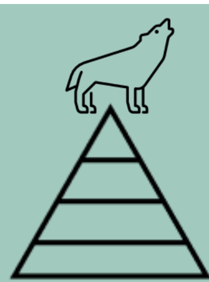
Photosynthesis Promenade & Food Chain Game



Summary:
By participating in physical activities, students will simulate the process of photosynthesis and transfer of energy between organisms.

Activity 1: Photosynthesis Promenade

Objective
Students will be able to illustrate how plants use the sun's energy to make food.

Rationale
Understanding the process of photosynthesis is important because almost all living things depend on plants for food. Photosynthesis also produces oxygen. It also helps students appreciate the plants growing around them.

Materials **(K)**=materials in DEN Kit
- Picture or drawing of a rabbit **(K)**
- Growing plants that have turned their leaves towards the sun (optional)
- Fruits and vegetables for students to taste (optional)
- Photographs of magnified leaf cells showing chlorophyll (optional)
- Flashlight (or yellow Sun name tag) **(K)**
- Colored name tags for students **(K)**
    - Chlorophyll = green
    - Water = blue
    - CO_2 = purple
    - Sugar = pink
    - Oxygen = white
- Diagram of Photosynthesis **(K)**
- **Photosynthesis student sheet (S1)**

Background
Photosynthesis is the process by which green plants use sunlight to produce **carbohydrates,** such as **glucose,** and **oxygen** from simple compounds such as water and **carbon dioxide**.

In energy terms, photosynthesis converts **solar energy** into **chemical potential energy** that is stored in plants as carbohydrates.

Photosynthesis occurs when water is absorbed by the roots of the plant and is then carried to the leaves. Carbon dioxide enters the plant through the leaves and goes into the plant cells that contain **chlorophyll**. Chlorophyll is the green pigment found in **chloroplasts**, the special structures in plant cells that perform photosynthesis.

During photosynthesis, plant cells gives off oxygen and take in carbon dioxide. When people breathe, they take in oxygen and give off carbon dioxide. This makes photosynthesis a great example of how people and plants depend on each other.

Procedure
Steps for Educators
1. Ask a volunteer to share what they ate that day or the previous day. Write the student's name on the board and with all the things the student ate around it. Pick one of the foods the student ate (preferably a fruit or vegetable) and discuss with the class where that food came from. For example, if the student lists an apple, draw an apple tree on the board. Then ask students what the apple tree needs to grow. As students list things add them to the board as well. Make sure students don't forget the sun.

Grade Level: 4-8

Subject Areas: Science, Environmental Literacy, Agriculture Education

Setting: Classroom and large playing area (outdoors or indoors)

Time:
Preparation: 30 minutes (15/activity)
Activity: two 50-minute periods

Vocabulary: Atom, Carbohydrate, Carbon dioxide, Chemical potential energy, Chlorophyll, Chloroplasts, Glucose, Oxygen, Photosynthesis, Solar energy, Molecule Carnivore, Biomass, Carnivore, Consumer, Decomposer, Ecosystem, Food chain, Herbivore, Omnivore, Producer, Trophic level

Major Concept Areas:
- Energy flow in living systems
- Energy flow in ecosystems

Connections to Standards:
Wisconsin Standards for Science
- CC2: Cause and Effect
- CC4: Systems and Models
- CC5: Energy and Matter
- CC7: Stability and Change
- SEP2: Using Models
- SEP4: Analyzing and Interpreting Data
- SCI.LS1.C: Organization for Matter & Energy Flow in Organisms
- SCI.LS2.A: Interdependent Relationships in Ecosystems
- SCI.LS2.B: Cycles of Matter & Energy Transfer in Ecosystems
- SCI.LS2.C: Ecosystem Dynamics, Functioning, and Resilience
- SCI.PS3.D: Energy in Chemical Processes & Everyday Life

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Connections to Standards:

Wisconsin Standards for Environmental Literacy and Sustainability

- Connect; Standard 1
- Explore; Standards 2, 4 & 5
- Engage; Standards 6 & 7

Getting Ready:

Educators:

Photosynthesis Promenade

Prepare an area to be the LEAF of the plant. Be sure to identify where the stem is. Gather and prepare materials for the activity.

Food Chain Game

Set up the playing field. Allow ample space for students to play tag, but not so much space that students will never encounter one another. Gather and prepare materials for the activity including the flip chart.

