

RECAP MATERIAL from CHEM641 - ANSWERS

CHEM642-010 2021 SOME QUESTIONS ABOUT CARBOHYDRATE/GLYCOLYSIS/TCA/FAO recap from CHEM641. MOSTLY TAKEN FROM OLD EXAMS – hence the clunky screen grabby appearance. And, this is not a comprehensive selection.

SUGGESTION: try the SAMPLE QUESTIONS VERSION FIRST

Sometimes there are isotope-tracing questions – note the format I might adopt on the first Question here.

Question 3zz (10 pts). Tracing isotopes. Note the position of the carbon labels in the molecules at the left of each arrow and write the placement of the corresponding labels in the molecule to the right

Here are sample answer formats: A) w, x, y, z (put as many as needed) ... if no label remains in the molecule shown write "NONE"

A)

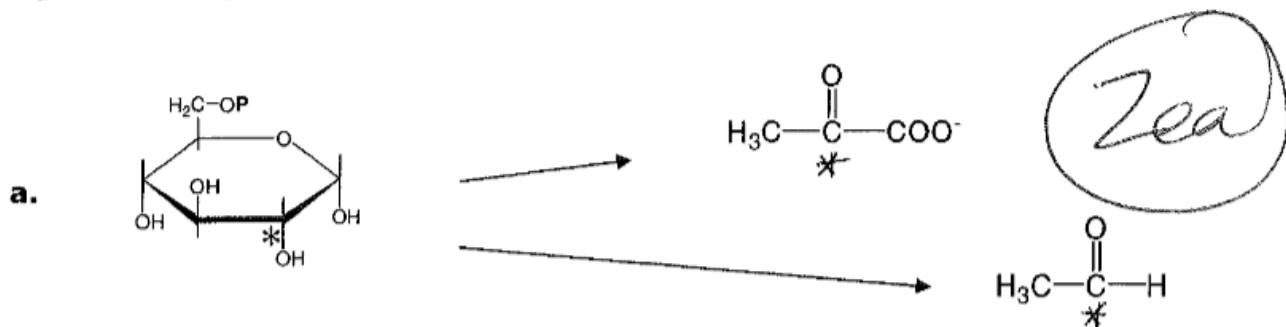


Answer:

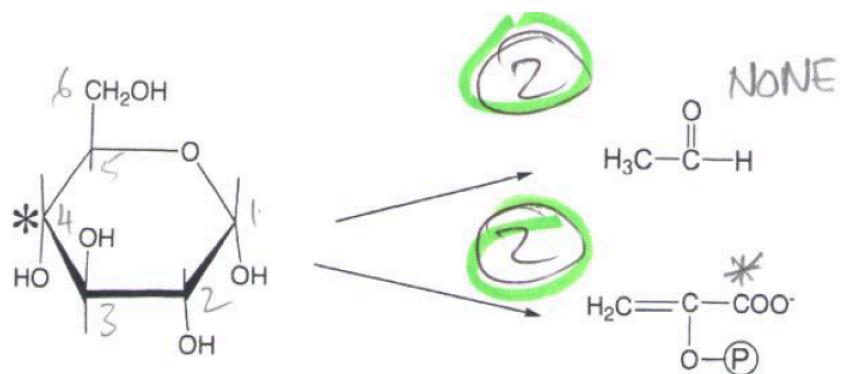
A) **r**

(The examples below were taken from paper exams – pre-COVID) – this semester you will fill in multiple blanks with one or more letters)

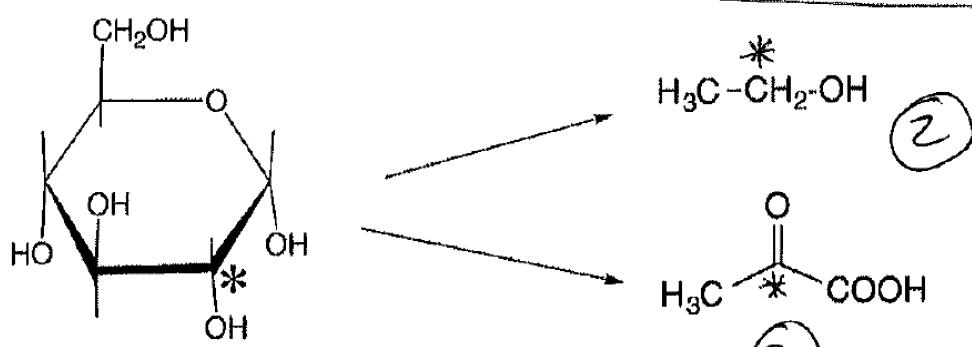
Question 1 (12 pts). Tracing radiolabels and etc. Place asterisks indicating the position of the radiolabel in the molecules shown to the right – if the product contains no radiolabel write “NONE”.



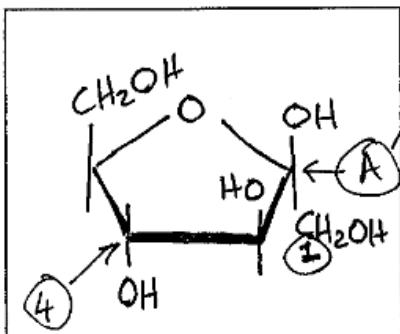
another Question ...



another Question ...

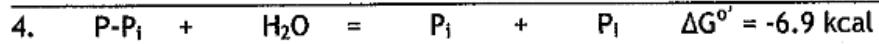
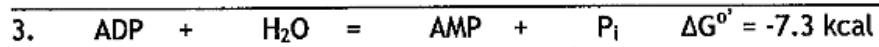


Question 2 (5 pts) Regarding the monosaccharide shown to the left

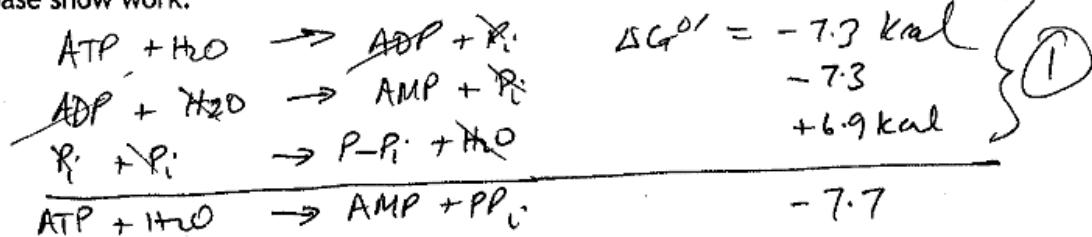


- Label the anomeric carbon with an A
- This molecule is in the α - or β - configuration β
- This molecule is: aldose ketose cannot say
- Label carbon atoms 1 and 4 1, 4

Question 7 (6 pts.) Given the following calculate $\Delta G^{\circ'}$ for equation 1:



Please show work:



Pyrophosphatase catalyzes reaction 4. The addition of this enzyme to equation 1 will (circle all answers that are appropriate)

- a. make reaction more exergonic
 b. drive the reaction to the right
 c. drive the reaction to the left
 d. have no effect on the equilibrium position incorrect
 e. insufficient information to make choices
- -1 for each
- (2)

What metal ion would you expect to be involved in pyrophosphatase action?

