PEEBEDU

Powerhouse Mitochondria Simulator

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

> Open **peebedu.com** and navigate to **Powerhouse (Mitochondria Simulator)**. Click the **Start Game!** button to begin. Read the instructions popup, which describes how to use the Eat button to spawn glucose, the Breathe button to spawn O_2 and clear CO_2, and how to drag and drop molecules into reaction zones to trigger each stage of cellular respiration.

Free Response Questions

Question 1 — Conceptual Analysis

> **Simulation Task:** *Click "Eat" to spawn glucose. Drag one glucose molecule into the Glycolysis zone and click the zone to trigger the reaction. Observe the products that appear and note the ATP counter. Continue dragging products through Pyruvate Oxidation and the Krebs Cycle, triggering each reaction. Record the number of NADH, FADH2, CO2, and ATP produced at each stage.*

(A) (1 pt) **Describe** the molecules that carry electrons from the earlier stages of cellular respiration to the electron transport chain and the stages in which they are produced.

(B) (1 pt) **Explain** why the majority of ATP produced during cellular respiration comes from the electron transport chain rather than directly from glycolysis or the Krebs cycle.

(C) (1 pt) **Predict** what would happen to total ATP production per glucose molecule in an organism with a heritable mutation that reduces the ability of NADH to transfer its electrons to the first protein complex of the electron transport chain.

(D) (1 pt) **Justify** your prediction.

Question 2 — Analyze Model / Visual Representation

> **Simulation Task:** *After completing glycolysis, pyruvate oxidation, and the Krebs cycle for one glucose molecule, observe the NADH and FADH2 molecules that have accumulated in the Oxidative Phosphorylation zone. Note the electron progress bar reading. Then click "Breathe" to spawn O2, drag one O2 molecule into the OxPhos zone, and trigger the reaction. Observe the product and the ATP counter change.*

(A) (1 pt) **Describe** what happens to molecular oxygen at the final step of the electron transport chain in the mitochondria.

(B) (1 pt) **Explain** why the electron transport chain cannot continue to accept electrons from NADH and FADH2 when oxygen is unavailable, even though the protein complexes of the chain are intact.

(C) (1 pt) **Represent** the four stages of aerobic cellular respiration by drawing a labeled diagram that traces the path of electrons from glucose through glycolysis, pyruvate oxidation, the Krebs cycle, and the electron transport chain, showing where ATP is produced at each stage and where oxygen is consumed.

Draw your diagram here.

(D) (1 pt) **Explain** how natural selection could favor individuals in a population of organisms that have been exposed to chronically low-oxygen environments over many generations.