

# Science Module 2

## Life Science: Energy Flow

## Module Goal

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The goal of this module is to provide information that will help educators increase their knowledge of grade-appropriate science concepts, knowledge, and skills to support effective planning or modification of their existing science instructional units for students with significant cognitive disabilities. The module includes important concepts, knowledge, and skills for the following instruction:

- Ecosystems: Interactions, Energy, and Dynamics (elementary)—Organisms have interconnected roles to meet needs (i.e., producers, consumers, decomposers); plants produce food (i.e., sugar) to grow through the process of photosynthesis; consumers get their food from plants or other consumers who eat plants. 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.
- Ecosystems: Interactions, Energy, and Dynamics (middle)—Ecosystems include competitive, symbiotic, and predatory interactions; energy transfers through organisms in an ecosystem and can be modeled by a food web or energy pyramid. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.
- From Molecules to Organisms: Structures and Processes (middle)—Matter, including carbon and oxygen, cycles through an ecosystem and can be represented by models. Plant growth can continue throughout the plant's life through production of plant matter in photosynthesis.
- Heredity: Inheritance and Variation of Traits (middle)—Mitosis and meiosis are two ways in which cells reproduce in humans and animals. When organisms reproduce, genetic information is transferred to their offspring, with half coming from each parent in sexual reproduction.

## Module Objectives

The content module supports educators' planning and implementation of instructional units in science by:

- Developing an understanding of the concepts and vocabulary that interconnect with information in the module units.
- Learning instructional strategies that support teaching students the concepts, knowledge, and skills related to the module units.
- Discovering ways to transfer and generalize the content, knowledge, and skills to future school, community, and work environments.

The module provides an overview of the science concepts, content, and vocabulary related to Life Science: Energy Flow and provides suggested teaching strategies and ways to support transference and generalization of the concepts, knowledge, and skills. The module does not include lesson plans and is not a comprehensive instructional unit. Rather, the module provides information for educators to use when developing instructional units and lesson plans.

The module organizes the information using the following sections:

- I. Tennessee Academic Standards for Science and Related Knowledge and Skills Statements and Underlying Concepts;
- II. Scientific Inquiry and Engineering Design;
- III. Crosscutting Concepts;
- IV. Vocabulary and Background Knowledge information, including ideas to teach vocabulary;
- V. Overview of Units' Content;

- VI. Universal Design for Learning (UDL) Suggestions;
- VII. Transference and Generalization of Concepts, Knowledge, and Skills; and
- VIII. Tactile Maps and Graphics.

## **Section I**

### **Tennessee Academic Standards for Science and Related Knowledge and Skills Statements and Underlying Concepts**

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It is important to know the expectations for each unit when planning for instruction. The first step in the planning process is to become familiar with the identified academic standards and the Knowledge and Skills Statements (KSSs) and Underlying Concepts (UCs) covered in the module. The KSSs are specific statements of knowledge and skills linked to the grade-specific science academic standards. The UCs are entry-level knowledge and skills that build toward a more complex understanding of the knowledge and skills represented in the KSSs and should not be taught in isolation. It is important to provide instruction on the KSSs along with the UCs to move toward acquisition of the same knowledge and skills.

Table 1 includes the academic standards and related KSSs and UCs for Life Science: Energy Flow. While only the academic standards targeted for the Tennessee Comprehensive Assessment Program/Alternate (TCAP/Alt) are included, instruction on additional standards will aid in student understanding. Standards that are not included still represent important content for students to master. Therefore, the KSSs and UCs included in the table do not cover all the concepts that can be taught to support progress and understanding aligned to the standards.

**Table 1. Tennessee Academic Standards for Science and Related KSSs and UCs <sup>1</sup>**

| Academic Standards   | Knowledge and Skills Statements (KSSs)   | Underlying Concepts (UCs)  |
|--|--|--|
| <b><i>Ecosystems: Interactions, Energy, and Dynamics (elementary)</i></b>  |  |  |
| <p><b>4.LS2.1:</b> Support an argument with evidence that plants get the materials they need for growth and reproduction chiefly through a process in which they use carbon dioxide from the air, water, and energy from the sun to produce sugars, plant materials, and waste (oxygen); and that this process is called photosynthesis.</p> | <p><b>4.LS2.1.a:</b> Ability to recognize that plants produce materials they need for growth through photosynthesis</p>  | <p><b>4.LS2.1.UC:</b> Identify the materials plants need for survival (i.e., sunlight, clean air, and water).</p>                                |
| <p><b>4.LS2.3:</b> Using information about the roles of organisms (producers, consumers, decomposers), evaluate how those roles in food chains are interconnected in a food web, and communicate how the organisms are continuously able to meet their needs in a stable food web.</p>   | <p><b>4.LS2.3.a:</b> Ability to identify an example of interconnectedness among plants and animals in their environment (e.g., animals that consume other animals)</p> <p><b>4.LS2.3.b:</b> Ability to identify that a healthy ecosystem is one in which multiple types of organisms are each able to meet their needs</p>   | <p><b>4.LS2.3.UC:</b> Identify roles of producers, consumers, or decomposers (e.g., dead plants and animals are broken down by decomposers).</p> |
| <b><i>Ecosystems: Interactions, Energy, and Dynamics (middle)</i></b>  |  |  |
| <p><b>6.LS2.2:</b> Determine the impact of competitive, symbiotic, and predatory interactions in an ecosystem.</p>   | <p><b>6.LS2.2.a:</b> Ability to use a model of interactions between organisms in an ecosystem to identify a predatory relationship</p> <p><b>6.LS2.2.b:</b> Ability to use a model of interactions between organisms in an ecosystem to identify a competitive relationship</p> <p><b>6.LS2.2.c:</b> Ability to use a model of interactions between organisms in an ecosystem to identify a symbiotic relationship</p> | <p><b>6.LS2.2.UC:</b> Identify the predator or the prey in a predation model.</p>  |
| <p><b>6.LS2.3:</b> Draw conclusions about the transfer of energy through a food web and energy pyramid in an ecosystem.</p>  | <p><b>6.LS2.3.a:</b> Ability to demonstrate an understanding of energy transfer between producers and consumers in an ecosystem using a model (i.e., food web or energy pyramid)</p>   | <p><b>6.LS2.3.UC:</b> Recognize that when people or animals eat plants they are taking energy into their bodies.</p>                             |
| <p><b>7.LS2.1:</b> Develop a model to depict the cycling of matter, including carbon and oxygen, including the flow of energy</p>  | <p><b>7.LS2.1.a:</b> Ability to identify relevant components in a simple model of matter being continually recycled in an ecosystem (i.e., carbon/oxygen cycle)</p>  | <p><b>7.LS2.1.UC:</b> Identify relevant components in a simple model of matter transfer (i.e., organisms are decomposed after death to</p>       |