Related KEEP Activities:

Prior to these activities, students should understand that living organisms get their energy from food. Consider using KEEP's activity, Energy from Food https://www3.uwsp.edu/cnr-ap/KEEP/Documents/Activities/EnergyFromFood.pdf

To help students understand that energy is stored in food, you may want to demonstrate how food can be burned using KEEP's activity, Roasted Vittles: https://www3.uwsp.edu/cnr-ap/KEEP/Documents/Activities/RoastedVittles.pdf

Have students participate in KEEP's activity, Energy Use in an Ecosystem: *add link*

2. Show students a picture of a rabbit and ask students to complete a food chain around the rabbit. Discuss that a **food chain** shows how each living organism gets its energy from the sun or from eating other living (or once living) organisms. For example, they might show the rabbit eating a carrot that gets its energy from the sun and list a predator, such as a hawk, that eats the rabbit.
3. Have students explain what is happening between the links of the food chain, starting between the predator and the prey. They will probably be able to describe how the hawk eats the rabbit and the rabbit eats carrots, but how do they explain the connection between the sun and the carrot (or any plant)?
4. Ask students how they know plants need sunlight. Have students share their observations and thoughts. For example, ask students if they have noticed how some plants turn their leaves toward the light. *Optional*-Point this out on plants in your learning space.
5. Ask students if they know how plants use the sunlight. Allow them to share their thoughts. Ask them if they have heard the word **photosynthesis**. If they don't know what it is, help them identify the root words **photo** (light) and **synthesis** (to make). See if they can use what they know to make a definition for photosynthesis. The goal is to use water, air, sun, sugar and oxygen in the definition.
6. Explain to students **photosynthesis** is a chemical process where plants use energy from the sun to produce **glucose** (sugar) and oxygen from water and **carbon dioxide**. Explain that this process takes **solar energy** and turns it into **chemical potential energy** (carbohydrates/sugars stored in plants). If you have brought in samples of fruits and vegetables, have students taste them now. Explain that the flesh they are eating are the carbohydrates/sugars the plants made through the process of photosynthesis.
7. Tell students that they are going to participate in a simulation to help them understand the process of photosynthesis.
8. Identify one student to be the sun and give them the flashlight (or yellow sun card). The sun should stand outside the leaf.
9. Identify 1-3 students to be **chlorophyll** and give them the green chlorophyll cards and the pink (sugar) and white (oxygen) cards. Chlorophyll will stand inside the leaf.
   Explain that plants are green because they contain a chemical called chlorophyll that helps the plant use sunlight to make sugar out of water and carbon dioxide.

Explain that the chlorophyll is found in **chloroplasts** which are structures within plant cells responsible for photosynthesis. If available, show the students an image of a magnified leaf cell with chlorophyll.

10. The remaining students should be divided evenly into pairs of carbon dioxide and pairs of water and given the corresponding cards. You need at least 2 participants to be carbon dioxide and 2 participants to be oxygen. If you have a very small group you can have only 1 student be chlorophyll and you can take on the role of the sun.

Steps for Students

Physical Activity

See diagram on next page for assistance.

11. The **sun** stands outside the leaf and shines the flashlight on the leaf.
12. **Water** partners enter the leaf through the stem and separate when **chlorophyll** tags them.
13. **Carbon dioxide** partners enter the leaf through a leaf edge and separate after **chlorophyll** tags them.
14. **Chlorophyll** inside the leaf tags water and carbon dioxide partners causing them to separate. **Chlorophyll** then regroups water and carbon dioxide partners into new groups of 1 and 3. Groups of 1 are given an oxygen card. Groups of 3 are given a sugar card.
15. Sugar groups remain stored in the leaf.
16. Oxygen partner with another oxygen and exit the leaf together (as a molecule).
17. Repeat the simulation a few times then take on new roles and repeat again.

Closure/Reflection

Ask students to think about the process of photosynthesis as if it were a math equation. Have them think about it independently and try to write out what it might look like on a piece of paper or in their notebook. Give students a hint that it should be an addition equation.

Ask students to share their equation with a peer(s) and discuss differences if there are any and rewrite their equations if needed. Ask groups if anyone wants to volunteer to share their equation on the board. Once the equation is written on the board, go over it with students to check and see if it includes all the parts of photosynthesis, if chemical formulas aren't included in the equation, add them.

- Sun
- Carbon dioxide (CO_2)
- Water (H_2O)
- Glucose (sugar) ($C_6H_{12}O_6$)
- Oxygen (O_2)

By the time you are done, you should have the following equation written:

$$\text{Sun} + CO_2 + H_2O = C_6H_{12}O_6 + O_2$$

If you are working with students who have not done a lot of work with math equations, stop here and share the **Photosynthesis Student Sheet (S1)** with students.

