LESSON 4
Ecosystem Extravaganza

BIG IDEAS
- Ecosystem structure consists of different types of organisms (i.e., producers, consumers, decomposers) interacting with one another and their environment. Humans are part of ecosystems. (Subconcept 11)
- Ecosystem functions include the fixation of energy through the process of photosynthesis, the flow of energy through food chains and food webs, and the cycling of matter. (Subconcept 12)

OBJECTIVES
Upon completion of this lesson, students will be able to:
- Describe how consumers relate to producers.
- Summarize the major functions of an ecosystem, including:
  - Energy fixation through photosynthesis
  - Energy flow through food chains and food webs
  - Cycling of matter

SUBJECT AREAS
Language Arts, Mathematics, Science

LESSON/ACTIVITY TIME
- Total Lesson Time: 120 minutes
- Time Breakdown:

Introduction.....5 minutes
Activity 1 .....25 minutes
Activity 2 .....30 minutes
Activity 3 .....30 minutes
Conclusion.....30 minutes

TEACHING SITE
Classroom

NUTSHELL
In this lesson, students learn about ecosystem functions and the types of organisms found in ecosystems. Students complete a diagram of photosynthesis and use calculations to follow the flow of energy through producers, consumers, and decomposers. Students read to learn about the cycling of matter and create their own diagrams of the processes.

BACKGROUND INFORMATION
ECOSYSTEMS
An **ecosystem** is a community of living organisms interacting with one another and with the nonliving things that make up their environment. Ecosystems can be of any size. An ecosystem can be a pond, prairie, forest, or just a drop of water, as long as there are living and nonliving things interacting.

LIVING ORGANISMS
The organisms that make up the living (biotic) component of an ecosystem can be classified by their feeding status. They are either **producers** or **consumers**.

Producers are organisms that can manufacture their own food. Plants are producers. They produce their own food energy through **photosynthesis**.

Consumers are organisms that get the food energy they require by eating producers or other consumers. Some consumers feed on living plants and animals, and others feed on dead plant and animal matter. Consumers can be labeled based on the level at which they feed.

- **Primary consumers** eat producers.
- **Secondary consumers** eat other consumers.

The consumers that feed on both producers and consumers when they die are called **decomposers**. These organisms include beetles, ants, fungi, and bacteria that help break down leaf litter, dung, and other material into nutrients that can again be taken up by plants. It is because of the important job that decomposers do, that they are often listed with producers and consumers as one of the major types of organisms in an ecosystem.

Consumers can also be labeled by the kind of food they eat.

- Herbivores are plant eaters. Some examples of herbivores in a forest are deer, rabbits, grasshoppers, and gray squirrels.
- Carnivores are meat eaters. Some examples of carnivores in a forest are snakes, spiders, and wolves.
- Omnivores can eat both plants and other animals. Examples of omnivores in a forest are bears, people, foxes, and raccoons.
- Scavengers, detritivores, and decomposers all eat dead matter.

ECOSYSTEM FUNCTIONS

Ecosystems have many functions. These functions include the fixation of energy (photosynthesis), energy flow through food chains and food webs, and the cycling of matter.

PHOTOSYNTHESIS

Plants convert sunlight from radiant energy to chemical energy through a process called photosynthesis. Chlorophyll is an important molecule in this process. This green molecule contained in the leaves of plants has the ability to absorb light energy and create chemical bonds. Chlorophyll is what makes leaves green.

During photosynthesis, plants take water from the soil and carbon dioxide from the air and combine them using energy from sunlight.

MATERIALS LIST

FOR EACH STUDENT

- Glue
- One set of cards made from Teacher Page **1**, *Photosynthesis Cards*
- Copy of Student Page **1**, *Photosynthesis*
- Copy of Student Page **2A-B**, *Energy Flow*
- Copy of Student Page **3**, *How Forests Affect the Water Cycle*
- Copy of Student Page **4**, *How Forests Affect the Carbon Cycle*

FOR THE CLASS

- Chalk/marker board
- Overhead projector

FOR THE TEACHER

- Scissors
- Overhead transparency of Teacher Key **1**, *Photosynthesis Key*

TEACHER PREPARATION

Copy Teacher Page **1**, *Photosynthesis Cards* and cut apart one set of cards per student.

Oxygen and sugar are the results of photosynthesis. The oxygen is given off into the air, and the sugar is used by the plant to carry on its life functions. Some is stored in leaves and other parts of the plant. When other organisms eat those parts, they get energy.

Photosynthesis written out is:

Carbon Dioxide + Water + Light Energy → Sugar + Oxygen

Its equation is:

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

VOCABULARY

Abiotic: Refers to nonliving things.

Biotic: Refers to living things.

Condensation: The process of vapor turning into liquid.

Consumer: An organism that can't produce its own food energy and must get it by eating producers or other consumers.

