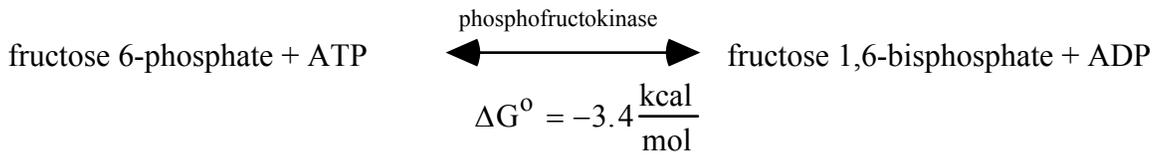


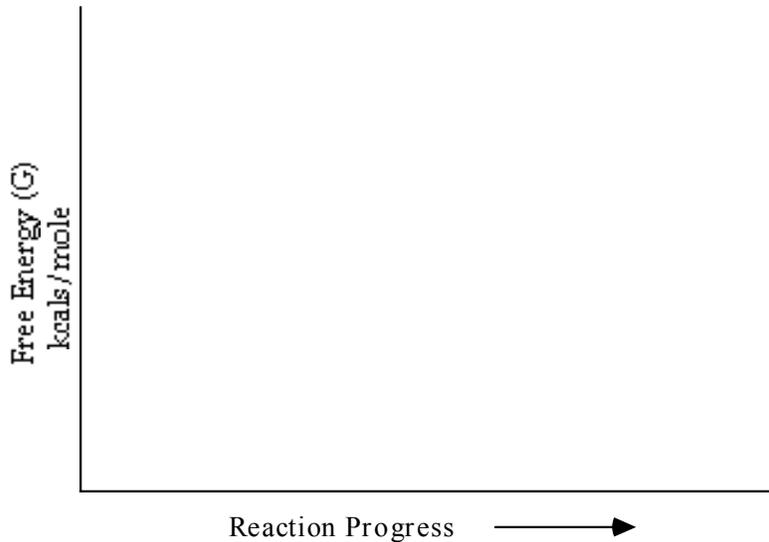
Question 2

The enzyme Phosphofructokinase (PFK) catalyzes the conversion of fructose 6-phosphate (F6P) to fructose 1,6-bisphosphate (FBP), in step 3 of glycolysis.



a) What two functions does ATP serve in this coupled reaction?

b) Draw and label an energy diagram for this reaction. Include the relative energy levels of the substrates and the products, the activation energy and the ΔG° for the reaction.



In erythrocytes, the following intracellular concentrations of metabolites are found:

Metabolite	Concentration
Fructose 6-phosphate	.014 mM
Fructose 1,6-bisphosphate	.028 mM
AMP	1 mM
ADP	0.2 mM
ATP	2 mM
Pi	1 mM

Question 2, continued

c) What is the free energy change of the phosphofructokinase reaction under these cellular conditions (37°C)? Show your work. Is the reaction spontaneous under these conditions?

Phosphofructokinase (PFK) is the primary site for regulation of the glycolytic pathway. The activity of PFK is dependent on the energy status of the cell.

d) Why would a cell regulate glycolysis?

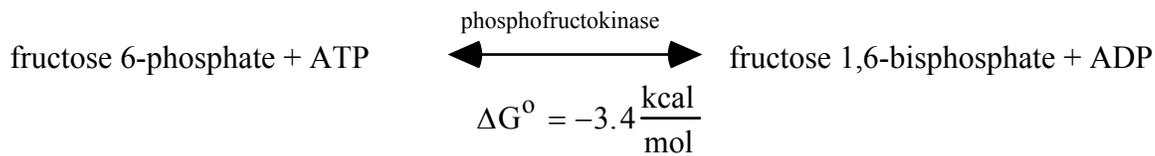
e) What is the specific signal or molecule(s) to which PFK responds?

f) Why does this mechanism of regulation make sense?

g) In certain tumor cells, an enzyme called ATPase becomes abnormally active, resulting in increased hydrolysis of ATP to ADP. What would be the effect on the overall rate of glycolysis in these cells?

