

HOMEWORK #6 - Metabolism & Energy Balance

This homework is due at 5:30 pm on Oct 24.

(10,000 pts)

1. The following metabolite concentrations were determined for the cytosolic compartment of a novel cell; glycolysis occurs exclusively in the cytosol (cytoplasm or cytosolic compartment).

METABOLITE	CONC(mM)	METABOLITE	CONC(mM)	METABOLITE	CONC(mM)
Glucose	5.2	1,3-BPG	0.0018	ATP	6.65
Glc-6-P	0.095	2,3-BPG	3.5	ADP	0.055
Frc-6-P	0.025	3-PGA	0.044	P _i	1.00
Frc-1,6-BP	0.020	2-PGA	0.022	H ⁺ (pH = 7)	10 ⁻⁴
DHAP	1.45	PEP	0.032	NADH	0.225
Glyc-3-P	0.022	pyruvate	0.250	NAD ⁺	0.525

(8,000 pts)

a) What is the ΔG (for these cellular conditions) for the conversion of one Dihydroxyacetone phosphate (DHAP) to one 3-Phosphoglycerate (3-PGA)? Be sure to include a balanced equation for this *net* reaction (include all molecules: ATP, H₂O, H⁺, etc). You will want to consult your text or the class notes for the separate glycolytic reactions and their ΔG° . Do not use the ΔG calculated for erythrocytes. Ignore [H₂O] & [H⁺] but do not ignore the additional small molecules (NADH, P_i, ATP, etc) in your ΔG calculations. Assume 25°C.

It is necessary to combine equations from the glycolytic pathway & it will be necessary to use the ΔG° values; the ΔG value can then be calculated using the concentrations given above.

 ΔG° 

$$\Delta G' = \Delta G^{\circ} + 5.7 \text{ kJ/mol} \log \frac{[\text{3-PGA}][\text{NADH}][\text{ATP}]}{[\text{DHAP}][\text{NAD}^+][\text{ADP}][\text{P}_i]} \quad \text{should convert mM to M}$$

$$\Delta G' = -4.7 \text{ kJ/mol} + 5.7 \text{ kJ/mol} \log \frac{(0.044 \times 10^{-3})(0.225 \times 10^{-3})(6.65 \times 10^{-3} \text{ M})}{(1.45 \times 10^{-3})(0.525 \times 10^{-3})(0.055 \times 10^{-3})(1 \times 10^{-3})}$$

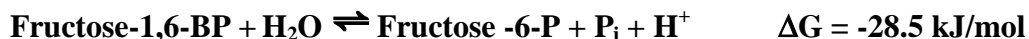
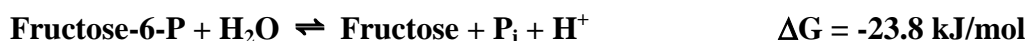
$$\Delta G' = -4.7 \text{ kJ/mol} + 5.7 \text{ kJ/mol} \log (1572) = (-4.7 + 18.2) \text{ kJ/mol} = +13.5 \text{ kJ/mol}$$

(2,000 pts)

b) Under these cellular conditions, is the glycolytic direction of the net conversion of DHAP to 3-PGA favorable? **No.** $\Delta G = +13.5 \text{ kJ/mol}$; favors reverse or right-to-left.

(10,000 pts)

2) The change in free energy was determined for each of the following reactions at a specific condition; do not use ΔG or ΔG° values from other sources to solve the following problems.



(5,000 pts)

a) We are going to imagine a net reaction for the conversion of glucose to glucose-6-phosphate (Glc-6-P) using glucose and pyrophosphate as the substrates.

- Show the net balanced reaction
- Determine the ΔG for the net balanced reaction
- Is this conversion (production of Glc-6-P) favorable under these conditions?



Favorable under these conditions

(2 k pts for balanced rxn; 2 k pts for ΔG ; 1 k pts for favorable/unfavorable)

(5,000 pts)

b) We are going to imagine another net reaction where two high energy phosphates are transferred from acetylphosphate molecules to fructose to form the compound, fructose-1,6-bisphosphate (Frc-1,6-BP).

- Write the balanced chemical reaction for the formation of fructose-1,6-bisphosphate using *only* fructose and acetylphosphate.
- Determine the ΔG for the balanced net reaction
- Is the production of Frc-1,6-BP favorable under these conditions



Production of Frc-1,6-BP has a negative ΔG , thus it is favorable ‘to-the-right.’