

HS-LS1-6

Students who demonstrate understanding can:

- HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules. [Clarification Statement: Emphasis is on using evidence from models and simulations to support explanations.] [Assessment Boundary: Assessment does not include the details of the specific chemical reactions or identification of macromolecules.]**

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>Constructing Explanations and Designing Solutions</p> <p>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</p> <ul style="list-style-type: none"> Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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. 	<p>LS1.C: Organization for Matter and Energy Flow in Organisms</p> <ul style="list-style-type: none"> The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for example to form new cells. As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. 	<p>Energy and Matter</p> <ul style="list-style-type: none"> Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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

1	Articulating the explanation of phenomena												
	a Students construct an explanation that includes: <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 20px;">i.</td> <td>The relationship between the carbon, hydrogen, and oxygen atoms from sugar molecules formed in or ingested by an organism and those same atoms found in amino acids and other large carbon-based molecules; and</td> </tr> <tr> <td>ii.</td> <td>That larger carbon-based molecules and amino acids can be a result of chemical reactions between sugar molecules (or their component atoms) and other atoms.</td> </tr> </tbody> </table>	i.	The relationship between the carbon, hydrogen, and oxygen atoms from sugar molecules formed in or ingested by an organism and those same atoms found in amino acids and other large carbon-based molecules; and	ii.	That larger carbon-based molecules and amino acids can be a result of chemical reactions between sugar molecules (or their component atoms) and other atoms.								
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2	Evidence												
	a Students identify and describe* the evidence to construct the explanation, including: <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 20px;">i.</td> <td>All organisms take in matter (allowing growth and maintenance) and rearrange the atoms in chemical reactions.</td> </tr> <tr> <td>ii.</td> <td>Cellular respiration involves chemical reactions between sugar molecules and other molecules in which energy is released that can be used to drive other chemical reactions.</td> </tr> <tr> <td>iii.</td> <td>Sugar molecules are composed of carbon, oxygen, and hydrogen atoms.</td> </tr> <tr> <td>iv.</td> <td>Amino acids and other complex carbon-based molecules are composed largely of carbon, oxygen, and hydrogen atoms.</td> </tr> <tr> <td>v.</td> <td>Chemical reactions can create products that are more complex than the reactants.</td> </tr> <tr> <td>vi.</td> <td>Chemical reactions involve changes in the energies of the molecules involved in the reaction.</td> </tr> </tbody> </table>	i.	All organisms take in matter (allowing growth and maintenance) and rearrange the atoms in chemical reactions.	ii.	Cellular respiration involves chemical reactions between sugar molecules and other molecules in which energy is released that can be used to drive other chemical reactions.	iii.	Sugar molecules are composed of carbon, oxygen, and hydrogen atoms.	iv.	Amino acids and other complex carbon-based molecules are composed largely of carbon, oxygen, and hydrogen atoms.	v.	Chemical reactions can create products that are more complex than the reactants.	vi.	Chemical reactions involve changes in the energies of the molecules involved in the reaction.
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	b	Students use a variety of valid and reliable sources for the evidence (e.g., theories, simulations, students' own investigations).
3	Reasoning	
	a	Students use reasoning to connect the evidence, 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 construct the explanation that atoms from sugar molecules may combine with other elements via chemical reactions to form other large carbon-based molecules. Students describe* the following chain of reasoning for their explanation:
		i. The atoms in sugar molecules can provide most of the atoms that comprise amino acids and other complex carbon-based molecules.
		ii. The energy released in respiration can be used to drive chemical reactions between sugars and other substances, and the products of those reactions can include amino acids and other complex carbon-based molecules.
		iii. The matter flows in cellular processes are the result of the rearrangement of primarily the atoms in sugar molecules because those are the molecules whose reactions release the energy needed for cell processes.
4	Revising the explanation	
	a	Given new evidence or context, students revise or expand their explanation about the relationships between atoms in sugar molecules and atoms in large carbon-based molecules, and justify their revision.