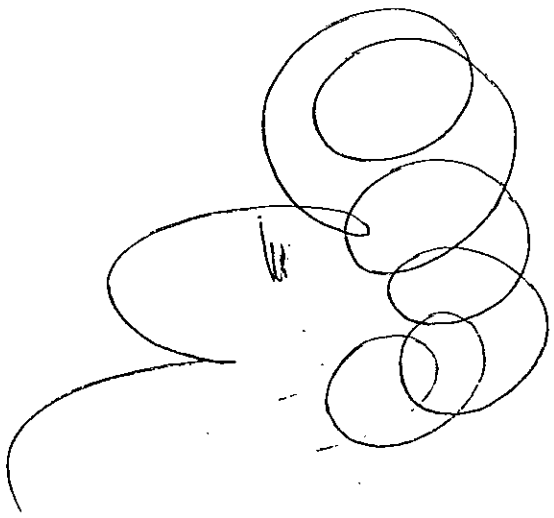
Name Key

Biochemistry 5700
Fall, 1998
Exam 3
November 23, 1998

INSTRUCTIONS:

Do not begin until 10:30 AM. The exam must be turned in by 11:20 AM. This exam should have 5 questions and 7 pages. Please print your name at the top of each page of the exam. Answer **all** questions completely, concisely, and legibly in the spaces provided. Good Luck!!



 Name Key

(1) 15 points. For each of the cofactors listed below, name a catabolic enzyme using that cofactor and briefly describe the function of the cofactor in accelerating the enzymatic reaction.
Example: pyridoxal phosphate- found in alanine aminotransferase. Used in the transfer of the amino group of alanine to α-KG to form pyruvate and glutamate. A covalent schiff base adduct is formed between PLP and alanine; this adduct is hydrolyzed to pyruvate with the amino group subsequently being transferred to α-KG.

(a) biotin

Propionyl-CoA carboxylase activates HCO_3^- to CO_2 in a rxn requiring ATP hydrolysis.

(b) coenzyme B12

methylmalonyl-CoA. Assists in migration of a group "R" by generating the 5'deoxyadenosyl radical, which promotes C-C homolytic bond cleavage.

(c) FAD

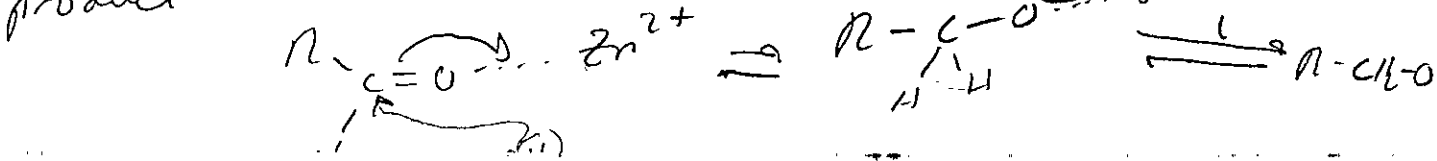
Pyruvate DH complex (and others). An electron transfer cofactor, accepts 1 or 2 e^-. In PDH, facilitates lipoamide oxidation

(d) Lipoic acid

Pyruvate DH complex (and others). Participates in oxidative decarboxylation of pyruvate by accepting 2 e^- as hydroxyethyl TPP intermediate is oxidized to acetyl-level. Both e^- carrier & acyl group carrier

