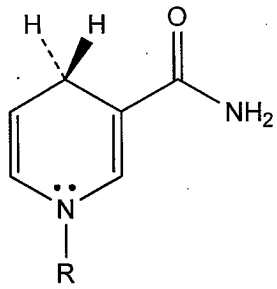
 Name _____

Biochemistry 5700
Fall, 2010
Exam 4

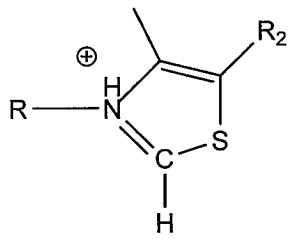
INSTRUCTIONS:
Do not begin until 10:30 AM. The exam must be turned in by 11:20 AM.

PLEASE USE THE FOLLOWING ABBREVIATED STRUCTURES AS THE BASIS FOR DRAWING MECHANISMS INVOLVING THESE COFACTORS. Note cofactors will undergo structural changes (e.g. oxidation, reduction, deprotonation, acylation, etc. during catalysis, so modify the structures as needed as you draw mechanisms.

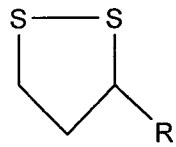
Abbreviated cofactor structures



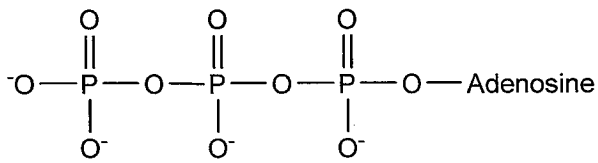
(1)



(2)



(3)



(4)

FAD

(5)

HSCoA

(6)

 Name _____

1. (3 points) The reactions of glycolysis beginning with glucose and ending with pyruvate consume 2 ATP molecules, form 4 ATP molecules via substrate level phosphorylation, and form 2 NADH molecules.