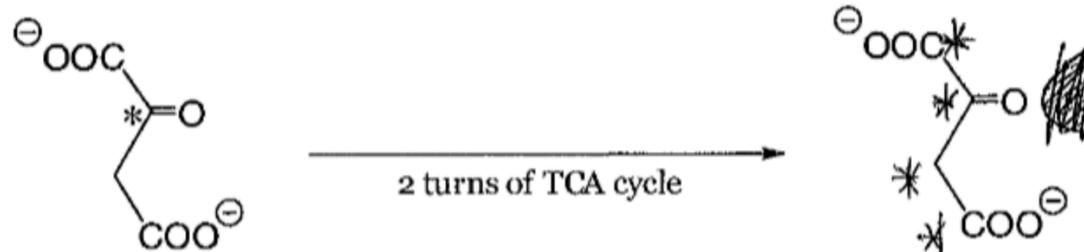
Mg²⁺

(1)

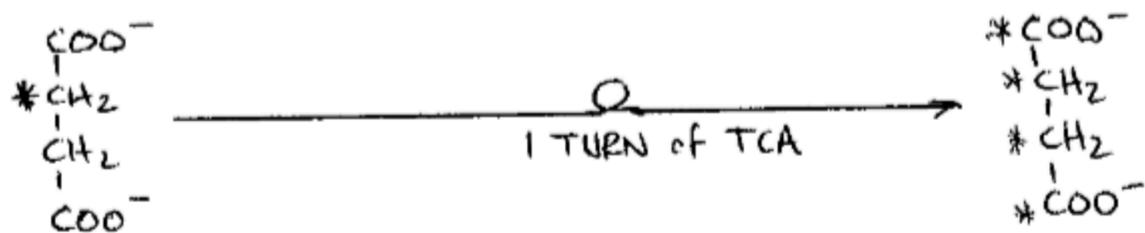
or a divalent ...

TCA CYCLE

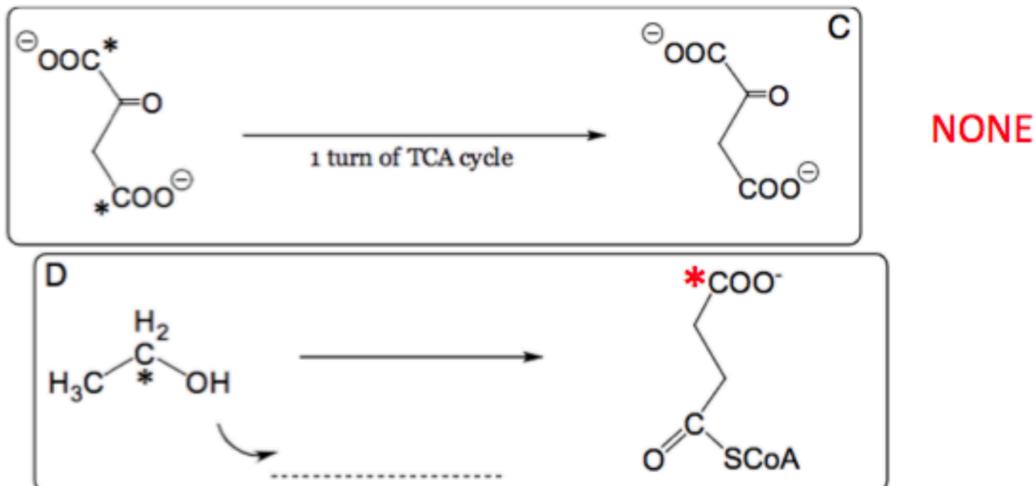
b.



c.



d)



Question 2 (17 pts) In the space provided, give the yield of ATP (or equivalent e.g. GTP) that would be formed in the following processes:

a. per molecule of lactate completely oxidized to CO₂

14 (2)

b. per molecule of acetyl-CoA in the presence of arsenite

2.5 (2)

c. per molecule of pyruvate in the presence of malonate

8.5 (1)

d. per molecule of fructose-1,6-diP completely oxidized to CO₂

32 (6)

Question 1 (10 pts) Yield of ATP. In the space provided give the yield of ATP (or equivalent e.g. GTP) that would be formed in the following processes:

a. per molecule of glucose completely oxidized to CO₂ and water

30

b. per isocitrate in the presence of arsenite

2.5

c. per molecule of ethanol converted to CO₂

1.5

NOTE: NOW WE USE 11-13 (IF THE first two dH were cytosolic it would be 11. So 11, 12 or 13 is OK

Question 12 (14 pts) In the space provided, give the maximum yield of ATP (or equivalent e.g. GTP) that would be formed in the following processes.

a. per molecule of glucose completely oxidized to CO₂

↑ 30
3
16

b. per molecule of glucose-1P converted to lactate

12.5

c. per molecule of glyceraldehyde 3-P completely oxidized to CO₂

32
6

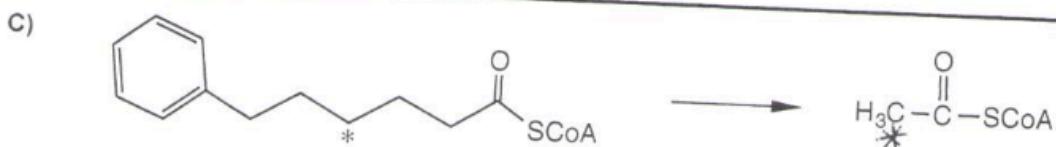
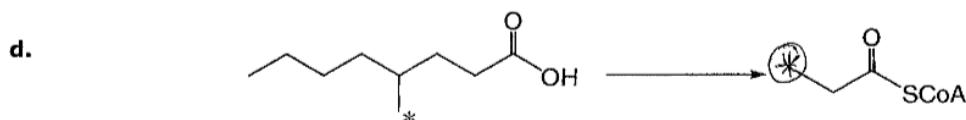
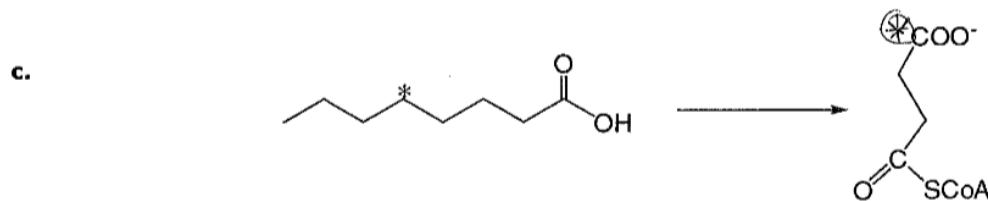
d. per molecule of pyruvate completely oxidized to CO₂ 2.5+12.5

