Grade 5

Science

Coursebook

Oak Meadow

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Lesson 1

Scientific Inquiry

Science is all around us. All children are natural scientists, looking at the world around them and trying to make sense of it. Children experiment all the time: What happens when you hit a pile of blocks? What happens if you keep filling a cup with water? What happens when you step on the cat's tail? As we grow, we answer these questions and move on to more sophisticated questions, such as "Why is the sky blue?" or "What is inside your eyeball?" This is the beginning of scientific inquiry.

Science is defined as a branch of knowledge involving systematic observation, experimentation, and induction. In plain speaking, this means that scientists make an observation, and then ask a question about this observation. They then perform an experiment and draw some conclusions based on the results of their experiment.

Reading

Read "The Scientific Method" and "Bird Beaks as Tools" (both found in Reading Selections at the end of this lesson).

Assignments

1. After reading about bird beaks, collect as many pictures of birds as you can. Arrange your bird pictures according to beak type, and group the different beak types together.

   Paste the pictures on a piece of paper, grouped according to beak types, and then draw pictures of the food that each bird eats, using the information in "Bird Beaks as Tools" as a reference. Alternately, you might like to make up a game that matches each bird with its food.

ASSIGNMENT SUMMARY

- ☐ Read "The Scientific Method" and "Bird Beaks as Tools."
- ☐ Collect pictures of birds and group them according to beak type.
- ☐ Make a guess about the bird's diet based on its beak.
- ☐ Observe birds and make predictions about their diets.
- ☐ Experiment: Bird Beaks

MATERIALS

- ☐ **Experiment: Bird Beaks**
  Birdseed (at least two kinds)

2. Observe the birds in your backyard or a local park. Ask yourself what type of food each bird might eat based on the shape of its beak. Make a list of at least three different types of birds you observe (if you don't know the type of bird, just describe it as well as you can, particularly its beak shape). If you can't observe birds directly, find three different pictures to use. Create a hypothesis for each that predicts which types of food the bird will prefer.

Experiment

Bird Beaks

Design a simple experiment to determine which types of food the birds you've observed actually eat. One way to do this is to purchase different types of birdseed and set up "feeding stations." For instance, you might wonder, "Will only birds with triangle-shaped beaks eat sunflower seeds?" Or you might ask, "If I put out two different types of birdseed, one with shells and one without, will the birds that eat from each pile of seed have different types of beaks?" You can pose whatever question you like! Once you decide on your question and make a prediction about what will happen, brainstorm ways to test your hypothesis.

List the steps of the scientific method, and follow them one by one as you carry out your experiment. Try to remove as many variables as you can. For instance, in this experiment, a variable might be the location of the birdseed. If one pile of birdseed is raised off the ground (where birds feel safe) and one is on the ground near the dog's resting spot, how might this variable (location) affect your experiment results? You want to make everything the same except for the one thing you are testing.

After conducting your experiment, write a few sentences about what happened during each step of the scientific method. What are your conclusions? How could your experiment be improved?

Reading Selections

The Scientific Method

The *scientific method* is the set of rules that scientists use to try to make sense of the world around us. Every day in our own lives we make observations to try to find the answers to inquiries, just like scientists do. However, in our day-to-day lives there are many factors affecting our results or conclusions, like whether or not we are late for school or have missed breakfast. These factors will influence our ability to notice things in our world and interpret them accurately. If you are in a hurry, you may not notice that flock of birds that feeds in your yard every morning.

A scientist is usually trying to figure out the effect of one particular factor on something. This means that a scientist will set up a *controlled experiment* to try to test an idea. A controlled experiment means that you are testing one thing at a time, so you want only one variable in each experiment. Variables are aspects of the experiment that might change (thereby possibly changing the outcome of the experiment). Some examples of variables are time of day, temperature, type of plant or animal, type of food, amount of sunlight or air, etc.

A scientific experiment will always follow the steps of the scientific method:

Observation/Question: A question is formed about something that you have noticed. The question should be brief, clear, and "testable." This is the *observation*.

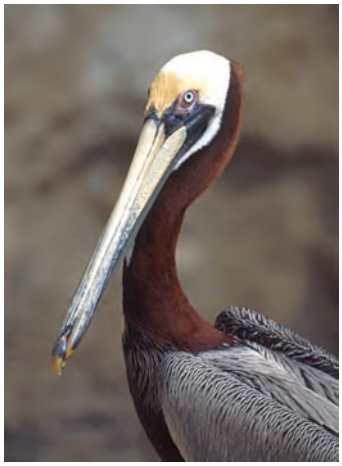
Hypothesis: A guess or prediction is made about what the answer to the question might be. This is called a *hypothesis*.

Experiment: A step-by-step process is developed to test the hypothesis. It is important to try to have as few variables as possible so that you will be able to answer your original question. When performing the experiment, all the variables are taken into account.

Results: Observations are recorded describing what happened during the experiment. These are called the *results*. Sometimes the results of an experiment are not clear or not what was expected! The important thing is to notice what happened.

Conclusions: Comparisons are made between the hypothesis (the original question and what was expected to happen) and what actually did happen. The *conclusion* notes how the variables may have affected the experiment results.

Bird Beaks as Tools



Have you ever noticed how different the beaks of birds are? Some are long and straight; some are short and fat. Others seem very strange, like a toucan's, or a pelican's big pouch-like beak. Why do you think birds have such a variety of beaks? The answer is because they eat different things. A toucan's beak is designed to pluck whole fruits off of trees. A pelican's beak makes it possible for the pelican to scoop up fish like a net. The shape and size of its beak enables the bird to eat what it wants.

Let's look at some other examples. Ducks have bills with a sieve-like edge that strains out water and allows the duck to capture plants and small aquatic organisms. Warblers have small beaks that can pick small insects off tree bark. Hummingbirds have long thin beaks that act like straws to make it easy to gather nectar from deep inside a flower.

A cardinal has a triangle or cone-shaped beak. The beak's shape and size make it useful for cracking open seeds and nuts, which is what cardinals like to eat. If you were to see another bird with a similar beak (like a grosbeak, finch, or an indigo bunting), you could reasonably guess that they eat the same foods.

However, a cardinal's beak would not be very useful for catching fish or frogs. What birds have a good beak for that purpose? Herons, egrets, and kingfishers do. These birds have beaks that are like spears, and that is how they use them. Herons stand very still while staring at a certain spot in the water. When a fish or other water creature swims close enough, the heron reaches out with a lightning quick movement and (with luck) stabs the fish with the end of its beak. Herons and egrets then usually flip the fish around so they can swallow it. Kingfishers, while they have similar beaks, are too small to stand in the water, so they wait on a branch or hover over the water until they see something that they want to eat. Then they dive headfirst into the water and stab the fish.