Credit:

Food Chain Game

Adapted from University of California at Berkeley, Outdoor Biology Instructional Strategies (OBIS) *Food Chain Game*. Hudson, New Hampshire: Delta Education and the Regents of the University of California, 1970. Used with permission. All rights reserved.

Updated by KEEP staff, May 2023.

If you are working with students who have experience working with math equations, ask them if they think there is anything left to do with the equation. If needed, give them a hint…ask them if they have the same number of oxygen atoms on each side of the equation.

Explain to students that equations must always be balanced (have the same number of each type of atom on both sides of the equation). Model the process of balancing the equation for students if you know how. If not, simply count the number of each atom on both sides of the original equation to show that it is not balanced.

$$\text{Sun} + CO_2 + H_2O = C_6H_{12}O_6 + O_2$$

2C, 3O, 2H = 6C, 12H, 8O

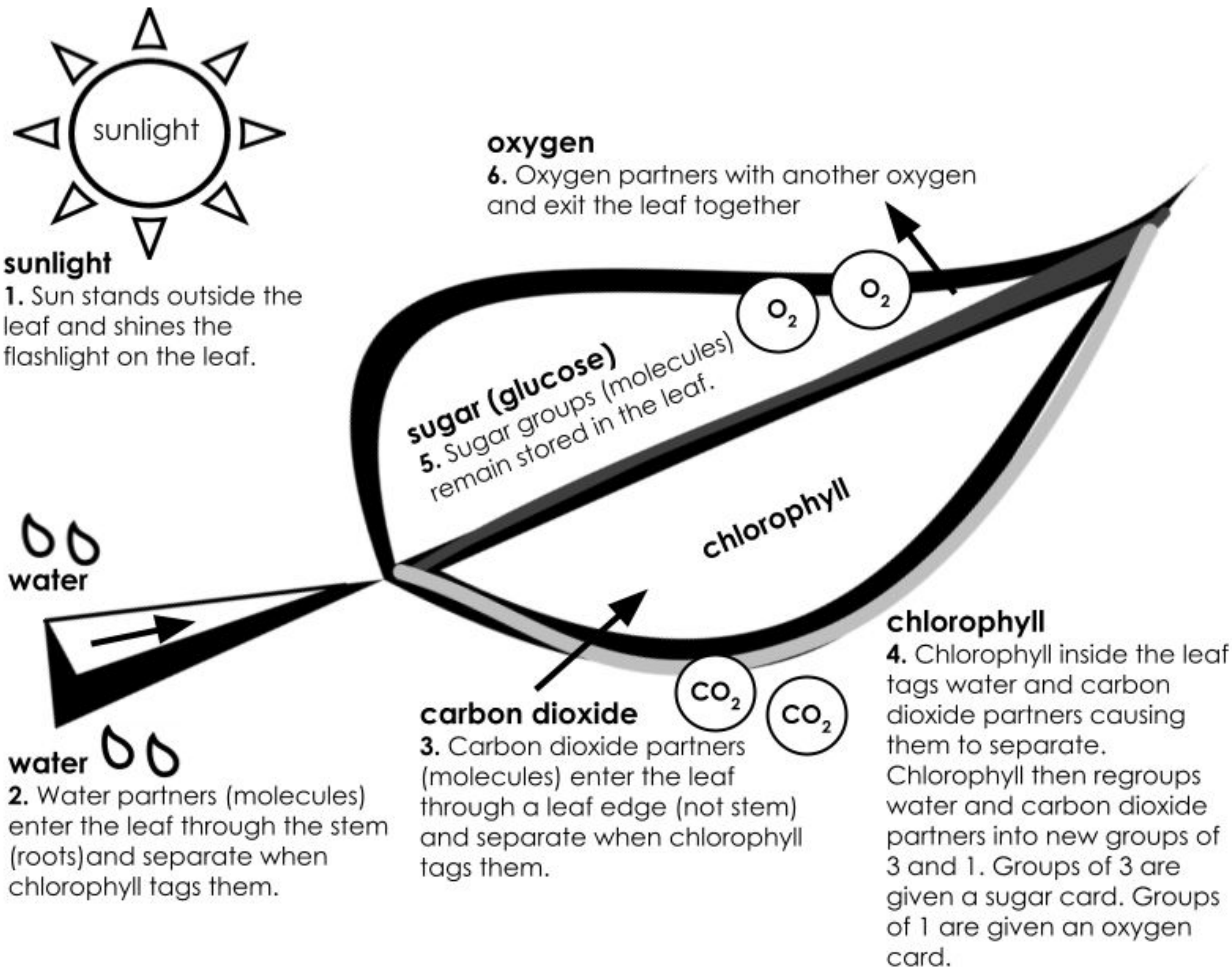
Then share the balanced equation and count the number of each atom on both sides of the equation to show it is balanced.

$$\text{Sun} + 6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$$

6C, 18O, 12H = 6C, 18O, 12H

Share the **Photosynthesis Student Sheet (S1)** with students.

