

## MS-LS1-6 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:

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

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><b>Constructing Explanations and Designing Solutions</b></p> <p>Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.</p> <ul style="list-style-type: none"> <li>Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.</li> </ul> <hr style="border-top: 1px dashed black;"/> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical connections between evidence and explanations.</li> </ul>	<p><b>LS1.C: Organization for Matter and Energy Flow in Organisms</b></p> <ul style="list-style-type: none"> <li>Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use.</li> </ul> <p><b>PS3.D: Energy in Chemical Processes and Everyday Life</b></p> <ul style="list-style-type: none"> <li>The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (<i>secondary</i>)</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Within a natural system, the transfer of energy drives the motion and/or cycling of matter.</li> </ul>

Observable features of the student performance by the end of the course:	
1	Articulating the explanation of phenomena
a	Students articulate a statement that relates the given phenomenon to a scientific idea, including the idea that photosynthesis results in the cycling of matter and energy into and out of organisms.
b	Students use evidence and reasoning to construct a scientific explanation for the given phenomenon.
2	Evidence
a	Students identify and describe* evidence (e.g., from students' own investigations, observations, reading material, archived data) necessary to constructing the explanation, including that: <ol style="list-style-type: none"> <li>i. Plants, algae, and photosynthetic microorganisms require energy (in the form of sunlight) and must take in carbon dioxide and water to survive.</li> <li>ii. Energy from sunlight is used to combine simple nonfood molecules (e.g., carbon dioxide and water) into food molecules (e.g., sugar) and oxygen, which can be used immediately or stored by the plant.</li> <li>iii. Animals take in food and oxygen to provide energy and materials for growth and survival.</li> <li>iv. Some animals eat plants, algae, and photosynthetic microorganisms, and some animals eat other animals, which have themselves eaten photosynthetic organisms.</li> </ol>
b	Students use multiple valid and reliable sources of evidence.

3	Reasoning
a	<p>Students use reasoning, along with the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future, to connect the evidence and support an explanation for energy and matter cycling during photosynthesis. Students describe* a chain of reasoning for their explanation, including:</p> <ul style="list-style-type: none"> <li>i. Plants, algae, and photosynthetic microorganisms take in matter (in the form of carbon dioxide and water) and use energy from the sun to produce carbon-based organic molecules (food), which they can use immediately or store, and release oxygen into the environment through photosynthesis.</li> <li>ii. Plants use the food they have made for energy, growth, and other necessary functions (e.g., repair, seed production).</li> <li>iii. Animals depend on matter from plants for growth and survival, including: <ul style="list-style-type: none"> <li>1. Eating photosynthetic organisms (or other organisms that have eaten photosynthetic organisms), thus acquiring the matter they contain, the production of which was driven by photosynthesis.</li> <li>2. Breathing in oxygen, which was released when plants used energy to rearrange carbon dioxide and water during photosynthesis.</li> </ul> </li> <li>iv. Because animals acquire their food from photosynthetic organisms (or from other animals that have eaten those organisms) and their oxygen from the products of photosynthesis, all food and most of the oxygen animals use for life processes are the results of energy from the sun driving matter flows through the process of photosynthesis.</li> <li>v. The process of photosynthesis has an important role in energy and matter cycling within plants (i.e., the conversion of carbon dioxide and water into complex carbon-based molecules (sugars) and oxygen, the contribution of sugars to plant growth and internal processes) as well as from plants to other organisms.</li> </ul>