

Food Chain Game

By playing an outdoor tag game, students simulate the transfer of energy between organisms.

Grade Level: (K-4) 5-8

Subject Areas: Agriculture Education, English Language Arts, Mathematics, Science

Setting: Classroom and large playing area

Time:

Preparation: 50 minutes

Activity: 50 minutes

Vocabulary: Biomass, Carnivore, Chemical energy, Consumer, Decomposer, Food chain, Herbivore, Omnivore, Photosynthesis, Producer, Trophic

Major Concept Area:

- Energy flow in ecosystems

Getting Ready: Thread strings through the cups so students can tie them around their waists. Set up the playing field boundaries. Allow ample space for students to play tag, but not so much space that students will never encounter one another.

Objectives

Students will be able to:

- draw a simple food chain or web;
- explain why energy is “lost” at each successive link in a food chain; and
- diagram how energy flows and how nutrients cycle in a food chain.

Rationale

Understanding these concepts helps students recognize how energy flows through communities. It also helps students appreciate that the world around them depends on a continuous supply of energy.

Materials

- A sandwich or a photograph of a sandwich
- Cones or other objects to mark playing field boundaries
- Small, medium, and large cups, preferably each size a different color (one of each type per student)
- Two to three large bags of white popcorn
- Portable whiteboard and marker, or flip chart and marking pen
- String (optional)
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Background

“Hey, what’s for dinner?”

“Sunshine.”

“Sunshine?”

“Yes, sunshine.”

Almost everything you eat can be traced back through food chains to the sun. A food chain consists of a series of organisms in which the first organism is eaten by a second and the second is eaten by a third. During this process, nutrients and stored energy in the eaten organism are transferred to the organism that eats it.

Most of the food we eat comes from simple food chains derived from human-controlled agricultural ecosystems. For example, the beef we eat comes from a cow that ate corn. The corn received its energy from the sun. However, in natural ecosystems, a hawk may eat a snake that may have received its energy from a mouse, a frog, or a rabbit. If it ate a mouse, that mouse may have consumed seeds from any number of

plants. None of these food chains is exactly alike.

The food chain begins with producers, organisms such as green plants, that can make their own food. Through photosynthesis, producers convert solar energy to chemical energy—energy stored in the chemical bonds of the food. Of all the energy a plant receives from the sun, only about three percent is converted into chemical energy. (The amount of chemical energy varies depending on the plant species and the location of the plant.)

Plants are eaten by consumers, which are organisms that cannot make their own food. Herbivores are consumers that eat only producers. Consumers that prey on other consumers are called carnivores, or secondary consumers. If an animal can get its energy by ingesting either producers or consumers, it is an omnivore.

A food chain does not consist of a set amount of organic matter and stored energy being passed along like a baton from one organism to another. In reality, the baton gets smaller and smaller with each transfer through the trophic levels, or a position in a food chain that is comprised of organisms that share the same function in a food chain. When an herbivore eats a plant, it does not get all the energy the plant received from the sun. This decrease is because the herbivore may not eat all parts of the plant, and it may not be able to digest what it does eat. These undigested plant parts are excreted as waste. The same holds true for other organisms along the food chain.

Another reason why energy obtained by one organism isn't passed on in the food chain is because it is no longer available. Some energy has already been used by the first organism. A plant uses some of the energy it receives to grow and function. An herbivore uses its energy to grow, but also to look for food and escape predators. A predator (carnivore) uses large amounts of energy to chase after its food in addition to its regular life processes—breathing, digesting food, moving. The energy these organisms use eventually leaves their bodies in the form of heat.

The amount of energy that is transferred from one organism to the next varies in different food chains.

Generally, about ten percent of the energy from one level of a food chain makes it to the next. Because energy is lost with each successive link there must be enough stored energy in the organisms to allow for this loss and still have enough energy remaining for the consumers in the next level. In other words, the total biomass (organic matter) of the producers must be greater than the total biomass of the herbivores they support, and the total biomass of the herbivores must be greater than that of the carnivores. Because of this energy loss there are usually more producers than herbivores, and more herbivores than carnivores in an ecosystem.

What happens to the massive amount of organic material (and its stored energy) that is unconsumed or undigested? Decomposers such as bacteria and fungi, and small animals such as ants and worms, eat nonliving organic matter. Decomposers cycle nutrients back into food chains and the remaining stored energy in unconsumed matter is used and eventually dissipated as heat. Therefore, decomposers are an integral component of all ecosystems.

