Science

Module 3

Life Science: Interdependent Relationships in Ecosystems

Module Goal

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 depend on the environment to meet their needs. Environmental changes affect physical characteristics, temperature, and/or availability of resources. Some organisms survive and reproduce, some move to new locations, and some die.
- Heredity: Inheritance and Variation of Traits (elementary)—Different organisms, even within the same family/species, vary in how they look and function because they have different inherited information; the environment also affects the traits that an organism develops.
- Biological Change: Unity and Diversity (elementary)—Changes in habitats affect organisms' ability to survive. Variation among members of a species provides some individuals with advantages in survival and reproduction. Fossils provide evidence about the types of organisms and environments that existed long ago.
- Ecosystems: Interactions, Energy, and Dynamics (middle)—Ecosystem characteristics vary over time. Disruptions to any part of an ecosystem can lead to shifts in all its populations.
- Heredity: Inheritance and Variation of Traits (middle)—Genes chiefly regulate a specific protein. These genes determine an individual's traits. In all organisms, the genetic instructions for forming species' characteristics are carried in the chromosomes.
- Biological Change: Unity and Diversity (middle)—The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. The fossil record documents the existence, diversity, extinction, and change of many life forms and their environments through Earth's history. Natural selection results from certain traits giving some individuals an advantage in surviving and reproducing, leading to predominance of certain traits in a population.

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: Interdependent Relationships in Ecosystems 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

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: Interdependent Relationships in Ecosystems. 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 [1]

Academic Standards	Knowledge and Skills Statement (KSS)	Underlying Concept (UC) of the Academic Standard
Ecosystems: Interactions, Energy, and Dynamics		
4.LS2.5: Analyze and interpret data about changes (land characteristics, water distribution, temperature, food, and other organisms) in the environment and describe what mechanisms organisms can use to affect their ability to survive and reproduce.	**4.LS2.5.a:** Ability to identify examples of how organisms are affected by other organisms given data or a scenario **4.LS2.5.b:** Ability to identify examples of how organisms are affected by various physical factors (e.g., rainfall, temperature) given data or a scenario	**4.LS2.5.UC:** Recognize that plants and animals need sufficient space and resources to survive.

	4.LS2.5.c: Ability to identify examples of how organisms are affected by changes in land characteristics (e.g., storms, earthquakes) given data or a scenario **4.LS2.5.d:** Ability to identify examples of how organisms are affected by changes in water distribution and food given data or a scenario **4.LS2.5.e:** Ability to identify a mechanism that organisms use to affect their ability to survive and reproduce (e.g., migration)	
Heredity: Inheritance and Variation of Traits		
5.LS3.2: Provide evidence and analyze data that plants and animals have traits inherited from parents and that variations of these traits exist in a group of similar organisms.	**5.LS3.2.a:** Ability to identify similarities in the traits of a parent and the traits of an offspring (e.g., bush type bean plants typically have bush type offspring, whereas pole/climbing type beans typically have offspring that are also climbers) **5.LS3.2.b:** Ability to identify variations in similar traits in a group of similar organisms (e.g., the sizes and shapes of fish can vary)	**5.LS3.2.UC:** Identify similarities and differences between plant or animal parents and their offspring (e.g., eye color, hair/fur color, and leaf shape).
Biological Change: Unity and Diversity		
3.LS4.1: Explain the cause and effect relationship between a naturally changing environment and an organism's ability to survive.	**3.LS4.1.a:** Ability to identify changes in a habitat that affect an organism's ability to survive **3.LS4.1.b:** Ability to identify changes in a habitat that would cause some organisms to move to new locations	**3.LS4.1.UC:** Identify ways that an organism's needs are met by its habitat.
4.LS4.1: Obtain information about what a fossil is and ways a fossil can provide information about the past.	**4.LS4.1.a:** Ability to identify examples of living organisms that resemble organisms that once lived on Earth	**4.LS4.1.UC:** Recognize that fossils are the remains of plants and animals that lived long ago.
5.LS4.2: Use evidence to construct an explanation for how variations in characteristics among individuals within the	**5.LS4.2.a:** Ability to identify a cause-and-effect relationship between a specific variation in a characteristic (e.g., longer	**5.LS4.2.UC:** Identify differences between organisms of the same species.

