

4.1: Molecular Models for Cow Cellular Respiration Worksheet

You will use models to learn about cow cellular respiration at the atomic-molecular scale, as you continue to look for answers to “unanswered questions” from your investigation.

A. Introduction

In our investigation, we saw the mealworms moving. Where did they get the energy to move?

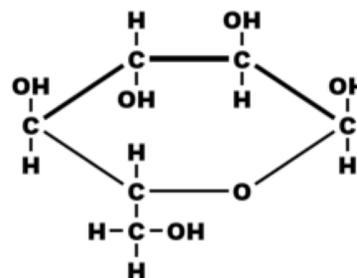
Animals, like mealworms and cows, get energy from chemical energy stored either in their food (like carbohydrates) or in molecules (like fats) in their bodies. Carbohydrates and fats contain chemical energy stored in high-energy bonds: C-C and C-H bonds.

When animals use energy from carbohydrates or fats, they use oxygen (O_2) in the air from breathing to produce carbon dioxide (CO_2) and water (H_2O). Since carbon dioxide and water have only low-energy bonds (C-O and H-O), the chemical energy is released as motion and heat. Use the molecular models to show how this happens.

B. Using molecular models to show the chemical change

Work with your partner to make models of the reactant molecules: *glucose and oxygen*.

Glucose—a kind of sugar—is a carbohydrate. Using twist ties, show how chemical energy is stored in the high-energy bonds of glucose and other sugars.



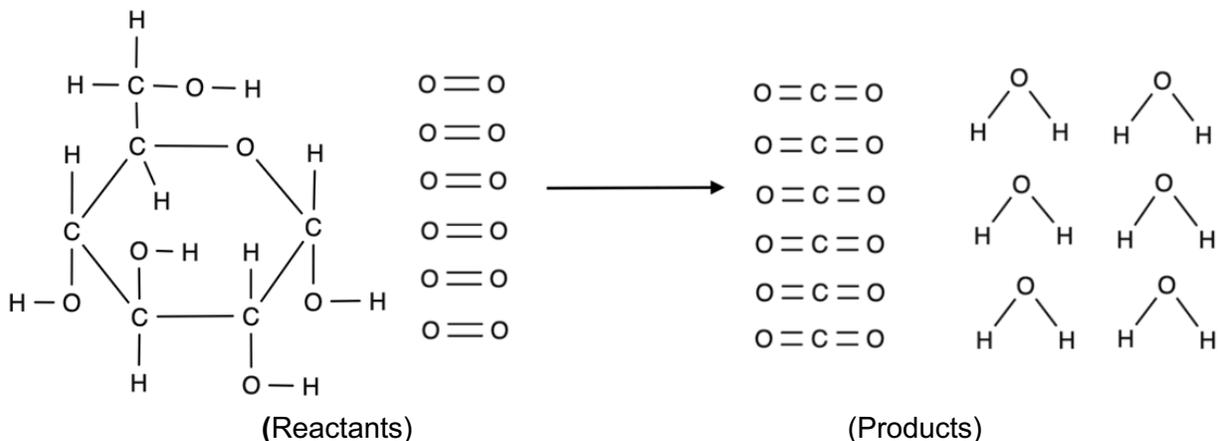
- Make models of a glucose molecule ($C_6H_{12}O_6$) and oxygen molecules (O_2 , with a double bond). Animals breathe in air, which has lots of oxygen, so make at least 6 O_2 molecules. Put these molecules on the *reactant* side of the Molecular Models Placemat.
- Use twist ties to represent chemical energy. Put a twist tie around **each** high-energy bond (C-C and C-H bonds) in the glucose molecule. Put the “Chemical Energy” card under the glucose molecule to label the energy in the C-C and C-H bonds. Note how many energy units (twist ties) there are in the glucose molecule.

Show how the atoms of the reactant molecules can recombine into product molecules—carbon dioxide and water—and show how chemical energy is released when this happens.

- Take the glucose and some of the oxygen molecules apart and recombine them into carbon dioxide (CO_2) and water (H_2O) molecules. Put these molecules on the *product* side of the Molecular Models Placemat. Some things to notice:
 - How many oxygen molecules reacted with one glucose molecule? _____
 - How many carbon dioxide molecules were produced? _____
 - How many water molecules were produced? _____
- Energy lasts forever, so move the twist ties to the *product* side of the Molecular Models Placemat. Carbon dioxide and water have only low-energy bonds (C-O and H-O), so what forms does the chemical energy change into? Put the correct energy cards under the twist ties.

C. Atoms last forever!

Account for all the atoms in your models.



1. Circle all of the Carbon ATOMS in the reactants. How many are there? _____
2. Circle all of the Carbon ATOMS in the products. How many are there? _____
3. Underline all of the Hydrogen ATOMS in the reactants. How many are there? _____
4. Underline all of the Hydrogen ATOMS in the products. How many are there? _____
5. Put a square around all of the Oxygen ATOMS in the reactants. How many are there? _____
6. Put a square around all of the Oxygen ATOMS in the products. How many are there? _____

D. Energy lasts forever! Account for all the energy in your models.

1. How many twist ties are there before the chemical change? _____
2. What form of energy is there before the chemical change? _____
3. How many twist ties are there after the chemical change? _____
4. What forms of energy is there after the chemical change? _____

E. Check Yourself!

1. Did the number and type of atoms stay the same at the beginning and end of the chemical change? _____
2. Did the number of twist ties (representing energy) stay the same at the beginning and end of the chemical change? _____
3. Why do the numbers of atoms and twist ties have to stay the same?

F. Writing the chemical equation

Use the molecular formulas ($C_6H_{12}O_6$, O_2 , CO_2 , H_2O) and the yield sign (\rightarrow) to write a balanced chemical equation for the reaction:
