BIOENERGETICS

10/8/91, rvsd 10/4/93, 10/2/95, 2 Oct 00, 4 Oct 2004, 1 October 2007, 6Oct08, 5Oct09
BKH, 4th: p 110-133, 5th: 106-126, 6th: 105-124, 7th: 106-124

Functions of energy in the cell: biosynthesis (anabolism) (p. 107)
mechanical work
concentration work
electrical work
heat energy
bioluminescence

Source of that energy?: **Phototrophs** vs **chemotrophs** (p. 110)
See pict on p 110 for overview of energy flow in biosphere

chemotrophs depend on **catabolic pathways to yield energy**:
1) **fermentation:** breaking bonds without oxidation, **terminal H acceptor is organic**
2) **respiration:** involving oxidation, **terminal H acceptor is inorganic**

NOTE: Respiration may or may *not* require O_2 = **aerobic**, or not: **anaerobic** (S, N, etc)

Not 100% efficient: lose heat, and increase in disorder of system (entropy)

THERMODYNAMICS: laws involving energy transactions
biological thermodynamics = *bioenergetics*

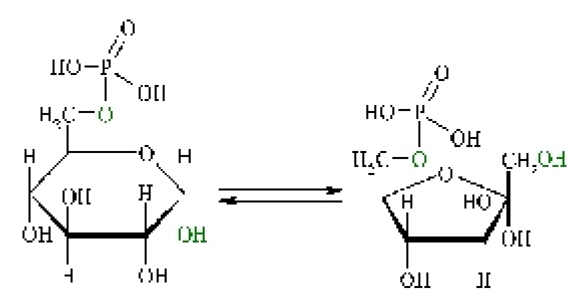
FIRST LAW OF THERMODYNAMICS:
Conservation of energy: total energy in universe is constant (p. 113)

Internal energy = E: stored within a system, (not directly measurable)
In biology use enthalpy = H: (inner warmth or heat), the heat content: $\Delta H = \Delta E + \Delta(PV)$
(Note that enthalpy = E if no change in P or V)
During spontaneous reaction, usually
exothermic (heat released) = $-\Delta H$ (heat is lost from the system)
Glucose burnt yields 673 kcal: $\Delta E = -673$ Kcal
opposite for synthesis of glucose $\Delta E = +673$ Kcal
take home lesson: **A negative ΔH favors spontaneity**.

SECOND LAW OF THERMODYNAMICS:
Entropy in the universe is increasing. (Universe tends towards disorder.)
Take home lesson: **A positive ΔS favors spontaneity.**

Gibbs free energy includes both internal energy and entropy, is predictor of spontaneity:
$\Delta H = \Delta G + T\Delta S$ (T = temp in Kelvin)
$\mathbf{\Delta G = \Delta H - T\Delta S}$ predicts spontaneity of a chemical reaction
(note that at absolute zero K, ΔH (or ΔE) predicts spontaneity)
take home lesson: **All spontaneous reactions have a negative ΔG**

K_{eq} indicates direction of rxn: $= \frac{\text{products}}{\text{reactants}} = \frac{[\text{F-6-P}]}{[\text{G-6-P}]} = \frac{1}{2}$
(At equilibrium)



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What would be the size of K_{eq} a favorable reaction? = **large**
(reverse rxn K_{eq} small)
I.e., F-6-P to G-6-P has Keq of 2.0