Food chains cycle nutrients within an ecosystem and provide the mechanism for energy to flow through the ecosystem. In natural ecosystems, these food chains have many alternate routes through which energy can flow, creating integrated, complex food webs. Through agriculture, humans have simplified food chains so the energy flow is more direct. It is very easy to trace almost anything you eat back to its original source of energy: the sun. So, what's for dinner? The sun, of course!



Procedure

Orientation

Ask students where humans get energy to grow and to function. They should know that our energy comes from food. Show a picture or describe the components of a sandwich, such as a hamburger. Challenge students to trace each food item in the sandwich back to the sun. Discuss how energy is being transferred from one organism to another and how each organism uses the energy it receives. Share the definition of a food chain (see **Background**). Review the process of photosynthesis, stressing how plants are able to convert the sun’s energy into chemical energy (stored energy in food). Tell students that they will be playing a game that simulates energy transfer in a food chain.

Steps

1. Ask students to list a simple food chain found in nature. Limit the organisms in the chain to a producer, a primary consumer (herbivore), and secondary consumer (carnivore). An example is corn > mouse > hawk.
2. Take the class outside and show them the small cups. Tell students the cups represent the producer—corn—in the food chain. Count out one cup for every two students in the class. Randomly place these cups throughout the playing field.
3. Point out the large bag of popcorn and indicate that it represents energy from the sun. Walk around to each plant and pour “sunlight” onto each cup. Be sloppy when you pour, allowing popcorn to spill around the cup, and do not try to fill the cups completely. Since the popcorn in the cup represents energy plants converted to make food, ask students, “What does the spilled popcorn represent?” Students should suggest that the popcorn is sunlight that missed the plant or that the popcorn is energy that the plant did not convert. Tell students that plants are able to use about three percent of the solar energy they receive to make food.
4. Divide the class into two groups of equal size. One group represents the herbivores—mice—and the other, carnivores—hawks. Copy the **Organism Tally** chart onto a flip chart or portable whiteboard. In “Beginning” under “Round 1,” record the number of producers (small cups) in the playing field and the number of herbivores and carnivores.
5. Give the herbivores the medium-size cups and the carnivores the large cups. The cup represents the organisms’ food needs. Students’ cups should be at least half-filled with popcorn for the organism they represent to survive. Ask students why the carnivores’ cups are bigger than the herbivores’. Discuss things such as energy needed to hunt food, size, growth rate, etc. NOTE: There are exceptions. Some primary consumers, such as shrews, need large amounts of energy for their size (mostly to make up for heat loss).
6. Discuss the rules of the game. The purpose is for the consumers to get enough energy (popcorn) to survive.

Organism Tally

Organisms	Number of Organisms			
	Round 1		Round 2	
	Beginning	End	Beginning	End
Carnivores				
Herbivores				
Producers				
Sun Energy				

- The herbivores start at one end of the playing field.
 - When the game begins, the herbivores go to the plants, take the energy (popcorn) from the plant and put it in their cups (they can only take popcorn that is in a cup). Taking the popcorn means that they ate the plant. They are trying to fill their cups to get enough energy to survive.
 - At the same time, the carnivores try to tag the herbivores. They can only get popcorn from herbivores.
 - Tagged herbivores empty their popcorn into the carnivores' cups and leave the game.
7. Each game should last about one or two minutes. Under the "End" column of the **Organism Tally** chart for "Round 1" record the number of producers, herbivores, and carnivores that survived (students with cups at least half-filled).
 8. Point out that many organisms were not able to survive because there wasn't enough energy. Help students identify reasons for insufficient energy. Reasons include not enough energy (popcorn) available at the beginning of the food chain (too few producers to convert solar energy to energy in food), and loss of energy by organisms (popcorn spilling out of their cups) when running around trying to get food. Remind the class that it takes energy to get energy and organisms use energy for other life processes. This energy eventually leaves the organism in the form of heat and is unavailable to the next organism in the food chain (see **Extensions** for ways to illustrate this energy loss).
 9. Discuss what changes to the game would have to be made to make the food chain more sustainable. Help students understand that because energy is lost at each link of the food chain, there needs to be enough energy at the beginning so that there is still enough energy remaining in the system after the necessary losses. Remind students of the budget. Emphasize that reducing the loss of energy at each link is not possible because animals can only digest certain portions of what they eat and they must use energy to get energy.
 10. Students should conclude that there must be more producers than primary consumers, and more primary consumers than secondary consumers. Ask students how many plants (small cups), primary consumers, and secondary consumers there should be at the beginning of the game. Record their suggestions in the chart in the column "Round 2" under "Beginning." Add

cups and arrange students accordingly.

