PEEBEDU

Electron Transport Chain Simulator

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

> Open **peebedu.com** and navigate to **Electron Transport Chain Simulator**. Click the **Power Up!** button to begin. Read the introduction popup, which describes the inputs (NADH, $FADH_2$, O_2), the process (electron flow and proton pumping), the outputs (ATP and H_2O), and the significance of the electron transport chain.

Free Response Questions

Question 1 — Conceptual Analysis

> **Simulation Task:** *Set the Oxygen Concentration slider to its maximum value (10) and the Electron Carrier Supply to Medium. Click Start and observe the electron flow, H+ gradient buildup, and ATP counter for 30 seconds. Then reduce the Oxygen Concentration slider to 1 (Low) and observe what happens to electron flow, the H+ gradient, and ATP production for another 30 seconds.*

(A) (1 pt) **Describe** the relationship between oxygen availability and the rate of ATP production in the mitochondria.

(B) (1 pt) **Explain** why electron flow through the protein complexes of the inner mitochondrial membrane stops when oxygen is absent, even though NADH and FADH2 are still available to donate electrons.

(C) (1 pt) **Predict** what would happen to the ATP production of an endothermic organism's cells if the oxygen concentration in its environment decreased significantly.

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

Question 2 — Analyze Model / Visual Representation

> **Simulation Task:** *Set Temperature to Normal, Electron Carrier Supply to Fast, and Oxygen Concentration to 5 (Medium). Click Start and observe for 30 seconds. Watch the H+ particles being pumped into the intermembrane space, the gradient indicator, and the ATP synthase animation. Note when ATP synthase begins spinning and when new ATP molecules appear.*

(A) (1 pt) **Describe** the relationship between the concentration of H+ ions in the intermembrane space and the rate of ATP synthesis in the mitochondria.

(B) (1 pt) **Explain** how the transfer of electrons between protein complexes in the inner mitochondrial membrane results in the production of ATP, even though the electron carriers themselves do not directly synthesize ATP.

(C) (1 pt) **Represent** chemiosmosis in the mitochondrion by drawing a labeled diagram of the inner mitochondrial membrane showing the intermembrane space, the matrix, at least two proton-pumping complexes, and ATP synthase, with arrows indicating the direction of H+ movement.

Draw your diagram here.

(D) (1 pt) **Explain** how a heritable mutation that reduces the number of functional proton-pumping complexes in the inner mitochondrial membrane could affect an organism's competitive ability in a population.

3.5.A.3, 3.4.B.4