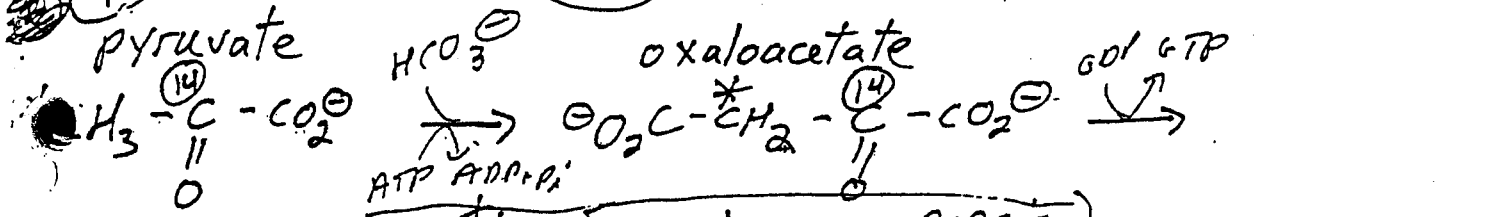
Practice Problem Answers for Exam IV:

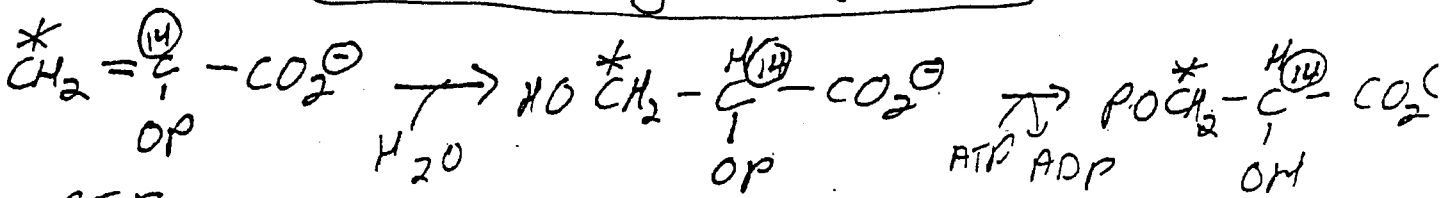
Note: You are not allowed with this packet into the exam!

(7+1)

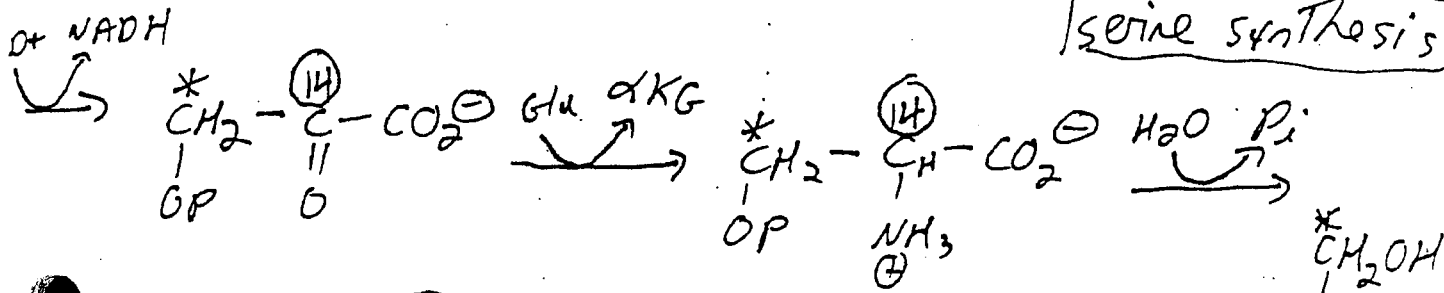
1) pyruvate

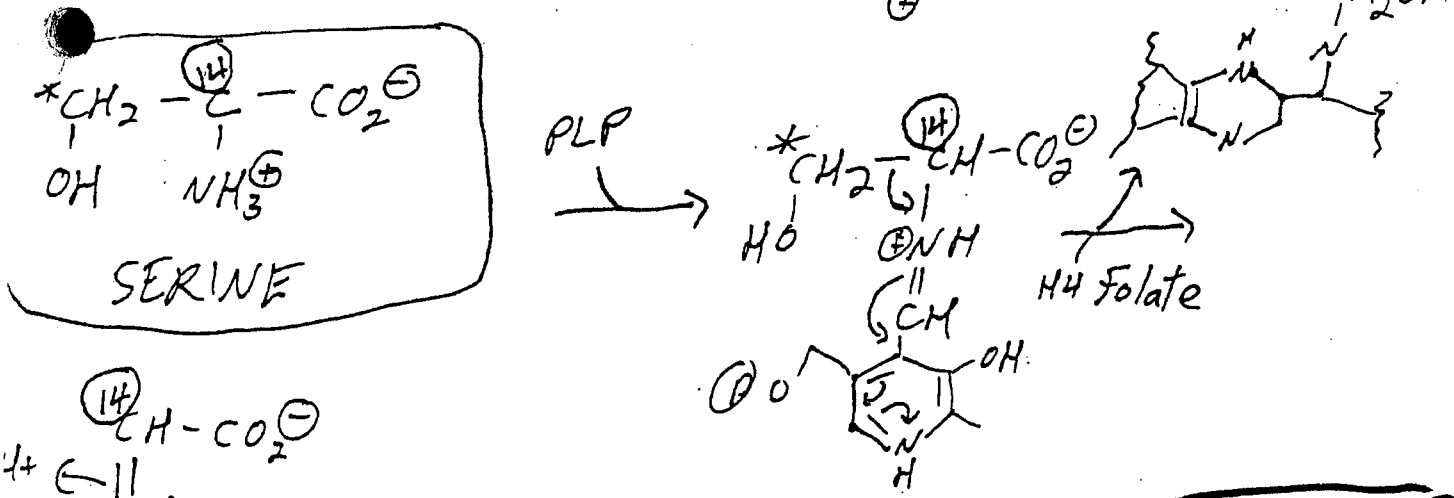


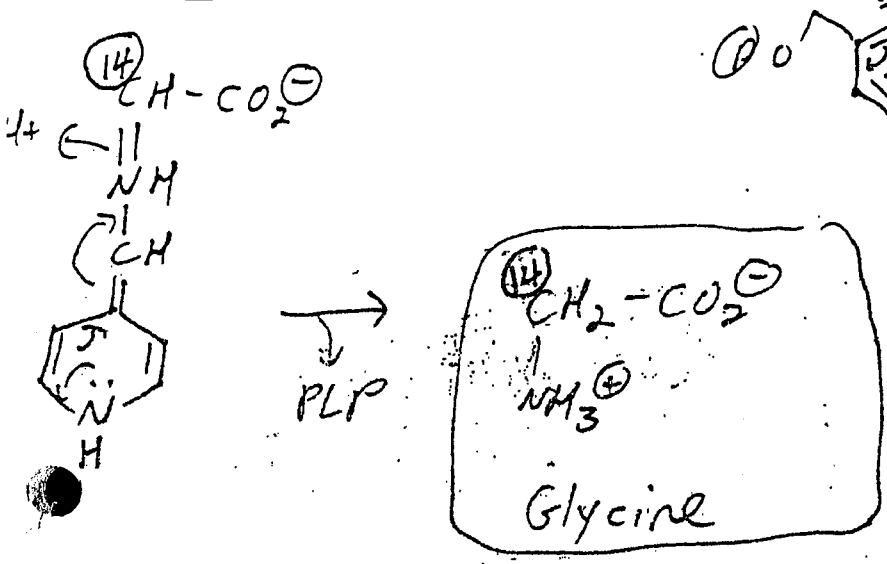
(reactions from gluconeogenesis)



Serine synthesis



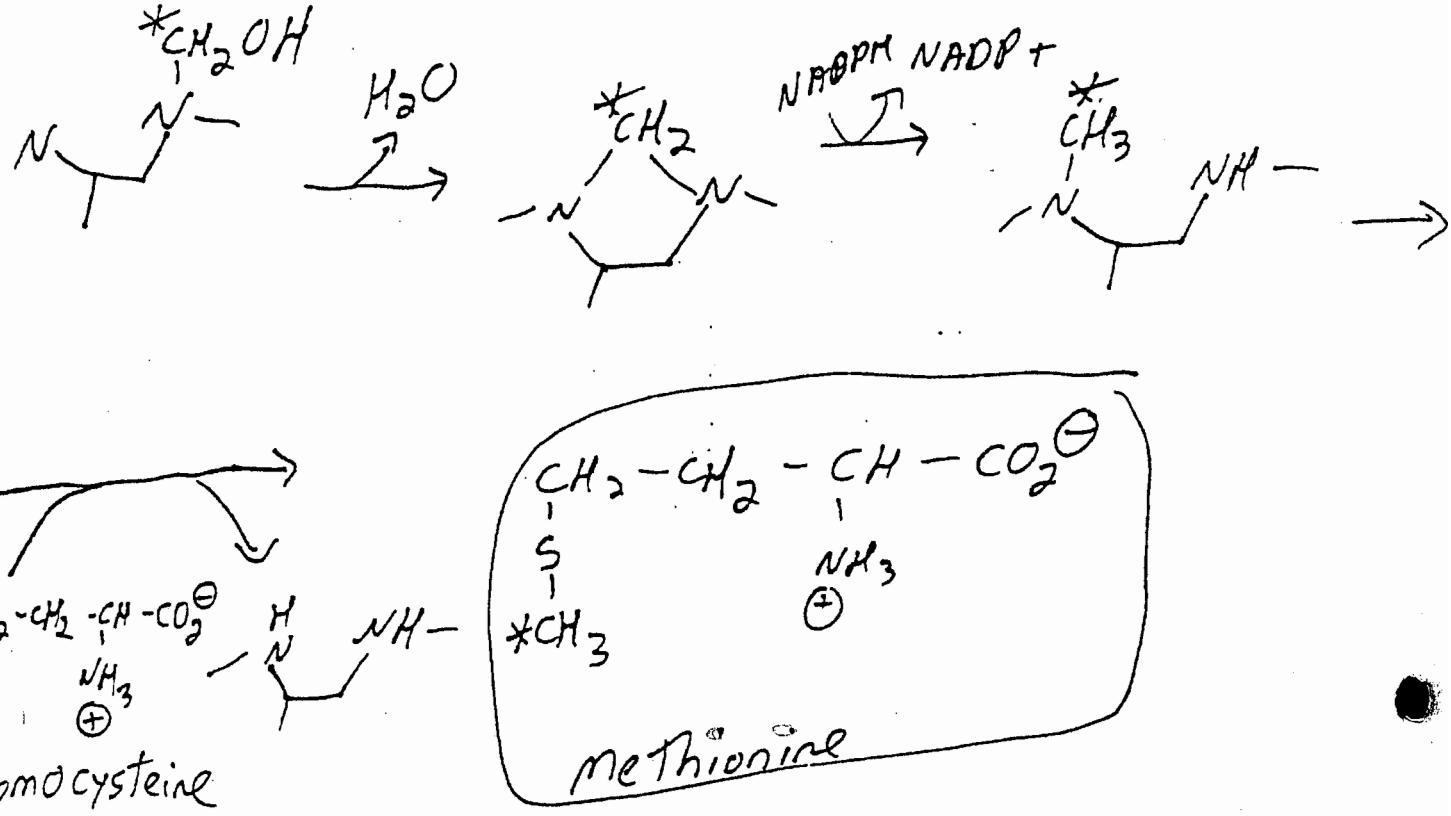




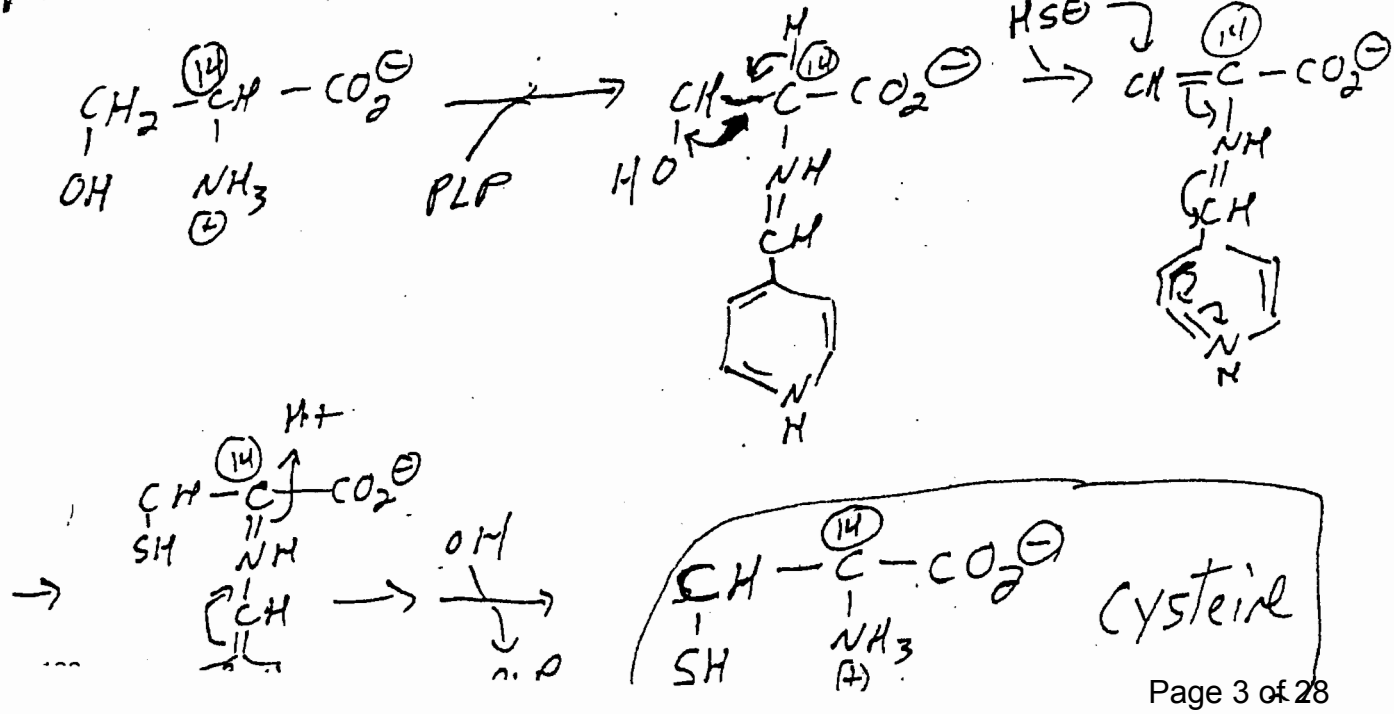
7.05
P.58
SOLUTIONS
1998

#1 cont.

