# Science

# Module 1

# Life Science: Structure and Function/Growth and Development of Organisms

## 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:

- Structure and Function (elementary)—plants and animals have internal and external structures to help them survive, grow, and meet their needs.
- Information Processing (elementary)—most animal behaviors help an animal survive and reproduce.
- Structure and Function (middle)—all living things are made of cells; cells in multi-cellular organisms function together to form tissues, organs, organ systems, and organisms.

### 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: Structure and Function/Growth and Development of Organisms 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: Structure and Function/Growth and Development of Organisms. 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 Statements (KSSs) | Underlying Concepts (UCs) |
|---|---|---|
| ***Structure and Function (elementary)*** | | |
| **3.LS1.1:** Analyze the internal and external structures that aquatic and land animals and plants have to support survival, growth, behavior, and reproduction. | **3.LS1.1.a:** Ability to identify how animals use their external parts to help them survive, grow, and meet their needs (e.g., having thick fur in polar regions)<br>**3.LS1.1.b:** Ability to identify how plants use their external parts to help them survive, grow, and meet their needs (e.g., thorns discourage predators)<br>**3.LS1.1.c:** Ability to identify how animals use their internal parts to help them survive, grow, and meet their needs (e.g., the heart pumps blood to the body)<br>**3.LS1.1.d:** Ability to identify how plants use their internal parts to help them survive, grow, and meet their needs (e.g., pollen or seeds in plants help them to reproduce) | **3.LS1.1.UC:** Identify the function of a particular animal or plant structure (e.g., fins for swimming in aquatic environments). |
| ***Information Processing (elementary)*** | | |

| Academic Standards | Knowledge and Skills Statements (KSSs) | Underlying Concepts (UCs) |
|---|---|---|
| **5.LS1.1:** Compare and contrast animal responses that are instinctual versus those that are gathered through the senses, processed, and stored as memories to guide their actions. | **5.LS1.1.a:** Ability to identify how animals use their sense receptors (e.g., eyes contain light receptors) to respond to different types of information (e.g., sound, light, odor, temperature) in their surroundings with behaviors that help them survive<br>**5.LS1.1.b:** Ability to identify how animals use their memories to help them survive<br>**5.LS1.1.c:** Ability to differentiate between an instinctive behavior and a learned behavior | **5.LS1.1.UC:** Identify types of information animals use from their surroundings (e.g., sound, light, odor, temperature) to guide their actions. |
| ***Structure and Function (middle)*** | | |
| **7.LS1.1:** Develop and construct models that identify and explain the structure and function of major cell organelles as they contribute to the life activities of the cell and organisms. | **7.LS1.1.a:** Ability to identify that cells have internal structures<br>**7.LS1.1.b:** Ability to identify components of a cell<br>**7.LS1.1.c:** Ability to identify the functions of the components of a cell | **7.LS1.1.UC:** Recognize that all living things are made of cells. |
| **7.LS1.4:** Diagram the hierarchical organization of multicellular organisms from cells to organism. | **7.LS1.4.a:** Ability to identify a model of the hierarchical organization of multi-cellular organisms (i.e., cells, tissues, organs, organ systems, and organisms) | **7.LS1.4.UC:** Recognize that animals are multi-cellular organisms. |
| **7.LS1.5:** Explain that the body is a system comprised of subsystems that maintain equilibrium and support life through digestion, respiration, excretion, circulation, sensation (nervous and integumentary), and locomotion (musculoskeletal). | **7.LS1.5.a:** Ability to identify the basic functions of major organ systems (i.e., circulatory, excretory, digestive, respiratory, muscular, or nervous systems)<br>**7.LS1.5.b:** Ability to identify examples illustrating how the body is a system of interacting subsystems, which work together to carry out life processes for the entire organism<br>**7.LS1.5.c:** Ability to match an organ to an organ system | **7.LS1.5.UC:** Recognize major organs of animals. |

