Ecology: Organisms in Their Environments
from the series
*Biology: The Science of Life*

Teacher's Guide by
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Distributed by...
Ecology: Organisms in Their Environments

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INTRODUCTION TO THE SERIES

This series of programs was designed in accordance with the guidelines for teaching Life Science as proposed by the American Association for the Advancement of Science.

INTRODUCTION TO THE PROGRAM

This fifteen-minute program examines the interactions between organisms in their environments. The program addresses two important questions posed by core-curriculum standards. The first is, "What are ecosystems and how do organisms interact in them?" The second is, "How do matter and energy flow in the environment?" The concepts of ecosystem, population, niche, food chain, food web, energy pyramid, and the carbon cycle are all explained in this program.

LINKS TO CURRICULUM STANDARDS

This program was designed to meet the curriculum standards of the California Public Schools, the McREL standards for the Life Sciences, and the National Science Education Standards.

A. California Life Science teaching standards Section C, Ecosystems.

1. What are ecosystems and how do organisms interact in ecosystems?

2. How does energy flow within an ecosystem?
B. McREL Life Science Standard Six:
The relationships among organisms and their physical environment.

C. National Science Education Standard:
"Populations and Ecosystems"

SUMMARY OF THE PROGRAM

This program is divided into several major topics that are presented in this order:
• Introduction
• Ecosystems
• Populations, Habitats, and Niches
• Food Chains and Food Webs
• Pyramids of Energy and Numbers
• The Carbon Cycle
• Conclusion

INSTRUCTIONAL NOTES

Before presenting these lessons to your students, we suggest that you preview the program, review the guide, and the accompanying Blackline Master activities in order to familiarize yourself with their content.

As you review the materials presented in this guide, you may find it necessary to make some changes, additions or deletions to meet the specific needs of your class. We encourage you to do so; for only by tailoring this program to your class will they obtain the maximum instructional benefits afforded by the materials.

PRE-TEST AND POST-TEST

Pre-Test is an assessment tool intended to gauge student comprehension of the objectives prior to viewing the program. Remind your students that these are key concepts upon which they should focus while watching the program.
Post-Test is an assessment tool to be administered after viewing the program and completing additional activities. The results of this assessment can be compared to the results of the Pre-Test to determine the change in student comprehension before and after participation in this lesson.

STUDENT PREPARATION

Set up an ecology learning center using diagrams, charts, or captioned photographs to demonstrate key ecological concepts such as ecosystem, population, species, food chain, habitat, and niche. Newspaper or magazine articles on invasive species could also be included in this display.

STUDENT OBJECTIVES

After viewing the program and completing the follow-up activities, students should be able to:

1. Chart the organization of simple food webs and chains in terms of producers, consumers, and decomposers.
2. Explain the concept of an ecosystem.
3. Describe how energy is transmitted through food webs.
4. Define how matter is recycled in ecosystems in the carbon cycle.
5. Explain the concepts of species, population, habitat, and niche.

INTRODUCING THE PROGRAM

A good way to introduce this program would be to discuss how intricately organisms are linked to the environments they share with other organisms (biotic factors), as well as to the physical environment itself (abiotic factors). Talk about what comprises a "healthy" ecosystem; contrast to an "unhealthy" ecosystem.
VIEW THE PROGRAM

Running Time: 15 minutes including a one-minute, five-question Video Quiz.

Hand out Blackline Master #3, Video Quiz.

DISCUSSION QUESTIONS

The following are some suggested topics for post-viewing discussion:
• invasive species
• the number of common plants that are non-native, e.g., dandelion and clover
• the movement of matter and energy through ecosystems
• conflicts encountered meeting healthy ecological goals: balancing economic versus biological needs

DESCRIPTION OF BLACKLINE MASTERS

Blackline Master #1, Pre-Test, is an assessment tool intended to gauge student comprehension of the objectives prior to viewing the program.

