46. *Energy in Bosque Ecosystems*

Description: Students follow the path of energy through the bosque ecosystem. In either a small group presentation or as a poster, teams of students use appropriate vocabulary to illustrate energy gained and lost through a short food chain, from a plant to an herbivore to a carnivore.

Objective: Students will be able to state sources of energy in ecosystems, show a path of energy through a short energy food chain, and describe at least 3 types of energy that are gained and lost by plants and/or animals. This activity is centered on the bosque and river ecosystems of the Southwestern US.

Materials:

- Selected "Food Chain Sets" cut apart; distribute one food chain per team
- Animal and plant cards from "Who Lives Where?" and "Who Grows Where?" activities in this *Guide*. Go here to find corresponding plants and animals for each team's assigned "Food Chain Set." Include both the picture and its description. Note you may need several copies of some card sets, such as algae. Be sure to count the number of cards needed for all of your chosen food chain sets.
- Algae card - copy from this activity
- Markers
- Tape or glue
- Scissors
- Poster paper (for option B)

46. Energy in Bosque Ecosystems

Grades: 4-8

Time: 45 - 90 minutes

Subjects: science, environmental education

Standards: see end of activity

Terms: *carnivore, primary and secondary consumers, decomposer, detritivores, dissipate, food chain, food web, glucose, herbivore, matter, photosynthesis, predator/prey, producer; energy terms: chemical potential energy, electrical energy, heat energy, kinetic energy, light energy, sound energy*

New Mexico STEM Ready! / Next Generation Science Standards

NGSS DCIs and Performance Expectations

5.LS1.C Organization for Matter & Energy Flow in Organisms
5.LS2.A Interdependent Relationships in Ecosystems
5.LS2.B Cycles of Matter & Energy Transfer in Ecosystems
5.PS3.D Energy in Chemical Processes & Everyday Life
MS.LS1.C Organization for Matter & Energy Flow in Organisms
MS.LS2.B Cycles of Matter and Energy Transfer in Ecosystems
MS.PS3.D Energy in Chemical Processes & Everyday Life

NGSS CCCs

Systems and System Models; Energy and Matter: Flows, Cycles & Conservation

NGSS SEPs

Developing & Using Models; Constructing Explanations & Designing Solutions; Engaging in Argument from Evidence

Option A

- Acting out an energy food chain—Paper strips / index cards—students will write types of energy on index cards

Option B

- Drawing out an energy food chain

Background: Energy as a unifying concept is addressed in a range of fields of science including physical science and biological science. In the biological sciences, foundational concepts include understanding the sources of energy in an ecosystem, and how each organism gets the energy that it needs to survive and thrive. This activity helps students both understand the types of energy in ecosystems, and also adaptations and interrelationships of organisms in their local bosque ecosystem. *Bosque* is the Spanish word for "forest" or "woods" but it is generally used in New Mexico to refer to the cottonwood forest along rivers in the region. Bosque habitat is found along rivers throughout the Southwest, and the same ecological processes occur anywhere cottonwoods are found in the Southwest and can be illustrated in both aquatic and terrestrial parts of the ecosystem.

Most students, by the time they reach upper elementary and middle school, can tell you that plants do something unique called **photosynthesis**. But in order to fully put that word into the context of the energy needs of an entire ecosystem, it takes some focused vocabulary and tracing of that energy in different parts of the ecosystem.

What is the source of energy for plants growing in the bosque (and across most of the Earth)? ***Light Energy*** (LE) from the sun. Plants are able to take carbon dioxide and water and through the process of photosynthesis— using their green chlorophyll pigment and using *Light Energy* from the sun, run complex reactions—to produce sugars in the form of glucose. The plants also produce oxygen as a waste product—which is something that animals make vital use of in respiration. In this way, plants make their own food and food that is available to other organisms; they are known as **producers**.

Glucose sugar is, for the plant, a source of ***Chemical Potential Energy*** (CPE). Glucose sugar is a stable substance that can be used later for growing stems, leaves, roots, flowers, and seeds-- the normal processes of a plant's life—all run by the glucose energy produced by photosynthesis. CPE—Glucose, is a compound with a chemical structure that can be stable for extended periods, later providing the energy for plant growth and other needs. This is the chemical energy, stored in a way to provide potential energy (available for later use) for the organism—*Chemical Potential Energy*.

