Final Exam Answer Key

Part I (Answer Sheet 1)

1. a. (2) B
   b. (3) In eukaryotes, mitochondria are required for the oxidation of amino acids and fatty acids to yield ATP. In contrast, sugars can yield ATP through fermentation.
2. a. (3) Although in the aldolase reaction, glucose carbons 4-6 yield GAP (and 1-3 yield DHAP), GAP can be rapidly isomerized to DHAP by TIM.
   b. (2) C1
3. (2) False – *no TPP*
4. (2) True
5. (2) True
6. (2) False – *Coenzyme A is an acyl carrier.*
7. (2) True
8. (20) 1) A, E, I
   2) C, D, E, G, I
   3) A, B, C, E, I
   4) B, F, G, I
   5) C, I
   6) D, F, I
9. (4) a, f, h
10. a. (3) Creatine phosphate
    b. (3)

	$ATP + H_2O \rightarrow ADP + P_i$	$\Delta G'^{\circ} = -30.5$ kJ/mol
+	creatine + $P_i \rightarrow$ creatine phosphate + H_2O	$\Delta G'^{\circ} = +43.1$ kJ/mol
=	ATP + creatine $\rightarrow$ ADP + creatine phosphate	$\Delta G'^{\circ} = +12.6$ kJ/mol

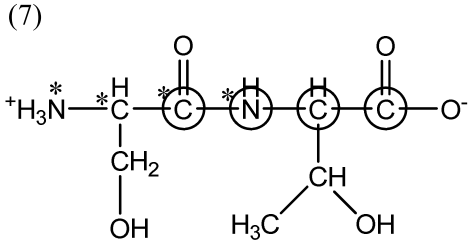
    c. (3) [ATP] is high relative to [ADP]
    d. (5) Since the reaction is close to equilibrium, rising ATP levels (= falling ADP levels) will lead ATP to get used to make creatine phosphate, and falling ATP levels (= rising ADP levels) will lead creatine phosphate to get used to phosphorylate ADP.
    e. (4) $\Delta G = \Delta G'^{\circ} + RT \ln Q$, so $\ln Q = (\Delta G - \Delta G'^{\circ})/RT$
    $Q = ([ADP][\text{creatine phosphate}])/([ATP][\text{creatine}]) = e^{(\Delta G - \Delta G'^{\circ})/RT}$
    $[\text{creatine phosphate}]/[\text{creatine}] = ([ATP]/[ADP])\, e^{(\Delta G - \Delta G'^{\circ})/RT}$
    $= 10\, e^{(0 \text{ kJ/mol} - 12.6 \text{ kJ/mol})/(0.00831 \text{ kJ/mol}\cdot\text{K})(310\text{K})} = 0.075$
    f. (3) In aerobic exercise, creatine phosphate is used up quickly, and the majority of ATP is regenerated through oxidative phosphorylation.
    g. (3) No; it catalyzes a reversible reaction
    h. (5) B, C, E, G
11. a. (4) Oxaloacetate, because [oxaloacetate] is very low in the cell. (Also accepted: because oxaloacetate binds first.)
    b. (3) Citrate synthase is located in the mitochondrial matrix, which has a higher pH than physiologic (due to proton pumping in the electron transport chain).
    c. (4) (i) A; (ii) C
    d. (5) $K_m^{app} = \alpha \cdot K_m$ and $\alpha = 1 + ([ATP]/K_I)$
    $K_I = [ATP]/\alpha - 1 = [ATP]/(K_m^{app}/K_m - 1) = 4 \text{ mM}/(143\mu M/16\mu M - 1) = 0.5 \text{ mM}$
    e. (4) In the acetyl-CoA binding site. Both ATP and CoA contain adenosine.
    f. (2) ATP
12. (5) a, b, e

Extra Credit: ATP Synthase

A. (1) Paul Boyer
B. (1) c, γ, ε
C. (3) No. They are necessary to hold the alpha-beta dimers in place. If the alpha-beta dimers rotate, no ATP wll be released.
D. (3) 3 protons enter/exit the ATP synthase for each ATP released. The fourth proton is trasported in with P_i.
E. (2) ATP gets hydrolysed

Part II (Answer Sheet 2)

13. (2) Because they are marine mammals, they need extra fat for insulation.
14. (3) Because fats are the most reduced and yield the most energy on oxidation.
15. (5) Greater. The reduced surface area per FA reduces the number of van der Waals contacts between molecules, which keeps the lipids fluid at a lower temperature.
16. (4) Proline disrupts regular secondary structures like alpha-helices and beta sheets and restricts the conformational possibilities for the protein.
17. (4) Hydrophobic residues cluster together to reduce the entropy of water (hydrophobic effect). This is true within polypeptide chains and between chains.
18. a. (3) A
    b. (3) C
19. (7)