[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 birds have different shaped beaks? How do spiders know how to make a web? Why do both my heart rate and breathing rate increase when I exercise? How do lions and leopards learn to hunt? How can humans improve technologies or develop new ones to increase their benefits (e.g., better artificial limbs)?*

- Developing and using models.
  *Examples: Create a model illustrating the type of information different sense receptors gather from the environment. Use a model of a cell to identify its basic structures. Create a model of the different body systems. Use a model to explain the hierarchical organization of multi-cellular organisms. Modeling with mathematics by graphing the average number of organisms that make up a group among a variety of species.*

- Planning and carrying out investigations.
  *Examples: Conduct an investigation to discover how animals use external body parts to get food. Conduct an investigation on students' reactions to various objects through the sense of touch. Conduct an investigation to determine the purpose of the cell wall using a balloon and protective sleeve (e.g., pantyhose). Conduct an investigation to determine the best type of artificial light (e.g., florescent, LED, incandescent, etc.) for plant growth in order to design lighting for a plant shop. Data can be collected about rates of growth, height, and heartiness of plants.*

- Analyzing and interpreting data.
  *Examples: Create a chart of birds with different shaped beaks and the food they eat to discover the purpose of the beak shape. Analyze data of migration patterns of polar bears, caribou, or Monarch butterflies over a period of years and describe the pattern or changes. Analyze data comparing breathing rate and heart rate over extended period of time to determine effective exercises.*

- Using mathematics and computational thinking.
  *Example: Using computers to process large amounts of breathing and heart rate data to reveal patterns that suggest relationships. Organize data on plant growth to compare alternative types of lighting.*

- Constructing explanations (for science) and designing solutions (for engineering).
  *Examples: Identify evidence that animals can use their senses to take in information, process, store as a memory, and use later to make a decision. Explain how the structure of the cell membrane or cell wall relates to the function of the organelles and the whole cell. Describe how different organs*

*can work together as subsystems to form organ systems that carry out complex functions (e.g., the heart and blood vessels work together as the circulatory system to transport blood and materials throughout the body). Design a device mimicking human muscles and bones that can grab and release an object.*

- Engaging in argument from evidence.
  *Examples: Use evidence to describe the function of an animal's external parts. Use reasoning to connect the relevant and appropriate evidence and construct an argument that includes the idea that animals store information gathered through their sense receptors to guide their actions. Construct an argument with evidence (e.g., internal and external structures of aquatic and land animals and plants) that in a particular habitat these structures can support survival, growth, behavior, and reproduction.*
- Obtaining, evaluating, and communicating information.
  *Examples: Gather information from texts or reliable media on the functions of internal plant parts and communicate it using multi-media. Communicate the idea that the body is a system of interacting subsystems composed of groups of cells to others. Students engage in a portion of engineering design process in order to investigate the merit of solutions to problems caused when the environment changes.*

### Science Practices Resources[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/
- These are a variety of sites that provide models or directions to build models.
  - http://seplessons.ucsf.edu/node/1760
  - http://sciencenetlinks.com/lessons/cells-1-make-a-model-cell/
  - http://www.perkinselearning.org/accessible-science/modeling-backbone-and-spinal-cord
- Education.com provides a variety of life science activities and experiments. http://www.education.com/activity/life-science/

# 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 growth and development of organisms, symmetry of flowers, and the repeated base pairs of DNA. Some Crosscutting Concepts may apply across multiple content areas and instructional emphases (e.g., cause and effect in reading science texts).

This content module, Life Science: Structure and Function/Growth and Development of Organisms, addresses the type of animal responses (i.e., instinctual versus learned) for elementary school and how individual organisms are configured and how these structures function to support life, growth, behavior, and reproduction for middle school. A critical concept is the unifying principle that cells are the basic unit of life.

### 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: Structure and Function/Growth and Development of Organisms. 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 observed when learning about cells by pointing out that we are made of cells, animals are made of cells, plants are made of cells, etc.