Other types of energy can be associated with plants: there might be ***Sound Energy*** (SE) as when the wind blows and leaves rustle; ***Kinetic Energy*** (KE) as when plants grow or move with wind or when sunflowers move their flower head to follow the sun. Some plants actually produce ***Heat Energy*** (HE), intensifying their flower scent for pollinators. These are some of the ways that small amounts of energy leave the plant, beyond the *Chemical Potential Energy* described above.

Sometimes, an animal, called an **herbivore**, will come along and eat a plant. *Why does an animal do this?* To get energy for itself. The energy the herbivore needs is the glucose sugar the plant has produced—this is the *Chemical Potential Energy* stored in the plant cells, that the animal is able to access. Through digestion, the sugars are broken down and provide energy for the animal's processes of daily life—growing cells, digesting, breathing, moving, reproducing, etc. Plant-eating animals are also known as **primary consumers**.

Other types of energy that the animal creates are: *Kinetic Energy,* as the animal moves; *Sound Energy* made through calls or interactive movements; *Heat Energy* generated through metabolism and movement; *Electrical Energy* within the working brain and nervous system. (See ***Terms***.)

Each of these other types of animal energy go off into the world, and are not really useable by other living organisms: the heat **dissipates**, scattering in the air, the sound, as well as the kinetic movement dissipates. Energy is never lost—it can be accounted for, but it does not necessarily help other living parts of the ecosystem. In this way you can start to see that energy is not cycled through the ecosystem—it is on a one-way path from the sun through organisms as CPE, but is lost from potential usefulness to others, bit by bit, by various organisms in the ecosystem (see Energy Chain diagram).

Finally, a **carnivore** may eat an herbivore. When it eats the herbivore, it is accessing Chemical Potential Energy! The herbivore has CPE in the form of glucose in its body—in the muscle and organs that it built as it ate and digested its food. So the carnivore is utilizing the CPE that the plant produced to grow itself, that the herbivore ate to grow itself and now the carnivore eats to grow itself. Because they eat the primary consumers (herbivores), carnivores are called **secondary consumers**.

Again, there are many other forms of energy that the carnivore may produce during its daily activities: *Kinetic Energy* as it moves; *Heat Energy* as it keeps its body temperature constant; *Electrical Energy* as its brain and nervous system work; *Sound Energy* as it communicates with others, or, if a bird, as its feathers cut through the air.

The important point for your students to understand is that *Chemical Potential Energy* is the main source of energy for the ecosystem. CPE, in the form of glucose, is produced by plants for their own growth. Herbivores eat plants, gaining the source of energy for their own daily life and growth—CPE—glucose sugars. And finally, a carnivore may eat an herbivore, gaining the *Chemical Potential Energy* that it needs to survive and thrive, also in the form of glucose sugars.

Contrast matter to energy

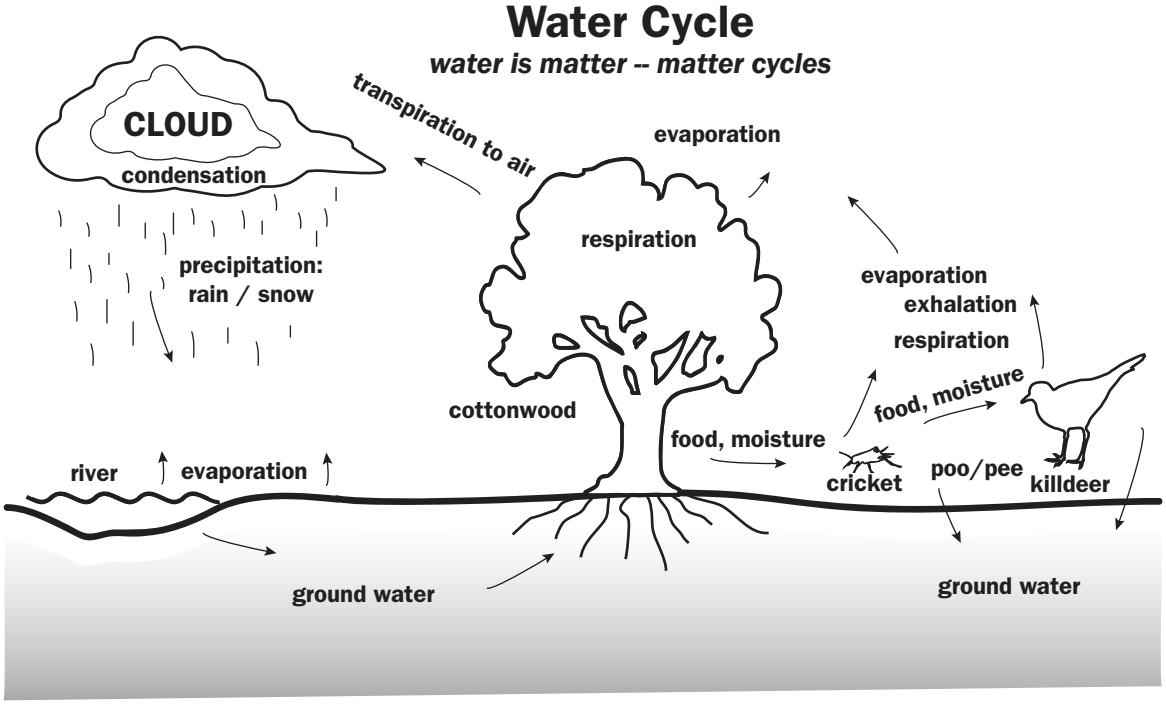
Energy is on a one-way path—it cannot be cycled back like matter. As *Chemical Potential Energy* it travels through the ecosystem as a critical energy source, but once used for heating, moving, sound, and brain work, it is never available again. Only the *Chemical Potential Energy* contained in the organism that becomes food for something else (such as muscle and organs, or poo!) is passed along and useful for another organism's survival—fulfilling their energy needs for living (see Ecosystem Energy Chain diagram).