Blackline Master #2, Post-Test, is an assessment tool to be administered after viewing the program and completing additional activities. The results of this assessment can be compared to the results of the Pre-Test to determine the change in student comprehension before and after participation in this lesson.

Blackline Master #3, Video Quiz, is an assessment tool primarily intended to promote student attention to the program presentation

Blackline Master #4, Crossword Puzzle, is a puzzle game based on information presented in the Vocabulary.
Blackline Masters #5 and 6, Vocabulary List and Activity, important words and names pertaining to Ecology: Organisms in Their Environment.

EXTENDED LEARNING ACTIVITIES

Papers, oral reports, or presentations could be done on the following subjects:
1. Local invasive species: problems caused and how they are being solved.
2. An analysis of food webs in different ecosystems.
3. The concept of species: How does it apply in organisms that reproduce asexually?
4. The ways in which useable energy disappears from ecosystems.

ANSWER KEY

Blackline Master #1, Pre-Test
1. True
2. True
3. False: Food chains are based on feeding links between organisms. Food chains are different routes in which, matter and energy can flow through an ecosystem.
4. False: Food webs are interconnected food chains.
5. False: Ecosystems can be damaged when non-native species are introduced into them because native species get crowded out.

Blackline Master #2, Post-Test
1. d       6. d
2. b       7. d
3. c       8. b
4. c       9. d
5. b       10. b

Blackline Master #3, Video Quiz
1. False: Living things make up the biotic factors. Abiotic factors are nonliving things such as water and air.
2. True
3. False: A niche is the unique role of an organism in an ecosystem. A habitat is a place in which an organism lives.
4. True
5. False: Many food-producers are needed to support just a few third-order consumers.

Blackline Master #4, Crossword Puzzle

<table>
<thead>
<tr>
<th>Blackline Master #4, Crossword Puzzle</th>
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<tbody>
<tr>
<td>P C A</td>
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<tr>
<td>FIRST ORDER CONSUMERS</td>
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<tr>
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Blackline Master #6, Vocabulary Activity

1. first-order consumers
2. population
3. cellular respiration and combustion
4. energy
5. biotic

SCRIPT OF NARRATION

Introduction
The science of ecology is the branch of biology that is devoted to the study of organisms in their environments.
In particular, ecology examines the relationships and the interactions of living things with each other and with the environment in which they live.

The Earth supports a vast diversity of environments that possess very different physical characteristics in terms of climate, moisture, temperature and so on. Every part of an environment is interdependent on every other part: The nonliving parts support living organisms and, in turn, the living organisms help to renew the non-living environment.

**Ecosystems**

Ecologists study ecosystems. An ecosystem is defined as all the interactions of a group of organisms living in a certain area with one another and with their physical environment. There are a lot of differences in the amount of area ecosystems occupy, for they literally can be as small as this drop of pond water, or as large as this tropical jungle. The variations in ecosystems are based on two different factors. First, are the non-living things known as abiotic factors; things such as water and light. Second, are the biotic factors, the living community of organisms. For example, in terms of both abiotic and biotic factors, the “wet-lands” ecosystem of this swamp, is very different from the ecosystem of this rugged ocean shoreline, which in turn is quite different from the tundra ecosystem found on this snowy mountaintop.

In order to better understand what an ecosystem is, let us take a closer look at some of the factors present in the ecosystem of a swamp. Water is a swamp’s most important abiotic feature, for it plays a key role in supporting a huge biotic community consisting of aquatic organisms. Water provides them with a place in which to move about and supplies the moisture they need to stay alive. Untold trillions of organisms, of ten of thousands of different types, inhabit every swamp ecosystem. And each day, each member, of each interdependent community, plays
its own special role in the great drama of life. The community of organisms in a swamp ecosystem would include tiny rod-shaped bacteria like these, one-celled animal-like and plant-like protists, microscopic multicelled animals, such as this cyclops, and much larger animals, such as fish to name just a few. Living on the water's surface are a different assortment of organisms consisting of plants, insects, and large animals like frogs and turtles. Of course, there are also birds and mammals that are attracted to swampy environments because they are good places to hunt. And for water-loving cypress trees they are excellent places to put down roots.