| Academic Standards  | Knowledge and Skills Statements (KSSs)  | Underlying Concepts (UCs)  |
|---|---|--|
| among biotic and abiotic parts of an ecosystem.   | <b>7.LS2.1.b:</b> Ability to identify relevant components in a simple model of the flow of energy among parts of an ecosystem (e.g., energy passes from organism to organism through food webs)   | return food materials to the ecosystem).   |
| <b><i>From Molecules to Organisms: Structures and Processes (middle)</i></b>  |   |  |
| <b>7.LS1.9:</b> Construct a scientific explanation based on compiled evidence for the processes of photosynthesis, cellular respiration, and anaerobic respiration in the cycling of matter and flow of energy into and out of organisms. | <b>7.LS1.9.a:</b> Ability to identify a model illustrating the cycle of matter among the processes of photosynthesis and respiration (e.g., animals breathe in oxygen and breathe out carbon dioxide, while plants do the opposite)<br><b>7.LS1.9.b:</b> Ability to recognize a model of the flow of matter or energy in aerobic and anaerobic conditions   | <b>7.LS1.9.UC:</b> Recognize that living organisms require both energy and carbon for growth.              |
| <b><i>Heredity: Inheritance and Variation of Traits (middle)</i></b>  |   |  |
| <b>7.LS3.2:</b> Distinguish between mitosis and meiosis and compare the resulting daughter cells.   | <b>7.LS3.2.a:</b> Ability to use a model to identify that mitosis produces two genetically identical daughter cells from one parent cell<br><b>7.LS3.2.b:</b> Ability to identify that meiosis results in four daughter cells, each with half the number of chromosomes as the parent cell<br><b>7.LS3.2.c:</b> Ability to recognize that two sex cells combine to form a new organism that is genetically unique from the parent | <b>7.LS3.2.UC:</b> Recognize that plants and animals grow as a result of cells dividing to form new cells. |

<sup>1</sup> Instruction is not intended to be limited to the concepts, knowledge, and skills represented by the KSSs and UCs listed in Table 1.

## Section II

### Scientific Inquiry and Engineering Design

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It is important for students with significant cognitive disabilities to have the opportunity to explore the world around them and learn to problem solve during science instruction. This approach to science instruction does not involve rote memorization of facts; instead it involves scientific inquiry. A Framework for K–12 Science Education (2012) unpacks scientific inquiry, providing eight practices for learning science and engineering in grades K–12. These practices provide students an opportunity to learn science in a meaningful manner. Students should combine the science and engineering practices as appropriate to conduct scientific investigations instead of using a practice in isolation or sequentially moving through each practice. Support should be provided as necessary for students with significant cognitive disabilities to actively use the practices. A link to *Safety in the Elementary Science Classroom* is in the resources of this section. See Section VI. Universal Design for Learning Suggestions for support ideas. Following are the eight science and engineering practices (National Research Council, 2012) with added examples.

- Asking questions (for science) and defining problems (for engineering).  
*Examples: What would happen to a bean plant if it did not get any water? What would happen to the wolves in an ecosystem if the rabbits and other small animals left? Which organism in a food chain has the most energy? Why do offspring resemble both parents? What types of groundcover can be used to stabilize a hillside, but not disturb native plant or animal species?*
- Developing and using models.  
*Examples: Use a model of photosynthesis (without chemical symbols) to understand and explain the flow of oxygen and carbon dioxide. Develop a model to describe a food chain or food web in an ecosystem. Use a model of mitosis to demonstrate how a single parent cell produces two identical daughter cells. Design a self-contained ecosystem that cycles oxygen and carbon dioxide. Use a model to test interactions concerning the functioning of a natural system. Use appropriate tools and measurements to construct a model of energy transfer between producers and consumers in an ecosystem.*
- Planning and carrying out investigations.  
*Examples: Design and conduct an investigation to find what plants need to live and grow (e.g., test the effect of saturation on a plant; have students collect a soil sample, weigh and dry a soil sample, and determine the moisture content of the sample.). Design investigations about particular phenomena, such as the growth of plants. Perform investigations where the input of light energy is manipulated.*
- Analyzing and interpreting data.  
*Examples: Use data to determine if a specific animal is a predator or prey. Analyze a predator-prey relationship graph to determine what happens when the prey population decreases. Collect data during investigations and observations of simulations; construct an explanation for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.*
- Using mathematics and computational thinking.  
*Examples: Measure and chart a plant as it grows. Count the number of consumers in a food web. Use information presented in various modes (e.g., graphs, diagrams, photographs, text, mathematical, verbal) to classify types of relationship based on trends in two species' population*

size. Use mathematical representations of phenomena, students identify relevant components, including population changes, number of trophic levels supported by an ecosystem, and the energy available for top level consumers compared to organisms at lower levels.

- Constructing explanations (for science) and designing solutions (for engineering).  
*Examples: Explain the results of an investigation on the needs of plants to grow. Explain what happens to plants in soil that has been flooded (oversaturated) with water. Explain, using a model, how matter in an ecosystem is repeatedly recycled between organisms, and between organisms and the physical environment. Identify elements of the model that need to be improved. Develop possible solutions to problems caused when changes in an ecosystem affect resources (food, energy, and medicine). Compare the approaches/merits of multiple proposed solutions for design solutions for maintaining biodiversity.*
- Engaging in argument from evidence.  
*Example: Use empirical evidence to construct, critique, and defend scientific arguments. Evaluate empirical evidence supporting arguments about changes to ecosystems. Assess possible side effects of a given design solution on various aspects of an ecosystem (i.e., the possibility that a small change in one component of an ecosystem can produce a large change in another component of the ecosystem).*
- Obtaining, evaluating, and communicating information.  
*Examples: Communicate the idea that energy flows through an ecosystem. Gather information on a local predator-prey relationship from multiple sources and summarize for a presentation. Students gather and use information to identify and describe how organisms are able to meet their needs in a stable food web. Students engage in a portion of the engineering design process in order to investigate the merit of solutions to problems caused when the environment changes.*

## Science Practices Resources<sup>2</sup>

- Safety in the Elementary Science Classroom provides safety information for teachers and students.  
<https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/safetypractices/safety-in-the-elementary-school-science-classroom.pdf>
- This site categorizes inquiry into three types: structured inquiry, guided inquiry, and open inquiry. Each type provides a wide range of example lessons grouped by elementary and middle school.  
<http://www.justsciencenow.com/inquiry/>
- These are a variety of sites that provide models or directions to build models.
  - <http://seplessons.ucsf.edu/node/1760>
  - <https://sciencing.com/science-projects-food-chain-7992636.html>
  - <https://www.education.com/science-fair/article/food-chains/>
  - <http://www.cpalms.org/Public/PreviewResourceLesson/Preview/130159>
  - <http://www.scienceprofonline.com/genetics/classroom-demonstration-meiosis-with-photos.html>
- Education.com provides a variety of life science activities and experiments.  
<http://www.education.com/activity/life-science/>

## Section III

### Crosscutting Concepts

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Grade-level science content includes Crosscutting Concepts, which are concepts that connect information between different science strands and grade levels. The Crosscutting Concepts are intended to work together with the science inquiry and engineering practices, in addition to core content, to enable students to reason with evidence, make sense of phenomena, and design solutions to problems. Helping students make connections between these types of concepts and new content information supports comprehension of the concepts, knowledge, and skills as well as transference and generalization (see Section VII for more information). Crosscutting Concepts that are specific to this module connect to content across the units within the module as well as across modules.

Crosscutting Concepts are a common link between multiple standards and units of study. The Crosscutting Concepts, by being revisited and linked to multiple units of study, become a strong foundation of understanding, and support the students in learning new concepts. Life sciences focus on patterns, processes, and relationships of living organisms. For example, understanding patterns of change is a Crosscutting Concept that applies to the growth and development of organisms, symmetry of flowers, and the repeated base pairs of DNA. Crosscutting Concepts may apply across multiple content areas and instructional emphases (e.g., Observations and data describe cause and effect relationships). The Crosscutting Concepts of cause and effect and structure and function provide a framework for understanding how gene structure determines differences in the functioning of organisms.

