Grade 4 Science, Quarter 4, Unit 4.1

Cycles and Energy in Ecosystems

Overview

Number of instructional days: 12 (1 day = 45 minutes)

Content to be learned

- Identify sources of energy that contribute to organisms' survival.
- Recognize that energy is needed for all organisms to grow and survive.
- Demonstrate in a food web that all animals' food begins with the sun.
- Use information about organisms to design a habitat and explain how the habitat provides for the needs of the organisms that live there.
- Explain and describe ways that plants and animals within a habitat depend on each other.
- Explain what plants and animals might do if their environment changes.
- Explain how the balance of an ecosystem can be disturbed.
- Use information (data or scenario) to explain how changes in the environment can cause organisms to respond (e.g., survive there and reproduce, move away, die).

Science processes to be integrated

- Conduct safe and ethical investigations with living organisms.
- Explain and describe the relationships among organisms within a system.
- Build explanations about the flow of energy among the living components within a system.
- Use information and observations to describe and explain changes that can interfere with the balance within a system and the processes that lead to equilibrium.
- Use scientific processes, including making and recording observations, citing evidence, comparing, collecting and analyzing data, and drawing conclusions.

Essential questions

- How do ecosystems change over time?
- What happens within an ecosystem when changes occur?
- How are the living organisms within an ecosystem interdependent?
- How are an animal's needs met within its environment?

Written Curriculum

Grade-Span Expectations

LS2 - Matter cycles and energy flows through an ecosystem.

LS2 (K-4) SAE –5

Recognize that energy is needed for all organisms to stay alive and grow or identify where a plant or animal gets its energy.

LS2 (3-4) –5 Students demonstrate an understanding of energy flow in an ecosystem by …

5a identifying sources of energy for survival of organisms (i.e. light or food).

LS2 (K-4) SAE –6

Describe ways plants and animals depend on each other (e.g., shelter, nesting, food).

LS2 (3-4)–6 Students demonstrate an understanding of food webs in an ecosystem by …

6a demonstrating in a food web that all animals' food begins with the sun.

6b using information about organisms to design a habitat and explain how the habitat provides for the needs of the organisms that live there

6c explaining the way that plants and animals in that habitat depend on each other.

LS3 - Groups of organisms show evidence of change over time (structures, behaviors, and biochemistry).

LS3 (K-4) SAE –7

Using information (data or scenario), explain how changes in the environment can cause organisms to respond (e.g., survive there and reproduce, move away, die).

LS3 (3-4) –7 Students demonstrate an understanding of equilibrium in an ecosystem by …

7a explaining what plants or animals might do if their environment changes (e.g., changing food supply or habitat due to fire, human impact, sudden weather-related changes).

7b explaining how the balance of the ecosystem can be disturbed (e.g., how does overpopulation of a species affect the rest of the ecosystem).

Clarifying the Standards

Prior Learning

In grades K–2, students distinguished between living and nonliving things. They identified and sorted based on similar or different external features, and observed and recorded the external features that make up living things. Students observed that plants need water, air, food, and light, and animals need water, air, food, and shelter to grow. They observed and scientifically drew and labeled the stages in the life cycle of a familiar plant and animal, and they sequenced the life cycle of a plant or animal when given a set of pictures. Students identified the specific functions of the physical structures of a plant or an animal.

They cared for plants and animals by identifying and providing for their needs, and experimented with a plant's growth under different conditions, including light and no light. Students acted out and constructed simple diagrams that showed a simple food web, and they used information about a simple food web to determine how basic needs are met by the habitat/environment.

In grade 3, the focus of student learning was on the structures and characteristics that allow for survival. Students cited evidence to distinguish between living and nonliving things, and identified, sorted, and compared organisms based on similar and/or different external features. They recorded and analyzed observations/data about external features, and cited evidence to draw conclusions, explaining why organisms are or are not grouped together. Students observed that plants need water, air, food, light, and space, and animals need water, air, food, and shelter/space to grow and reproduce. They also observed changes and recorded data to scientifically draw and label the stages in the life cycle of a familiar plant and animal. Students sequenced the life cycle of a plant or animal, and compared the life cycles of two plants or two animals when given a set of data or pictures. They identified and explained how the physical structure/characteristics of an organism allow it to survive and defend itself, and analyzed the structures needed for survival of plant and animal populations in a particular habitat/environment.