Decomposer: An organism that gets its food energy from dead parts of other organisms.

Ecosystem: An area that contains organisms (e.g., plants, animals, bacteria) interacting with one another and their nonliving environment. Ecosystems can be of any size (e.g., forest, meadow, log).

Energy: The ability to do work (e.g., grow, reproduce, move).

Evaporation: The process of a liquid turning into vapor.

Food Chain: A series of organisms in which one eats or decomposes another and the transfer of food energy occurs.

Food Web: A group of interconnected food chains.

Photosynthesis: The process a plant uses to combine sunlight, water, and carbon dioxide to produce oxygen and sugar.

Precipitation: All forms of moisture that fall from the sky, including rain, snow, hail, etc.

Primary Consumer: A consumer that gets its energy from producers (plants). These are often called herbivores.

Producer: An organism that produces its own food energy by using sunlight, water, and carbon dioxide through the process of photosynthesis. Plants are producers.

Runoff: Water that flows on the surface of the ground.

Secondary Consumer: A consumer that gets its energy from other consumers. These are often called carnivores.

Transpiration: The evaporation of water from plants.

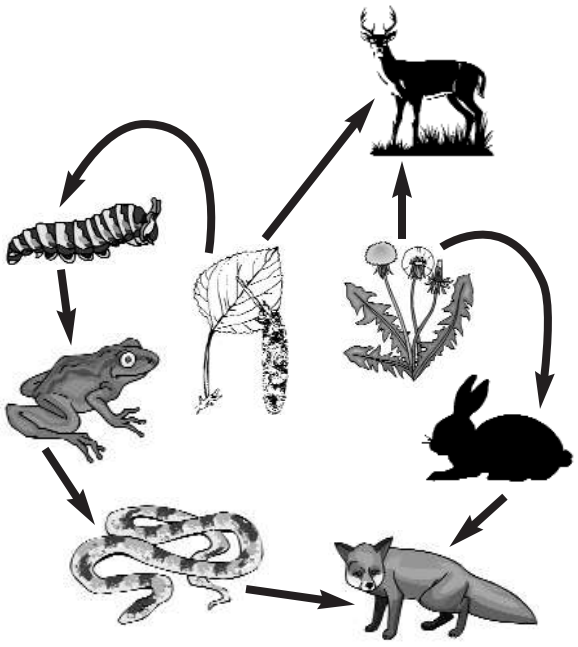
FOOD CHAINS

In an ecosystem, energy passes from one organism to the next in a sequence. This is called a **food chain**. Producers form the beginning of the food chain by capturing the sun's energy through photosynthesis. Primary consumers eat producers, obtaining the chemical energy of the producers. Secondary consumers reap the energy stored in the primary consumers. Decomposers consume the remaining energy and break down organic molecules in the remains of all members of the food chain.

Food chains can be as short as two links. Chains longer than four or five links are not as common, but can occur. An example of a food chain would be: aspen leaf - caterpillar - frog - snake - fox. Another simpler food chain could be aspen leaf - deer.

FOOD WEBS

A **food web** is a set of interconnected food chains. Energy and materials circulate within an ecosystem through food webs. The chains become a web when there are mutual food sources. Consider the previous examples. Aspen leaf - caterpillar - frog - snake - fox and aspen leaf - deer are interconnected by the leaf. If we added dandelion - rabbit - fox, that adds more connections. When all of these are combined, we have a very complex system of food chains in an ecosystem.



EXAMPLE OF A FOOD WEB

ENERGY

Energy is the ability to do work. Energy is one of the things transferred in the food web. (Nutrients are also transferred.) It is important to understand that energy is not destroyed, but it is given off. For instance, if a mouse gets 10 units worth of energy by eating acorns, and a hawk later eats that mouse, the hawk doesn't get all 10 units of energy. Why? The mouse was using energy to move, breathe, and keep its heart beating. That energy was given off and is not available to the hawk. This is sometimes referred to as the 10 percent law. Only 10 percent of the energy is carried through to the next step.

CYCLING OF MATTER IN ECOSYSTEMS

Matter cycles from **biotic** (living) communities to the **abiotic** (nonliving) environment and back again. There are a variety of cycles that materials flow in. Some of them are: the carbon cycle, nitrogen cycle, phosphorus cycle, sulfur cycle, and water cycle. These are important to organisms because they involve materials used to make the chemical components of cells. Energy flow fuels the cycles. The cycling of nutrients begins when they are released and are picked up by plants. Plants incorporate nutrients available in soil and water and store them in their tissues. Trees in forest ecosystems are well adapted to cycling nutrients and storing them in their trunks and branches. The nutrients are transferred from one organism to another through food webs. Nutrients are either deposited in long-term storage (such as mineral deposits) or are ultimately released by bacterial and fungal decomposition so the nutrients are again made available to plants.