same species may provide advantages to these individuals in their survival and reproduction.	thorns) and its effect on the ability of the individual organism to survive (e.g., plants with longer thorns are less likely to be eaten)	
Ecosystems: Interactions, Energy, and Dynamics		
6.LS2.4: Using evidence from climate data, draw conclusions about the patterns of abiotic and biotic factors in different biomes, specifically the tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater ecosystems.	**6.LS2.4.a:** Ability to match a description of abiotic and biotic features to biomes (i.e., tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater ecosystems) **6.LS2.4.b:** Ability to match a description of climate patterns to biomes (i.e., tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater ecosystems)	**6.LS2.4.UC:** Identify biotic and abiotic factors in a biome (i.e., tundra, taiga, deciduous forest, desert, grasslands, rainforest, marine, and freshwater ecosystems).
6.LS2.6: Research the ways in which an ecosystem has changed over time in response to changes in physical conditions, population balances, human interactions, and natural catastrophes.	**6.LS2.6.a:** Ability to use evidence (e.g., data about rainfall) to identify the outcome of changes in physical conditions of an ecosystem to population balances in that ecosystem **6.LS2.6.b:** Ability to use evidence (e.g., data about predator removal or species introduction) to identify the outcome of human interactions to an ecosystem to population balances in that ecosystem **6.LS2.6.c:** Ability to use evidence (e.g., data about heavy rain or snow, strong winds, lightning, flooding along river banks) to identify the outcome of a natural disaster in an ecosystem to population balances in that ecosystem	**6.LS2.6.UC:** Recognize effects of changes in an ecosystem to an organism (e.g., some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die).
Heredity: Inheritance and Variation of Traits		
7.LS3.3: Predict the probability of individual dominant and recessive alleles to be transmitted from each parent to offspring during sexual reproduction and represent the	**7.LS3.3.a:** Ability to identify the dominant and/or recessive allele in a given gene pair (i.e., allele shown in a gene pair represented by a capital letter [dominant], allele shown in a	**7.LS3.3.UC:** Identify that a variety of inherited traits passed from parents to offspring lead to differences in offspring (e.g., eye color).

phenotypic and genotypic patterns using ratios.	gene pair represented by a lowercase letter [recessive]) **7.LS3.3.b:** Ability to identify that chromosomes within sex cells carry one allele (either dominant or recessive) for each trait	
Biological Change: Unity and Diversity		
6.LS4.1: Explain how changes in biodiversity would impact ecosystem stability and natural resources.	**6.LS4.1.a:** Ability to recognize the stability of an ecosystem's biodiversity is the foundation of a healthy, functioning ecosystem **6.LS4.1.b:** Ability to identify factors (e.g., warmer than average year; more/less diversity amongst producers) that affect the stability of the biodiversity of a given ecosystem	**6.LS4.1.UC:** Recognize that the biodiversity of an ecosystem may change over time.
8.LS4.1: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change in life forms throughout Earth's history.	**8.LS4.1.a:** Ability to identify patterns between sedimentary layers and the relative ages of those layers **8.LS4.1.b:** Ability to use data to identify evidence for the existence, diversity, extinction, or change in life forms throughout the history of Earth	**8.LS4.1.UC:** Recognize that fossils of different animals that lived at different times are located in different sedimentary layers.
8.LS4.4: Develop a scientific explanation of how natural selection plays a role in determining the survival of a species in a changing environment.	**8.LS4.4.a:** Ability to recognize from evidence which genetic differences over many generations lead to traits that make a species better adapted to its environment	**8.LS4.4.UC:** Identify that natural selection is the process by which some individuals with certain characteristics are more likely to survive.