Current Learning

Students are coming to fourth grade with some experience constructing diagrams of simple food webs. This prior experience will provide a foundation for the concepts in this unit of study. In this unit, grade 4 students identify sources of energy needed for the survival of organisms (e.g., light and food), and they demonstrate in a food web that all animals' food begins with the sun. They use information about organisms to design a habitat and explain how the habitat provides for the needs of the organisms that live there, and they explain the way that plants and animals in that habitat depend on each other. These concepts are taught at the developmental to the reinforcement level of instruction. Students also explain what plants or animals might do if their environment changes, and explain how the balance of the ecosystem can be disturbed. These concepts will not be revisited in later grade levels, and should be taught at the developmental level to the drill-and-practice level of instruction.

In the classroom, there are a number of investigations/activities that can be used to help students gain a conceptual understanding of the concepts in this unit of study.

- Online Research — To learn more about the habitats the class has been studying, students visit websites about different habitats. Students should be able to find sites easily, but there are some suggestions in the Resources section of this unit. After an initial research on different habitats, small groups or individual students can select an animal and create a presentation that describes/explains how the animal survives or has adapted to its environment. Students can also use their information about the characteristics of an organism and design an artificial habitat in which the organism can survive.
- Mystery Animals — Divide your class into groups. Have each group choose an unusual or unfamiliar animal from the habitat it has been assigned and prepare a card with the name of the animal, a description of the animal's physical and behavioral characteristics, and a picture of the animal. Mix up the cards and give one to each group, making sure that no group gets its own card. Then challenge each group to figure out, on the basis of the animal's physical and behavioral characteristics, whether the animal belongs in the habitat the group was assigned.
- Dioramas — Have students make dioramas or models of different habitats as a visual to use throughout the unit.

Students have been exposed to some of these vocabulary words before; however, during this unit of study, students will understand the following terms: *organism*, *habitat*, *survival*, *ecosystem*, *overpopulation*, *species*, *dependence*, *environment*, *energy*, and *cycle*.

The Resources section below includes a number of websites and resources that can help with planning lessons.

Future Learning

Students in grades 5–6 will identify and define ecosystem and the variety of relationships within it (predator/prey, consumer/producer/decomposer, host/parasite). They will identify the sun as the major source of energy for life on earth and will sequence the energy flow in an ecosystem. Students will describe the basic processes and recognize the substances involved in photosynthesis and respiration, and will explain the processes of precipitation, evaporation, and condensation as parts of the water cycle. They will also complete a basic food web for a given ecosystem,

Additional Findings

The natural and designed world is complex; it is too large and complicated to investigate and comprehend all at once. Scientists and students learn to define small portions for the convenience of investigation. These units of investigation can be referred to as "systems." A system is an organized group of related objects or components that form a whole and can carry out functions its individual parts cannot. A system can be described in terms of its components and their interactions, and all systems have boundaries, resources flow, and feedback. The goal is for students to think and analyze in terms of systems (*National Science Education Standards*, p. 116).

Students should become acquainted with many examples of ecosystems, starting with those nearby. In grades 3–5, students should explore how various organisms satisfy their needs in the environments in which they are typically found. They can examine the survival needs of different organisms and consider how the conditions in particular habitats can limit what kinds of living things can survive. Their studies of interactions between organisms and the environment should begin with direct observation of nearby surroundings. Then, through viewing nature films, students' observations should expand to include a greater diversity of life in different habitats. Students should know that for any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all, organisms interact with one another in various ways besides providing food, and changes in an organism's habitat are sometimes beneficial to it and sometimes harmful (*Benchmarks for Science Literacy*, pp. 115– 116).