e. per molecule of fructose-1,6-diP completely oxidized to CO₂

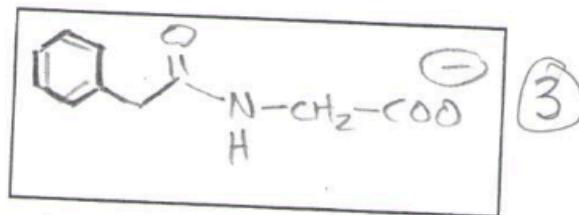
f. per molecule of citrate converted to succinate

FATTY ACID OXIDATION

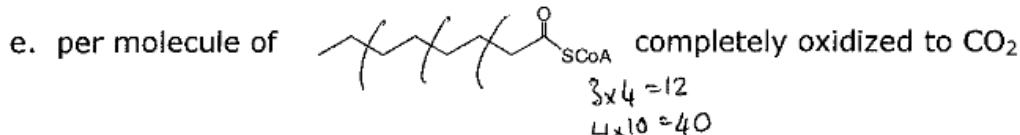
Isotope tracing



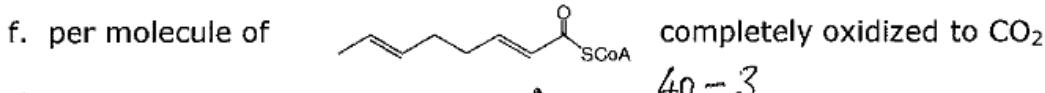
In the box to the right draw the structure of the glycine conjugate you would expect would be secreted during the mammalian metabolism of the compound shown above



ATP yield



52 (3)



49 (3)

$$2 \times 4 = 8$$

$$3 \times 10 = 30$$

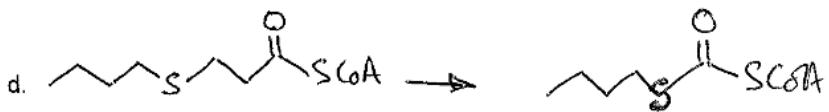
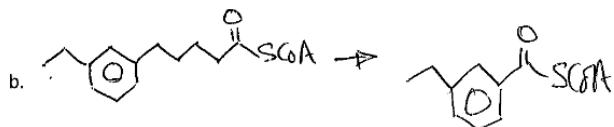
$$\underline{38}$$



40 (3)

Note in "g." above we would accept 39-41

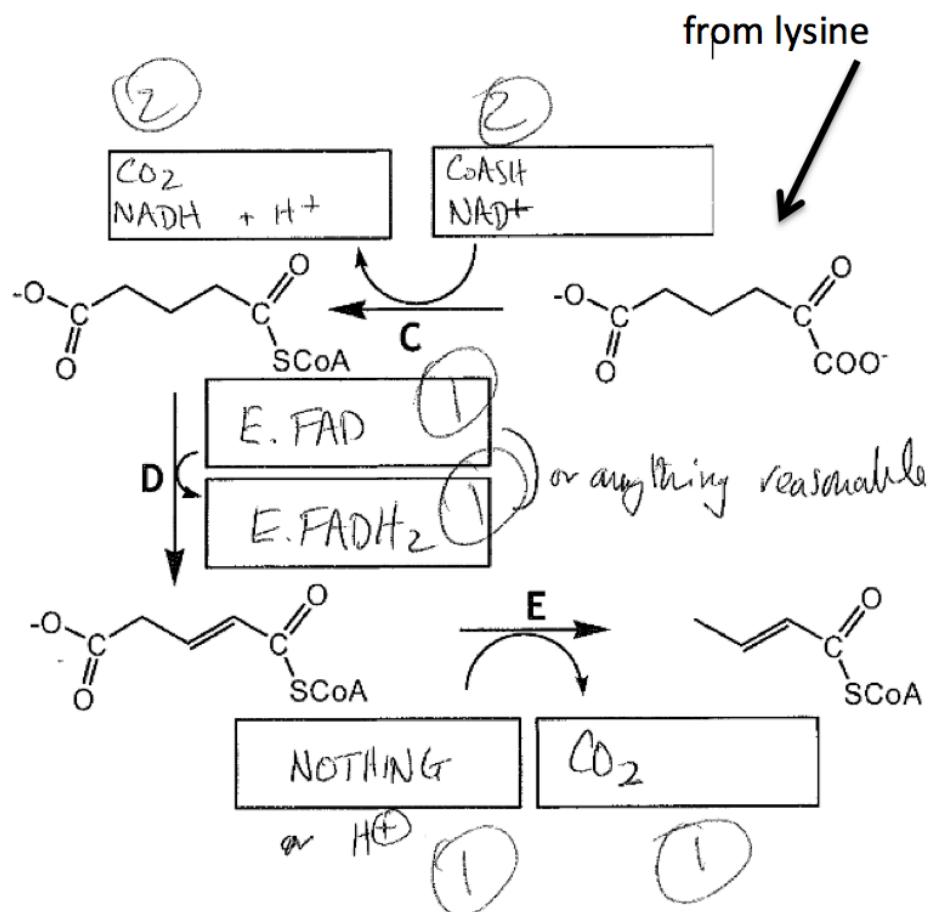
Question 8 (8 pts). Fatty acid oxidation handles unusual fatty acids as well as normal (e.g. straight-chain) ones. For each of these compounds shown to the left show what compound you would expect to accumulate after conventional β -oxidation has finished.



Question 7 (cont.) The following is part of the degradation pathway for LYSINE. Reason by analogy to clearly indicate in the boxes every substrate and product missing for each reaction A-E. Don't put enzyme names - a hypothetical example for one box is shown below). If nothing is needed in the box put "NONE".

NADH, H₂O, CO₂

Note: this question has been abbreviated – but it shows how to relate unfamiliar pathways (this from the catabolism of lysine) to known biochemical reactions –



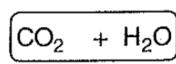
Question 14 (2 pts). A short thought question: Fido, the friendly dog, can tell when normal healthy people have not eaten for several days (note, you feed Fido well!). Give a scientifically-plausible, biochemically-themed and non-flippant one-sentence explanation.