20. (9) - (3) Wrong pKa's for terminal groups (shown as 2 & 9.5; should be 3 & 8)
    - (2) Only one equivalent for 2 sidechains (should span 2 eq. from pH 14 to 12)
    - (2) y-axis should be pH (not pKa)
    - (2) slope of buffering zones is too flat (should span 2 pH units)
21. a. (5) Glycolysis: Glc + Gal $\rightarrow$ 4 pyruvate:
    4 ATP, 4 NADH
    PDH complex: 4 pyruvate $\rightarrow$ 4 AcCoA + 4 CO_2:
    4 NADH
    TCA cycle: 4 AcCoA $\rightarrow$ 4 CO_2:
    12 NADH, 4 $FADH_2$, 4 GTP
    Total: 4 ATP, 4 GTP, 20 NADH, 4 $FADH_2$
    b. (4) GTP = ATP
    NADH $\rightarrow$ 2.5 ATP; $FADH_2$ $\rightarrow$ 1.5 ATP
    Total: 4 + 4 + (2.5 x 20) + (1.5 x 4) = 8 + 50 + 6 = 64 ATP
    c. (2) lyase
    d. (4) Initial conversion: Ser $\rightarrow$ pyruvate: none;
    Thr $\rightarrow$ pyruvate + AcCoA: 1 NADH
    PDH complex: 2 pyruvate $\rightarrow$ 2 AcCoA + 2 CO_2:
    2 NADH
    TCA cycle: 3 AcCoA $\rightarrow$ 3 CO_2:
    9 NADH, 3 $FADH_2$, 3 GTP
    Total: 3 GTP, 12 NADH, 3 $FADH_2$
    e. (2) GTP = ATP
    NADH $\rightarrow$ 2.5 ATP; $FADH_2$ $\rightarrow$ 1.5 ATP
    Total: 3 + (2.5 x 12) + (1.5 x 3) = 3 + 30 + 4.5 = 37.5 ATP
    f. (4) Lactose: 64 ATP/342 g/mol = 0.19 ATP/g
    Dipeptide: 37.5 ATP/206 g/mol = 0.18 ATP/g
    Lactose (barely)
    g. (4) Product inhibitor: pyruvate, acetyl-CoA, NADH, or NH_3 (or NH_4^+)
    Feedback inhibitor: succinyl-CoA, ATP, or NADH
    h. (4) Each is a molecule that may build up when the energy status of the cell is high. (Specifics of answer will vary for each choice.)
22. (4) b
23. a. (3) Lipase
    b. (2) Fatty acids
    c. (4) Diffusion of the enzyme and substrate(s) is limited, but the enzyme is still active.
    d. (4) Warming increases the rate of collisioins between the enzyme and substrate.
    e. (4) The enzyme denatures. (Heat breaks the weak bonds of its tertiary structure.)
    f. (3) Glycosidase
24. a. (3) Because lactose is also in the mother's milk.
    b. (5) Protein. It is common for proteins having the same function in different animals to have different sequences, whereas sugars and fats in different organisms are more likely to be identical.
25. a. (2) Homolactic fermentation
    b. (3) C
    c. (Lactate, labeled at C3 – methyl)
26. a. (2) Hb-Fe^{2+} + ½ NO_3^- + H^+ $\rightarrow$ Hb-Fe^{3+} ½ NO_2^- + ½ H_2O
    b. (4) $\Delta \mathscr{E}'^{\circ} = \mathscr{E}'^{\circ}_{acceptor} - \mathscr{E}'^{\circ}_{donor}$
    $= \mathscr{E}'^{\circ}_{NO3-} - \mathscr{E}'^{\circ}_{Hb\text{-}Fe2+} = 0.42\ V - (0.12\ V)$
    = 0.30 V
    c. (4) $\Delta G'^{\circ} = -nF\,\Delta \mathscr{E}'^{\circ}$
    = -(1)(96.5 kJ/V·mol)(0.30V) = -28.95 kJ/mol
    d. (2) True
    e. (4) O_2 dissociates from a T-state Hb *more quickly than* from an R-state Hb. The affinity of O_2 for the T-state ($K_A = k_A/k_D$) is lower than for the R-state, so the rate constant for dissociation will be larger.
    f. (6) The oxidized hemes are not able to bind oxygen, but they promote the formation of the R-state, making hemoglobin less able to release oxygen in the tissues. (Transfer is reduced.)
    g. (3) CO, NO, or H_2S
27. (2) False
28. (2) True