

Name: _____ Period: _____ Date: _____

Open **peebedu.com** and navigate to **Run The Pathways**. Type your first name on the title screen: you play as an enzyme named after you (Maria plays as **Mariase**), in a cell laid out like a town. Keep the town in order by making more ATP than it uses: first with glycolysis and fermentation, then with a mitochondrion, then with a chloroplast. Your teacher may start you at Act 2 or Act 3 from the **Chapters** button.

Free Response Questions

Question 1: Conceptual Analysis

Game Task: Play Act 1. Split two sugars at Gly's bench by hand and read each receipt. Then try to split a third.

(A) (1 pt) **Describe** the molecules that went in and came out of one run of glycolysis, and the number of ATP made, invested and gained.

(B) (1 pt) **Explain** why Gly could not split a third sugar.

(C) (1 pt) **Explain** how fermentation at Brew's bar or Lacy's crock let glycolysis continue, even though fermentation makes no ATP.

(D) (1 pt) **Identify** the products of alcohol fermentation and of lactic acid fermentation.

3.5.B.1, 3.5.B.6, 3.3.A.3

Question 2: Analyze Data

Game Task: Open the Ledger after your crews are running. Record its numbers for the last hour. Watch what happens to the town when the membrane pumps work overtime.

(A) (1 pt) **Record** the energy in (ATP made), the running costs, and the profit or loss for one game hour.

(B) (1 pt) **Describe** what happened to the town (Order, roads, junk) while the Ledger showed a loss, and what happened when it showed a profit again.

(C) (1 pt) **Explain** one example from the game of an energy-releasing process coupled to an energy-requiring one.

(D) (1 pt) **Justify** the claim that a cell must take in more energy than it loses to stay organized.

Question 3: Analyze Model / Visual Representation

Game Task: *Play Act 2. Walk through the mitochondrion from the entrance to the Krebs roundabout. Read the signs in the hallway and in the matrix.*

(A) (1 pt) **Represent** the mitochondrion with a labeled diagram: outer membrane, intermembrane space, inner membrane with cristae, matrix. Mark where the Krebs cycle, the electron transport chain and ATP synthase are, and draw arrows for the direction H^+ are pumped and the direction they flow back.

Draw your diagram here.

(B) (1 pt) **Identify** which side of the inner membrane has the higher pH.

(C) (1 pt) **Explain** how folding the inner membrane into more cristae increased the town's ATP.

3.5.A.3, 3.5.B.3, 3.5.B.4, 3.5.B.5

Question 4: Scientific Investigation

Game Task: Before the low-oxygen event, open the Ledger and note how much ATP each sugar split paid. During the event, talk to Citra and Chainy, and watch the ATP bar and the Ledger.

(A) (1 pt) **Describe** what happened to the town's ATP income while oxygen was low.

(B) (1 pt) **Explain** why the Krebs cycle stopped, even though the Krebs cycle does not use oxygen.

(C) (1 pt) **Explain** how glycolysis kept going during the event.

(D) (1 pt) **Calculate** how many times more ATP one sugar paid the town with oxygen than with glycolysis and fermentation alone, using the Ledger's numbers.

3.5.A.1, 3.5.A.2, 3.5.A.3, 3.5.B.2, 3.5.B.6

Question 5: Conceptual Analysis

Game Task: Open Alfie's leak valve and watch the thermometer and the Ledger.

(A) (1 pt) **Describe** what the valve did to H^+ , to ATP production and to the temperature.

(B) (1 pt) **Explain** how endothermic animals use a leak like this.

3.5.A.3.iv

Question 6: Analyze Model / Visual Representation

Game Task: Play Act 3. Enter a granum and run the light reactions and the thylakoid turbine. Then run the Calvin cycle in the stroma.

(A) (1 pt) **Represent** a thylakoid in the chloroplast with a labeled diagram: stroma, thylakoid membrane, lumen, photosystem II, the electron transport chain, photosystem I, ATP synthase. Show where water is split, where NADP⁺ is reduced, which side H⁺ build up on, and where the Calvin cycle runs.

Draw your diagram here.

(B) (1 pt) **Explain** why electrons must be boosted by light twice.

(C) (1 pt) **Explain** why the chloroplast's ATP and NADPH are used inside the chloroplast rather than sent out to the rest of the cell.

3.4.A.1, 3.4.A.2, 3.4.A.3, 3.4.B.1, 3.4.B.2, 3.4.B.3, 3.4.B.4, 3.4.B.5, 3.4.B.6

Question 7: Scientific Investigation

Game Task: *During the finale, watch the town through the night. Talk to Cal and to Cyan, and open the Storehouse at dusk and again at dawn.*

(A) (1 pt) **Describe** what happened to the Calvin cycle at night, and why.

(B) (1 pt) **Explain** why a cell that photosynthesizes still needs its mitochondria.

(C) (1 pt) **Predict** what would happen to the town after several days with no light, and justify your prediction.

3.4.A.1.i, 3.4.A.3, 3.4.B.6, 3.5.A.1

Question 8: Argumentation

Game Task: *Open the Field Guide and complete the Shared by all life grid by talking to the neighbours at the North Window.*

(A) (1 pt) **Describe** which pathways the neighbours from all three domains share with the town.

(B) (1 pt) **Justify** the claim that all living things share a common ancestor, using the grid.

(C) (1 pt) **Explain** how Cyan's story supports the claim that photosynthesis first evolved in prokaryotes and that prokaryotic photosynthesis was the foundation of photosynthesis in eukaryotes.

3.3.B.1, 3.4.A.1.ii-iv, 3.4.B.1

Question 9: Analyze Model

Game Task: *Finish the finale and look at the energy flow map on the end card.*

(A) (1 pt) **Represent** the path energy took through your town, from sunlight to the town's work, and show where energy left as heat.

Draw your diagram here.

(B) (1 pt) **Explain** how the energy flow map shows that the cell never made energy, only moved it.

(C) (1 pt) **Explain** why the town could stay in order only while energy kept flowing in.

3.3.A.2