PEEBEDU

Sugar Factory

Unit 1: Chemistry of Life

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 — NGSS Questions

1.

> *Simulation Task: Click “Water the Plant” to add H_2O molecules, then click “Provide Sunlight & CO_2” to activate photons and generate CO_2. Drag 2 H_2O molecules into the thylakoid membrane slots and click the thylakoid zone to trigger the light-dependent reactions. Observe which molecules are produced and which molecule is released as a waste product.*

Identify the inputs and outputs of the light-dependent reactions you just performed. Explain how splitting water molecules provides the energy carriers (ATP and NADPH) that are needed to build sugar in later steps.

HS-LS1-6

2.

> *Simulation Task: After completing the light reactions, drag 3 CO_2, 3 ATP, and 2 NADPH into the Calvin Cycle slots. Click the Calvin Cycle zone and watch the reaction produce G3P. Note how many of each molecule were consumed to make one G3P.*

Describe how carbon dioxide from the atmosphere is incorporated into an organic molecule (G3P) during the Calvin Cycle. Explain why both energy carriers (ATP and NADPH) from the light reactions are required for this carbon-fixation step.

HS-LS1-6

3.

> *Simulation Task: Drag 2 G3P molecules into the Glucose Synthesis zone and click it to produce glucose. Watch the glucose molecule appear and the Glucose Stored counter increase. Answer the quiz question confirming that glucose is a carbohydrate.*

Explain how two smaller G3P molecules are combined to form one larger glucose molecule. Describe what type of chemical reaction joins smaller molecular subunits into a larger molecule and identify the byproduct that is released when a covalent bond forms between them.

HS-LS1-6

4.

> *Simulation Task: Run the full Sugar Factory cycle a second time — water the plant, provide sunlight and CO_2, complete the light reactions, the Calvin Cycle, and glucose synthesis again. Watch the Glucose Stored counter increase from 1 to 2. Compare the total number of CO_2 and H_2O molecules you used across both cycles.*

The simulation shows that building glucose requires many small inorganic molecules (CO_2 and H_2O) and multiple energy-requiring steps. Explain why organisms must continuously capture energy from sunlight to drive the synthesis of carbohydrates, and describe what would happen to glucose production if the supply of CO_2 were suddenly cut off.

HS-LS1-6

5.

> *Simulation Task: After producing at least 2 glucose molecules, observe the Glucose Stored counter and the activity log on the left sidebar. Think about what would happen to the stored glucose if the plant needed energy for growth or cellular processes.*

The simulation builds glucose through dehydration synthesis (removing water to form bonds). Describe the reverse process — hydrolysis — and explain how breaking glucose back down into smaller molecules would release stored energy for the plant to use in cellular activities.

HS-LS1-6

6.

> *Simulation Task: Review the three reaction zones in the chloroplast diagram — the Thylakoid Membrane, the Calvin Cycle, and the Glucose Synthesis zone. Trace the path of molecules from water and CO_2 through each zone until glucose is produced.*

In the box below, draw a flowchart showing the path of matter through the Sugar Factory. Label each reaction zone, the molecules that enter and leave each zone, and use arrows to show how the outputs of one reaction become the inputs of the next.

Draw your flowchart here.

HS-LS1-6

7.

> *Simulation Task: Click “Store Glucose & Finish” to view your final glucose production total. Consider that every glucose molecule your plant produced started as CO_2 from the atmosphere and H_2O from the soil.*

The glucose produced by photosynthesis is the foundation of nearly all food webs. Explain how the matter and energy captured in glucose by producers (plants) flows to primary consumers and then to secondary consumers. Predict how a significant decrease in photosynthesis within an ecosystem — caused by reduced sunlight or drought — would affect the populations of organisms at each level of the food web.

HS-LS2-3