Diagram for Photosynthesis Promenade



Recommended student numbers for simulation:

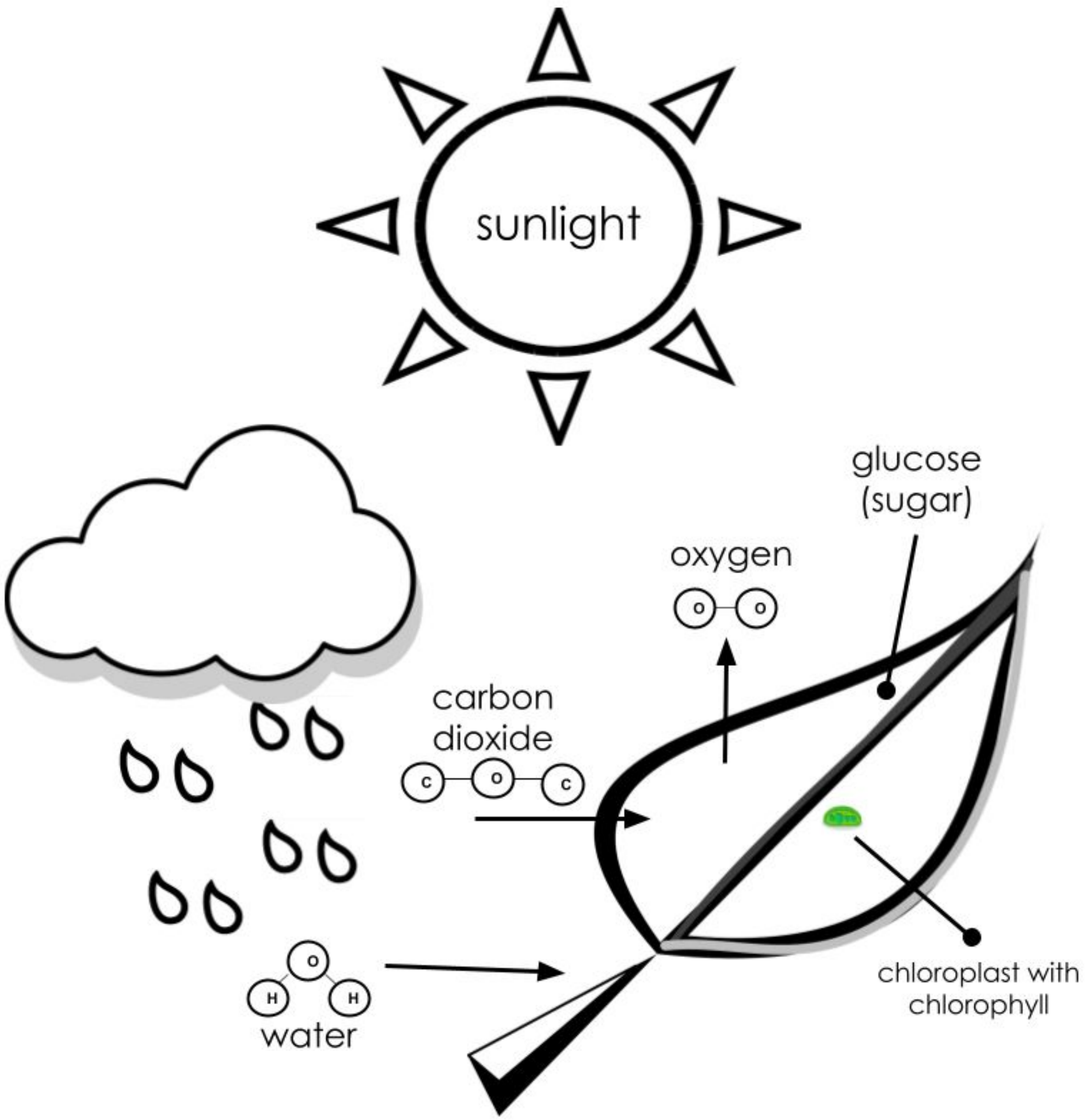
- Sunlight (1)
- Chlorophyll (1-3)
- Water (minimum 2, preferably even number)
- Carbon dioxide (minimum 2, preferably even number)
- Most students should be water and carbon dioxide.