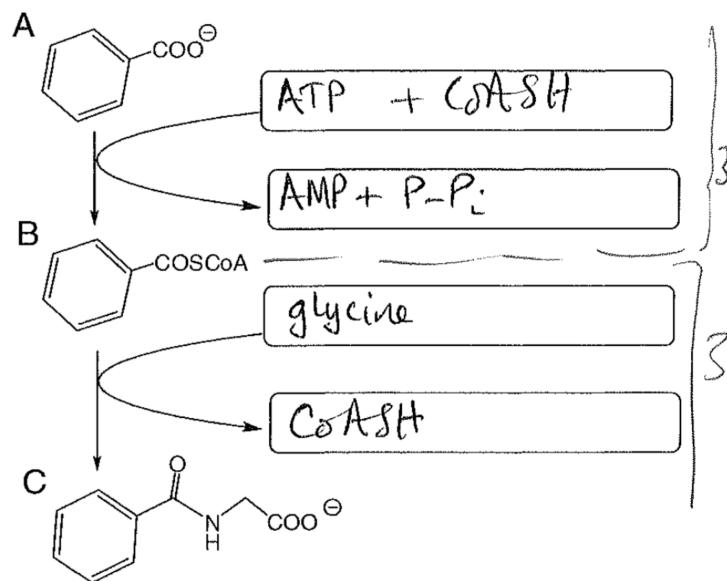
Fido likely can smell the most volatile ketone body, acetone, on the breath of patients who are ketotic. ((There are numerous reports of dogs recognizing biochemical anomalies in their owners.))

Question 5 (6 pts.) Benzoate compound "A" is added to certain foods as a preservative. It is metabolized via "B" to "C" which is excreted from the body. In the spaces provided write the abbreviations or names of all of the other substrates for these reactions. DO NOT put enzyme names.

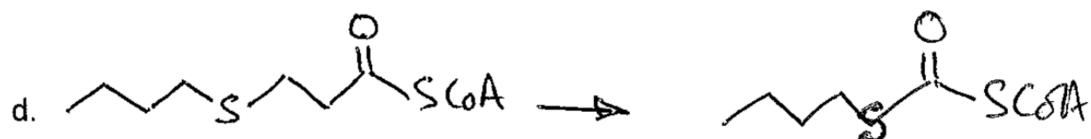
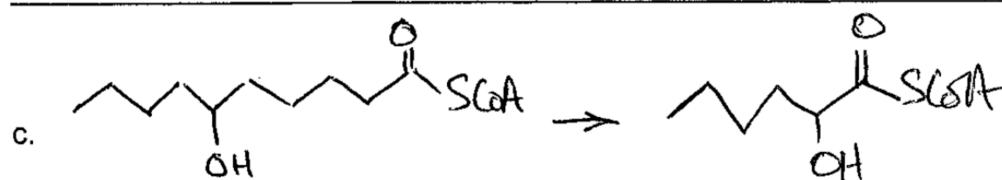
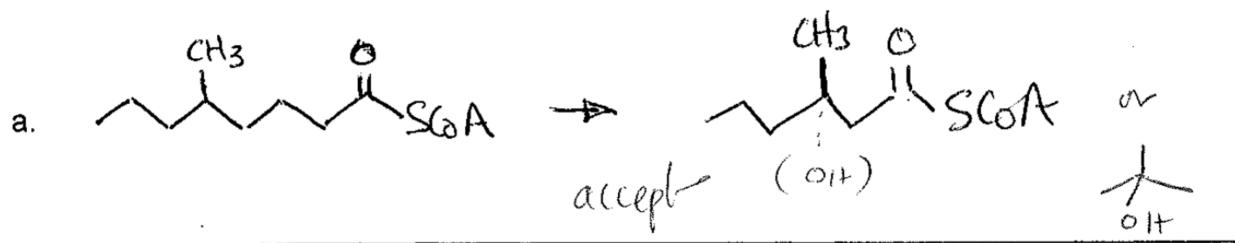
Example:



each
sig. ENZYME
for each half



Question 8 (8 pts). Fatty acid oxidation handles unusual fatty acids as well as normal (e.g. straight-chain) ones. For each of these compounds shown to the left show what compound you would expect to accumulate after conventional β -oxidation has finished.

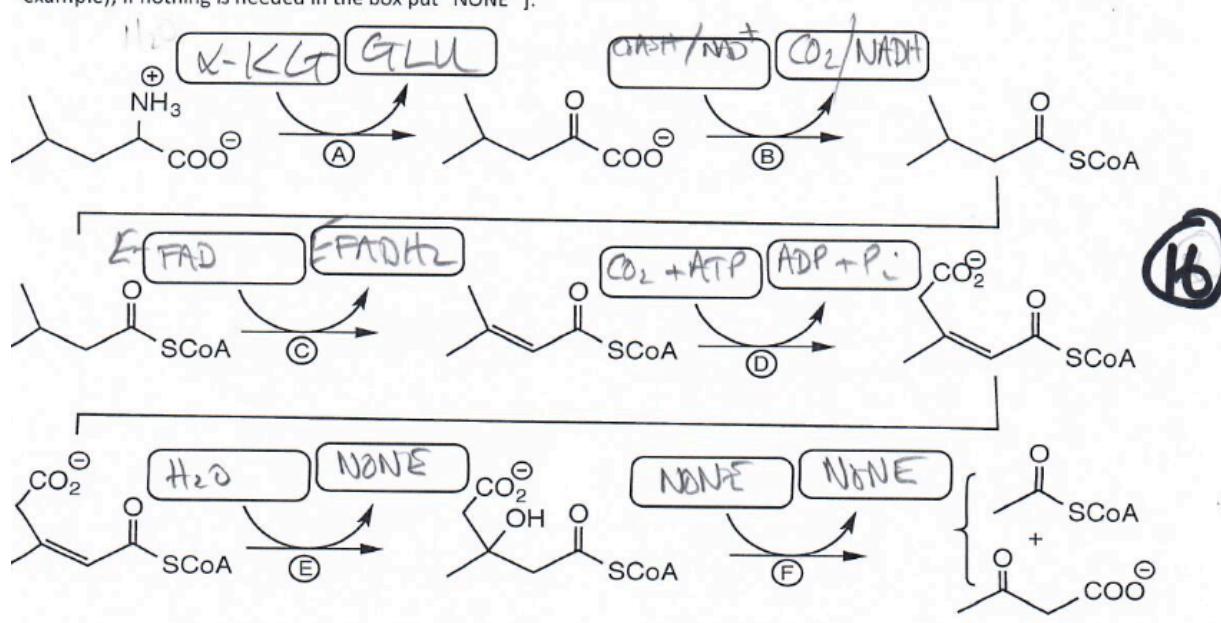


ANSWERS CHEM642-010 2021 SOME QUESTIONS ABOUT AMINO ACID CATABOLISM AND RELATED TOPICS/ TAKEN FROM OLD EXAMS – hence the clunky screen grabby appearance. The aim is to give you some practice in working out metabolic transformations. Some Q will require thought.