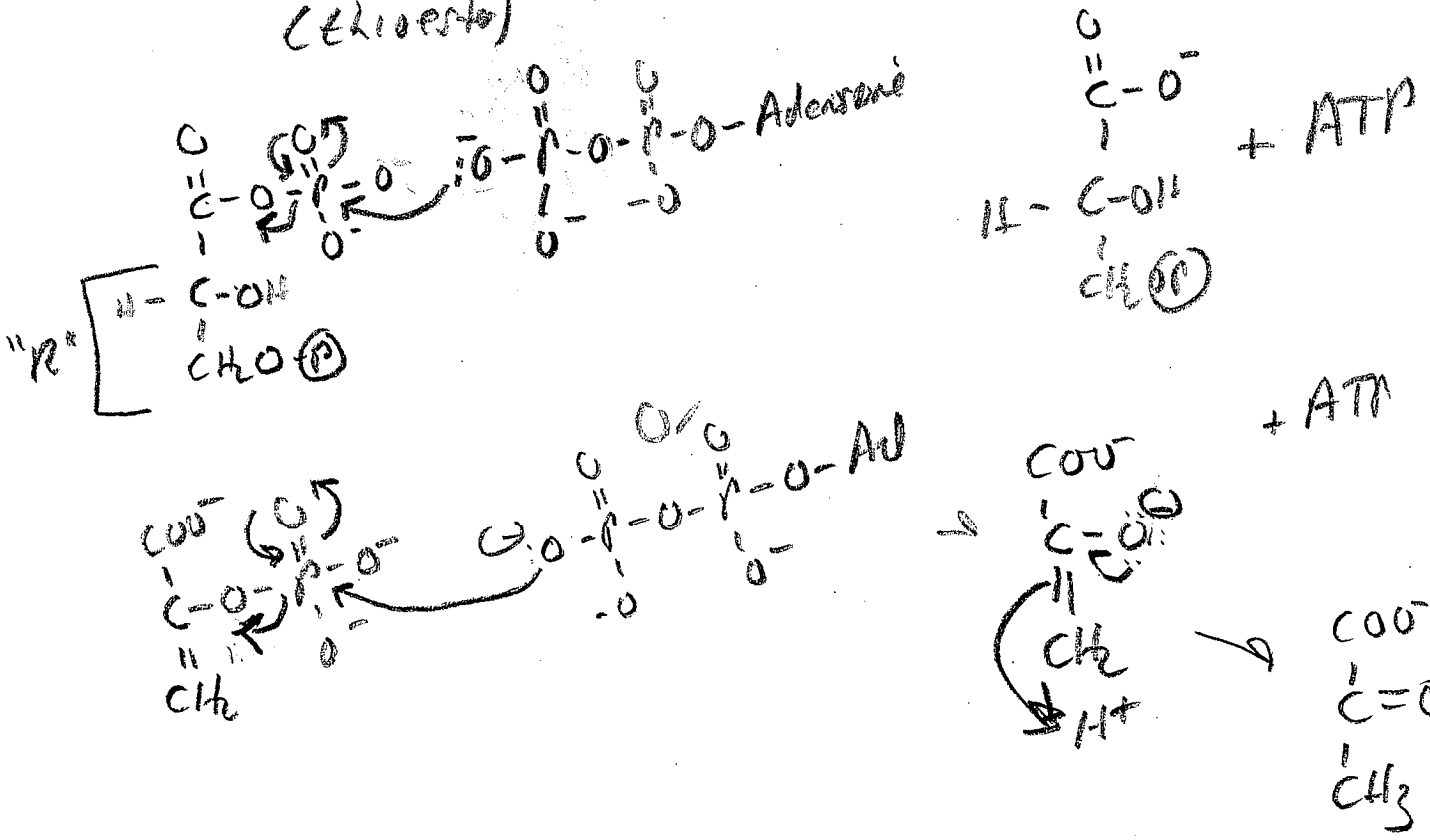
2. (3 points) For the reactions of glycolysis, a schiff base adduct is formed by the enzyme aldolase, a thioester adduct is formed by the enzyme glyceralde-3-phosphate DH and a phosphoenzyme adduct is involved in the enzyme phosphoglucomutase.

3. (12 points) Write balanced chemical equations (no structures) for the reactions of glycolysis and the citric acid cycle that result in substrate level phosphorylation. Then, indicate which general class of high energy compound each substrate in these reactions belongs to. Finally, draw a reaction mechanism (with structures) for any one of these enzymes.