Raptors (eagles, hawks, falcons, owls, and vultures) also have special beaks, which are curved and hook-shaped. This enables them to cut or tear their food. Raptors usually eat small mammals, like mice or rabbits, or reptiles, but depending on their size may eat grasshoppers, deer, or other birds. However, these birds do not use their beaks to catch their food. Instead they use the talons on their feet. Then they take their meal somewhere and tear it apart with their beaks.

Birds would have a hard time trying to eat foods for which their beaks were not well-suited. It would be like trying to eat soup with a fork! Bird beaks are perfectly adapted for eating their preferred foods.

FOR ENROLLED STUDENTS

You will be sending your student's work from this lesson to your Oak Meadow teacher at the end of lesson 2. In the meantime, feel free to contact your teacher if you have any questions about the assignments or the learning process. You can use your assignment summary checklist and the learning assessment form to keep track of your student's progress. You will be sending this documentation to your teacher every two weeks (with each submission of student work).

Learning Assessment

These assessment rubrics are intended to help track student progress throughout the year. Please remember that these skills continue to develop over time. Parents and teachers can use this space to make notes about the learning the student demonstrates or skills that need work.

SKILLS	Developing	Consistent	Competent	Notes
Demonstrates knowledge of the scientific method				
Demonstrates knowledge of experiment variables				
Displays focused observation skills				
Forms a hypothesis based on previous knowledge				
Follows the steps of the scientific method				
Records observations in detail				
Draws conclusions based on results				
Reflects on experiment process and ways to gain more accurate results				
Sorts and classifies information according to different variables				

Lesson 2

Scientific Ways of Knowing

Have you ever watched frogs hopping or tried to catch them to take a closer look? Watching how frogs move, how they eat, where they live—these are all scientific inquiries! Frogs usually manage to keep one hop ahead of kids, but are they managing to stay ahead of pollution? In this lesson, you'll find out more about frogs, and then you will design an experiment to answer a question about frogs in your neighborhood.

ASSIGNMENT SUMMARY

- ☐ Read "Scientific Ways of Knowing" and "Frogs."
- ☐ Make a prediction about the local frog population.
- ☐ Consider how humans affect the environment.
- ☐ Complete a science test.
- ☐ Experiment: Frog Population

Reading

Read "Scientific Ways of Knowing" and "Frogs" (found in Reading Selections).

Assignments

1. After completing the frog experiment in this lesson, make a prediction about the frog population based on what you observed. What did you discover? Are frogs in your pond in trouble? Can you think of any other explanations for what you found? Can you think of ways to help the frogs in your area to keep a healthy population?

   Support your findings with evidence. That means you will give specific examples of why you believe what you say, and what led you to have this opinion.

   Note: if your experiment lasts longer than two weeks, just complete this assignment when your experiment ends.

2. Write a paragraph about the ways humans have affected the environment, both for good and bad. Do some research on this topic so you can back up your thoughts with facts (support your opinion). Include any ideas you might have for ways that people could change their behavior to help the environment.

3. Complete the science test (found after the experiment).

Experiment

Frog Population

Design an experiment to determine if the frog population in your neighborhood is healthy and growing or having any problems. Find a pond in your neighborhood where you can observe frogs. You may want to record data from your pond site for several weeks, so it should be a place you can visit frequently. The spring is the mating and egg-laying season, but frogs may be found throughout the summer and fall. They may be hibernating in your area in the winter.

Choose a "clue" from the following list to research, and use as the basis for your hypothesis.

- **Habitat destruction.** This can include roads that were built where frogs have to cross to reach their breeding ponds. You may need to talk to older adults to learn about how the landscape used to look.
- **Pollution, pesticides, acid rain.** You may want to talk to farmers or landowners around your pond. You could test the pond water's acidity.
- **Ultraviolet (UV) radiation.** Since this affects mainly the egg production and viability, you might conduct a frog count to see how many are hatching and making it to adulthood.
- **Competition and predators.** After doing a frog survey, can you identify any non-native frogs?

Brainstorm ways to design an experiment that will answer your question. Collect your data (pieces of information), and record your observations.

Report the results of your investigation by listing the five steps of the scientific method (question, hypothesis, experiment, results, and conclusion) and writing a couple of sentences about what you did for each step.

Science Test

Complete the following test to show what you have learned. Answer any questions in complete sentences.

1. List the five steps of the scientific method, and explain each one.
2. Explain why variables must be taken into account in a controlled experiment.
3. List three different types of bird beaks, and describe how they are related to the bird's diet.
4. Describe a frog's life cycle.

5. What is an indicator species? Why are frogs an indicator species?
6. List four things that can cause problems for frogs, and explain why each is a problem.

Reading Selections

Scientific Ways of Knowing

Science is a work in progress. This means that when scientists see something that puzzles them, they develop a hypothesis to explain the puzzle. The next step is to design an experiment to test their hypothesis. Throughout this process, remember that scientists are people, so their lives and beliefs may influence their thinking. The only thing that is absolutely true in science is that nothing is absolutely true. When people first began looking at the stars in the sky and trying to make sense of our world's place among those stars, it was believed that Earth was the center and all the other planets revolved around Earth. This is how the human eye perceived the movement that was the rising and setting of the sun.

Copernicus and Galileo

In 1543, Nicolaus Copernicus revived the theory that the sun was the center of the universe, and all of the planets, including Earth, revolved around it. This is called the *heliocentric* (sun-centered) theory. The heliocentric theory was first advanced by Aristarchus in the 3rd century BCE. He lived on the island of Samos, off the coast of Turkey. His theory did not survive long, being discredited by Aristotle. Aristotle "disproved" the heliocentric theory by asking, "If Earth is spinning on an axis, why don't objects fly off into space?" and "If Earth is in motion around the sun, why doesn't it leave behind the birds flying in the air?"

Copernicus was also discredited and disbelieved when he once again put forward the sun-centered theory. Scholars and scientists of the time believed that Earth was the center of the universe and that man was one step removed from God, therefore superior to all other animals on the planet. To accept any other idea might question humankind's superiority. It was not until the middle of the 17th century that Copernicus's ideas were defended by scientists like Galileo Galilei and finally accepted. This is an example of how people's beliefs can influence the scientific theories that are considered acceptable.

Many scientists today accept an assumption that the ancient Greeks put forth: Whatever they are, the basic truths of the universe are "laws" that do not change—only our ideas about them change. Remember, this is an *assumption*. Keep in mind that in the 14th century, people "knew" that Earth was the center of the universe, and it took 300 years before anyone changed their minds about this idea.