[1] 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

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: Why do offspring from the same parents look different from each other? What happens when people dump an unwanted tropical fish in a local river? Ask questions related to changes in ecosystems and possible design solutions.

- Developing and using models.
  Examples: Use a model (e.g., Punnett squares) to explain dominant and recessive alleles. Engaging in the engineering design process, students work with peers to construct a closed (system) environment containing plants and animals existing in equilibrium.

- Planning and carrying out investigations.
  Examples: Conduct an investigation to discover fossils in a soil profile. Conduct an investigation on natural selection using various colored grains of rice to represent small organisms. Students can investigate a variety of environmental factors that may influence the natural selection that is taking place in populations, and compare and contrast the information gained from investigations, simulations, video, or multimedia sources with information gained from reading science and technical texts. Students work with peers to design investigations to test their ideas and develop possible solutions to problems caused when changes in the biodiversity of an ecosystem affect resources (food, energy, and medicine).

- Analyzing and interpreting data.
  Examples: Collect and analyze data of animal sightings in a local area or view a live cam of a nature reserve park. Use data of traits of two parent animals and their offspring to identify similarities and differences of the traits. Use data to identify fossils that indicate the existence of certain living organisms that once lived on Earth. Analyze data of the location of fossils in layers of sedimentary rock to determine the relative age of the fossils. Conduct experiments and collect data on the environmental conditions that affect the growth of organisms (e.g., the effect of variables such as food, light, space, and water on plant growth).

- Using mathematics and computational thinking.
  Example: Collect and organize data on inherited traits within a family. Compute the average number of "prey" caught in a simulation of variation of traits (types of claws) to determine which predators, given their traits, are likely to die. Students can draw scaled picture graphs or bar graphs to

represent a data set with several categories, such as the varying reproductive capacity of organisms, which could range from a single offspring to thousands.

- Constructing explanations (for science) and designing solutions (for engineering).
  Examples: Explain the purpose of an organism's physical feature or behavior for survival and reproduction. Use evidence to explain how some organisms of the same species survive while others do not. After reading texts about a given organism, students use key details and appropriate facts about that organism to compose an informative piece of writing that lists some of the organism's traits that might give it an advantage in survival, growth, or reproduction over others of its kind.
- Engaging in argument from evidence.
  Examples: Support a claim using relevant data that the types of plants and animals living in an ecosystem change when the environment changes. Students can construct arguments, using evidence, to support recognized patterns of change in factors such as global temperatures and their effect on populations and the environment.
- Obtaining, evaluating, and communicating information.
  Examples: Gather information on the causes of animals moving away from their ecosystem and clearly communicate the information. Communicate, using evidence, why an organism has adapted in a certain ecosystem over several generations (e.g., Why green lizards in Florida have grown larger toe pads and stickier scales). Evaluate competing design solutions for maintaining biodiversity in a forest.

Science Practices Resource[2]

- 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/
- Education.com provides a variety of life science activities and experiments. http://www.education.com/activity/life-science/
- This site provides information on introducing models to elementary students. http://seplessons.ucsf.edu/node/1760

Section III

Crosscutting Concepts

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 similarities in the traits of a parent and the traits of an offspring, relationships between types of fossils (e.g., those of marine animals) and the current environments where similar organisms are found, and the patterns of interactions that occur between organisms and their environment. Some Crosscutting Concepts may apply across multiple content areas and instructional emphases (e.g., cause and effect in reading science texts). 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: Interdependent Relationships in Ecosystems, addresses organisms and their needs for particular environments. It addresses how natural selection acts over generations and allows species to adapt to changes in environmental conditions.

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 important features),
- big ideas (e.g., present and reinforce the “big ideas” that students should take and apply to the students’ 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: Interdependent Relationships in Ecosystems. 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., biotic and abiotic relationships in a biome).
- Similarities and differences in patterns can be used to sort and classify natural phenomena (e.g., inherited traits).
- Graphs, charts, and images can be used to identify patterns in data (e.g., charts showing the time period of various fossilized organisms).