This content module, Life Science: Energy Flow, addresses how plants produce their food, the interconnectedness among plants and animals in their environment, how organisms are affected by physical factors, and ways that new cells are created. A critical concept is the unifying principle that energy and matter flow through organisms and the environment.

#### Teaching Crosscutting Concepts

The following strategies pulled from the principles of UDL (CAST, 2011) are ways in which to teach Crosscutting Concepts to help students understand the concepts and make connections between different curricular content. During instruction, highlight:

- patterns (e.g., Point out patterns in the shape of a graph or repeating pattern on a chart.),
- critical features (e.g., Provide explicit cues or prompts such as highlighting that help students to attend to the important features.),
- big ideas (e.g., Present and reinforce the “big ideas” that students should take and apply throughout their lives.), and
- relationships (e.g., Make the connection between the unit concepts and how they apply to the students’ lives.).

Following are **Crosscutting Concepts** for this Content Module—Life Science: Energy Flow. According to *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012), these concepts help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world.



## Patterns

### *Patterns*

- Patterns can be used to identify cause-and-effect relationships (e.g., predator-prey relationships).
- Patterns of interactions of organisms can be observed when learning about organisms and ecosystems, such as healthy ecosystems that have competitive, predatory, and mutually beneficial interactions.

## Causality

### *Cause and Effect*

- Cause-and-effect relationships may be used to predict phenomena in natural systems (e.g., the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation).

## Systems

### *Systems and System Models*

- A system can be described in terms of its components and their interactions (e.g., plants and animals, and their interactions within an ecosystem).

### *Energy and Matter*

- Matter is transported into, out of, and within systems (e.g., photosynthesis: the input of light energy, water, and carbon dioxide produces glucose within a plant and an output of oxygen).
- The transfer of energy can be tracked as energy flows through a natural system (e.g., food web or energy pyramid).
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter (e.g., Some animals eat plants and some animals eat other animals that eat plants for food to provide energy for growth and survival.).

### *Stability and Change*

- An ecosystem can be seen as a system with specific roles performed by different organisms.
- As a system, stability is achieved by having specific functions performed by different organisms.

## Crosscutting Concept Resources

- Grant Wiggins talks about “big ideas” in this article.  
[http://www.authenticeducation.org/ae\\_bigideas/article.lasso?artid=99](http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=99)
- A Framework for K–12 Science Education, Appendix G explains the Crosscutting Concepts and how the concepts help students deepen their understanding of the information.  
<http://www.nextgenscience.org/sites/default/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf>
- Teacher Vision provides 10 science graphic organizers that are free and printable.  
<https://www.teachervision.com/graphic-organizers/science/52539.html>
- Utah Education Network provides a variety of student interactives for:

- grades three through six. <http://www.uen.org/3-6interactives/science.shtml>
- grades seven through twelve. <http://www.uen.org/7-12interactives/science.shtml>

## Section IV

### Vocabulary and Background Knowledge

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Vocabulary is critical to building an understanding of science concepts, knowledge, and skills. The vocabulary words that students gain through experiences provide ways for students to comprehend new information (Sprenger, 2013). Students can better understand new vocabulary when they have some background knowledge to which they can make connections. In addition, learning new vocabulary increases students' background knowledge. Therefore, it is important to teach vocabulary purposely when introducing new concepts, knowledge, or skills (e.g., interconnectedness of animals in an ecosystem) and in the context of the specific content (e.g., teach the terms producer, consumer, decomposer while learning about a specific ecosystem).

This module includes two types of vocabulary words, both equally important to teach. The first type, **general vocabulary words**, labels groups of words that generalize to a variety of animals, plants, organisms, and activities. For example, understanding the meaning of the word “energy” helps students to connect the different ways organisms acquire and use energy. The second type, **specific content words**, represents groups of words that are associated with an organism, system, process, or phenomena. For example, the specific word “photosynthesis” connects to the general words “carbon dioxide” and “sugar” when learning how plants produce food. Providing exposure and instruction on general words provides background knowledge when introducing corresponding or related specific words.

#### Key Vocabulary for Instructional Units

Table 2 and Table 3 contain lists of key general vocabulary words and specific content words that are important to the units in this module. The vocabulary words span across grades four, six, and seven. Refer to the Tennessee Academic Standards for Science for grade specific words. Teach general vocabulary words to the student using a student-friendly description of the word meaning (e.g., Habitat is the place a plant or animal normally lives.) and an example of the word (e.g., A barred owl's habitat is usually a forest.). Teach the specific content vocabulary using a student-friendly description of the word meaning (e.g., Photosynthesis is when plants take sunlight, air, and water and turn it into sugar.) and a possible connection to a general vocabulary word (e.g., Animals break down sugars to release energy.).

Do not teach memorization of vocabulary words; instead, place emphasis on understanding the word as a result of observation, investigation, viewing a model, etc. For example, a student should learn to identify an animal as a prey or a predator instead of formally defining each.

**Table 2. General Vocabulary Words**

|  |               |                    |
|--|---------------|--------------------|
| <b>General Vocabulary</b> —words that generalize to different animals, plants, organisms, and activities. Describe the word and provide examples (e.g., An ecosystem is the place where several plants and animals live and interact with each other. <i>Example: A lake ecosystem includes fish, turtles, and plants</i> ). |               |                    |
| • animal   | • energy      | • predator         |
| • carbon dioxide   | • environment | • prey             |
| • cell   | • habitat     | • produce/producer |
| • chromosome   | • matter      | • reproduce        |

|                         |             |                    |
|-------------------------|-------------|--------------------|
| • competitive           | • organisms | • resources        |
| • consume/consumer      | • oxygen    | • sugar            |
| • decompose/decomposers | • parent    | • survive/survival |
| • ecosystem             | • plant     | • variation        |

**Table 3. Specific Content Words**

|   |                  |                  |
|---|------------------|------------------|
| <p><b>Specific Content Words</b>—words that specify a particular thing (e.g., chlorophyll) or phenomena (e.g., cellular respiration).<br/>Describe the word and when possible make the connection to a Crosscutting Concept (e.g., Cellular respiration uses sugar from food we eat and oxygen from the air we breathe to make carbon dioxide, water, and energy. Cellular respiration is an important part of cycling matter.)</p> |                  |                  |
| • aerobic   | • daughter cells | • photosynthesis |
| • anaerobic   | • food chain     | • respiration    |
| • cellular respiration  | • food web       | • symbiotic      |
| • chlorophyll   | • meiosis        |                  |
| • cycle of matter   | • mitosis        |                  |

**Ideas to Support Vocabulary Learning**

Table 4 includes ideas and examples for teaching vocabulary in ways to build conceptual understanding of the words. The examples include ideas on how to provide individualization, indicated in brackets, for unique student needs. These individualization ideas are provided to guide educators in ways to create access to vocabulary instruction for individual students.