**Populations, Habitats, and Niches**

When studying the community of organisms in a particular ecosystem, ecologists place them into various groups based on certain characteristics in order to make them easier to understand. The most basic of these are the natural breeding groups called populations. A population is a group of the same species of organism that shares the same environment. The term species refers to organisms that are able to interbreed and produce fertile offspring. For example, in certain ecosystems it is possible to find two distinct populations of frogs. There is a population made up of a species of small frogs like this one that dwell in trees, and another population of a different species of larger frogs that prefer to dwell in ponds. Because they belong to different species, a male tree frog and a female pond frog are unable to mate and cannot produce living offspring like those seen here.

**Population Size**

The success of certain biological processes, such as mating and obtaining food, also depends on having populations of a large enough size. For example, certain butterflies need good-sized populations of particular flowering plants to get enough food to support an adequate breeding population.
Big changes in certain populations often indicate big ecological problems. For example, when the West Nile virus kills-off ravens, the populations of the rodents and insects they eat will automatically increase. And when non-native species, such as European zebra mussels invade ecosystems like those in the Great Lakes, various native species get crowded out and their populations can be brought to the brink of extinction.

Habitats
Different populations interact with other members of their ecological community in different ways depending on their own particular needs. For example, maple trees require a lot of light to support their life processes and produce dense canopies of leaves high above the forest floor in order to gather the sun's energy. Their leaves create a shady habitat for plants, such as ferns that don't do well in a lot of sunlight. A habitat is the particular place in which an organism lives.

Niches
Besides their physical habitats, organisms also occupy distinct niches within the ecosystem as well. A niche is the unique role an organism plays in its community or environment. For example, this clown fish occupies a very special niche in certain coral reef ecosystems. Clown fish are not affected by the stinging tentacles of sea anemones and live among them without fear, in other words, sea anemones provide a safe habitat for clown fish. At the same time, part of the role or niche of the clown fish in the community of coral reef organisms is to act as bait, luring other fish into the sea anemone's mouth, where they can be stung and eaten.

Food Chains and Food Webs
Organisms take from their environments the matter and energy they need to sustain their lives. The energy in the environment eventually gets used up, but the atoms of
matter in the environment are used over and over again. The "recycling" of the materials needed for life has been going on for billions of years and in a healthy ecosystem is maintained in a state of near perfect balance.

**Food Chains**
Both matter and energy flow through ecosystems whenever organisms feed on one another, creating what ecologists call food chains. Different food chains provide different routes for the transfer of energy and materials through an ecosystem.

Food producers are the first link in every food chain. Food producers are organisms such as plants or algae that can capture the raw energy of sunlight and, by the process of photosynthesis, convert it into the chemical energy of food. After food producers, in a food chain are the first-order consumers. These are organisms that eat the food producers. A familiar example of first-order consumers are leaf-eating animals, such as these caterpillars. Next, in a food chain are the second-order consumers, such as caterpillar-eating lizards that eat the first-order consumers. Then, there are the third-order consumers that eat the second order consumers. For example, a bird that eats a caterpillar-eating lizard would be a third-order consumer. Organisms such as fungi, protests, and certain bacteria normally act as decomposers in ecosystems by breaking down dead organisms into simple nutrient materials that are used by food producers. However, decomposers are capable of feeding off of living organisms too.