(1) 1,3-diphosphoglycerate (acyl phosphate) + ADP ⇌ ATP + 3-phosphoglycerate

(2) phosphoenolpyruvate (enol phosphate) + ADP ⇌ Pyruvate + ATP

(3) Succinyl-CoA (thioester) + GDP + Pi ⇌ succinate + GTP + HSCoA

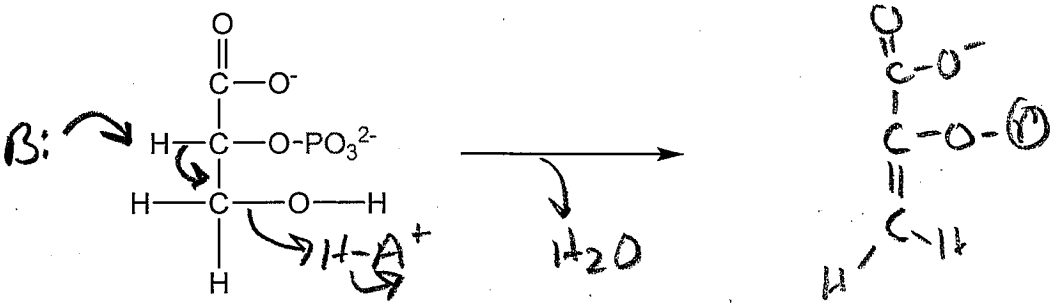


18

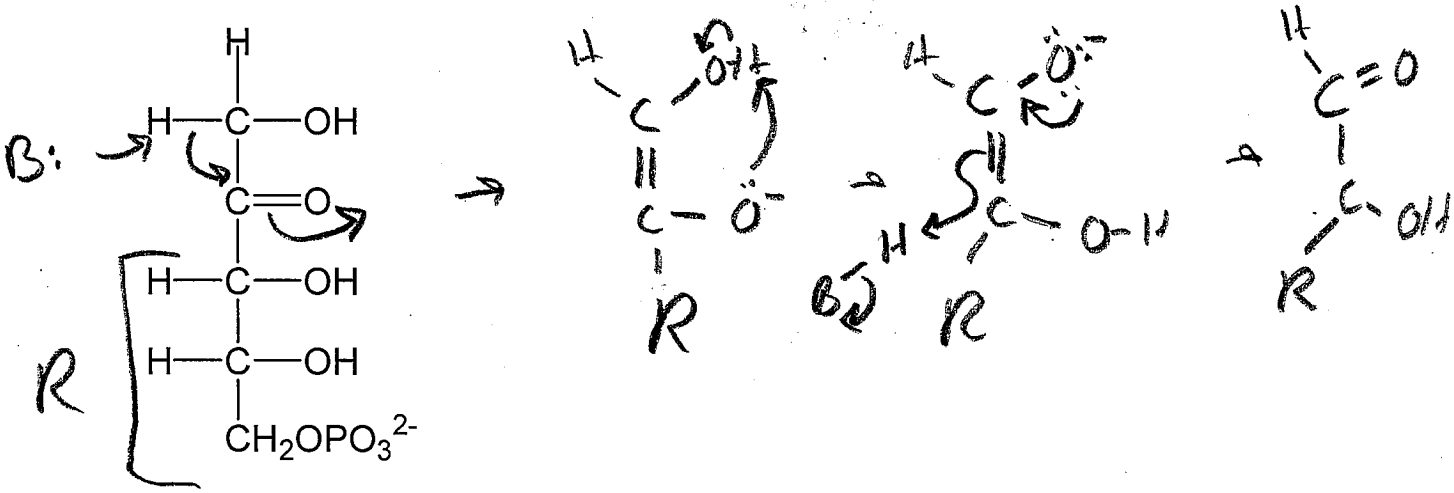
 Name _____

4. (6 points) Oxidation of glucose to two pyruvates releases 4 electrons; oxidation of one pyruvate to two CO_2 releases 10 electrons, and the complete oxidation of glucose to CO_2 and water releases 24 electrons.

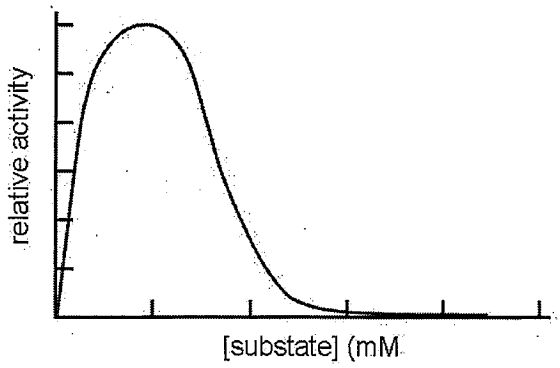
5. (5 pts) Add electron pushing arrows and draw the structure of the product to complete the following transformation (one step should be sufficient, no intermediates necessary).



6. (6 points). Ribose-5-phosphate isomerase catalyzes the interconversion of the keto sugar ribose-5-phosphate and the aldo sugar ribulose-5-phosphate during photosynthetic carbon fixation. Based on your knowledge of the chemistry of aldo/keto sugar conversions, propose a mechanism for converting ribose-5-phosphate to ribulose-5-phosphate. Start with the structure drawn below:



7. (2 points) The following v vs. S plot would be observed for the enzyme phosphofructokinase where the substrate being varied is ATP