**Causality**

*Structure and Function*

- Complex and microscopic structures and systems, as well as groups of populations functioning as systems can be visualized, modeled, and used to describe how their functions depend on the shapes, composition, and relationships among their parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function (e.g., a model can show how cell parts contribute to a cell's function).

**Systems**

*Systems and System Models*

- A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot (e.g., internal and external parts of plants and animals help them survive, grow, and meet their needs; animals gather information through senses, process the information in their brains, and respond to the information immediately or store it as a memory; cell organelles work together to carry out the function of the cell).
- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems (e.g., cells work together to form tissues and organs; organs form organ systems that perform body functions needed to live).
- A system can be described in terms of its components and their interactions.

*Scale, Proportion, and Quantity*

- Scales include macroscopic scales that we experience through our senses and lifetime, as well as those that may be too large or slow to observe or too small or fast.
- Phenomena that can be observed at one scale may not be observable at another scale (e.g., cells).

## Crosscutting Concepts 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

# Section IV

## Vocabulary and Background Knowledge

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., basic structures of an animal cell) and in the context of the specific content (e.g., teach the terms cell membrane, nucleus, mitochondria, and vacuole while exploring a model of a cell).

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 "system" helps students to connect many different systems and how they work together to form a function. The second type, **specific content words,** represents groups of words that are associated with an organism, system, process, or phenomena. For example, the specific words "circulatory system" connect to the general word "system" when learning about the body systems. 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 three, five, 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., Instinct is a behavior that an animal does not have to learn.) and an example of the word (e.g., a spider spinning a web). Teach the specific content vocabulary using a student-friendly description of the word meaning (e.g., a cell membrane controls what enters or leaves a cell) and a possible connection to a general vocabulary word (e.g., a cell membrane is part of a cell and cells make up our bodies).

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 the skeletal system by pointing to the bones in a model as opposed to defining skeletal system.

**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., cells are the smallest part of living matter that can exist by themselves. *Example: red blood cells and skin cells).* | | | |
|---|---|---|---|
| • arteries | • external | • muscles | • specialized |
| • behavior | • function | • nerves | • stimulus |
| • blood vessels | • heart | • odor | • stomach |
| • bones | • internal | • organism | • survive |
| • brain | • learn/learned | • reflex | • system |
| • cell | • light | • response | • temperature |

| | | | |
|---|---|---|---|
| • condition | • lungs | • senses | • veins |
| • environmental | • memory/memories | • sound | |

**Table 3. Specific Content Words**

| **Specific Content Words**—words that specify a particular thing (e.g., cell membrane) or phenomena (e.g., instinct).<br>Describe the word and when possible make the connection to a Crosscutting Concept (e.g., The heart and lungs are organs. These organs work with blood vessels to carry oxygen to the body.) | | |
|---|---|---|
| • cell membrane | • mitochondria | • organelles |
| • cell wall | • multi-cellular | • reproductive system |
| • circulatory system | • muscular system | • respiratory system |
| • cytoplasm | • neurological system | • sense receptors |
| • excretory system | • nucleus | • skeleton |
| • genes | • organ | • tissue |
| • instinct/instinctual | • organ system | • vacuoles |

## 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 analogy for a cell and its parts: "A cell is the basic structure of all organisms. A cell is like a restaurant. The cell membrane is like the restaurant doors; it lets things come in and out. The cytoplasm is a jelly-like substance that keeps all the other cell parts in place; it is like the restaurant floor that holds the tables and chairs in place. The nucleus controls what happens inside of the cell, like a restaurant manager controls what happens inside of the restaurant. The ribosome makes proteins for the cell, similar to the cook making hamburgers. The mitochondria store energy until the other parts need it; this is like the warming ovens where food is stored in the restaurant. The Golgi bodies sort and transport substances that are used or discarded; this is like the server who sorts food either on plates for eating inside the |