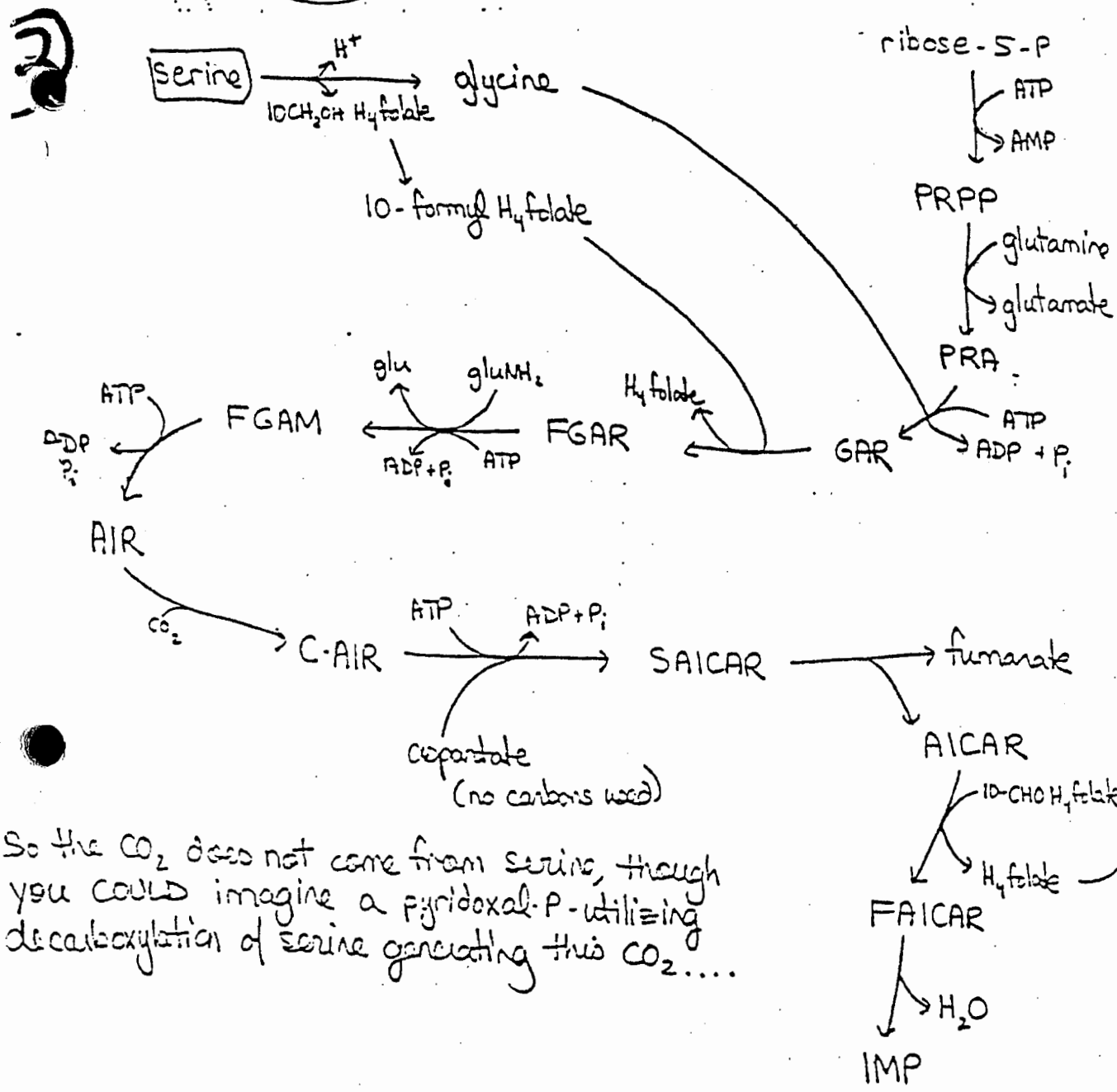
Following the folate released in formation of glycine:



Alternatively, serine can be converted to cysteine:



#2

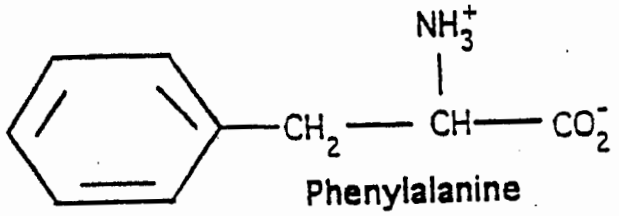


So the CO_2 does not come from serine, though you COULD imagine a pyridoxal-P-utilizing decarboxylation of serine generating this CO_2....

(#3)

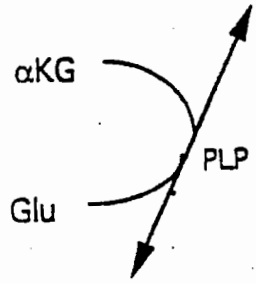
Problem 2 Solution

Graded by Steve



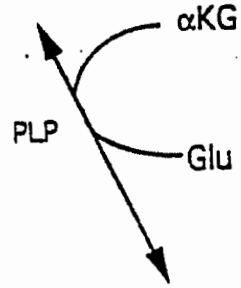
Phenylalanine

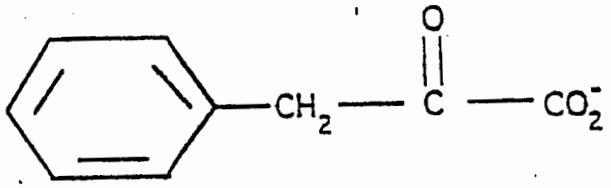
a.

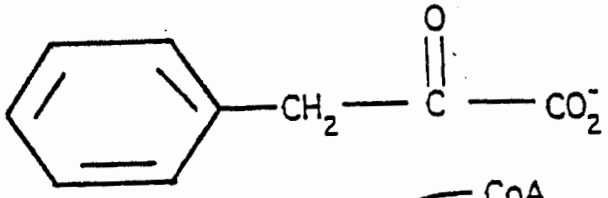


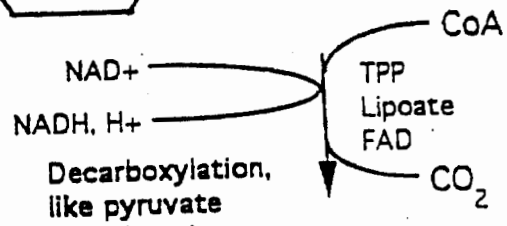
De/transamination

b.



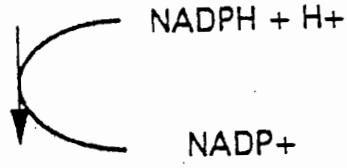


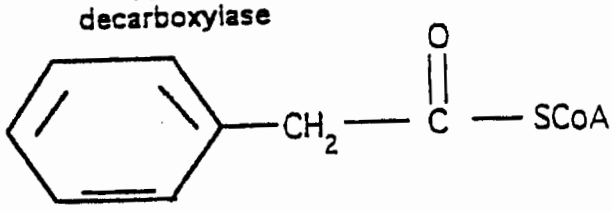


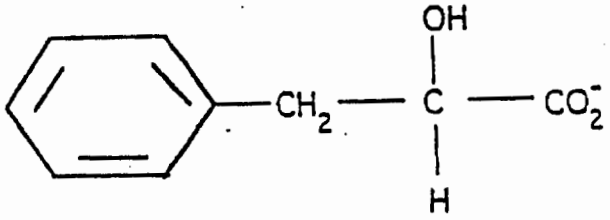


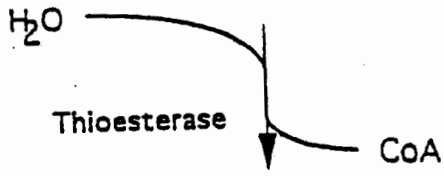
Decarboxylation, like pyruvate decarboxylase

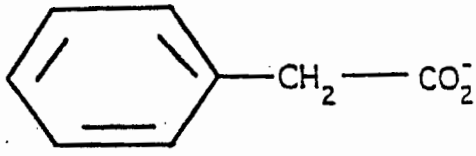
Reduction, like FA synth.











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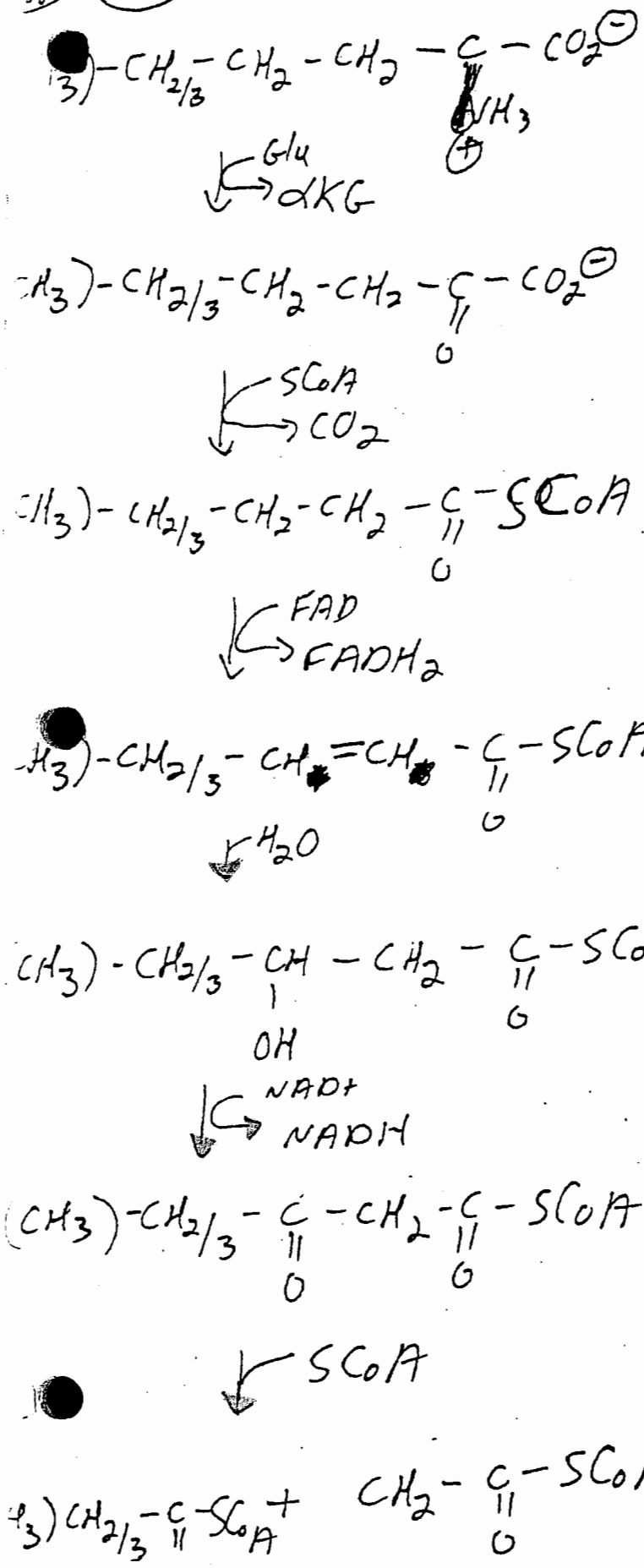
#3

