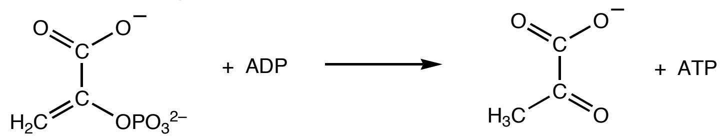
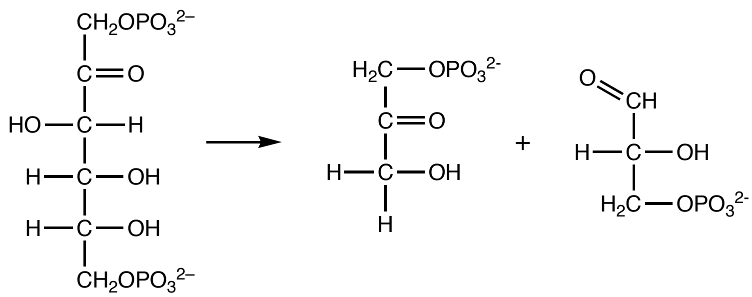
Name ___________________________ Test 3
PHYS 0213 (Biochem) Spring 2005

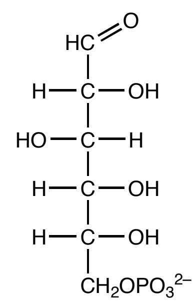
1. (8 pts.) In glycolysis, ATP is formed during the conversion of phosphoenolpyruvate to pyruvate. What is the driving force for this reaction?



2. In glycolysis, fructose-1,6-bisphophate is converted to dihydroxyacetonephosphate and glyceraldehyde-3-phosphate via a reverse aldol condensation.



Reverse aldol condensation of fructose-1,6-bisphosphate



glucose-6-phosphate

a. (3 pts.) Between which C atoms is fructose cleaved.

b. (3 pts.) Imagine that glucose-6-phosphate underwent a reverse aldol condensation. Between which C atoms would glucose be cleaved?

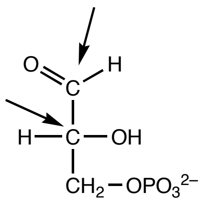
c. (2 pts.) Draw the products of the reverse aldol condensation described in part b.

d. (3 pts) What advantage does the reverse aldol condensation of fructose have over the reverse aldol condensation of glucose? (Hint: consider the size of the resulting product molecules.)

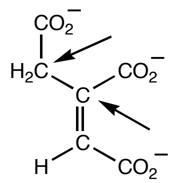
1. _______
2. _______
3. _______
4. _______
5. _______
6. _______
7. _______
8. _______
9. _______
10. _______
11. _______
12. _______
13. _______
14. _______
15. _______
16. _______
17. _______

3. (8 pts.) For each of the following pairs of carbon atoms indicate (circle) which carbon is the more oxidized carbon atom.

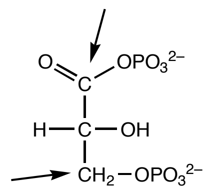
a.



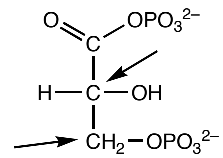
b.



