I. Multiple choice

1.The only membrane-bound enzyme in the citric acid cycle is

a) aconitase
b) the α–ketoglutarate dehydrogenase complex
c) malate dehydrogenase
d) succinate dehydrogenase

2. Control of the citric acid cycle is exercised by each of the following enzymes, except for

a) citrate synthase
b) isocitrate dehydrogenase
c) aconitase
d) the α-ketoglutarate dehydrogenase complex

3.Another name for Complex II in the electron transport chain is

a) cytochrome *c* oxidase
b) NADH-CoQ oxidoreductase
c) cytochrome *bc1* complex
d) succinate dehydrogenase

4.The complex in the electron transport chain that does not have a direct link to coenzyme Q in some form is

a) the succinate dehydrogenase complex
b) Complex I
c) cytochrome *c* oxidase
d) Complex III

5.Redox reactions of NADH-linked dehydrogenases involve

a) hydride ion transfer
b) transfer of two-carbon groups
c) transfer of three-carbon groups
d) transfer of acetyl groups

6. Which enzymes in the citric acid cycle catalyze oxidative decarboxylation reactions?

a) isocitrate dehydrogenase and the α–ketoglutarate dehydrogenase complex
b) aconitase and succinate dehydrogenase
c) the α–ketoglutarate dehydrogenase complex and succinate thiokinase
d) fumarase and succinate dehydrogenase

7.A unique feature of the glyoxylate cycle is that it allows the organisms that possess this pathway to

a) produce fats from carbohydrates
b) produce carbohydrates from fats
c) convert acetyl-CoA to pyruvate
d) do all of the above

2)Below are steady state (not at equilibrium) concentrations of metabolites in red blood cells. Answer the following. (10)

a) If the ratio of NAD+/NADH is 1000./1, what is the $\Delta G'$ of the lactate dehydrogenase reaction. The $\Delta G^{o'}$ is –25.2 kJ/mol.

Steady-State Concentrations of Glycolytic Metabolites in Erythrocytes

Metabolite	m*M*
Glucose	5.0
Glucose-6-phosphate	0.083
Fructose-6-phosphate	0.014
Fructose-1,6-bisphosphate	0.031
Dihydroxyacetone phosphate	0.14
Glyceraldehyde-3-phosphate	0.019
1,3-Bisphosphoglycerate	0.001
2,3-Bisphosphoglycerate	4.0
3-Phosphoglycerate	0.12
2-Phosphoglycerate	0.030
Phosphoenolpyruvate	0.023
Pyruvate	0.051
Lactate	2.9
ATP	1.85
ADP	0.14
P_i	1.0

Pyr + NADH ⇌ Lactate + NAD^+

$$\Delta G' = \Delta G^{o'} + RT \ln \frac{[lac]}{[Pyr]} \frac{1000}{1}$$

$$+ 8.31 \cdot 310 \ln \frac{2.9 \times 1000}{0.051 \times 1}$$

$$-25{,}200 + 8.31 \cdot 310 \cdot 10.9$$

$$+ 28080$$

$$\Delta G' = +2.9 \text{ kJ/mol}$$

b) Is the phosphoglucoisomerase reaction more or less favorable thermodynamically under real erythrocyte conditions as compared to standard conditions? Show why! The $\Delta G^{o'}$ is –16.7 kJ/mol.

$$\Delta G' = -16{,}700 + 8.31 \cdot 310 \ln \frac{0.014}{0.083}$$

0.083 0.014

G-6-P → F-6-P

$$= -16{,}700 + -543$$

$$= -17{,}24 \text{ kJ/mol}$$

More Favorable

II.Problems, etc-Show all work to receive any credit

1. a) Hunters often claim that meat from game that was run to exhaustion is sour. Explain from a metabolic pespective why this might be so. (9)

Under conditions of anaerobic muscle activity (run to death!), the TCA & ETS cannot use the pyruvate from glycolysis. Thus to maintain glycolysis for ATP NAD^+ must be regenerated by pyr + NADH → lactate + NAD^+, or glycolysis will stop So lactic acid is the sour taste.

b) Yeast in the anaerobic beer brewing process (fermentation) make ethanol to solve a metabolic problem. Explain the problem and how yeast solve it. What other product is produced by this process?

Yeast (anaerobic) have ~~the~~ same problem they need to regenerate NAD^+ to keep making ATP. They instead convert pyruvate → ethanol using up NADH in the process. They also generate CO_2 as part of this process.

DHAP $\rightleftharpoons$ G-3-P $\quad \Delta G^{\circ\prime} = +7.5$

2. a) What would be the ratio of glyceraldehyde-3-phosphate (G-3-P)/dihydroxyacetone phosphate (DHAP) at equilibrium (K_{eq}) at 37°C? (8)

$$K_{eq} = e^{-\left(\frac{+7{,}560}{8.315 \cdot 310K}\right)} = 0.0532$$

b) Under "realistic" cellular conditions [G-3-P]= 0.0012 mM and [DHAP]= 0.20 mM. What is the ΔG' at 37°C under these conditions?

$$\Delta G' = +7{,}560 + (8.315)(310)\ln\frac{0.0012}{0.20} + -13{,}200$$

$$= -5640\ J/mol = -5.64\ kJ/mol$$

3. a)What is the $\Delta G^{\circ\prime}$ for the process where succinate passes on its 2 electrons to O_2 ? b)What would be the K_{eq} for this process? c)What is the maximum number of ATPs which could be synthesized in this 2 electron process?(9)

Succinate (donor) + $\frac{1}{2}O_2$ (acc) $\longrightarrow$ Fumarate + H_2O

a) $\Delta G^{\circ\prime} = -2(96{,}500)(0.816 - 0.031) = -151\ kJ/mol$

b) $K_{eq} = e^{-\left(\frac{-151{,}000}{8.315 \cdot 298}\right)} = 2.92 \times 10^{26}$ (298K)

c) $\frac{-151}{-30.5} = 4.95$ ATP or 4 in whole numbers is maximum