

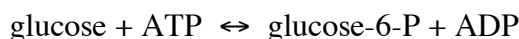
Problem Set 16: Bioenergetics

Due Oct 23, 2008

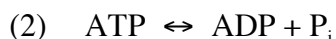
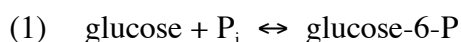
1. Problem 6.29 (p. 232):

The reaction $\text{L-glutamate} + \text{pyruvate} \rightarrow \alpha\text{-ketoglutarate} + \text{L-alanine}$ is catalyzed by the enzyme L-glutamate-pyruvate aminotransferase. At 300 K, the equilibrium constant for the reaction is 1.11. Predict whether the forward reaction (left to right) will occur spontaneously if the concentrations of the reactants and products are $[\text{L-glutamate}] = 3.0 \times 10^{-5} \text{ M}$, $[\text{pyruvate}] = 3.3 \times 10^{-4} \text{ M}$, $[\alpha\text{-ketoglutarate}] = 1.6 \times 10^{-2} \text{ M}$, and $[\text{L-alanine}] = 6.25 \times 10^{-3} \text{ M}$.

2. The first step in glycolysis is catalyzed by the enzyme hexokinase:



This reaction can be thought of as two coupled reactions (P_i is phosphate):



For the overall reaction, $\Delta G^\circ = -16.7 \text{ kJ/mol}$. For the hydrolysis of ATP (equation 2), $\Delta G^\circ = -31.0 \text{ kJ/mol}$. All reactions are performed at 37°C .

- (a) What is ΔG° for reaction 1?

- (b) What is $\frac{[\text{glucose-6-P}]}{[\text{glucose}][\text{phosphate}]}$ if $\Delta G = 0$?

- (c) Starting with 1 M glucose and 1 M phosphate, what are the equilibrium concentrations of glucose, phosphate, and glucose-6-phosphate if only reaction 1 occurs?

3. A later step in glycolysis is catalyzed by the enzyme aldolase:



or



For this reaction, $\Delta G^\circ = 23.8 \text{ kJ/mol}$.

- (a) Under physiological conditions in a red blood cell, $[\text{FBP}] = 35 \mu\text{M}$, $[\text{DHAP}] = 130 \mu\text{M}$ and $[\text{GAP}] = 15 \mu\text{M}$. Is the reaction spontaneous at 298K under these conditions?

- (b) In some cells, the enzyme triose phosphate isomerase is not functional. In these cells, the level of DHAP can be much higher than the concentrations reported in part A. What is ΔG for the reaction (at 298K) if $[\text{FBP}] = 35 \mu\text{M}$, $[\text{DHAP}] = 1 \text{ mM}$ and $[\text{GAP}] = 3.5 \mu\text{M}$?

- (c) Would you expect the cell described in part (b) to live?

4. Problem 6.37, reworded (p. 233):

Based on the material covered so far, describe three ways to calculate ΔG° for a process.