NOTE: Make sure students understand that plants only get their energy from the sun. Once energy passes through a food chain it is lost as heat and cannot be reused (see **Extensions** for a way to introduce the role of decomposers in the food chain).

11. Play the game a second time to see if students' suggested changes allow for a more sustainable ecosystem. Record the number of survivors at the end of Round 2. If necessary, students can adjust the ratio and play again.

Closure

After the game, draw the simple food chain used during the game on the board. Discuss the number of producers, primary consumers (herbivores), and secondary consumers (carnivores) that worked best to achieve a sustainable ecosystem.

Ask students how to adjust the diagram to be more representative of energy transfer in a real ecosystem. For example, what other organisms eat corn? What else do hawks eat besides mice? Have students suggest additions to the food chain, creating a food web. Make sure that students note the many paths energy can travel in an ecosystem. Ask students what important component should be added to this food web to further complete it. Write the word "decomposers" along the bottom of the diagram. Draw arrows from all the organisms in the food web to the decomposers. Emphasize that organisms throughout the food chain use energy. For living organisms to use energy, the fuel (stored energy in food) is burned, and the energy ultimately leaves an ecosystem in the form of heat (students can touch their arm to feel this). Draw arrows to compare nutrient cycling and energy flowing through a food chain and have students draw their own food chains (see **Assessment**).

Assessment

Formative

- Did students follow the game directions?
- Were students able to explain why all the energy and nutrients from one organism in a food chain are not transferred to the next?
- Was the class able to suggest a good proportion of producers to consumers to help create a sustainable ecosystem?

Summative

Have students create a simple food chain or web showing how energy flows through the system and nutrients are cycled. Request that students use food chains commonly found in Wisconsin. If possible, they should state the biological community in which the food chain may be found. Make sure their food chain or web includes:

- representation of how energy enters a food chain (an arrow from the sun to a plant);
- nutrients being transferred from one organism to the next (arrows pointing from producers to primary consumers, from primary consumers to secondary consumers);
- energy being transferred from one organism to the next and also being unconsumed (energy arrows can be drawn in a different color, but they must follow the same path as the nutrient arrows); and
- energy leaving organisms as heat when it is used for life processes (wavy arrows leaving each organism, including decomposers, and traveling upward away from the ground).

Extensions

Play the game again with one or more of the following variations:

- Add a tertiary level consumer that eats the secondary consumer, or an omnivore that eats the producers and consumers.
- Introduce a competitor organism (a caterpillar that competes with the mouse for corn).
- Introduce organisms that, for their size, use energy more quickly for growth and metabolism (for example, a shrew rather than a mouse in a farm field food chain) and therefore must obtain more energy in order to survive.

To illustrate energy loss, tell students who were able to get enough food to dump out half of their popcorn. The remaining popcorn represents the energy from the eaten organism that was actually utilized. The popcorn that was dumped represents energy loss through heat and food

material that wasn't eaten or that passed through the animal's digestive system.

To introduce the role of decomposers, after playing the game, point out that many of the small cups (producers) are empty and that there is popcorn scattered all over the playing field. Some of this popcorn should come from spills and rejected kernels the consumers could not use. Ask students what happens to plant and animal material such as leaf litter and animal waste left on the ground in ecosystems. Help students realize that decomposers break down unconsumed organic matter, returning nutrients to the soil. The energy in the organic matter is used by the decomposers and is eventually lost as heat. Stress the importance of decomposers in cycling nutrients.

Encourage students to format their illustration of a food web into a pyramid shape. The pyramid should show that there are more producers than herbivores, and more herbivores than carnivores. Emphasize that the size of the pyramid level represents stored energy that is available within that level.