Organisms are linked to one another and to their physical setting by the transfer and transformation of matter and energy. Energy transfer in biological systems is less obvious than in physical systems. The study of food webs can start in elementary grades with the transfer of matter, then continue in the middle grades with the flow of energy through organisms. Students should know that almost all kinds of animals' food can be traced back to plants, and that some source of energy is needed for all organisms to grow and survive (*Benchmarks,* p. 118).

Young children tend to think of animals only in terms of individual organisms which people keep and which need humans for their survival. Older students extend their thinking to wild organisms, although some may think that these are fed and cared for by people. It is not until much later that students think in terms of populations of organisms in the wild competing for scarce resources (*Making Sense of Secondary Science,* p. 59).

Many children associate the word "food" only with what they identify as being edible. Few associate substances such as starch with food. Although students of all ages identify food as necessary to promote growth and health, many do not recognize that it is the source of material that becomes either part of their bodies in growth and repair, or sources of energy. A universal and very persistent misconception among children and adults is that plants get their food from the soil. Many pupils think that "food' for plants is anything taken in from the environment. They believe that plants have multiple sources of food, and few pupils have the understanding that photosynthesis makes food that provides energy and body material for the plant (*Making Sense*, p. 60).

The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. Food releases energy when digested, and organisms "use" energy for body/life processes. The energy released by digesting food was once energy from the sun that was captured by plants in the chemical process of photosynthesis that forms plant matter from air and water. The fact that plants capture energy from sunlight is introduced at this grade level, but details of photosynthesis are not (*A Framework for K–12 Science Education*, p. 129).

According to *A Framework for K–12 Science Education*, by the end of grade 5, students should know that the food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Either way, they are "consumers." Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil for plants to use. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem (pp. 151–152). When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die (p. 154). Changes in an organism's habitat are sometimes beneficial to it and sometimes harmful. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all (p. 165).

Notes About Resources and Materials

Websites

- NECAP Released Items, http://www.ride.ri.gov/assessment/necap_materials.aspx, 2009, #10; Released Task, 2008, Birds and Beaks
- http://pbskids.org/zoom/activities/sci
- www.brainpop.com
- www.discoveryeducation.com
- www.projectwild.org
- http://wwf.panda.org/about_our_earth/teacher_resources/webfieldtrips/ecological_balance/
- http://www.pbs.org/journeytoplanetearth/stateoftheplanet/ecosystems.html
- http://www.neok12.com/Ecosystems.htm (This video explains how an ecosystem works and how it changes)

- http://wwf.panda.org/about_our_earth/teacher_resources/webfieldtrips/ecological_balance/ (This website will help you understand the importance to a balanced ecosystem.)
- Habitat websites
    - Grasslands: http://www.cheetahspot.com
    - Temperate forest: http://www.northolympic.com/index.php/index.html
    - Tropical rainforest: http://www.pbs.org/edens/manu/index.htm
    - Desert: http://www.desertusa.com/animal.html
    - Polar Ice: http://octopus.gma.org/surfing/antarctica/penguin.html
    - Tidepool: http://www.umassd.edu/public/people/kamarl/thesis/tidepools.html
    - http://www.pbs.org/journeytoplanetearth/stateoftheplanet/ecosystems.html

Books

- *Hands-on Science Activities for Grades 3–4* by Marvin Tolman
- *Project Wild K–12 Curriculum and Activity Guide*
- *Project Wild Aquatic K–12 Curriculum and Activity Guide*
- *Hands-On Nature: Information and Activities for Exploring the Environment with Children*
- *Take a City Nature Walk* by Jane Kirkland
- *Science Essentials* - Elementary Level, Jossey-Bass Teacher, Mark J. Handwerker
- *Differentiated Lessons and Assessments – Science, Grade 4,* Teacher Created Resources
- *I Have, Who Has?* Science Grades 3-5 by Creative Teaching Press
- *Hands-On Life Science* K-6 by Marvin Tolman
- *What are Food Chains and Webs? (Science of Living Things),* by Bobbie Kalman

Presentations

- Audubon Society
- Biomes, South Kingstown, RI
- URI Learning Landscape

Grade 4 Science, Quarter 4, Unit 4.2

The Sun and Moon

Overview

Number of instructional days: 7 (1 day = 45 minutes)

Content to be learned

- Observe that the moon looks slightly different from day to day, but looks the same again in about four weeks.
- Recognize that the rotation of the earth on its axis every 24 hours produces the day/night cycle.
- Recognize that the sun is the center of our solar system.
- Recognize that the earth is one of several planets that orbits the sun, and that the moon orbits the earth.
- Recognize that it takes approximately 365 days for the earth to orbit the sun.