Causality

Cause and Effect

- Cause-and-effect relationships may be used to predict phenomena in natural systems (e.g., combination of dominant and recessive traits predicting trait of offspring).
- Cause-and-effect relationships are routinely identified and used to explain change (e.g., the cause-and-effect relationship between genetic makeup and anatomy).
- Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability (e.g., cause and effect of a changing environment in the past can be described using probability—for instance, the probability that a specific organism will survive and reproduce in a specific environment.).

Systems

Scale, Proportion, and Quantity

- Observable phenomena exist from very short to very long time periods (e.g., fossils are evidence of change in species over generations in the history of Earth.).

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).

Stability and Change

- Small changes in one part of a system might cause large changes in another part (e.g., factors that affect the stability of the biodiversity of the given ecosystem).

Crosscutting Concept Resources

- Grant Wiggins talks about "big ideas" in this article. 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 ten 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

Table 2. General Vocabulary Words

General Vocabulary—words that generalize to different animals, plants, organisms, and activities. Describe the word and provide examples (e.g., A biome is an environment with plants and animals with features that help them do well in that environment. *Example: A deciduous forest is a biome that has four seasons and trees that change with each season. Animals living in a deciduous forest learn to adapt with the seasons. For example, squirrels collect and store food for the cold winter season.).*		
• biome	• grow/growth	• space
• camouflage	• habitat	• species
• data	• inherit	• stability
• distribution	• migration	• storm
• earthquake	• natural disaster	• structure
• ecosystem	• needs	• survive/survival
• evidence	• offspring	• temperature
• extinction	• rainfall	• trait
• fossil	• reproduce	• variation
• function	• resources	

Table 3. Specific Content Words

Specific Content Words—words that specify a particular thing (e.g., sedimentary rock) or phenomena (e.g., biodiversity). Describe the word and when possible make the connection to a Crosscutting Concept (e.g., Natural selection is the theory that plants and animals that have features suited for their environment are more likely to survive. Changes in an environment cause changes in plants and animals that can help them survive in the environment.		
• abiotic	• chromosome	• population balance
• allele	• dominant trait	• recessive trait
• biodiversity	• gene	• sedimentary rock
• biotic	• natural selection	• sex cells

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)[1]

Ideas	Examples
Explain, describe, and/or give examples of the vocabulary word rather than formal definitions.	• Provide a description and an example of camouflage, "Camouflage disguises a plant or animal so predators cannot find it. The snowshoe hares and polar bears in the Arctic have a camouflage of white coloring so they blend in with the snow."
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.	• Have students state in their own words or give an example of "migration." Help students make the connection to local birds that migrate. [Individualization idea: Have students move pictures of migrating animals from their original location to the place in which they migrate on a map.]
Have students represent vocabulary words in a variety of ways (e.g., pictures, symbols, graphic organizers, or models).	• Have students complete a three-piece vocabulary puzzle by combining a vocabulary word, its definition, and a representation of the word (see Figure 1).
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 http://projectlearnet.org/tutorials/learning_trials.html for information on learning trials.	• Read books or watch videos related to the vocabulary and concepts. (e.g., fossils: https://www.youtube.com/watch?v=sgPnnzou0og. • Have students access online texts about fossils (e.g., https://kids.nationalgeographic.com/explore/science/dino-death-pit/#trex.jpg). [Individualization idea: Have students use a screen reader to access the text.] • Have students complete activities such as pairing animal adaptations to environments. • Label adaptations of animals on pictures and post around the room.
Ask students to discuss the vocabulary words with each other.	• 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.] • Have students share their representations (e.g., drawings or pictures) of a vocabulary word with each other.
Play vocabulary word games with students.	• Have students play vocabulary games (e.g., https://www.eduplace.com/parents/hmsc/content/vocabgames/ and

Ideas	Examples
	https://www.flocabulary.com/vocabulary-mini-games/). • Have students practice vocabulary with online study sets that read the word and definition (e.g., https://quizlet.com/173405922/inherited-traits-flash-cards/).
Have students watch a dramatization or have them act out the vocabulary term.	• Have students act out behaviors and mimic adaptations that help them survive when the environment changes.