| Ideas | Examples |
|---|---|
| | restaurant or places it in bags to send out of the restaurant. All of the parts work together so the cell can perform its specific job. [Individualization idea: Provide a tactile or three-dimensional model of a cell for the student to explore. Help the student locate and match the nucleus to its function. Begin introducing additional organelles one by one.] |
| 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 an animal's internal parts. Help students understand how the internal part helps with survival. [Individualization idea: Have students match a picture of an internal part of an animal to what it does to help the animal survive.] |
| Have students represent vocabulary words in a variety of ways (e.g., pictures, symbols, graphic organizers, or models). | Ask students to complete a vocabulary concept definition map (See Figure 1. Example Concept Definition Map). [Individualization idea: Have students use a mouse/adapted mouse to click and drag words paired with pictures onto the concept definition map or use objects and/or textures to complete the concept definition map.] |
| 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. | • Incorporate vocabulary into daily activities when it is appropriate (e.g., After the students have been active during recess or physical education class, ask, "Do you feel your heart beating? Your heart is part of your circulatory system.").<br>• Read books or watch videos related to the vocabulary and concepts (e.g., Have students watch a video clip on the circulatory system.). [Individualization idea: Create a digital vocabulary book using graphics from the web (e.g., http://textproject.org/assets/products/word-pictures/content-area-word-pictures/CAWP-The-Human-Body.pdf)]<br>• Have students complete activities such as sorting words (e.g., organs) into categories (e.g., organ system). [Individualization idea: Have students sort labeled graphics of organs into the correct organ system on a graphic organizer.] |

| Ideas | Examples |
|---|---|
| Ask students to discuss the vocabulary words with each other. | • Have students use their preferred mode of communication, including alternative and augmentative communication (AAC), to share their favorite words and why. [Individualization idea: Place the vocabulary word description on a voice output device and have students share with classmates.]<br>• Have students share their drawings or pictures they have gathered that represent the vocabulary word (e.g., different organs, cell parts, etc.) [Individualization idea: Have students choose pictures/photos when provided multiple options.] |
| Play vocabulary word games with students. | • Have students use their preferred mode of communication to describe a word and have peers guess what it is (e.g., This is the part of a cell that controls the cell). [Individualization idea: Provide students with a grid with pictures or symbols that describe a word and have them choose the description (with help) to use for peers to guess.]<br>• Have students organize vocabulary words/pictures/representative objects on a graphic organizer.<br>• Have students match a description or representative picture to a word. |
| Have students watch a dramatization or have them act out the vocabulary term. | • Watch a video of the circulatory, nervous, or respiratory system. [Individualization idea: Provide a tactile version of the system and help the student follow as the video describes how the system works]<br>• Act out a body system (circulatory, nervous, or respiratory). |

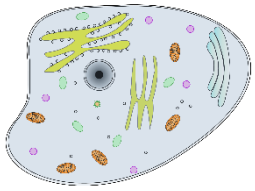
[1] Refer to Section VI, Universal Design for Learning (UDL) Suggestions for additional instructional strategies.

### Vocabulary Example

Use a concept definition map, a graphic organizer using graphics representing the vocabulary word and descriptive characteristics, to build student understanding (see Figure 1). Educators may need to support, modify, or adapt steps as needed for individual students. [Individualization idea: Allow student to choose a picture to represent the word and choose descriptions from multiple options. Create a digital version with text to speech option that allows the student to drag and drop the choices into the concept definition map.] 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 Concept Definition Map**

| *term* | *examples* |
|---|---|
| organism | - a living thing<br>- animal: puppy<br>- human: me<br>- plant: daisy<br>- single cell: bacteria |
| *graphics*<br>  *picture of student, classmate, or family member*  <br>   | |

## 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

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.