The water cycle is the key to the other cycles. Water is often what carries the phosphorus, nitrogen, and sulfur from place to place. The water cycle is a series of movements of water above, on, and below the surface of Earth. The water cycle consists of different stages: **evaporation**, **condensation**, **transpiration**, **precipitation**, and **runoff**. Water may be stored temporarily in the ground, in oceans, lakes, and rivers, and in icecaps and glaciers. It evaporates from Earth's surface, condenses in clouds, and falls back to the earth as precipitation (rain or snow). Eventually it either runs into the oceans or evaporates into the atmosphere. Almost all the water on Earth has passed through the water cycle countless times.

PROCEDURE

INTRODUCTION

Tell students that you will be talking about ecosystems. *(Review the definition if needed. An area that contains organisms [e.g., plants, animals, bacteria] interacting with one another and their nonliving environment. Ecosystems can be of any size [e.g., forest, meadow, log].)* You will talk about the types of organisms that live in ecosystems and the connections that exist in forest ecosystems.

Ask students to name some foods they've eaten recently. With students, follow the path of the food they ate back to plant material. Here are some examples:

- Student - chicken - corn
- Student - potato chip (potato)
- Student - salad (vegetables)
- Student - fish - minnow - snail - algae

Explain that these are all simple connections in our ecosystem. Ask students if they can think of examples of connections that might link us to forests. *(Student - deer - leaves.)* Tell students that now we'll talk about the parts of the ecosystem and how there are connections that are even more complex.

ACTIVITY 1

1. Ask the students if they know why leaves are green. *(The chlorophyll in the leaves is green.)* Explain that chlorophyll is a green molecule. It is special because it can absorb light energy and use it to combine other molecules. Chlorophyll is very important to trees and other plants because it is important to photosynthesis. Define photosynthesis. *(The process a plant uses to combine sunlight, water, and carbon dioxide to produce oxygen and sugar. The sugar is the energy that plants use as food.)* Write the formula for photosynthesis on the board *(light energy + water + carbon dioxide → oxygen + sugar)*. Go over each part and explain. *(Light energy [from the sun], water [collected from the soil by the plant's roots], and carbon dioxide [from the air] are combined to make oxygen and sugar [energy]. All this work is done in the leaves of trees and other plants.)* Once you are confident the students understand the process, erase the formula before you move on to the next step.
2. Shuffle the *Photosynthesis Cards* you have already made and cut apart. Pass out five cards to each student. Without leaving their seats, each student must collect cards that represent all five parts of photosynthesis by trading with other students. They may only trade with the people sitting immediately next to, in front of, or behind them.
3. Once they have collected all the cards, they should glue them in order on Student Page **1**, *Photosynthesis*, and label the steps on the lines below the pictures.
4. Display the overhead transparency of Teacher Key **1**, *Photosynthesis Key*, for students to correct their work.
5. Ask students how photosynthesis done by trees is beneficial to humans and other animals. *(Trees use carbon dioxide and release oxygen.)*

ACTIVITY 2

1. Discuss the terms producer and consumer. *(Producers are plants. They use photosynthesis to make sugars which are used as energy for the plant to grow. Consumers are animals that cannot make their own energy, but get it by eating something else.)*
   - Explain that consumers can be primary and secondary. *(Primary consumers eat plants, secondary consumers eat other consumers such as animals.)*

- Explain that these members of the ecosystem are involved in many cycles. One of the cycles is the flow of energy.
- Tell students that energy is the ability to do work. Ask them how humans get energy. *(We eat food. We are both primary and secondary consumers.)*
- Tell the class that they are going to learn about energy flow in a forest ecosystem.

2. Hand out Student Page **2A-B**, *Energy Flow*, one to each student. Tell them to read the directions and fill in the first chart.

3. After students have filled in the first chart, ask them to move on to the second chart. After the second chart is complete, discuss the question asked on the worksheet. Ask why all of the energy that was taken from the producers by the primary consumers wasn't available to the secondary consumers. *(Energy is given off when plants and animals use it to grow, move, live, and reproduce.)*

4. Write the following information on the board after students have filled in the second chart.

   a. Each wolf needs 600 units of energy from deer, rabbit, grouse, squirrel, or mouse.
   b. Each fox needs 400 units of energy from rabbit, grouse, squirrel, or mouse.
   c. Each least weasel needs 150 units of energy from rabbit, grouse, squirrel, or mouse.

5. Ask students to use the third chart to fill in the energy the secondary consumers need, and figure out which ones and how many can survive using the primary consumers they chose. They will use the information you have written on the board.

6. Discuss the reasons secondary consumers might not be able to live, even if there is energy there. *(It may not be in a primary consumer they eat. A weasel can't kill and eat a deer, so if there are only deer, the weasel can't survive.)* What would happen if there weren't as many producers? *(There would be less energy available and fewer consumers would be able to survive.)*

7. If time permits, allow students to go back and change the numbers of primary consumers to make the outcome different.

ACTIVITY 3

1. Tell the class that they are going to learn how things other than energy move through a system. There are many things that cycle. Some examples are nitrogen, sulfur, phosphorus, and carbon. Water also has a cycle. They are going to learn about the water cycle and carbon cycle.