Science processes to be integrated

- Identify the structures found in a system.
- Describe the interactions between the structures within in a system.
- Describe the patterns of change that occur within a system.
- Use models to understand the relationships between the components of a system.

Essential questions

- What patterns of change can be observed in the moon?
- Why do we experience day and night?
- What is the relationship between the moon and earth? Between the sun and the earth?
- What patterns of change occur within the sun, earth, and moon system?

Written Curriculum

Grade-Span Expectations

ESS2 - The earth is part of a solar system, made up of distinct parts that have temporal and spatial interrelationships.

No further targets for EK ESS2 at the K-4 Grade Span

ESS2 (3-4)-7 Students demonstrate an understanding of temporal or positional relationships between or among the Earth, sun, and moon by …

7b observing that the moon looks slightly different from day to day**,** but looks the same again in about 4 weeks.

7c recognizing that the rotation of the Earth on its axis every 24 hours produces the day/night cycle.

No further targets for EK ESS2 at the K-4 Grade Span

ESS2 (3-4)-8 Students demonstrate an understanding of characteristics of the solar system by …

8a recognizing that: the sun is the center of our solar system; the Earth is one of several planets that orbits the sun; and the moon orbits the Earth.

8b recognizing that it takes approximately 365 days for the Earth to orbit the sun.

Clarifying the Standards

Prior Learning

In grades K–2, students demonstrated an understanding of temporal and positional relationships between or among the earth, sun, and moon by observing that the sun can only be seen in the daytime, but the moon can be seen sometimes at night and sometimes during the day. They observed that the sun and moon appear to move slowly across the sky, and that the moon looks slightly different day to day. Students also observed that there are more stars in the sky than can be easily counted, they are not scattered evenly, and they are not all the same in brightness.

In grade 3, students demonstrated an understanding of temporal or positional relationships between or among the earth, sun and moon by observing that the sun, moon, and stars appear to move slowly across the sky, and that the moon looks slightly different from day to day, but looks the same again in about four weeks. Students demonstrated an understanding of processes and change over time within the system of the universe by recognizing that throughout history people have identified patterns of stars that we call constellations.

Current Learning

In grade 4, students observe that the moon looks slightly different day to day, but looks the same in about four weeks. This concept has been addressed in prior grade levels, and is taught at the reinforcement level of instruction. Students also recognize that the rotation of the earth on its axis every 24 hours produces the

day/night cycle, and that it takes approximately 365 days for the earth to orbit the sun. They recognize that the sun is the center of our solar system; the earth is one of several planets that orbit the sun; and the moon orbits the earth. These concepts are new to this grade level, and are taught at the developmental level to the reinforcement level of instruction.

Because of the abstract nature of these concepts, models are a must in the classroom. Through active discussion and manipulation of models, teachers should encourage dialogue about the limitations that models present. For instance, a poster showing the traditional linear model of planets (starting with the sun and extending to the planets in a line) is limiting in that planets are never aligned as illustrated. This model can also lead to misconceptions about the center of the solar system. While a drawing that features the planets orbiting around the sun can clarify the concept that the sun is the center of our solar system, it can lead to erroneous thinking about the distorted nature of the orbit's path (shown as elliptical in a 2-D drawing). Providing students with a 3-D model of the sun and planets that can mimic the orbits can help further students' understanding of the movements, however, this model, too, has limitations. In addition, while students have experience in observing the changes of the moon's phases, using an Internet model and/or a lunar calendar can reinforce prior experience.

In the classroom, there are a number of investigations/activities that can be used to help students gain a conceptual understanding of the concepts in this unit of study. In addition to those listed below, there are additional activities found in the Resources section of this unit.

