Chemistry and Biochemistry 153A, Winter 2010

# Final Exam Answers

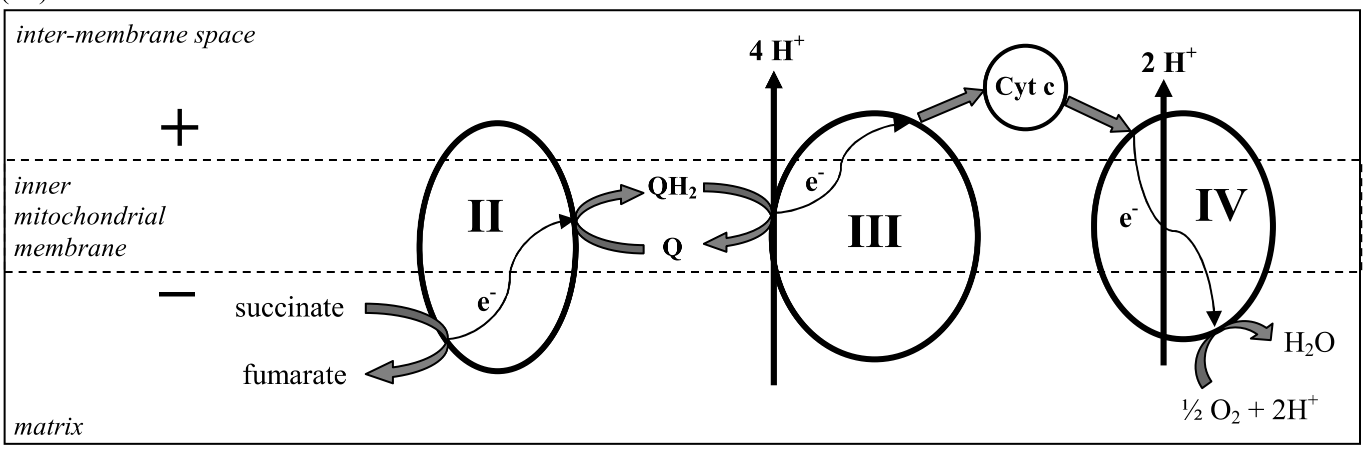
1. (5) 1,3-BPG. It transfers a phosphoryl group to ADP, whereas F6P gets a phosphoryl from ATP to form FBP. (*Or*, it has a more negative $\Delta G$ of hydrolysis. *Or*, it has a greater stabilization of hydrolysis products relative to reactants.)

2. (4) a, b

3. a. (3) True  b. (3) True  c. (3) False  d. (3) False

4. a. (2) a
   b. (3) Competitive inhibitors bind in place of the substrate, so a higher concentration of substrate is required to achieve half-maximal reaction velocity.
   c. (2) True

5. (12)




6. a. (3) An interaction between a protein and its ligand, which results in a conformational change that increases the protein's affinity for the ligand
   b. (3) A, D, I
   c. (4) It prevents hydrolysis of the 'high-energy' substrates

7. a. (3) A, C
   b. (3)

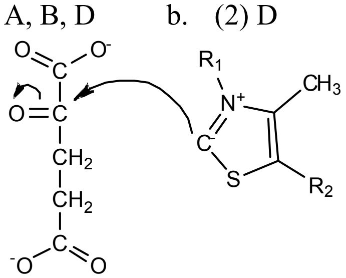
$$\begin{array}{lr} GAP + H_2O + NAD^+ \rightarrow 3\text{-}PG + NADH + 2H^+ & \Delta G'^{\circ}_{redox} = \ ? \\ + \quad 3\text{-}PG + P_i \rightarrow 1,3\text{-}BPG + H_2O & \Delta G'^{\circ}_{phosphorylation} = +49.4 \text{ kJ/mol} \\ \hline GAP + P_i + NAD^+ \rightarrow 1,3\text{-}BPG + NADH + 2H^+ & \Delta G'^{\circ}_{total} = +6.7 \text{ kJ/mol} \end{array}$$

$$\Delta G'^{\circ}_{redox} = +6.7 \text{ kJ/mol} - 49.4 \text{ kJ/mol} = \underline{-42.7 \text{ kJ/mol}}$$

   c. (3) $\Delta G'^{\circ} = -nF\Delta E'^{\circ}$; $\Delta E'^{\circ} = \Delta G'^{\circ}/-nF = (-42.7 \text{ kJ/mol})/-2(96.5 \text{ kJ/ V·mol}) = \underline{0.221 \text{ V}}$
   d. (3) $\Delta E'^{\circ} = E'^{\circ}_{acceptor} - E'^{\circ}_{donor} = E'^{\circ}_{NAD+} - E'^{\circ}_{GAP}$; $E'^{\circ}_{GAP} = E'^{\circ}_{NAD+} - \Delta E'^{\circ} = -0.315 \text{ V} - 0.221 \text{ V} = \underline{-0.536 \text{ V}}$
   e. (3) $3\text{-PG} + 3H^+ + 2e^- \rightarrow GAP + H_2O$
   f. (4) The following reaction is highly favored, so it depletes 1,3-BPG and pulls this reaction forward.

