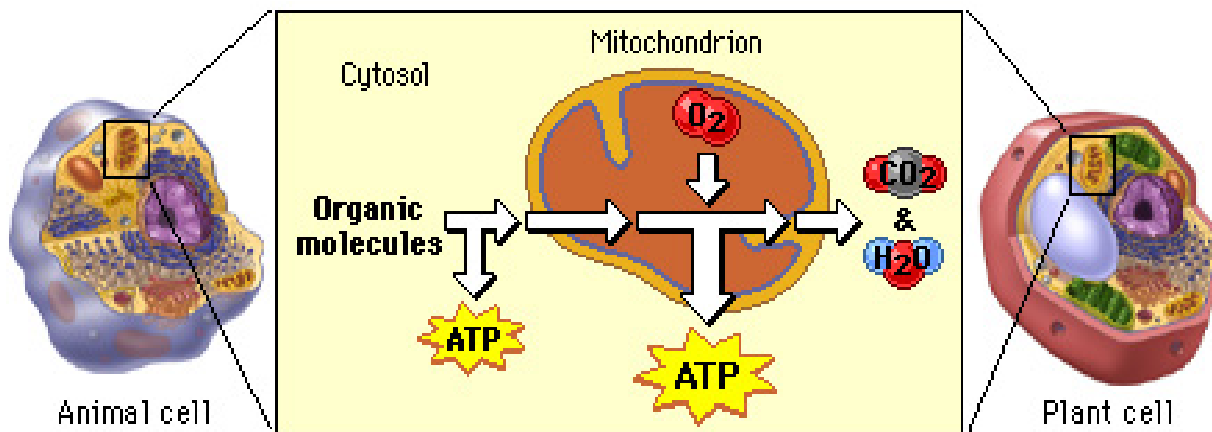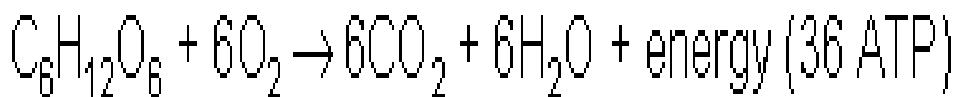# What is Cellular Respiration?

Cellular respiration is the process by which the chemical energy of "food" molecules is released and partially captured in the form of ATP. Carbohydrates, fats, and proteins can all be used as fuels in cellular respiration, but glucose is most commonly used as an example to examine the reactions and pathways involved. Cellular respiration allows organisms to use (release) energy stored in the chemical bonds of glucose ($C_6H_{12}O_6$). The energy in glucose is used to produce ATP. Cells use ATP to supply their energy needs. Cellular respiration is therefore a process in which the energy in glucose is transferred to ATP.

Note: Cellular respiration happens in both plant AND animal cells.

In respiration, glucose is ***oxidized*** and thus releases energy. Oxygen is ***reduced*** to form water. The carbon atoms of the sugar molecule are released as ***carbon dioxide*** (CO_2). The complete breakdown of glucose to carbon dioxide and water requires two major steps: 1) glycolysis and 2) aerobic respiration. Glycolysis produces two ATP. Thirty-four more ATP are produced by aerobic pathways if oxygen is present.

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + energy \, (36 \, ATP)$$

The term cellular respiration refers to the biochemical pathway by which cells release energy from the chemical bonds of food molecules and provide that energy for the essential processes of life. All living cells must carry out cellular respiration. It can be aerobic respiration in the presence of oxygen or anaerobic respiration. Prokaryotic cells carry out cellular respiration within the cytoplasm or on the inner surfaces of the cells. More emphasis here will be placed on eukaryotic cells where the mitochondria are the site of most of the reactions. The energy currency of these cells is ATP, and one way to view the outcome of cellular respiration is as a production process for ATP.

Aerobic respiration, or cell respiration in the presence of oxygen, uses the end product of glycolysis (pyruvate) in the TCA cycle to produce much more energy currency in the form of ATP than can be obtained from any anaerobic pathway. Aerobic respiration is characteristic of eukaryotic cells when they have sufficient oxygen and most of it takes place in the mitochondria.

The first step in cellular respiration in all living cells is glycolysis, which can take place without the presence of molecular oxygen. If oxygen is present in the cell, then the cell can subsequently take advantage of aerobic respiration via the TCA cycle to produce much more usable energy in the form of ATP than any anaerobic pathway. Nevertheless, the anaerobic pathways are important and are the sole source of ATP for many anaerobic bacteria. Eukaryotic cells also resort to anaerobic pathways if their oxygen supply is low. For example, when muscle cells are working very hard and exhaust their oxygen supply, they utilize the anaerobic pathway to lactic acid to continue to provide ATP for cell function.

Anaerobic respiration (both glycolysis and fermentation) takes place in the fluid portion of the cytoplasm whereas the bulk of the energy yield of aerobic respiration takes place in the mitochondria. Anaerobic respiration leaves a lot of energy in the ethanol or lactate molecules that the cell cannot use and must excrete (get rid of).

Assignment

1. Write a one-sentence summary for each of the paragraphs above (6) (KNOWLEDGE RI 8.2).
2. List the parts of the cell where cellular respiration occurs (KNOWLEDGE RI 8.2).
3. Compare and contrast the differences between aerobic cellular respiration and anaerobic cellular respiration (COMPREHENSION RI 8.4).
4. What type of cells goes through the process of aerobic cellular respiration? What type of cells goes through the process of anaerobic cellular respiration (ANALYSIS RI 8.4)?
5. Look carefully at the chemical equation in this article. What equation is this similar to (COMPREHENSION RI 8.2)?
6. Choose examples of where in the human body aerobic cellular respiration and anaerobic cellular respiration could occur. HINT- carefully review the characteristics of each, and then think of a possible example (APPLICATION RI 8.1).