coldest of all the biomes. It has extremely low temperatures, little precipitation (25–50 cm), poor nutrients, and short growing seasons. There is little diversity. Tundra plants are small and short-lived. Most of the nutrients are in the form of decaying organic matter.



Grasslands are regions that are dominated by grasses rather than large shrubs or trees. They have two seasons, rainy and dry. During the rainy season, grasslands receive between 50 and 90 cm of rainfall each year. Grasslands experience a wide range of temperatures and support a wide variety of large mammals such as elk, moose, lions, zebras, and elephants.