CCSSO
Council of Chief State School Officers

Science Assessment Item Collaborative

High School Item Cluster Prototype

for assessment of the

Next Generation Science Standards

December 2015

Developed by WestEd in collaboration with CCSSO Science Assessment Item Collaborative state members and content experts.

WestEd

Intended Use of this Prototype

1. To serve as an initial model for measuring the 3-dimensional science learning (NGSS).
2. To support states in guiding NGSS assessment development.
3. To promote ongoing dialogue.

Level:	High School
Primary Target Domain:	Life Sciences
Target PEs:	HS-LS1-5, HS-LS1-7
Crosscutting Concept(s) Focus:	Energy and Matter
Science and Engineering Practice(s) Focus:	Developing and Using Models
Phenomenon:	A pond ecosystem has remained stable for several years.
Allowable Item Types:	SR, TE, CR

	HS-LS1-5	**HS-LS1-7**
Performance Expectations:	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	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.
Target Clarifications:	Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.	Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration.
Assessment Boundary:	Assessment does not include specific biochemical steps.	Assessment should not include identification of the steps or specific processes involved in cellular respiration.
Disciplinary Core Idea(s):	**LS1.C: Organization for Matter and Energy Flow in Organisms** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • 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. • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.
Science and Engineering Practice(s):	**Developing and Using Models** 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. • Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**Developing and Using Models** 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. • Use a model based on evidence to illustrate the relationships between systems or between components of a system.
Crosscutting Concept(s):	**Energy and Matter** • 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.	**Energy and Matter** • Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.

HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

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.

ITEM CLUSTER

Stimulus

Item 1a: Drag-and-Drop (TEI)

Item 1b: Text Entry

HS-LS1-5 HS-LS1-7 | DCI | SEP | CCC

Item 2a: Drop-Down Menu (TEI)

Item 2b: Multiple Choice

HS-LS1-5 HS-LS1-7 | DCI | SEP | CCC

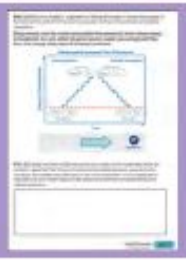
Item 3: Hot Spot (TEI) with Multiple Select

HS-LS1-5 | DCI | SEP | CCC

Item 4a: Multiple Select

Item 4b: Multiple Choice

HS-LS1-5 HS-LS1-7 | DCI | SEP | CCC



Item 5a: Drag-and-Drop w/Fill-in Labeling (TEI)

Item 5b: Constructed Response

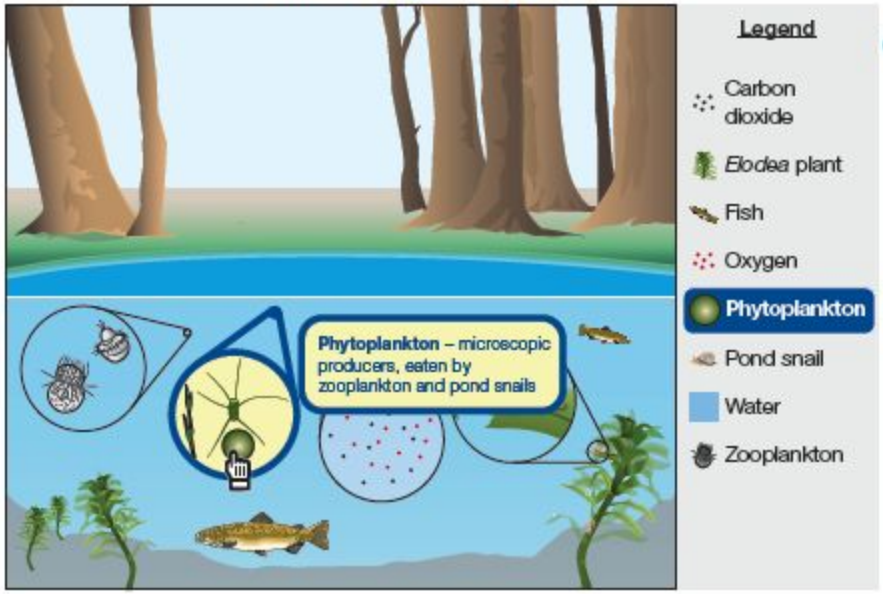
HS-LS1-5 HS-LS1-7 | DCI | SEP | CCC

(Stimulus)

