1. a. acetyl-CoA + 3NAD^+ + FAD + GDP + P_i + 2H_2O → 2CO_2 + CoA + 3NADH + $FADH_2$ + GTP + 2H^+
   b. 3 NADH → 3*2.5 ATP = 7.5 ATP; 1 $FADH_2$ → 1.5 ATP; 1 GTP ≈ 1 ATP
   7.5 + 1.5 + 1 = <u>10 ATP equivalents</u>
2. a. FMN
   b. NADH:CoQ oxidoreductase (Complex I of ETC)
3. a. Complex I: D, E
   Complex II: C, E, F
   Complex III: E, F
   Complex IV: B, F
   b. succinate → complex II → CoQ → complex III → cytochrome c → complex IV → O_2, so:
   C E A E F B F B
4. a. False; ΔG depends only on reactants and products, not how reactants are converted to products
   b. True
   c. False; it predominantly binds the O-state (open or empty conformation).
   d. True
   e. True
   f. True; the proton gradient, which drives the rotation of ATP synthesis, results in lower pH in the intermembrane space than in the matrix
   g. True
   h. True; carbon monoxide can bind in place of oxygen in Complex IV, stopping electron transport
   i. False; P_i attached by GAPDH to form 1,3-BPG is then transferred to ADP to make ATP. This can happen in anaerobic metabolism, which doesn't require a pH gradient, or even mitochondria.
   j. False; they bring the *electrons* from NADH into the electron transport chain.
   k. False; $FADH_2$ is a prosthetic group of Complex II; it is succinate that diffuses to Complex II to 'drop off' its electrons.
5. a. B, G, I, K, L
   b. A, B, L
   c. A
   d. C, G, L
   e. A, B
   f. B, C, G
   g. D, E, L
6. Coenzyme Q. It has a long, hydrophobic (isoprene-based) tail.
7. b, c, d
8. a. FAD is the 1st redox center in complex 2, so:
   $\Delta E'^\circ = E'^\circ_{\text{acceptor}} - E'^\circ_{\text{donor}} = E'^\circ_{O_2} - E'^\circ_{\text{FAD}} = 0.82\text{ V} - 0.05\text{ V} = \mathbf{0.77\ V}$
   b. $\Delta G'^\circ = -nF\Delta E'^\circ = -2(96.5\text{ kJ/V·mol})(0.77\text{ V}) = \mathbf{-148\ kJ/mol}$
   c. 6 protons are pumped across the inner membrane as a result of two electrons going from FAD to O_2 (or 6 moles of protons pumped for 2 moles of electrons transferred). So,
      6 moles of protons × 20 kJ/mol = 120 kJ
      -148 kJ (released) + 120 kJ (stored) = -28 kJ (not stored; released as heat)
      100% × (-28 kJ/-148 kJ) = **19%**

9. a. $\Delta E = \Delta E'^{\circ} - \frac{RT}{nF}\ln Q$ so at equilibrium, when $\Delta E = 0$ and $Q = K'_{eq}$, $\Delta E'^{\circ} = \frac{RT}{nF}\ln K'_{eq}$

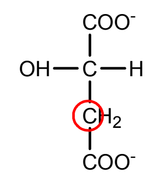
$$\Delta E'^{\circ} = \frac{(0.008315\ \text{kJ/mol}\cdot\text{K})(298\ \text{K})}{2(96.5\ \text{kJ/V}\cdot\text{mol})}\ln\left(\frac{[0.09][0.09]}{[0.01][0.01]}\right) = 0.0128 \times \ln(81) = 0.056\ \text{V}$$

b. To the right. Under these conditions, $Q = 1$, so $\Delta G = \Delta G'^{\circ}$ = negative, since $\Delta E'^{\circ}$ is positive.

c. It depends, since both Q and $K'_{eq} < 1$. If $Q < K'_{eq}$, reaction goes right; if $Q = K'_{eq}$, neither (at equilibrium); if $Q > K'_{eq}$, reaction goes left.

10. a. B
b. A
c. B

11. a. Ethanol, $H_3C{-}CH_2{-}OH$
b. glucose ($C_6H_{12}O_6$) + 2 CO_2 $\rightarrow$ 2 malate ($2 \times C_4H_4O_5$) + 4 H^+
c. 1. Glucose is broken down to pyruvate in glycolysis.
2. Pyruvate is converted to oxaloacetate (OAA) by pyruvate carboxylase.
3. OAA is reduced to L-malate by malate DH (which reoxidizes NADH to NAD^+).
d.



12. b f l d c j l d a i l d b