Energy Summary Sheet
Prof. Lester's BIOL 150

Energy is the capacity to cause change (kinetic, potential, thermal, chemical)

Enthalpy – is a measure of the total energy of a thermodynamic system. It includes all sources of energy in a system including the "internal" energy that was required to create the system.

Entropy – is a measure of the disorder (randomness) of a system (usually the universe); entropy of the universe is always increasing

- ice melting (see below!)
- heat dissipating
- diffusion of solute from high concentration to low concentration
- when a living organism dies and decomposes

First law of thermodynamics - the energy of the universe is constant, energy can be transferred and transformed, but it cannot be created or destroyed (conservation of energy)

Second law of thermodynamics - every energy transfer or transformation increases the entropy (disorder) of the universe

Free energy is a measure of a system's instability, its tendency to change to a more stable state (ΔG, Gibb's free energy, free enthalpy).

During a spontaneous change, free energy decreases and the stability of a system increases.

Equilibrium is a state of maximum stability. Cells are not in equilibrium. They are "open systems" requiring continuous input of energy and resources.

A process is spontaneous and can perform work only when it is moving toward equilibrium.

Exothermic reactions release heat energy. Endothermic reactions absorb heat energy from the environment.

Exergonic reaction - Usually enthalpy (energy) of the reactants is greater than the products, so the reaction proceeds spontaneously (ΔG is negative); entropy increases

- exergonic reactions release energy
- cell respiration is an exergonic process that leads to increased entropy

Endergonic reaction - Usually enthalpy of the products is greater than the reactant, so energy (from the system, environment) is required to make the reaction proceed; the reaction is usually not spontaneous (ΔG is positive); entropy of the system (not the universe) usually decreases

- forming a peptide bond
- photosynthesis
- ice melting to water??? Entropy is increasing but reaction is endergonic and spontaneous?

To make an endergonic reaction proceed, it is coupled to an exergonic reaction so that the sum of the ΔG's is negative, therefore the reactions will occur. ATP is usually coupled to an endergonic reaction to make the reaction occur. ATP drives endergonic reactions by phosphorylation, transferring a phosphate group to some other molecule, such as a reactant.

Catabolic reactions (catabolism) are exergonic. ATP and heat are produced.

Anabolic reactions (anabolism) are endergonic. ATP and sometimes heat are consumed/used.