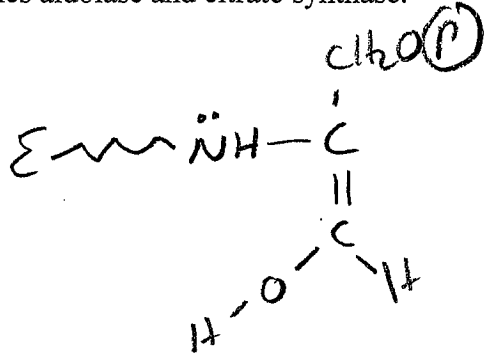


19

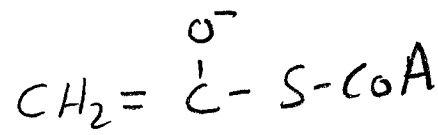
 Name _____

8. (8 points) Draw the structures of the resonance stabilized carbanions that are formed as intermediates by the enzymes aldolase and citrate synthase.

aldolase



Citrate synthase



9. (6 points) Fructose can serve as a substrate for hexokinase (muscle) but not glucokinase (liver). Use this information to outline the pathways by which fructose is converted to glycolytic intermediate(s) in the (a) muscle and (b) liver. Do not show structures, just names for compounds.

(a) fructose —ATP/ADP→ fructose-6-P —ATP/ADP→ fructose 1,6-di-P

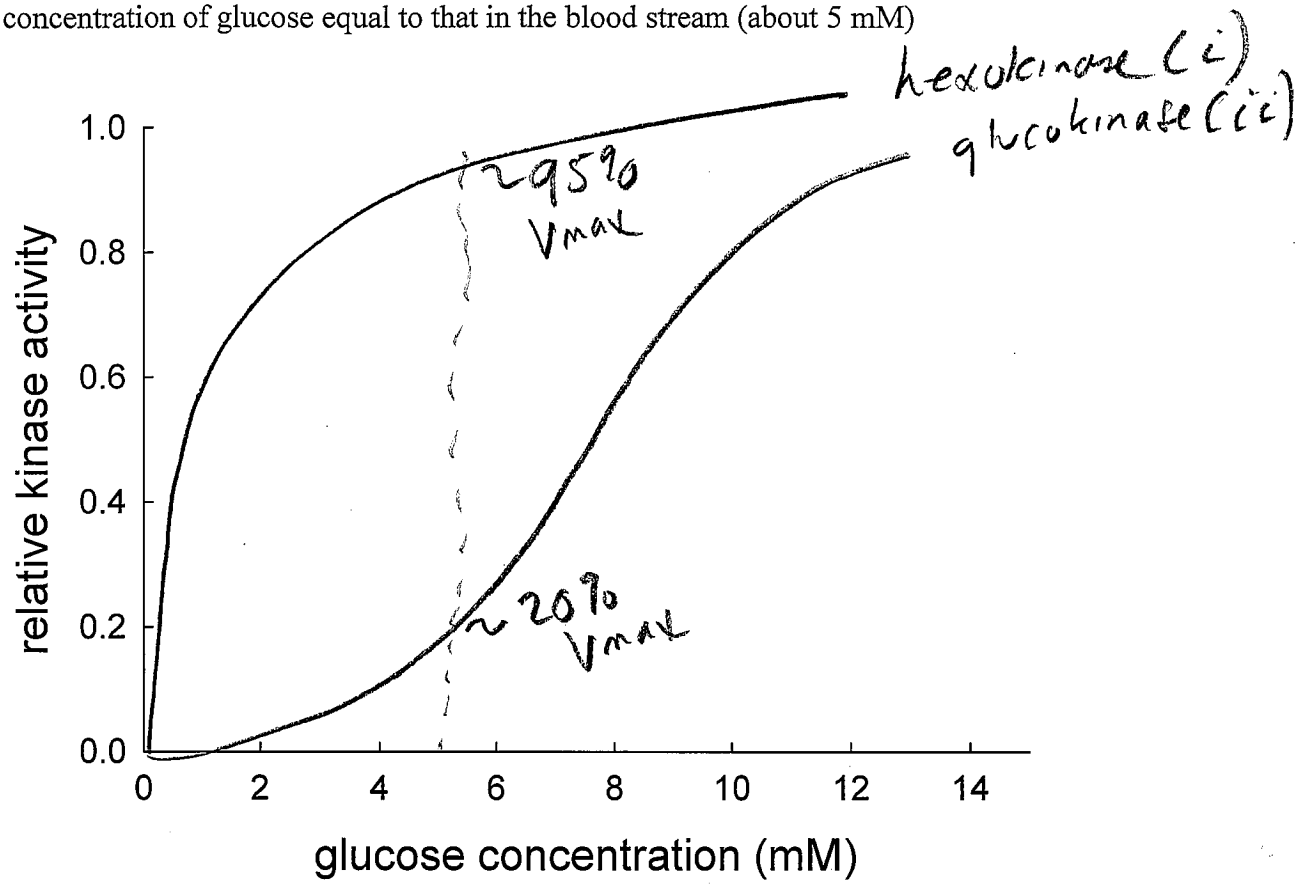
fructose-6-P → dihydroxyacetone-P + glyceraldehyde-3-P (to use)