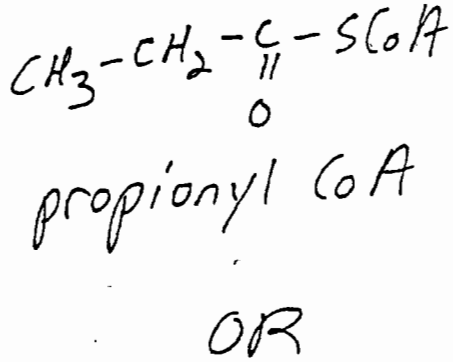
Problem 2 solution: Scoring

	POINTS
a. 1. Transamination	3
I. αKG--> Glu	1
II. PLP	1
III. α- keto acid	1
2. Reduction	3
I. Recognizing transformation req. reduction	2
II. Using NADPH, H+	1
b. 1. Transamination (same as 'a')	3
2. Decarboxylation	3
I. Coenzymes	1
II. NAD+ --> NADH, H+	1
III. CoA, CO_2	1
3. Hydrolysis of Thioester	3
I. CoA activated intermediate	1
II. H_2O	1
III. CoA	1
TOTAL	15

#4

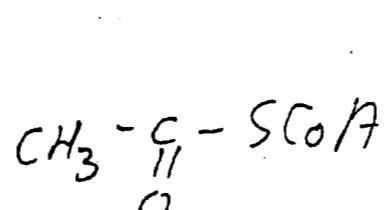
4





propionyl CoA

OR



acetyl CoA

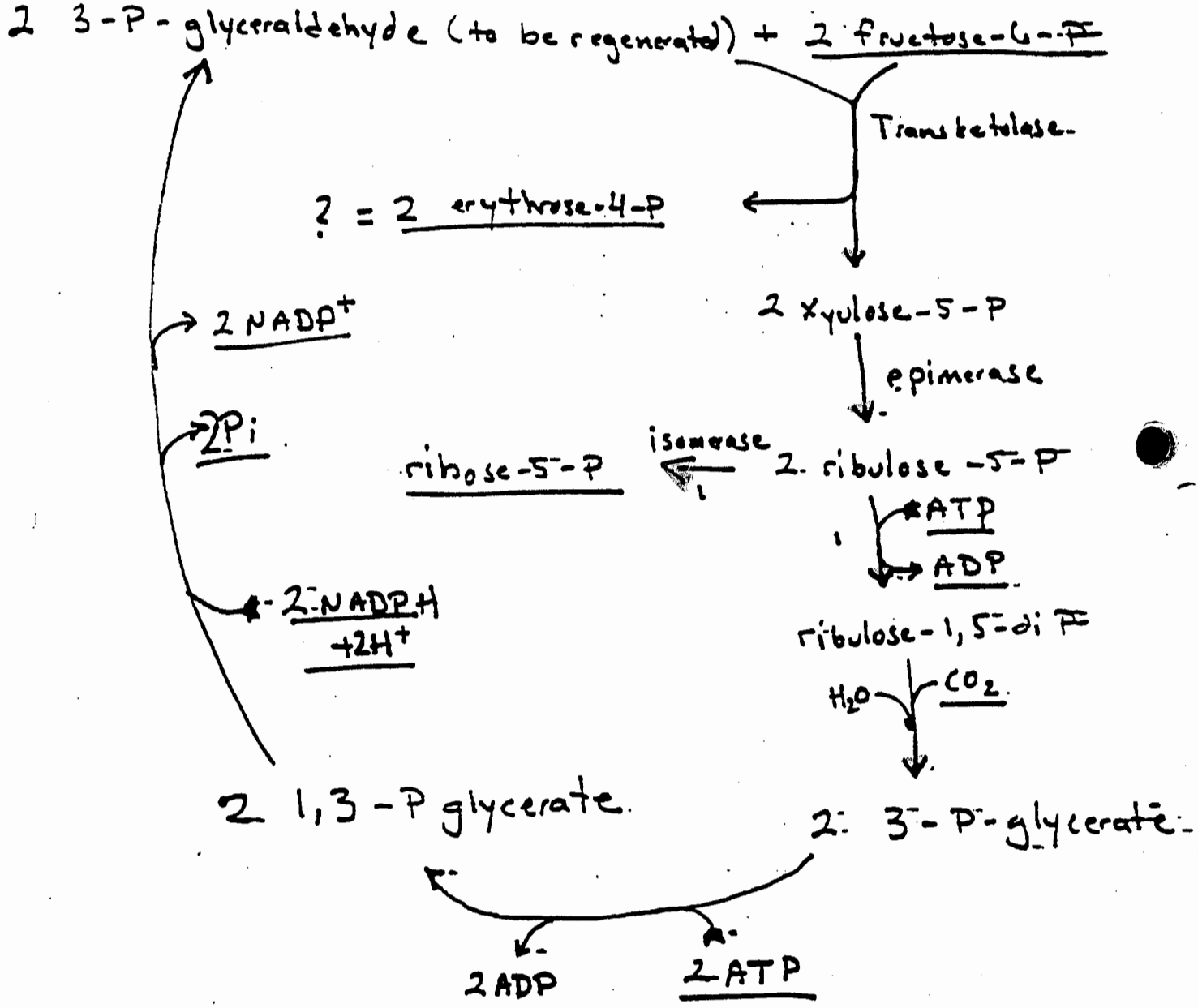
So Marsbar yields 2 acetyl CoA, so it is only Ketogenic

Milkyway yields 1 acetyl CoA and 1 propionyl CoA, and since propionyl CoA can yield Succinyl CoA Milkyway is both Ketogenic (for the acetyl CoA) and

(7 J)

1). Aldolase and Transaldolase (TA) are inactive.

CO_2 + 3 ATP + 2 NADPH + 2 H^+ + 2 fructose-6-P → 3 ADP + 2 Pi + 2 $NADP^+$ + ribose-5-P + ? = 2 erythro



#6

Question #2: Graded by Robert Batey

The only way that the chemical transformation given can be accomplished with *two* enzymes is by using an enzyme similar in mechanism to transaldolase followed by an enzyme similar in mechanism to transketolase. Thus, the two enzymatic transformations would look like:

(TA) Fructose (6C) + 5 C sugar ——————> 8 C sugar + glyceraldehyde 3-P
(TK) 8 C sugar + glyceraldeyde 3-P ——> xylulose 5-P + glucose 6-P

The mechanism of this transformation is given below.

Many people decided to perform this reaction using the action of epimerases and isomerases. While this can be done and these enzymes are part of the pentose pathway, it requires *three* enzymes to accomplish this overall transformation:

hexose isomerase: Fructose 6-P ——————> Glucose 6-P
epimerase: 5 C sugar (aldose) ---> 5 C sugar (ketose)
penotse isomerase: 5 C sugar (ketose) ---> xylulose 5-P

Generally, if you showed the products and intermediates of this enzymatic transformation, then you recieved 12 out of 20 points.

Another common problem was to go through the entire pentose cycle by bringing in other sugars to aid in the overall transformation. Besides using far more than the alloted two enzymes, people had to use sugars and substrates that were not given in the problem.

Lastly, note that this transformation cannot be accomplished by using a transketolase first and then a transaldolase. If you were to do this, the result would be:

(TK) Fructose (6C) + 5 C sugar ——————> 7 C sugar + 4 C sugar
(TA) 7 C sugar + 4 C sugar ——————————> another 7 C sugar + another 4 C sugar

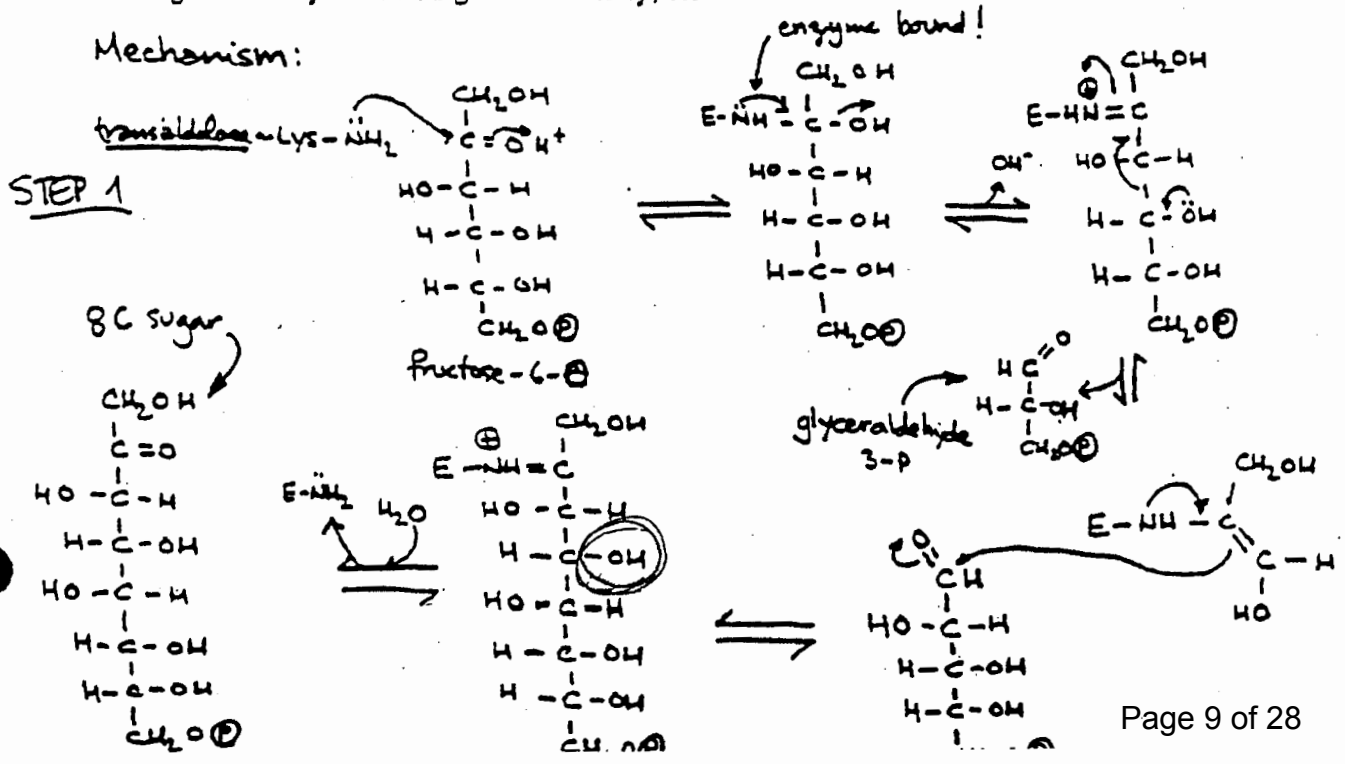
The approximate point breakdown was:

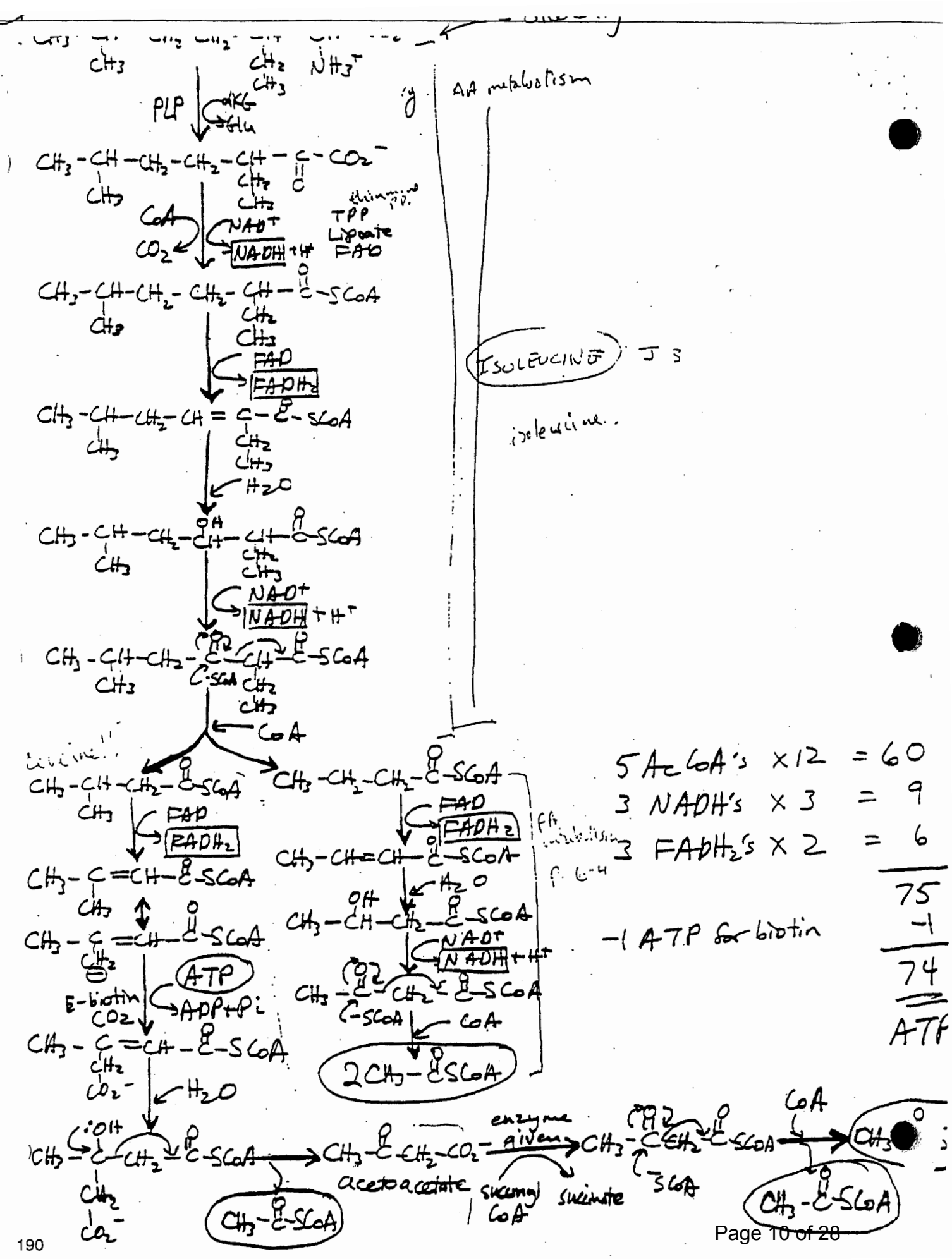
8 points for explicitly stating that the two enzymes needed were a transaldolase and a tranketolase.