Facts and Opinions

There are several ways of "knowing" and of processing information. We can start with facts. A *fact* is something that has actually happened or is unquestionably true. It is a fact that the sun rises in the east every morning. People also have *opinions*, about which they may feel very deeply. These may be based on facts or not. It is more what seems true, or probable. "It is my opinion that it is going to rain today."

Scientists, like all of us, are constantly making observations. Usually, when we are observing our environment, we notice things that have changed. These observations can form the basis of our opinions. Maybe we observe that the sky is overcast (a fact that everyone can agree on), and we form the opinion that it will rain. We also can draw *inferences* from information that is known or even assumed. Inferences are guesses based on information. Here are some examples of inferences:

> The sky looks overcast and the weather report called for rain, so I think it is going to rain soon.
>
> My friend said he's bored, so I bet he will want to go the park with me.
>
> You look upset.

These are all inferences—not fact or opinion, but guesses we make based on what we observe or know. This is how our minds work. But just because we *think* something (that it will rain, or our friend will want to go to the park, or someone is upset) doesn't mean it will happen or it is true.

So, how do scientists know whether or not their conclusions are true? Think back to the scientific method. Once the scientist has made an observation and developed a hypothesis, they will then design an experiment to test the hypothesis. If the experiment is well-designed, then other scientists could repeat the same process and get the same results. If this happens, then the first scientist is reasonably sure that the results are accurate and the conclusions are true. By showing that the same results can be brought about again and again, the experiment results will be accepted by other scientists, and eventually by other people as well.

Frogs

What are frogs? Frogs are small animals belonging to a group called *vertebrates* (animals with backbones), in a subgroup known as *amphibians*. Amphibians live part of their lives in the water and part on land. Amphibians are cold-blooded animals. This means that their body temperature is the same as the surrounding temperature in the environment. Snakes and reptiles are cold-blooded too. Amphibians absorb water through their skin, so they don't have to drink water! Frogs have strong back legs that help them leap forward great distances. Their front legs are short, and are used to prop the frog up when it is sitting. Frogs have webbed feet to help

them swim fast. The largest frog in the world is the goliath frog of West Central Africa, and it can grow to be more than one foot long. The smallest frog is the Cuban pygmy frog, and it is about one-half inch long. The largest frog in America is the bullfrog, which grows up to six inches long.

Frogs live all over the world, except in Antarctica. Most frog species, however, prefer warmer climates. Therefore, most frog species are found in the tropics. Frogs are usually found in or near water. This does not mean that all frogs live in water: some frogs only go to water to mate and lay their eggs. Some frogs live in trees, and others burrow underground. Frogs that live in places with a cold winter will hibernate, either burrowed in the ground or buried in the mud at the bottom of a pond, until the weather warms up again in the spring.

The life cycle of frogs is very interesting. The males and females mate, and the female lays her eggs in the water. The eggs hatch within 3–25 days, depending on the type of frog and on the temperature of the water (warmer water results in faster hatching). The eggs are usually covered with a jellylike substance as a protective coating. When they hatch, the baby frogs are called *tadpoles* or *polliwogs*. They look like little fish because they don't have legs yet. They have a tail, which helps them swim, and gills through which they breathe. Most tadpoles eat plants and decaying animal matter, but some will eat frog eggs and other tadpoles. As time passes, first the back legs grow, then the front legs. The tail slowly disappears, and the young frog hops up onto land.

Frogs eat mostly insects and small animals, like earthworms, minnows, and spiders. They flip out their sticky tongue, get the food, and pull back the tongue. Frogs swallow their prey whole, and hunt mostly at night.

Perhaps you have heard frogs croak or "sing." Why do frogs sing? It is the male frogs that sing. They are the ones with the loud voice. The males sing to attract females for mating and to stake out their territory. Female frogs have voices too, but they are much softer.

The place in which an animal can be found is called its *habitat*. Most frogs need two different habitats, within easy reach of each other. They need dry land with cover for protection and a good food supply. They also need a nearby pond in which to lay their eggs and allow their tadpoles to grow up into frogs.

Since frogs breathe air through their skin, and water passes through as well, they are very sensitive to pollution in their habitat. If there are toxins (poisons) in the water or air, the frogs will easily absorb these toxins directly into their bodies. This can make them sick. Frogs are called an *indicator species* because a frog's health may tell us a lot about the health of its environment. If frogs are doing well, then the water quality is high, and pollution is under control. If frogs are not doing well, we should see that as a wake-up call.

There are several things that can cause problems for frogs (and ultimately for the whole habitat or ecosystem):

- **Habitat destruction:** With the logging of forests, especially rain forests, and the draining of wetlands for agriculture and building, frogs are losing their habitats at a rapid rate.
- **Depletion of the ozone:** Changes in the ozone layer of Earth's atmosphere means that more ultraviolet rays from the sun come through to Earth. This causes changes in temperature, which can interfere with the frogs' egg development.
- **Pollution, pesticides, and acid rain:** Since frogs take in water and air through their skin, they are especially sensitive to environmental pollution. These toxins can result in deformities as the frogs grow.
- **Competition and predators:** Non-native "sport" fish that are released in rivers and lakes for fishing can eat tadpoles and wipe out entire frog populations. The Cuban tree frog was accidentally brought into the United States with a shipment of fruit, and since has been eating smaller native frogs.

It's important for us to think and talk about how people's behavior affects the environment. Since the human population has grown so large, we have had an increasing impact on the natural world. We have expanded our roads and housing into areas that were once wild and undisturbed. We have increased our use of natural resources, using them up faster than they are renewed. On the other hand, in recent years, people have been working hard to reestablish endangered species and bring back populations of animals that were almost gone, like the buffalo and wolf. People can have a powerful impact on the environment, for good or bad, and it's up to every person to do their part to take care of Earth, which is home to every living thing.

FOR ENROLLED STUDENTS

If you have any questions about how to structure your frog experiment, please contact your teacher.

At the end of this lesson, you will be sending the first batch of work to your Oak Meadow teacher along with your assignment summary checklist and the learning assessment forms, or any alternate form of documentation. Include any additional notes about the lesson work or anything you'd like your teacher to know. Feel free to include questions with your documentation—your teacher is eager to help.

If you have any questions about what to send or how to send it, please refer to your parent handbook and your teacher's welcome letter. Your teacher will respond to your submission of student work with detailed comments and individualized guidance. In the meantime, proceed to lesson 3, and continue your work.

Learning Assessment

These assessment rubrics are intended to help track student progress throughout the year. Please remember that these skills continue to develop over time. Parents and teachers can use this space to make notes about the learning the student demonstrates or skills that need work.

