Consume or be consumed: breaking down the structure of a food web

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A food web is made up of all the food chains in a single ecosystem. Each living thing in an ecosystem belongs to many food chains. A food chain is a path that energy takes through a certain ecosystem.

Trophic Levels

Organisms in food webs are grouped into categories called trophic levels.

Producers

Producers make up the first trophic level. Producers, also known as autotrophs, make their own food and do not depend on any other organism for nutrition. Most autotrophs use photosynthesis to create food from sunlight, carbon dioxide and water.

Plants are the most familiar type of autotroph, but there are many other kinds. Algae are autotrophic. Some types of bacteria are autotrophs. For example, bacteria living in

active volcanoes use sulfur, not carbon dioxide, to produce their own food. This process is called chemosynthesis.

Consumers

The next trophic levels are made up of animals that eat producers. These organisms are called consumers.

Primary consumers are herbivores, who eat plants, algae and other producers. In a grassland ecosystem, deer, mice and even elephants are herbivores. They eat grasses, shrubs and trees. In a desert ecosystem, a mouse that eats seeds and fruits is a primary consumer. In an ocean ecosystem, many types of fish and turtles are herbivores that eat algae and seagrass.

Secondary consumers eat herbivores. They are at the third trophic level. In a desert ecosystem, a secondary consumer may be a snake that eats a mouse. In underwater kelp forests, sea otters are secondary consumers that hunt sea urchins as prey.

The next level is made up of tertiary consumers that eat secondary consumers. In the desert ecosystem, an owl or eagle may prey on the snake.

Top predators, also called apex predators, eat other consumers. Lions are apex predators in the grassland ecosystem. In the ocean, fish such as the great white shark are apex predators. In the desert, bobcats and mountain lions are top predators.

Consumers can be carnivores or omnivores.

Detritivores And Decomposers

Detritivores and decomposers make up the last part of food chains. Detritivores are organisms that eat nonliving plant and animal remains. For example, scavengers such as vultures eat dead animals.

Decomposers, like fungi and bacteria, complete the food chain by turning organic waste, such as decaying plants, into inorganic materials, such as nutrient-rich soil.

For example, grass in a forest clearing produces its own food through photosynthesis. A rabbit eats the grass and then a fox eats the rabbit. When the fox dies, decomposers such as worms and mushrooms break down its body, returning it to the soil where it provides nutrients for plants like grass.

Biomass

Food webs are defined by their biomass — the energy in living organisms. Autotrophs, the producers in a food web, convert the sun's energy into biomass. Biomass decreases with each trophic level. There is always more biomass in lower trophic levels than in higher ones.

Because biomass decreases with each trophic level, there are always more autotrophs than herbivores in a healthy food web. There are more herbivores than carnivores.

A healthy food web has an abundance of autotrophs, many herbivores and few carnivores and omnivores. This balance helps the ecosystem maintain and recycle biomass.

Every link in a food web is connected to at least two others. When one link is threatened, other links are weakened or stressed and the ecosystem's biomass declines.

The loss of plant life usually leads to a decline in the herbivore population. Plants can disappear due to drought, disease or human activity. Forests are cut down to provide lumber for construction. Grasslands are paved over for shopping malls or parking lots.

Bioaccumulation

Toxic chemicals increase with each level in the food web.

When an herbivore eats a plant or other autotroph that is covered in pesticides, for example, those pesticides are stored in the animal's fat. When a carnivore eats several of these herbivores, it takes in the pesticide chemicals stored in its prey. This process is called bioaccumulation.

Bioaccumulation happens in marine ecosystems, too. Runoff from urban areas or farms can be full of pollutants. Tiny producers such as algae, bacteria and seagrass absorb minute amounts of these pollutants. Primary consumers, such as sea turtles and fish, eat the seagrass. Predators, such as sharks or tuna, eat the fish. By the time people eat the tuna, it may have a large amount of bioaccumulated toxins in its body.

A pesticide called DDT (dichloro-diphenyl-trichloroethane) was a major reason for the decline of the bald eagle. In the 1940s and 1950s, DDT was used to kill insects that spread diseases. DDT built up in the soil and water. Worms, grasses, algae and fish took in the DDT. As a consequence, eagles and other apex predators preyed on fish and small mammals that were poisoned with DDT.

Birds with high amounts of DDT in their bodies lay eggs with extremely thin shells. These shells would often break before the baby birds were ready to hatch. The bald eagle population declined.