12 points for drawing the enzyme bound intermediates of the transaldolase and transketolase reactions and the products of each enzymatic step.

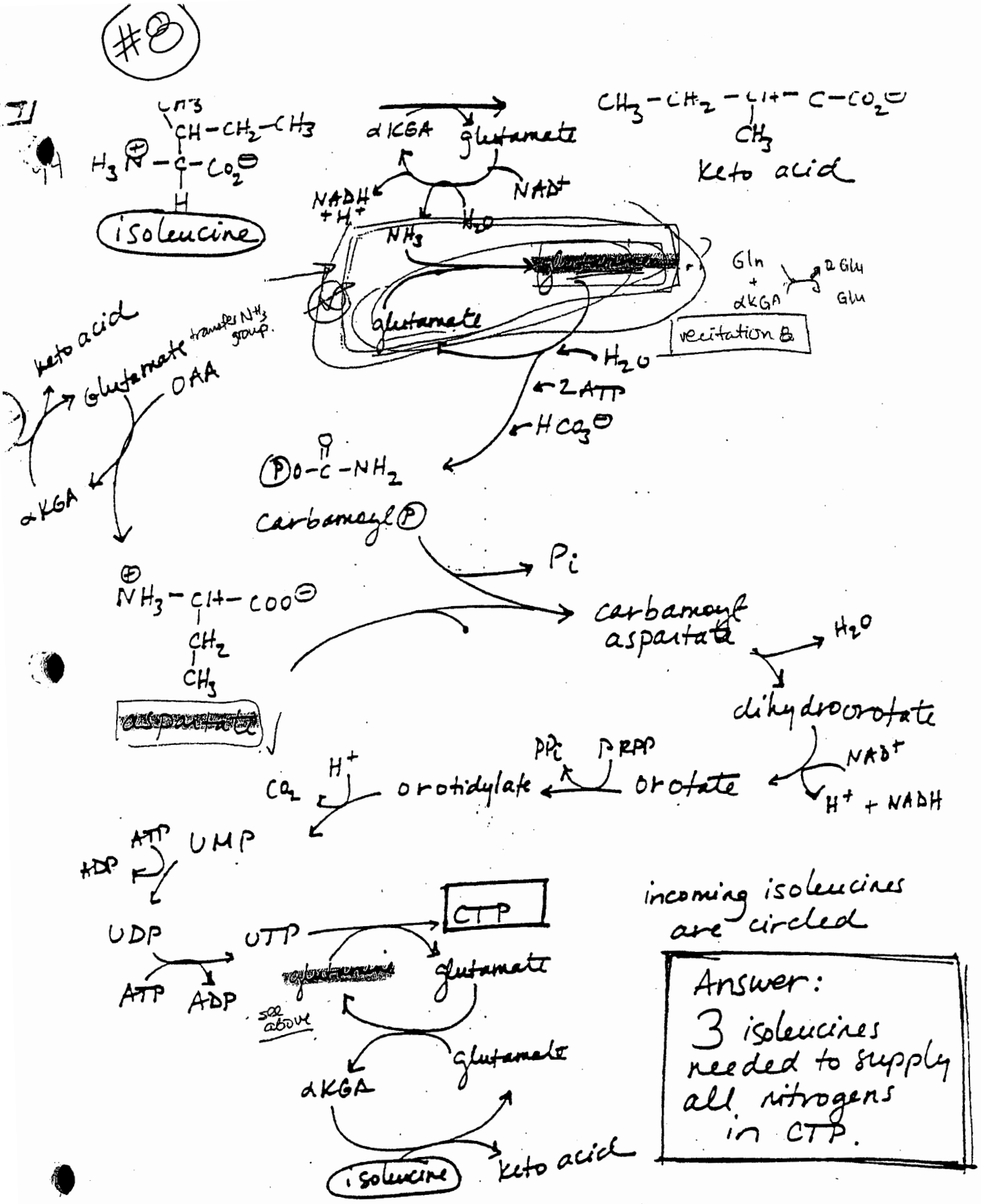
Points were deducted for errors in chemistry and/or mechanism, not explicitly stating what enzyme is doing the chemistry, etc.

Mechanism:




AA metabolism
PLP
αKG
Glu
CoA
CO2
NAD+
NADH + H+
TPP
Lipoate
FAD
FADH2
H2O
ISOLEUCINE
isoleucine
leucine
ATP
ADP + Pi
E-biotin
CO2
CoA
2 CH3-C-SCoA
FA metabolism
p. 6-4
5 AcCoA's x 12 = 60
3 NADH's x 3 = 9
3 FADH2's x 2 = 6
75
-1 ATP for biotin
-1
74
ATP
acetoacetate
enzyme
given
succinyl CoA
succinate
-SCoA

#8



incoming isoleucines are circled

Answer:
3 isoleucines needed to supply all nitrogens in CTP.

(#4)

Exam #3. Answer Key

Problem 1) Graded by Aric

2 Glucose-6-phosphate

1 point | Hexose-phosphate isomerase

2 Fructose-6-phosphate

Glucose-6-phosphate

0.5 points | Hexose-phosphate isomerase

Fructose-6-phosphate

ATP → ADP (1.5 points for use of ATP) | Phosphofructo-kinase (1.5 points for rxn)

Fructose 1,6 diphosphate

1.5 points → Glyceraldehyde 3-phosphate

Aldolase (1.5 points) → Dihydroxyacetone phosphate

Triose phosphate isomerase 1.5 points

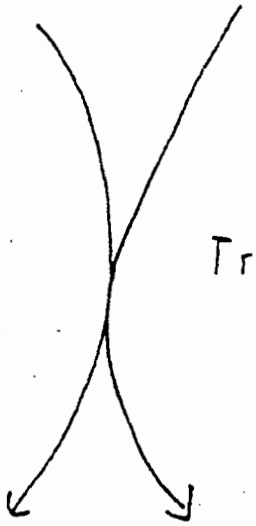
Glyceraldehyde-3-phosphate

continues...

(#9 con't)

2 Glyceraldehyde -3- Phosphate

2 Fructose-6-Phosphate



2 Erythrose-4 phosphate

1.5 points

1.5 points

2 xylulose-5-Phosphate

↓ Phosphopentose Epimerase — 1.5 points

2 ribulose-5-Phosphate

↓ Phosphopentose Isomerase — 1.5 points

2 ribose-5-Phosphate

In order to get full credit for a step you needed to include the reactants, the products, the enzyme and to have the correct stoichiometry.

Solutions for #10, see #3

Solutions for #11, see #2

Why did I bother to even mention these questions twice...? Just so you get yet another example of what to expect from this exam. 

Besides, doesn't it feel good that you're done with #10 + #11 so fast?

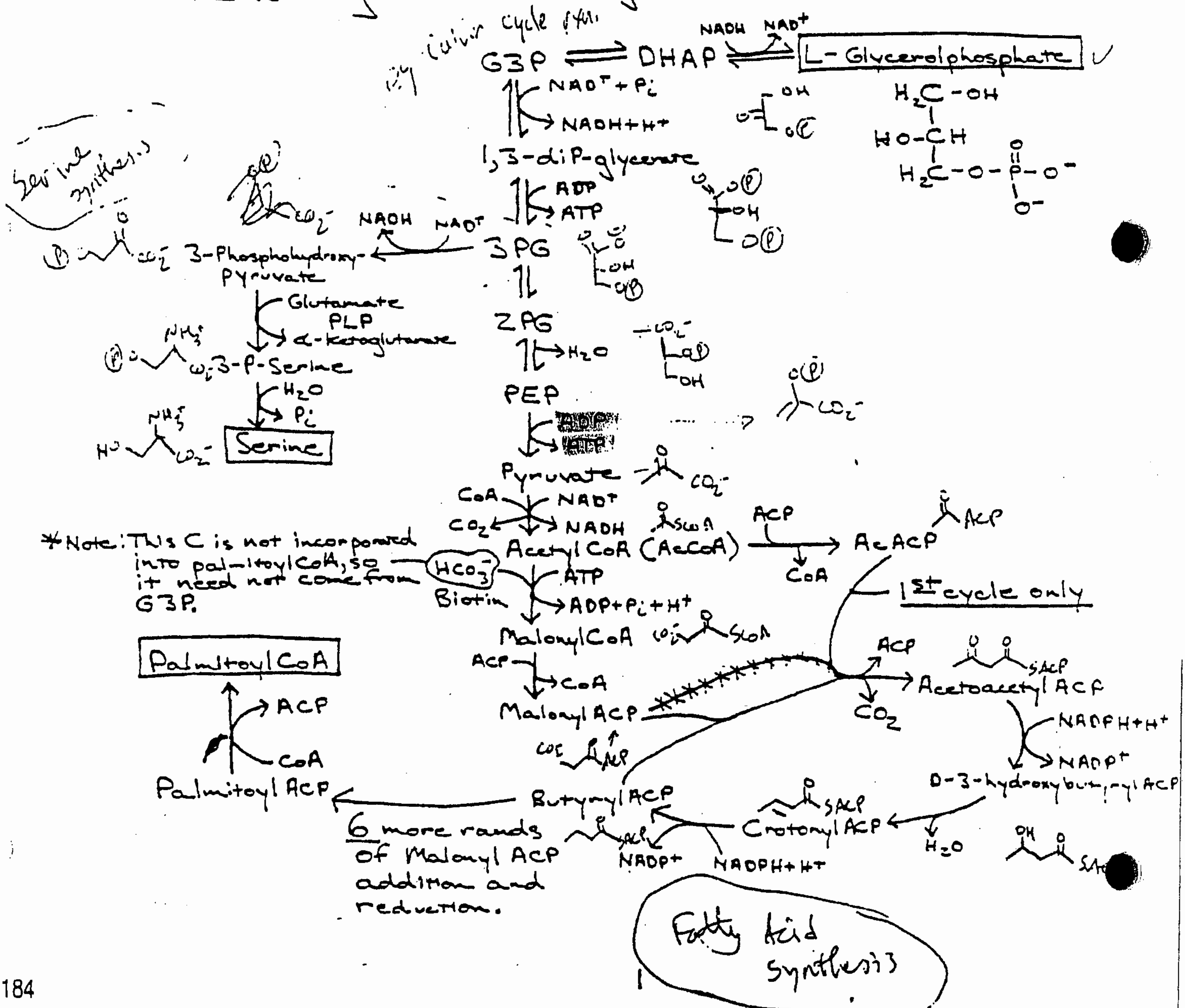
Graded by Tom, Kachna, & Rion

Problem 4 # SEE 19 Jan's packet

To obtain full credit for this problem, you needed to:

1) Show how the four basic building blocks of phosphatidyl choline are synthesized from G3P. These four building blocks are:
   - i) L-glycerol-P
   - ii) palmitoyl CoA
   - iii) Serine
   - iv) S-Adenosylmethionine (SAM)
2) Show how these building blocks are put together to make phosphatidyl choline.

