

“Focus on the Learning”
Using Core Concepts to Build Learning Progressions

Creating twenty-first century critical thinking classrooms in North Carolina starts with the establishment of core concepts and essential standards that are focused, prioritized and enduring. The 2009 Science Essential Standards are anchored in the premise that one of the best ways for students to learn these core concepts is to learn successively more sophisticated ways of thinking about these ideas over multiple years. If mastery of the core concepts is the ultimate destination, efforts of reform must be to redirect the focus from the “content” to the “learning”. Dr. Lorin W. Anderson, Carolina Distinguished Professor of Education, says content exists outside the student. When content gets inside the student, it becomes knowledge. This transformation of content to knowledge takes place through the cognitive processes used by the student. In other words, he says, “you must tinker with their thinking”. The following learning progressions demonstrate how students’ thinking about carbon cycling becomes more sophisticated over time.




Flow of Energy and Cycling of Matter in Organisms Major Implications:

1. Organisms require energy to carry out a variety of chemical reactions necessary to live and grow. Energy from the sun flows in one direction through an ecosystem and is conserved as organisms use and transform it.
2. Energy needed to carryout life’s functions is derived from the sun and transformed into chemical energy by plants and other energy-fixing organisms such as bacteria to maintain their activities and sustain the rest of the food chain.
3. Organisms have structures and functions that facilitate their life processes, growth and reproduction.
4. The complexity and organization of organisms accommodates the need for obtaining, transforming, transporting, releasing, and eliminating the matter and energy used to sustain the organisms.

<p><i>Flow of Energy & Cycling of Matter</i> AP Bio. Enduring Understanding 4A Interactions within biological systems lead to complex properties.</p>	<p>AP Bio. Enduring Understanding 4A Interactions within biological systems lead to complex properties.</p>	<p>AP Bio. Enduring Understanding 4A Interactions within biological systems lead to complex properties.</p>	<p>Bio.4.2 Analyze the relationships between biochemical processes and energy use in the cell. Bio.2.2 Understand the impact of human activities on the environment (one generation affects the next).</p>
<p>The energy flow in ecosystems is based on the primary productivity of autotrophs.</p> <p>(a) Discuss the energy flow through an ecosystem and the relative efficiency with which it occurs.</p> <p>(b) Discuss the impact of the following on energy flow on a global scale.</p> <ol style="list-style-type: none"> a. Deforestation b. Global climate change 	<p>In many ways, all organisms in a food web can be said to be solar-powered. The producer level of the food web is responsible for the transformation of the solar energy into a form that can be used by other organisms.</p> <p>(a) Discuss the role of green plants in transforming the Sun’s energy into a form that can be ultimately used by heterotrophs.</p> <p>(b) Discuss the flow of energy from producers through top carnivores in a food web in terms of the laws of thermodynamics.</p>	<p>Bacteria play central biological roles.</p> <p>a) Bacteria may act as</p> <ul style="list-style-type: none"> • producers • parasites • mutualistic symbionts • decomposers <p>Select THREE of the ecological roles above. For each one you choose, describe how bacteria carry out the role and discuss its ecological importance.</p>	<p>Bio.4.2.1 Mr. Green Gene cherished his lovely Clydesdale horse which he used to plough his garden and work his farm. When the horse died, Mr. Green Gene buried him under the big oak tree in the south pasture where he keeps his cows. Describe below the path of a carbon atom from the horse’s remains, to inside Mr. Green Gene’s leg muscle. NOTE: Mr. Green Gene does not eat his horse; however, he does eat his cows. Describe as many biochemical pathways as you can relate.</p>

