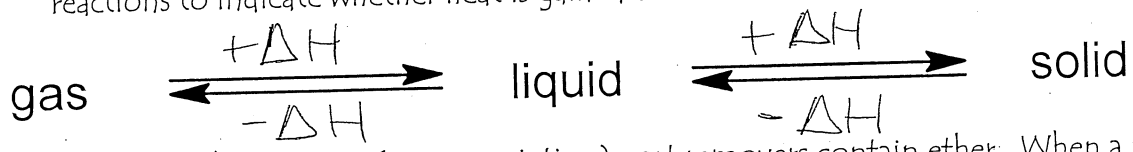
Metabolism Part 2

Exercises

1. Heat must be added or removed for phase changes to occur. Label the forward and reverse reactions to indicate whether heat is gained (+ΔH) or removed (-ΔH).



2. Some over-the-counter (nonprescription) wart removers contain ether. When a few drops are placed on a wart, it feels cold as the ether rapidly evaporates. Where does the heat energy from the wart go? What process is the energy used for?

endothermic

l + heat → gas

3. What if the formula for Gibbs Free Energy? $\Delta G = \Delta H - T\Delta S$

4. Let's look at the flow of energy of a snowball.
   a) In terms of enthalpy, is melting a solid to a liquid exothermic or endothermic? Is ΔH positive or negative? Write the generic reaction including heat as a product or reactant.

   s + heat → l +ΔH endothermic

   b) In terms of enthalpy, is melting a solid to a liquid spontaneous or non-spontaneous?

   non-spontaneous

   c) In terms of entropy, does melting a solid to a liquid increase or decrease entropy?

   s → l +ΔS

   d) ~~In terms of entropy,~~ is the melting of the snow ball spontaneous or non-spontaneous?

   spontaneous

   e) Do enthalpy and entropy make the same prediction regarding the spontaneity of solids melting to liquids?

   NO

   f) What factor comes into play when enthalpy and entropy do not agree?

   Temperature

   g) At what temperature (high or low) does the enthalpy term dominate the overall free energy of a solid melting to a liquid?

   low temp

   h) At what temperature (high or low) does the entropy term dominate the overall free energy of a solid melting to liquid?

   high temp

5. Use the reactions below to answer the following questions.

i) 1,3-bisphosophoglycerate + H_2O → 3-phosphoglycerate + Pi $\Delta G = -12$ kcal/mol

ii) pyruvate + Pi → phosphoenolpyruvate + H_2O $\Delta G = +15$ kcal/mol

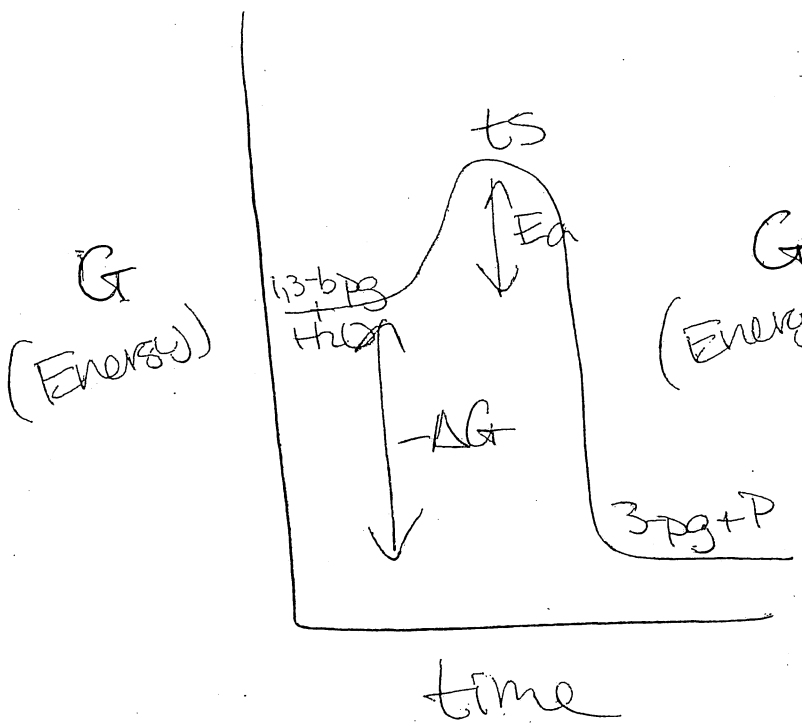
a) Which of the reactions are spontaneous? (i)