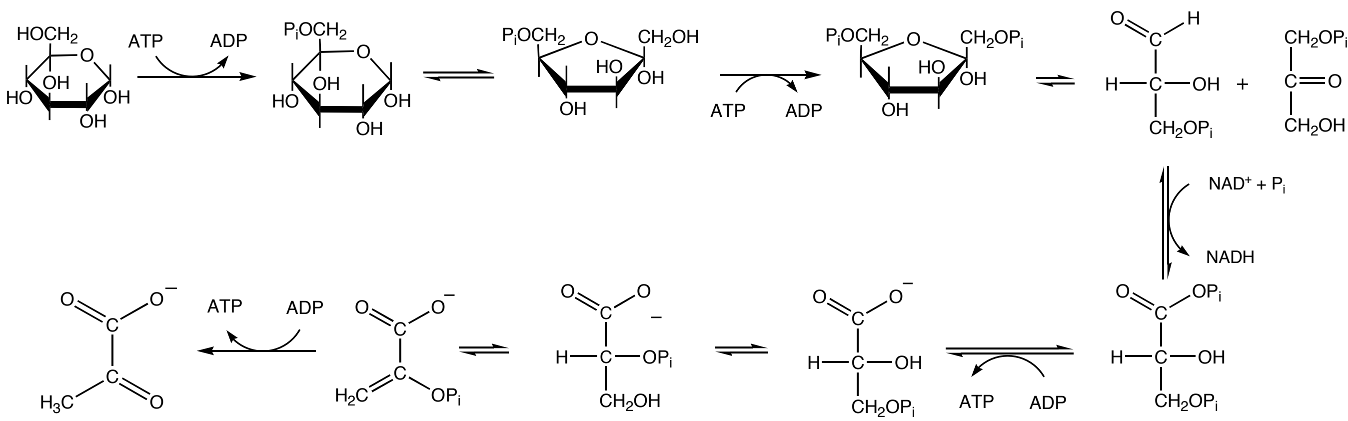
c.



d.



4. The reactions in the glycolytic pathway are summarized below.

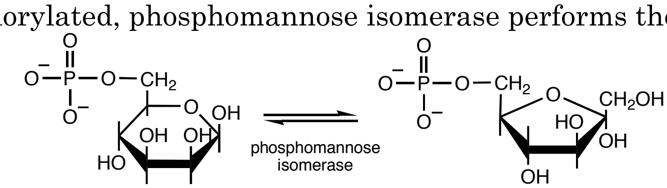


a. (4 pts.) In which step is the sugar being oxidized?

b. (4 pts.) Which part of the sugar molecule is being oxidized?

c. (4 pts.) How many ATP molecules are synthesized for each glucose molecule that enters glycolysis?

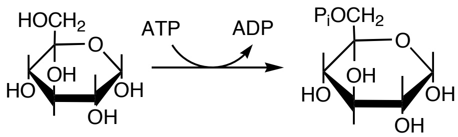
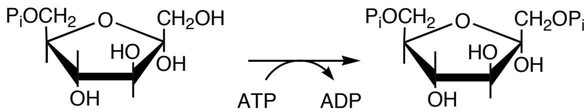
After mannose is phosphorylated, phosphomannose isomerase performs the following conversion:



d. (4 pts.) Phosphomannose isomerase converts mannose to what sugar?

e. (4 pts.) At what step does mannose get fed into glycolysis?

5. Gluconeogenesis is basically glycolysis run in reverse, but there are three important steps were glycolysis cannot run in reverse. Two of those steps from the glycolytic pathway are drawn below.

Glycolysis	Glycolysis in reverse
 glu, glu-6-Pi	
 fru-6-Pi, fru-1,6-bisPi	

a. (2 pts.) Draw the reactions in reverse (you can use the abbreviations if you wish).

b. (4 pts.) Why don’t these reactions run in reverse?

c. (4 pts.) How does gluconeogenesis get around these two irreversible steps?

6. (2 pts. each) Which of the following molecules could be candidates for controlling glycolysis via feedback inhibition?