<p>Flow of Energy & Cycling of Matter Bio. 2.1 Analyze the interdependent relationships of living organisms within their environments.</p>	<p>Bio.4.1 Understand how biological molecules are essential to the survival of living organisms.</p>	<p>8.L.3 Understand how organisms interact with and respond to the biotic and abiotic components of their environment. 8.L.5 Understand the composition of various substances as it relates to their ability to serve as a source of energy and building materials for growth and repair of organisms.</p>	<p>7.L.1 Understand the processes, structures and functions of living organisms that enable them to survive, reproduce and carry out the basic functions of life.</p>
<p>Bio.2.1.1 When you are using a gasoline powered lawnmower to cut your lawn, eventually the gasoline tank becomes empty. (a) What do you think happens to the gas? What happens to the matter the gasoline is made of? (b) Can using gasoline in car affect global warming? How?</p> <p>Bio. 2.1.1 A tree falls in the forest. After many years, the tree will appear as a long, soft lump barely distinguishable from the surrounding forest floor. Describe the path of a carbon atom from the air to the fallen tree back into the air.</p> <p>Bio 2.2.1 Mr. Green Gene buried his horse under a tree that was planted from a seed by his father when Mr. Green Gene was born. Where did the increase in the tree’s mass come from?(Grade 8)</p> <p>Mr. Green Gene’s neighbors are always asking him to cut down some of his trees. Although he lives in North Carolina, Mr. Green Gene says he’s trying to save the Amazon.</p> <p>How can this happen and how could human actions influence trees to grow in the Amazon?</p> <p>How could cutting down trees affect our climate?</p>	<p>Bio.4.1.1 During science class, Mr. Johnson made three groups A, B, and C, like the following: A. Sugar, meat, bread B. Water, limestone, sand C. Coal, gasoline, wood He asked his students to make careful observations of each group and answer the following: (a) What makes each group go together? (b) Why would water go with limestone and sand rather than sugar and meat (c) Do you think groups A and C have anything in common? Explain your reasoning.</p>	<p>8.L.3.3 Mr. Green Gene’s has a large farm with plenty of oak trees. Sometimes a tree falls and no one is around to remove it. After many years, the tree will appear as a long, soft lump barely distinguishable from the surrounding grounds. a. The mass of the lump on the ground is less than the mass of the original tree. Where would you find the mass that is no longer in the lump? In what form? b. What caused the changes in the wood? How did those changes happen? 8.L.3.3 Which gas(es) do the living oak trees take in from their environments? (you may circle more than one) oxygen carbon dioxide nitrogen water vapor Explain what happens to the gases once they are inside the plant. 8.L.5.1 A small acorn grows into a large oak tree. (a) Which of the following is FOOD for plants (circle ALL correct answers)? Soil Air Sunlight Fertilizer Water Minerals in soil Sugar that plants make (b) Where do you think the plant’s increase in weight comes from? 8.L.5.2 After the holidays, Paul set a goal to lose weight by eating a low calorie diet. Two weeks later, he was halfway to reaching his goal. Where did the mass of his fat go (how was it lost)?</p>	<p>7.L.1.4 Six friends were talking about the function of the digestive system. This is what they said: Mina: “I think the main function is to release energy from food.” Manny: “I think the main function is to help us breathe.” Sasha: “I think the main function is to break food down into molecules that can be absorbed by cells. Harriet: “I think the main function is to break food down in the stomach into small pieces of food that can be used by the body.” Todd: “I think the main function is to carry bits of food and nutrients to all the different parts of our body.” Curtis: “I think the main functions is to store food so that we can get energy when we need it.” Which student do you most agree with? Explain your thinking. Describe your ideas about the main function of the digestive system Respiration: Put an X next to the organisms on the list that use the process of respiration. Explain your thinking about your choices and respiration. ___ human ___ grass ___ duck ___ frog eggs ___ mushroom ___ tomato plant ___ fish ___ chick inside an egg ___ human body cell ___ worm ___ single-celled pond organism ___germinating seed ___ horse ___ apple tree ___ bacteria ___ butterfly larvae inside a chrysalis ___ honeybee</p>