The following answer would get full credit:



grading scale for (#12)

Point Allocation:

Serine +4

+1 for indicating G3P → Serine
+1 for using PLP
+1 for showing all coenzymes (NADH/NAD$^+$, ATP/ADP)
+1 for α-KG → Glu

L-Glycerol-P +4

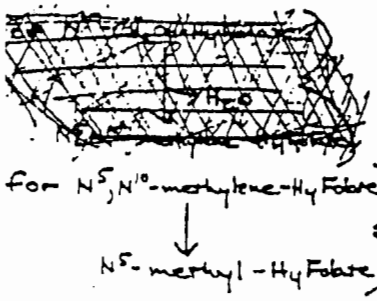
+1 for indicating G3P → L-Glycerol-P
+1 for using DHAP as an intermediate
+1 for indicating DHAP → L-glycerol-P
+1 for showing NADH → NAD$^+$

Palmitoyl CoA +9

+4 for G3P → Acetyl CoA
+1 for AcCoA → malonyl CoA
+1 for using ACP
+1 for condensation & reduction to butyryl ACP
+1 for 7 total additions of malonyl ACP
+1 for ACP → AcCoA again

SAM +13

+1 for indicating Serine → Glycine (Hy Folate → N^{10}-methylene-Hy Folate)
+1 for using PLP in above step
+1 for N^{10}-methylene-Hy Folate → N^5, N^{10}-methylene-Hy Folate + H_2O
+1 for NADPH → NADP$^+$ in above step
+3 for Homocysteine → Methionine (N^5-methyl-Hy Folate → Hy Folate)



+1 for using B_{12} in above step
+4 for Methionine → S-AM (ATP → PP_i + P_i)

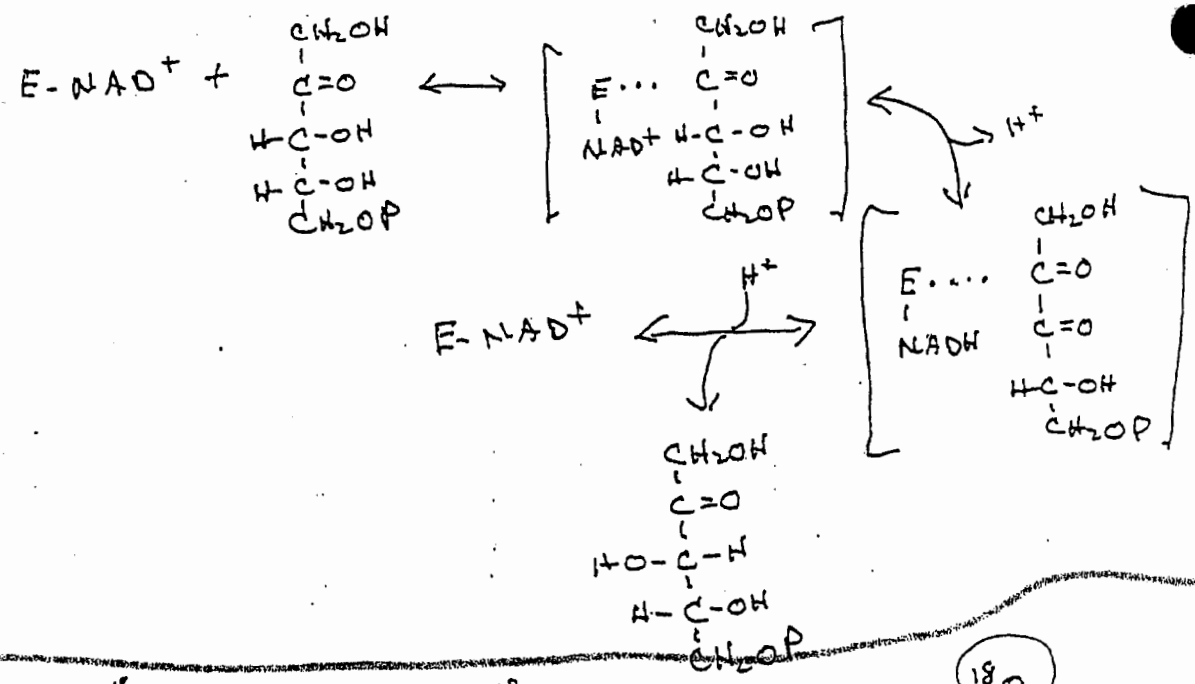
Assembly +20

+4 for each of 5 steps based on correct: 1) Substrate, 2) Product, 3) Coenzymes, 4) Structure of Product.

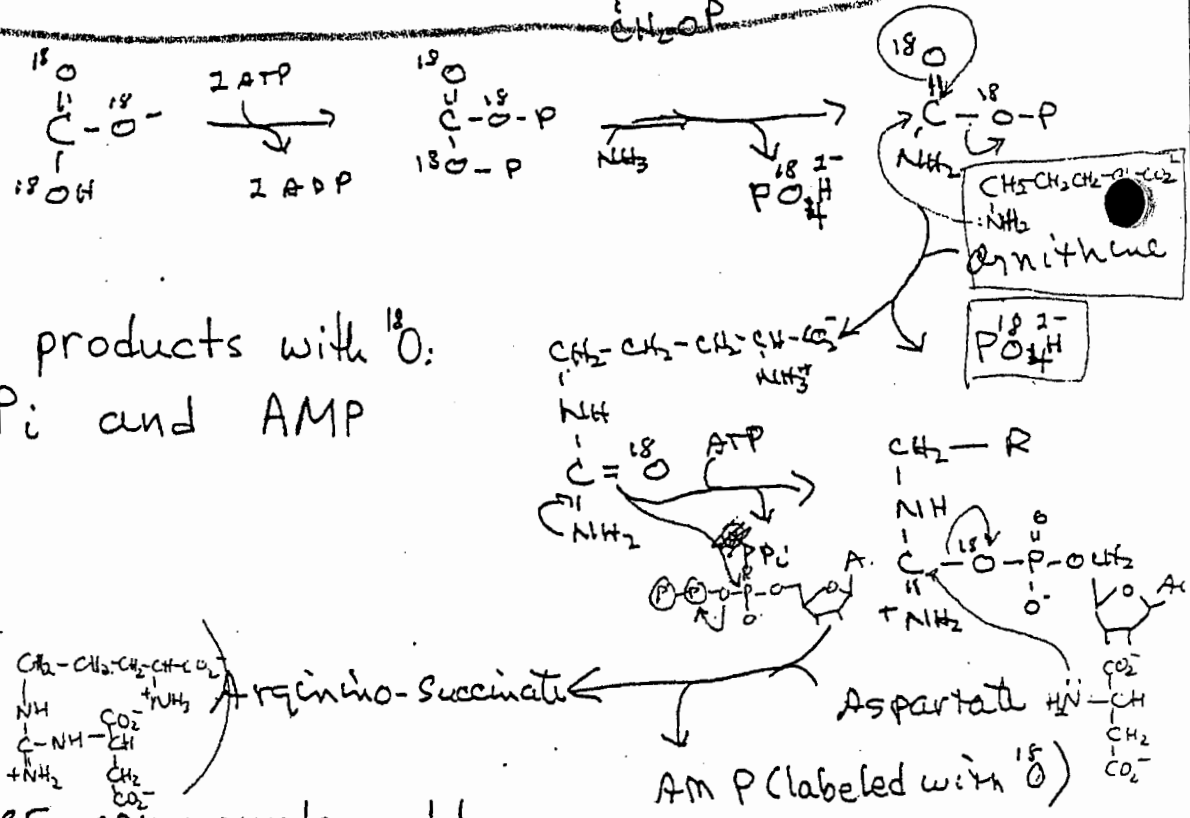
1) L-Glycerol-P + 2 Palmitoyl CoA → Phosphatidate + 2 CoA
2) Phosphatidate + CTP → CDP-diacylglycerol + PP_i
3) CDP-diacylglycerol + Serine → Phosphatidyl Serine + CM
4) Phosphatidyl Serine + H^+ —PLP→ Phosphatidyl Ethanolamine + CC
5) Phosphatidyl Ethanolamine + 3 SAM → Phosphatidyl Choline + 3 SA-Homocys

(#10)

1. a.



b.

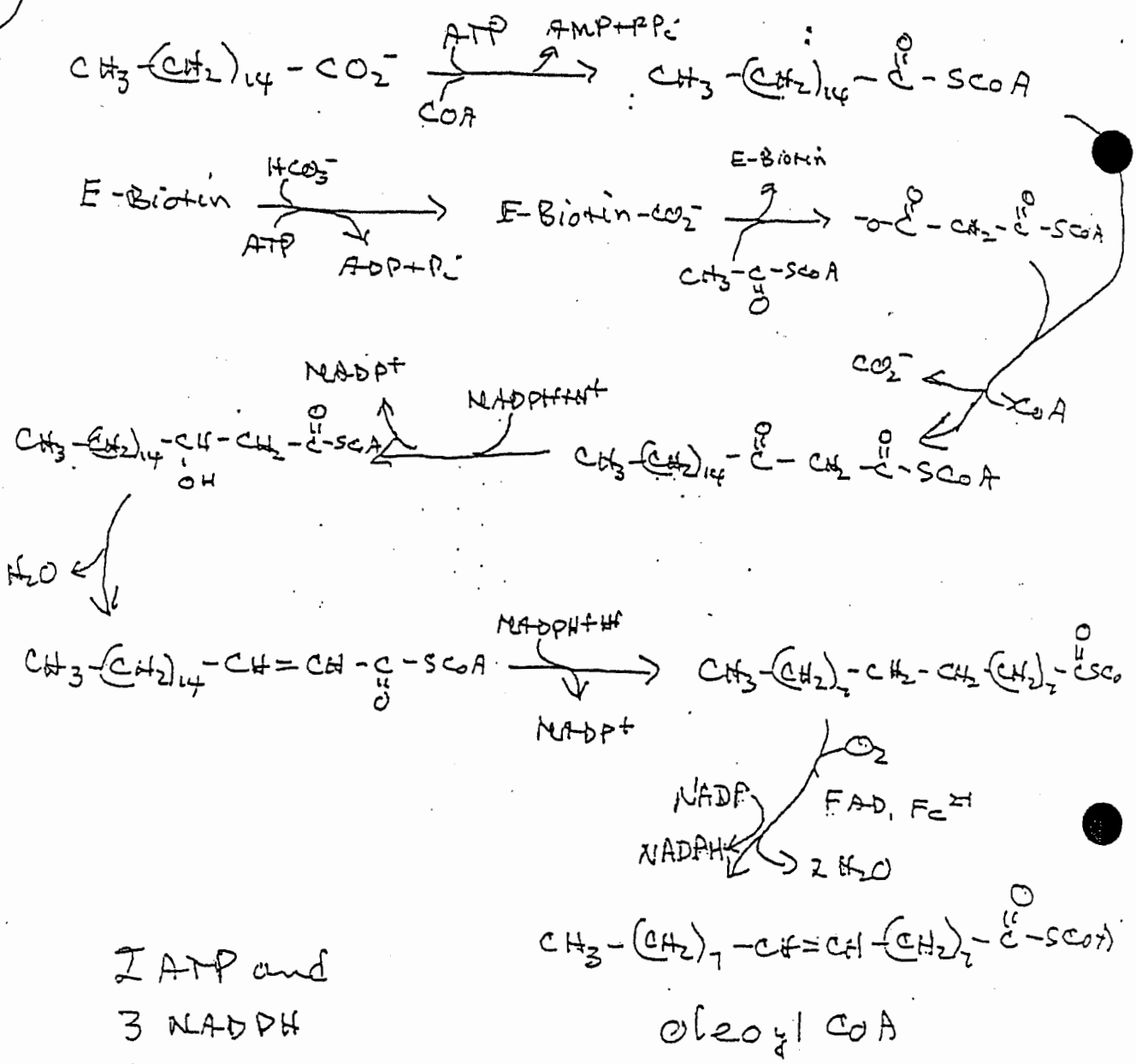


Final products with ^{18}O:
2 P_i and AMP

Other compounds needed:
3ATP (4 high energy bonds)
NH_3
Aspartate

(#14)

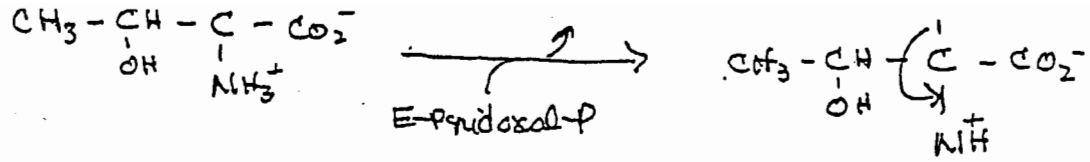
2.