Student Sheet
Photosynthesis

PHOTOSYNTHESIS

$$\text{Sunlight} + 6CO_2 + 6H_2O = C_6H_{12}O_6 + 6O_2$$

carbon dioxide + water = glucose + oxygen



Photosynthesis Promenade & Food Chain Game

Activity 2: Food Chain Game

Objective

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
- diagram how energy flows and how nutrients cycle in a food chain
- Explain potential impacts of climate change on food chains/food webs
- Explain how human eating habits can either contribute to climate change or be a climate solution

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 **(K)**=materials in DEN Kit

- Picture of a sandwich **(K)**
- Cones or other objects to mark playing field boundaries
- Small (~5-6-oz) cups; 1 cup/2 students **(K)**
- Medium (~9-12 oz) cups; 1 cup/2 students **(K)**
- Large (~16-18 oz) cups; 1 cup/2 students **(K)**
- Two-three large bags of popped corn (outdoors) or cotton balls (indoors)**(K)**
- Energy Pyramid **(K)**
- Flipchart paper with copy of Organism Tally Chart and marking pen

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. An **ecosystem** consists of species in a biological community interacting with each other and with the physical and chemical factors that make up their environment. 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 are **autotrophs**, organisms 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.)

Producers are eaten by **consumers**, which are **heterotrophs,** 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 defined 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, reproducing. (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 **trophic 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** from the background information. Review the process of **photosynthesis**, stressing how plants are able to convert the sun's energy into chemical energy (stored energy in food). Refer to the Energy Pyramid diagram. Tell students that they will be playing a game that simulates energy transfer in a food chain.

STEPS FOR EDUCATORS

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 berries > snowshoe hare > hawk. Use the background information to help you review the definitions of the vocabulary words in bold.
2. Take the class outside and show them the small cups. Tell students the cups represent the producer - corn - in the food chain. Use one cup for every two students in the class. Randomly place small cups throughout the playing field.
3. Point out the large bag of popped corn and indicate that it represents energy from the sun. Walk around to each small cup (**producer**) and pour "sunlight" onto each cup. Be sloppy when you pour, allowing popped corn to spill around the cup. Do not fill the cups completely. Since the popped corn in the cup represents energy plants converted to make food, ask students, "What does the spilled popped corn represent?" Students should suggest that the spilled popped corn is sunlight that missed the plant or that the popped corn is energy that the plant did not convert into food. 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** (primary consumer) - snowshoe hare - and the other, the **carnivores** (secondary consumer) - hawks. Copy the Organism Tally Chart onto a flip chart. 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. All students will start with empty cups. By the end of each round of play, students' cups need to be at least half-filled with popped corn 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 with students.

STEPS FOR STUDENTS (GAME)

7. The purpose is for the consumers to get enough energy (popped corn) to survive.
8. The herbivores start at one end of the playing field and the carnivores at the other end.
9. When the game begins, the herbivores go to the plants, pour the energy (popped corn) from the plant into their cups (they can only take popped corn that is in a cup). Taking the popped corn means that they ate the plant. They are trying to fill their cups to get enough energy to survive.
10. At the same time, the carnivores try to tag the herbivores. They can only get popped corn from herbivores.
11. Tagged herbivores empty their popped corn into the carnivores' cups and leave the game.

AT THE END OF EACH ROUND

12. The game should last one or two minutes. Under the "End" column on the **Organism Tally Chart** for "Round 1" record the number of producers, herbivores, and carnivores that survived (students with cups at least half-filled). Play 2-3 games this round; record results of each game in additional rows. Discuss the questions on the Tally Chart.
13. 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 (popped corn) 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 (popped corn 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.
14. 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 level 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 level is not possible because animals can only digest certain portions of what they eat and they must use energy to get energy.
15. Students should conclude that there must be more producers than primary consumers, and more primary consumers than secondary consumers. Ask students how many producers (small cups), primary consumers (medium cups) and secondary consumers (large cups) 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 and that once energy passes through a food chain it is lost as heat and cannot be reused.