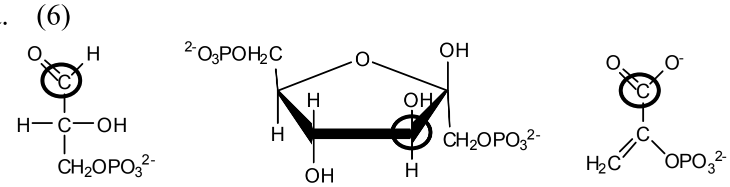
8. (4) A, D, E

9. a. (3) A, B, D  b. (2) D
   c. (6)



   d. (2) True
   e. (2) True

10. a. (6)



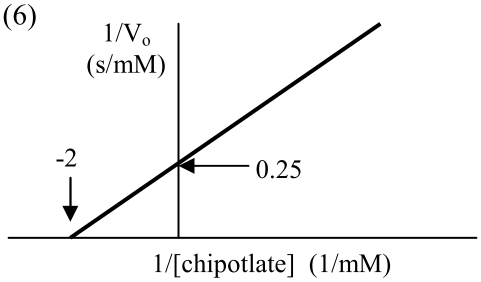
   b. (3) $CO_2$
   c. (3) No; $CO_2$ will still be the labeled product.

11. (10) Sidechain is not Tyr (both)
N-H bonds are circled (left)
$\phi$, $\psi$ labels are switched (left)
Amino acid is not L (right)
$\phi = 0°$ and $\psi = 180°$ (right)

12. a. (5) B, E  b. (3) D

13. a. (5) The rate is determined by the activation energy (free energy difference between reactants & TS), whereas the favorability is determined by $\Delta G$ (free energy difference between reactants and products).
b. (5) A slow reaction (that uses its substrate more slowly than it is produced, and produces its product more slowlythan it is used) causes buildup of substrate and depletion of product; this results in a large, negative $\Delta G$.

14. a. (6)




b. (3) False
c. (5) Cat. eff. = $k_{cat}/K_m = V_{max}/[E]\cdot K_m$
$= (4 \text{ mM/s})/(0.01 \times 10^{-3}\text{mM})(0.5 \text{ mM})$
$= 800{,}000 \text{ s}^{-1}\text{mM}^{-1}$ = $\underline{8 \times 10^{8} \text{ s}^{-1}\text{M}^{-1}}$
d. (2) True
e. (4) No, you can't tell. It could be a mixed or an uncompetitive inhibitor. You would need to know the actual *values* of $K_m^{app}$ and $V_{max}^{app}$ (along with $K_m$ and $V_{max}$), or the ratios of $K_m^{app}/K_m$ and $V_{max}^{app}/V_{max}$.
f. (5) $\alpha' = 1+[I]/K'_I$, so $K'_I = [I]/(\alpha'-1)$
$V_{max} = V_{max}^{app}/\alpha'$, so $\alpha' = V_{max}^{app}/V_{max}$.
$K'_I = [I]/\{(V_{max}^{app}/V_{max}) - 1\}$
g. (3) C
h. (2) M

15. a. (2) B  b. (2) A

16. (6) A synthase is a lyase; ATP synthase is a hydrolase. – *ex. names:* ATP phosphatase; ATP hydrolase; ATP condensase

17. a. (4) Pyruvate + NADH + $H^+$ $\rightleftharpoons$ Lactate + $NAD^+$
b. (3) A
c. (7) x-axis: [pyruvate]; y-axis: $V_O$
curve A: hyperbolic, farthest left
curve B: sigmoidal, farthest right
curve C: sigmoidal, between curves A & B
d. (6) B, D, E, F
e. (7) Sodium phosphate. The reaction produces protons, so the buffer must absorb protons (to prevent a drop in pH). A buffer with more deprotonated molecules (pKa < desired pH) is better at absorbing protons.

18. (6) These reactions require $NAD^+$ and FAD as electron acceptors. The resulting NADH and $FADH_2$ are reoxidized via electron transport to $O_2$. Without $O_2$, $NAD^+$ levels drop (minimal substrate) and NADH levels rise (lots of inhibitory product), stopping the pathway.

19. a. (5) Low pH can disrupt protein structure and function by protonating important functional groups.
b. (5) Acetic acid → Acetyl-CoA: -1 ATP
Acetyl-CoA → 2 $CO_2$: +3 NADH; +1 $FADH_2$; +1 GTP (= 1 ATP)
Sum: -1 + 3 NADH (2.5 ATP/NADH) + 1$FADH_2$ (1.5 ATP/$FADH_2$) + 1 = <u>9 ATP</u>

20. a. (2) Carbohydrates
b. (5) A, B, C, F
c. (3) α-D-glucopyranose
d. (3) α-1,4 and α-1,6 *O*-glycosidic linkages
e. (3) To provide a sugar source for fermentation

21. a. (4) The geckos are able to form *lots* of these individually weak contacts. (There is a large surface area of interaction.)
b. (4) A, D
c. (5) The tighter packing of these lipids adds stiffness to the geckos' membranes, to counteract the increased fluidity caused by higher temperatures