SKILLS	Developing	Consistent	Competent	Notes
Demonstrates knowledge of the scientific method				
Demonstrates knowledge of experiment variables				
Displays focused observation skills				
Forms a hypothesis based on previous knowledge				
Follows the steps of the scientific method				
Records observations in detail				
Draws conclusions based on results				
Reflects on experiment process and ways to gain more accurate results				
Sorts and classifies information according to different variables				

Lesson

6

The Web of Life

Reading

Read "Energy in Ecosystems" (found in Reading Selections).

Assignments

1. After completing the reading assignment, make a list of eight different things that you eat. Describe the food chain for each food.
2. Using the eight food chains you identified above, draw a food web that shows how all these things are connected. Take your time to draw your food web carefully, in color, and label each segment of it. Make it clear how things are related.
3. Make a list of the plants and animals you would raise if you were a farmer. Explain why you chose each of them.
4. Complete your mold growth experiment. Did you see any mold growth? Did different types of molds grow on different foods? Describe the changes as carefully and accurately as you can. Perhaps you will measure the mold growth in terms of length and width, or perhaps you will estimate how much of the item is covered with mold (10%, 50%, etc.). Try to be as exact as you can. In addition, make drawings of the different kinds of molds that you grew.

   When you are finished with your experiment, be sure to put your sealed bags into the garbage. Don't open them because some kinds of mold are dangerous to breathe. Remember, safety first!

   Conclusions: Did the placement (warm + light, warm + dark, cold + dark) have any effect? Why do you think that the food needed to be dipped in water?

   For each step of the scientific process, write one or two sentences about what you did, what you observed, and why you think it happened.

ASSIGNMENT SUMMARY

- ☐ Read "Energy in Ecosystems."
- ☐ List the food chain for different types of food.
- ☐ Draw a food web.
- ☐ List plants and animals you would raise on a farm.
- ☐ Complete the science test.
- ☐ Write the results of your mold experiment.

Science Test

1. Describe two different environments.
2. Explain the difference between a food chain and a food web.
3. How does each and every food chain begin?
4. How does each and every food chain end? Why is this such an important step in the food chain?
5. Define producers, consumers, scavengers, and decomposers. Explain the role of each in the environment.
6. Why are plants so important to Earth?
7. What happens to energy in each step of the food chain?
8. Why do some people want to keep the human food chain short by eating grains instead of meat?
9. Explain diversity in an ecosystem and why it is important.

Reading Selections

Energy in Ecosystems

Living things move, grow, and change. Even nonliving things change and move. What causes all of these things to happen? *Energy* is what is needed for anything to grow, move, or change.

It takes energy to light and heat your house, to make your car run, and to cook your food. It takes energy for you to move from one place or from one position to another. It takes energy for you to use your eyes and for your brain to read this page. In fact, everything you do, whether it is breathing, sleeping, eating, walking, working, or digesting, takes energy.

All plants and animals need energy to grow, work, move, and keep warm. These things have to get their energy from where they live. Therefore, their ecosystems must contain some form of energy for them to use.

Food Chains

Ecosystems must get energy from something too. Where do you think the energy comes from? It comes from the sun! All of the energy, all over the world, in all its different forms, began as energy from the sun.

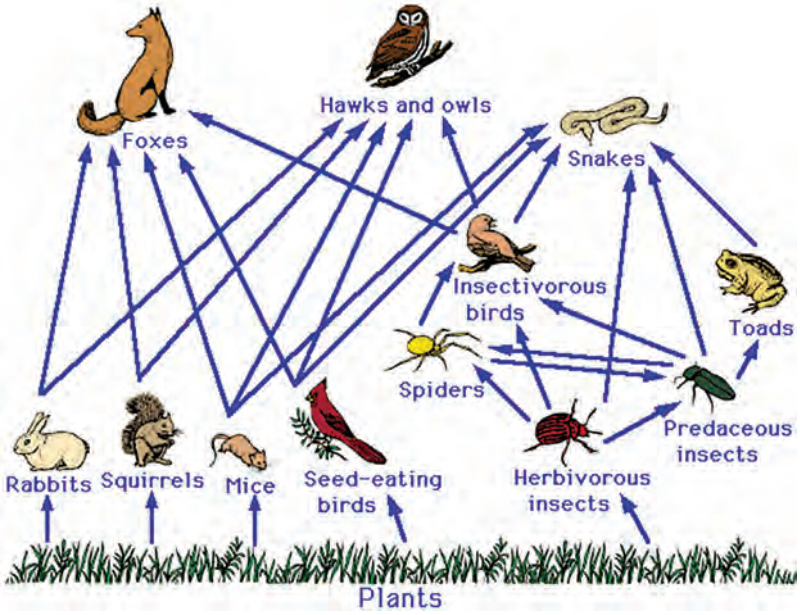
When it comes to energy and living things, plants have a very special job. Only plants can take the energy from the sun and turn it into food energy for themselves and other living things. First, a plant takes in sunlight and changes it into food for itself. This food is a type of sugar called a *carbohydrate*. When a plant takes sunlight to make food, the process is called *photosynthesis*. "Photo" means light; "synthesis" means combining different materials into something new. Photosynthesis changes sunlight and air into sugar. Without photosynthesis, there would be no life on Earth.

Many animals get their energy from plants. Food energy in plants is passed on to animals when they eat plants. This energy then moves on to other animals when they eat the animals that ate the plants. This is how energy moves through an ecosystem. It starts with the sun, moves on to plants, then to animals that eat the plants, then to animals that eat animals and then to other animals that eat those animals. It's a long chain, starting with the sun.

Every time you eat anything, you are eating part of the sun's energy. Think about an apple. The apple tree used sunlight to make food to grow strong and healthy, and fed the developing apples with this energy. What about a chicken sandwich? If you eat a chicken sandwich, you are getting energy from eating a chicken that got its energy from eating seeds and bugs that got their energy from the sun.

The way the energy moves from the sun to living things is called a *food chain*.

Producers, Consumers, Scavengers, and Decomposers



The food chain always starts with the sun. The first link in the chain is between the sun and plants. Because plants are the only things that can make their own food from sun energy, they are called *producers*.

The next link in the food chain is the animals that eat plants. These animals are called *consumers*. Grasshoppers, rabbits, and cows are all consumers. There are many other consumers. They all eat plants. You are a consumer too. You eat salads, vegetables, and plants of many different kinds.

Some consumers eat only other consumers. Foxes eat rabbits, snakes and owls eat mice, and most birds eat bugs and worms of one type or another. Some consumers eat both producers and consumers—both plants and animals. Bears eat fish, roots, and berries. You might eat oranges, beans, carrots, and some type of meat or fish.