<p><i>Flow of Energy & Cycling of Matter</i> 6.L.2 Understand the flow of energy through ecosystems and the responses of populations to the biotic and abiotic factors in their environment.</p>	<p>6.L.1 Understand the structures, processes and behaviors of plants that enable them to survive and reproduce.</p>	<p>5.L.2 Understand the interdependence of plants and animals with their ecosystem.</p>	<p>4.L.2 Understand food and the benefits of vitamins, minerals and exercise. 5.L.1 Understand how structures and systems of organisms (to include the human body) perform functions necessary for life.</p>
<p>6.L.2.I Explain how are the following living things connected with each other: (a) Grass. (b) Cows. (c) Human beings. (d) Decomposing bacteria 6.L.2.I A small acorn grows into a large oak tree. (a) Which of the following is FOOD for plants (circle ALL correct answers)?</p> <p>Soil Air Sunlight Fertilizer Water Minerals in soil Sugar that plants make</p> <p>(b) Where do you think the plant’s increase in weight comes from?</p> <p>6.L.2.I Which gas(es) do plants take in from their environments? (you may circle more than one)</p> <p>oxygen carbon dioxide other</p> <p>Explain what happens to the gases once they are inside the plant. Energy can change from one form to another in living things. 5E/M3a Organisms get energy from oxidizing their food, releasing some of its energy as thermal energy. 5E/M3b* Almost all food energy comes originally from sunlight. 5E/M3c</p>	<p>Respiration: Put an X next to the organisms on the list that use the process of respiration. Explain your thinking about your choices and respiration.</p> <p>___ human ___ grass ___ duck ___ frog eggs</p> <p>___ mushroom ___ tomato plant ___ fish</p> <p>___ chick inside an egg ___ human body cell</p> <p>___ worm</p> <p>___ single-celled pond organism</p> <p>___ germinating seed</p> <p>___ horse ___ apple tree ___ bacteria</p> <p>___ butterfly larvae inside a chrysalis</p> <p>___ honeybee</p> <p><i>One of the most general distinctions among organisms is between plants, which use sunlight to make their own food, and animals, which consume energy-rich foods. Some kinds of organisms, many of them microscopic, cannot be neatly classified as either plants or animals. 5A/MI</i></p>	<p><i>Rotting Apple</i></p> <p>5.L.2.2 Four friends argued about why an apple on the ground eventually rots away and disappears. This is what they said: Anna: “ I think it is just something that happens over time.” Selma: “I think small organisms use it for energy and building material.” Felicia: “ I think the atoms and molecules in the apple just break down.” Logan: “I think the wind and water soften it, and it dissolves into the soil.” Eli: “I think water and air rot it, then small animals come and eat the rest.” Jack: “I think it gets old and breaks apart into pieces too small to see.”</p> <p>Which student do you most agree with? Explain your answer.</p> <p>Benchmark Note: <i>Almost all kinds of animals’ food can be traced back to plants. 5E/1 Insects and various other organisms depend on dead plants and animal material for food. 5D/1</i></p>	<p>4.L.2.2 An infant grows to become a big adult. (a) What role does food play in the growth and development of an infant? (b) Explain how vitamins minerals and exercise enable an infant to gain weight as she grows.</p> <p>5.L.1.2 An infant grows to become a big adult. (a) What causes the infant to grow? (b) Explain how an infant gains weight as she grows.</p> <p>Benchmark Note: <i>From food, people obtain energy and materials for body repair and growth.6C/E1</i> Start the interconnected functions of the human system.</p>