Today, the use of DDT has been restricted. Food webs, which include the bald eagle, have recovered in most parts of the country.

Fast Facts:

Lost Energy

Biomass shrinks with each trophic level. That is because between 80 and 90 percent of an organism's energy, or biomass, is lost as heat or waste. A predator consumes only the remaining biomass.

A Million To One

Marine food webs are usually longer than terrestrial food webs. Scientists estimate that if there are a million producers (algae, phytoplankton and sea grass) in a food web, there may only be 10,000 herbivores. Such a food web may support 100 secondary consumers, such as tuna. All these organisms support only one apex predator, such as a person.

Out For Blood

One of the earliest descriptions of food webs was given by the scientist Al-Jahiz, working in Baghdad, Iraq, in the early 800s. Al-Jahiz wrote about mosquitoes preying on the blood of elephants and hippos. Al-Jahiz understood that although mosquitoes preyed on other animals, they were also prey to animals such as flies and small birds.

Quiz

1 Which is the BEST explanation for how a secondary consumer differs from from a primary consumer?

(A) Primary consumers can make their own food, but secondary consumers cannot.

(B) Primary consumers are herbivores while secondary consumers can be carnivores or omnivores.

(C) Primary consumers can also be decomposers, but secondary consumers cannot.

(D) Secondary consumers provide more biomass in a food web than primary consumers.

2 Read the section "Biomass."

Which selection from the section suggests that one small change could disrupt an entire food chain?

(A) Food webs are defined by their biomass — the energy in living organisms.

(B) Because biomass decreases with each trophic level, there are always more autotrophs than herbivores in a healthy food web.

(C) When one link is threatened, other links are weakened or stressed and the ecosystem's biomass declines.

(D) Forests are cut down to provide lumber for construction. Grasslands are paved over for shopping malls or parking lots.

3 What would eventually happen to Bald Eagles if DDT was not restricted in its use?

(A) They would have found another food source to reduce their bioaccumulation of DDT.

(B) They would have had to produce more babies to make up for the ones that died.

(C) They would have continued to decline and perhaps eventually have become extinct.

(D) They would have moved to different ecosystems that did not contain DDT.

4 Read the conclusion below.

Apex predators must eat much more than consumers who are lower on the food chain in order to get the energy they need.

Which selection from the article provides the BEST support for the statement above?

(A) In the desert ecosystem, an owl or eagle may prey on the snake. Top predators, also called apex predators, eat other consumers. Lions are apex predators in the grassland ecosystem.

(B) In the ocean, fish such as the great white shark are apex predators. In the desert, bobcats and mountain lions are top predators. Consumers can be carnivores or omnivores.

(C) Primary consumers, such as sea turtles and fish, eat the seagrass. Predators, such as sharks or tuna, eat the fish. By the time people eat the tuna, it may have a large amount of bioaccumulated toxins in its body.

(D) Biomass shrinks with each trophic level. That is because between 80 and 90 percent of an organism's energy, or biomass, is lost as heat or waste. A predator consumes only the remaining biomass.

5 Why must there be more autotrophs than herbivores in an ecosystem?

(A) To maintain the biomass balance of the ecosystem.

(B) To insure their is enough food for apex predators.

(C) So decomposers will have enough organisms to break down.

(D) So bioaccumulation of pesticides and pollutants does not occur.

6 How does the author build understanding of food webs?

(A) The author describes the way that photosynthesis and inorganic materials combine to help plants grow.

(B) The author contrasts the jobs of producers and consumers living in marine and terrestrial food chains.

(C) The author provides anecdotes about scientists who have studied the food chain and how their work has changed over time.

(D) The author begins at the bottom of the food chain and describes each trophic level as well as the relationships between them.

7 Why are decomposers essential to a healthy food web and ecosystem?

(A) They help reduce bioaccumulation of pollution and pesticides.

(B) They return essential nutrients to the soil and water for producers to use.

(C) They maintain the biomass balance between producers and consumers.

(D) They eat apex predators, thus controlling their population.

8 What is the MOST likely reason the author included the information about bald eagles?

(A) to elaborate on the negative effects of bioaccumulation on the food chain

(B) to emphasize that people now do a much better job at protecting ecosystems

(C) to describe the causes of decreased numbers of disease-spreading insects

(D) to argue that further restrictions are needed on the use of pesticides