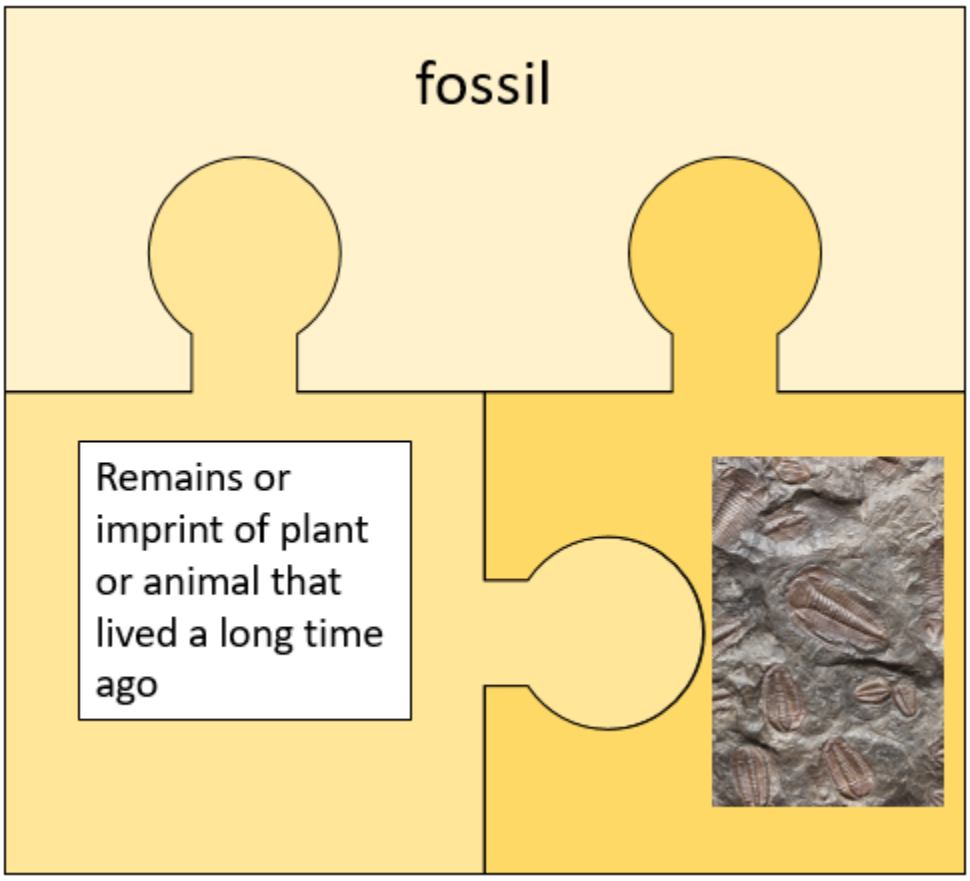
[1] Refer to Section VI, Universal Design for Learning (UDL) Suggestions for additional instructional strategies.

Vocabulary Example

Have students complete vocabulary puzzles for vocabulary words (see Figure 1). Educators may need to support, modify, or adapt steps as needed for individual students. [Individualization idea: Color code or place textures on pieces to provide cues.] 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 Vocabulary Puzzle



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

- Natural selection is the process in which a species adapts over time in response to changes in environmental conditions.

