Bonds in Motion

Model how matter and energy change during cellular respiration.

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..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each input molecule and circle each product molecule. Number 1, 2, and 3 beside statements that explain bond changes, atom conservation, and energy transfer.

A Model for Respiring Seeds

(1) During a hard sprint, muscle cells need a steady supply of usable energy. They obtain it through cellular respiration, a chemical process that rearranges atoms. Glucose, a food molecule, and oxygen are inputs. Their bonds do not simply disappear. Some bonds in glucose and oxygen molecules break, and atoms are reorganized. New bonds form in carbon dioxide and water molecules. A model of this change can use molecule drawings, arrows, and labels. The model should show the same kinds and numbers of atoms before and after the reaction, even though those atoms are connected in different ways.

(2) Cellular respiration has an energy result as well as a matter result. Energy stored in the chemical bonds of the inputs is transferred as bonds break and new bonds form. The process releases energy that cells can use for activities such as muscle contraction. However, not all of the transferred energy becomes usable cellular energy. Some is released as thermal energy, which can contribute to body warmth. A complete model includes energy arrows, not only molecule names. It shows energy leaving the rearrangement of reactant bonds and being captured in a usable form, while some energy moves to the surroundings. This represents a net transfer of energy, not the creation of energy.

(3) Consider a sealed container holding germinating seeds. As the seeds carry out cellular respiration, they take in oxygen from the air in the container and release carbon dioxide and water. The seed's stored food molecules provide the other input. A before-and-after model can explain why oxygen decreases while carbon dioxide increases. It should also explain that mass is not lost when food and oxygen become different compounds. Atoms from the inputs are conserved and appear in the products. If the container warms slightly, that observation supports the idea that some transferred energy moved to the surroundings as thermal energy. The model connects observations to bond changes, atom rearrangement, and energy transfer.

2 ANSWER WITH EVIDENCE

Use the passage

1. What must a before-and-after model show to support the claim that matter is conserved during cellular respiration?

2. A seed container has less oxygen and more carbon dioxide after several hours. How can a cellular respiration model explain both observations?

3. Where should energy arrows point in a complete model of cellular respiration?

4. Why does the passage describe cellular respiration as a net transfer of energy rather than the creation of energy?

3 YOUR TURN

Your own words

Create a labeled before-and-after model of cellular respiration using glucose and oxygen. Include the molecules on each side, show that carbon, hydrogen, and oxygen atoms are conserved, and add arrows that show net energy transfer to usable cellular energy and thermal energy.

ANSWER KEY

Bonds in Motion

PART 1 · READ AND MARK

Underline each input molecule and circle each product molecule. Number 1, 2, and 3 beside statements that explain bond changes, atom conservation, and energy transfer. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What must a before-and-after model show to support the claim that matter is conserved during cellular respiration?	**It must show the same kinds and numbers of atoms before and after the reaction, arranged in different molecules.**
2	A seed container has less oxygen and more carbon dioxide after several hours. How can a cellular respiration model explain both observations?	**The model shows oxygen and food molecules as inputs whose atoms are rearranged into products, including carbon dioxide.**
3	Where should energy arrows point in a complete model of cellular respiration?	**They should show energy transferred to a usable cellular form and some energy transferred to the surroundings as thermal energy.**
4	Why does the passage describe cellular respiration as a net transfer of energy rather than the creation of energy?	**Energy is transferred from the chemical rearrangement into usable cellular energy and thermal energy, not created.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Before: C6H12O6 + 6 O2. After: 6 CO2 + 6 H2O. I would show bonds in glucose and oxygen breaking and new bonds forming in carbon dioxide and water. Each side has 6 carbon atoms, 12 hydrogen atoms, and 18 oxygen atoms. Energy arrows would point to usable cellular energy and to thermal energy in the surroundings, showing a net transfer of energy.

Accept equivalent labeled particle drawings, chemical formulas, or written models that conserve atom types and numbers. The model must identify glucose and oxygen as inputs, carbon dioxide and water as products, bond rearrangement, and energy transfer without naming cellular respiration steps.