Matter, on the other hand, is cycled. For example, carbon is used by organisms, and after death, the carbon may be freed to be taken up by another organism. Water is cycled, used by an organism, eliminated, and returned back to the ecosystem and used again. The same is true for nitrogen and other compounds of matter; they are important and used over and over (see Water Cycle diagram).

Also see "Rio Grande Water Cycle" activity in this *Guide.*

Cottonwood leaf
Photograph by Letitia Morris

Compare the cycling of matter such as this water cycle to the one-way path of energy in an ecosystem.

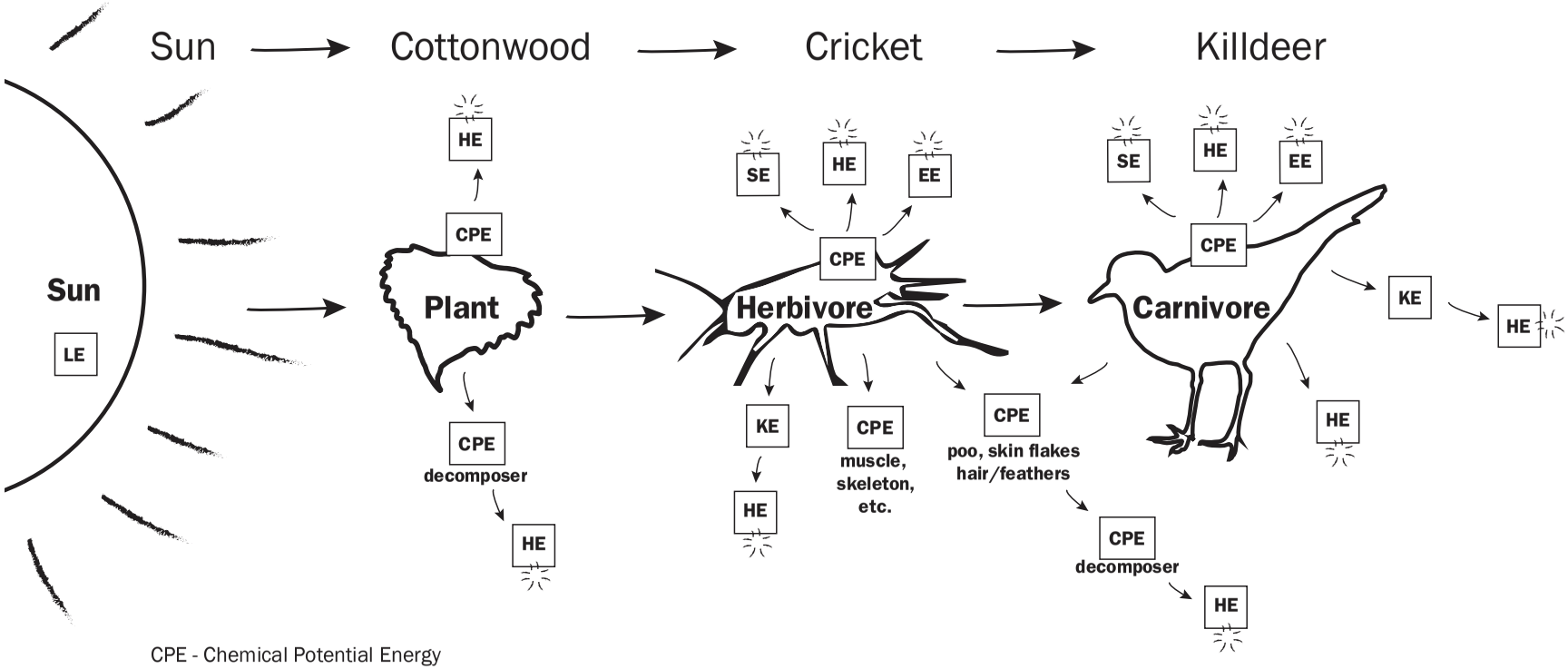


Misconceptions:

Where do plants get their food? —Many students think that food comes through roots, from soil. Even though you can see "Plant Food" sold in gardening supply stores—those are just plant nutrients—*plants make their own food* from sunlight, carbon dioxide (CO_2), and water (H_2O) through the process of photosynthesis. This is similar to humans taking vitamins; vitamins provide important nutrients, but they are not food. Humans cannot live on vitamins alone, but do need vitamins to survive.

Should you include the sun in a "food" chain? No—It is energy. Include in an energy chain, but not a matter/food chain! This activity does focus on energy transfers, and is focusing on energy chains.

Ecosystem Energy Chain



CPE - Chemical Potential Energy
EE - Electrical Energy
HE - Heat Energy
KE - Kinetic Energy
LE - Light Energy
SE - Sound Energy
- Energy leaving the system, no longer useable by organisms in the ecosystem

Terms:[1]

Energy: a quantity of how much change can happen in a system. Energy is conserved—not lost or destroyed; all energy can be measured and accounted for even through many changes in the natural world. Another definition of energy is: the ability to do work, to make things happen. [This activity illustrates the types of energy, and not the quantity of energy—which would be measured in joules or calories (among other units used in various fields).]

Matter: has mass and takes-up space. The molecules of matter are the material that make up all the things around us: rocks, plants and animals, the oxygen in the air, the water on Earth, and so much more.

Types of Energy

Energy of Position—Energy due to the relative positions of matter

Chemical Potential Energy (CPE)—is a result of the structural arrangement of atoms and molecules. When bonds are broken and new bonds form, atoms rearrange. This rearrangement changes the relative positions of atoms and, in turn, changes the amount of CPE present.