**Table 4. Ideas to Teach Vocabulary Effectively (Marzano, 2004)<sup>1</sup>**

| Ideas   | Examples  |
|---|---|
| <p>Explain, describe, and/or give examples of the vocabulary word rather than formal definitions.</p> | <ul style="list-style-type: none"> <li>• Provide a description of a producer, “A daisy is a producer because it makes its own food by using light energy from the sun, carbon dioxide from the air, and water from the soil.” [Individualization idea: Pair the description with a diagram showing an arrow from the sun to the plant, an arrow from the surrounding air to the plant, and an arrow from the ground to the roots of the plant.]</li> <li>• Provide an example of producers, “Trees, grass, flowers, and vegetable plants are examples of producers.” [Individualization idea: Put the word “producer” on the wall with pictures of different producers and connect the pictures to the word with string. Do the same for consumer and decomposer.]</li> </ul> |

| Ideas  | Examples   |
|--|--|
| <p>Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge.</p> | <ul style="list-style-type: none"> <li>• Have students keep a science vocabulary notebook and add words as they are introduced and discussed in context. Each page can have three columns with the following headings: My Description, Drawing or Picture, and New Understanding. [Individualization idea: Use hook and loop tape on the three column charts and continue to add into a three-ring binder (See Figure 1. Example Science Vocabulary Notebook Page). Have students pick from phrases/sentences and pictures to complete the pages of the notebook.]</li> <li>• Remind students that energy is what they need to work and play and then explain how the food we eat is converted to energy.</li> <li>• Have students state in their own words the meaning of cellular respiration (e.g., Cellular respiration happens when the food I eat changes into energy that my body can use.). [Individualization idea: Provide words or phrases needed to describe vocabulary words on the student’s AAC system.]</li> </ul> |
| <p>Have students represent vocabulary words in a variety of ways (e.g., pictures, symbols, graphic organizers, or models).</p>   | <ul style="list-style-type: none"> <li>• Ask students to complete a vocabulary concept map that includes the word (e.g., mitosis), category it fits into (e.g., reproduction), a description (e.g., one cell divides into two identical cells), and an illustration (e.g., drawing or picture of a cell dividing into two cells). [Individualization idea: Have the student partner with a peer and provide choices that can be copied or pasted onto the map.]</li> <li>• Have students construct a model of a food chain using pictures labeled with the plant or animal name and place holders labeled: producer, consumer, and decomposer. [Individualization idea: Add pictures to slide show or document that allows the student to drag and drop the pictures representing the components of the food chain into the correct order. (<a href="https://www.youtube.com/watch?v=OKCDHrwAwcM">https://www.youtube.com/watch?v=OKCDHrwAwcM</a>)]</li> </ul>   |

| Ideas  | Examples   |
|--|--|
| <p>Provide multiple exposure to vocabulary words in a variety of ways. This does not suggest mass trials, but rather distributed trials in different ways or contexts. Reference <a href="http://projectlearnnet.org/tutorials/learning_trials.html">http://projectlearnnet.org/tutorials/learning_trials.html</a> for information on learning trials.</p> | <ul style="list-style-type: none"> <li>• Incorporate vocabulary into daily activities when appropriate (e.g., Talk about why a classroom plant needs to have sunlight, water, and clean air and how it makes its own food). [Individualization idea: Provide a picture checklist that includes the essential needs for a plant for the student to use each day to care for a classroom plant.]</li> <li>• Read books or watch videos related to the vocabulary and concepts (e.g., watch an animated video clip on photosynthesis <a href="https://www.youtube.com/watch?v=3pD68uxRLkM">https://www.youtube.com/watch?v=3pD68uxRLkM</a>).</li> <li>• Have students complete activities such as sorting words into categories or labeling a model (e.g., living things in an ecosystem).</li> <li>• Help students compare terms (e.g., habitat and ecosystem). [Individualization idea: Have a template and have students sort pictures representing habitats into the appropriate ecosystem.]</li> </ul> |
| <p>Ask students to discuss the vocabulary words with each other.</p>   | <ul style="list-style-type: none"> <li>• Have students share a favorite word and explain why. [Individualization idea: Place a description of a few vocabulary words on a voice output device and have the student choose which one to share with a classmate using an adapted switch.]</li> <li>• Have students share their representations (e.g., drawings or pictures) of a vocabulary word with each other.</li> </ul>   |
| <p>Play vocabulary word games with students.</p>   | <ul style="list-style-type: none"> <li>• Have students play a vocabulary game (e.g., <a href="https://www.eduplace.com/kids/hmsc/activities/ewordgame/index.html?grade=3&amp;unit=b&amp;chapter=4">https://www.eduplace.com/kids/hmsc/activities/ewordgame/index.html?grade=3&amp;unit=b&amp;chapter=4</a>).</li> <li>• Have students organize vocabulary words/pictures/representative objects on a graphic organizer.</li> <li>• Have students complete interactive software on the food chain (e.g., <a href="http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm">http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm</a>).</li> </ul>   |

| Ideas   | Examples   |
|---|--|
| Have students watch a dramatization or have them act out the vocabulary term. | <ul style="list-style-type: none"><li>• Watch a video on photosynthesis (e.g., <a href="https://www.youtube.com/watch?v=xuivYRmIACM">https://www.youtube.com/watch?v=xuivYRmIACM</a>).</li></ul> |

<sup>1</sup> Refer to Section VI, Universal Design for Learning (UDL) Suggestions for additional instructional strategies.

**Vocabulary Example**


Have students keep a science notebook and have some vocabulary pages include a three-column chart (i.e., My Description, Drawing or Picture, and New Understanding) for the vocabulary word (see

Figure 1). Educators may need to support, modify, or adapt steps as needed for individual students. [Individualization idea: Use hook and loop tape on the three column charts and continue to add into a three-ring binder. Have students pick from phrases/sentences and pictures to complete the pages of their notebook.] Two National Center and State Collaborative (NCSC) resources are available and may prove helpful:

- Use systematic instruction as described in the NCSC Instructional Guide.  
<https://wiki.ncscpartners.org>
- Reference ideas in the NCSC Vocabulary and Acquisition Content Module.  
<https://wiki.ncscpartners.org>



Figure 1. Example Science Vocabulary Notebook Page

| Vocabulary Word: ecosystem  |  |  |
|---|--|--|
| My Description  | Drawing or Picture   | New Understanding  |
| <p>An environment that is shared by all the plants and animals that live there.</p> |  | <p>A good ecosystem needs:</p> <p>producer</p> <p>consumer</p> <p>decomposer</p> |

### Vocabulary Resources

- Vocabulary.com provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. <http://www.vocabulary.com/>
- TextProject provides Word Pictures that are free for educators to use. Their site includes word pictures for core vocabulary and various content areas including science and social studies. This link will take you to the Word Pictures page where you can select the category of words you want to use. <http://textproject.org/classroom-materials/textproject-word-pictures/>
- The Science Penguin site provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary terms. <http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html>

## Section V

### Overview of Units' Content

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This section of the module contains additional content and references to support educators' understanding and instruction of the instructional units. The information reflects important content to address the KSSs and to build students' knowledge, skills, and abilities; however, it is not exhaustive and should be expanded upon as appropriate.

#### **Ecosystems: Interactions, Energy, and Dynamics (elementary)**

##### **Content:**

- Plants need sunlight, clean air, and water to produce food.
- Plants produce materials needed for growth and reproduction through the process of photosynthesis (i.e., carbon dioxide from the air, water from the soil, and energy from the sun to produce sugars).
- Plants use the sugar produced during photosynthesis immediately or store it for later use.
- Each organism in an ecosystem has a role: producer, consumer, or decomposer.
- Living systems are interconnected and interacting.