2. Hand out Student Page **3**, *How Forests Affect the Water Cycle*, and Student Page **4**, *How Forests Affect the Carbon Cycle*, to each student. Tell them to read the description at the bottom of the page. After they have read the description, they should label the parts of the picture listed and draw arrows to show how the cycle works.

3. After students have had time to label their diagrams, discuss the results. Ask how forest ecosystems play a role in each of these cycles. (*Forests are part of the water cycle as they contribute to evaporation through transpiration. Forests remove carbon from the air and store it in the carbon cycle.)*

   NOTE: To facilitate discussion, make an overhead transparency of the student pages and have students take turns drawing the connections as you discuss them.

CONCLUSION

Assign students to write or draw how they fit into one of the processes you discussed. (How do they fit into the flow of energy, the water cycle, or the carbon cycle?) Have them present what they created to the class.

CAREERS

The career profile in this lesson is about Marty Johnson, Wildlife Biologist, Wisconsin DNR. Career Profile 4D.WB is found on page 71. Use this profile to enhance the lesson and/or use it with the special careers lesson on page 148.

SUMMATIVE ASSESSMENT

Assign students to draw a food web using the following producers and consumers: human, fox, hawk, deer, rabbit, grass, tree (leaves). Ask them to write a paper describing how those producers and consumers fit into the water and carbon cycles.

REFERENCES

Cunningham, W. P., Woodworth Saigo, B. (2001). Environmental Science: A Global Concern. Madison: McGraw-Hill Higher Education.

Smith, R. L., & Smith, T. M. (2000). Elements of Ecology. New York: Addison Wesley Longman.

RECOMMENDED RESOURCES

●●● WEBSITE ●●●

FT Exploring Science and Technology
www.ftexploring.com/photosyn/photosynth.html
This website contains information about energy flow, photosynthesis, and food webs. There is additional information about other science subjects as well.

●●● GAME ●●●

Into the Forest Nature's Food Chain Game (Oakland CA: Ampersand Press.) This card game uses producers, consumers, and decomposers to trade energy. You choose the amount of time the game is played.

●●● VIDEO ●●●

Food Chains & Food Webs (Evanston IL: United Learning. 1998.) This video introduces the terms and ideas of food chains and food webs. It was filmed in Vermont and is not all about forest systems, but is a good extension.

Marty works with volunteers who help him do research.

MARTY, WILDLIFE BIOLOGIST

Meet Marty Johnson. Marty is a Wildlife Biologist. He works for the Wisconsin Department of Natural Resources. A wildlife biologist has duties both inside and outside. Marty works outside surveying which animals, or wildlife, live in certain places and improving their habitat by managing it. He also works inside writing management plans and reports, and working on budgets. A lot of the things he does help hunters and trappers in Wisconsin. Those same things also help other people such as bird-watchers, hikers, wildlife photographers, students, and teachers. Since Marty works in the southeastern part of Wisconsin, where a lot of people live, a big part of his job is working with people.

In order for Marty to be a wildlife biologist, he went to college and studied Wildlife Ecology. While he was in college, Marty got to study birds in Everglades National Park in Florida. He also worked in Wisconsin and California to learn more about wildlife. Some of those jobs weren't directly related to wildlife, but Marty gained other skills from them that help him with his job now.

Marty says his favorite part of his job is being able to work closely with animals and work outside, at least every once in a while. He also says that seeing the results of his work is a special part of his job. "We use a variety of techniques to get the desired affect and it is really satisfying to see how the landscape responds and to see wildlife use these areas."

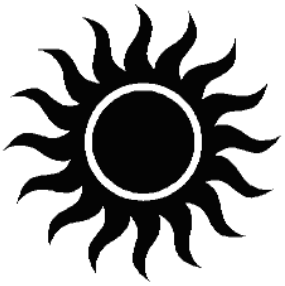
If you want to become a wildlife biologist, Marty says you should learn as much as you can by reading and spending time outdoors. He says it is a good idea to take up an outdoor hobby such as bird-watching or hunting.