Energy of Motion—Energy due to the motion of matter

Kinetic Energy (KE)—is a result of an individual object's motion (e.g., a hockey puck sliding on ice, a car speeding along a road, a particle moving through space). Objects with more mass and those moving at higher velocities have more KE.

Heat Energy (HE)—is a result of the random motion of all the atoms and molecules that make up an object. Objects with more mass and at a higher temperature have more HE. The kind of matter and its phase (e.g., solid, liquid, gas) affect the amount of HE produced.

Light Energy (LE)—is a result of the coordinated motion of photons that are emitted when electrons, protons, and other charged particles accelerate. High frequency colors (e.g., blue) transmit more LE than low frequency colors.

Sound Energy (SE)—is a result of atoms and molecules moving in concert to form temporary regions of compression and expansion in a medium (e.g., air or water). Louder sounds and higher pitched sounds transmit more SE compared to whispers and deep pitched sounds.

Electrical Energy (EE)—is a result of charged particles moving through a conductor (e.g., current from electrons moving through a wire). The more current that flows and the longer the period of time it flows, the more EE is present.

Procedure:

- As a class, brainstorm, *What does the word "energy" make you think of?*

  List ideas on the board. Examples: moving, warming, growing, sound, light, heat, electrical, collisions.

  This activity will focus on energy in ecosystems, leaving other energy discussions for other times.

Option A: **Acting out an energy food chain**

- Choose the correct number of "Food Chain Sets" for your class. Each set needs 3 students; a few two and four person sets are available if needed.
- Hand out animal and plant cards, one per person; hand both the image and the text card to that person.

  You could assign teams to the sets above. Or, depending on your group's dynamics, you could use a more random group assembly—hand out cards, give a few moments to read their cards, then stand and find others that should be in a short food chain with them, finding a plant, an herbivore, and a carnivore to form a food chain set. Each text card lists these connections.
- Their challenge is to first make a simple food chain. Each group must include a plant, a plant eater (herbivore), and an eater of plant eater (carnivore).