#### **Ecosystems: Interactions, Energy, and Dynamics (middle)**

##### **Content:**

- Ecosystems include predators and prey.
- Predators are animals that eat other animals.
- Prey are the animals which the predator eats.
- Limited resources (e.g., space, food, or water) in an ecosystem result in competition within and between species for the needed resources.
- Symbiotic relationships occur when two organisms have a close association that benefits at least one of the organisms.
- People take energy into their bodies by eating plants and/or animals.
- Energy is transferred when an organism consumes other organisms.
- A food web and energy pyramid are models illustrating energy flow in an ecosystem.
- Sunlight provides energy to producers that transform the energy into a form of matter through photosynthesis.
- Matter continually cycles through organisms and their physical environment.
- Plants release oxygen into the atmosphere that animals and plants breathe in from the atmosphere, and animals and plants release carbon dioxide into the atmosphere that plants take in from the atmosphere.
- Non-living parts of an ecosystem (e.g., water, minerals, air) can provide matter to living organisms (e.g., Plants use water and minerals in the soil to grow and produce food for consumers.).
- Non-living parts of an ecosystem can receive matter from living organisms (e.g., Nutrients are deposited into the soil when an organism decomposes).

## From Molecules to Organisms: Structures and Processes (middle)

### Content:

- Living organisms require energy and carbon for growth.
- Cellular respiration is the process cells use to release energy from sugar (food molecules).
- Plants use energy from sunlight, carbon dioxide, and water to produce sugars through a process called photosynthesis.
- Matter is cycled as animals breathe in oxygen and breathe out carbon dioxide, while plants do the opposite.
- Energy and matter flow through an ecosystem in aerobic conditions (with oxygen) and anaerobic conditions (lack of oxygen).
- Models can be used to illustrate how energy or matter flow through an ecosystem in aerobic conditions and in anaerobic conditions.

## Heredity (middle)

### Content:

- Plants and animals grow by cells dividing to create new cells.
- Mitosis produces two genetically identical daughter cells from one parent cell.
- Mitosis is used to produce body cells (e.g., skin cells, stomach cells, etc.) for growth and repair.
- Meiosis produces four daughter cells from one parent cell.
- Meiosis is used to produce two sex cells (egg for females and sperm for males).
- The sex cells are unique from the parent cell and are used for reproducing a new organism.

## Unit Content Resources

- Interactive Sites for Education provides a wide variety of topics that include interactive animations.  
<http://interactivesites.weebly.com/science.html>

### *Photosynthesis*

- Better Lesson Plans provides a lesson on where plants get the materials they need.  
<https://betterlesson.com/lesson/633008/where-do-plants-get-the-materials-they-need-day-1-gathering-evidence-to-support-your-claim>
- These sites explain photosynthesis:
  - <http://photosynthesiseducation.com/photosynthesis-for-kids/>
  - <https://biologywise.com/photosynthesis-for-kids>

### *Roles of Organisms in an Ecosystem*

- This site provides an explanation and photos of producers, consumers, and decomposers in a forest community. <http://dendro.cnre.vt.edu/forsite/2004presentations/taylor/forsite/forsite.html>
- PBS Learning Media provides a lesson on producers, consumers, and decomposers.  
[https://www.pbslearningmedia.org/resource/tdc02.sci.life.oate.lp\\_energyweb/producers-consumers-decomposers/#.WutZXYiUsdU](https://www.pbslearningmedia.org/resource/tdc02.sci.life.oate.lp_energyweb/producers-consumers-decomposers/#.WutZXYiUsdU)
- Geography 4 Kids has information on roles of organisms in an ecosystem.  
[http://www.geography4kids.com/files/land\\_foodchain.html](http://www.geography4kids.com/files/land_foodchain.html)

- Khan Academy provides information on predation. <https://www.khanacademy.org/science/biology/ecology/community-ecosystem-ecology/a/predation-herbivory>
- Biology 4 Kids provides information on relationships between organisms, including competition, symbiotic (i.e., commensalism, mutualism, and parasitism), and predator-prey. [http://www.biology4kids.com/files/studies\\_relationships.html](http://www.biology4kids.com/files/studies_relationships.html)
- These sites have information on competition in an ecosystem.
  - <https://sciencing.com/competitive-relationships-ecosystems-8451289.html>
  - [http://www.bbc.co.uk/schools/gcsebitesize/science/ocr\\_gateway/understanding\\_environment/interdependencerev1.shtml](http://www.bbc.co.uk/schools/gcsebitesize/science/ocr_gateway/understanding_environment/interdependencerev1.shtml)
- Sciencing has information on symbiotic relationships. <https://sciencing.com/symbiotic-relationship-8794702.html>

### *Flow of Energy and Cycling of Matter*

- Ducksters has information on the oxygen cycle and the carbon cycle.
  - oxygen: [http://www.ducksters.com/science/ecosystems/oxygen\\_cycle.php](http://www.ducksters.com/science/ecosystems/oxygen_cycle.php)
  - carbon: [http://www.ducksters.com/science/ecosystems/carbon\\_cycle.php](http://www.ducksters.com/science/ecosystems/carbon_cycle.php)
- This site provides a lesson plan on matter cycles and energy flows in ecosystems. <http://carbontime.bsccs.org/ecosystems/lesson-3>
- cK-12 has a lesson plan on cycles of matter. <https://www.ck12.org/book/CK-12-Earth-Science-For-Middle-School/section/18.2/>
- This site provides a lesson plan on food webs. <http://www.teacherstryscience.org/ngsslp/backyard-biodiversity-food-web-ngss>
- Texas Gateway has an online resource for food chains, food webs, and energy pyramids. <https://www.texasgateway.org/resource/food-chains-food-webs-and-energy-pyramids>

### *Cellular Respiration*

- These sites have information on cellular respiration.
  - [https://kids.kiddle.co/Cellular\\_respiration](https://kids.kiddle.co/Cellular_respiration)
  - <http://mocomi.com/cellular-respiration/>
- Sciencing has information on anaerobic environments. <https://sciencing.com/anaerobic-environment-10003906.html>

### *Mitosis and Meiosis*

- These sites provide lesson plans on mitosis and meiosis.
  - <https://www.keslerscience.com/sexual-reproduction-and-aseexual-reproduction-lesson-plan-a-complete-science-lesson-using-the-5e-method-of-instruction/>
  - <http://www.cpalms.org/Public/PreviewResourceLesson/Preview/75954>
  - <http://cavalierscience.blogspot.com/2009/04/phases-of-mitosis-activity-worksheet.html>

## Section VI

### Universal Design for Learning (UDL) Suggestions

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Three principles of the UDL—multiple means of representation, multiple means of action and expression, and multiple means of engagement—guide development of instruction, instructional materials, and assessments to provide access to learning to the widest range of students. A well-designed lesson using the principles of UDL reduces the need to make accommodations and modifications. However, some students with significant cognitive disabilities, especially students with visual and/or hearing impairments, physical disabilities, and students with complex communication needs, may require additional scaffolds, adaptations, and modifications to access content and support learning. UDL’s three guiding principles guide educators in creating instructional materials and activities in a flexible manner to address the needs of different types of learners. Utilizing the three principles of UDL as a framework when designing instruction allows for individualization when needed. Table 5 provides strategies and examples for the UDL Principle I, **Multiple Means of Representation**: presenting information in a variety of ways to address the needs of different types of learners.

Table 6 provides strategies and examples for the UDL Principle II, **Multiple Means of Action and Expression**: providing a variety of ways for students to interact with the instructional materials and to demonstrate understanding.