Unit Content Resources

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

Interactions within an Ecosystem

- Earth Eclipse provides information on the causes of loss or change in habitats that affect organisms. https://www.eartheclipse.com/ecosystem/reasons-for-habitat-loss-and-destruction.html
- The National Wildlife Federation provides information on invasive species and the threat to native wildlife. https://www.nwf.org/Educational-Resources/Wildlife-Guide/Threats-to-Wildlife/Invasive-Species
- This site lists the invasive species in Tennessee. https://defenders.org/publication/invasive-species-tennessee
- This site has a lesson plan about migration and includes links for specific species. https://www.learner.org/jnorth/tm/AdaptationsLesson.html
- Mpala Live has a lesson plan on causes of habitat change. http://mpalalive.org/classroom/lesson/how-habitats-change
- PBS Learning has a lesson plan with videos on biomes. https://www.pbslearningmedia.org/resource/tdc02.sci.life.eco.lp_biomes/biomes/#.Wv8oVUiUs2y
- Mr. Nussbaum's site provides information and videos on biomes. http://mrnussbaum.com/biomes/
- OER provides a lesson plan on interactions in an ecosystem. https://www.oercommons.org/courses/interactions-everywhere/view
- This site has information on loss of habitat due to human interaction. http://wwf.panda.org/our_work/wildlife/problems/habitat_loss_degradation/
- This site provides information on plants in various biomes. http://www.mbgnet.net/bioplants/adapt.html
- This site includes an article on the human impact on river organisms. https://www.sciencelearn.org.nz/resources/440-human-impact-on-rivers
- These sites provide information about how natural occurrences affect ecosystems:
  - https://sciencing.com/natural-changes-can-affect-ecosystem-6777.html
  - https://www.lpi.usra.edu/education/step2012/participant/catastrophic_events_impact_on_the_ecosystem_nxpowerlite.ppt

Heredity

- Better Lesson provides a lesson plan on Who's Your Plant Parent. https://betterlesson.com/lesson/640492/who-s-your-plant-parent
- This site provides pictures of inherited physical traits. https://www.babygaga.com/15-physical-traits-and-who-they-come-from/
- This site provides pictures and information on inherited physical traits. http://learn.genetics.utah.edu/content/basics/observable/
- Teach Genetics has a multi-day unit on inherited traits. http://teach.genetics.utah.edu/content/heredity/
- This site provides information on probability of inheritance. https://www2.palomar.edu/anthro/mendel/mendel_2.htm

Section VI

Universal Design for Learning (UDL) Suggestions

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**
Introduce information through a multi-sensory approach (e.g., auditory, visual, tactile).	Conduct a Punnett square activity that pairs pictures of the dominant trait and recessive trait with the representative letter. [Individualization idea: Have students use shapes rather than letters. Perkins School for the Blind provides directions: http://www.perkinselearning.org/accessible-science/activities/punnett-squares.] **V** Introduce fossils using pictures (e.g., http://paleoportal.org/index.php?globalnav=fossil_gallery&sectionnav=main) and actual fossils. Follow guidelines to describe graphs (e.g., rainfall) and diagrams (e.g., fossils in rock layers). The National Center for Accessible Media provides guidance on various graphs and diagrams: http://diagramcenter.org/table-of-contents-2.html. **V** Have students participate in a citizen science project (e.g., https://www.tnnaturalist.org/citizenscience.html).
Model content through pictures, dramatization, videos, etc.	View animals on web cams or in videos and point out physical features and characteristics that make them suitable for the biome in which they live (e.g., https://explore.org/livecams). [Individualization idea: Provide representative pictures or objects for students to choose to describe the physical features or the biome.] Show videos on: • plant adaptations (e.g., http://studyjams.scholastic.com/studyjams/jams/science/plants/plant-adaptations.htm) and • chameleon adaptations (e.g., https://www.youtube.com/watch?v=KJtaIqahi3I).
Present information using graphic organizers and models.	Use a KWHL to help students make connections between what they already **K**now, **W**hat they want to know, **H**ow they can find out, and finally, what they **L**earn. (Here's a slide show explaining the use of the KWHL chart and how it was made accessible for students with significant cognitive disabilities: https://nceo.umn.edu/docs/Teleconferences/tele14/CourtadeFlowers.pdf). **V/H/P** Use an extended version of the KWHL: What do I **K**now? What do I **W**ant to know about or wonder about (e.g., a phenomena)? **H**ow will I find out (e.g., determine how to organize investigations)? What have I **L**earned? What **A**ction will I take (e.g., share with others, apply to daily life, etc.)? What new **Q**uestions do I have? More information can be found at http://langwitches.org/blog/2015/06/12/an-update-to-the-upgraded-kwl-for-the-21st-century/. [Individualization idea: Use strategies for the KWHL chart for accessibility ideas:

