

Some Background Concerning Life Science Content Standards for Fourth-Grade Teachers:

Energy and Matter in Ecosystems

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Introduction

The background information for teachers in this document addresses the following life science content standards¹ for fourth-grade teachers:

- 2. All organisms need energy and matter to live and grow. As a basis for understanding this concept:***
- a. Students know plants are the primary source of matter and energy entering most food chains.*
 - b. Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.*
 - c. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.*

¹ As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp. 60-61.

Biological Overview: Hierarchy of Ecological Structures

If a biologist studies just the species (biota) living in a defined area, the biologist is studying a *biological community*. If the biologist also considers the abiotic portions of that defined area (such as, sunlight energy and/or mineral-nutrients), the biologist is studying an *ecosystem*. An *ecosystem* can be very small (e.g., the biota and abiota of a small pond community) to very large (e.g., the biota and abiota of our entire planet).

Life science students sometimes have difficulty remembering what level of biological structure is being discussed in each classroom activity. Therefore, Table 1 is an important overview for life science students studying ecosystems.

Table 1. Hierarchy of ecological structures composed of many living organisms (biota). Biologists study how plants and animals interact with each other and with their environment. This table is best used by starting at *organism* and working up through larger and larger structures composed of many organisms.

Level of Biological Organization	Description	Animal Examples	Plant Examples
Biosphere*	All living creatures on the planet (on land and in water)	All biomes on Earth	All biomes on Earth
Biome*	All communities within a regional vegetation type	Catalina Island is in a chaparral biome	San Francisco Bay Area is in an oak savanna biome
Biological Community*	All populations of all species present in a given area	All species of plants and animals living on Catalina Island	All species in a meadow near San Francisco Bay
Population	All individuals of one species in an area (area can be defined to be small to large)	All people living on Catalina Island	All California poppies in a meadow near San Francisco
Organism	One individual of a species	You!	California poppy

*Note that the levels of *community*, *biome*, and/or *biosphere* can also be described as *ecosystems* when we are referring to both the *biotic* and *abiotic* components of the environment.

Life Science Topic: Energy and Matter in Ecosystems

The flow of energy and matter through an ecosystem is called a food chain. The combination of several interconnected food chains in an ecosystem is called a food web.

Plants Capture Energy and Matter

Science Framework² for California Public Schools

Grade 4: Standard Set 2. Life Sciences: 2.a. "*Students know plants are the primary source of matter and energy entering most food chains.*"

"A food chain is a representation of the orderly flow of matter and energy from organism to organism by consumption. Plants harness energy from the sun, herbivores eat plants, and carnivores eat herbivores. Solar energy therefore sustains herbivores and, indirectly, the carnivores that eat them; this is the important principle to be taught."

Background for Teachers

The source of energy for almost all ecosystems on Earth is the sun³. Sunlight enters an ecosystem when it is captured and stored as food by photosynthetic organisms: plants, algae, and blue-green bacteria.

The sunlight energy stored in the food is passed on to consumers that eat the plant, or eat an animal that has eaten the plant until all of the energy is eventually released as heat energy (by each organism) back into outer space.

**Energy in ecosystems comes to the Earth as sunlight
and then leaves the Earth as heat
– energy travels in a one-way flow.**

If no sunlight reached our ecosystem, our ecosystem would not function. We are very dependent on the sun! If no photosynthetic organisms were present to capture the sunlight, our ecosystem would not function. We are very dependent on plants, algae, and blue-green bacteria!

² As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp. 60-61.

³ Note that sea vent ecosystems in the dark, deep bottom of the ocean are an exception; their ecosystems are driven by chemical energy captured by chemosynthetic bacteria.

See website: http://www.jochemnet.de/fiu/OCB3043_42.html

This website provides information, photographs, maps, and diagrams documenting these unusual ecosystems.

Food Chains Indicate the Flow of Energy and Matter **Science Framework⁴ for California Public Schools**

Grade 4: Standard Set 2. Life Sciences: 2.b. *"Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem."*

"Students may recall from previous grade levels that animals eat plants or other animals. This standard extends the subject to a greater depth. Food chains and food webs represent the relationships between organisms (i.e., which organisms are consumed by which other organisms). Generally, food chains and food webs must originate with a primary producer, such as a plant that is producing biomass. Herbivores and omnivores eat the plants; carnivores (secondary consumers) in turn eat the herbivores and omnivores. Decomposers consume plant and animal waste, a step that returns nutrients to the soil and begins the process again. Decomposers, such as fungi and bacteria, should be included at each level of the food web as they consume the remains and wastes of plants and animals."