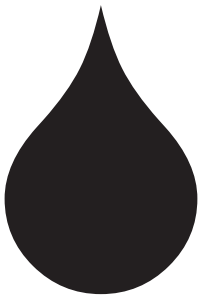
PHOTOSYNTHESIS CARDS

O

Oxygen

Atomic Number: 8
Atomic Mass: 16



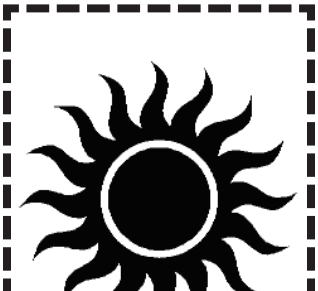


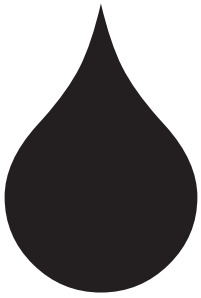
CO_2

O

Oxygen

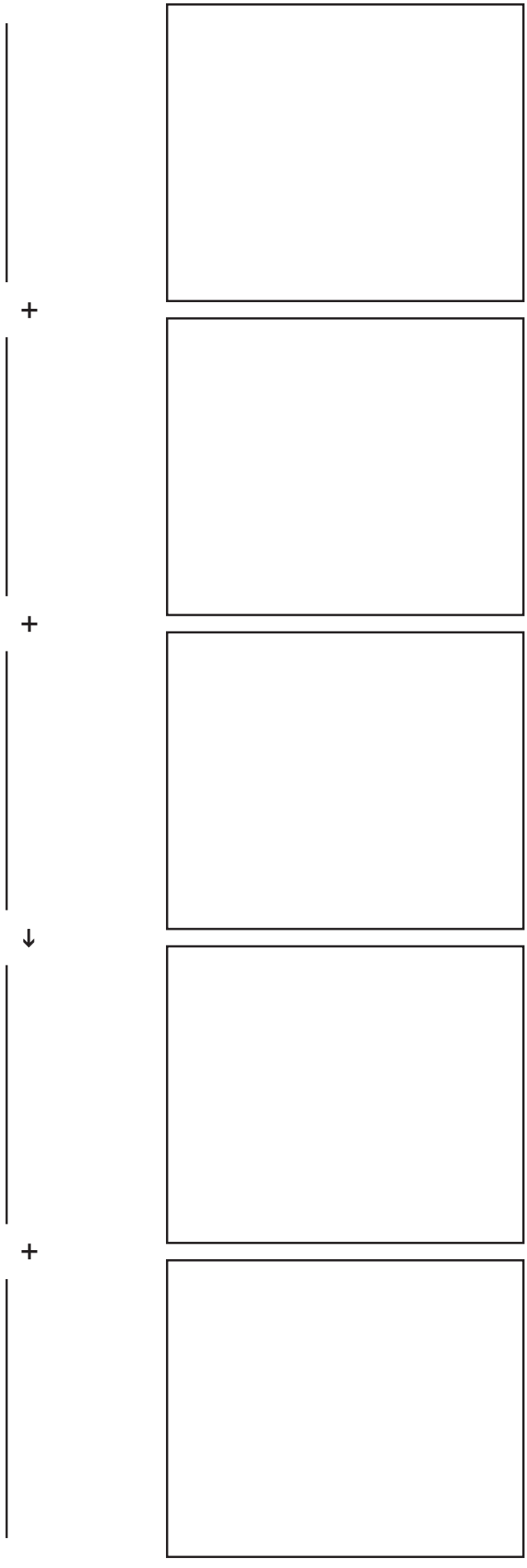
Atomic Number: 8
Atomic Mass: 16



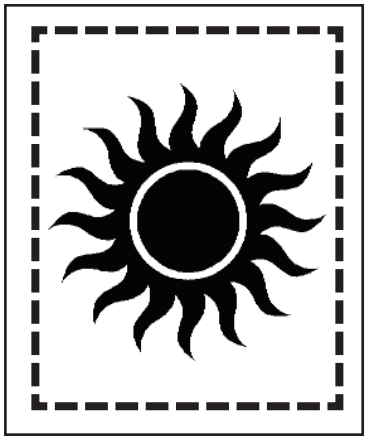


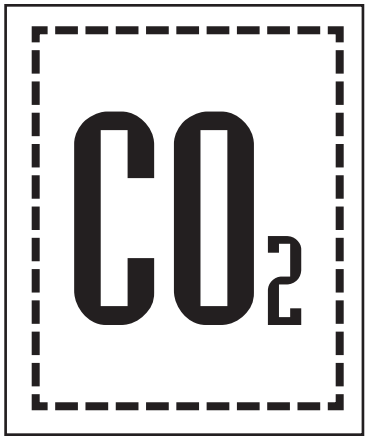
CO_2

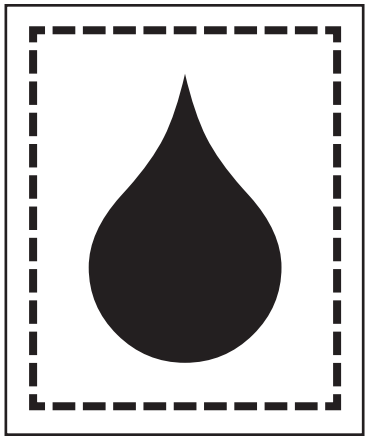
PHOTOSYNTHESIS

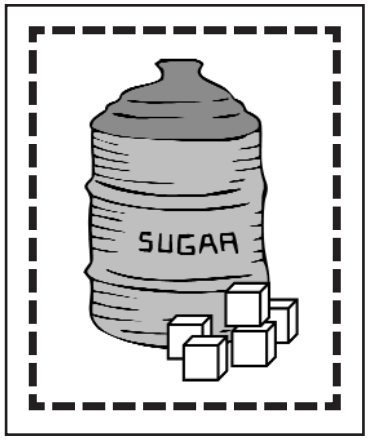


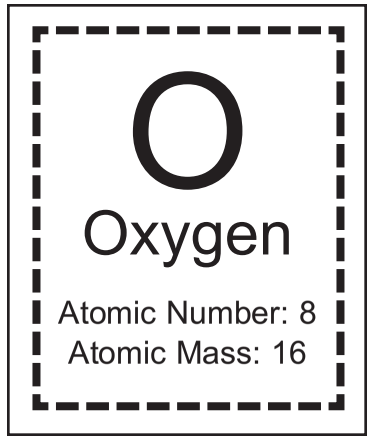
PHOTOSYNTHESIS KEY









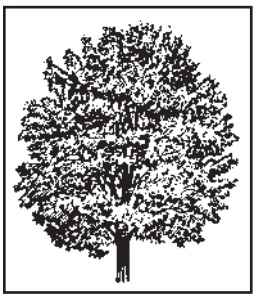


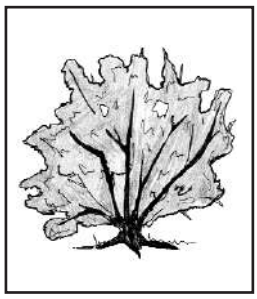
sunlight + carbon dioxide + water → sugar + oxygen

ENERGY FLOW

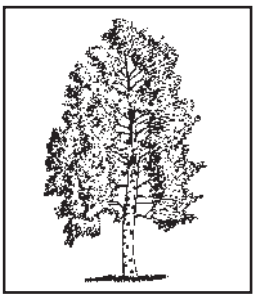
PRODUCERS

Trees and other plants in the forest produce 100,000 units of energy. Only 10,000 units of energy are available for the primary consumers.


Tree


Shrub

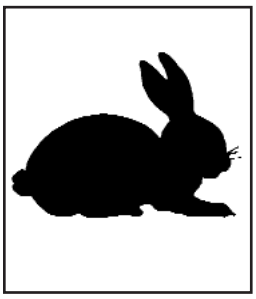

Flower


Tree


Flower

PRIMARY CONSUMERS

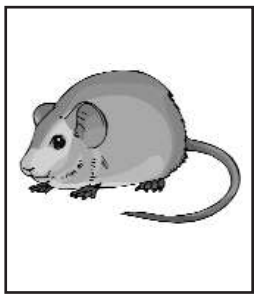
Choose any combination of these primary consumers to use the energy that the producers made.


