

Name _____ Date _____ Section _____

Cellular Respiration worksheet

Read these passages from the text and answer the questions that follow.

Cellular Respiration Stage III: Electron Transport

Electron transport is the final stage of aerobic respiration. In this stage, energy from NADH and FADH₂, which result from the Krebs cycle, is transferred to ATP. Can you predict how this happens? (Hint: How does electron transport occur in photosynthesis?)

Transporting Electrons

High-energy electrons are released from NADH and FADH₂, and they move along electron transport chains, like those used in photosynthesis. The electron transport chains are on the inner membrane of the mitochondrion. As the high-energy electrons are transported along the chains, some of their energy is captured. This energy is used to pump hydrogen ions (from NADH and FADH₂) across the inner membrane, from the matrix into the intermembrane space.

Making ATP

The pumping of hydrogen ions across the inner membrane creates a greater concentration of the ions in the intermembrane space than in the matrix. This chemiosmotic gradient causes the ions to flow back across the membrane into the matrix, where their concentration is lower. ATP synthase acts as a channel protein, helping the hydrogen ions cross the membrane. It also acts as an enzyme, forming ATP from ADP and inorganic phosphate. After passing through the electron-transport chain, the “spent” electrons combine with oxygen to form water. This is why oxygen is needed; in the absence of oxygen, this process cannot occur.

How Much ATP?

You have seen how the three stages of aerobic respiration use the energy in glucose to make ATP. How much ATP is produced in all three stages? Glycolysis produces 2 ATP molecules, and the Krebs cycle produces 2 more. Electron transport begins with several molecules of NADH and FADH₂ from the Krebs cycle and transfers their energy into as many as 34 more ATP molecules. All told, then, up to 38 molecules of ATP can be produced from just one molecule of glucose in the process of aerobic respiration.

Questions

1. In photosynthesis, electron transport comes at the beginning of the process. Where does electron transport occur during cellular respiration?

2. What is the role of the electron transport chain in cellular respiration?

3. Why is the role of oxygen in cellular respiration?

4. Describe ATP synthase and its role.

5. Summarize how up to 38 molecules of ATP are produced for each glucose molecule.

Fermentation

An important way of making ATP without oxygen is called fermentation. It involves glycolysis but not the other two stages of aerobic respiration. Many bacteria and yeasts carry out fermentation. People use these organisms to make yogurt, bread, wine, and biofuels. Human muscle cells also use fermentation. This occurs when muscle cells cannot get oxygen fast enough to meet their energy needs through aerobic respiration. There are two types of fermentation: lactic acid fermentation and alcoholic fermentation. Both types are described below.

Lactic Acid Fermentation

In lactic acid fermentation, pyruvic acid from glycolysis changes to lactic acid. In the process, NAD⁺ forms from NADH. NAD⁺, in turn, lets glycolysis continue. This results in additional molecules of ATP. This type of fermentation is carried out by the bacteria in yogurt. It is also used by your own muscle cells when you work them hard and fast. Did you ever run a race and notice that your muscles feel tired and sore afterward? This is because your muscle cells used

lactic acid fermentation for energy. This causes lactic acid to build up in the muscles. It is the buildup of lactic acid that makes the muscles feel tired and sore.

Alcoholic Fermentation

In alcoholic fermentation, pyruvic acid changes to alcohol and carbon dioxide. NAD^+ also forms from NADH , allowing glycolysis to continue making ATP. This type of fermentation is carried out by yeasts and some bacteria. It is used to make bread, wine, and biofuels. Alcoholic fermentation produces ethanol and NAD^+ . The NAD^+ allows glycolysis to continue making ATP.

Have your parents ever put corn in the gas tank of their car? They did if they used gas containing ethanol. Ethanol is produced by alcoholic fermentation of the glucose in corn or other plants. This type of fermentation also explains why bread dough rises. Yeasts in bread dough use alcoholic fermentation and produce carbon dioxide gas. The gas forms bubbles in the dough, which cause the dough to expand. The bubbles also leave small holes in the bread after it bakes, making the bread light and fluffy.

Questions

1. What is fermentation?

2. Why is NAD^+ so important in fermentation?

3. Both lactic acid fermentation and alcoholic fermentation begin with the same molecule. What is that molecule and where did it come from?

4. Why is bread light and fluffy?

5. Why do your muscles get sore after intense activity?