(b) fructose —ATP/ADP→ fructose-1-P → glyceraldehyde —ATP/ADP→ glyceraldehyde-3-P

14

 Name _____

10. (6 points) Add the curves to the plot below that will be seen for the enzymes (i) kexokinase in muscle and (ii) glucokinase in liver. Indicate at about what % of V_{max} each enzyme will operate at the concentration of glucose equal to that in the blood stream (about 5 mM)



11. (4 points) What is the correct sequence of events involved in hormonal activation of glycogen breakdown in the muscle? Number the following steps in the order in which they occur (1 to 7).

Step	step
Production of cAMP	4
Conformational change in G protein	2
Activation of glycogen phosphorylase	7
Binding of epinephrine to cell receptor	1
Activation of phosphorylase kinase	6
activation of protein kinase	5
Migration of G_α to adenylyl cyclase	3

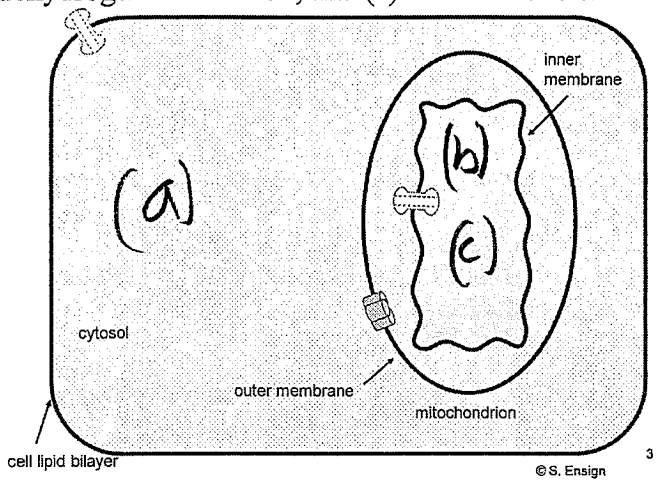
12. (4 pts) ~~In one or two sentence,~~ Briefly explain the mechanism by which active glycogen phosphorylase *a* in the liver undergoes deactivation when glucose levels rise

Glucose binds to modulator sites. This induces a conformational change exposing the phosphorylated residues and glycogen phosphorylase phosphatase now removes the phosphates, activating the enzyme

14

 Name _____

13. 6 points. Indicate on the following diagram where (a) the reactions of glycolysis, (b) the pyruvate dehydrogenase reaction, and (c) the reactions of the citric acid cycle occur.