### Structure and Function (elementary)

**Content:**

- All organisms have external parts (e.g., bears have legs, fish have fins, birds have wings).
- Different animals use their external body parts in diverse ways to help them survive, grow, and meet their needs (e.g., bird's feet help grasp food, a bee's stinger provides protection, a monkey's tail helps it move from place to place, a dog's mouth and tongue help it take in food and water).
- Animals have internal parts to help them survive, grow, and meet their needs (e.g., a squirrel's teeth and stomach break down its food to use as fuel to move and grow).
- Plants have different external parts to help them survive, grow, and meet their needs (e.g., thorns provide protection, leaves absorb sunlight, roots keep a plant in place and take in water and minerals from the soil).
- Plants have internal parts that help them survive, grow, and meet their needs (e.g., stems have tissues that move food and water around the plant).

### Information Processing (elementary)

**Content:**

- Animals use information from their surroundings (e.g., sound, light, odor, temperature) to guide their actions.
- Animals use their sense receptors to gain information from the environment.
- Some animal behaviors are instinctual (e.g., salmon migrating back to where they were born).
- Instinctual behaviors are not learned and occur the first time the animal is presented with a stimulus (e.g., dogs drool when presented with food).
- Some behaviors are learned due to experience or environmental conditions.
- Animals use their memories to guide their behavior and help them survive.

### Structure and Function (middle)

**Content:**

- Plants and animals are living organisms.
- All organisms are composed of cells.
- Plants and animals are multi-cellular organisms.
- Cells have internal structures (e.g., nucleus, chloroplast, mitochondria, cell membrane, cell wall, vacuole, and cytoplasm).

- Each cell structure serves a specialized function (e.g., cell wall controls what gets in and out of the cell).
- Different types of cells serve specialized functions (e.g., red blood cells carry oxygen to the cells).
- There is a hierarchical organization of multi-cellular organisms (i.e., cells, tissues, organs, organ systems, and organisms) that can be illustrated using models.
- Animals have major organs (e.g., heart, lungs, stomach).
- Organs (heart, arteries, and veins) work together to form organ systems (e.g., circulatory system).
- There is a relationship among cells, tissues, organs, and organ systems.
- Organ systems interact with each other (e.g., circulatory system and respiratory system).

**Unit Content Resources**

- Discovery Education provides a lesson plan on animal instincts. http://www.discoveryeducation.com/teachers/free-lesson-plans/animal-instincts.cfm
- Sea World provides descriptions of animal behavior including photographs. https://seaworld.org/animal-info/animal-infobooks/animal-training/animal-behavior-and-learning
- The Learning Zone compares human senses to how animals use their senses. http://www.oum.ox.ac.uk/thezone/animals/life/sense.htm
- This site provides examples of animal senses with photographs. http://metro.co.uk/2014/09/03/17-amazing-facts-about-animal-senses-4839096/
- This site provides information on innate behavior of animals. https://www.ck12.org/biology/innate-behavior/lesson/Innate-Behavior-of-Animals-BIO/
- Sciencing includes information on innate and learned animal behaviors. https://sciencing.com/innate-learned-animal-behavior-6668264.html
- This site provides information on learned behavior of animals. https://www.ck12.org/biology/learned-behavior/lesson/Learned-Behavior-of-Animals-BIO/
- Interactive Sites for Education provides a wide variety of topics that include interactive animations. http://interactivesites.weebly.com/science.html
- These sites provide information on:
    - cell structure. http://www.biology4kids.com/files/cell_main.html
    - a variety of information with images and videos about cells, their size and scale, and how they communicate information. http://learn.genetics.utah.edu/content/cells/
    - specialized cells. https://sciencing.com/specialized-cells-body-7245490.html
- This site has biology games and topics including function of cell structures, organ systems, and animal/plant cells. http://www.softschools.com/science/biology/
- Bitesize provides information on cell structure and function, specialized cells, diffusion, and osmosis followed by an interactive activity and quiz. https://www.bbc.com/education/guides/z9hyvcw/revision/1
- Better Lesson provides science lesson plans for middle school. https://betterlesson.com/next_gen_science/browse/2214/ngss-ms-ls-life-sciences

