

## Chapter 6

### Topic: Bioenergetics

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#### Main concepts:

- Energy is defined as the capacity of a system to do work or the capacity to cause change, such as synthesizing molecules or moving objects. **Potential energy** can be thought of as stored energy. Chemical energy, in the bonds between atoms in a molecule, is a form of potential energy. **Kinetic energy** can be thought of as released energy, and is usually associated with motion. Heat (kinetic motion of molecules) and movement of large objects (such as ourselves) are forms of kinetic energy.
- Energy is a phenomenon, not a material substance.
- Energy can be converted from one form to another. For example, cellular metabolism converts chemical energy into heat, motion, and other processes. However, energy may be lost in the conversion. Energy is conserved throughout the universe, but it can be lost to biological systems in the form of heat.
- The energy of the sun runs nearly all of the biosphere.
- Some chemical reactions require the input of energy (**endergonic reactions**), while others release energy (**exergonic reactions**). In biological systems, endergonic reactions are those that store energy in chemical forms, such as photosynthesis. Exergonic reactions are those that release energy for use, such as cellular respiration.
- ATP (Adenosine triphosphate) is an energy-rich molecule used by all cells to transport energy. Loss of the last phosphate group in ATP releases a small amount of energy, and turns ATP into ADP (Adenosine diphosphate).
- ATP synthesis (an endergonic reaction) is coupled with the exergonic reaction of glucose breakdown in cellular respiration. ATP breakdown (an exergonic reaction) is coupled with endergonic reactions in the cell, such as protein synthesis. This coupling efficiently passes energy from one reaction to another.
- Electron carrier molecules also assist with transfer of energy in cells. Two energy carrier molecules, NAD and FAD, are made up partially of two of the B vitamins.
- (Not in the text) The amount of chemical (potential) energy in food is measured in units called calories. Therefore, by a scientific definition, there can be no such thing as a calorie-free energy drink.

#### Common misconceptions:

- Students often think of energy and various forms of energy (such as light or electricity) as material or quasi-material. Often student will talk about energy “mixing” with something as part of a chemical reaction.
- Food labeling confuses the definition of “energy.” Nervous stimulation from caffeine is the so-called “energy” in “energy drinks.” In a scientific sense, the real “energy” in these drinks comes from the metabolism of the sugars they contain.

#### Reading notes:

- Define “energy” in a scientific sense.
- State the first and second laws of thermodynamics. Consider how these relate to biological systems.
- Describe the difference between exergonic and endergonic reactions. How do the descriptions in the text relate to the graphs in figure 6-2?
- Describe how coupled reactions help conserve energy in a system.
- Describe the structure of ATP. Name the three molecules that make up ATP. State what ATP is used for in living system.
- List two other electron carriers.

#### Useful websites:

- “Energy” <http://en.wikipedia.org/wiki/Energy>, is a Wikipedia article with more than you’ll probably ever want to know about the scientific definition of energy.
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