Practice Exam E

This is the fifth of six practice exams. These exam questions have been taken from actual past BIS105 exams. The numbers in parentheses indicate the points for these questions (out of 100 points for the whole exam). Thus these questions represented approximately 1/5 the value of the exam. If this is a reasonable estimate of the difficulty of these questions, you should be able to answer them in 20/100 * 50 = 10 minutes

1. (8) The entrance of pyruvic acid into the matrix of a mitochondrion is the first step in a series of reactions that oxidize the carbons and convert a portion of the free energy of oxidation to the energy of condensation of ATP. At which steps in the oxidation process is CO₂ liberated? Give enzyme names and show the reactions (detailed structures of substrates and products but not cofactors).

   pyruvate dehydrogenase
   \[ \text{pyruvate} + \text{TPP} \rightarrow \text{acetyl-TPP} + \text{CO}_2 \]

   isocitric dehydrogenase
   \[ \text{isocitrate} + \text{NAD}^+ \rightarrow \text{a-ketoglutarate} + \text{NADH} + \text{H}^+ + \text{CO}_2 \]

   α-ketoglutarate dehydrogenase
   \[ \alpha\text{-ketoglutarate} + \text{NAD}^+ + \text{CoASH} \rightarrow \text{succinyl-CoA} + \text{NADH} + \text{H}^+ + \text{CO}_2 \]

2. (12) The \( \Delta E_{o}^{'} \) for the reaction, \( \text{OAA} + \text{NADH} + \text{H}^+ \rightarrow \text{malate} + \text{NAD}^+ \), is +0.154 volts. Assuming a ratio of \([\text{NAD}^+]/[\text{NADH}]\) of 1/3, what is the ratio of \([\text{malate}]/[\text{OAA}]\) at equilibrium?

\[
\Delta G^{o'} = -n F \Delta E_{o}^{'} = -2(96.5 \text{ kJ/V-mol})(0.154 \text{ V}) = -29.7 \text{ kJ/mol}
\]

\[
\Delta G = 0 \text{ (equilibrium) } = \Delta G^{o'} + RT \ln \frac{[\text{malate}][\text{NAD}^+][\text{OAA}]}{[\text{NADH}][\text{OAA}]}
\]

\[
\ln \left( \frac{[\text{malate}]}{[\text{OAA}]} \times \frac{[\text{NAD}^+]}{[\text{NADH}]} \right) = 29,700 / (8.31 \text{ J/ mol} \cdot \text{K})(298 \text{ K})
\]

\[
[\text{malate}]/[\text{OAA}] = 3 \times \exp(12) = 4.9 \times 10^5
\]
Practice Exam F

This is the sixth of six practice exams. These exam questions have been taken from actual past BIS105 exams. The numbers in parentheses indicate the points for these questions (out of 100 points for the whole exam). Thus these questions represented approximately 1/5 the value of the exam. IF this is a reasonable estimate of the difficulty of these questions, you should be able to answer them in $21/100 \times 50 = 10.5$ minutes

1. The breakdown of glycogen by phosphorolysis proceeds as,
$$\text{glycogen}_n + P_i \rightarrow \text{glycogen}_{n-1} + \text{glucose-1-P}$$

(Pi is inorganic phosphate), with a $\Delta G^\circ = +3.1 \text{ kJ/mol}$.  

a) (6) Assuming that the concentration of Pi in the cell is 1 mM, what is the equilibrium concentration of glucose-1-P?

$$\Delta G = 0 \ (equilibrium) = \Delta G^\circ + RT \ln \frac{[\text{glycogen}_{n-1}][\text{gluc-1-P}]}{[\text{glycogen}_n][\text{Pi}]}$$

$$0 = 3,100 + (8.31)(298) \ln \frac{[\text{glycogen}_{n-1}][\text{gluc-1-P}]}{[\text{glycogen}_n][\text{Pi}]}$$

Assuming the glycogen concentration is not affected by the hydrolysis,
$$\ln[\text{gluc-1-P}] = -3,100/(8.31)(298) = -1.25$$

$$[\text{gluc-1-P}][\text{Pi}] = \exp(-1.25) = 0.29; \ [\text{gluc-1-P}] = 0.29 \text{ mM}$$

b) (6) Although the synthesis of glycogen by the reverse of the reaction shown above is downhill ($\Delta G^\circ = -3.1$), this is not the way glycogen is synthesized. Diagram the reactions by which one glucose-1-P is added to a growing glycogen chain (give names rather than structures of the substrates and products).

$$\text{UTP} + \text{G-1-P} \rightarrow \text{UDPG} + \text{PPi} \quad \text{PPi} + \text{H}_2\text{O} \rightarrow 2 \text{ Pi}$$

$$\text{glycogen}_{n-1} + \text{UDPG} \rightarrow \text{glycogen}_n + \text{UDP}$$

2. (9) How much ATP will be formed from the total metabolism of one molecule of palmitoyl(16C)-S-CoA? Show your work.

$$\text{palmitoyl-CoA}(16 \text{ C}) + \text{CoASH} + \text{FAD} + \text{NAD}^+ + \text{H}_2\text{O}$$

$$\rightarrow \text{myristyl-CoA}(14 \text{ C}) + \text{acetyl-CoA} + \text{FADH}_2 + \text{NADH} + \text{H}^+$$

7 times through produces:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>ATP</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 NADH + H$^+$</td>
<td>17.5</td>
</tr>
<tr>
<td>7 FADH$_2$</td>
<td>10.5</td>
</tr>
<tr>
<td>8 acetyl-CoA</td>
<td>80</td>
</tr>
<tr>
<td>less activation</td>
<td>-2</td>
</tr>
<tr>
<td></td>
<td>106</td>
</tr>
</tbody>
</table>