# 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). | Demonstrate how bird beaks are specific for the food they eat using various tools (e.g., tweezers, clothespin, spoons); representation of food types (e.g., fluffy balls, marbles, straws, beads); and pictures of bird beaks: http://www.estuarypartnership.org/educational-resource/bird-beak-adaptations-kit.<br>Develop and have students explore tactile or 3-D model of a cell: https://sciencing.com/ideas-making-3d-model-cell-6705594.html. **V**<br>Help students create and explore a model of the respiratory system using a plastic bottle, straws, and balloons: https://www.youtube.com/watch?v=D4a-HOvzmQY |
| Model content through pictures, dramatization, videos, etc. | Have students watch a video on animal parts (e.g., https://www.youtube.com/watch?v=lNd6wQ3S38s) and plant parts (e.g., https://www.youtube.com/watch?v=DGpPHrLF-5M&t=11s).<br>Have students explore a cell by creating a room-size cell (e.g., http://www.perkinselearning.org/accessible-science/cell-activity-room-cell). **V**<br>Show videos demonstrating learned and instinctive animal behaviors (e.g., http://www.cpalms.org/Public/PreviewResourceLesson/Preview/29845 - in the explore section of the lesson plan).<br>Show videos about cell structure and function: https://www.youtube.com/watch?v=3nBtY6LR030 and https://www.youtube.com/watch?v=Tfy1mOT-gEQ. |
| Present information using graphic organizers and models. | Use a chart to show how animals' internal and external parts help them: survive (e.g., protection and reproduction), grow (e.g., get and process food and water), or meet their needs (e.g., move from place to place). [Individualization idea: provide pictures and watch a short video or listen to short text of each function as student completes the chart.]<br>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. (A slide show explaining the use of the KWHL chart and how it was made accessible for students with significant cognitive disabilities is available here: http://www.cehd.umn.edu/nceo/teleconferences/tele14/CourtadeFlowers.pdf). **V/H/P**<br>Have students complete a chart in which they order an animal or a person from simplest (cell) to most complex (animal's or person's body). Provide cutaway pictures of a cell, an organ, an organ system, showing animal or human organ systems and a chart with the simplest at the bottom and most complex at the top. |

| Multiple Means of Representation | |
|---|---|
| **Strategies** | **Examples** |
| Provide appropriate and accessible text on the content for students to listen to or read. | Paraphrase information from a textbook (e.g., Sound is very important to whales and dolphins for hunting, moving around, and communicating. Toothed whales (including dolphins) make sounds. The echoes from these sounds give the whales information about everything around them. This includes their food.) 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). **V**<br>Provide lower reading level informational books online such as one on how animal use their senses: http://textproject.org/assets/products/beginningreads/download-texts/BR-Level06-Texts.pdf.<br>Record paraphrased information about animal senses, learned behaviors, and instinctive behaviors and store them online using a program such as https://recordmp3online.com/. **V** Provide access to the recordings using an icon-based bookmark program such as Symbaloo (www.symbaloo.com). |
| Teach information using songs. | Teach parts of a cell through songs: https://www.youtube.com/watch?v=rABKB5aS2Zg or https://www.youtube.com/watch?v=-zafJKbMPA8. |

**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. | Read a book about animal parts online (e.g., http://bookbuilder.cast.org/view.php?op=view&book=7666&page=1). [Individualization idea: Have student use a button switch to turn the pages of the digital book.]<br>Using a virtual lab, drag and drop predicted mealworm behavior to a given stimulus, watch a video showing the stimulus applied, and then drag and drop the actual behavior: https://www.livebinders.com/play/play?id=195109.<br>Set up an adaptive keyboard or a computer access switch to allow the student to record data after conducting or viewing an investigation. **P**<br>Create a graph using hook and loop tape and small blocks for graphing. **V/P**<br>Provide access to the smartboard with extended pointer or wireless button switch. |
| Allow for instructional materials that can be modified to provide access. | Have students build a model of a cell and its parts. [Individualization idea: Use hook and loop tape or magnets for the cell model and its |