  They must consider the path of energy through this food chain and show to the whole group in a demonstration or skit-like presentation:

  What species are in their food chain?

  Identify the energy types and path in your food chain/energy transfers.

  They should look at the list of optional energy types and make index cards of those types (e.g., several CPE cards for each team, one LE card for sunlight to plant, a few SE, HE, KE, and EE for each team).
- Their challenge is to tell the class:

  Where does the energy come from in this food chain?
  Show examples of energy types moving through the food chain.
- Use these terms as well, when/where appropriate:

  Producer Predator/Prey or Herbivore/Carnivore

  Consumer Detritivores/Decomposers
- Optional—during class presentations, have other teams help out in adding additional energy that would be a part of that food chain. And, adding other species that might connect with the food chain being presented. You may see some food webs appearing! Food webs have multiple interactions among organisms in an ecosystem. Research shows that students need to work at making the leap from individual food chains to food webs. This may be a way to make the leap to understanding these complexities of dependencies.[2]

Option B

Drawing an energy chain

Introduce the activity as in Option A above.

Review types of energy listed in the terms section. List each energy type on the board.

Do one example for the class. Write name of one "Food Chain Set" on board and label energy types; draw in arrows for direction of movement of energy.

- *What do arrows in an energy food chain represent?* Follow the energy from plant to eater of plant…X goes into the mouth of Y—the CPE/energy of the plant goes into the mouth of the herbivore—the arrow goes from the plant to the eater of the plant. Say in words what is meant by the arrow direction shown.
- Distribute one "Food Chain Set" –one plant, one herbivore, and one carnivore—to each team of three students.

  A team is challenged to make a poster showing their assigned short food chain and the energy involved in the chain.

  Have copies of animal and plant cards from "Who Lives Where?" and "Who Grows Where?" activities--the corresponding plant and animals for each team's assigned "Food Chain Set." Include both the picture and its description. Note, you may need several copies of some card sets, such as cottonwoods. Be sure to count the number of cards needed for all of your chosen sets.

- Each team will show on their poster:
  - What species they have in their food chain
  - Identify the energy types and path in that food chain—the energy transfers, both in and out (see diagram Energy Chain).

  The students should look at the list of optional energy types and label their poster with the following where they occur: CPE LE, SE, HE, KE, EE.
  - Use arrows to show the direction of energy movement.
  - Label your food chain with these terms, when/where appropriate:

    Producer Predator/Prey or Herbivore/Carnivore

    Consumer Detritivores/Decomposers

  - Their challenge is: To tell the whole class

  Where does the energy come from in your food chain?

  All energy comes from the Sun.

  Show examples of energy types moving through the food chain.

- Have the students do a class presentation and describe the energy flow that they have illustrated through the food chain.

Energy in Bosque Ecosystems Discussion Questions

What is the major source of energy in ecosystems? The sun with light energy.

What do we need plants for?

- Food. Even if you think of yourself as primarily a carnivore, your energy has ultimately come from plants. Plants produce CPE, herbivores eat plants, carnivores eat herbivores. All organisms are needed.
- Oxygen! Earth has an oxygen-rich atmosphere because plants give off oxygen during photosynthesis.

Where do plants get their food? Through photosynthesis; with carbon dioxide and water, and energy from sunlight, they produce glucose—food for their own growth. [It is a misconception to think that food comes through roots, from soil.]

What do plants need to live, in general?

Water, sunlight, nutrients, carbon dioxide in the air.

What do animals need to survive?

Water, food (CPE!), oxygen in the air.

What would happen if all _____ were gone from this ecosystem?

Predators (carnivore; secondary consumer) Predators eat animals and keep the ecosystem from being over-populated by herbivores.

Herbivores? (primary consumers) If there were no herbivores, there would be no food for carnivores and plants might take over.

Plants? (producers) The ecosystem depends on plants to produce chemical potential energy that is eaten by other organisms—No plants, no plant eaters, no carnivores.

Any one kind/species of organism? Once you look closely at food webs in an ecosystem, you see that the loss of one species often affects many other species. Remove an insect species-- maybe the plant it pollinates fails to produce seed; the animal that eats the insect and the animal that eats the seed decline.

What does your energy food chain help you understand about the ecosystem?

The Sun provides energy for plants, plants provide energy for herbivores, and herbivores provide energy for carnivores.

What doesn't it help with?

It does not show the cycling of matter, only the energy part of a food chain.