Compound A is a well known toxin that targets fatty acid oxidation (at E1) after conversion to compound Z. This is not important for CHEM642 (we dealt with it in CHEM641) – but the transformations should be work-out-able. Of course we are not going to have structure drawing in CHEM642 exams for this semester – but this is good practice. If you need help – ask.

Question 4 (24 pts) In the space provided indicate the metabolism of an amino acid. Do NOT show any mechanisms, and NO curved arrows - just indicate the identity of the main product in the larger boxes and any co-substrates/co-products [in the smaller boxes (see example); if nothing is needed in the box put "NONE"].

NADH, H₂O, CO₂



a) what is the amino acid at the top left of the diagram?

① LEUCINE

b) name an analogous enzyme reaction to "B"

② pyruvate dH
multienzyme complex

c) name an analogous enzyme reaction to "C"

③ acyl-βA dH

d) is this pathway? (circle all that are appropriate)

glucogenic

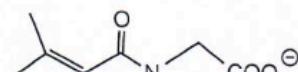
ketogenic

② anabolic

catabolic

④

e) In a rare genetic disease the patients may, in some cases, present with intractable seizures shortly after birth. This molecule is found excreted in the urine



Circle the most obvious enzyme deficiency responsible for its accumulation

Enzyme:

A

B

C

④ D

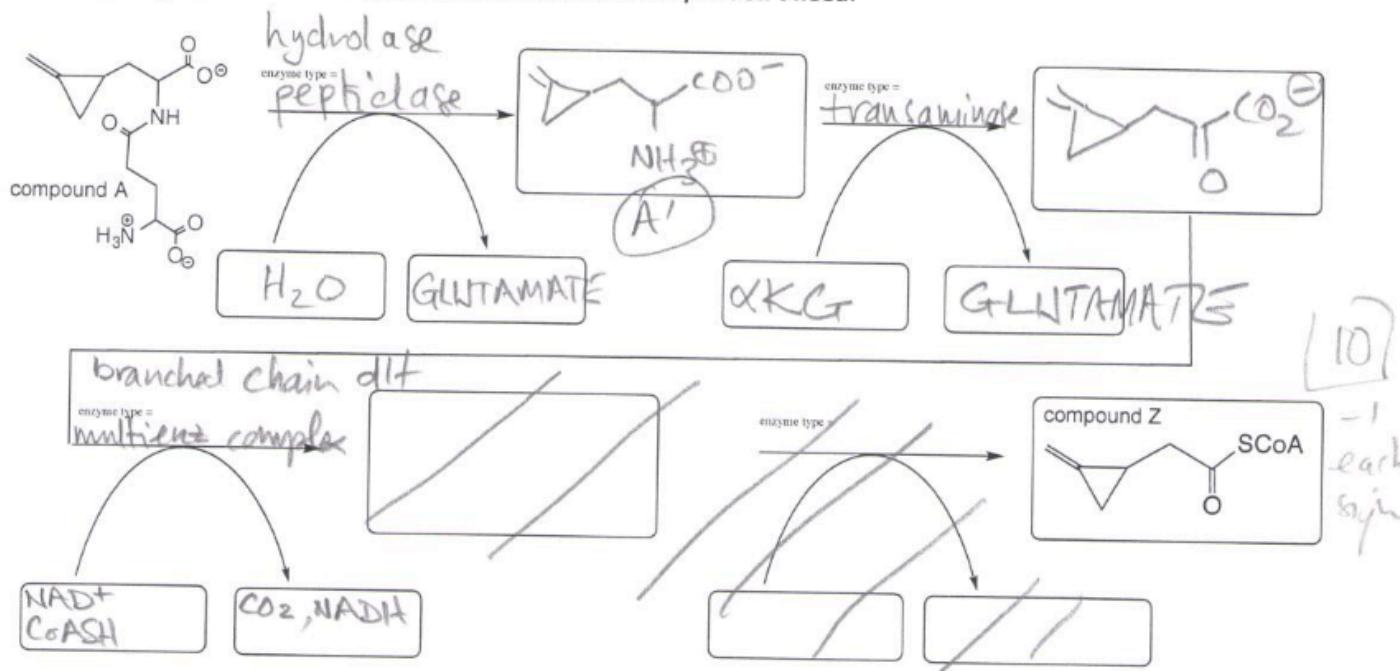
E

F

⑤ Z

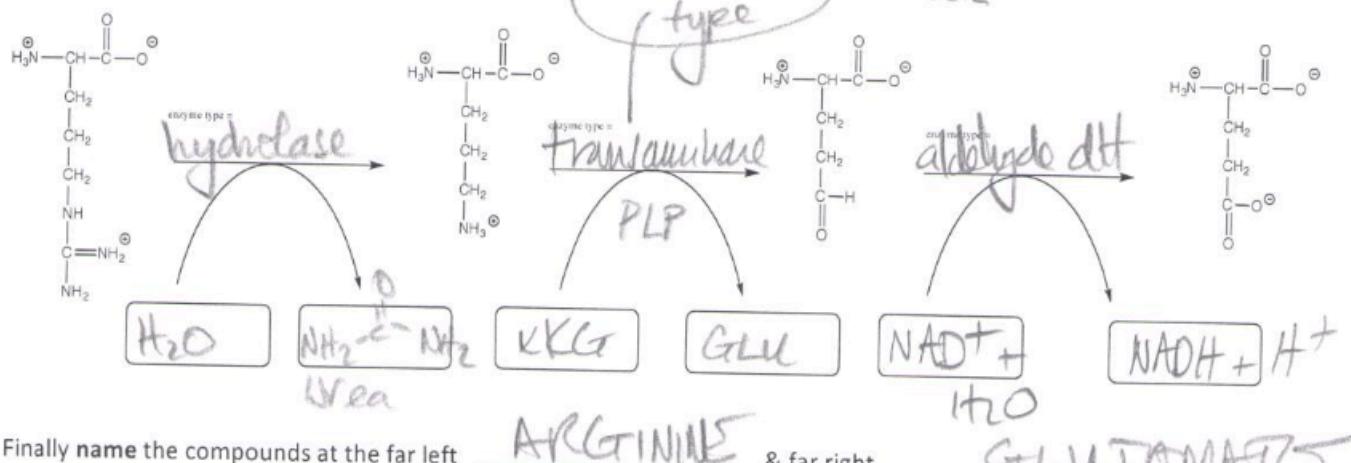
Question 1 (12 pts) In the space provided indicate the metabolism of compound A to compound Z. Do NOT show any mechanisms, and NO curved arrows - just indicate the identity of the main product in the larger boxes and any co-substrates/co-products [in the smaller boxes (see example); if nothing is needed in the box put "NONE"]. In addition, above each arrow write a general name for the enzyme involved in each step. You may not need all the spaces ... cross out the ones you don't need.

