Where Sugar Goes

Trace matter and energy through yeast respiration

HS-LS1-7 "Use a model of the major inputs and outputs of cellular respiration (aerobic and anaerobic) to exemplify the chemical process in which the bonds of food molecules are broken, the bonds of new compounds are formed..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the inputs and circle the products of each yeast pathway. Number the sentences that explain how bonds change and where energy goes.

Inside Rising Dough

1. At a bakery, yeast cells use energy from sugar while dough rises. Imagine tracking matter through one yeast cell rather than watching the whole loaf. Its food supply includes glucose, a molecule with carbon, hydrogen, and oxygen atoms. When oxygen is available, the cell uses aerobic cellular respiration. Glucose and oxygen enter this chemical process. Bonds in glucose and oxygen are broken, and atoms are rearranged into carbon dioxide and water with new bonds. The cell also uses some of the transferred energy to join ADP and a phosphate group, making ATP, a molecule that can power cellular work.

2. In a dense patch of dough, oxygen may become scarce even though glucose is still present. Yeast can then use an anaerobic pathway called alcoholic fermentation. First, glucose is partly broken down, and a small amount of ATP is made from ADP and phosphate. Then atoms from glucose end up in ethanol and carbon dioxide as old bonds break and new bonds form. Oxygen is not an input to this pathway, and water is not its main waste product. The carbon dioxide bubbles help dough rise; the ethanol mostly evaporates during baking. Fermentation yields less ATP per glucose than aerobic respiration.

3. A model can use arrows to show both pathways without claiming that atoms disappear. For aerobic respiration, label incoming glucose, oxygen, ADP, and phosphate, then label the products carbon dioxide, water, and ATP. For alcoholic fermentation, label incoming glucose, ADP, and phosphate, then label the products ethanol, carbon dioxide, and ATP. In both pathways, chemical bonds change and energy from food is transferred to ATP; some energy also spreads to the surroundings as heat. Aerobic respiration makes much more ATP from each glucose molecule than fermentation does. The arrows show products of each process, not necessarily substances that leave the cell.

2 ANSWER WITH EVIDENCE

Use the passage

1. In an aerobic respiration model, which matter inputs and products would you label? Include the molecules used to make ATP.

2. In a fermentation model, which arrow brings in carbon, which product arrows carry carbon out, and should oxygen have an input arrow?

3. How do bond changes in either pathway relate to the transfer of energy? Name two places the energy goes.

4. When oxygen becomes scarce in dough, how would the yeast pathway in a model change, and what happens to ATP yield per glucose?

3 YOUR TURN

Your own words

A student models yeast in a sealed bottle of sweet juice after its oxygen runs out as “glucose → ATP + water” and says the carbon atoms vanished. Write a corrected arrow model, then explain where the carbon goes, how bond changes transfer energy, and how its ATP yield compares with aerobic respiration.

ANSWER KEY

Where Sugar Goes

HIGH SCHOOL · HS-LS1-7

PART 1 · READ AND MARK

Underline the inputs and circle the products of each yeast pathway. Number the sentences that explain how bonds change and where energy goes. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In an aerobic respiration model, which matter inputs and products would you label? Include the molecules used to make ATP.	**Inputs: glucose, oxygen, ADP, and phosphate. Products: carbon dioxide, water, and ATP.**
2	In a fermentation model, which arrow brings in carbon, which product arrows carry carbon out, and should oxygen have an input arrow?	**Glucose brings in carbon. Ethanol and carbon dioxide carry carbon into products. Oxygen has no input arrow.**
3	How do bond changes in either pathway relate to the transfer of energy? Name two places the energy goes.	**Old bonds break and new bonds form as atoms are rearranged. A net transfer of energy from food helps make ATP, and some energy spreads to the surroundings as heat.**
4	When oxygen becomes scarce in dough, how would the yeast pathway in a model change, and what happens to ATP yield per glucose?	**The model changes from aerobic respiration to alcoholic fermentation. It no longer shows oxygen as an input, shows ethanol and carbon dioxide as products, and shows a lower ATP yield per glucose.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

After oxygen runs out, yeast can use alcoholic fermentation. A better model is glucose + ADP + phosphate → ethanol + carbon dioxide + ATP. Oxygen is not an input. The carbon atoms from glucose have not vanished; they are in ethanol and carbon dioxide, not water alone. As old bonds break and new bonds form, energy from the food is transferred to ATP, while some spreads to the surroundings as heat. Fermentation makes less ATP per glucose than aerobic respiration.

Accept arrow models that show glucose, ADP, and phosphate as inputs and ethanol, carbon dioxide, and ATP as products. Students should account for carbon and describe energy transfer through bond rearrangement, not claim that breaking bonds alone releases energy.