Rabbit


Deer


Grouse


Squirrel


Mouse

Primary Consumer	Units of Energy Needed Per Consumer	Number of Consumers	Total Energy Needed
Rabbit	200		
Deer	600		
Grouse	75		
Squirrel	100		
Mouse	50		
			10,000

2B

ENERGY FLOW

SECONDARY CONSUMERS

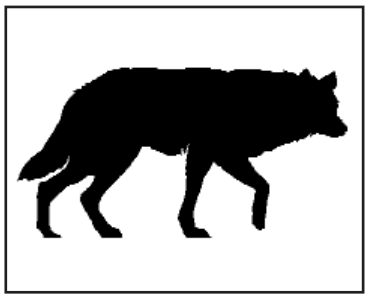
Just as the primary consumers didn't get all of the energy the producers made, the secondary consumers will not get all 10,000 units of energy that the primary consumers got from the producers.

Why?_____

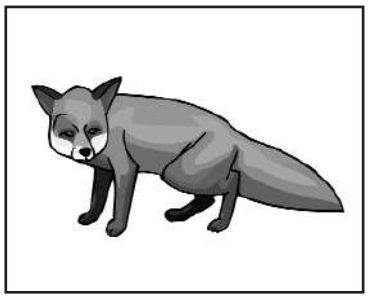
Below is a list of the energy available to the secondary consumers from each of the primary consumers. Fill in the columns with the numbers of primary consumers you chose from Student Page 2A.

Primary Consumer	Units of Energy Available Per Consumer	Number of Consumers	Total Energy Available
Rabbit	20		
Deer	60		
Grouse	8		
Squirrel	10		
Mouse	5		

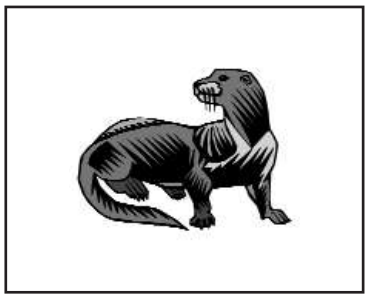
Read the requirements of the secondary consumers that your teacher has written on the board. Write down how much energy each needs, and how many the energy available will support.



