Sunlight to Sugar

Trace matter and energy through photosynthesis

BIO.2.2 "Develop models of the major reactants and products of photosynthesis to demonstrate the transformation of light energy into stored chemical energy in cells. Emphasize the chemical processes in which bonds are broken..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline descriptions of bonds breaking and forming, circle the major reactants and products, and number light, ATP and NADPH, and glucose to trace the path of energy.

Inside a Sunlit Leaf

1. On a sunny morning, a bean plant builds sugar inside cells in its leaves. Chloroplasts absorb light, which supplies energy for photosynthesis. The major inputs are carbon dioxide (CO_2) from air and water (H_2O) from soil. The major outputs are glucose ($C_6H_{12}O_6$) and oxygen (O_2). One balanced summary is $6CO_2 + 6H_2O$ + light energy $\rightarrow C_6H_{12}O_6 + 6O_2$. This equation tracks atoms, but it does not show every step. A model must also show where light energy enters and how some of it becomes chemical energy stored in sugar.

2. First, light excites electrons in chlorophyll. In the light-dependent reactions, water molecules are split, replacing those electrons and producing oxygen gas. Breaking bonds in water takes energy; bond breaking alone does not release energy. As energized electrons move through a transport chain, their energy helps make ATP, an energy-carrying molecule. The electrons also help form NADPH, another energy carrier. ATP and NADPH temporarily hold energy and deliver it to the next stage. A useful model shows water entering this stage, oxygen leaving it, and light energy flowing into ATP and NADPH rather than straight into glucose.

3. Next, in the Calvin cycle, enzymes incorporate carbon from CO_2 into small carbon compounds. Reactions rearrange atoms and, using energy from ATP and electrons from NADPH, build higher-energy carbon compounds that can be assembled into glucose. Chemical bonds are broken and new bonds form during these reactions. The energy change depends on both processes: breaking a bond requires energy, while forming a bond releases energy. Overall, light energy makes it possible to store energy in the chemical structure of sugar. A model can connect the two stages with arrows for ATP and NADPH and show glucose leaving the carbon-building stage.

2 ANSWER WITH EVIDENCE

Use the passage

1. In a model of the whole process, which two substances enter, which two leave, and where does the energy arrow begin?

2. What should a model show happening to water and oxygen in the light-dependent reactions? Does splitting water's bonds release energy?

3. Which two carriers should connect the stages in a model, and what does each provide for building sugar?

4. A classmate labels a model, “Breaking bonds in CO_2 releases the energy stored in glucose.” How would you correct that label?

3 YOUR TURN

Your own words

Draw a two-panel model of photosynthesis in a bean leaf. Label the light-dependent reactions and Calvin cycle, use arrows for the major inputs, outputs, and carriers between stages, and add notes showing one bond change, where energy enters, and where some energy ends up.

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PART 1 · READ AND MARK

Underline descriptions of bonds breaking and forming, circle the major reactants and products, and number light, ATP and NADPH, and glucose to trace the path of energy. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	In a model of the whole process, which two substances enter, which two leave, and where does the energy arrow begin?	**CO_2 and H_2O enter; glucose and O_2 leave. The energy arrow begins with light.**
2	What should a model show happening to water and oxygen in the light-dependent reactions? Does splitting water's bonds release energy?	**Water enters and is split, and oxygen gas leaves. Splitting bonds requires energy; bond breaking alone does not release it.**
3	Which two carriers should connect the stages in a model, and what does each provide for building sugar?	**ATP provides energy, and NADPH provides electrons for building higher-energy carbon compounds.**
4	A classmate labels a model, "Breaking bonds in CO_2 releases the energy stored in glucose." How would you correct that label?	**Breaking bonds requires energy. Light supplies energy that passes through ATP and NADPH and helps build glucose, where some of that energy is stored.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Panel 1, light-dependent reactions: Light energy and H_2O enter. Energy is needed to break bonds in water, and O_2 leaves. Arrows carry ATP and NADPH to panel 2. Panel 2, Calvin cycle: CO_2 enters. ATP supplies energy and NADPH supplies electrons as atoms are rearranged and new bonds form. Glucose leaves, with some captured light energy stored in its chemical structure.

Accept models that show the major matter inputs and outputs, ATP and NADPH connecting the stages, and light energy contributing to stored chemical energy. Bond breaking must not be described as releasing energy by itself.