Eventually all consumers die. What happens to them? They are eaten by scavengers and decomposers. *Scavengers* are animals who specialize in eating only other animals that have died. Most scavengers do not kill their own food. Vultures, hyenas, and certain kinds of ants, beetles, and worms are scavengers. They are very important because they provide a sort of clean-up service for an ecosystem.

Decomposers, as we learned in the previous lesson, are those tiny living things that eat dead plants and animals. Decomposers are the final link in a food chain. This makes them very important because it is they who break dead things down into soil so that plants can use them to begin another food chain.

Food Webs

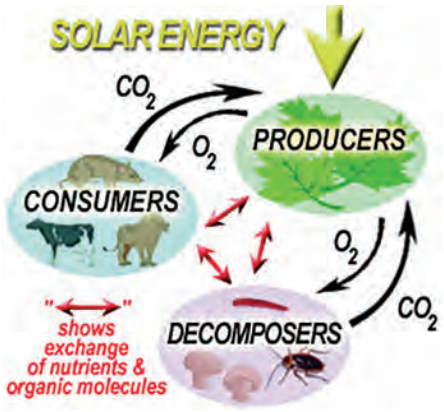
Most animals eat more than one type of food. Grasshoppers eat more than one kind of plant. Foxes eat mice, rabbits, and squirrels. You probably eat lots of things. Each of the things you eat are part of separate food chains, but they all combine together to show all of the eating relationships in your life.

When you eat corn, you are part of one food chain. When you eat fish, you are part of another. In the first, energy goes from the sun, through the corn, and to you. When you eat fish, the sun energy goes through a plant growing in a river or ocean, to smaller fish that are then eaten by the bigger fish you eat. All the different things you eat are connected through you, so you are a common link in many different food chains.

An ecosystem has many, many different food chains that all have common links. Most animals are part of many food chains. All of these food chains together make up a *food web*. Each and every ecosystem, whether it is a desert, forest, or river, has many food chains and one big food web containing all of the chains in the ecosystem.

Losing Energy

In a food chain, not all of the energy a plant gets from the sun makes it all the way to the decomposers at the end of the chain. In fact, very little of the energy makes it that far. Lots of energy gets used along the path of a food chain. Actually, 90% of the energy is used within each link in the chain. The plant uses most of the energy it gets from the sun to grow, to move water and nutrients through its stem and leaves, and to move itself around to get as much of the sunlight on itself as it can. When a bug eats this plant, it stores only 10% of the plant's energy in its own body. When a bird eats the bug, it gets only 10%



of the energy that the bug stored in its body. You can see that by the time the sun energy gets to the bird, it gets only 1% (that's 10% of 10%) of the energy that was in the plant.

Just think how little of the energy is left when you eat a bird! At the end of a food chain, there just isn't much energy left. Notice that there are many, many more bugs in the world than there are people. With every step in a food chain, there are fewer animals because there is less energy to go around.

But where does all of that energy go? Energy is necessary for living creatures to grow, to move, to keep warm, and to reproduce. When you walk, run, or swim, you use energy. Every time an animal breathes, it is using energy to do it. This energy changes form into heat energy that leaves the living thing. Where does it go? This heat energy escapes into the environment. It goes into the air or water around the animal.

Conserving Energy in Food Chains

Here's some food for thought. Do you know anyone who doesn't eat meat? In some countries where there are many, many people, very few people eat meat. That's because there are so many people to feed, and there just isn't enough energy around to feed them all meat at the end of a long food chain. There is just too much energy lost along the way. These countries have to keep food chains short so that as many people as possible can eat. Grains and legumes are the primary sources of nourishment in such countries.

Animals have to do the same thing. The more animals there are, the more energy is needed to keep all of them alive. Animals that have large populations have to keep their food chains short in order to keep that large population alive and healthy. Insect food chains are really short. There are more insects than any other type of living thing. There are lots of bugs that eat bugs, but not as many as there are that eat plants. At the other end of the food chain, large animals that eat other animals have much smaller populations. Look at lions, tigers, and bears, and notice that their populations are relatively small. In fact, there are so few of some particular types of animals that they are considered rare, threatened, or endangered.

Short food chains are really good for animals. That includes people. There are many doctors and nutritionists who believe that we'd all be a lot healthier if we ate less meat. Some think we should eat no meat at all. There are many health reasons for this. One important reason is that it would let our planet feed more people if we fed fewer cows on the grains that people could be eating. It takes about eight or nine cows a year to feed the average

meat eater. Each cow needs one acre of green plants, corn, or soybeans a year. If it takes nine acres of plants a year just to make the meat you eat, that's a whole lot more than the half an acre it would take to feed you if you didn't eat meat. The amount of grain needed to provide meat for one person is enough to feed 20 people sufficient grain to live for a year.

Years ago, when an animal was raised for meat on the family farm, all parts of the animal were used. For example, when a pig was killed in the fall, this helped to ensure that the family survived the long winter. The pig would be killed and cut up into various parts (chops, ribs, etc.). The leftover parts were ground up into sausage meat and stuffed into cleaned-out intestine casings. The fat was rendered and made into lard for baking or tallow for candles. There was no thought of waste. This "use it up, wear it out, make do, or do without" philosophy conveyed a respect for the animals' loss of life, and minimized the impact of eating meat.

Today, most of us do not live on the family farm, and many people eat meat at almost every meal. Most of this meat originates from huge animal farms and slaughterhouses where the animals are treated as part of the machinery. There are options to purchase meat grown in a more humane manner, on smaller farms and without the use of growth hormones. We can choose to eat less meat and to support farmers who raise healthy animals in an ethical manner. This is good for the environment and good for your health!

Ecosystem Diversity

Although there are some relatively simple food webs, a forest or ocean food web will be quite involved and contain many living things. All plants and animals in an ecosystem would have to be included in a food web of that ecosystem.

One very important thing to remember about ecosystems is that the bigger the food web, the stronger and less fragile the whole ecosystem will be. An ecosystem works best when it has *diversity*; that means there are lots of different plants and animals in it.

Imagine an ecosystem that has only one type of plant. What would happen if something happened to that one kind of plant? A sickness or disease could attack the plant. It could spread from one plant to another, and cause all of them to get sick or die. Some diseases can spread quickly throughout an ecosystem. If many or most plants in an ecosystem died, it would be a very bad situation for all of the animals that depend on those plants for their energy. All of the consumers in that ecosystem would be in trouble because if there is not enough food for plant eaters, there won't be enough of the plant eaters to provide food for the consumers who eat them. In a simple food chain, every level of the food chain suffers when something happens to the producers.