14. (7 points) Name the enzyme from the citric acid cycle that catalyzes each of the following reactions:

(a) isomerization — aconitase

(b) claisen condensation — citrate synthase

(c) oxidative decarboxylation using thiamine pyrophosphate (TPP) — α-KG DH

(d) oxidative decarboxylation not requiring TPP — Isocitrate DH

(e) net substrate hydration — fumarase

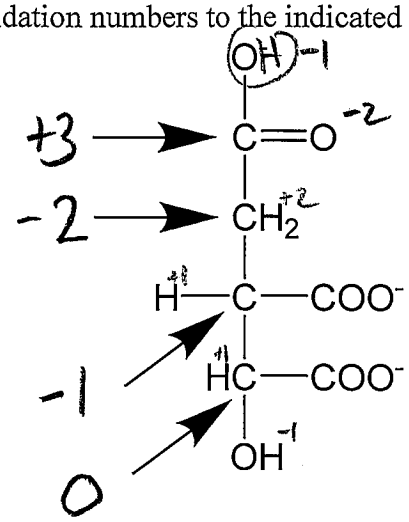
(f) alcohol dehydrogenation — malate DH

(g) dehydrogenation of a C-C bond — succinate DH

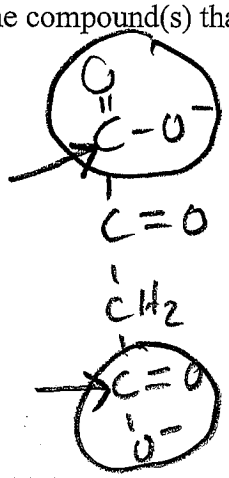
13

 Name _____

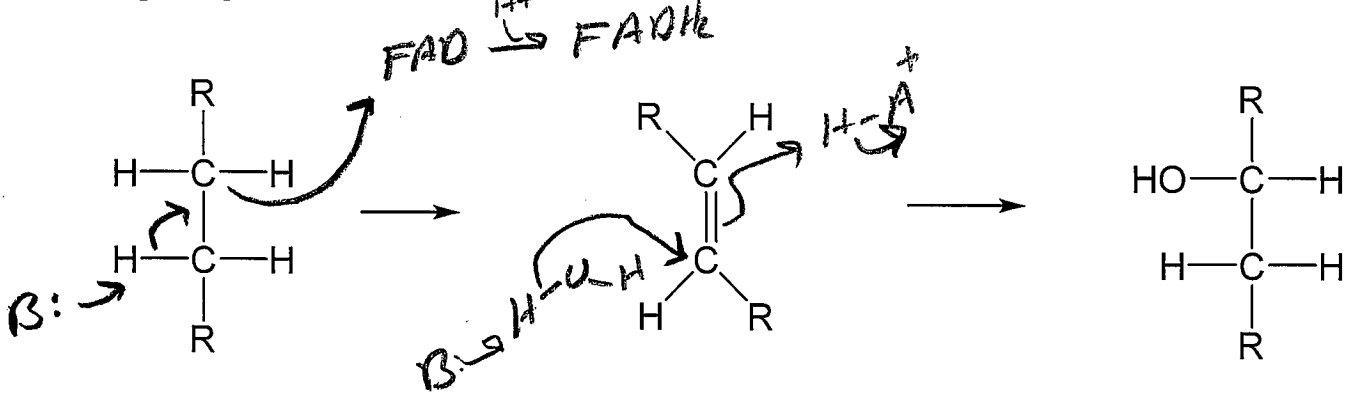
15. (4 points) Assign correct oxidation numbers to the indicated carbon atoms in the compound.



16. (4 points) The two molecules of CO_2 released in one turn of the citric acid cycle are derived from which carbon atoms on which of the substrate(s) that feed into the cycle? To answer this, draw the structure(s) of the compound(s) that provide the two CO_2, and label the carbon atoms that end up in the two CO_2.