NADH, H₂O, CO₂

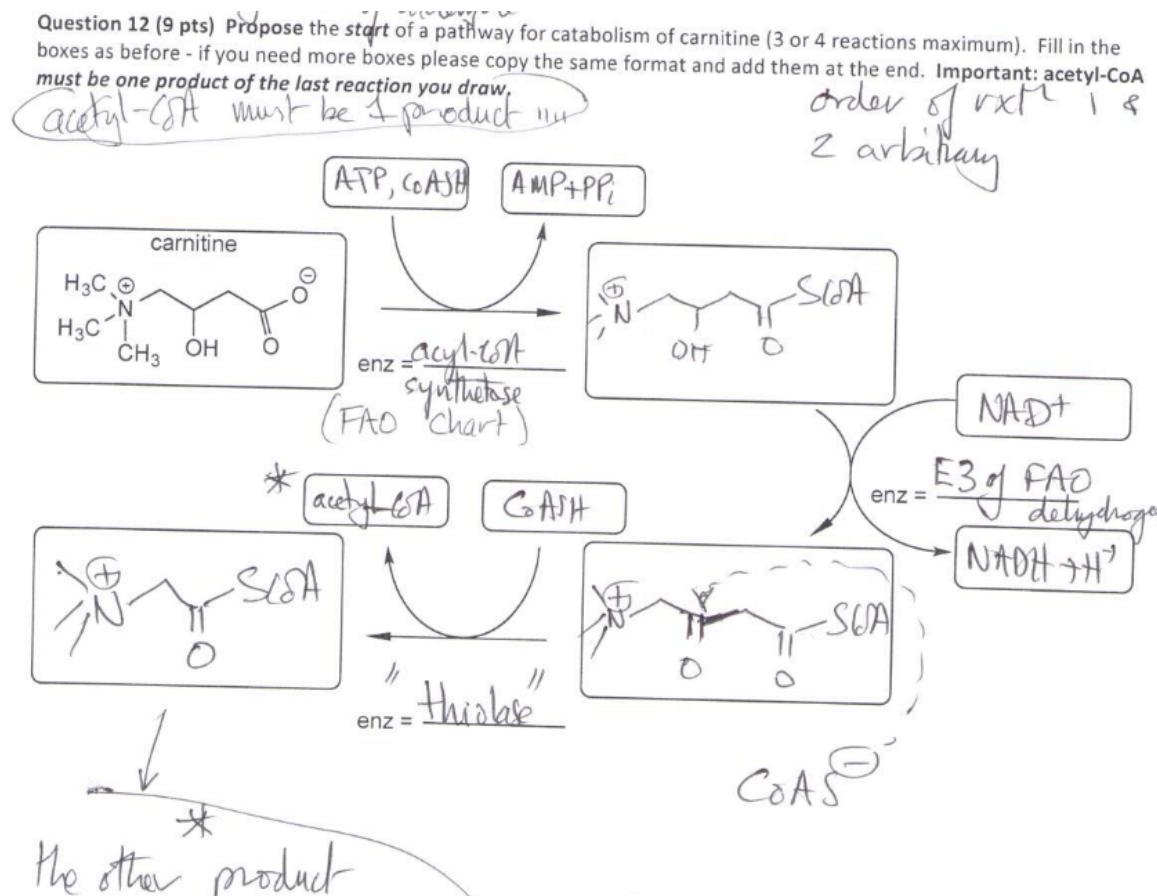


Question 3 (10 pts) In the space provided indicate the metabolism of the compound at the left to the compound at the right. Do NOT show mechanisms, and NO curved arrows - just indicate the identity of any co-substrates/co-products [sample at right; if nothing is needed in the box put "NONE".] AND above each arrow a general name for the enzyme involved in each step.

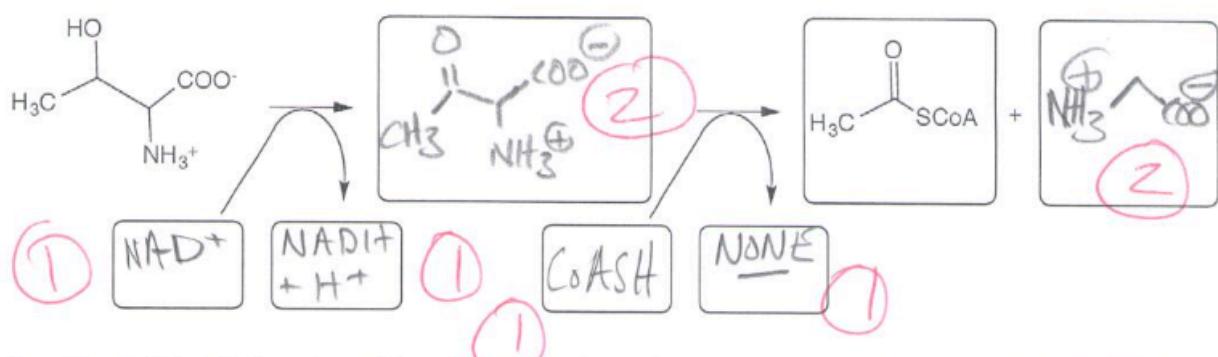
NADH, H₂O, CO₂



Q 12 is perhaps a little tricky ... hint, start this by making a CoA thioester of carnitine in the first reaction. Note, both final products are CoA thioesters.



Question 3 (7 pts) More than 90% of threonine (shown at the left) is degraded to glycine via a pathway that first involves a dehydrogenase and then a "thiolase-like activity" enzyme. Complete these steps filling in the boxes with structures, acceptable names or "none". No curved arrows or mechanism or enzyme names please.