b) For which of the reactions, is the reverse reaction spontaneous? (ii)

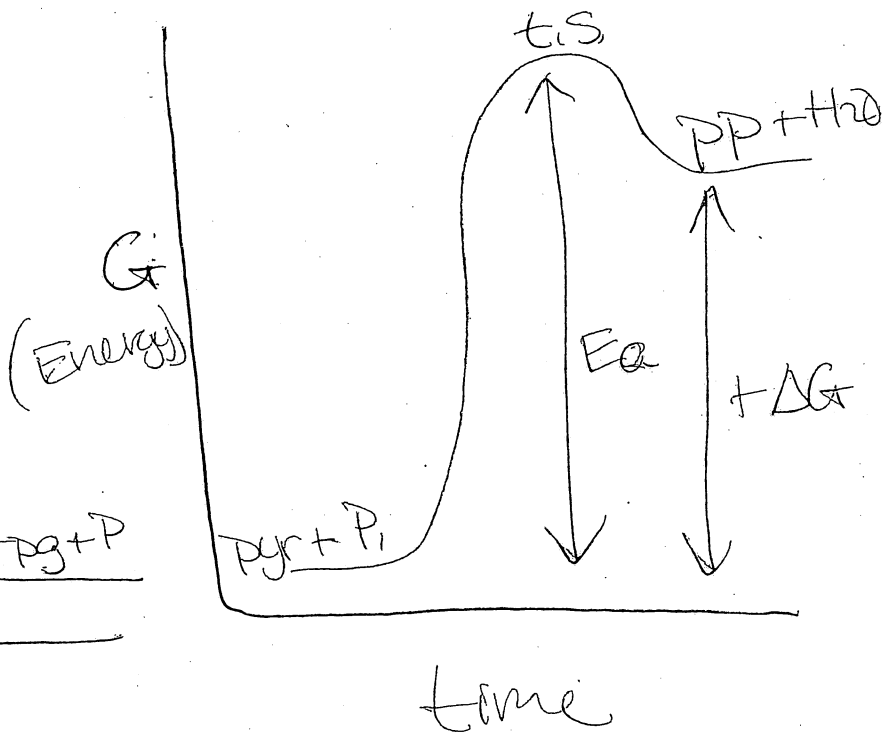
c) Could these reactions be coupled as written to create a spontaneous process Exlpain.
No, the net ΔG would + 3 kcal/mol

d) Draw reaction energy diagrams for both processes. Remember to completely label the diagrams: axis labels, reactants, produces, ± ΔG, Ea, and transition state.

(i)



(ii)