Multiple Means of Representation	
Strategies	**Examples**
	https://nceo.umn.edu/docs/Teleconferences/tele14/CourtadeFlowers.pdf.]
Provide appropriate and accessible text on the content for students to listen to or read.	Provide a video reading of a book that shows biomes and organisms living in the biome (e.g., https://www.youtube.com/watch?v=CoBKz38yZqY&t=307s). Provide online books that have an embedded text reader (e.g., http://bookbuilder.cast.org/view.php?op=view&book=17644&page=1 *(requires free account)*) or create book(s) on the unit topics (e.g., http://bookbuilder.cast.org/). [Individualization idea: Have students use an adapted mouse to turn the pages of the online book.]
Teach information using songs, poems, or rhymes.	Teach concepts using songs (e.g., fossils - https://www.youtube.com/watch?v=RNSrNT-nIDE and Inherited traits - https://www.youtube.com/watch?v=IenzshiKI4c). [Individualization ideas: Only sing the chorus and add motions to the words.]

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

Multiple Means of Action and Expression	
Strategies	**Examples**
Use technology/assistive technology to optimize student access and interaction with the instructional materials and content.	Have students complete online interactive activities related to unit topics (e.g., fossils - http://www.bbc.co.uk/sn/prehistoric_life/games/skeleton_jigsaw/). [Individualization idea: Have student use adapted mouse to drag and drop puzzle pieces. Work with a partner to complete the puzzles.] Have students enter data into a spreadsheet. [Individualization ideas: Increase accessibility as needed. For example, enlarge online spreadsheet by pressing control +, use size 18 or higher font, set up to allow use by a screen reader. Provide a task analysis for entering data and inserting a chart.] **V** Have students play online games: • build a habitat - https://switchzoo.com/games/habitatgame.htm, • build a biome - https://switchzoo.com/games/buildabiome.htm, and • natural selection - http://sciencenetlinks.com/media/filer/2017/12/21/evolution.html.
Allow for instructional materials that can be modified to provide access.	Place printed text and pictures on a slant board. **V/P** Have students read online texts related to unit topics: • plant and animal habitats - http://www.bbc.co.uk/bitesize/ks2/science/living_things/plant_animal_habitats/read/1/, • environmental change - https://www.ck12.org/book/CK-12-Third-Grade-Science/section/3.3/, • biotic and abiotic factors - http://peabody.yale.edu/sites/default/files/documents/education/Abiotic%20and%20Biotic%20Factors%20DF.doc, • animal evolving traits and behaviors - http://mentalfloss.com/article/64300/6-animals-are-rapidly-evolving, and • importance of fossils - https://sciencing.com/importance-fossils-2470.html.
Provide multiple means for students to make choices and select answers.	Have student dictate answers. [Individualization idea: Place answer options in the student's AAC device or on multi-select voice output switch.] **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.] **V/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.] **P**

