Cellular Respiration: Harvesting Chemical Energy Review Questions

1. Provide reasoning for describing cellular respiration as an exergonic process. (The products of cellular respiration are more simple than the reactants and the process involves a net release of energy.)

2. If the following redox reaction occurred, which compound would be oxidized and which would be reduced? $C_4H_6O_5 + NAD^+ \rightarrow C_4H_4O_5 + NADH + H^+$ ($C_4H_6O_5$ would be oxidized and NAD+ would be reduced.)

3. Describe cellular respiration as a redox reaction. (Glucose gets oxidized and oxygen gets reduced.)

4. Describe the purpose of the citric acid cycle. (The purpose of the citric acid cycle is to oxidize pyruvate to provide electrons for electron transport.)

5. Identify the processes in your cells that produce the carbon dioxide you exhale. (Pyruvate produced in glycolysis is oxidized to carbon dioxide in the citric acid cycle.)

6. After the citric acid cycle, most of the energy originally in fuel molecules is contained in NADH. Identify the process that will release that energy in a slow, controlled fashion. (NADH and $FADH_2$. They will donate their electrons to the ETC, and the energy will be used to establish a proton gradient across the inner mitochondrial membrane.)

7. Identify the immediate source of the energy used by ATP synthase to drive the endergonic production of ATP from ADP + Pi.

8. Imagine that the fourth electron carrier in the ETC were nonfunctional. Predict the effect on the rate of ATP production. (At first, some ATP could be made, since electron transport could proceed as far as complex III, and a small H+ gradient could be built up. Soon, however, no more electrons could be passed to complex III because it could not be reoxidized by passing its electrons to complex IV.)

9. Explain the effect of a lack of oxygen on the ETC and ATP production. (Oxidative phosphorylation would eventually stop entirely, resulting in no ATP production by this process. Without oxygen to accept electrons from the ETC, H+ would not be pumped into the mitochondrion's intermembrane space and chemiosmosis would not occur.)

10. A researcher develops a method of artificially keeping the pH of the intermembrane space low. After treating some mitochondria with his method, he places the mitochondria in a completely anaerobic environment. Predict whether the mitochondria will produce ATP. Justify your prediction. (Decreasing the pH means addition of H+. This would establish a proton gradient even in the absence of oxygen without the function of the electron transport chain, so ATP synthase could continue to function and synthesize ATP.)

11. Describe the evidence that suggests glycolysis evolved very early in the history of life. (Glycolysis is nearly ubiquitous in living organisms. Also, it does not require oxygen which suggests it evolved at a time before the presence of oxygen in the atmosphere.)

12. Consider the chemical structure of carbohydrates and lipids. Explain why lipids contain more energy per gram than carbohydrates. (The carbon atoms in lipids are more reduced than those in

carbohydrates. This means they can be oxidized further, releasing more energy.)

13. Describe how yeast cells are able to use glucose as a source of energy even in the absence of oxygen. (As single-celled organisms, yeasts are simple enough that they can produce sufficient ATP using anaerobic respiration alone.)

14. a) Describe how the rate of cellular respiration is regulated. (ATP inhibits an enzyme in glycolysis, slowing the rate of cellular respiration and decreasing the production of ATP. AMP stimulates the same enzyme in glycolysis, increasing the rate of cellular respiration and, consequently, the production of ATP.)

    b) Predict what will happen in a muscle cell that has exhausted its supply of oxygen and ATP. (AMP will accumulate, simulating phosphofructokinase, increasing the rate of glycolysis. Since oxygen is absent, the cell will convert pyruvate to lactate in lactic acid fermentation to provide some ATP.)