6. Shown below are two reactions that occur during metabolism of glucose.

iii) glucose-6-phosphate → glucose + Pi $\Delta G = -3.3$ kcal/mol

iv) glucose + ATP → glucose-6-phosphate + Pi $\Delta G = -4.0$ kcal/mol

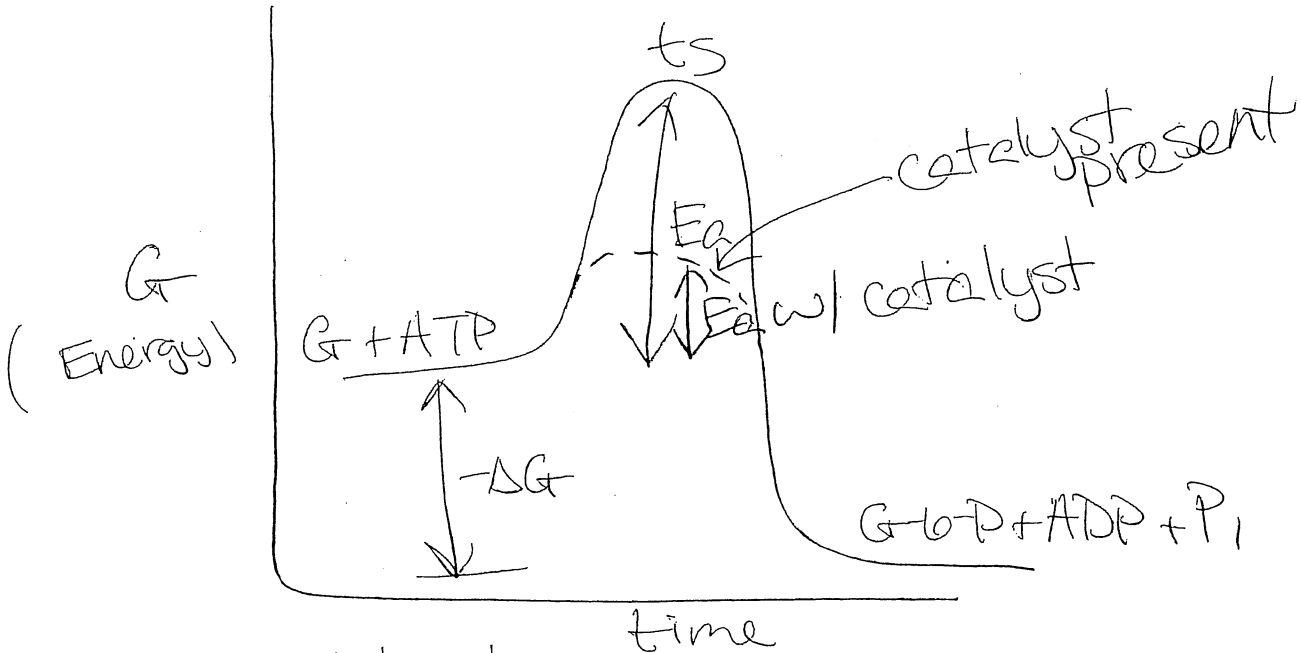
a) Is reaction (iii) spontaneous or non-spontaneous?

b) Is reaction (iv) spontaneous or non-spontaneous?

c) How can both reactions (iii) and (iv) be spontaneous when they appear to be reverse reactions?

Rxn IV is coupled w/ ATP hydrolysis,

d) The enzyme hexokinase catalyzes reaction (iv). Draw the reaction energy diagrams with and without the presence of a catalyst. Remember to completely label the diagrams: axis labels, reactants, produces, ± ΔG, Ea, and transition state.



7. How does a reaction rate change when
   a) reactant concentration decreases? rate ↓
   b) temperature is increased? rate ↑

8. Explain why high temperatures can cause a decrease in the reaction rate of enzyme catalyzed reactions. The ↑T can denature the enzyme so it can no longer catalyze the rxn

9. Explain how coupling an unfavorable reaction with ATP hydrolysis can make the reaction favorable. What is the necessary relationship between the free energy values for each reaction? ATP hydrolysis is exergonic. The released energy drives the coupled endergonic rxn. $\Delta G_{ender} < \Delta G_{ATPhydrol}$

10. The oxidation of alcohol groups can provide enough energy to transfer electrons to NAD^+.

a) Which form of this coenzyme is more oxidized: NAD^+ or NADH?

NAD^+

b) Which form is more reduced?

NADH

c) In an oxygen-containing environment, oxidation reactions are generally spontaneous, which form of the coenzyme is at a higher potential energy state?

reduced coenzyme

d) In general, would oxidized or reduced coenzymes provide a "stockpile" of energy? Explain.

Reduced coenzyme