Assessment:

The final poster or presentation students create will need to include the following: state the source of energy in ecosystems, show the path of energy through a short energy food chain, and describe at least three types of energy that are gained and lost by plants and/or animals in their food chain.

Extensions:

- Post the food chain posters on the wall. Use yarn to make more connections between the plants and animals across posters—creating an energy-food web.
- Use the decomposer card to add to their energy chain. You could also research other types of decomposers. Write a description of how the decomposer fits into the energy chain—what eats them, and what do they need to survive?
- The base of the food chain in the bosque are plants on land and algae in the water—that make their own food from sunlight. But, there is a different source of energy forming the base of the food chain in deep sea vents-- chemosynthesizing organisms; they get their energy from "black smokers" --volcanic gases emerging at the bottom of the ocean—creating an energy source for an ecosystem that is unrelated to Light Energy from the sun.[3] Have students research this process to contrast with the bosque/terrestrial system.

Resources/References

[1] *Making Sense of Science: Energy for Teachers of Grades 6-8*. Kirsten R. Daehler, Jennifer Folsom, Mayumi Shinohara. WestEd. NSTA Press. 2011.

[2] *Uncovering Student Ideas in Life Science, 25 New Formative Assessment Probes. Vol.1.* Page Keeley. NSTA Press. 2011. (p. 106 must make connections between food chains to get to understanding of food webs.)

[3] *Ecology: Concepts and Applications*, Manuel C. Molles, Jr. WCB McGraw-Hill. 1999.

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Three-Step Food Chain Sets for the Bosque Education Guide

Algae to Caddisfly larvae to American Dipper
Algae to Mayfly larvae to Northern leopard frog
Algae to Mayfly larvae to Rio Grande cutthroat trout
Algae to Mayfly to Southwestern Willow Flycatcher
Algae to Mayfly larvae to Western chorus frog
Algae to Mosquito to Little brown bat
Algae to Mosquito larvae to Red shiner
Algae to Mosquito larvae to Western painted turtle
Algae to Rio Grande silvery minnow to Garter snake
Algae to Rio Grande silvery minnow to Great Blue Heron
Algae to Rio Grande silvery minnow to Belted Kingfisher
Cattail to Canada geese to Coyote
Cottonwood to Cricket to Killdeer
Cottonwood to Cricket to New Mexico whiptail
Cottonwood to Cicada to Greater Roadrunner
Cottonwood to Cricket to Sandhill Crane
Cottonwood to Isopod (Pillbug or Sowbug) to Harvester ants
Cottonwood to Leaf-roller caterpillar to Yellow-billed Cuckoo
Coyote willow to Beaver to Coyote
Giant sacaton to Meadow jumping mouse to Great Horned Owl
Saltgrass to Desert cottontail to Coyote
Saltgrass to White-footed mouse to Bullsnake
Saltgrass to White-footed mouse to Great Horned Owl
Sedge to Mallard duck to Coyote
Spectacle pod (Mustard) to Harvester ants to New Mexico whiptail lizard
Sunflower (roots) to Botta pocket gopher to Coyote
Wolfberry to Summer tanager to Coopers Hawk

Four-Step Food Chain Sets for the Bosque Education Guide

Algae to Mayfly larvae to Northern leopard frog to Spiny softshell turtle
Algae to Mayfly larvae to Rio Grande cutthroat trout to Bald Eagle
Algae to Rio Grande silvery minnow to Garter snake to Greater Roadrunner
Cottonwood to Cricket to New Mexico whiptail to Greater Roadrunner
Cottonwood to Cricket to New Mexico whiptail to Bull snake

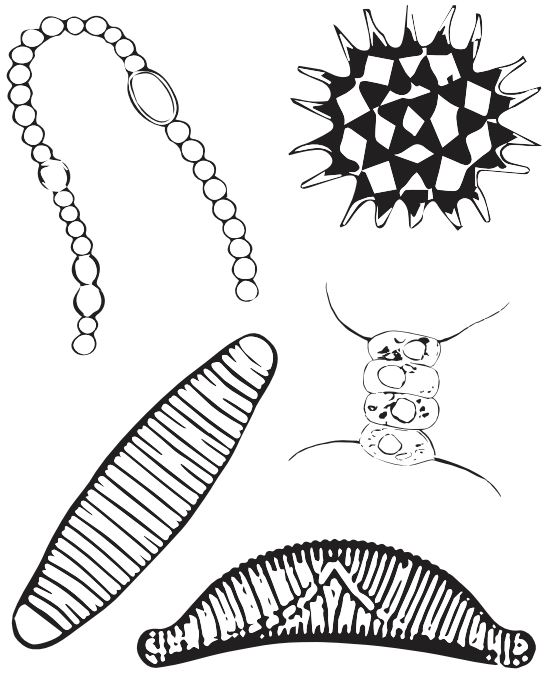
Two-Step Food Chain Sets for the Bosque Education Guide