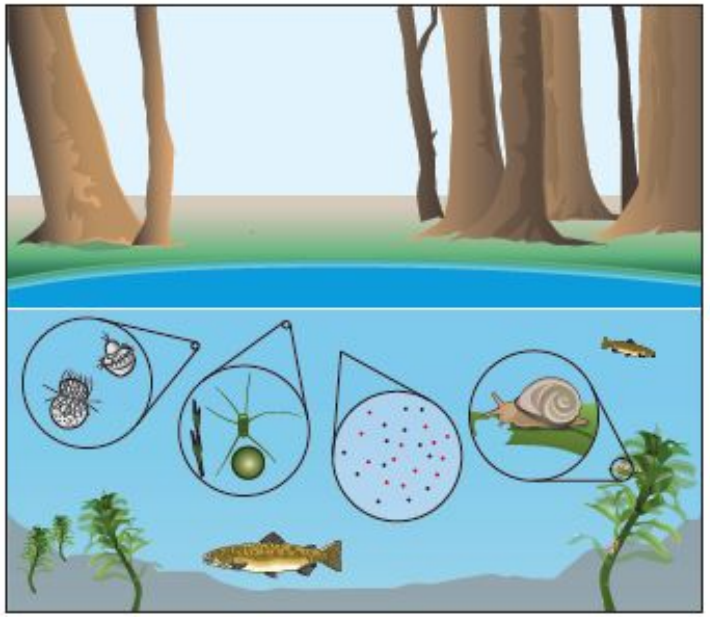
Each year, in the spring, a teacher takes her students on a field trip to the same pond to observe the pond ecosystem. The students measure and observe different components of the pond ecosystem, including the numbers and types of organisms present and the concentrations of gases in the water.

Scroll over the parts of the Interactive Pond Exploration image to explore the different components.

Interactive Pond Exploration



The students compare their measurements and observations with the notes left by previous classes and notice that the pond ecosystem has remained relatively stable for the past several years. The teacher asks her students to think about the factors that affect stability in pond ecosystems, including the processes that transfer energy and matter. She asks her students to develop a model that can be used to explain how the flow of energy and matter relate to stability in the pond ecosystem.

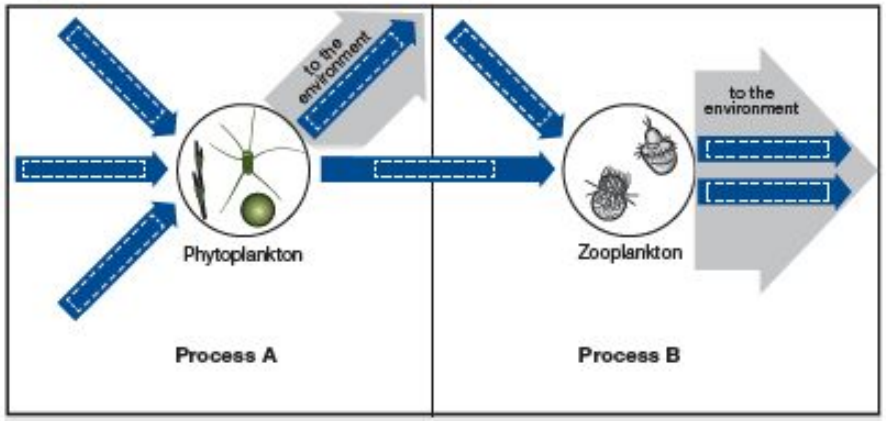


#1.

Part (a) Complete a model to represent the two main processes by which energy and matter are transferred among the various components of the pond ecosystem.

