**Answers to Problem Set 3**

1. a) i) Electrostatic repulsion between the charged groups of ATP compared to that of ADP and Pi. ii) Resonance stabilization of ADP and Pi compared to ATP. iii) Greater solvation of ADP and Pi compared to ATP.

   b) There is no necessary relationship between $\Delta G$ and the rate of a reaction.

   c) Phosphate is tribasic, so it can link two molecules and still retain a negative charge. Sulfate is a dibasic acid; it can link two molecules but will not have a negative charge. The negative charge of the phosphodiester bond protects against attack by $\text{OH}^-$.

2. See Voet and Voet (pages 334-6). Experiment of Vennesland and Westheimer.

3. \[
\begin{align*}
\text{CH}_3\text{C}^{\cdot}\text{OH}^{\cdot}^{2\text{H}} + \text{NAD}^+ & \xrightarrow{\text{Alcohol Dehydrogenase}} \text{CH}_3\text{C}^{\cdot}=\text{O}^{\cdot}^{2\text{H}} + \text{NADH} + \text{H}^+ \\
\text{CH}_3\text{C}^{\cdot}=\text{O}^{\cdot} + \text{NAD}^{\text{2H}} + \text{H}^+ & \xrightarrow{\text{Alcohol Dehydrogenase}} \text{CH}_3\text{C}^{\cdot}\text{OH}^{\cdot}^{2\text{H}} + \text{NAD}^+ \\
\text{CH}_3\text{C}^{\cdot}\text{OH}^{\cdot}^{2\text{H}} + \text{NAD}^+ & \xrightarrow{\text{Alcohol Dehydrogenase}} \text{CH}_3\text{C}^{\cdot}=\text{O}^{\cdot} + \text{NAD}^{\text{2H}} + \text{H}^+
\end{align*}
\]
3. a) 

\[
\begin{align*}
\text{N-Lys} & \quad \text{H} \quad \text{H} \quad \text{CH}_2 \quad \text{OP} \quad \text{C=O} \quad \text{C} \\
\text{H} & \quad \text{H} \quad \text{2O} \\
\text{H} & \quad \text{2O} \\
\text{H} & \quad \text{3H} \\
\text{3H} & \quad \text{N} \quad \text{CH}_2 \quad \text{OP} \quad \text{C=O} \\
\text{H} & \quad \text{H} \quad \text{N} \quad \text{CH}_2 \quad \text{OP} \\
\text{H} & \quad \text{H} \quad \text{N-Lys} \\
\end{align*}
\]

b) Phosphate binding by:
- R or K or
- N-terminus of \( \alpha \)-helix

base: \(-\text{COO}^- \)

or

Histidine \(-\text{N}^+\)
c) 
\[
\begin{align*}
\text{OP} \\
\text{CH}_2 \\
\text{C}=\text{O} \\
\text{HC-OH} \\
\text{HO-CH} \\
\text{H}_2\text{C-OH}
\end{align*}
\]

4. a) Glu is the base; it reacts with bromohydroxyacetone-P to give:
\[
\begin{align*}
\text{O} & \quad \text{O} \\
\text{||} & \quad \text{||} \\
\text{Glu - C - O - CH}_2 - C - \text{CH}_2\text{OP}
\end{align*}
\]

b) The substrate binds to the enzymatic active site in a way that only one surface of the carbonyl is accessible to borohydride.

5. a) This reaction proceeds similarly to the aldolase reaction via a Schiff base intermediate. The stereochemistry of [A] can be determined by the requirement for the hydroxyls at positions 3 and 4 to be on opposing sides.
6. a) Eukaryotic citrate synthetases promote the attack of acetyl CoA on the si face of oxaloacetate (from above the plane of the paper), while the Bacillus rectus enzyme catalyzes the condensation of acetyl CoA with the re face of oxaloacetate (from below the plane of the paper).

b) If the entering acetyl group is given the highest priority, the citrate molecule made by B. rectus has the R configuration. Thus, the entering acetyl group is in the proR position. (It is still proR even if the -OH has highest priority as normal.)