MCB102: Quiz 3

NAME: _____ SECTION: _____

1. (1pt) Given $\Delta G'^{\circ}$ for each of the following reactions,

   1. ATP $\rightarrow$ ADP + P_i $\Delta G'^{\circ} = -30.5$ kJ/mol
   2. glucose 6-phosphate $\rightarrow$ glucose + P_i $\Delta G'^{\circ} = -13.8$ kJ/mol

show how you would calculate the standard free-energy change ($\Delta G'^{\circ}$) for the reaction:

   3. ATP + glucose $\rightarrow$ glucose 6-phosphate + ADP

Ans: Reaction 3 is the sum of reaction 1 and the reversal of reaction 2. Because of the additivity of free energy changes, the overall $\Delta G'^{\circ}$ for reaction 3 is the sum of the free energy changes for reaction 1 and the reversal of reaction 2:

   1. ATP $\rightarrow$ ADP + P_i $\Delta G_1'^{\circ} = -30.5$ kJ/mol
   2. glucose + P_i $\rightarrow$ glucose 6-phosphate $\Delta G_2'^{\circ} = +13.8$ kJ/mol
   3. ATP + glucose $\rightarrow$ ADP + glucose 6-phosphate

$\Delta G_3'^{\circ} = \Delta G_1'^{\circ} + \Delta G_2'^{\circ} = (-30.5 + 13.8)$ kJ/mol $= -16.7$ kJ/mol

2. (1pt) Why is it important to recycle NADH produced during glycolysis to NAD^+?

Ans: Cells contain a limited supply of NAD^+ and NADH. The oxidation of glyceraldehyde 3-phosphate requires NAD^+ as as electron acceptor—it converts NAD^+ to NADH. Unless this NADH is recycled to NAD^+, oxidative metabolism in this cell will cease for lack of an electron acceptor. Under aerobic conditions, NADH passes electrons to O_2; under anaerobic conditions, NADH reduces pyruvate to lactate, and is thereby recycled to NAD^+.

3a. (1pt) Describe the part of the glycolytic pathway from fructose 6-phosphate to glyceraldehyde 3-phosphate. Show structures of intermediates, enzyme names, and indicate where any cofactors participate.

Ans: This part of the pathway involves the reactions catalyzed by phosphofructokinase-1, aldolase, and triose phosphate isomerase. (Fig 14-2)

3b. (1pt) Describe the glycolytic pathway from fructose 1,6-bisphosphate to 1,3-bisphospho-glycerate, showing structures of intermediates and names of enzymes. Indicate where any cofactors participate.

Ans: The answer should show the reactions catalyzed by aldolase, triose phosphate isomerase, and glyceraldehyde 3-phosphate dehydrogenase. (Fig 14-2)

4. (1pt) In gluconeogenesis, how do animals convert pyruvate to phosphoenolpyruvate? Show structures, enzymes, and cofactors.

Ans: Pyruvate is converted into phosphoenolpyruvate in two steps:
(1) Pyruvate + HCO_3^- + ATP $\longrightarrow$ oxaloacetate + ADP + P_i
(2) Oxaloacetate + GTP $\longrightarrow$ CO_2 + GDP + phosphoenolpyruvate
The first reaction is catalyzed by pyruvate carboxylase, which requires biotin as a cofactor; the second, by phosphoenolpyruvate carboxykinase. Fig 14-17.

5. (1pt) Diagram the pathway from glucose to glycogen; show the participation of cofactors and name the enzymes involved.

Ans:
(1) Glucose + ATP $\xrightarrow[\text{hexokinase}]{}$ glucose 6-phosphate + ADP

(2) Glucose 6-phosphate $\xrightarrow[\text{phosphoglucomutase}]{}$ glucose 1-phosphate

(3) Glucose 1-phosphate + UTP $\xrightarrow[\text{UDP-glucose pyrophosphorylase}]{}$ UDP-glucose + PP_i

(4) UDP-glucose $\xrightarrow[\text{glycogen synthase}]{}$ glycogen + UDP

6. (1pt) Order the steps leading to glycogen breakdown resulting from the stimulation of liver cells by glucagon.

1) Activation of protein kinase A (PKA)
2) cAMP levels rise
3) Phosphorylation of phosphorylase *b*
4) Phosphorylation of phosphorylase *b* kinase
5) Stimulation of adenyl cyclase

Ans: The correct temporal order is 5-2-1-4-3.