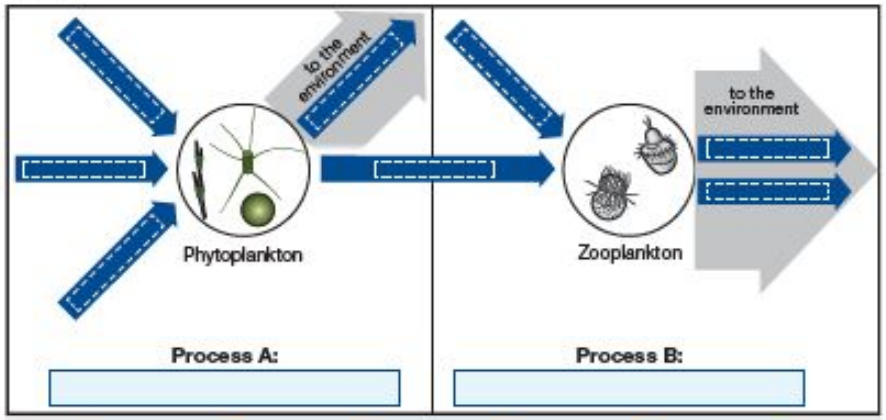
Drag the correct labels into the blue arrows in the model to identify the reactants, products, and energy involved in each of these processes.

Every arrow must be labeled. Some labels may be used more than once.



Carbon dioxide | Oxygen | Sugar | Sunlight | Water

Part (b) Type the name of Process A and the name of Process B into the appropriate boxes.



Carbon dioxide | Oxygen | Sugar | Sunlight | Water

Click NEXT to continue to the next question. NEXT

HS-LS1-5
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

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.

Alignment to the PE and targeted dimensions is intended through the entirety of the item cluster. Partial to strong alignment to the dimensions for each item is achieved through alignment to the evidence statements, and is inclusive of all item parts for any given item.

LS1.C: Organization for Matter and Energy Flow in Organisms
- The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.
- 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.
- As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products.

Developing and Using Models
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.
- Use a model based on evidence to illustrate the relationships between systems or between components of a system.

Energy and Matter
- 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.
- Energy cannot be created or destroyed; it only moves between one place and another place, between objects and/or fields, or between systems.

#2.

Part (a) Based upon your completed model, explain how the model demonstrates how energy flows into, within, and out of this system. Use the drop-down menus to write your explanation.

Energy flows **into** the system as

Select	when	Select	as a result of Process A.
chemical energy		energy is converted into matter	
heat energy		bonds break in sugar	
light energy		sunlight is absorbed	
		bonds form in sugar	

Energy flows **within** the system as

Select	after	Select	as a result of Process A.
chemical energy		energy is converted into matter	
heat energy		bonds break in sugar	
light energy		sunlight is absorbed	
		bonds form in sugar	

Energy flows **out of** the system as

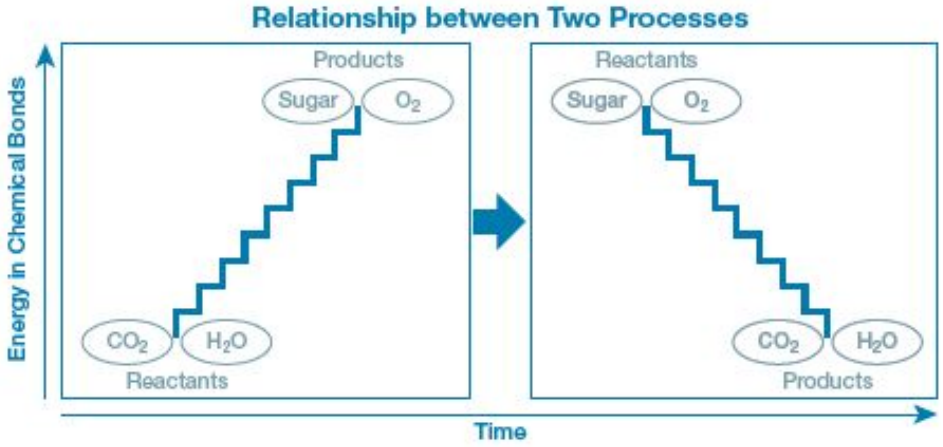
Select	after	Select	as a result of Process B.
chemical energy		energy is converted into matter	
heat energy		bonds break in sugar	
light energy		sunlight is absorbed	
		bonds form in sugar	