MODIFY THE GAME

16. Play the game a second time to see if students' suggested changes allow for a more sustainable ecosystem. Play 2-3 games and record the number of survivors at the end of each game. Discuss how the results changed.
17. Add an omnivore that is also a tertiary consumer, like a fox. Keep the original number of producers (sm cups - 1 cup per 2 students). Have ½ students be Herbivores (med cups), ¼ be Carnivores (lg cups, and ¼ be Omnivores (lg cups). Record this as Round 3.

Photosynthesis Promenade & Food Chain Game

ADD A CLIMATE SCENARIO

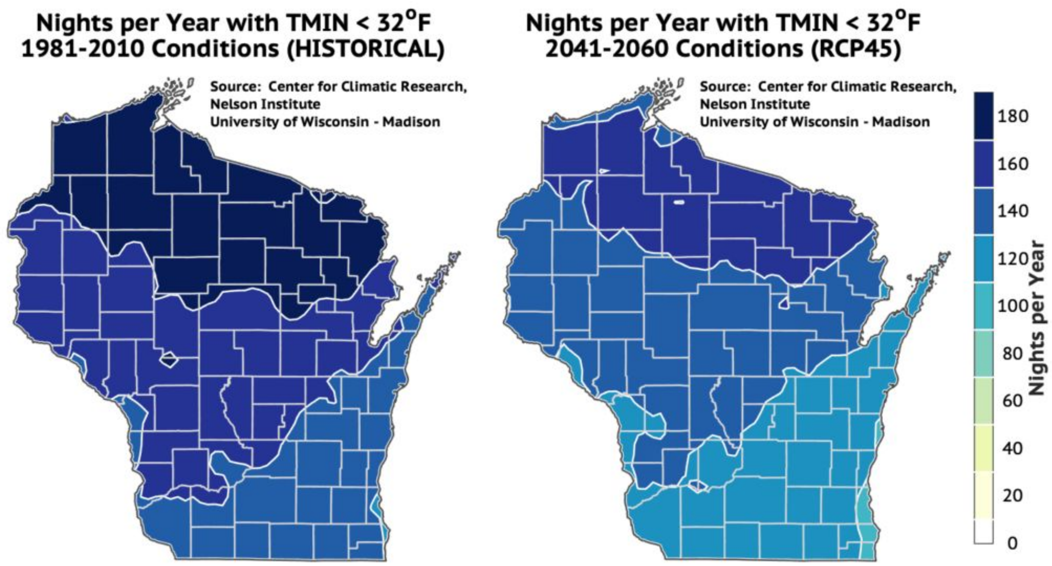
18. The population of the snowshoe hare is strongly linked to snow cover. The range of the snowshoe hare includes most of the northern half of the state of Wisconsin. What does the temperature need to be for precipitation to fall as snow (and remain on the ground as snow)? *(Answer: 32°F)*

The map at the immediate right shows the historical data of number of nights per year with a minimum temperature below 32°F. Historically, how about how many nights per year was the minimum temperature below 32°F for most of Northern Wisconsin? *(Answer: 180 nights per year between 1981-2010)*

The map at the far right shows the projection for the number of nights per year with a minimum temperature below 32°F. What is the projected number of nights below 32°F for most of northern Wisconsin in 2041-2060? *(Answer: 140-160 nights per year between 2041-2060)*

What is the projected trend for the number of nights with temperatures below freezing for most of Northern Wisconsin? *(Answer: The number of nights below freezing in N WI is projected to decrease by 20-40 nights.)*

How do you think this will impact snow cover in most of Northern Wisconsin? *(Answer: Less nights below freezing in N WI will decrease the winter snowpack.)*



Maps created by Nelson Institutes Center for Climatic Research, University of Wisconsin - Madison
Maps published on the WICCI site: https://wicci.wisc.edu/wisconsin-climate-trends-and-projections/

How do you think the projected decrease in nights below freezing and resulting decrease in snowpack will impact the snowshoe hare? *(Answer: The snowshoe hare will have a more difficult time surviving and their numbers may decrease over time.)*

How could a declining population of snowshoe hares impact food chains/ecosystems?

Play round 4 of the food chain game to see. Keep the original number of producers (sm cups). Divide students so ⅓ are snowshoe hares (herbivores, med cups) ⅓ are hawks (carnivores) and ⅓ are fox (omnivores) (large cups). Record your data.

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CLOSURE/REFLECTION

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 food chain/ecosystem during the game.

