Sugar Factory

Name: _____ **Period:** _____ **Date:** _____

> Open **peebedu.com** and navigate to **Sugar Factory**. Click the **Let's Make Sugar!** button to begin. Read the introduction popup, which outlines six steps for producing glucose through light-dependent reactions, the Calvin cycle, and glucose synthesis.

Part 1 — Model Evaluation (MAPP Framework)

Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Sugar Factory as a scientific model.

M — Mode

What type of model is the Sugar Factory? Describe how this computational simulation represents the process of building glucose inside a chloroplast. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how cells construct carbohydrates from smaller molecules.

A — Accuracy

(a) Identify two things this simulation represents **accurately** about the chemical reactions that build and break down biological molecules. For each, name the specific simulation feature and explain what it demonstrates about covalent bond formation or breakage.

(b) Identify two things this simulation **oversimplifies or leaves out** about how organisms build carbohydrates from smaller molecules. Consider what you cannot observe in the simulation that would be important for a complete understanding of dehydration synthesis and hydrolysis at the molecular level.

P — Purpose

What is the learning goal of this simulation? Explain how the Sugar Factory is designed to help you understand how monosaccharides are assembled from smaller molecular subunits through covalent bond formation. In your answer, connect at least one specific simulation feature to the biological importance of producing and storing glucose as a carbohydrate monomer.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries about carbohydrate synthesis or carbon fixation might change or improve a simulation like the Sugar Factory. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

Small-Group Discussion

With your group, discuss the following:

- How does dragging molecules into reaction slots help you visualize the difference between breaking bonds (hydrolysis) and forming bonds (dehydration synthesis)?
- The simulation produces glucose as the final product. What additional steps would be needed to show how glucose monomers are connected into polysaccharides?
- If you could add one feature to this simulation to better represent the role of water in dehydration synthesis, what would it be and why?
- How does the simulation help you understand why organisms need both synthesis reactions (building molecules) and hydrolysis reactions (breaking them down)?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Building Glucose Through Covalent Bond Formation

> *Simulation Task: Click "Water the Plant" and "Provide Sunlight & CO_2" to generate ATP, NADPH, and CO_2. Drag 3 CO_2, 3 ATP, and 2 NADPH into the Calvin Cycle slots, then click the Calvin Cycle to produce G3P. Next, drag 2 G3P molecules into the Glucose Synthesis zone and click it to produce glucose. Observe the Glucose Stored counter and note how many smaller molecules were required to build one glucose molecule.*

(A) (1 pt) **Describe** how dehydration synthesis joins two smaller molecules through covalent bonding, including the specific atoms removed from each reactant and the byproduct released during the reaction.

(B) (1 pt) **Explain** how the assembly of glucose from G3P molecules in the simulation demonstrates the principle that larger biological molecules are built from smaller molecular subunits through the formation of covalent bonds.

(C) (1 pt) **Predict** what would happen to the rate of glucose production in a plant cell if the supply of G3P molecules were suddenly reduced due to a decrease in available CO_2.

(D) (1 pt) **Justify** your prediction by explaining the relationship between the availability of molecular subunits and the rate of covalent bond formation during dehydration synthesis.

EK 1.3.A.2

Analyze Model / Visual Representation

Question 2 — Monosaccharides as Monomers for Polysaccharides

> *Simulation Task: Complete one full cycle of the Sugar Factory — add water, provide sunlight and CO_2, run the light reactions, the Calvin Cycle, and glucose synthesis. After producing glucose, note the quiz answer confirming that glucose is a carbohydrate. Then repeat the cycle to accumulate at least 2 glucose molecules and observe the Glucose Stored counter increase.*

(A) (1 pt) **Describe** the relationship between monosaccharides and polysaccharides, including how monomers are connected to form polymers through covalent bonds.

(B) (1 pt) **Explain** the relationship between the glucose molecules produced in the simulation and the formation of polysaccharides, including why the accumulation of glucose monomers is a necessary precursor to building complex carbohydrates.

(C) (1 pt) **Represent** the molecular relationship between glucose monomers and a polysaccharide.

Draw your diagram here.

(D) (1 pt) **Explain** how a change in the availability of glucose produced by photosynthesis could function as an abiotic factor that influences the distribution and abundance of heterotrophic organisms within an ecosystem.

EK 1.4.A.1