a. glucose b. ADP c. ATP

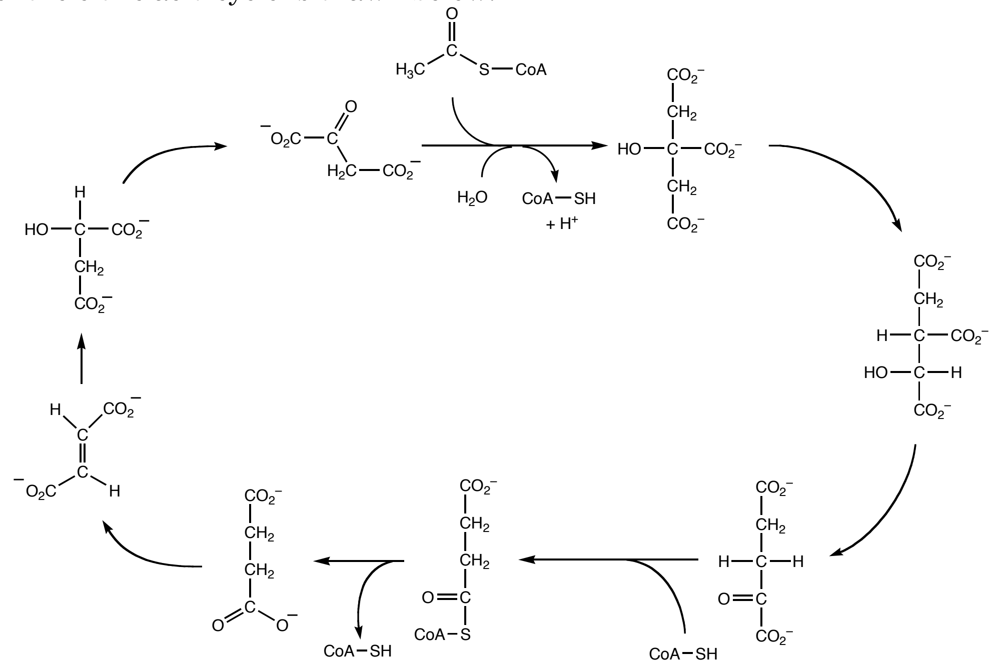
d. AMP e. citrate f. pyruvate

7. (2 pts. each) Which of the following molecules could be candidates for activators of glycolysis?

a. NADH b. ADP c. ATP

d. AMP e. citrate f. pyruvate

8. A version of the citric acid cycle is drawn below.

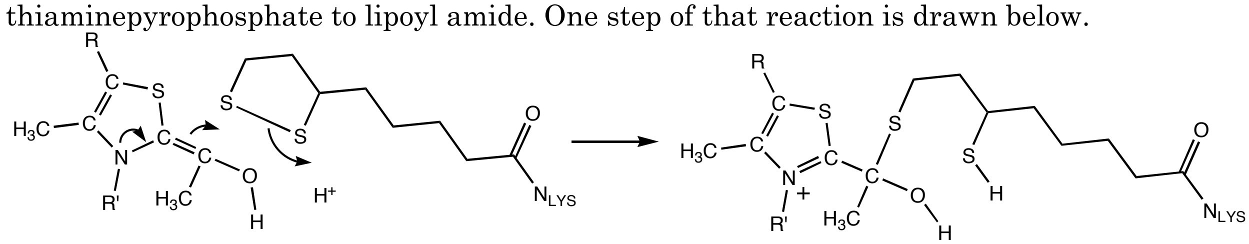


a. (6 pts.) Identify the reactions were both CO_2 and NADH are produced.

b. (4 pts.) In terms of ΔG, what is the significance of the release of CO_2 in the steps in part a?

c. (4 pts.) In addition to the steps where both CO_2 and NADH are produced, there are two more steps where "reducing power" (NADH or $FADH_2$) are produced. Identify those steps. (It is not necessary to specify whether NADH or $FADH_2$ is formed.)

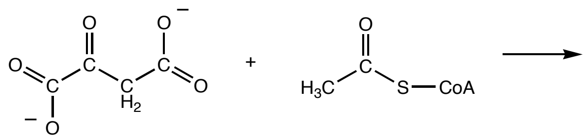
9. In the pyruvate decarboxylase complex, an acetyl group is transferred from thiaminepyrophosphate to lipoyl amide. One step of that reaction is drawn below.