Question 3 (12 pts.) Ammonia comes from an odd place - please read this: "Free ammonia also arises from the gastrointestinal tract from the bacterial hydrolysis of urea in the colon (perhaps as much as 25% of the daily urea synthesis undergoes such recycling). This large amount of ammonia produced by the gut is not a problem in healthy individuals since it is delivered, via the portal vein, directly to the liver to be detoxified by the urea cycle" (Quote from: Watford, 2003 The Urea cycle: ...; Biochemistry and Mol. Biol. Education)

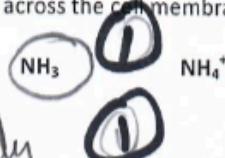
a) draw a balanced equation for the hydrolysis of urea to release ammonia



b) the pK for ammonia is 9.3. Suppose the pH of the colon is 7. If "ammonia" diffuses across the cell membrane - circle which form would be most rapidly penetrant:

explain why:

Uncharged cross membranes easily



c) If you introduce urea into the colon using a syringe and a flexible tube (just imagine that it can be done easily!). How could you prove that this recycling occurs. Here is a listing of the natural abundance of stable isotopes of carbon, nitrogen, oxygen and hydrogen.

| | | | | |
|----------|-----------------|--------|-----------------|--------|
| Carbon | ^{12}C | 99% | ^{13}C | 1% |
| Nitrogen | ^{14}N | 99.6% | ^{15}N | 0.4% |
| Oxygen | ^{16}O | 99.8% | ^{18}O | 0.2% |
| Hydrogen | ^1H | 99.997 | ^2H | 0.003% |

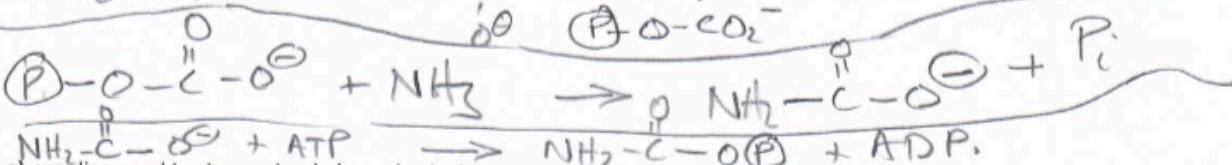
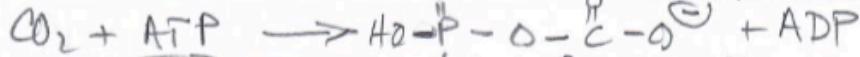
Chose a single element (C, N, O, or H) and explain which isotopic form of urea would you use to investigate recycling in mammals?

Element ^{15}N (1)

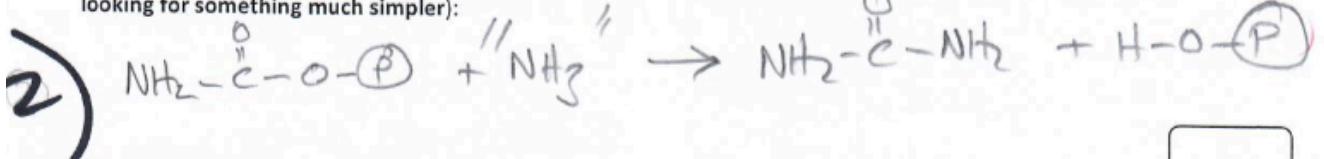
Explain the rationale for your choice - how would you analyze and explain the data

(2) use $^{15}\text{NH}_2-\text{C}(=\text{O})-\text{NH}_2$ and follow the $\frac{\text{urea}}{\text{urea}}$ in urine
 Note the $^{15}\text{NH}_3$ will get diluted into other nitrogenous compds. Also analyze stool

d) In the liver ammonia is converted to carbamoyl phosphate. Show the steps with balanced equations



e) we discussed in class a simple hypothetical way to make urea from carbamoyl-phosphate - it is not in textbooks (because it does not happen). Briefly show the hypothetical scheme here (do not show the urea cycle - we are looking for something much simpler):



d) the name of the type of cells that secrete pepsinogen

CHIEF

e) what metabolite of isoleucine was mistaken for ethylene glycol in the death of Ryan Stallings

PROPIONATE
acetyl methyl malonate

f) in that case ("e" above) what deposits were "erroneously" described to be present in the Ryan's brain

CALCIUM
OXALATE (crystals)

g) name an enzyme that decomposes hydrogen peroxide in cells

CATALASE



That is enough for now ...

Gluconeogenesis Answers CHEM642-010 022621

Sample Answers – Gluconeogenesis - from old CT exams

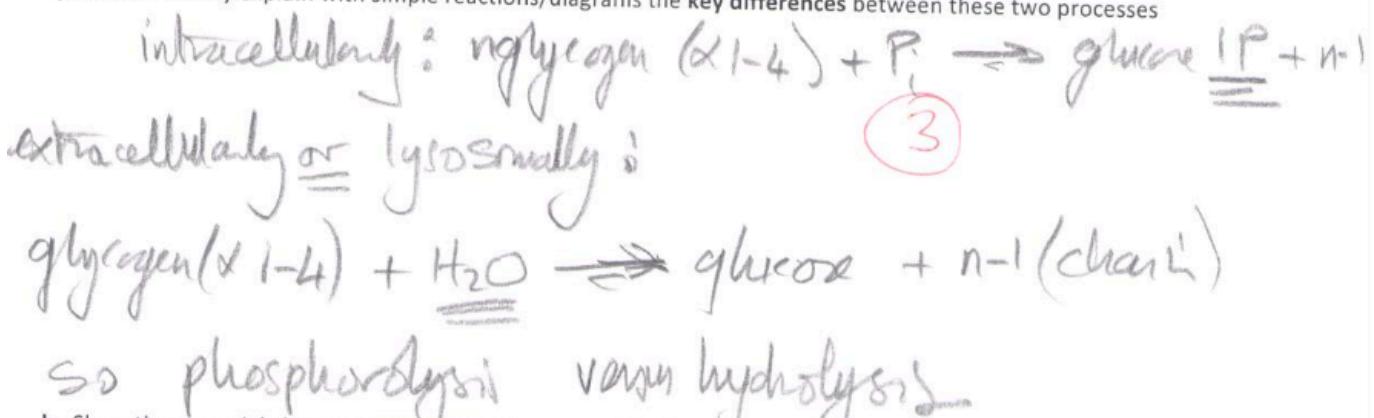
GL_1

- c. Explain, mechanistically, the role of glycogenin

See notes & slides // couples NDP-glucose to active site tyrosine "" & forms primer for each glycogen granule.