Cattail to Elk
One-seed juniper to Bear
Prickly pear to Coyote
Screwbean mesquite to Coyote

We are microscopic organisms that live in the Rio Grande or damp sunny places. Some of us live alone; some connect like strands of beads, or stars, or just hang out together. Some of us can "swim" while others just go with the flow. We make our own food from sunlight using our green, blue-green, or golden pigment in our cells. Our growth depends on the amount of light and nutrients available. We take in carbon dioxide and make sugars for our food, like land plants. Oxygen is released by this process. Together with ocean-living relatives, we produce 70-80% of Earth's atmosphere's oxygen! Some of us have cell walls made of glass; the glass pattern of each species is unique. Some of us can create usable nitrogen from the air, supplementing important nutrients for our growth. We are eaten by caddisfly, mayfly, and mosquito larvae and Rio Grande Silvery Minnows among many other animals.

River Algae

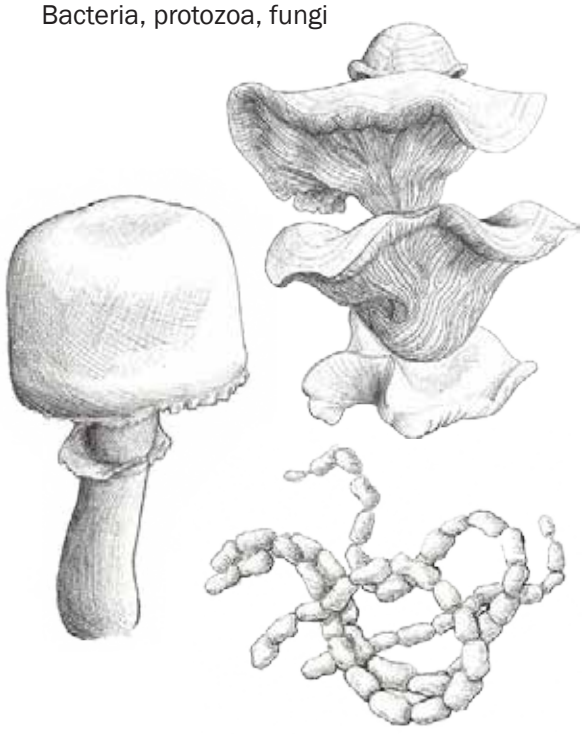
Anabaena, Pediastrum, Scenedesmus, Epithemia, Diatoma



We are nature's recyclers. Any place there is natural waste to break down, we help out. We are small organisms that find the energy and matter we need to grow from the remains of plants and animals. A cricket or isopod will chew fallen cottonwood leaves and then we get to work on the small particles. We break down dead animals, too. Underground, some of us grow slender filaments called hyphae (HI-fee) where we produce enzymes (EN-zimes) to digest material around us, then absorb the nutritious results. We grow better in moist soil. Above ground, you might see our fruiting bodies, which include mushrooms and woody structures called conks. Others of us are microscopic, so you would never know we are there, but we are always at work. A side effect of our diet is that by breaking down this material we leave tiny vital nutrients needed by living plants and algae. Without our work dead things would pile-up everywhere! Imagine that!

Decomposers

Bacteria, protozoa, fungi



NGSS CONNECTIONS TO ENERGY IN BOSQUE ECOSYSTEMS - DISCIPLINARY CORE IDEAS

5.LS1.C Organization for Matter and Energy Flow in Organisms

Food provided animals with the materials they need for body repair, and growth and the energy they need to maintain body warmth and for motion. Plants acquire material for growth chiefly from air, water.

• How do organisms obtain and use the matter and energy they need to live and grow?

PE: 5-LS1-1 *Support an argument that plants get the materials they need for growth chiefly from air and water.*

CCC: Energy and Matter: Flows, Cycles and Conservation *Matter is transported into, out of and within systems.*

***SEP:* Engaging in Argument from Evidence** *Support an argument with evidence, data or a model.*

PE: 5-PS3-1 *Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. [Examples of models could include diagrams and flow charts.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *Energy can be transferred in various ways and between objects.*

SEP: Developing and Using Models *Use models to describe phenomena.*

5.LS2.A Interdependent Relationships in Ecosystems

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. Some organisms such as fungi and bacteria, break down dead organisms (both plants or their parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. 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.