Table 7 provides strategies and examples for the UDL Principle III, **Multiple Means of Engagement**: providing a variety of ways to engage and motivate students to learn.

The strategies and examples provided in Tables 5 through 7 are based on UDL principles and can assist all students in understanding the basic concepts. The strategies and examples, as well as individualization ideas, should serve as a catalyst for ideas that can be individualized to meet the needs of each student. Some of the examples include activities that work exceptionally well for students with vision, hearing, and/or physical limitations as well as for all students. Each example has a code to indicate when it includes specific ideas or activities that meet these needs:

**V** = visually impaired (low vision, blind, or deaf-blind)

**H** = hearing impaired (deaf, hard of hearing, or deaf-blind)

**P** = physical disability (limited use of hands)

**Table 5. Instructional strategy ideas using the UDL Principle: Multiple Means of Representation**

| Multiple Means of Representation   |   |
|--|---|
| Strategies   | Examples  |
| <p>Introduce information through a multi-sensory approach (e.g., auditory, visual, tactile).</p> | <p>Provide tactile representation of the carbon/oxygen cycle (see Section VIII Tactile Maps and Graphics for guidance) and use each time the student is presented with information on photosynthesis and the cycling of matter. [Individualization idea: Pair each part of the graphic with what it represents (e.g., graphic of sun to feeling the heat of the sun; seeing the light from a lamp; touching a live plant; feeling breath for carbon dioxide; breeze for oxygen).]</p> <p>Introduce cellular respiration using a kinesthetic activity (e.g., <a href="http://www.perkinselearning.org/accessible-science/activities/cellular-respiration-kinesthetic-activity">http://www.perkinselearning.org/accessible-science/activities/cellular-respiration-kinesthetic-activity</a>).</p> <p>Present the “Mitosis Hand Jive,” hand movements that demonstrate how cells divide during mitosis (e.g., <a href="https://www.youtube.com/watch?v=PYIMWgyQVtg">https://www.youtube.com/watch?v=PYIMWgyQVtg</a>).</p> <p>Pair various animal sounds with pictures when teaching about predators and prey. [Individualization idea: Provide the sound of a predator and a prey on a dual switch that includes pictures and the label of each animal. Have the student select which animal is a predator or a prey.]</p> |
| <p>Model content through pictures, dramatization, videos, etc.</p>                               | <p>Have students watch a video on photosynthesis (e.g., <a href="https://www.youtube.com/watch?v=68b1HAIfX08">https://www.youtube.com/watch?v=68b1HAIfX08</a> or <a href="https://www.youtube.com/watch?v=uixA8ZX0KU">https://www.youtube.com/watch?v=uixA8ZX0KU</a>).</p> <p>Show a video on organisms and ecosystems (e.g., <a href="https://www.youtube.com/watch?v=bJEToQ49Yjc&amp;t=122s">https://www.youtube.com/watch?v=bJEToQ49Yjc&amp;t=122s</a>).</p> <p>Share an animation of the carbon cycle (e.g., <a href="http://www.kscience.co.uk/animations/carbon_cycle.htm">http://www.kscience.co.uk/animations/carbon_cycle.htm</a>).</p> <p>[Individualization idea: Re-create the model of the carbon cycle by taping pictures of the stages on the floor and using painter’s tape for the arrows. Have students move from one stage to the next as you describe what happens.]</p> <p>Have students watch videos on mitosis and meiosis (e.g., <a href="https://www.youtube.com/watch?v=f-lDPgEfAHJ">https://www.youtube.com/watch?v=f-lDPgEfAHJ</a>, <a href="https://www.youtube.com/watch?v=VzDMG7ke69g">https://www.youtube.com/watch?v=VzDMG7ke69g</a>, and <a href="https://www.youtube.com/watch?v=VzDMG7ke69g&amp;t=28s">https://www.youtube.com/watch?v=VzDMG7ke69g&amp;t=28s</a>).</p>              |
| <p>Present information using graphic organizers and models.</p>                                  | <p>Use a KWHL to help students make connections between what they already <b>Know</b>, <b>What</b> they want to know, <b>How</b> they can find out, and finally, what they <b>Learn</b>. (Here’s a slide show explaining the use of the KWHL chart and how it was made accessible for students with significant cognitive disabilities: <a href="http://www.cehd.umn.edu/nceo/teleconferences/tele14/CourtadeFlowers.pdf">http://www.cehd.umn.edu/nceo/teleconferences/tele14/CourtadeFlowers.pdf</a>). <b>V/H/P</b></p>  |



| <b>Multiple Means of Representation</b>  |  |
|--|--|
| <b>Strategies</b>  | <b>Examples</b>  |
|  | <p>Present models of food chains, food webs, and energy pyramids to explain the flow of energy. [Individualization idea: Use 3-D representations of producers, consumers (primary and secondary), and decomposers and have students place in small baskets to represent food chains. To label the baskets, place a picture of the sun and a plant in the consumer basket, a picture of plants in the primary consumer basket, a picture of herbivores in the secondary consumer basket, and a picture of dirt in the decomposer basket.] <b>V</b></p>  |
| <p>Provide appropriate and accessible text on the content for students to listen to or read.</p> | <p>Paraphrase information from a textbook (e.g., Sunlight is the source of energy for plants. Plants are called producers. Plants turn sunlight into sugar, which can be used for food. Animals eat plants or other animals that eat plants to get the energy the plant has produced. Animals are called consumers.) on large sticky notes (e.g., Place the sticky note over the original text, leaving the graphics. Write or type with a bold and plain font (e.g., Verdana, 18 pt. font) with good spacing between lines (e.g., 1.5 vs. single spacing). <b>V</b> [Individualization idea: Have a peer read the paraphrased text to the student and/or have the student read repetitive words such as “plants.”]</p> <p>Record paraphrased information about energy flow or cycling of matter in an ecosystem and store online using a program such as <a href="https://recordmp3online.com/">https://recordmp3online.com/</a>. <b>V</b> Provide access to the recordings using an icon-based bookmark program such as Symbaloo (<a href="http://www.symbaloo.com">www.symbaloo.com</a>).</p> <p>Provide online text that can be read to the students using a screen reader (e.g., <a href="https://www.ck12.org/c/life-science/importance-of-mammals/lesson/Importance-of-Mammals-MS-LS/?referrer=concept_details">https://www.ck12.org/c/life-science/importance-of-mammals/lesson/Importance-of-Mammals-MS-LS/?referrer=concept_details</a> or <a href="https://www.ck12.org/earth-science/roles-in-an-ecosystem/lesson/Roles-in-an-Ecosystem-MS-ES/?referrer=concept_details">https://www.ck12.org/earth-science/roles-in-an-ecosystem/lesson/Roles-in-an-Ecosystem-MS-ES/?referrer=concept_details</a>).</p> |
| <p>Teach information using songs.</p>  | <p>Teach and reinforce concepts using songs on plant needs (e.g., <a href="https://www.youtube.com/watch?v=dUBIQ1fTRzI">https://www.youtube.com/watch?v=dUBIQ1fTRzI</a>), mitosis (e.g., <a href="https://www.youtube.com/watch?v=f7Dmhfo7XXA">https://www.youtube.com/watch?v=f7Dmhfo7XXA</a>), etc.</p> <p>[Individualization idea: Pair written words to the song and sign as other students are listening to the song.] <b>H</b></p>   |