Part (b) Which statement explains why the mass of sugar and oxygen that is taken in during Process B is the same as the mass of carbon dioxide and water that is produced?

- ○ Only one gas, oxygen, is taken in, and only one gas, carbon dioxide, is released.
- ○ All the atoms that are in the oxygen and sugar are rearranged to form the carbon dioxide and water.
- ○ The energy in the bonds of the oxygen and sugar is equal to the energy in the bonds of the carbon dioxide and water.
- ○ The number of bonds broken in oxygen and sugar is equal to the number of bonds formed in carbon dioxide and water.

#3. A student in class develops the graph below to represent the two main processes by which matter and energy are transferred within this pond ecosystem.

Click on the box in the graph that represents **photosynthesis**, and then select the statements that **best** explain the reasoning for selecting that part of the graph. Select all the statements that apply.



- ○ More energy is released than is stored during photosynthesis.
- ○ Energy is absorbed when the bonds in the reactants are broken.
- ○ Energy is created during photosynthesis, resulting in high-energy sugar molecules.
- ○ The total amounts of energy in the molecules of the reactants and in the molecules of the products are equal.
- ○ The amount of energy in the bonds of the products formed is greater than the amount of energy in the bonds of the reactants.

HS-LS1-5
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

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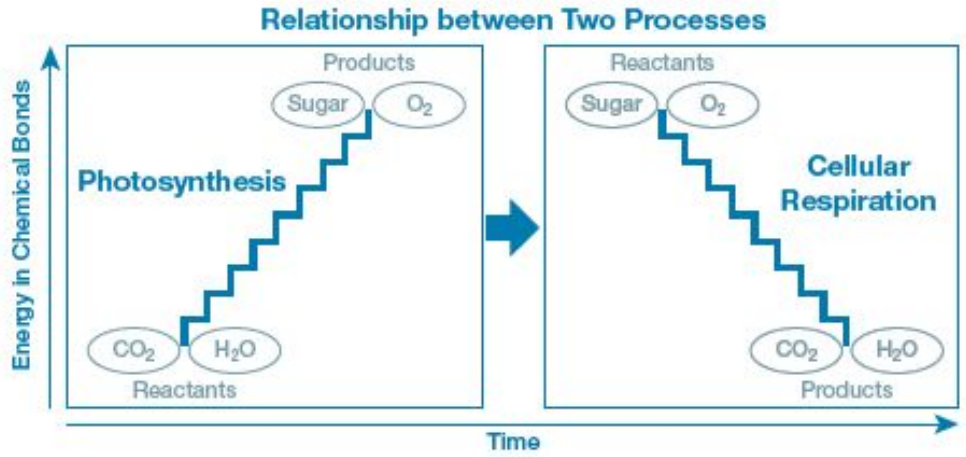
#4.



Part (a) What do the steps in the box labeled "Photosynthesis" represent? Select all that apply.

- ○ the conversion of energy into matter
- ○ the formation of chemical bonds that store energy
- ○ the transformation of matter, which releases energy
- ○ the destruction of matter, a process that releases energy
- ○ the breaking of chemical bonds, a process that absorbs energy

Part (b) What do the steps in the box labeled "Cellular Respiration" represent?

- ○ a decrease in energy as heat is converted into the reactants
- ○ a decrease in energy as chemical bonds of the products form
- ○ a decrease in matter as molecules are transferred to the environment
- ○ a decrease in matter as atoms are rearranged to form smaller molecules

Click NEXT to continue to the next question. NEXT

HS-LS1-5
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

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.