Related KEEP Activities

Prior to this activity, students should understand that living organisms get their energy from food (see "Energy from Food"). To help students see that energy is stored in food, you may want to demonstrate how food can be burned (see "Roasted Vittles"). Have students participate in "Energy Use in an Ecosystem" to investigate energy flow through biological communities in their school yard. K-5 Energy Sparks for Theme II: "Sunvestigations" identifies ways for students to investigate how plants need the sun's energy to survive and enables students to trace their food back to the sun.

Credits

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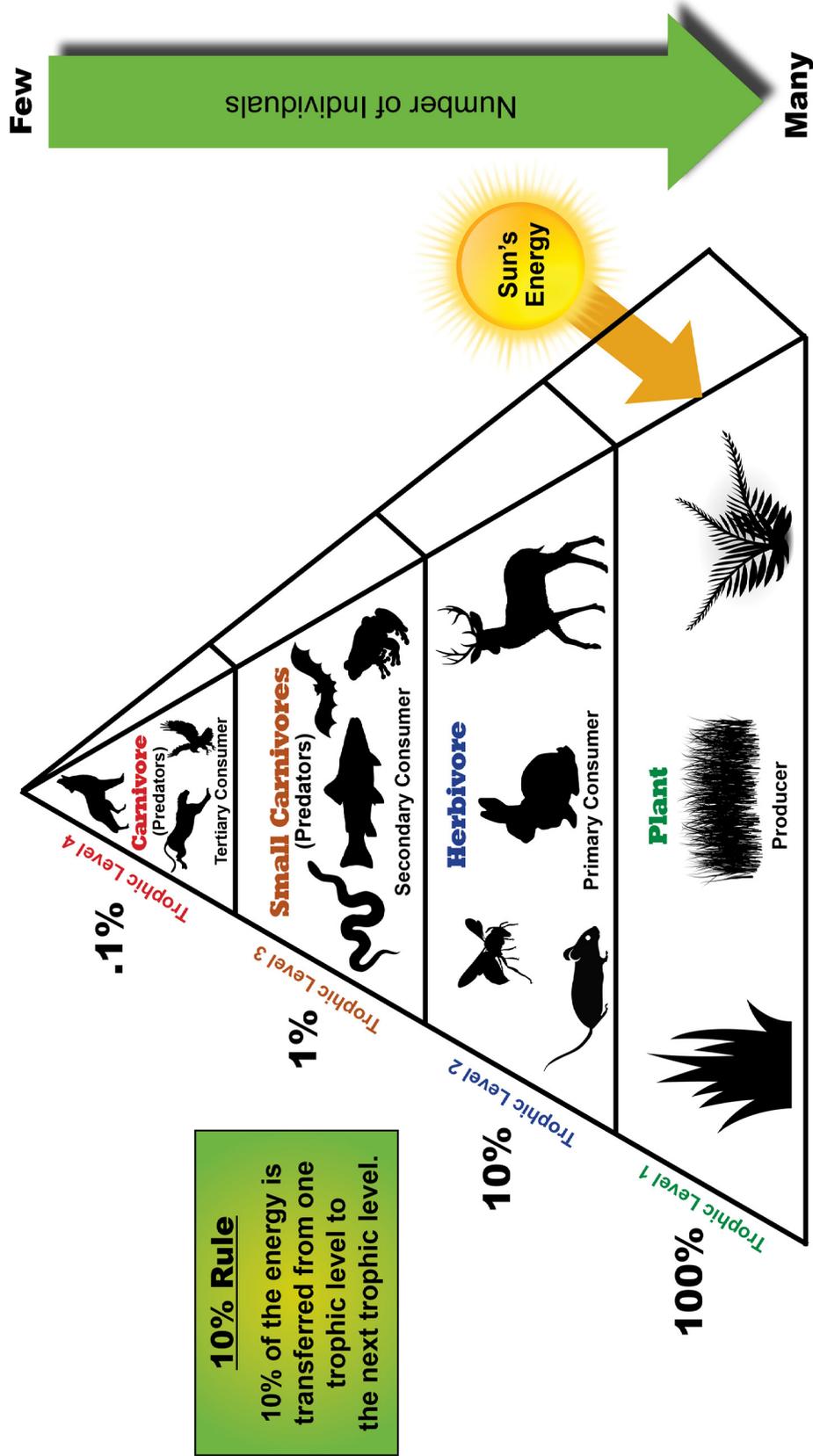
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Energy Pyramid



10% Rule
 10% of the energy is transferred from one trophic level to the next trophic level.