- Using foam balls, pencils, markers, and flashlights, students model how sunlight strikes earth. Prior to the activity, the teacher should push a pencil through the center of each foam ball. (The eraser end will be North Pole, and the point will be the South Pole.) Put students in pairs, and have them use a marker to draw the equator around the model of the earth. One student should hold the model so that the North Pole is tilted away from the flashlight, which is held by the second student. Move the earth at same angle slowly around the partner holding the sun (flashlight stays shining on the model). Have students record their observations.
- Have students model the phases of the moon using a lamp and a plastic foam ball, observing what happens to the light on the ball at each 1/8th turn. Ask students, "How much of the ball is in shadow? How did the shadow change as the model continued to revolve around the light?"
- Use a model of a rotating, spherical earth and the relative positions of the sun and moon to explain patterns in daily changes in length and direction of shadows, day and night, and the phases of the moon.

During this unit of study, students will use the following content vocabulary: *temporal*, *positional*, *rotation*, *revolution*, *axis*, *orbit*, *planet*, and *solar system*.

Future Learning

In grades 5–6, students will identify and compare the size, location, distances, and movement of the objects in our solar system, and will compare the composition, atmosphere, and surface features of the objects in our solar system. They will use models to describe the relative motion/position of the earth, sun, and moon, and will explain night/day, seasons, year, and tides as a result of the regular and predictable motion of the earth, sun, and moon. Students will use a model of the earth, sun, and moon to recreate the phases of the moon, and will define the earth's gravity as a force that pulls any object on or near the earth towards its center without touching it. They will describe the apparent motion/position of the objects in the sky, and will identify the sun as a medium-sized star located near the edge of a disk-shaped galaxy of stars.

In grades 7–8, students will identify major discoveries from different scientists and cultures and describe how these discoveries have contributed to our understanding of the solar system. They will use or create a model of the earth, sun, and moon system to show rotation and revolution, and will explain night/day, seasons, year, and tides as a result of the regular and predictable motion of the earth, sun, and moon. Students will use a model of the earth, sun, and moon to recreate the phases of the moon, and will describe the relationship between mass and the gravitational force between objects. They will describe the relationship between distance and the gravitational force between objects, and will explain that the sun's gravitational pull holds the earth and other planets in their orbits, just as the planet's gravitational pull keeps their moons in orbit. Students will describe the universe as containing many billions of galaxies, and each galaxy contains many billions of stars.

Additional Findings

According to *Making Sense of Secondary Science*, as children learn about the solar system and the universe, they naturally bring preconceived ideas about the size and shape of the earth. Children's ideas progress from belief in a flat earth with a limited sky and an absolute view of down, to a spherical earth surrounded by sky with "down" directed toward the center of the planet. With regard to the cause of the day/night cycle, children's thinking ranges from "covering" ideas, such as, the sun goes behind hills; clouds cover the sun; and the moon covers the sun, to orbital theories, such as, the sun goes behind the earth once a day; the earth goes around the sun once a day; and the earth spins on its axis once a day. As children age and gain greater understanding of the sun/earth/moon system, thinking progresses from an earth-centered to a sun-centered solar system. However, even at an older age, children are much less certain of the moon's position. Ideas about the shapes of the earth, sun, and moon appear to change with age. Younger children think these bodies are two-dimensional or non-spherical, three-dimensional shapes, while older children think they're spheres. There is also a lack of understanding about the relative sizes and distances between the earth, sun, and moon. These misconceptions may be compounded or caused by the models used in classrooms or by the diagrams in books, which do not use the true scale for size and distance (pp. 168–170).

When teaching and discussing the solar system, we must stress to students that the earth, not the sun, is moving. Films, computer simulations, planetariums, and telescopic observations will help when teaching the earth's relationship to the sun, moon, and other planets. However, it is essential for all students to make physical models and explain what the models show. At the same time, students can begin learning about scale (comparative distances, times, sizes, etc.), keeping in mind that scale factors larger than thousands may be difficult before early adolescence (*Benchmarks for Science Literacy,* p. 67).