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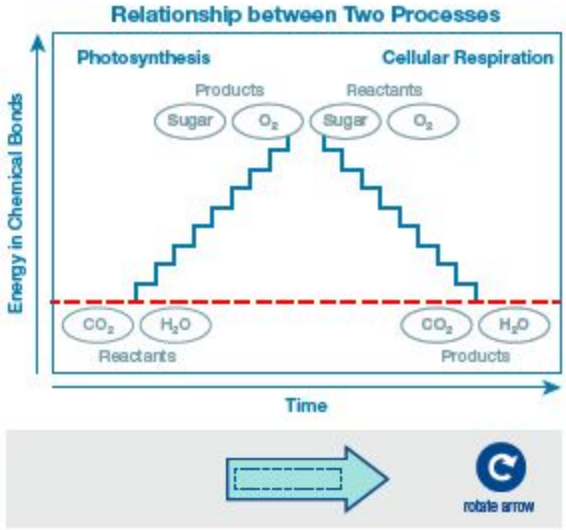
#5.

Some of the students in the class argue that the pond ecosystem has remained stable for the past several years because the same amount of energy that is created in the ecosystem is later destroyed. The students add the red dotted line to the model to show that the same amount of energy exists at the beginning of photosynthesis as at the end of cellular respiration.

Part (a) Refute the students' argument by refining the model to show how energy is transferred into and within the pond ecosystem during photosynthesis and cellular respiration.

Drag arrow(s) onto the model and position the arrow(s) to show where energy is transferred into and within the pond system. Label your arrow(s) with the form that energy takes when it is being transferred.



Part (b) Explain how the modifications that you made to the model help refute the students' argument that the pond has remained stable because equal amounts of energy are created and destroyed in the pond ecosystem. In your explanation, describe how the model relates to the relationship between photosynthesis and cellular respiration.

Item	Item Part	Brief Description	Item Type	PE	DCI	SEP	CCC	EV Level	EVs	Points	Estimated Time (min)	Hand or Automated Scoring
Stimulus		Interactive Pond Exploration	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4	N/A
1	1a	Complete a model of photosynthesis and cellular respiration	Drag-and-Drop	HS-LS1-6	LS1.C	2	6	1	1.a.i 1.a.iv	2	2	A
				HS-LS1-7				1	1.a.i			
	1b	Identify processes in model	Text Entry	HS-LS1-6				2	2.a	1	1	A
				HS-LS1-7				2	2.a.i			
2	2a	Explain transfer of energy in model	Drop-Down Menu	HS-LS1-6	LS1.C	2	6	3	3.a.ii	2	2	A
				HS-LS1-7				2	2.a.ii			
	2b	Conservation of mass	Multiple Choice	HS-LS1-7				3	3.a.i 3.a.ii	1	1	A
Stimulus		Relationship between Two Processes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	N/A
3		Identification of photosynthesis based on energy	Hot Spot with Multiple Select	HS-LS1-6	LS1.C	2	6	3	3.a.ii	2	2	A
4	4a	Energy storage in bonds	Multiple Select	HS-LS1-6	LS1.C	2	6	1	1.a.ii	1	1	A
	4b	Energy released when products form	Multiple Choice	HS-LS1-7				1	1.a.ii 1.a.iii	1	1	A
Stimulus		Relationship between Two Processes, Starting and Ending	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2	N/A
5	5a	Energy transfer and refuting a claim	Drag-and-Drop w/ Fill-in Labeling	HS-LS1-6	LS1.C	2	6	3	3.a.i	2	2	A or H
				HS-LS1-7				3	3.a.ii			
	5b	Explanation of interdependence of photosynthesis and cellular respiration	Constructed Response	HS-LS1-6				3	3.a.i	4	6	H
				HS-LS1-7				3	3.a.i			
								Total:	**13 of 14**	**16**	**24**	