Multiple Means of Action and Expression	
Strategies	**Examples**
Provide simulation activities.	Have students participate in activities that simulate a unit topic: • Peppered Moth Simulation - https://www.biologycorner.com/worksheets/peppermoth_paper.html, • Natural Selection Simulation - https://www.biologycorner.com/worksheets/naturalselection.html, and • Scavenger Hunt Natural Selection Simulation - https://pumas.gsfc.nasa.gov/examples/index.php?id=73. [Individualization ideas: Use tactile or 3-D objects to replace paper materials. Create steps, directions, or a checklist and pair each with pictures. Have students work as partners. Allow a student to give directions to a partner to complete steps of the task.] **P**
Provide graphic organizers and templates.	Have students complete a family tree showing inherited traits (e.g., https://familylocket.com/inherited-traits-family-tree-worksheet/). [Individualization idea: Provide the communication tools the student needs to ask family members the pertinent questions. For example, short questions, paired with pictures, program into AAC device, reinforce vocabulary in sign language, pre-record on voice output and switch activated device, etc.] Have students create a data table using data on invasive species (e.g., https://www.eddmaps.org/). [Individualization idea: Have the students chart how many states are affected by various invasive mammals by placing one picture or icon of each mammal for each affected state.] Have students complete Punnett square activities. [Individualization idea: Replace letters with tactile representations. See http://perkinselearning.org/accessible-science/activities/punnett-squares.]

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

Multiple Means of Engagement	
Strategies	**Examples**
Provide a schedule.	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. Use a first/then schedule (e.g., https://www.autismclassroomresources.com/visual-schedule-series-first-then/). Provide checklist of tasks to complete in a particular order. [Individualization idea: Place words paired with pictures on a sheet with a "To Do" column and a "Finished" column using hook and loop tape.]
Vary the challenge and amount of information presented at a time.	Present and practice abiotic characteristics of a familiar biome (e.g., deciduous forest), and then introduce some biotic factors of the familiar biome (e.g., trees, deer, rabbit). Connect other biomes to the familiar biome. [Individualization idea: Have students sort pictures of plants and animals onto pictures of biomes.]
Make connections to topics or activities that are motivating.	Watch short movie clips in which the scene is in a particular biome and have students guess the correct biome (e.g., without biomes labeled - https://www.youtube.com/watch?v=HFyXTXUQ5vM; with biomes labeled - https://www.youtube.com/watch?v=a1QU1hUGwEo). Provide comic book style text on natural selection (e.g., https://evolution.berkeley.edu/evolibrary/print/printable_template.php?article_id=sneakermales_01&context=0_0_0).
Allow choices as possible.	Allow students to choose where to sit and options of types of seats (e.g., stool, exercise ball, etc.).
Provide opportunities to work collaboratively with peers.	Provide opportunities for students to work in a general education classroom with peers when learning about unit topics or have peer tutors come into the special education classroom to work on a project about photosynthesis. Have students work in cooperative groups with mixed abilities. [Individualization ideas: Present instructions and group expectations using a task checklist and group rules. Develop and read a social story about working in a group to the student. Provide the student with the necessary communication tools to participate in the group activity. Assign specific pieces of the task to each student.]
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. Teach students how to self-reflect on their performance using scaffolding.

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
- 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
- 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

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

Area	Instruction	Opportunity to Embed Skills
Communication	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 in social situations (e.g., sharing information clearly and accurately with friends).	Use the context of the content area instruction to increase language skills, work on articulation, or access alternative and augmentative communication (AAC) systems.
Reading and Listening Comprehension	Provide content information through reading books and articles on science concepts (e.g., biodiversity) while working on reading comprehension.	Provide practice on communication skills when students are answering questions about information in the book or article. Work on use of assistive technology to independently read online text using a screen reader.
Mathematics	Teach graphing when investigating climate patterns in biomes.	Provide practice on counting and determining quantities and patterns.
Age-Appropriate Social Skills	Make connections between the Crosscutting Concepts (e.g., a system can be described in terms of its components and their interactions) and real-life experiences (e.g., student is part of a system and must interact to make the system work).	Provide opportunities to work cooperatively in groups, including students without identified disabilities.
Independent Work Behaviors	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.
Skills in Accessing Support Systems	Encourage students to ask appropriately for assistance from peers and adults when researching information on the effect natural disasters have on organisms.	Use this time to have the student work on behavior and communication skills.

Section VIII

Tactile Maps and Graphics

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.

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
- 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

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Picture Citations

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[2]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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