• How do organisms interact with the living and nonliving environments to obtain matter and energy?

PE: 5-LS2-1 *Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and Earth.] [Does not include molecular explanations.]*

CCC: Systems and System Models *A system can be described in terms of its components and their interactions.*

SEP: Developing and Using Models *Develop a model to describe phenomena.*

5.LS2.B Cycles of Matter and Energy Transfer in Ecosystems

Matter cycles between the air and soil and among organisms as they live and die. Organisms obtain gases and water from the environment and release waste matter (gas, liquid, or solid) back into the environment.

• How do matter and energy move through an ecosystem?

This activity focuses on the energy moving through the ecosystem and less on the matter moving through. But it is not hard to look at matter as well. It is also a confusing concept where students need to tease apart the ideas about chemical potential energy (CPE) that is stored in the form of glucose and has mass—it is the "stuff" of the food we all eat—but through cellular respiration CPE is released, providing the energy all life uses to move, build cells and grow. The Rio Grande Bosque Water Cycle activity in this *Guide* demonstrates a matter cycle.

PE: 5-LS2-1 *Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. [Clarification statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and Earth.] [Does not include molecular explanations.]*

CCC: Systems and System Models *A system can be described in terms of its components and their interactions.*

SEP: Developing and Using Models *Develop a model to describe phenomena.*

5.PS3.D Energy in Chemical Processes and Everyday Life

The energy released from digesting food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). 5-PS3-1

• How do food and fuel provide energy?

PE: 5-PS3-1 *Use models to describe that energy in animals food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. [Examples of models could include diagrams and flow charts.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *Energy can be transferred in various ways and between objects.*

SEP: Developing and Using Models *Use models to describe phenomena.*

MS.LS1.C Organization for Matter and Energy Flow in Organisms

Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. Animals obtain food from eating plants or eating other animals. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. In most animals and plants, oxygen reacts with carbon-containing molecules (sugars) to provide energy and produce carbon dioxide.

--anaerobic bacteria achieve their energy needs in other chemical processes that do not require oxygen. (*extension: research chemosynthesis)

• *How do organisms obtain and use the matter and energy they need to live and grow?*

This is the perfect activity to address this standard. Using local plant and animal examples, students can trace the path of energy from the sun to plants, to herbivores and carnivores.

PE: MS-LS1-6 *Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *Within a natural system, the transfer of energy drives the motion and or cycling of matter.*

SEP: Constructing Explanations and Designing Solutions *Construct a scientific explanation based on valid and reliable evidence obtained from sources and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*

PE: MS-LS1-7 *Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]* (*extension)

CCC: Energy and Matter: Flows, Cycles and Conservation *Matter is conserved because atoms are conserved in physical and chemical processes.*

SEP: Developing and Using Models *Develop a model to describe unobservable mechanisms.*

This activity lays the groundwork for further study to understand how chemical potential energy in the food that any animal eats, becomes the energy needed to live. By following the energy in an ecosystem through these short food chain sets, you can see that energy is moving through the system. But, how that food becomes energy through cellular respiration can be another focus of study for students.

MS.LS2.B Cycles of Matter and Energy Transfer in Ecosystems

Food webs are models that demonstrate how matter and energy are transferred between producers, consumers and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.

• *How do matter and energy move through an ecosystem?*

PE: MS-LS2-3 *Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. [Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system. Assessment does not include the use of chemical reactions to describe the processes.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *The transfer of energy can be tracked as energy flows through a natural system.*

SEP: Developing and Using Models *Develop a model to describe phenomena.*

MS.PS3.D Energy in Chemical Processes and Everyday Life

The chemical reaction by which plants produce complex food molecules (sugars) requires energy input (i.e. from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen.

Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.

· *How do food and fuel provide energy?*

PE: MS-LS1-6 *Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *Within a natural system, the transfer of energy drives the motion and or cycling of matter.*

SEP: Constructing Explanations and Designing Solutions *Construct a scientific explanation based on valid and reliable evidence obtained from sources and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*

PE: MS-LS1-7. *Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]*

CCC: Energy and Matter: Flows, Cycles and Conservation *Matter is conserved because atoms are conserved in physical and chemical processes.*

SEP: Developing and Using Models *Develop a model to describe unobservable mechanisms.*