Ask students how we could adjust the diagram to be a more accurate representation of a real ecosystem. For example, what other organisms eat berries? What else do hawks eat besides snowshoe hares? Turn the food chain into a food web and show the paths that energy can travel from one being to another in the food web. At the very bottom of the food web write the word **decomposers**. Draw arrows from all organisms in the food web to the decomposers.

Emphasize that organisms in a food chain/ecosystem use energy. For living organisms to use energy, the fuel (stored energy in food) is burned and the energy ultimately leaves the ecosystem in the form of heat.

Ask students to think about the ways in which humans can impact food chains/ecosystems. Listen to their answers, share some of these ideas if they struggle to come up with their own.

- Climate change is caused by humans and impacts animals (warmer temperatures, more rainfall, more large rainfall events)
- Hunting/fishing/gathering
- Deforestation
- Transfer of invasive species
- Planting new plants/trees in deforested areas
- Reintroducing animals that were previously removed/ missing from an ecosystem.

Ask students to think about solutions we can implement to minimize human impact on food chains/ecosystems. Listen to their answers, share some of these ideas if they struggle to come up with their own.

- Climate change
    - We can choose to eat lower on the food chain (producers/ plants). This maximizes energy use and minimizes energy loss. We also use fewer fossil fuels in the production of plants vs animals.
    - We can reduce food waste. Throwing away food is throwing away stored energy. Food waste will be broken down by bacteria and produce methane (a greenhouse gas like CO_2)
- Hunting/fishing/gathering
    - Follow regulations related to season and limits and encourage others to do so
    - Support conservation organizations
- Deforestation
    - Consume less
    - Implement sustainable forest management practices
    - Purchase goods from places that practice sustainable forest management
    - Reduce meat consumption
- Transfer of invasive species
    - Prevention
    - Educate ourselves
    - Educate others
    - Clean boots and boats
    - Don't move living organisms from one place to another

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. Request that students use food chains commonly found in Wisconsin. If possible, they should investigate (and share) the biological community in which the food chain may be found.

Food chains/webs should include:

- 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)
- 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).

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Extensions

Include additional variations in the game:

- Add a tertiary level consumer that eats the secondary consumer, or an omnivore that eats the producers and consumers.
- Introduce a competitor organism that competes with the herbivore.
- Introduce organisms that, for their size, use energy more quickly for growth and metabolism and therefore must obtain more energy in order to survive. (i.e. hummingbirds)

To illustrate energy loss, tell students who were able to get enough food to dump out half of their popped corn. The remaining popped corn 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 an animal material such as leaf litter and animal waste left on the ground in ecosystems.