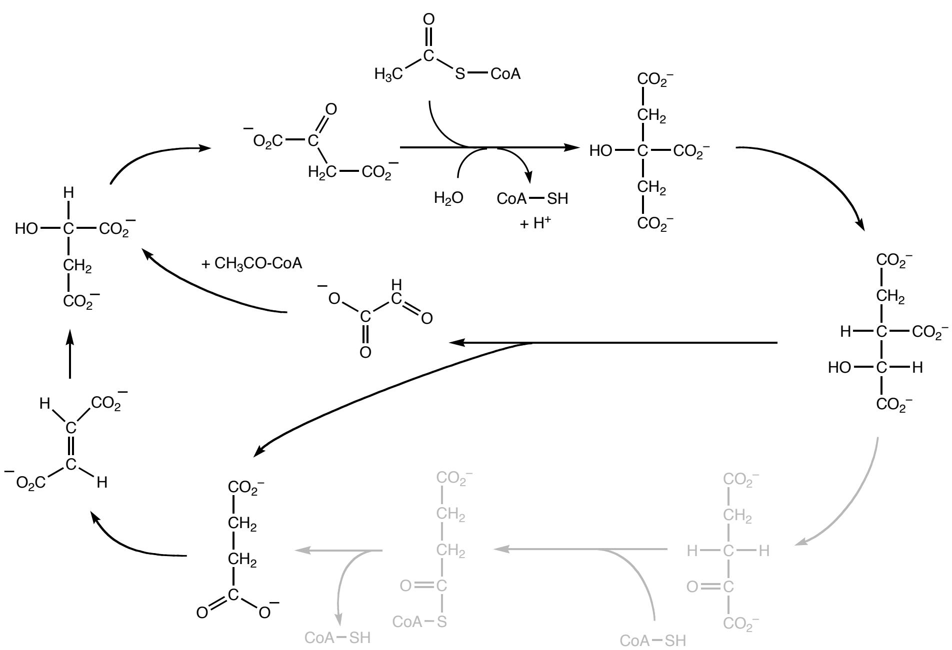
(6 pts.) Redox wise, what is the significance of this step for the S atoms of the lipoyl amide?

10. Considering only the carbon atoms, for one crank of the citric acid cycle the overall stoichiometry of the reaction is... (One crank means start at the top and go all the way around until you get back to the top.)

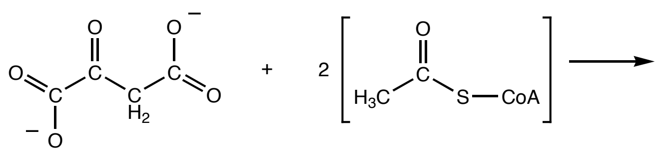
a. (4 pts.)



Drawn below is a representation of the glyoxylate cycle. Considering only the carbon atoms, for one crank of the glyoxylate cycle the overall stoichiometry of the reaction is... (One crank means start at the top and go all the way around until you get back to the top.)



b. (4 pts.)

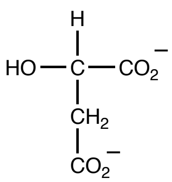


c. (2 pts.) Which pathway is better suited for building molecules containing four carbon atoms from two-carbon atom precursors, the citric acid cycle or the glyoxalate cycle?

d. (6 pts.) Explain why one path is better suited for the task described in part c.