Wolf



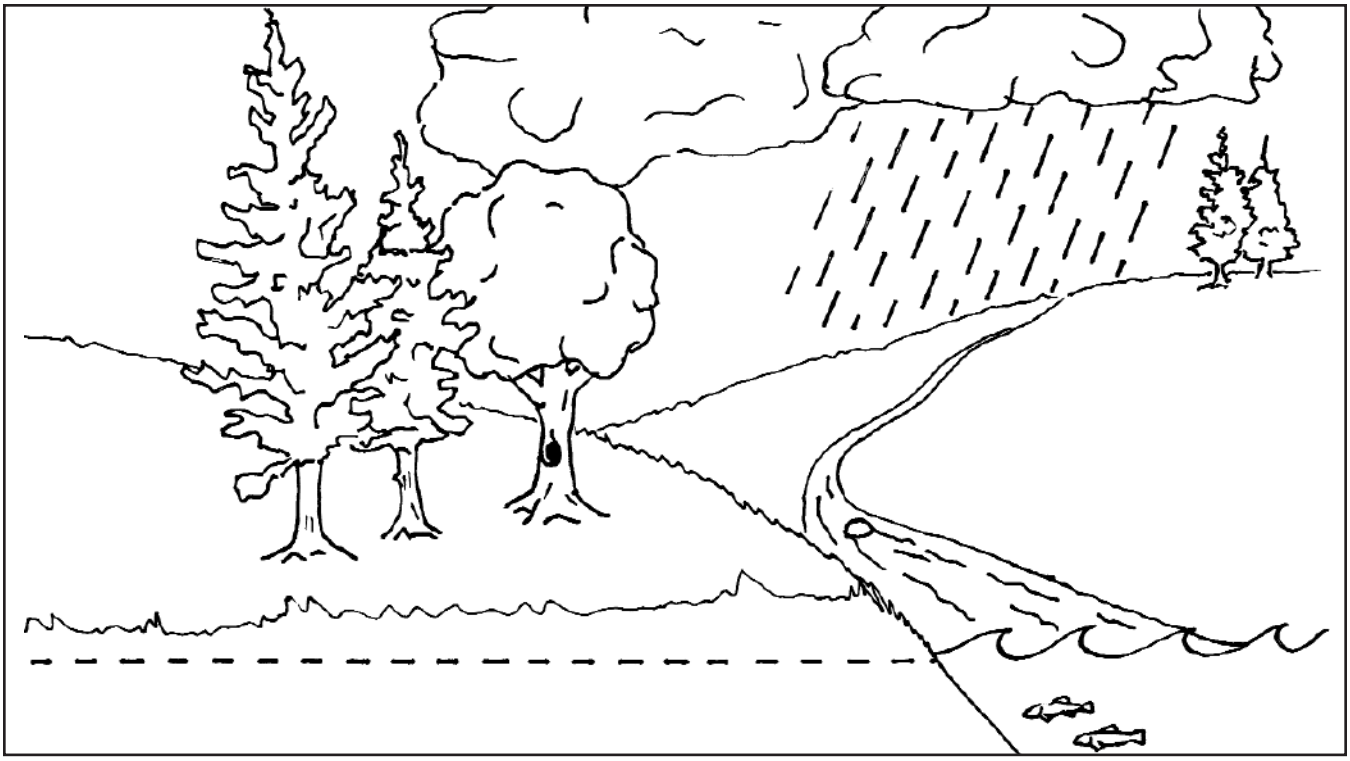
Fox



Weasel

Secondary Consumer	Units of Energy Needed Per Consumer	Number of Consumers
Wolf		
Fox		
Weasel		