**Table 6. Instructional strategy ideas using the UDL Principle: Multiple Means of Action and Expression**

| <b>Multiple Means of Action and Expression</b>   |   |
|--|---|
| <b>Strategies</b>  | <b>Examples</b>   |
| Use technology/assistive technology to optimize student access and interaction with the instructional materials and content. | <p>Read a book about animal parts online (e.g., <a href="http://bookbuilder.cast.org/view.php?op=view&amp;book=89446&amp;page=1">http://bookbuilder.cast.org/view.php?op=view&amp;book=89446&amp;page=1</a>).</p> <p>[Individualization idea: Create a personalized book for the student using CAST UDL Book Builder (<a href="http://bookbuilder.cast.org/create.php">http://bookbuilder.cast.org/create.php</a>, requires user to set up free account). For example, write a short book about the carbon/oxygen cycle using a picture of the student, the student’s yard, etc., to illustrate the book.]</p> <p>Have the student complete online interactive activities (e.g., food chains: <a href="http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT06/CT06.swf">http://www.glencoe.com/sites/common_assets/science/virtual_labs/CT06/CT06.swf</a>, <a href="http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm">http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm</a> or food web: <a href="http://teacher.scholastic.com/activities/explorer/ecosystems/be_an_explorer/map/line_experiment14.swf">http://teacher.scholastic.com/activities/explorer/ecosystems/be_an_explorer/map/line_experiment14.swf</a>).</p> |
| Allow for instructional materials that can be modified to provide access.  | <p>Have students complete online interactions among organisms’ resources (e.g., <a href="http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm">http://www.sheppardsoftware.com/content/animals/kidscorner/games/foodchaingame.htm</a>). [Individualization idea: Have student use tracker ball or other adapted mouse to make selections. Read information and choices to the student.]</p> <p>Have students build a bottle ecosystem (e.g., <a href="http://www.thegeoexchange.org/carboncycle/projects/bottle-ecosystem.html">http://www.thegeoexchange.org/carboncycle/projects/bottle-ecosystem.html</a>) to develop an understanding of the carbon cycle.</p> <p>[Individualization idea: Print, cut, and paste the picture directions to create a checklist for the student to follow. Have student work on range of motion and crossing midline while reaching for materials.]</p>   |
| Provide multiple means for students to make choices and select answers.  | <p>Have student dictate answers. [Individualization idea: Place answer options in the student’s AAC device or on multi-select voice output switch.] <b>P</b></p> <p>Provide answer choices. [Individualization idea: Have students use three switches with generic labels (e.g., a, b, c; red, blue, green; or three different textures) to which they listen, and then choose their answer.] <b>V/P</b></p> <p>Allow multiple ways to indicate an answer when working with paper materials. [Individualization idea: Allow student to select answer using touch, large pencil grip, paper stabilizer, eye gaze board, etc.] <b>P</b></p>   |
| Provide simulation activities.   | <p>Simulate the flow of energy in an ecosystem by having students represent various producers, consumers, and decomposers (e.g., <a href="http://www.perkinselearning.org/accessible-science/activities/hunger-games">http://www.perkinselearning.org/accessible-science/activities/hunger-games</a>).</p> <p>Simulate the carbon cycle by having students play the role of carbon atoms (e.g., <a href="https://betterlesson.com/lesson/639294/carbon-and-nitrogen-cycles-1-of-2">https://betterlesson.com/lesson/639294/carbon-and-nitrogen-cycles-1-of-2</a>).</p>   |

| <b>Multiple Means of Action and Expression</b> |   |
|--|---|
| <b>Strategies</b>                              | <b>Examples</b>   |
| Provide graphic organizers and templates.      | Have students sort examples of producers, consumers, and decomposers. Complete a model of the flow of energy through an ecosystem using an energy pyramid. [Individualization idea: Provide a template and line drawings of the organisms to place in the energy pyramid. Provide more producers, fewer primary consumers, and one secondary consumer.] |

**Table 7. Instructional strategy ideas using the UDL Principle: Multiple Means of Engagement**

| <b>Multiple Means of Engagement</b>                               |  |
|---|--|
| <b>Strategies</b>   | <b>Examples</b>  |
| Provide a schedule and visual timer.                              | Provide personal schedules with tangible symbols. Have students select the next activity on the schedule and set the visual timer to indicate how long the student has before a break.<br>Use a first/then schedule (e.g., <a href="https://www.autismclassroomresources.com/visual-schedule-series-first-then/">https://www.autismclassroomresources.com/visual-schedule-series-first-then/</a> ).<br><br>Provide checklist of tasks to complete in a particular order.<br>[Individualization idea: Present task/steps with pictures of the student completing each.] |
| Vary the challenge and amount of information presented at a time. | Provide key concepts on predatory, competitive, and symbiotic relationships in an ecosystem for the student to study independently and at home. [Individualization idea: Create short video clips of the educator or a peer sharing the key concepts that can be played on a tablet.]  |
| Make connections to topics or activities that are motivating.     | Show a short video that relates to a concept (e.g., photosynthesis) from a popular movie (e.g., The Lorax— <a href="https://www.youtube.com/watch?v=pc9ueZYUdqA">https://www.youtube.com/watch?v=pc9ueZYUdqA</a> ).<br>Use animals that are interesting to the student when studying the food chain/web.   |
| Allow choices as possible.  | Allow students to choose whether to look at/listen to a book, watch a video, or play a computer game about the flow of energy during independent work time.  |
| Provide opportunities to work collaboratively with peers.         | Provide opportunities for students to work in a general education classroom with peers when learning about photosynthesis or have peer tutors come into the special education classroom to work on a project about photosynthesis.   |
| Teach student self-regulation skills.                             | Provide communication symbols to request a break or express feelings and model how to use them appropriately. Provide students with stress balls, finger fidgets, etc.   |

### **UDL Resources**

- The National Center on Universal Design for Learning has a plethora of information on UDL along with examples and resources. [www.udlcenter.org](http://www.udlcenter.org)
- The UDL Curriculum Toolkit provides two applications for science. <http://udl-toolkit.cast.org/p/applications/l1>
- Perkins School for the Blind provides life science activities for students who are blind or have low vision. <http://www.perkinselearning.org/accessible-science/activities/life-science>

- This Perkins School for the Blind 20-minute video describes the techniques used to make science accessible for students who are blind and deaf-blind. <https://www.youtube.com/watch?v=tpAejot1-Ec>
- Symbaloo is a free online tool that allows an educator to create bookmarks using icons. It is easy to create and allows an educator to provide students links to sources of information that can be used for specific instructional units. [www.symbaloo.com](http://www.symbaloo.com)
- This site provides a brief description of Symbaloo and multiple ways to use the online tool. <https://www.theedublogger.com/2014/04/09/11-ways-to-use-symbaloo-in-the-classroom/>
- Perkins School for the Blind provides information on using tangible symbols to increase communication, create personal schedules, and provide choices. <http://www.perkinselearning.org/videos/webcast/tangible-symbols>

## Section VII

### **Transference and Generalization of Concepts, Knowledge, and Skills**

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For learning to be meaningful for all students, including students with significant cognitive disabilities, it is important to intentionally make connections to future content, real-world application, and college and career readiness skills. For example, students can learn that the way they discover information through observation and investigation can also be used to problem solve daily living tasks. Additionally, the instruction of science concepts, knowledge, and skills may be the catalyst to developing other areas such as needed communication skills, reading/listening comprehension, mathematics skills, age-appropriate social skills, independent work behaviors, and skills in accessing support systems. Table 8 provides instructional ideas to help transfer and generalize concepts, knowledge, and skills and suggested opportunities to embed other skills into instruction.