**Food Webs**
Food chains almost always overlap with one another. That is why ecologists use the term food webs to describe the more complicated feeding relationships they observe. Food webs are defined as all the interconnected food chains that can exist in an ecosystem.
Pyramids of Energy and Numbers

Pyramids of Energy
In every food chain, as the materials needed to sustain life pass from producers to consumers, useable chemical energy is gradually lost to the environment in the form of heat. Ecologists depict the flow of energy through a food chain by using a diagram like this one, called a pyramid of energy. In such a diagram the producers form the base, next are the first-order consumers, followed by second-order consumers, with the third-order consumers at the top. One scientific study of energy flow, concluded that only 16% of the energy from food producers is passed on to the first-order consumers that eat them. After that, only 11% of the energy stored in the bodies of the first-order consumers are passed on to the second order consumers. When third-order consumers eat the second-order consumers only five percent of the available energy is passed on.

Pyramids of Numbers
To make this easier to understand, ecologists use a pyramid of numbers based on the number of organisms needed to make a simple food chain. For example, one study showed that it took 175 food-producing plants to support 40 first-order consumers like caterpillars. Forty first-order consumers were needed to support five, second-order consumers, such as the lizards that eat caterpillar, they in turn supported just one, third-order consumer, such as a lizard-eating bird. This pyramid clearly demonstrates how in a food chain large populations of certain organisms are needed to support very small populations of other organisms.

The Carbon Cycle: Recycling Matter
Chemically speaking, all life is based on carbon. This element of matter moves through ecosystems in what is called the carbon cycle. The carbon cycle starts with air because air contains carbon dioxide gas, a chemical
compound made from one atom of carbon and two of oxygen. Land-plants absorb carbon dioxide into their leaves and make sugar and other carbohydrates that can chemically store the sun's energy. Carbon dioxide also diffuses into water where it is used by aquatic food producers, such as seaweed. When organisms feed, they obtain both the chemical energy stored in carbohydrates and the carbon atoms the carbohydrates contain. Some carbon atoms are used to build body tissues. And others are released back into the environment as carbon dioxide when living things use chemically stored energy. Carbon is also returned to the environment when wood or fossil fuels are burned and when decomposers carry out the process of decay.

The carbon cycle clearly illustrates how the materials of life, in this example, carbon atoms, are borrowed for awhile by one organism and are passed on to others through food webs, or else are returned to the physical environment where they can be used again by other living things.

**Video Quiz**

1. True or False? The living things in an ecosystem make up its abiotic factors.

2. True or False? Different populations are composed of different species of organisms.

3. True or False? A niche is the particular place in which an organism lives.

4. True or False? Food webs are made up of interconnected food chains.

5. True or False? In food chains many third-order consumers are needed to support only a few food producers.
Pre-Test

Directions: Answer each of the following either true or false.

1. Ecosystems are made up of both living and non-living things. True___ False____

2. Ecosystems can be very large or very small. True___ False____

3. Ecologists use food chains to keep animals from eating certain plants. True___ False____

4. Food webs are woven by spiders and caterpillars. True___ False____

5. Ecosystems are always improved when non-native species are introduced into them. True___ False____
Directions: Circle the correct answer from among the following choices.

1. Within food chains, matter is ___________.
   a) constantly increasing
   b) constantly decreasing
   c) always changing from one element to another
   d) always recycled from one chemical form into another

2. Within food chains energy is ___________.
   a) always increasing
   b) always being lost to the environment as heat
   c) doesn't change in amount and is recycled
   d) is continually being converted into matter

3. In a pyramid of numbers, you would not expect to find ___________.
   a) a large number of food producers supporting a few second order consumers
   b) decomposers feeding on living things
   c) third-order consumers carrying out photosynthesis
   d) first-order consumers eating food producers

4. Which of the following is true?
   a) Each population of organisms contains many different species.
   b) Every frog in an ecosystem belongs to the same population.
   c) Each population of frogs in an ecosystem is made up of members of one species.
   d) Every ecological community is based on one population of organisms.