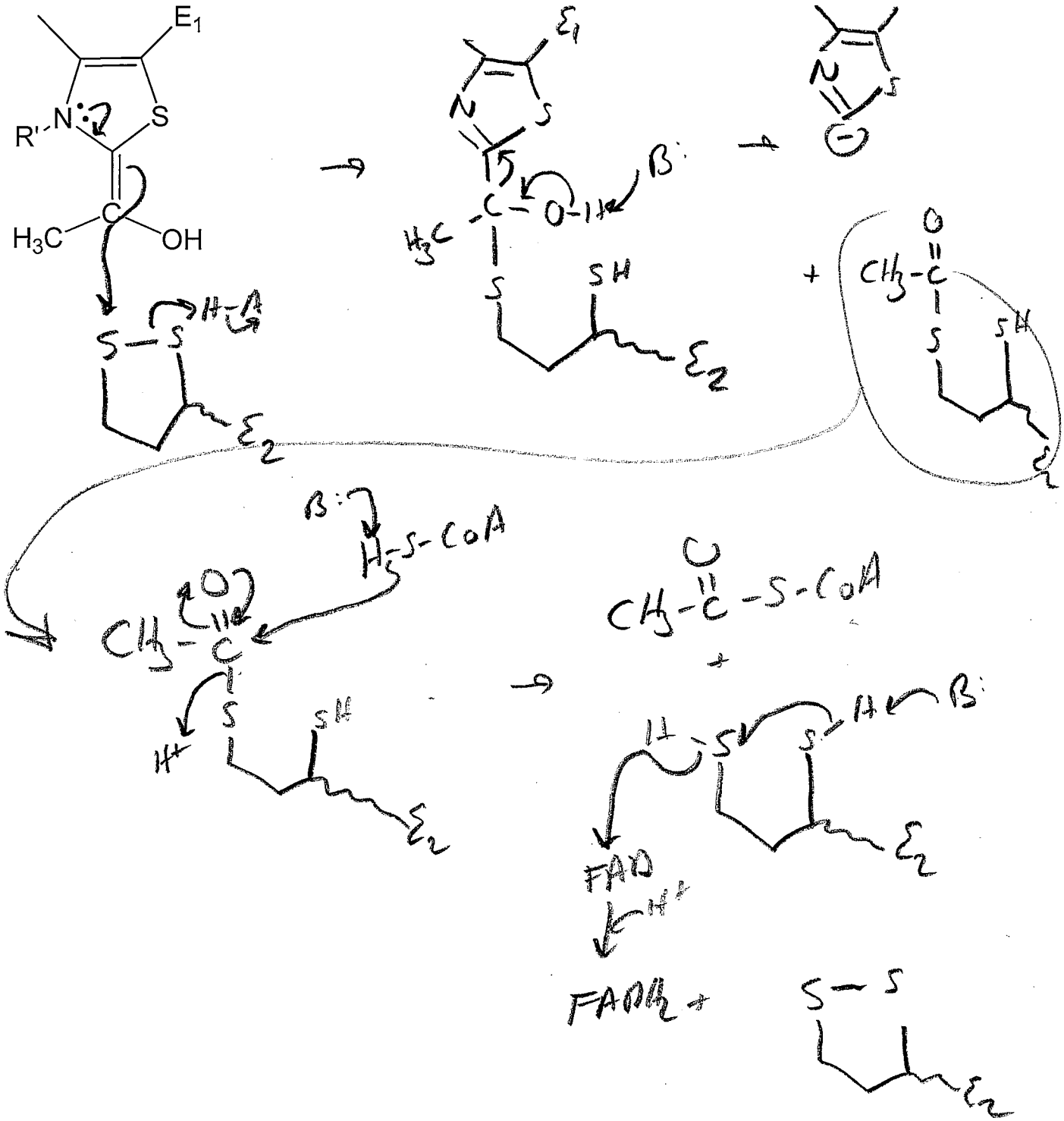
17. (6 points). Add the necessary electron pushing arrows for the following transformations, using any required general acids or bases, and additional substrates or cofactors..



14

 Name _____

18. (8 points). Complete the reaction mechanism for pyruvate dehydrogenase beginning with the resonance stabilized carbanion shown below. You may use the abbreviated forms of cofactors as indicated on the front page of the exam.



8