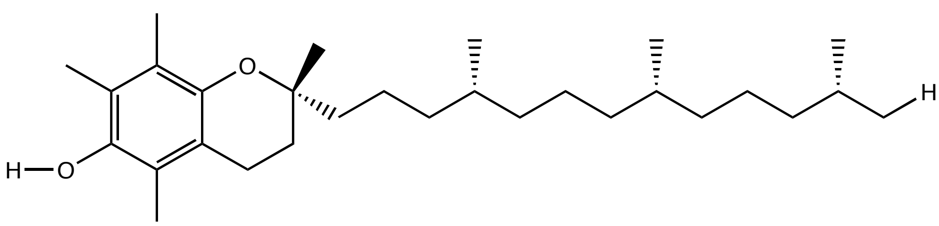
11. Although it is complicated, when it comes to getting NADH from the cytosol into the mitochondrial matrix the aspartate-malate shuttle has a distinct advantage over the glycerol phosphate shuttle. In the glycerol phosphate shuttle the reducing power of NADH is used to reduce dihydroxyacetone phosphate to glycerol phosphate which is then delivered to the mitochondrion and used to form $FADH_2$. However, in the aspartate-malate shuttle, the reducing power of NADH is used to convert oxaloacetate to malate, which is then delivered in the matrix of the mitochondrion.

(8 pts.) Why would delivering malate (in the aspartate-malate shuttle) into the mitochondrial matrix be better than converting NADH to $FADH_2$ (in the glycerol phosphate shuttle)? (Feel free to flip back through the test and see where malate appears in other important pathways. You may also want to flip to the last page where some supplemental information has been attached.)



malate

12. (6 pts.) Describe the traits that make vitamin E an effective intramembrane antioxidant.



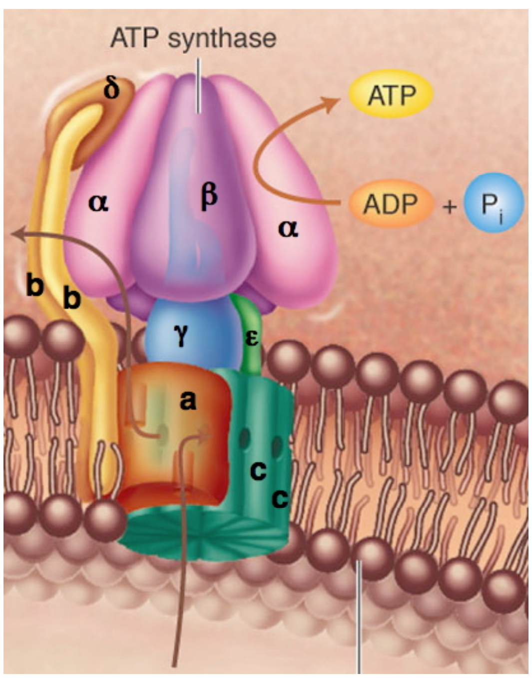
13. (6 pts.) Describe two strategies that cells use to deal with radicals.

14. (8 pts.) The primary goal of the electron transport chain is to do what?

15. (8 pts.) Explain why radicals are potentially so damaging to cells.

16. (10 pts.) ATP Sythase is a large molecular machine that synthesizes ATP. What provides the energy to drive this machine.

17. A cartoon of ATP Synthase from *Biochemistry* by McKee and McKee is pictured below.



a. (4 pts.) Which subunits move (list them by letter here)?

b. (4 pts.) Which subunits are stationary (list them by letter here)?

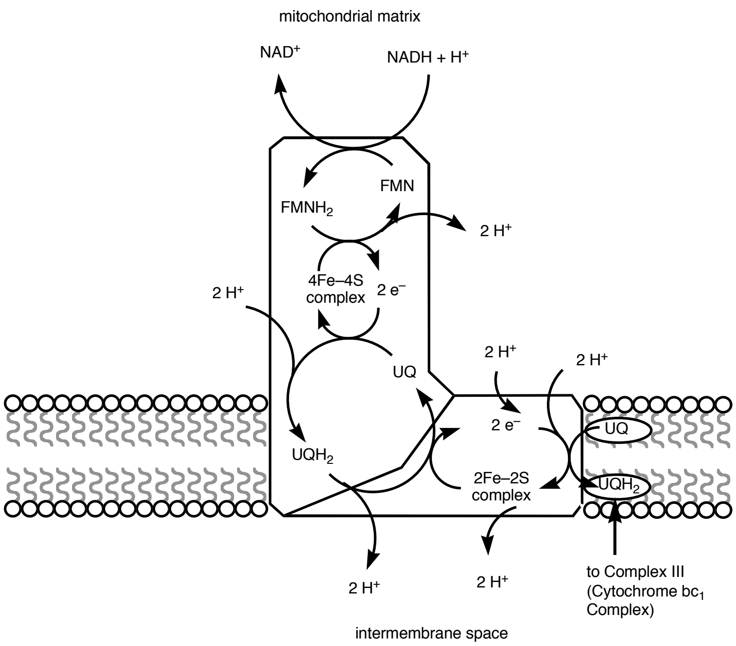
c. (4 pts) Which side of the drawing represents the matrix of the mitochondrion ?