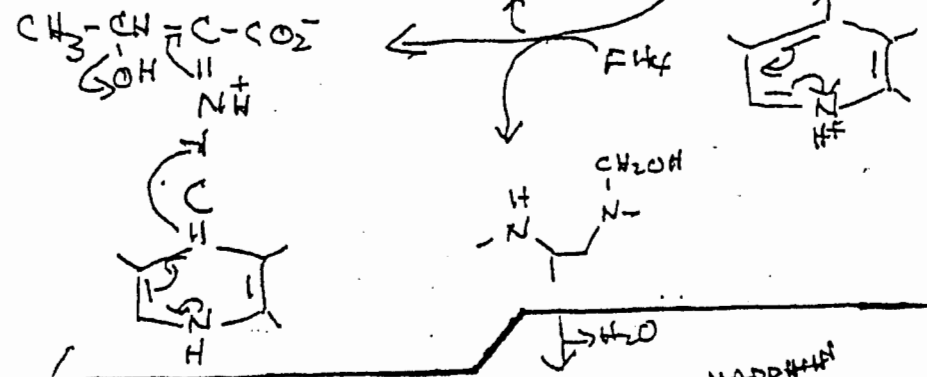
1 ATP and
3 NADPH
required

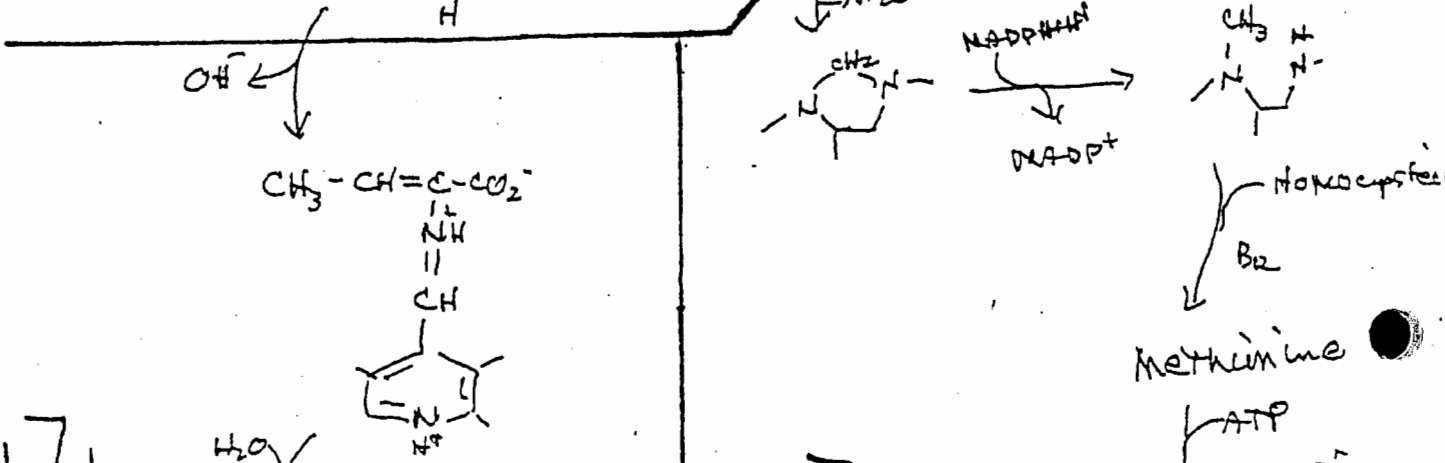
oleoyl CoA

#10) 5.

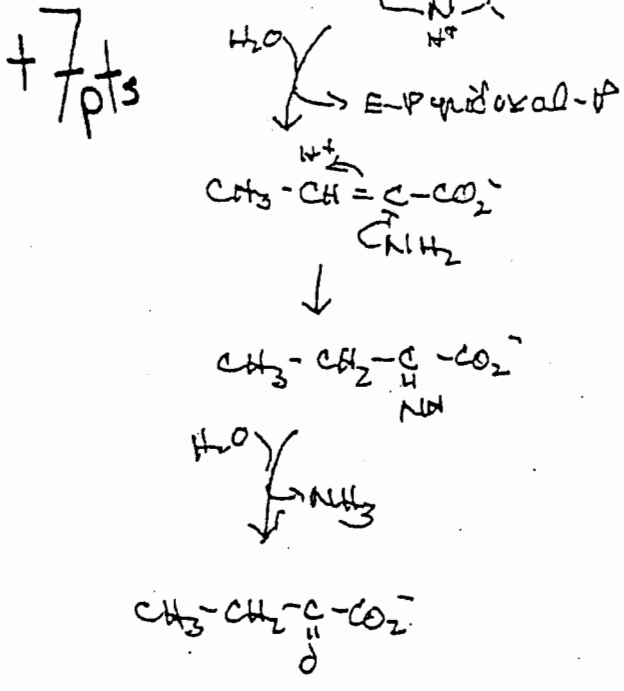


+6 pts

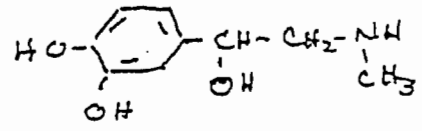




+7 pts



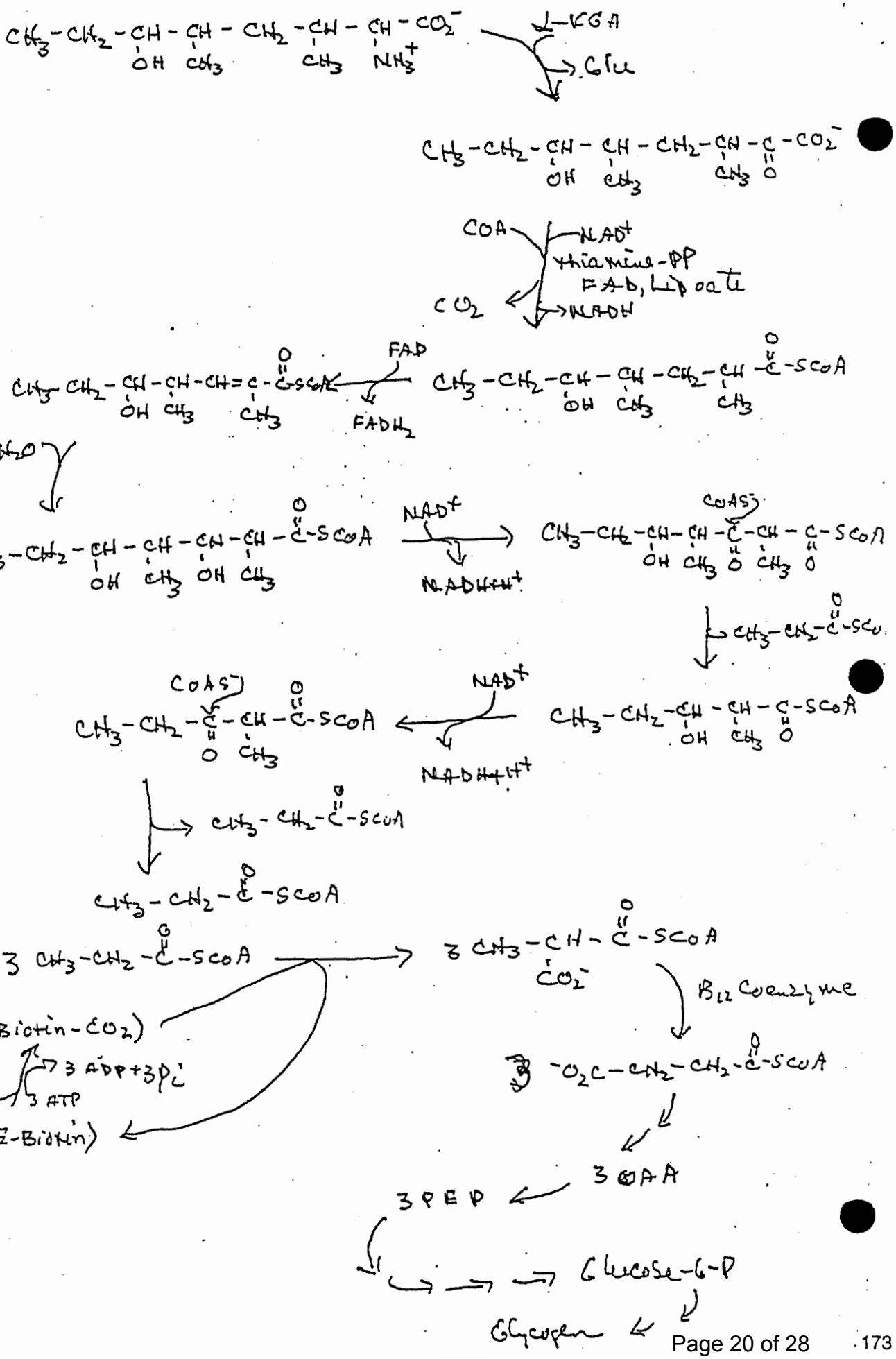
+7 pts



(Epinephrine)

(#16)

4.


L-KGA
Glu
COA
NAD+
thiamine-PP
FAD, Lipoate
CO2
NADH
FAD
FADH2
H2O
NAD+
NADH+H+
CoAS⁻
NAD+
NADH+H+
3 (E-Biotin-CO2)
3 ADP+3Pi
3 HCO3⁻
3 ATP
3 (E-Biotin)
B12 Coenzyme
3 OAA
3 PEP
Glucose-6-P
Glycogen

Grading Scales for...

Question 1. 20 points, graded by Anya
Note that points were given VERY generously, so I expect no complainers, except those with a VERY good reason!

A. (5 points) Mechanism for epimerase was presented in the lecture on March 11.
2 points for overall reaction catalyzed by epimerase; 1-2 points for trying;
only 3 people got it right-points for correct mechanism varied depending on part B.
B. (15 points) Only one person correctly placed the label on the first phosphate released (formation of carbamoyl phosphate). I did not take off points from the rest of the class for this or if you forgot to identify other compounds needed for this reaction.

+4 for showing two labeled oxygens on carbamoyl phosphate
+1 for showing labeled inorganic phosphate in the next reacion
+4 for correctly labeled citrulline
+3 for unlabeled arginino-succinate
+3 for labeled AMP

You got additional points if you showed how labeled bicarbonate was incorporated to form aspartate. Showing correct pathway w/o the label or with label in the wrong place was worth 5 points.

Question 2 15 points, graded by Steve

+2 Activation of palmitate to palmitoyl coA
+3 Addition of 2-carbon unit to palmitoyl coA
+6 Elongation reactions including correct NADPH additions
+2 Desaturation reaction
+2 Correct number of ATPs and NADPHs used in elongation
2 or 3 ATPs was acceptable
3 NADPH or 2 NADPH and 1 NADH was also acceptable.

I took 2 points off for not showing the reactions and their intermediates and I tried to give partial credit whenever I could. I mistakenly wrote methyl malonyl coA on some of your papers, but I was actually referring to the carboxylated acetyl coA that was added to the elongating fatty acid chain.

Question 3 20 points, graded by Jane

The point breakdown is written on the answer key.

Question 4 20 points, graded by David

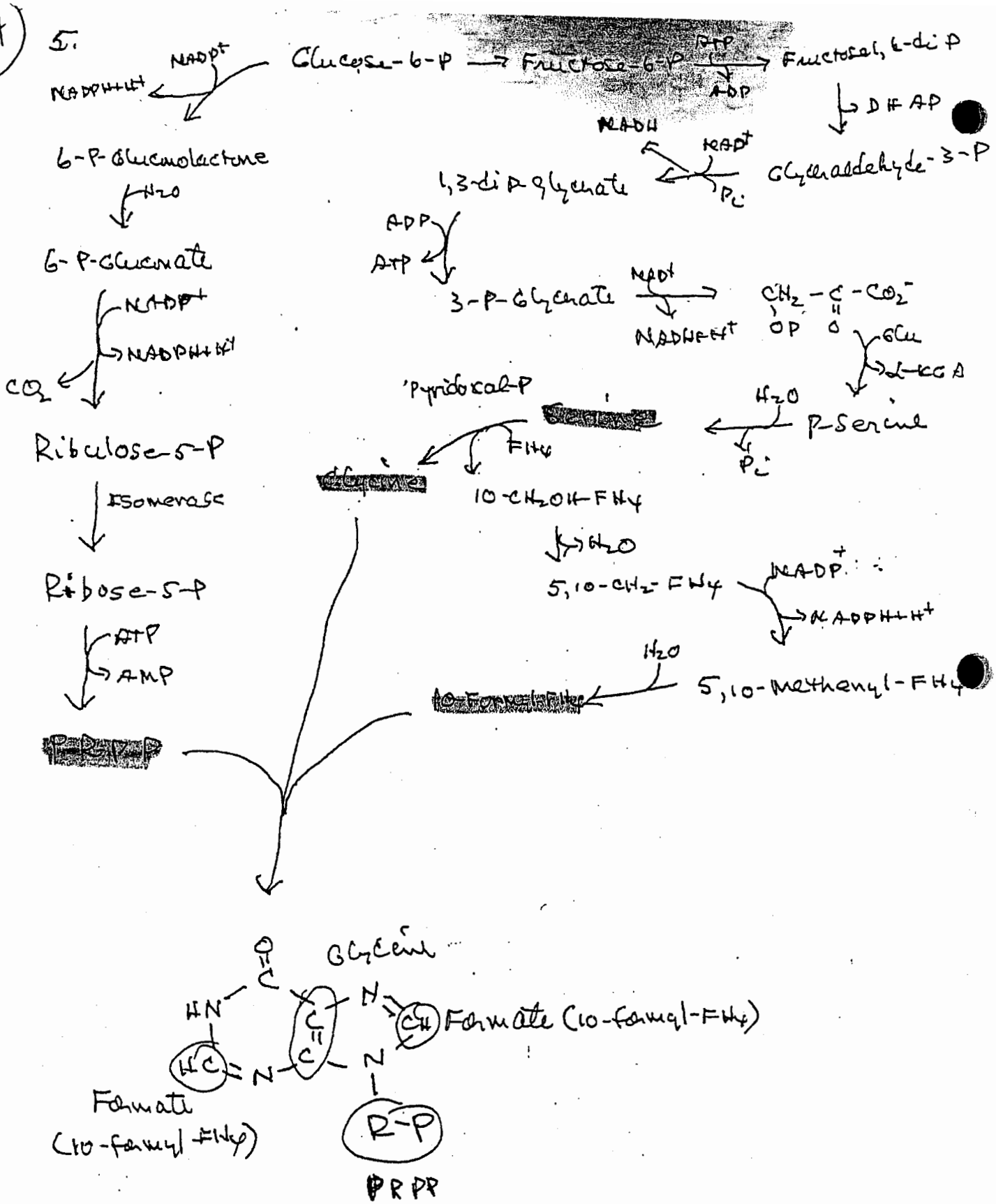
Everyone should thank Ilana for her problem set. If you don't understand that remark, you aren't doing the problem sets. If you didn't take the propriony-CoA to succinyl-CoA you could only get 16 points on the problem set. It was not necessary to review the rest of the TCA cycle. I gave equal credit for people who used NADH to oxidize the hydroxyl group to the ketone or for people who used FADH to make the double bond which underwent a subsequent keto-enol tautomerization. If you could get one proprionyl-CoA off, that was worth 8-10 points and you received 4-6 points for the initial decarboxylation. You needed to include the coenzymes (thiamine-PP, biotin, FAD, lipoate, B12), if you didn't one or two points was taken off.

