Name ______________________ Course/Section ______________________

Date ______________________ Professor/TA ______________________

Activity 9.1 A Quick Review of Energy Transformations

Review Chapter 8 and pages 160–162 of Chapter 9 in *Biology*, 7th edition. Then complete the discussion by supplying or choosing the appropriate terms.

To maintain life, organisms must be able to convert energy from one form to another. For example, in the process of photosynthesis, algae, plants, and photosynthetic prokaryotes use the energy from sunlight to convert carbon dioxide and water to glucose and oxygen (a waste product).

The summary reaction for photosynthesis can be written as

$$6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$$

This type of reaction is an oxidation-reduction (or redox) reaction. This reaction is also [**anabolic/catabolic**] and [**endergonic/exergonic**].

In redox reactions, ____________ (and associated H^+ ions) are transferred from one compound or element to another. If one compound or element loses ____________ and becomes oxidized, another must gain ____________ and become reduced. For example, in photosynthesis, water becomes [**oxidized/reduced**] (to O_2) and the ____________ (and associated H^+ ions) it "loses" in the process [**oxidize/reduce**] CO_2 to glucose.

[**Anabolic/Catabolic**] reactions "build" more complex molecules from simpler ones. To do this they require energy input. Reactions that require the input of energy are termed [**endergonic/exergonic**] reactions.

The reactions involved in aerobic respiration are also redox reactions:

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$$

In this set of reactions, however, more complex molecules are "broken down" into simpler ones. Glucose is broken down or becomes [**oxidized/reduced**] (to CO_2), and the oxygen becomes [**oxidized/reduced**] (to water).

[**Anabolic/Catabolic**] reactions break down more complex molecules into simpler ones and in the process release energy. Reactions that release energy that can be used to do work are [**endergonic/exergonic**]. Therefore, aerobic respiration is a(n) [**anabolic/catabolic**] process and is [**endergonic/exergonic**].

[**Endergonic/exergonic**] reactions are also said to be spontaneous reactions. Does this mean that if we don't keep glucose in tightly sealed containers it will spontaneously interact with atmospheric oxygen and turn into carbon dioxide and water? The answer is obviously no.

Spontaneous reactions rarely occur "spontaneously" because all chemical reactions, even those that release energy, require some addition of energy—the energy of activation—before they can occur. One way of supplying this energy is to add heat. An example is heating a marshmallow over a flame or campfire. When enough heat is added to reach (or overcome) the activation energy, the sugar in the marshmallow reacts by oxidizing. (Burning is a form of oxidation.) The marshmallow will continue to burn even if you remove it from the campfire. As the marshmallow burns, carbon dioxide and water are formed as products of the reaction, and the energy that was stored in the bonds of the sugar is released as heat.

If our cells used heat to overcome activation energies in metabolism, they would probably burn up like the marshmallow did. Instead, living systems use protein catalysts or enzymes to lower the energy of activation without adding heat. In addition, the metabolic breakdown of sugars is carried out in a controlled series of reactions. At each step or reaction in the sequence, a small amount of the total energy is released. Some of this energy is still lost as heat. The rest is converted to other forms that can be used in the cell to drive or fuel coupled endergonic reactions or to make ATP.