Background for Teachers

Each organism in an ecosystem has a general ecological function – it either makes food or consumes food. Organisms that make food capture sunlight and use the sunlight energy to build molecules of food (the sunlight energy is then stored in the food molecule as chemical energy) -- these organisms produce food (producers). Organisms that eat food use the chemical energy stored in the food molecules -- these organisms consume food (consumers). Consumers can be herbivores, carnivores, omnivores, scavengers, or decomposers.

Energy flows through an ecosystem as chemical energy in food molecules. Figure I shows the flow of energy through a simple food chain; Figure 1 shows energy flow through a more complex food web.

⁴ As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp. 60-61.

Energy Flow through a Simple Ecosystem

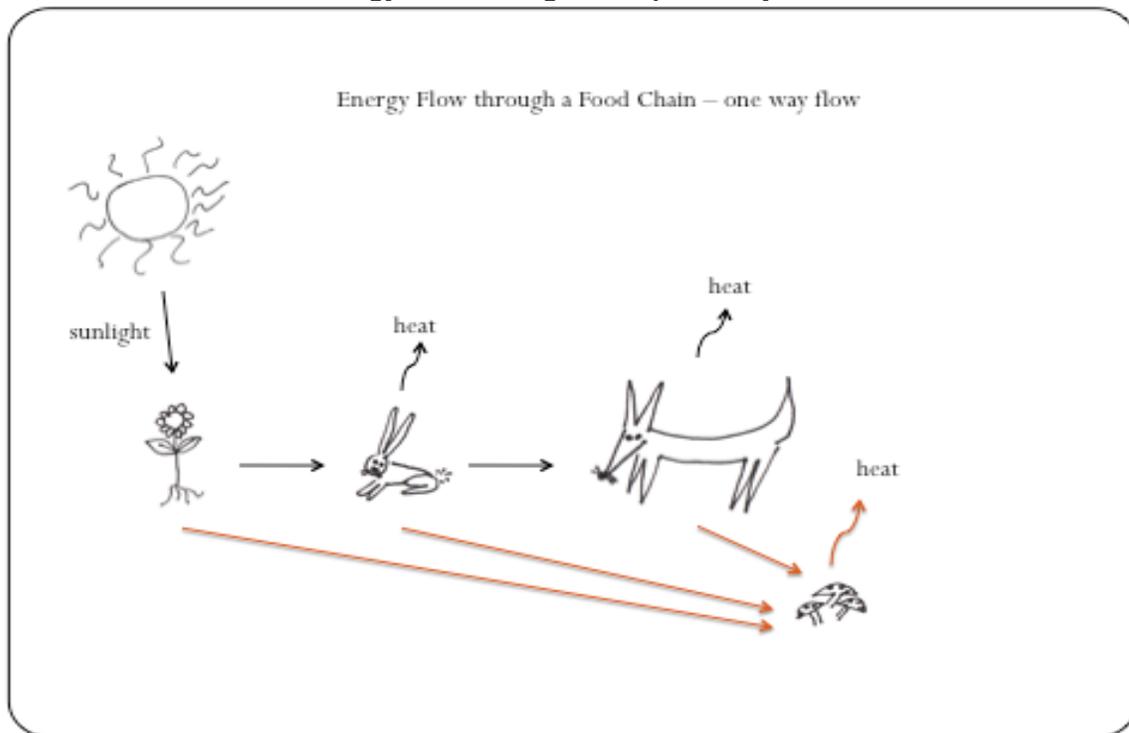


Figure 1. Movement of energy through a simplified food chain of an ecosystem. Energy enters the ecosystem as sunlight, travels through the ecosystem as chemical energy in food molecules, and leaves the ecosystem as heat.