<p><i>Flow of Energy & Cycling of Matter</i> 4.L.2 Understand food and the benefits of vitamins, minerals and exercise. <i>Some source of energy is needed for all organisms to stay alive and grow. 5E/2</i></p>	<p>1.L.1 Understand characteristics of various environments and behaviors of humans that enable plants and animals to survive. <i>Plants and animals both need to take in water, and animals need to take in food. In addition plants need light.5E/1 Most living things need water, food & air 5C/2.</i></p>	<p>1.L.2 Summarize the needs of living organisms for energy and growth. <i>(Animals eat plants or other animals for food. 5D/P1)</i></p>	<p>K.L.1.2 Compare characteristics of animals that make them alike and different from other animals and nonliving things. <i>(Most living things need water, food, and air. 5C/P2)</i></p>
<p>4.L.2.1The Grocery List: Johnny’s dad gave him a grocery list and told him to only buy items that are food. At the store, Johnny recalled the scientific definition of food and proceeded to shop. Based on the scientific definition of food, which items should Johnny omit from his list. Explain your thinking. What definition or “rule” did you use to decide what Johnny should omit.</p> <p>___ lettuce ___ sugar ___ salt ___ cookies</p> <p>___ bread ___ butter ___ milk ___ vitamins</p> <p>___ water ___ french fries ___ candy bar</p> <p>___ minerals ___ pancake syrup ___ banana</p> <p>___ ketchup ___ diet soda ___ flour</p>	<p>1. L.1.1 and 1.L.2.2 Create a garden habitat that will attract and provide the basic needs for birds, butterflies and plants that are found in North Carolina. Research and plant appropriate flowers.</p> <p><i>Have students research and draw habitats of similar plants and animals that are found in other parts of the world. Discuss differences and similarities (e.g., type of materials used to build each shelter) and explain how each environment enables the different plants and animals to survive.</i></p> <p>Joey decided to create a garden habitat, exactly like the one from school, in his backyard except he would include plants and animals from other parts of the world as well as those from NC. Which plants and animals do you think will grow and survive best? Explain your selections.</p>	<p>1.L.2 .2 Create a garden habitat that will attract and provide the basic needs for birds, butterflies and plants that are found in North Carolina. Research and plant appropriate flowers.</p> <p><i>Have students research and draw habitats of similar plants and animals that are found in other parts of the world. Discuss differences and similarities (e.g., type of materials used to build each shelter) and explain how each environment enables the different plants and animals to obtain the basic needs for energy and growth.</i></p> <p>Joey has decided to plant several plants and keep animals in his garden that are similar to the ones he has at home. Describe what Joey will need to keep his plants and animals alive, if he chooses the following:</p> <p>Plants: <i>Milkweed</i> <i>Butterfly bush</i> <i>Climbing aster</i> <i>Smooth coneflower</i></p> <p>Animals: <i>a turtle</i> <i>a toad</i> <i>a bunny</i></p>	<p>K.L.1.2 The pictures below represent an owl, a butterfly and a statue of an owl. What do the owl and butterfly have in common and how are they different? How is a living owl similar to the statue and how are they different?</p> <div style="display: flex; flex-direction: column; align-items: center;"> <div style="display: flex; align-items: center; margin-bottom: 10px;">  <div style="margin-left: 10px;">Living Owl</div> </div> <div style="display: flex; align-items: center; margin-bottom: 10px;">  <div style="margin-left: 10px;">Living Butterfly</div> </div> <div style="display: flex; align-items: center;">  <div style="margin-left: 10px;">Statue of Owl</div> </div> </div>

Assessment Work-sheet

Understanding What It Means to be “Academically Able”

Purpose: Participants will develop an understanding of being “academically able.”

Task: Read the selected AP Exam free-response questions in biology and other items aligned to the 2009 Science Essential Standards. While reading the questions, assess what a student needs to know and be able to do to answer each question correctly. As a vertical team, ask and answer the same question for all assessment items appearing in the learning progression.

Life Science Items: Flow of Energy and Cycling of Matter

Item 1	Item 2	Item 3	Item 4

Life Science Items: Flow of Energy and Cycling of Matter

Item 5	Item 6	Item 7	Item 8

Life Science Items: Flow of Energy and Cycling of Matter

Item 9	Item 10	Item 11	Item 12

Life Science Items: Flow of Energy and Cycling of Matter

Item 13	Item 14	Item 15	Item 16

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