5. The carbon cycle describes ___________.
   a) the movement of nitrogen through the environment
   b) the movement of carbon in ecosystems
   c) the events that happen when carbon is changed into nitrogen
   d) the events that happen when energy is converted into carbon

6. Different species cannot ___________.
   a) be in the same food chain
   b) be in the same food web
   c) live in the same habitat
   d) interbreed to produce fertile offspring

7. A niche is _________________.
   a) a small population of organisms
   b) a place in which organisms live
   c) a large collection of ecosystems
   d) the role an organism plays in an ecosystem

8. Which is an abiotic factor of an ecosystem?
   a) ferns
   b) water
   c) birds
   d) fish

9. Ecosystems are not based on ___________.
   a) interrelationships
   b) interactions
   c) feeding patterns
   d) one species

10. Food producers do not need ________ to make sugar.
    a) carbon dioxide
    b) nitrogen dioxide
    c) water
    d) light
Video Quiz

Directions: Answer the following either true or false.

1. True or False? The living things in an ecosystem make up its abiotic factors.

2. True or False? Different populations are composed of different species of organisms.

3. True or False? A niche is the particular place in which an organism lives.

4. True or False? Food webs are made up of interconnected food chains.

5. True or False? In food chains, many third-order consumers are needed to support only a few food producers.
ECOLOGY: ORGANISMS IN THEIR ENVIRONMENTS
from the series Biology: The Science of Life

Crossword Puzzle

Across
3. In food chains these organisms eat the food producers.
5. This is the special role of an organism in a certain environment.
6. These organisms break down material into nutrients for food producers.
8. These complex feeding relationships are formed from overlapping and interconnected food chains.
9. These are the special places in which an organism lives.
10. Ecologists study these interactions between organisms and their physical environment that occur within a certain area.