Question 5 25points, graded by Joel

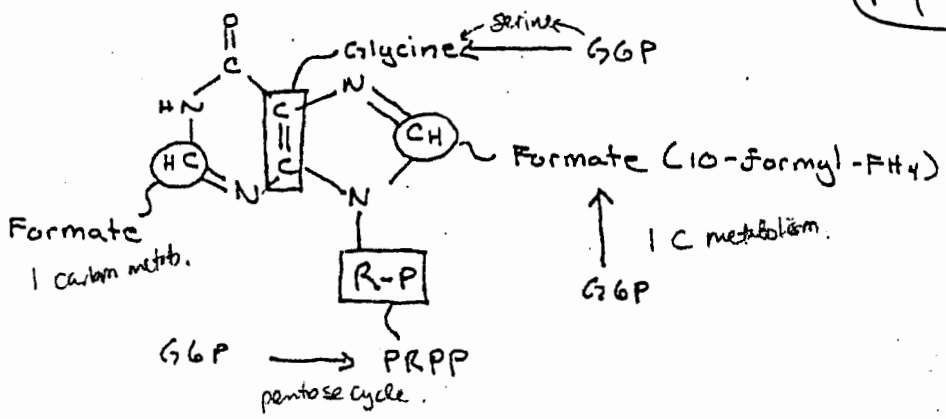
(see following page)

#17

5.


NADP+
NADPH+H+
Glucose-6-P
Fructose-6-P
ATP
ADP
Fructose 1,6-di P
DHAP
NADH
NAD+
Pi
Glyceraldehyde-3-P
1,3-di P-glycerate
6-P-Gluconolactone
H2O
6-P-Gluconate
ADP
ATP
3-P-Glycerate
NAD+
NADH+H+
CO2
Ribulose-5-P
Isomerase
Ribose-5-P
ATP
AMP
PRPP
Pyridoxal-P
FH4
10-CH2OH-FH4
H2O
5,10-CH2-FH4
NADP+
NADPH+H+
5,10-Methenyl-FH4
H2O
Glycine
Formate (10-formyl-FH4)
Formate
(10-formyl FH4)
R-P
PRPP

for #17



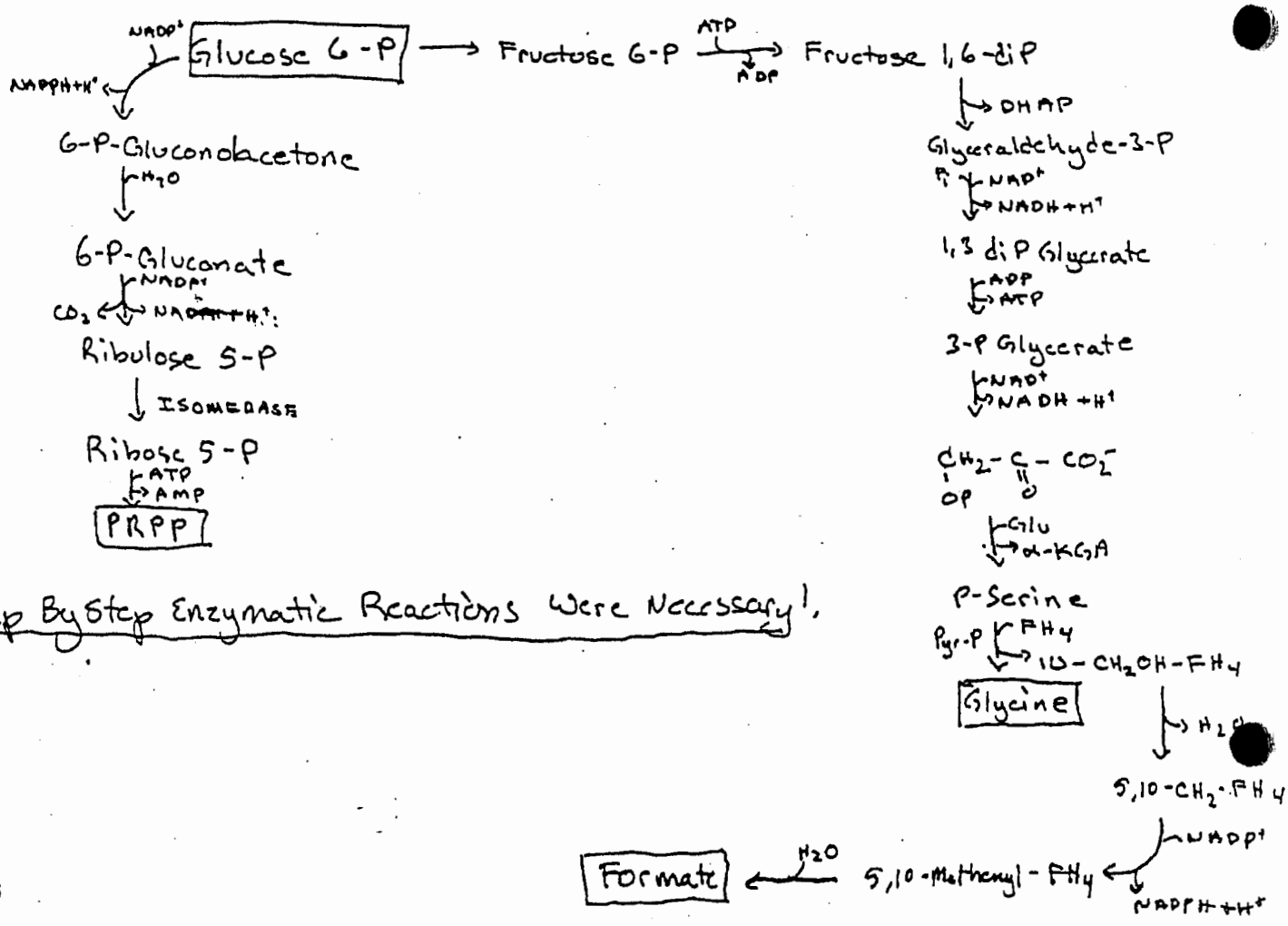
+5 For showing where the carbons come from.

+12 For deriving glycine from glucose 6-P.

+4 For deriving PRPP from glucose 6-P.

+4 For deriving Formate from glucose 6-P.

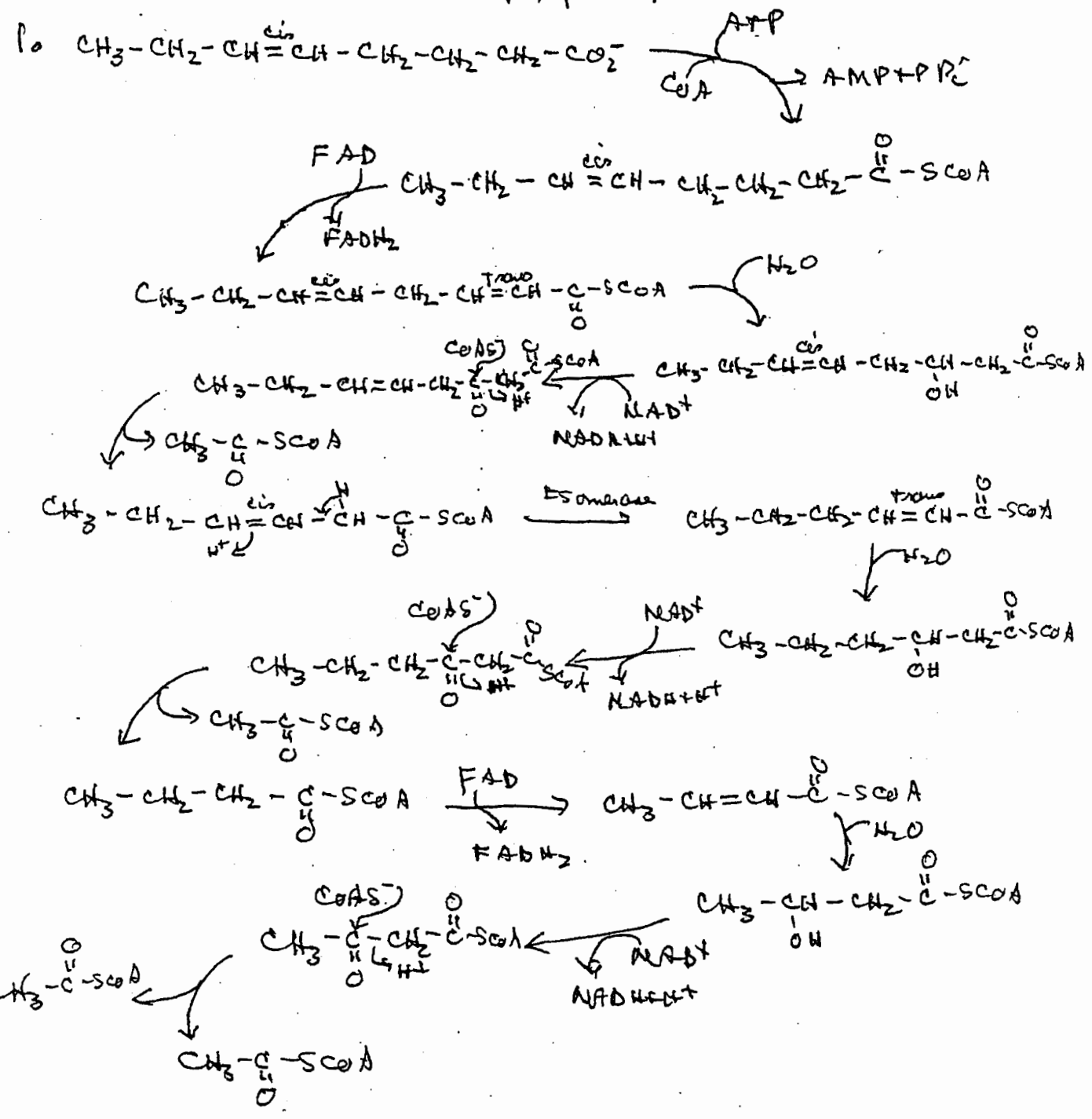
A proposal:



Step By Step Enzymatic Reactions Were Necessary!

#18

Answers to questions on 7.05 Exam of Apr. 28, 1999

1. 