(e) zinc

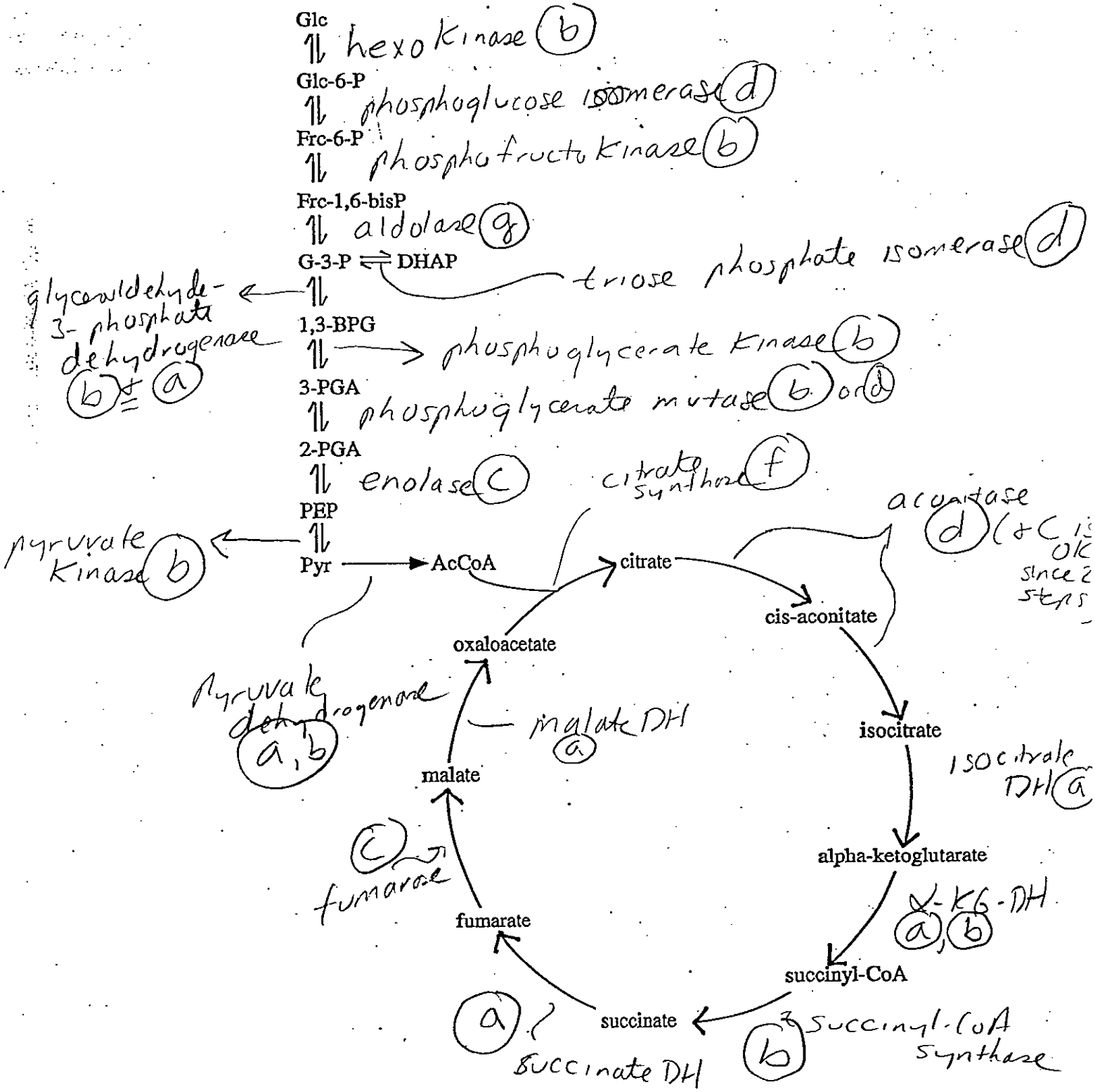
Alcohol dehydrogenase. Stabilizes "alkoxide" of alcohol substrate or product:



 Name Key

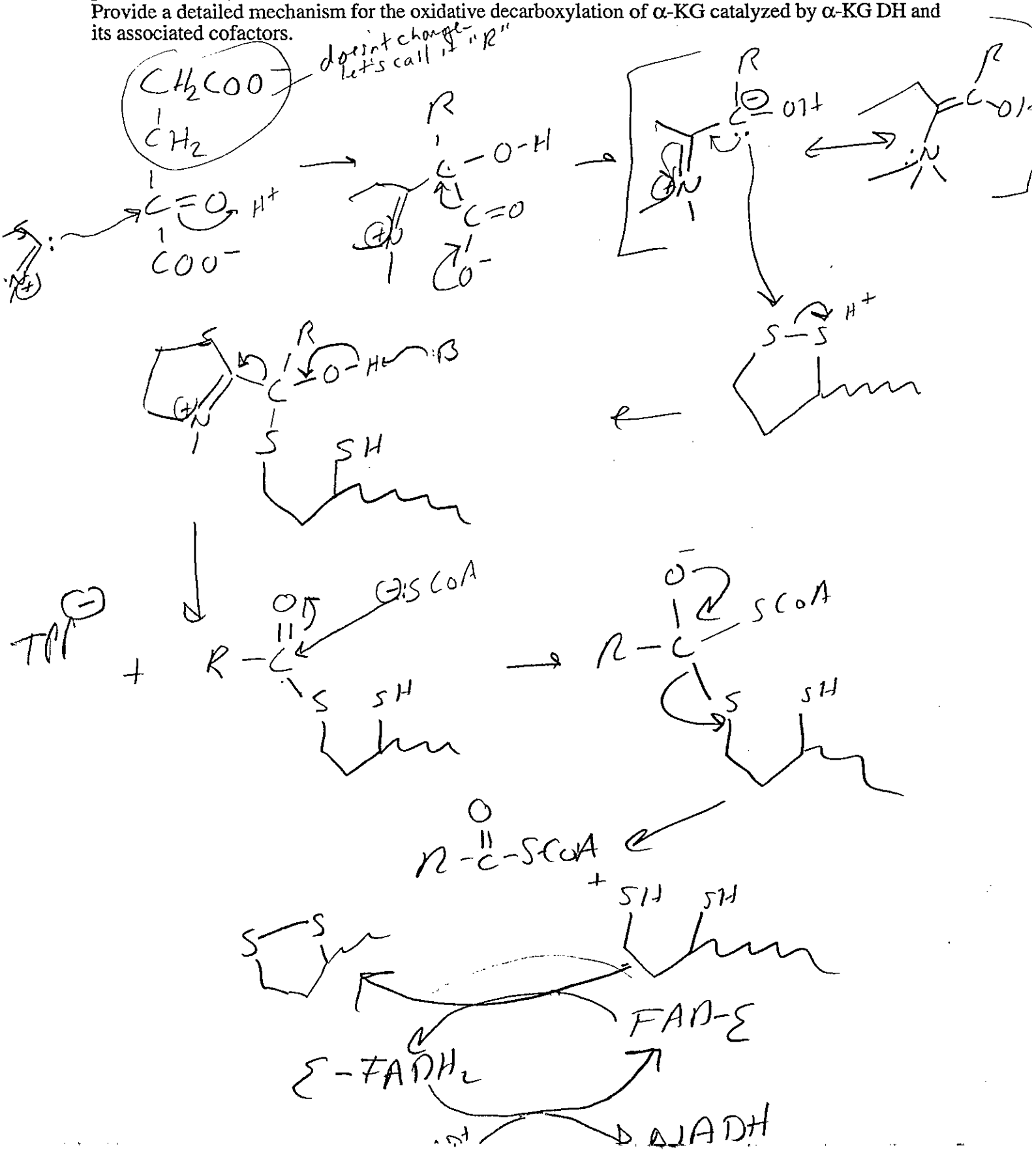
(2) (20 points) For each of the transformations shown below, name the enzyme catalyzing the reaction. Under the name of the enzyme, place the letter(s) indicating the type(s) of reaction the enzyme is catalyzing. Note that a given enzyme may be classified with more than one letter. The choices are:

