

## HS-LS1-7

Students who demonstrate understanding can:

- HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.** *[Clarification Statement: Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.] [Assessment Boundary: Assessment should not include identification of the steps or specific processes involved in cellular respiration.]*

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p><b>Developing and Using Models</b> Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</p> <ul style="list-style-type: none"> <li>Use a model based on evidence to illustrate the relationships between systems or between components of a system.</li> </ul>	<p><b>LS1.C: Organization for Matter and Energy Flow in Organisms</b></p> <ul style="list-style-type: none"> <li>As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.</li> <li>As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.</li> </ul>	<p><b>Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.</li> </ul>

### Observable features of the student performance by the end of the course:

1	Components of the model	
	a	From a given model, students identify and describe the components of the model relevant for their illustration of cellular respiration, including: <ol style="list-style-type: none"> <li>i. Matter in the form of food molecules, oxygen, and the products of their reaction (e.g., water and CO<sub>2</sub>);</li> <li>ii. The breaking and formation of chemical bonds; and</li> <li>iii. Energy from the chemical reactions.</li> </ol>
2	Relationships	
	a	From the given model, students describe the relationships between components, including: <ol style="list-style-type: none"> <li>i. Carbon dioxide and water are produced from sugar and oxygen by the process of cellular respiration; and</li> <li>ii. The process of cellular respiration releases energy because the energy released when the bonds that are formed in CO<sub>2</sub> and water is greater than the energy required to break the bonds of sugar and oxygen.</li> </ol>
3	Connections	
	a	Students use the given model to illustrate that: <ol style="list-style-type: none"> <li>i. The chemical reaction of oxygen and food molecules releases energy as the matter is rearranged, existing chemical bonds are broken, and new chemical bonds are formed, but matter and energy are neither created nor destroyed.</li> <li>ii. Food molecules and oxygen transfer energy to the cell to sustain life's processes, including the maintenance of body temperature despite ongoing energy transfer to the surrounding environment.</li> </ol>