Down
1. These diagrams are used to show how energy flows in a food chain.
2. All life is based on this chemical element.
4. Food producers can carry out this special light dependent chemical process.
7. Organisms that belong to these groups can interbreed and produce fertile offspring.
The following are important words and names pertaining to *Ecology: Organisms in Their Environments*. Listen for these terms while viewing the program; pay close attention so you can include them in your writing assignments.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>abiotic factors</strong></td>
<td>the non-living things in an ecosystem.</td>
</tr>
<tr>
<td><strong>atom</strong></td>
<td>a tiny particle of matter.</td>
</tr>
<tr>
<td><strong>biotic factors</strong></td>
<td>the living things in an ecosystem.</td>
</tr>
<tr>
<td><strong>carbohydrates</strong></td>
<td>chemical compounds containing carbon, hydrogen, and oxygen. Sugar is a carbohydrate. Carbohydrates store energy in their chemical bonds.</td>
</tr>
<tr>
<td><strong>carbon cycle</strong></td>
<td>the movement of carbon atoms through an ecosystem between living organisms as well as the non-living part of the environment.</td>
</tr>
<tr>
<td><strong>carbon dioxide</strong></td>
<td>a chemical compound made from one atom of the element carbon and two atoms of the element oxygen. The chemical formula for carbon dioxide is CO₂.</td>
</tr>
<tr>
<td><strong>cellular respiration</strong></td>
<td>the process of releasing energy stored in carbohydrates. Respiration produces carbon dioxide and water. Respiration usually requires oxygen.</td>
</tr>
<tr>
<td><strong>chemical compound</strong></td>
<td>a molecule composed of atoms of two or more different elements.</td>
</tr>
<tr>
<td><strong>combustion</strong></td>
<td>the process of burning such things as wood or fossil fuels. Combustion releases carbon dioxide and water, as well as stored energy.</td>
</tr>
<tr>
<td><strong>community</strong></td>
<td>the living part of an ecosystem.</td>
</tr>
<tr>
<td><strong>decomposers</strong></td>
<td>organisms such as fungi and bacteria that break down the complex chemical compounds made by living things into simple nutrients that are used by food producers.</td>
</tr>
<tr>
<td><strong>element of matter</strong></td>
<td>a basic type of matter such as the elements carbon, sulfur, iron, and oxygen. Every element has a different atomic structure.</td>
</tr>
<tr>
<td><strong>ecology</strong></td>
<td>the study of the relationships and interactions of living things with one another and with their physical environment.</td>
</tr>
<tr>
<td><strong>ecosystem</strong></td>
<td>all the interactions and relationships of organisms with one another and with their physical environment within a certain area.</td>
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<tr>
<td><strong>energy</strong></td>
<td>the ability to do work. Such things as light and heat are examples of energy. Energy has no mass (weight) and occupies no space.</td>
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<tr>
<td><strong>extinction</strong></td>
<td>the complete destruction of an entire species of organism.</td>
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<tr>
<td><strong>fertile offspring</strong></td>
<td>offspring that will mature and be able to reproduce.</td>
</tr>
<tr>
<td><strong>first-order consumers</strong></td>
<td>organisms that eat food producers.</td>
</tr>
<tr>
<td><strong>food chains</strong></td>
<td>energy links between different organisms in an ecosystem based on feeding habits.</td>
</tr>
<tr>
<td><strong>food producers</strong></td>
<td>organisms such as plants and algae, which through the process of photosynthesis create energy-rich food.</td>
</tr>
<tr>
<td><strong>food web</strong></td>
<td>interconnected food chains in an ecosystem.</td>
</tr>
<tr>
<td><strong>habitat</strong></td>
<td>the place in which an organism lives.</td>
</tr>
<tr>
<td><strong>interbreeding</strong></td>
<td>breeding that occurs only with its species and that produces fertile offspring.</td>
</tr>
<tr>
<td><strong>matter</strong></td>
<td>the material of the universe: those things that occupy space and have weight.</td>
</tr>
<tr>
<td><strong>niche</strong></td>
<td>the special role of an organism in its community or environment.</td>
</tr>
<tr>
<td><strong>nutrient</strong></td>
<td>a simple chemical compound used to nourish living things: the useable part of food.</td>
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<tr>
<td><strong>photosynthesis</strong></td>
<td>a chemical reaction in which carbon dioxide and water are combined in the presence of chlorophyll and sunlight to form energy-rich sugar.</td>
</tr>
<tr>
<td><strong>population</strong></td>
<td>a group of organisms of the same species living in the same ecosystem.</td>
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<tr>
<td><strong>protists</strong></td>
<td>one-celled animal and plantlike organisms that possess a nucleus. Members of the Kingdom Protista.</td>
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<tr>
<td><strong>pyramid of energy</strong></td>
<td>a pyramid-shaped diagram of energy flow in a food chain.</td>
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<tr>
<td><strong>pyramid of numbers</strong></td>
<td>a pyramid-shaped diagram like a pyramid of energy that lists the number of organisms (or the mass of the organisms) at every level of a food chain.</td>
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<tr>
<td><strong>second-order consumer</strong></td>
<td>organisms that eat first-order consumers.</td>
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<tr>
<td><strong>species</strong></td>
<td>very similar organisms that can interbreed and produce fertile offspring.</td>
</tr>
<tr>
<td><strong>third-order consumer</strong></td>
<td>organisms that eat second-order consumers.</td>
</tr>
<tr>
<td><strong>West Nile virus</strong></td>
<td>a virus from Africa that causes death or serious sickness among birds and humans.</td>
</tr>
<tr>
<td><strong>zebra mussel</strong></td>
<td>a species of small mussel not native to North America that is currently disrupting the ecosystem of the Great Lakes due to its rapidly expanding population.</td>
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</tbody>
</table>
Vocabulary Activity

Directions: From the vocabulary list select the correct word to fill in the blanks.

1. In a food chain organisms that eat food producers are called _____________________.

2. A ______________ is a group of organisms in an ecosystem that are all members of the same species.

3. Carbon dioxide is produced by both the processes of _____________ and ______________.

4. ____________________ is the ability to perform work.

5. All the living things in an ecosystem are called the _____________ factors.