| Multiple Means of Action and Expression | |
|---|---|
| **Strategies** | **Examples** |
| | parts and ensure that everything is in the student's range of motion.] **P**<br>Have the student match plant and animal external parts to the respective function for survival. [Individualized idea: Place paper on a slant board for ease of viewing and proper posture.] **V/P**<br>Have students create and explore three-dimensional models. **V**<br>Provide a USB microscope that transfers the image to the computer screen or an online microscope activity (e.g., http://www.pbslearningmedia.org/resource/f4f6097a-807f-4488-b874-0bae0d8446c8/microscope-activity/en/). **V/P** |
| Provide multiple means for students to make choices and select answers. | Allow answers to be dictated. [Individualization idea: Record correct answers and distractors on a voice output multiple message switch or multiple voice output switches and have students answer questions using the switch.] **P**<br>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**<br>Allow multiple ways to indicate an answer when working with paper materials. [Individualization idea: Allow student to select answer using a weighted pencil, bingo dauber, eye gaze board, etc.] **P** |
| Provide simulation activities. | Have students model external structures of animals (e.g., shortening to model blubber for insulation; tweezers or tongs to model bird's beak for picking up food, etc.).<br>Have students simulate a cell by creating a room as a cell (e.g., http://www.perkinselearning.org/accessible-science/activities/cell-activity-room-cell).<br>Provide a simulation of the cells forming tissues, tissues forming organs, and organs forming organ systems using connecting blocks. [Individualization idea: Sign all conversations and decisions.] **H** |
| Provide graphic organizers and templates. | Have students drag and drop pictures of external parts to the correct animal. [Individualization idea: Use system of least prompts (e.g., https://www.unr.edu/ndsip/tipsheets/UsingLeasttoMostPrompts.pdf) to help the student complete the activity. Have student use an adapted mouse.] **P** |

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

| Multiple Means of Engagement | |
|---|---|
| **Strategies** | **Examples** |
| Provide a schedule and visual timer. | Provide a schedule 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>Provide a planner to organize daily tasks. [Individualization ideas: Use hook and loop tape for the planner so a student can remove tasks as finished.] |
| Vary the challenge and amount of information presented at a time. | Provide students two minutes of processing time every ten minutes (or less) of instruction. Processing time is used to share an idea learned, draw an illustration of concept, find a pattern in the information, etc. [Individualization idea: Allow the student a choice of using communication system to share a fact learned, looking at pictures related to the concepts, or using technology to watch a video or play a game related to the concepts.] |
| Make connections to topics or activities that are motivating. | Use the computer, P.E., recess, etc., to explore science concepts. For example, have students watch an animation of the circulatory system on the computer, act as a blood cell moving through the circulatory system in P.E. class, or observe their heart beating after running on the playground. |
| Allow choices as possible. | Allow students to choose whether to look at/listen to a book or watch a video about cells 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 plant and animal structure and function or have peer tutors come into the special education classroom to work on a project about plant and animal structure and function. |
| Teach student self-regulation skills. | Provide communication symbols to request a break or express feelings and model how to use them appropriately. |

## 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** | While teaching vocabulary, make connections to real-life or future opportunities to use the words (e.g., discussing a topic with co-workers) or understand the concepts (e.g., while watching a TV show). | 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 information through reading books and articles on science concepts (e.g., animal senses and behaviors) 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. |
| **Mathematics** | Teach measuring and graphing during investigation of function of animal parts. | Provide practice on shapes, angles, and curves. |
| **Age-Appropriate Social Skills** | Make connections between the Crosscutting Concepts and real-life experiences showing how they can help students make decisions (e.g., understanding they are part of a larger system and play an important role in the system/community). | Provide opportunities to work along same age peers to practice age-appropriate social skills and serve a vital role in the group. |
| **Independent Work Behaviors** | Encourage and reinforce independent completion of tasks to build independent work skills. | Use positive behavior supports to encourage and reinforce independent work skills. |
| **Skills in Accessing Support Systems** | Encourage students to ask appropriately for assistance from peers and adults when working on the content. | 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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