In order to develop an understanding of the relationships between the objects in the solar system, young students need to begin with direct observations of objects in the sky. By observing the day and night sky regularly, children in grades K–4 will learn to identify sequences of change and to look for patterns in these changes. As they observe changes, such as the movement of an object's shadow during the course of a day, and the positions of the sun and the moon, they will find the patterns in these movements. These understandings should be confined to observations, descriptions, and finding patterns (*National Science Education Standards*, pp. 130, 134). Because the sun, moon, and earth system can't be observed directly, teachers must use carefully selected models. Students should understand that certain models are used to help them understand the relationships and interactions between the sun, earth, and moon, and students should also understand the limitations of the models used, to include scale (size and distance).

Notes About Resources and Materials

Websites

- http://www.ligowa.caltech.edu/teachers_corner/lessons/moon_phase_activity.pdf
- This website will take you through Motions of the moon and the earth.
- http://www.solarviews.com/cap/moon/vmoon2.htm
- Short video of the rotation of the moon
- http://www.kidport.com/RefLib/Science/Space/Earth.htm#Earth
- Students can make a model of the Earth Sun and moon and show the movement taken in the orbit around each other.
- http://www.bbc.co.uk/schools/scienceclips/ages/9_10/earth_sun_moon.shtml
- Video of the movement of the earth, sun, and moon
- http://pbskids.org/zoom/activities/sci
- www.brainpop.com
- www.discoveryeducation.com
- www.msnucleus.org
- www.teachthechildrenwell.com
- www.nasa.gov/audience/foreducators
- www.edhelper.com
- www.lessonplanet.com
- www.solarviews.com
- www.starchild.gsfc.nasa.gov
- www.brainpopjr.com
- www.kidsastronomy.com
- www.sunearthday.nasa.gov
- www.challenger.org/teachers/
- www.lessons/solarsystem.cfm

Books

- *Hands-on Science Activities for Grades 3-4* by Marvin Tolman
- *Find the Constellations* by H. A. Ray
- *Sun, Moon, and Stars* (Usborne Beginners)
- *The Moon Seems to Change* by Franklyn M. Branley

- *Faces of the Moon* by Bob Crelin
- *The Moon* by Seymour Simon
- *The Sun* by Seymour Simon
- *So That's How the Moon Changes Shape!* (Rookie Read-About Science) - Allan Fowler
- *Phases of the Moon* (Patterns in Nature series) - Gillia M. Olson
- *The Moon Seems to Change* (Let's-Read-and-Find-Out Science 2) - Franklyn M. Branley
- *What Makes Day and Night* (Let's-Read-and-Find-Out Science 2) - Franklyn M. Branley
- *13 Planets: The Latest View of the Solar System* (National Geographic Kids) - David A. Aguilar
- *The Planets in Our Solar System* (Let's-Read-and-Find-Out Science, Stage 2) - Franklyn M. Branley
- *Science Essentials* - Elementary Level, Jossey-Bass Teacher, Mark J. Handwerker
- *Differentiated Lessons and Assessments – Science, Grade 4,* Teacher Created Resources
- *I Have, Who Has?* Science Grades 3-5 by Creative Teaching Press
- *Hands-On Earth Science Activities for Grades K-6* by Marvin Tolman
- *So That's How the Moon Changes Shape!* (Rookie Read About Science), by Allan Fowler
- *Phases of the Moon* (Patterns in Nature Series), by Gillia Olson
- *The Moon Seems to Change (Let's Read and Find Out Science 2),* by Franklyn Branley
- *What Makes Day and Night* (Let's Read and Find Out Science 2), by Franklyn Branley
- *The Planets in Our Solar System (Let's Read and Find out Science 2),* by Franklyn Branley
- *13 Planets: The Latest View of the Solar System* (National Geographic Kids), by David Aguilar
- *Sunshine Makes the Seasons* (Let's Read and Find Out Science 2), by Franklyn B ranley
- *The Moon Book*, by Gail Gibbons
- *The Reasons for the Seasons,* by Gail Gibbons

Field Trips

- Roger Williams Natural History Museum Planetarium
- Boston Museum of Science

Resources

- Solar System Model