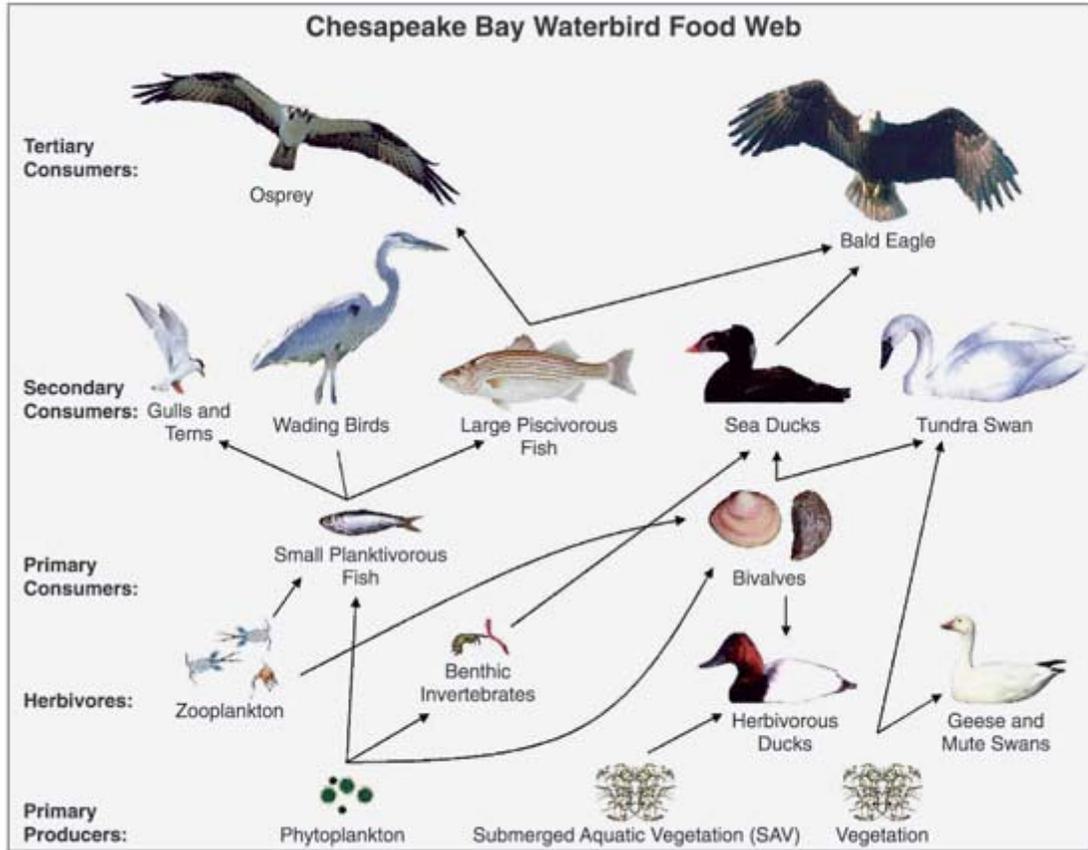


Figure 2. Diagram⁵ of food web of an ecosystem. Energy enters the ecosystem as sunlight, travels through the ecosystem as chemical energy in food molecules, and leaves the ecosystem as heat.

⁵ Image from: http://commons.wikimedia.org/wiki/File:Chesapeake_Waterbird_Food_Web.jpg

Decomposers Recycle Matter

Science Framework⁶ for California Public Schools

Grade 4: Standard Set 2. Life Sciences: 2.c. *"Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals."*

"Plant and animal wastes, including their dead remains, provide food for decomposer organisms such as bacteria, insects, fungi, and earthworms. Decomposers are adept at breaking down and consuming waste materials and therefore complete the food chain, returning nutrients to the soil so that plants may thrive as producers. Bacteria and fungi also pass energy to other parts of a food web. Those microorganisms are themselves consumed by slightly larger organisms, such as worms and small insects, and those small consumers are food for larger animals, such as birds. Microorganisms and their biological ability to decompose matter may be observed in video or film productions using time-lapse photography. Molds grown on bread and fruit may be studied with the use of magnifying lenses; however, it is dangerous for a class to collect wild fungi, culture bacteria, or molds derived from soils or rotting meats."

Background for Teachers

Decomposers are a special type of consumer that absorb (rather than eat) food and release mineral-nutrients (molecules) from the food back into the soil, which plants can then use again.

Atoms (matter) enter an ecosystem when they are taken up by plants in mineral-nutrient⁷ molecules and stored in food molecules. The atoms stored in the food molecules are passed on to consumers that eat the plant (or eat an animal that has eaten the plant) until eventually the atoms are absorbed by decomposers (bacteria and fungi) and released back into the soil in mineral-nutrient molecules. Plants can then take up these mineral-nutrients again. Matter is recycled.

⁶ As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp. 60-61.

⁷ *Mineral-nutrients* are inorganic molecules and atoms that usually come from weathered rock and are taken up by the roots of plants. *Mineral-nutrients* act as fertilizer for plants (e.g., nitrate, phosphate, potassium). *Mineral-nutrients* are not to be confused with *food nutrients*, which animals need. *Food nutrients* are organic molecules (such as: protein, fats, and carbohydrates).