d. (6 pts.) What is the role of the γ and ε subunits?

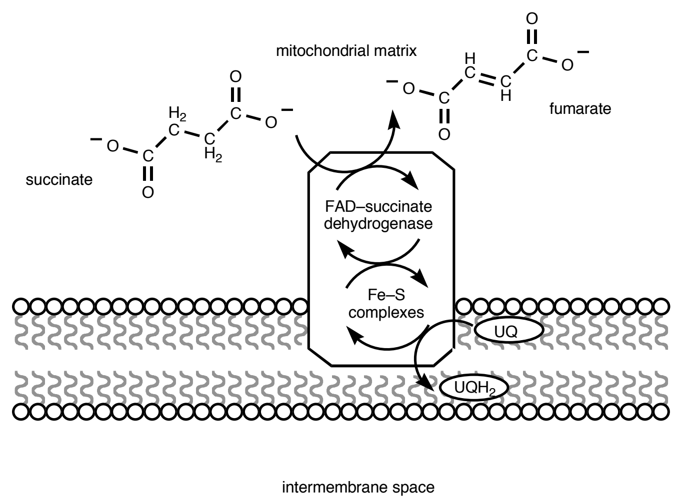
Supplemental information for question 11.

Complex I

NADH Dehydrogenase Complex

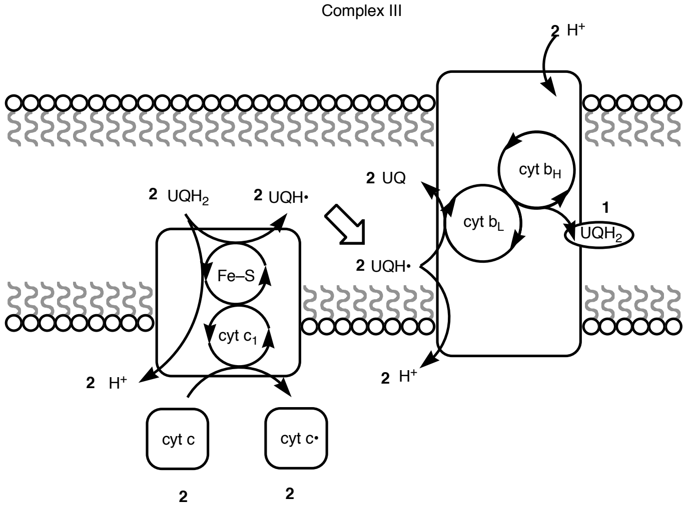


ETC Complex II

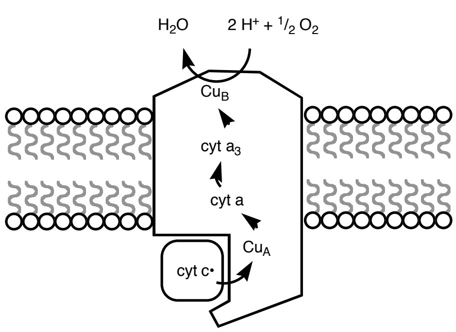


Cytochrome bc_1 complex

Complex III



Cytochrome Oxidase
Complex IV



Glycerol Phosphate Shuttle