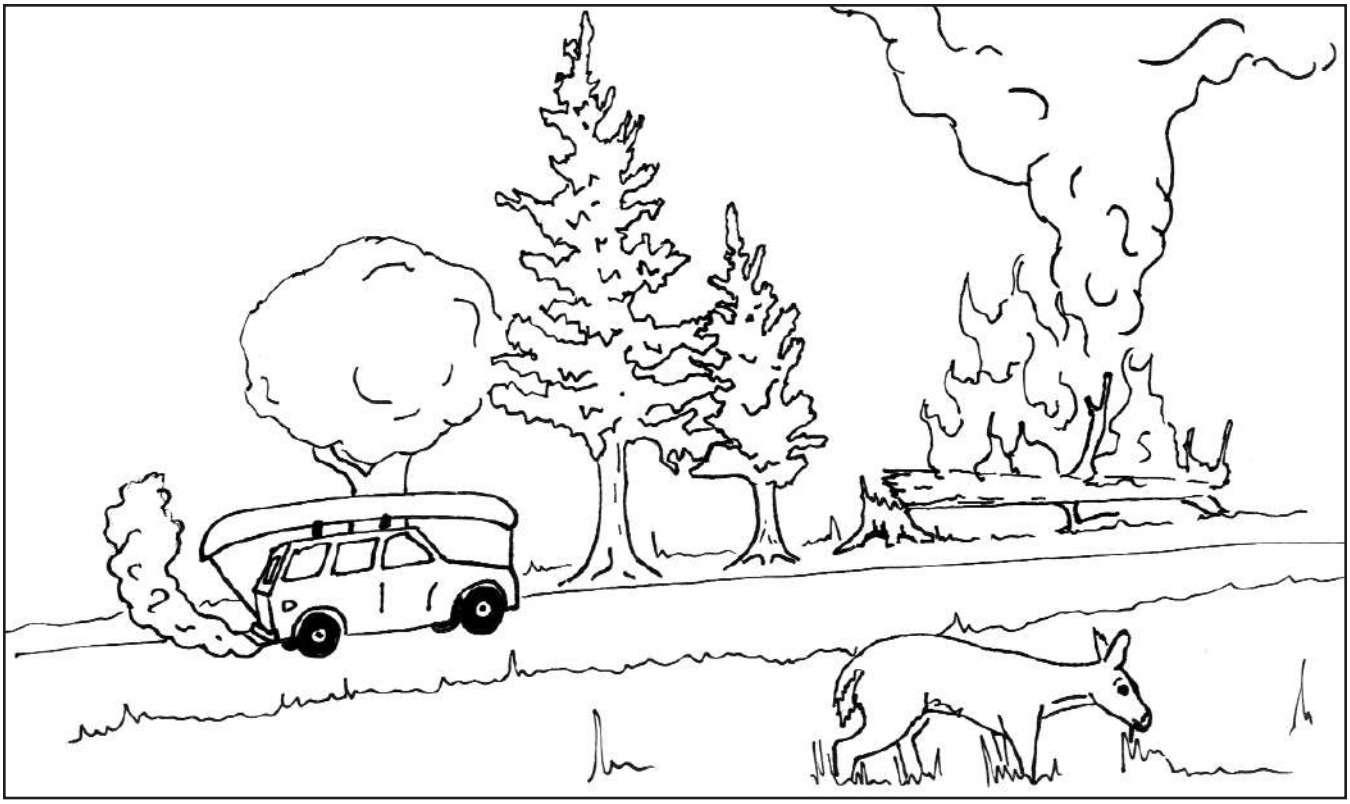
HOW FORESTS AFFECT THE WATER CYCLE



**Water is very important to the other cycles on Earth.
Water moves many other materials as it goes through its own cycle.
There are four main steps in the water cycle.**

- Water, in the form of vapor, goes through the process of **condensation** while it is in the air. The clouds that we see are actually water vapor.
- Water vapor that condenses enough falls to Earth during **precipitation**. Precipitation can be snow, rain, hail, etc.
- The water that is now on the ground will flow from higher points to lower points. Eventually it can reach the ocean. It is called **runoff**. The runoff will flow from smaller streams to larger rivers. It may stay in lakes, ponds, or wetlands. Forests help keep water from flowing too quickly and washing away soil. They slow rainwater as it falls through trees' leaves and the roots hold the soil in place. Some of the water that falls as precipitation will soak into the ground and become groundwater.
- The water that is on the surface is constantly **evaporating**. In evaporation, water on the ground becomes vapor and goes into the air. Water vapor is also released to the air as plants take water from the soil to use for photosynthesis and will give off water vapor as they live. That is called **transpiration**. Once the vapor is in the air, it follows the process through the water cycle again.

HOW FORESTS AFFECT THE CARBON CYCLE



Carbon is found in nearly everything. It is in people, trees, oil, rock, animals; even sugar has carbon in it. The carbon cycle is one of the material cycles on Earth.

- Carbon starts its cycle as **carbon dioxide** in the air. Trees and other plants make the carbon from carbon dioxide into the sugars they create during photosynthesis.
- Carbon can go many places. It may be **released** directly back into the air when trees use the sugar to grow.
- Carbon may be **stored** in trees. Trees are great carbon storage devices because they store carbon in their trunks and roots for years. The carbon can remain stored in dead plants as they change (over thousands of years) into oil, rock, or coal.
- Carbon may be **transferred** to animals that eat the plant. All carbon stays in something until it is released by being "burned" in some way. It may be a fire that burns wood that stores carbon. It may be burning gasoline (made from oil). Animals (including people) burn calories to live, and in that process we exhale carbon back into the air in the form of carbon dioxide.

WHAT PARTS OF THE WATER CYCLE AND CARBON CYCLE DO YOU SEE?