A good, healthy, stable ecosystem has many different types of food. If one food source vanishes, animals that eat many different types of food can merely eat more of something else. If animals can change from one type of food to another, then changes in the ecosystem will have little effect on the rest of the consumers in the food web.

You may love to eat corn chips. If for some reason, you woke up one day to find that no corn chips existed any longer, you could eat potato chips instead. Or you might decide to eat an apple or an orange. Because we have many foods to choose from in our ecosystem, we are still in good shape even when one type of food disappears. We can always eat something else if we want to. The more kinds of things there are to eat, the better.

However, not all people (or other animals, for that matter) are fortunate enough to have many different food choices. Consider what happened in Ireland in 1845. At that time, people in Ireland ate mostly potatoes. This was because potatoes grew so well there. Because so many potatoes could be grown easily, many families and farms grew only potatoes.

Between the years 1780 and 1845, the population of Ireland grew from 4,000,000 people to 8,500,000. The population more than doubled in 65 years because there was so much food, and so many potatoes. But in 1845 all of that changed. A virus came to Ireland on a plant that was brought on a ship from another part of the world. When the virus reached Ireland, it found lots and lots of its favorite food—potato leaves. The virus lived on the leaves of potato plants, causing the leaves to wilt and die. With no leaves to capture the sun's energy, the potatoes could get no energy for growing, so they rotted and died. For five years potatoes would not grow, and during that time many people had little or no food.

With no other type of food to fall back on, many people had no food to eat at all. During those five years, 1,000,000 people died from starvation in Ireland. Another 1,000,000 people left the country. Many of them moved to the United States, where there was more food.

In the United States, there are many types of food to choose from. The country is large, and has many different climates and plenty of fertile land. But many farmers grow only one single type of crop on their land. The biggest farms in the United States grow corn, soybeans, or wheat, but rarely all three. Farmers find that it is cheaper to grow just one type of crop. But is it really a good idea? Many farmers today find that growing a few or many different types of crops is safer, smarter, and more profitable in the long run. If something should go wrong with one kind of crop, the others will continue to produce the food we all need to live.

FOR ENROLLED STUDENTS

Please submit your student's work to your Oak Meadow teacher at the end of this lesson. Make sure all the assignments are completed (you can use the assignment checklist to help you organize your submission). Contact your teacher if you have any questions.

Learning Assessment

Use these assessment rubrics to track student progress throughout the year and to make notes about the learning the student demonstrates or skills that need work.

SKILLS	Developing	Consistent	Competent	Notes
Differentiates between producers, consumers, scavengers, and decomposers				
Demonstrates knowledge of food chains and food webs				
Shows awareness of the importance of diversity in an ecosystem				
Draws detailed, labeled illustrations				
Makes clear and detailed comparisons				
Demonstrates knowledge of the scientific method				
Displays focused observation skills				
Forms a hypothesis based on previous knowledge				
Follows the steps of the scientific method				
Records observations in detail in text				
Draws conclusions based on results				
Reflects on experiment process and ways to gain more accurate results				
Measures with accuracy and records accurate measurements				

Lesson 7

The Balance of Nature

Reading

Read "The Balance of Nature" (found in Reading Selections).

Assignments

1. Pick any animal of your choice. Draw a picture of this living thing in its natural habitat. List the things the animal needs in order to live. Include these things in your picture.

   Next, draw a picture of the same animal in a habitat that is not its own. Have your picture show how an animal out of its habitat stands out and might be easily caught by an enemy. List the dangers to your animal that exist in this foreign habitat.

2. Sometimes altering a place to create a more suitable habitat for other animals can cause problems. Do you own a cat or are there any nearby? When you complete the birdfeeder and birdbath this week (see the Activity section), what problems might the cat cause for the birds you hope to attract? What precautions can you take to keep the birds free from danger caused by your alteration of the habitat?

3. If you have space in your yard, start a small pile of bushes and branches that small animals may use for cover. After a week, examine it to see if any animals have "moved in." If you have any wild places near your home, look for similar piles of brush that provide a safe haven for animals in the wild.

   The National Wildlife Federation has a Wildlife Habitat Program that can give you ideas of other things you can do for local animals. Write to them for information:

ASSIGNMENT SUMMARY

- ☐ Read "The Balance of Nature."
- ☐ Show how an animal's habitat helps protect it.
- ☐ Consider how to make beneficial changes to a habitat.
- ☐ Learn how to help local wildlife.
- ☐ Identify examples of cooperation and competition.
- ☐ Show the natural camouflage of an animal's native habitat.
- ☐ Activity: Birdfeeder and Birdbath

MATERIALS

- ☐ **Birdfeeder and Birdbath**
  birdseed, pinecones, peanut butter, etc.
  shallow dish or planter

National Wildlife Federation
Backyard Wildlife Habitat Program
11100 Wildlife Center Drive
Reston, VA 20190
www.nwf.org/backyard/

When the information arrives, try out one or more of the ideas you receive. Write a short description of what you did and how it helped the local wildlife.

4. In a healthy ecosystem, everything fits its habitat. There is a good balance between cooperation and competition. For each situation below, identify whether it is an example of cooperation or competition:

   a. Bees are attracted to the sweet pollen of plants. Bees use the pollen to make honey. As they move from plant to plant, they transfer pollen from flower to flower, pollinating them and letting them reproduce. Flowers produce seeds that fall to the ground. The seeds eventually germinate and sprout into plants, and produce flowers that contain sweet pollen.

   b. Lots of deer used to live in the Grand Canyon. There were plenty of plants growing there. The deer ate the plants. Mountain lions, coyotes, and wolves ate the deer. There were plenty of deer for all of the mountain lions, coyotes, and wolves.

   c. Humans bring herds of cows and sheep to the plains near the Grand Canyon. These herds eat a lot of plants. Wolves, coyotes, and mountain lions begin to eat any cows and sheep they can catch.

   d. People living around the Grand Canyon decide to help the deer and save their cows and sheep by killing wolves, mountain lions, and coyotes. Many wolves, mountain lions, and coyotes were hunted and killed. Soon, the population of deer increased from 4,000 to 100,000. In the following two years over 60,000 deer died because they could not find enough food.

   e. People decide to stop killing coyotes, mountain lions, and wolves. The populations of the coyotes, mountain lions, and wolves rise again and the population of deer stays about the same from year to year.

5. Draw or find a picture of at least two of the following animals in their natural habitats. Your pictures should show how the animals blend into the habitats in which they live. For each animal and its habitat, tell what characteristics of the animal help it blend into its habitat.