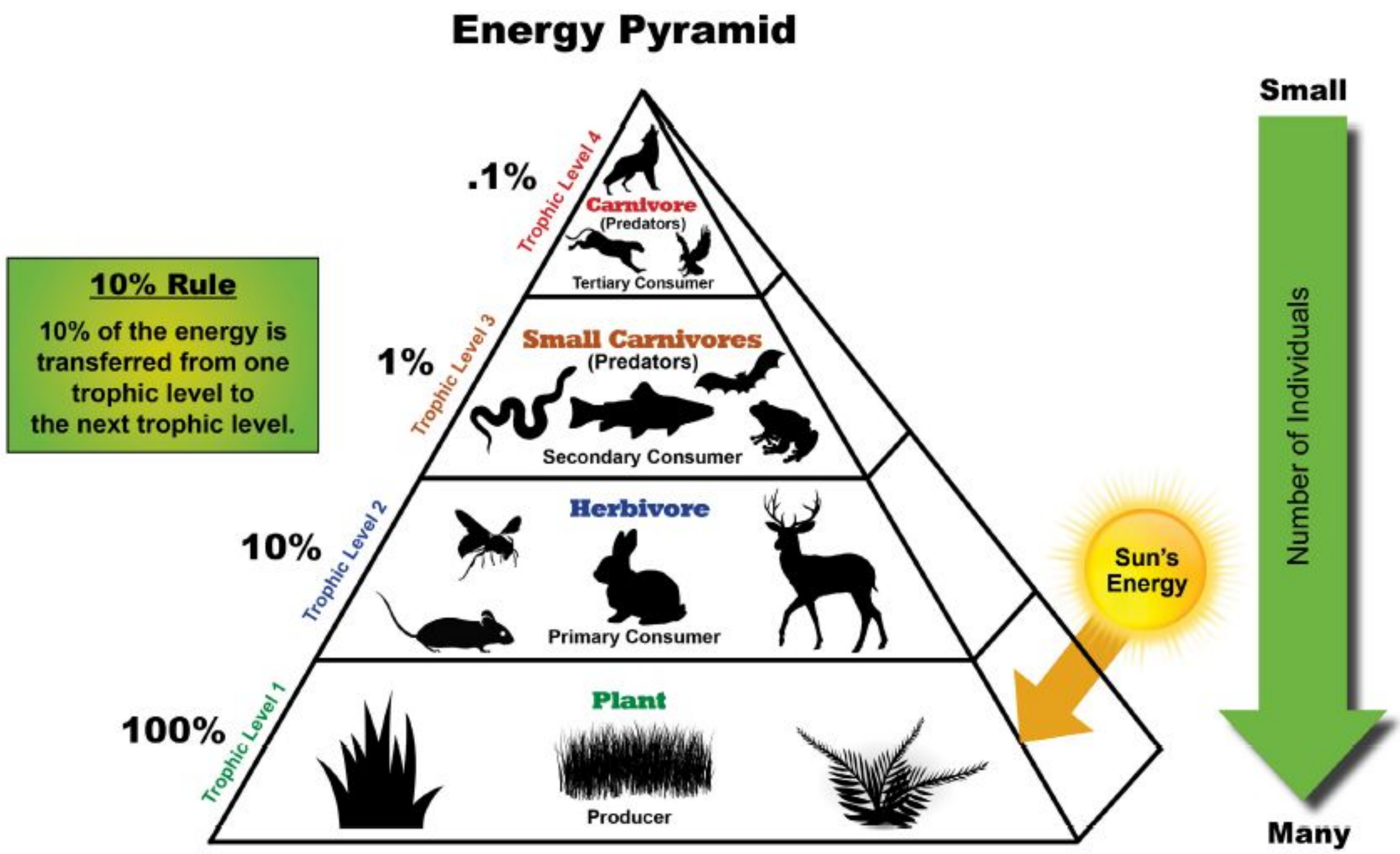
Help students realize that decomposers break down unconsumed organic matter, returning nutrients to the soil. The energy in the organic matter is used by the decomposers and is eventually lost as heat. Stress the importance of decomposers in cycling nutrients.

North American Association of Environmental Educators (NAAEE) Environmental Education Materials: Guidelines for Excellence

KEEP strives to create lessons that meet the NAAEE Environmental Education Materials: Guidelines for Excellence. This lesson meets the following guidelines under the six key characteristics of high-quality environmental education instructional materials.

- 1.1 Accurate
- 2.1 Thinking and process Skills
- 2.4 Skills for addressing environmental challenges and opportunities
- 3.1 Awareness
- 3.2 Focus on concepts
- 3.3 Concepts in context
- 4.1 Sense of personal stake and responsibility
- 5.1 Learner-centered instruction
- 5.2 Different ways of learning
- 5.3 Connections to learners' everyday lives
- 5.4 Expanded learning environment
- 5.4 Expanded learning environment
- 5.5 Equitable and inclusive learning environment
- 5.6 Interdisciplinary
- 5.7 Goals and objectives
- 5.8 Appropriateness for specific learning settings
- 5.9 Assessment
- 6.1 Clarity and logic
- 6.2 Easy to use
- 6.3 Long lived
- 6.4 Adaptable
- 6.5 Accompanied by instruction and support
- 6.6 Make substantiated claims

Photosynthesis Promenade & Food Chain Game



Photosynthesis Promenade & Food Chain Game

Organism Tally Chart

Organisms	Number of Organisms							
	Round 1		**Round 2**		**Round 3**		**Round 4**	
	Original Scenario Berries>hare>hawk		Student Suggestion		Omnivore (fox) Tertiary Consumer		Climate Scenario	
	2Prod :1Herb :1Carn				3Prod :1Herb :1Carn :1Omni		2Prod :1Herb :1Carn :1Omni	
	Start	**Finish**	**Start**	**Finish**	**Start**	**Finish**	**Start**	**Finish**
Omnivores Tertiary Consumers (Heterotrophs) **C**	x	x						
	x	x						
	x	x						
Carnivores Secondary Consumers (Heterotrophs) **C**								
Herbivores Primary Consumers (Heterotrophs) **H**								
Producers (Autotrophs) **P**								

Discussion prompts after each Round:

1. How did the number for each organism change from start to finish?
2. Describe the energy transfer between organisms in this game/round.
3. Explain why you think the numbers changed and what it might represent in nature.
4. Do you think the change in numbers during the game is similar to what we would observe in nature? Explain.