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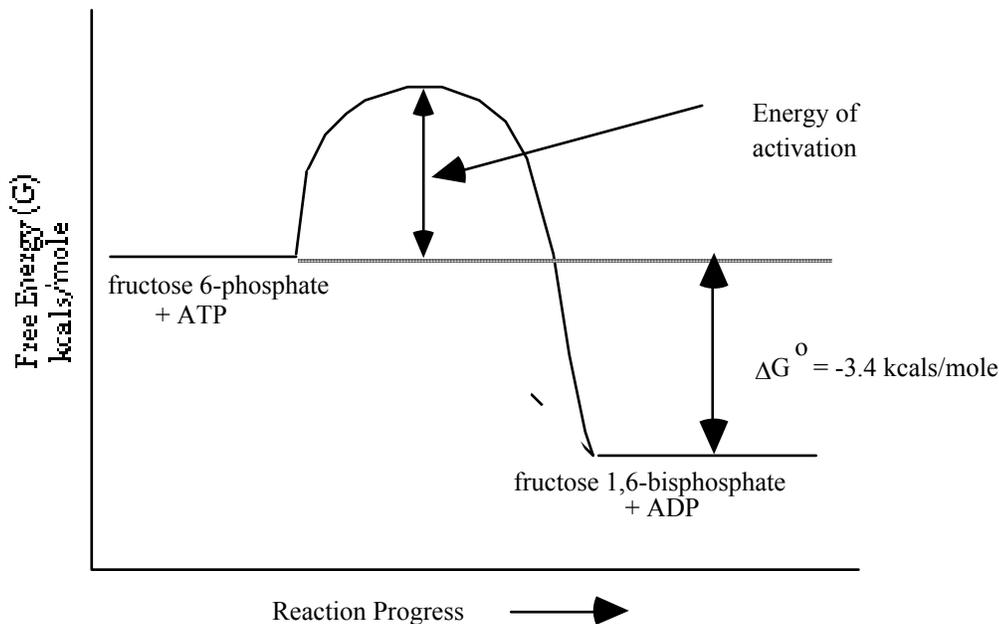


a) What two functions does ATP serve in this coupled reaction?

The hydrolysis of ATP provides the energy to drive this coupled reaction.

ATP also serves to donate a phosphate to fructose 1,6-bisphosphate from fructose 6-phosphate.

b) Draw and label an energy diagram for this reaction. Include the relative energy levels of the substrates and the products, the activation energy and the ΔG° for the reaction.



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Question 2, continued

c) What is the free energy change of the phosphofructokinase reaction under these cellular conditions (37°C)? Show your work. Is the reaction spontaneous under these conditions?

$$\Delta G = \Delta G^0 + RT \ln \frac{[\text{products}]}{[\text{reactants}]}$$

$$\Delta G = -3.4 \text{ kcal/mole} + 0.61 \text{ kcal/mole} \ln \frac{[\text{FBP}] [\text{ADP}]}{[\text{F6P}] [\text{ATP}]}$$

$$\Delta G = -3.4 \text{ kcal/mole} + 0.61 \text{ kcal/mole} \ln \frac{[.028 \text{ mM}] [0.2 \text{ mM}]}{[.014 \text{ mM}] [2 \text{ mM}]}$$

$$\Delta G = -3.4 + 0.61 \ln (0.2)$$

$$\Delta G = -4.38 \quad \text{Spontaneous}$$

Phosphofructokinase (PFK) is the primary site for regulation of the glycolytic pathway. The activity of PFK is dependent on the energy status of the cell.

d) Why would a cell regulate glycolysis?

The end result of glycolysis is the generation of ATP. If ATP levels in the cell are high, then the cell would not need to spend resources to generate more ATP. However, if the levels of ATP are low, then the cell would utilize the glycolytic pathway to generate the needed energy.

e) What is the specific signal or molecule(s) to which PFK responds?

PFK responds to the decreased ATP to ADP ratio (increased levels of ADP).

f) Why does this mechanism of regulation make sense?

Normally, a low ATP to ADP ratio indicates that cells need more energy currency available ready to use. By speeding up glycolysis, more ATP can be formed from ADP to raise the ATP to ADP ratio.

g) In certain tumor cells, an enzyme called ATPase becomes abnormally active, resulting in increased hydrolysis of ATP to ADP. What would be the effect on the overall rate of glycolysis in these cells?

The activity of the glycolytic enzymes would increase, increasing the overall rate of glycolysis.