**Table 8. Transfer and Generalization Ideas**

| <b>Area</b>                                | <b>Instruction</b>  | <b>Opportunity to Embed Skills</b>  |
|--|---|---|
| <b>Communication</b>                       | When students are engaging in Scientific Inquiry and Engineering Design practices (see Section II), help students make the connections between asking questions and communicating information to future work environments (e.g., asking for details about a job task and ability to communicate information to a supervisor). | Use the context of the content area instruction to increase language skills, work on articulation, or access alternative and augmentative communication (AAC) systems.  |
| <b>Reading and Listening Comprehension</b> | Provide information through reading books and articles on science concepts (e.g., energy flow and cycling of matter) while working on reading comprehension.  | Provide practice on communication skills when students are answering questions about information in the book or article.<br>Work on fine motor skills while turning pages or range of motion by pointing to pictures. |
| <b>Mathematics</b>                         | Teach measuring during an investigation on plant needs.   | Provide practice on number identification and relative quantity (e.g., Which is more?).   |
| <b>Age-Appropriate Social Skills</b>       | Make connections between the Crosscutting Concepts and real-life experiences showing the cause-and-effect relationships of their behaviors and how those can be used to predict outcomes.   | Provide opportunities to work along same age peers to practice age-appropriate social skills and serve a vital role in the group.   |
| <b>Independent Work Behaviors</b>          | Encourage and reinforce independent completion of tasks to build independent work skills.   | Use this time to have the student work on following task completion checklists independently.   |
| <b>Skills in Accessing Support Systems</b> | Encourage students to ask appropriately for assistance from peers and adults when accessing information on predator-prey relationships.   | Use this time to have the student work on behavior and communication skills.  |

## Section VIII

### Tactile Maps and Graphics

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The maps and graphics guidelines will help create tactile versions of instructional maps, diagrams, models, and timelines to use with students who are blind or deaf-blind. The tactile maps and graphics may be beneficial to other students as well. A tactile graphic is a representation of a graphic (e.g., picture, drawing, diagram, map, etc.) in a form that provides access through touch. It is not an exact copy of the graphic. The section provides basic guidance and links to more comprehensive resources.

#### Importance of Tactile Maps and Graphics

It is important to provide tactile graphics for young readers (BANA, 2010). It helps students understand and gain information when presented with science concepts, knowledge, and skills. Science instruction often presents diagrams (e.g., water cycle) and two-dimensional models of living and nonliving things (e.g., model of cell) to teach the related concepts. The following guidance includes information to build upon when creating tactile graphics.

#### Tactile Graphic Guidance

1. **Determine need for graphic:** When encountering graphics in instructional materials, determine if the graphic is essential to understanding the concept. The Braille Authority of North America (2010) provides a decision tree to help in this determination. It can be accessed online at <http://www.brailleauthority.org/tg/web-manual/index.html> by selecting “Unit 1 Criteria for Including a Tactile Graphic.”
2. **Consult with the local educator trained to work with students with visual impairments.**
3. **Determine the essential information in the graphic.** Read the surrounding information and the caption to determine which information in the graphic to exclude. For example, a model to illustrate the cell wall, nucleus, chloroplast, and vacuole would not need to include the nuclear membrane, Golgi body, and ribosomes.
4. **Reduce unnecessary detail in the graphic.** Identify details that are not necessary for interpreting the information in the graphic. For example, a model of the water cycle may show crevices on the mountains, leaves on a tree, and waves in an ocean. Eliminate unnecessary details, as they are difficult to interpret tactilely.
5. **Remove frames or image outlines if they serve no purpose.** Ensure that all lines are necessary (e.g., the lines showing the river), and remove any that are not (e.g., ripples in the water).
6. **Modify the size of the graphic.** Modify the graphic as needed to reduce clutter and allow a blank space between adjacent textures. Additionally, consider the size of the student’s hand.
7. **Use solid shapes as feasible.** When solid shapes do not clearly represent the information, use clear solid lines.
8. **Systematically teach exploration and interpretation of tactile graphics.** Systematic instruction and repetition are important when teaching a student to understand a tactile graphic. Pairing the tactile graphic with a 3-dimensional object may help (e.g., pair a raised line drawing of a plant, an example of plants and their parts, with a real plant).

#### *Specific Graphic Type Guidance*

Following is information for specific types of graphics that may support instruction in science.



### **Graphic Organizers/Concept Maps**

- It is best to present information to compare or make connections using a tactile graphic. A tactile graphic presents the information in a spatial display and aids in comparison better than a list.

### **Diagrams/Models**

- Limit the number of areas, lines, and labels. Having more than five makes interpretation difficult.
- Consider pairing a tactile graphic with a 3-dimensional model.

### **Timelines**

- Present timelines in the same direction every time (i.e., horizontal or vertical).

### **Maps**

- Distinguish water from land using a consistent background texture for the water.
- Align the direction of the compass rose arrows with the lines of longitude and latitude on the map.

### **Creating Tactile Graphics**

Following are some ways to create tactile graphics. Additional information can be found at [www.tactilegraphics.org](http://www.tactilegraphics.org).

#### **Commercial products:**

- Capsule paper or swell paper for printing, and
- Thermoform.

#### **Textured shapes can be made from:**

- Sticky back textured papers found at craft stores,
- Corrugated cardboard,
- Fabric with texture (e.g., corduroy, denim),
- Silk leaves,
- Cork,
- Felt,
- Vinyl,
- Mesh tape (used for drywall), and
- Sandpaper.

#### **Raised lines can be made from:**

- Glue (best not to use water-based glue), and
- Wax pipe cleaners.

## Resources

- Creating Tactile Graphics, created by the High Tech Center Training Unit, provides basic principles of tactile graphics, characteristics of good tactile graphics, the planning process, guidelines for designs, and more. [http://www.htctu.net/trainings/manuals/alt/Tactile\\_Graphics.pdf](http://www.htctu.net/trainings/manuals/alt/Tactile_Graphics.pdf)
- The Texas School for the Blind and Visually Impaired provides basic principles for preparing tactile graphics, element arrangement on a tactile graphic, resources for preparing quality graphics, etc. <http://www.tsbvi.edu/graphics-items/1465-basic-principles-for-preparing-tactile-graphics>
- Perkins School for the Blind has tips for reading tactile graphics in science with a focus on state assessment. <http://www.perkinselearning.org/accessible-science/blog/tips-reading-tactile-graphics-science-focus-state-assessment>

## References

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press.  
<https://doi.org/10.17226/13165>

Joint Project of the Braille Authority of North America and the Canadian Braille Authority L'Autorite Canadienne du Braille. (2011). *Guidelines and Standards for Tactile Graphics, 2010*. Retrieved February 19, 2014, from Braille Authority of North America: <http://www.brailleauthority.org/tg>.

CAST (2011). *Universal Design for Learning Guidelines version 2.0*. Wakefield, MA.

Marzano, R. J. (2004). *Building Background Knowledge for Academic Achievement*. Alexandria: ASCD.

Sprenger, M. (2013). *Teaching the Critical Vocabulary of the Common Core*. Alexandria: ASCD.

## Picture Citations

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<sup>2</sup> All resources provided for this module only. Mention does not imply endorsement, recommendation, or approval by the Tennessee Department of Education.

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