ATP Made: 4 AcCoA Through the TCA Cycle = 4 x 12 = 48

2 $FADH_2$ = 2 x 2 = 4

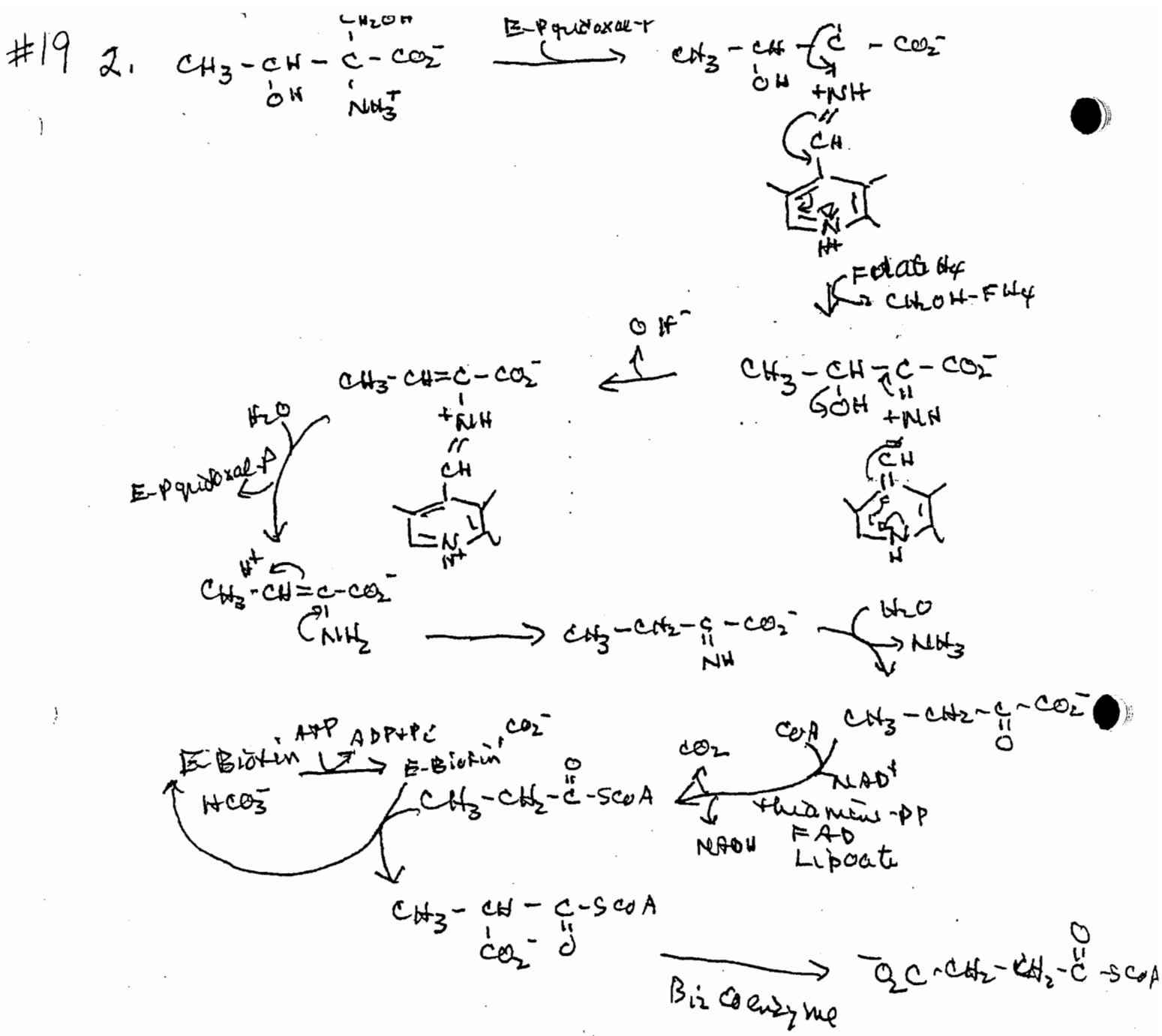
3 NADH = 3 x 3 = 9.

or 48 + 4 + 9 = 61

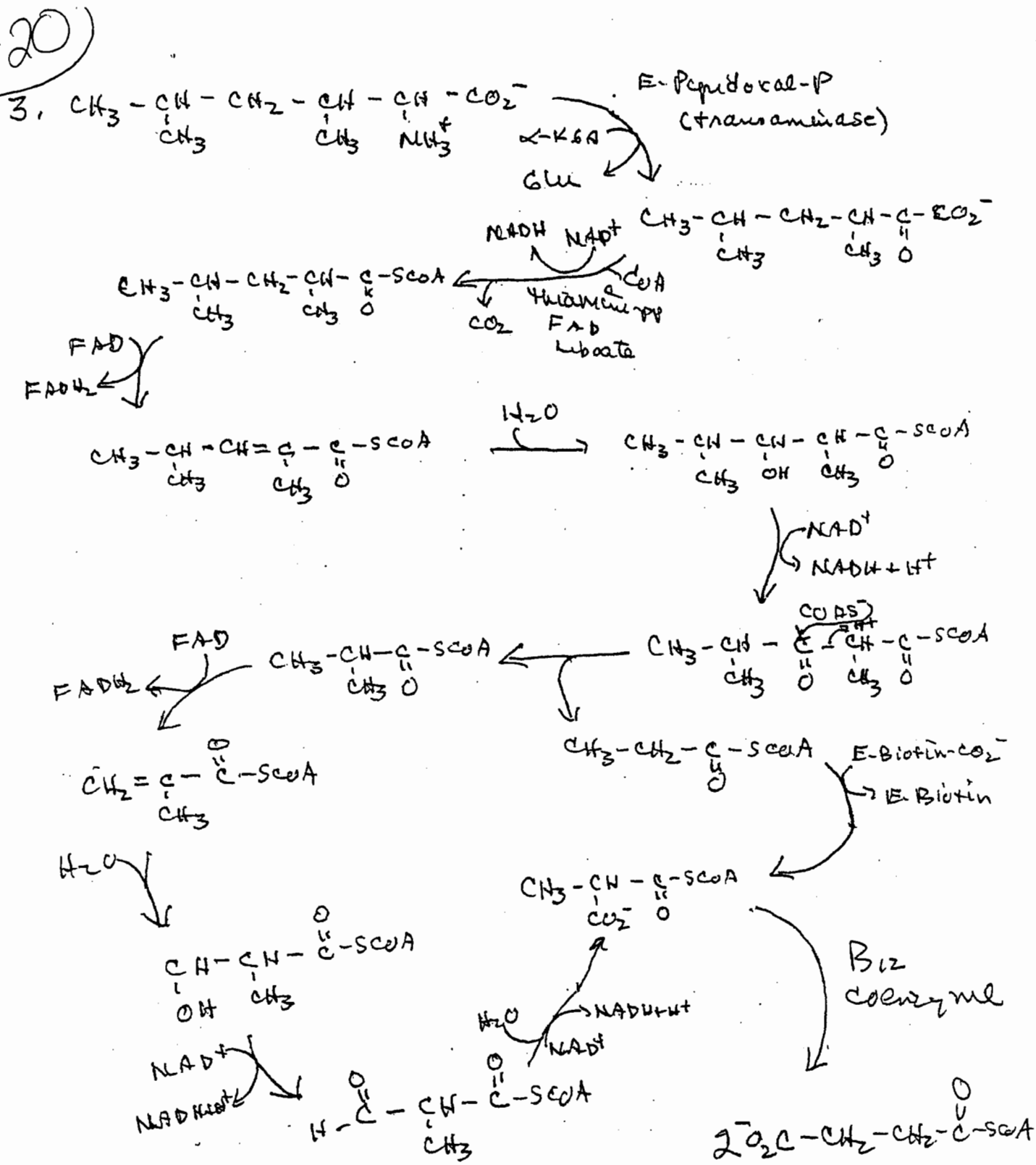
1 ATP used to activate the acid

61 - 1 = 60

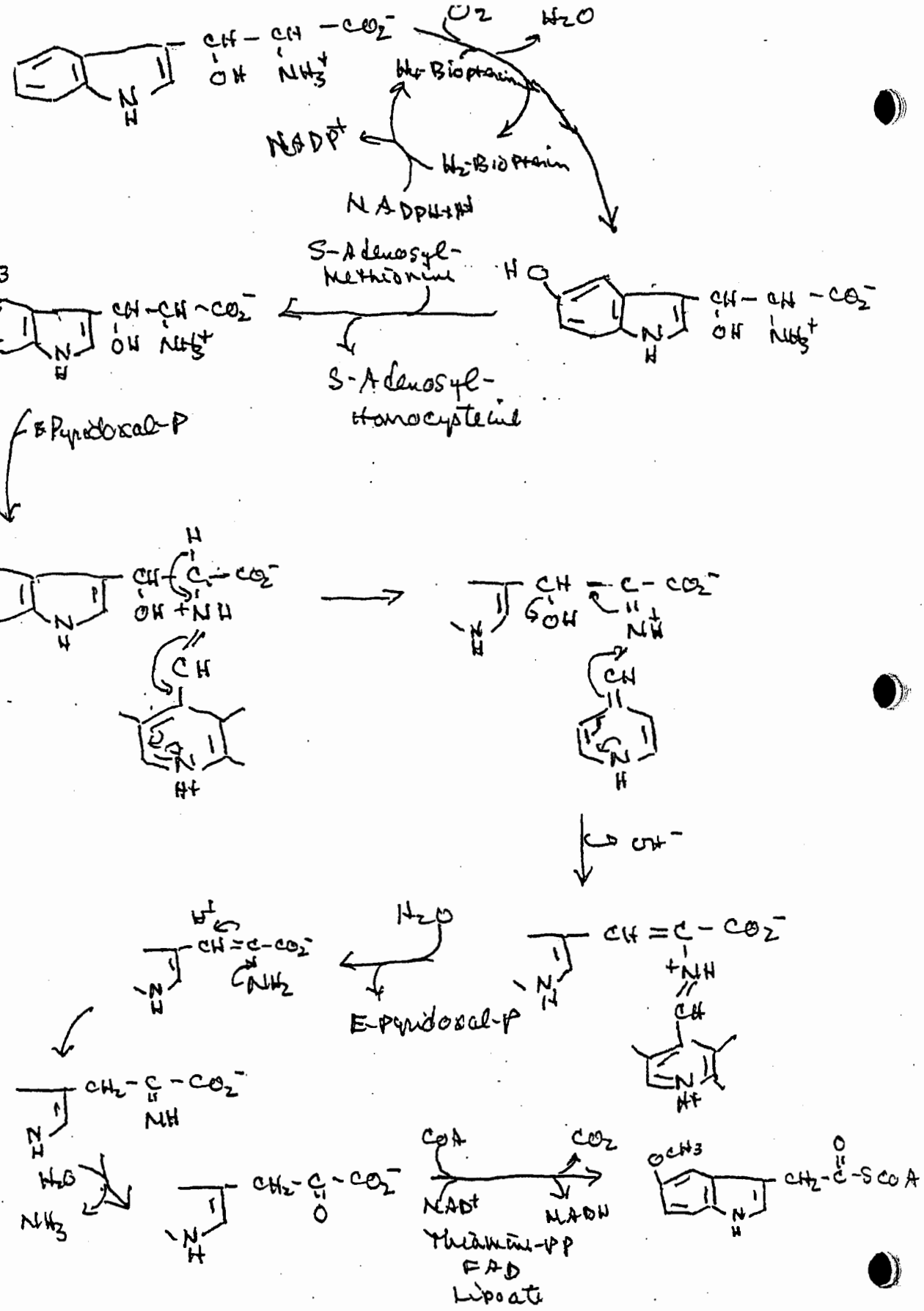
#19 2.



#20

3. 
E-Pyridoxal-P
(transaminase)
α-KGA
Glu
NADH
NAD+
CoA
Thiamine-PP
CO2
FAD
Lipoate
FAD
FADH2
H2O
NAD+
NADH + H+
CO2
FAD
FADH2
E-Biotin-CO2-
E-Biotin
H2O
NADH+H+
NAD+
NAD+
NADH+H+
B12
coenzyme

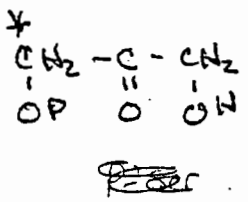
#21 4.

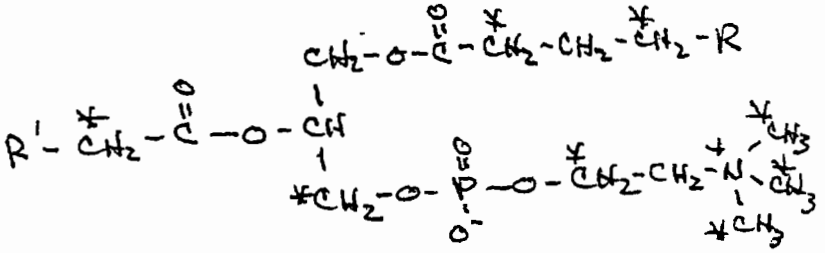

O2
H2O
NADP+
NADPH+H+
S-Adenosyl-Methionine
S-Adenosyl-Homocysteine
E-Pyridoxal-P
CoA
CO2
NADH
Thiamin-PP
FAD
Lipoate

#22

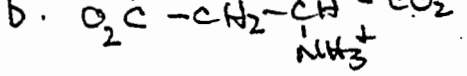
5. (11 points)

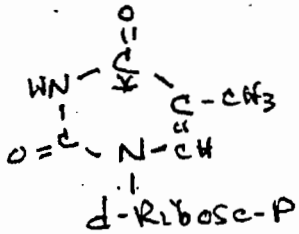
a.



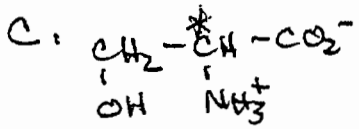


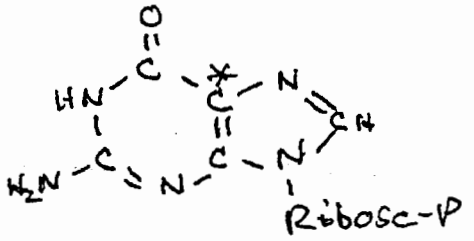
b.





c.





d.