If no decomposers were present on Earth, the recycling of matter would eventually stop. We are very dependent on decomposers! Figure 3 shows the recycling of matter through a simple food chain.

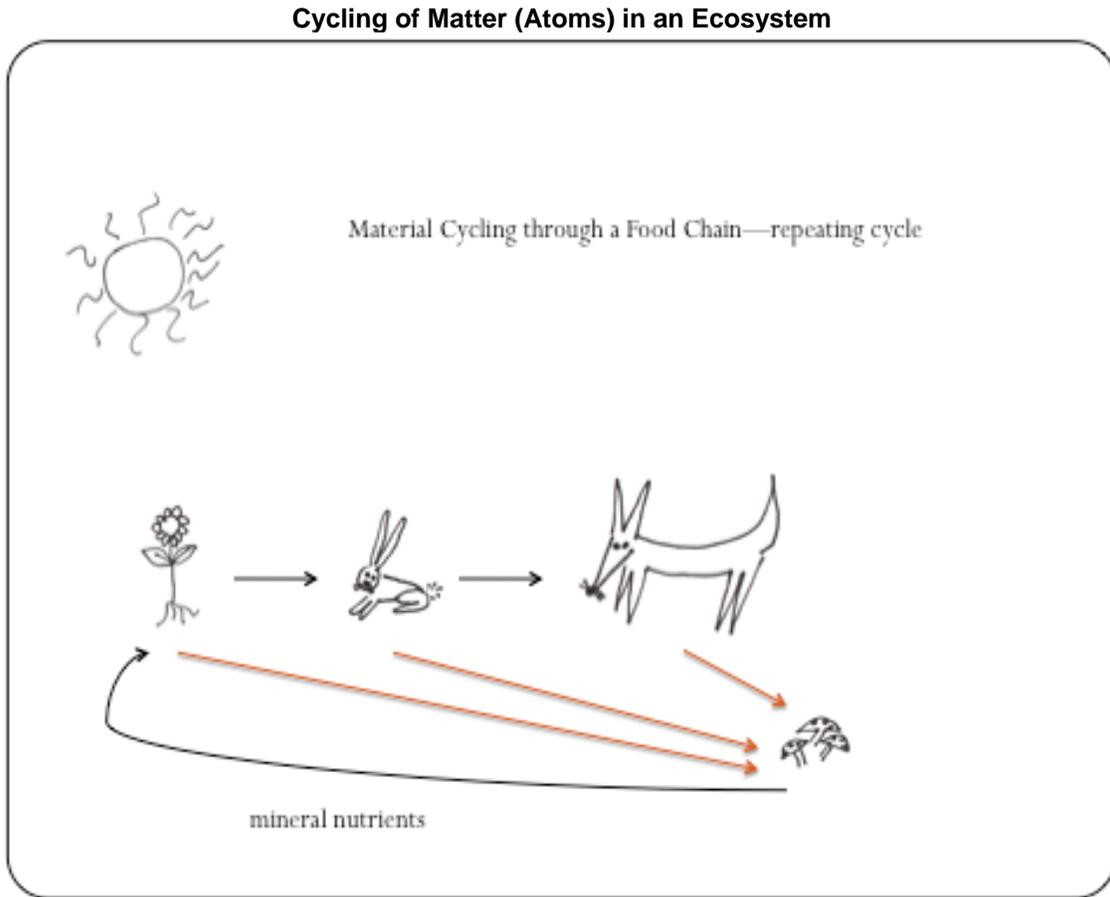


Figure 3. Movement of matter (atoms) through a simplified food chain of an ecosystem. Atoms enter the ecosystem in mineral-nutrients (inorganic molecules), travel through the ecosystem in food molecules (organic molecules), and return to the soil in mineral-nutrients.

Websites

1. Feeding Levels

This educational website from New Hampshire discusses several topics:

Producers and consumers

www.nhptv.org/natureworks/nwep9.htm

Consumers (herbivores and carnivores)

www.nhptv.org/natureworks/nwep10.htm

Scavengers and decomposers

www.nhptv.org/natureworks/nwep11.htm

2. Energy Flow

A food chain game for kids is on this educational website. Super fun!

www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm

3. Cycling of Matter

This website provides diagrams of the carbon cycle, nitrogen cycle, and phosphorus cycle:

<http://bioh.wikispaces.com/More+Elemental+Cycles?f=print>