(a) oxidation/reduction (b) group transfer (c) elimination
(d) isomerization (e) rearrangement (f) claisen condensation (or the reverse of this) (g) aldol condensation (or the reverse of this)



 Name Key

(3) (20 points) The reaction catalyzed by α-ketoglutarate dehydrogenase (α-KG DH) closely resembles that catalyzed by pyruvate dehydrogenase (PDH). The protein components of α-KG DH are very similar to those of PDH, the cofactors are identical, and the mechanisms of the two enzymes proceed similarly.
Provide a detailed mechanism for the oxidative decarboxylation of α-KG catalyzed by α-KG DH and its associated cofactors.

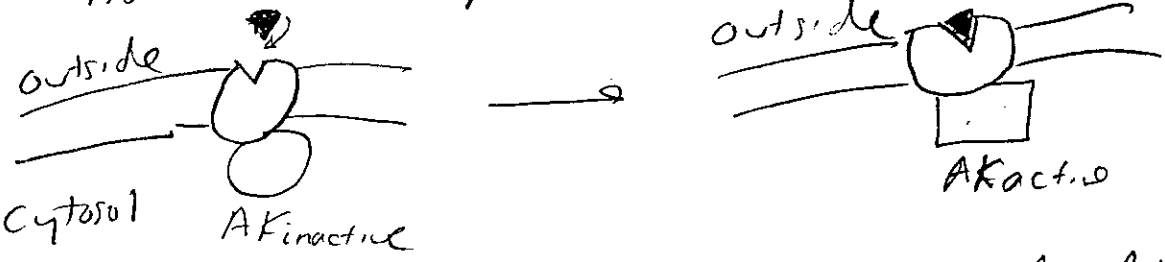


 Name Key

(4) (15 points) Describe the series of events involved in the hormonally-controlled mobilization of stored fat or glycogen (choose one) for use as an energy source (i.e. describe what happens from the time of hormone production and release from the adrenal gland).

glycogen: Epinephrine binds to a surface receptor of a myocyte; (in the case of a hepatocyte, the hormone is glucagon)

- Hormone binding activates adenylate cyclase:



- Activated Adenylate cyclase converts ATP to cAMP + PPi
- cAMP activates cAMP-dependent protein kinase
- Activated protein kinase phosphorylates "phosphorylase b kinase", thereby activating it
- Phosphorylase b kinase activates phosphorylase b to phosphorylase a (by phosphorylation)
- Active phosphorylase a can now break down glycogen to glc-1-(P)

FAs: Events are similar - except target of activated by protein kinase is a triacylglycerol lipase, that is activated by phosphorylation. Once activated, TAG is hydrolyzed to FAs

 Name Key

This is 1 example of an acceptable scheme

(5) (30 points) You have isolated a novel microbe from a Martian meteor that is capable of aerobic growth with glucose. In studying the pathway of glucose metabolism in this microbe, you find that it has a normal glycolytic pathway and pyruvate dehydrogenase but not a normal TCA cycle. Instead, it has a variation of the TCA cycle in which the acetyl-CoA formed from pyruvate decarboxylation condenses with acetaldehyde to produce 3-hydroxybutyrate (3-HB)! The 3-HB formed in this condensation goes through a cyclic pathway leading back to acetaldehyde, with the formation of $2CO_2$.

Based on your knowledge of catabolism, propose a plausible cyclic pathway by which acetaldehyde and acetyl-CoA condense to 3-HB and whereby 3-HB can be converted back to acetaldehyde. Show each step of the pathway, the structures of intermediates, and the origin of the carbon atoms at each step. Also, name the enzymes and intermediates of the pathway as best you can. Indicate which steps consume/form reducing equivalents (NADH, FADH2) and/or ATP. Continue on the next page if necessary. Note- you do not have to show mechanisms for the enzymes