   - a tiger in the tall grass and vegetation of the jungle
   - a grasshopper in the garden
   - a moth laying its eggs on the bark of a tree
   - a butterfly flying in a flower garden
   - a snake in the desert
   - a fish living among the seaweed and kelp beds of the ocean coast

Activity

Birdfeeder and Birdbath

Birds are always hungry. They need lots of energy to fly back and forth from their nests to their food sources and back again, many, many times a day. Some birds eat more than their own weight in bugs and grain in just one day!

Buy or make a birdfeeder for your backyard so that you can help local birds and observe them at the same time. Do some research, using books or by asking at a local gardening supply store, to find out about the types of seeds or nuts that attract different types of birds in your area.

You can make a birdfeeder in different ways:

- You can take a pinecone and coat it with unsalted peanut butter. Buy some unsalted sunflower seeds (in the shell), and roll the peanut butter covered pinecone in them. Hang the pinecone from a tree branch or on your porch.
- Get some unsalted peanuts in the shell and some orange peels. Tie string or thread around them, and hang them as you did with the pinecone feeder.
- You can even just scatter birdseed on a window ledge or other safe place so the birds can eat without risking an attack by a cat or dog.

To make a birdbath:

Find a large ceramic or plastic saucer like the ones used under potted plants. Fill it with water and place it close to your feeder. The water shouldn't be deeper than two inches at any time, but you should keep it filled to that depth regularly.

Place it where you can easily see it from a window. That way you can observe the birds' behavior without disturbing them. Watch and see who comes to your birdfeeder and who uses the birdbath. What do the birds do with the water?

Write a few sentences about your observations.

Further Study

You may want to contact the National Audubon Society and request information on supporting bird populations in your area.

There are plenty of other things you can do to attract other kinds of animals to where you live. Planting particular types of plants, trees, or shrubs can give certain animals more of the food or shelter they need. For instance, hummingbirds like red flowers; bats and moths like sweet smelling white flowers; and planting sunflowers can make your home a haven for hungry birds of all kinds.

Reading Selections

The Balance of Nature

Scientists study lots of different things in nature and examine them on many different levels. A biologist might examine a particular living thing such as a wild rose, a timber rattlesnake, or a specific kind of mushroom. Each of these things is an *individual*—it is one, separate, particular thing in an ecosystem. You are part of the human race, and you are part of your family, but you are also an individual.

A scientist might look at all the individuals in a particular area to see what they have in common. All individuals in a particular area are called a *population*. The city in which you live has a population, which is the number of people living there. You are an individual member of that population.

An *ecosystem* is a place that has many different kinds of things living there. There will be many populations of different things in an ecosystem. In a particular forest, there may be populations of snakes, slugs, and ants. There will be lots of individual ants, all of which make up the population of an entire anthill, or individual bees that make up the population of a hive. The study of these populations and how they interact with their environment is called *population ecology*.

All of the living things in an ecosystem are called a *community*. The community you live in is made up of many different types of living things: trees, dogs, cats, birds, flowers, and people. A community is a group of living things working together in a particular place. There may be many different populations in a community.

Community and Niche

Everybody plays a part in what goes on in any community. Where you live, some people are parents, others are children. Some of the dogs and cats are pets and are fed by people, while some animals may have no homes and have to find their own food. You might mow the grass that grows in your yard, or eat the vegetables from your garden. You might have a job on weekends, or be a member of the swim team. You breathe the fresh air produced by all of the plants in the area.

The roles things play in their community are called *niches*. Green plants are producers. Their job is being food for animals and making oxygen for animals to breathe. This is their niche.

You are a consumer who turns plants into energy, which powers your body and keeps it healthy. You also might mow the lawn, water the garden, or help take care of your brother or sister. These things you do all make up your niche. Your niche is your special job, one that can be done by no one but you.

Have you ever been bitten by a mosquito? You might think the world would be a better place if there were no mosquitoes. But mosquitoes have a very important niche in the community. They are food for birds, frogs, and fish. They exist in great numbers in the spring when these animals need lots of energy to grow and reproduce. Every animal plays an important role in the many different food chains that make up the web of life in the ecosystem where they live.

In a jungle, tigers hunt deer, and deer eat grass. Tigers live in one kind of home, and deer live in another. They live in the same jungle, but they each have their own niche. Every niche is important in an ecosystem because all of them are connected and depend on one another to tie the whole thing together.

Habitats

Every living thing has a place where it lives, eats, sleeps, and does its job. This place is called its *habitat*. Every plant and animal has a habitat. Its habitat is its home. In the forest, bugs and worms live in the soil. Blue jays and woodpeckers nest in hollow trees, fly through the air, and feed on insects that live in trees. Squirrels live in hollow tree trunks, but travel across wide areas to gather nuts that have fallen to the ground. Moles and worms live underground. Salamanders live in tiny streams, and frogs dwell at the water's edge. Many different kinds of fish may live in a river, but they don't all eat identical food, swim at identical speed or depth, or look for the same kinds of rocks to hide behind.

Every animal has to have a habitat where it can get all of the different things it needs to live. You need to have nutritious food, clean air, and pure water. For you to be able to survive in a habitat, all of these things must be there. Woodpeckers need hollow trees in which to nest, lay eggs, and nurture their young. They also need water and a big supply of insects to eat. It can't be too hot or too cold where they live, or they won't survive. All of these things need to be part of their habitat.

Living things often blend in with their habitats. This is because if animals are successful in not being eaten, they will pass on to their young those very characteristics that helped them live long enough to have babies. It is easier to avoid a hungry animal if you aren't easily noticed by them. Some creatures are camouflaged by the things around them, such as insects that look like leaves, or foxes that turn white in the snows of winter.

Often, if an animal or plant is placed in a habitat where they don't usually live, they stand out and are easily noticed. In a different habitat that is not its own, a living thing can be killed by an enemy or eaten more easily. An animal out of its habitat is usually an animal in danger of losing its life. This is why animals naturally stay close to home. Those that don't usually move only to find a better habitat, one that is safer or has more room or more food sources.

Birds migrate to find warmer places to have their babies. A bear roams many miles in search of fish for food, or to find a mate. For any plant or animal, its habitat is "home sweet home." There are many,

many things that we do that change habitats to make them better suited for certain living things or less attractive to others.

Have you ever watched a bird take a bath in a puddle of water or in a birdbath? Perhaps you have watched birds eating sunflower seeds or millet from a birdfeeder. Birdbaths and birdfeeders are two ways that people change habitats to make them more attractive to other animals. Particular types of birds are likely to come more often to an area where they can eat, drink, and bathe, as all of these things are necessary for them to live. If you put out a birdfeeder or birdbath where you live, you are changing your habitat in such a way that birds might find it more "homey." That's a good thing for you—you can observe birds closely and learn more about them—and also for them, because they have been given a larger habitat in which to live.

A Balanced Ecosystem

A healthy ecosystem is one in which all of the parts fit together so that everything works well. You know an ecosystem is healthy if everything has sufficient habitat. If everything in the community has a niche and a home that is not in danger of disappearing, the ecosystem is balanced.

Nature is balanced when it is left in an undisturbed state. Balance means that all parts of something are working together and are working well. Each of Earth's successful ecosystems is naturally balanced and each of them is connected in ways that help balance each other. But things can happen (and they do!) that cause ecosystems to get out of balance.

Here is an example of what can happen when an ecosystem gets out of balance. Consider a group of farmers who are upset because skunks, weasels, and hawks are eating their chickens. They certainly have reason to be upset, but let's consider the original disturbance that led to this situation. Perhaps land where these farms are now was originally part of a large forest, a forest in ecological balance. The trees were cut and used for wood to build the farm buildings. The clearing of the trees was a disturbance that had a huge impact on the ecosystem, and therefore on the habitats of plants and animals living there. Woodpeckers and squirrels probably lost their hollow-tree homes. Bugs that once lived in the shade and moisture now had to contend with direct sunlight and a drier ecosystem. Many populations died and many others were attracted to the clear area where lots of sunlight was available. Then farmers planted crops that again changed the balance of the area—another disturbance.

But the farmers (who were also struggling with bugs eating their crops) were probably not thinking of this when they became angry at the animals. They were looking at the situation only from the point of view of their own need, which was to protect their chickens. They grabbed their guns, set their traps, and killed as many skunks, weasels, and hawks as they could, causing yet another disturbance in the ecosystem.

You may think that now all the farmers and their chickens could be happy. Right? Wrong! Skunks, weasels, and hawks don't eat only chickens. In fact, if farmers or people didn't introduce chickens into the ecosystem, these creatures wouldn't eat them at all. Chickens are not usually part of a habitat where skunks, weasels, and hawks live. Skunks, weasels, and hawks naturally eat lots of mice, gophers, and rabbits. (These are all animals that love areas of open space near more forested areas.)

So what happens when the farmers kill off most of the skunks, weasels, and hawks? Then there's suddenly an abundance of mice, gophers, and rabbits. The farmers will find that, while their chickens are fine now, they have many more mice eating their stored grain, and gophers and rabbits feasting on everything they can find in the farmers' gardens. In trying to solve one problem, the farmers have created more, different, and maybe even bigger problems than they had before. This is an example of what can happen when an ecosystem gets out of balance, and how easily a system can be thrown out of balance by shifting one element.

How does an ecosystem get back in balance again? Naturally, all ecosystems tend to try and balance themselves, but it can take time. In our example, once the farmers find themselves overrun with mice, gophers, and rabbits, they may stop killing the hawks, skunks, and weasels. If they do, soon the populations of these animals will rise again and keep the populations of mice, gophers, and rabbits under control. Before long the ecosystem will be in balance again.

Cooperation and Competition

Ecosystems stay healthy by the continual balancing of two forces. These two forces are *cooperation* and *competition*. Cooperation is when different living things work together for the good of both. Cooperation is a major characteristic of old or mature ecosystems. The old-growth forests of the Pacific Northwest and the tropical rain forests of South America are two examples of mature ecosystems where all living things contribute to the support of all the others. For instance, giant sequoias, tree voles, spotted owls, ferns, and fungi all support one another in an old-growth forest ecosystem. They help one another live. This is the essence of cooperation.

There are many fascinating examples of cooperation in the animal world. There are fish, for example, that allow other, tiny fish to live inside their gills. The tiny fish are protected from predators, and in turn eat the fungi that grow along the gills of the larger fish. This system helps both kinds of fish.

Competition happens when two or more living things depend upon the same things for life, so they compete for what they need. Competition is often a struggle where one population (or individual) succeeds in getting what it needs, and therefore thrives, and another population doesn't. The population that doesn't get what it needs either has to live on what is left over, or change its ways in order to

survive, otherwise it will die. Animals or plants may compete for food, air, space, water, mates, or anything else they need to live.

There are only so many mice, gophers, and rabbits in an ecosystem. The hawks, skunks, and weasels all share them in their food chains. The hunters who are the quickest, quietest, and maybe the hungriest, catch and eat them. Those who cannot catch their own food will have a harder time getting enough to eat. They will either go hungry (and then maybe become sick or die), or they might change and find another food source. This kind of change is called *adaptation*. Animals and plants both adapt to new circumstances in order to survive, at least within certain limits. If they can't compete and they can't adapt, they die.

Competition is an important part of a young ecosystem that has resulted from some sort of major disturbance. If an area of old-growth forest is cut and cleared, or burned by a forest fire, the first plants and animals that move into the area will be those using lots of sunlight. They will struggle against each other for a place to get all the energy they need because the resources may be limited. This is a result of the disturbance that destroyed the natural balance of the area (the cutting of the forest or the fire). If left to progress naturally without further serious disturbances, an ecosystem will gradually change from being mostly competitive to being mostly cooperative.

When plants and animals work together to obtain enough food and water, light, and fresh air, there is cooperation. All of them need water to live. If there is a change and there is not enough water to go around, then some will get sufficient water and others will not. This is competition.

Competition doesn't mean fighting over something. All it means is that they share a common need. As long as there is enough to go around, everything is okay. If there is not enough to go around, the populations will decline to keep everything in balance. This is how ecosystems keep themselves in balance through the two processes of cooperation and competition.

FOR ENROLLED STUDENTS

Continue to document your student's progress using your weekly planner, assignment checklist, and learning assessment form in each lesson. Feel free to contact your teacher if you have any questions about the assignments or the learning process.

Learning Assessment

Use these assessment rubrics to track student progress throughout the year and to make notes about the learning the student demonstrates or skills that need work.

SKILLS	Developing	Consistent	Competent	Notes
Shows understanding of beneficial and disruptive changes to a habitat				
Identifies examples of cooperation and competition in an ecosystem				
Demonstrates knowledge of food chains and food webs				
Shows awareness of the importance of diversity in an ecosystem				
Draws detailed, labeled illustrations				
Makes clear and detailed comparisons				
Demonstrates knowledge of the scientific method				
Displays focused observation skills				
Forms a hypothesis based on previous knowledge				
Follows the steps of the scientific method				
Records observations in detail in text				
Draws conclusions based on results				
Reflects on experiment process and ways to gain more accurate results				
Measures with accuracy and records accurate measurements				