GL_2

- g. Intracellularly glycogen can be degraded via depolymerization both in the cytosol and, to a lesser extent, the lysosome. Clearly explain with simple reactions/diagrams the key differences between these two processes



GL_3

Question 8 (8 pts) Energy requirements (here consider that ATP needed represents the net (overall) conversion of ATP to ADP (so if a reaction converts ATP \rightarrow AMP that is equivalent to 2 ATPs))

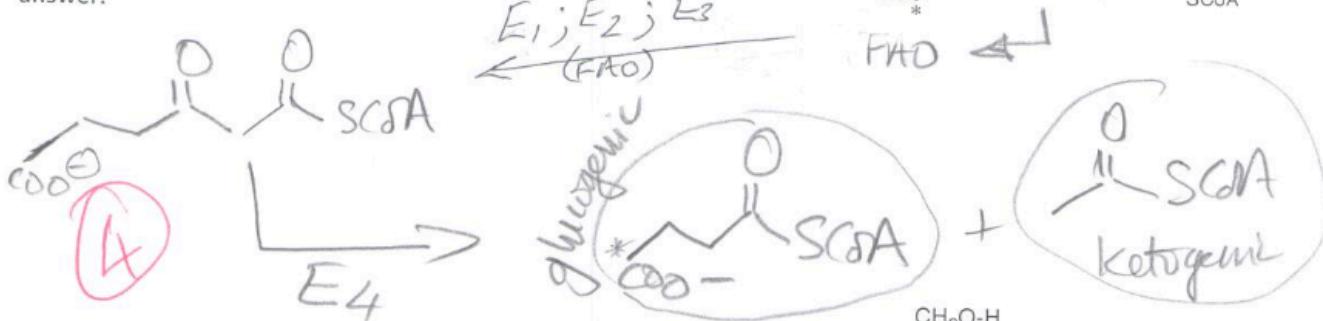
a) molecules of ATP needed for the formation of one molecule of Glucose-1P from lactate 6 2ea

b) the number of ATP molecules needed for the conversion of lactate to one molecule of glucose 6

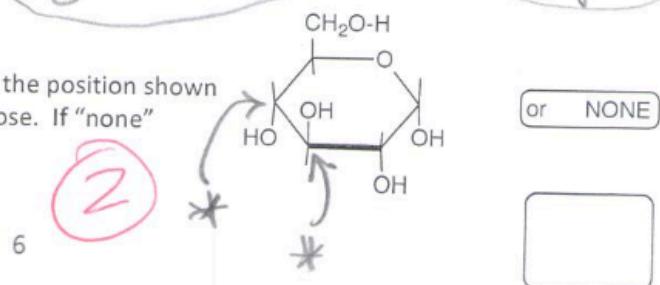
c) number of ATP molecules needed for the conversion of lactate to one molecule of fructose 1,6-diP 6

GL_4

Question 9 (6 pts) The molecule to the right is both glucogenic and ketogenic. a) Explain why - draw relevant structures illustrating your answer.

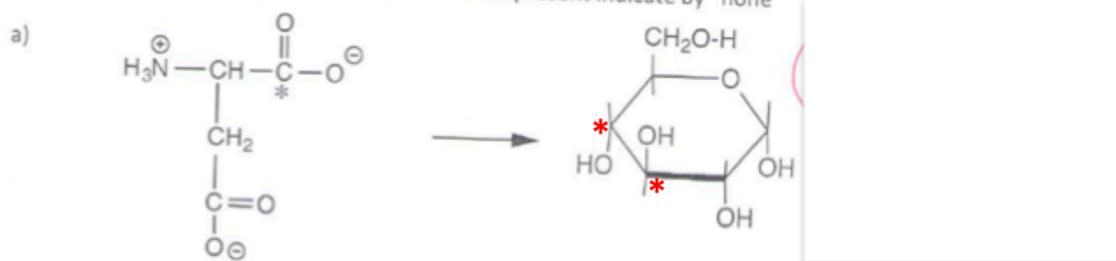


b) If the molecule is labeled with a carbon isotope at the position shown above, indicate where the label would appear in glucose. If "none" make this clear.



GL_5

Question 13 (6 pts) Tracing isotopes. The following asterisked carbons are labeled. Identify where the label would appear in the product. If no label would be present indicate by "none"



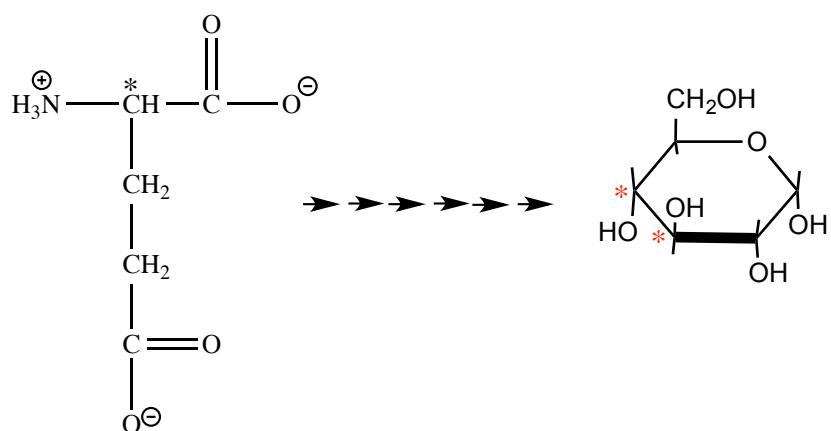
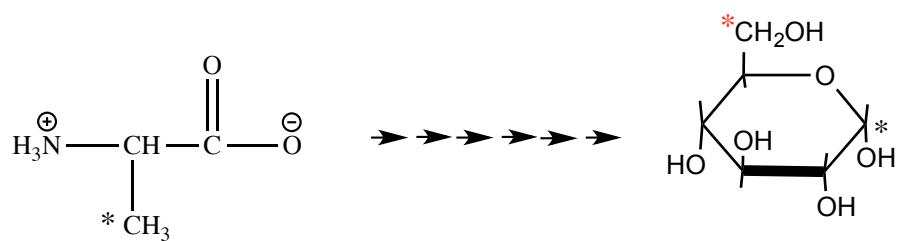
GL_6

Question (6 pts) When liver cells performing gluconeogenesis are supplied with pyruvate in the presence of $^{14}\text{CO}_2$ the resulting glycogen synthesized would not be expected to be radioactive.

a) Explain clearly why no label would be *initially expected*. Please put "a) ___" (one line of explanation)

initially one expects that the very same carbon added from CO_2 to pyruvate would be removed in the carboxykinase reaction

GL_7 More tracing isotope labels in gluconeogenesis



GL_8 Fill in the blanks with not more than three words

Name a major symptom of von Gierke's disease

accumulation of glycogen

This transformative scientist in glycogen biosynthesis was featured on a stamp **Gerty Cori**

This enzyme decarboxylates oxaloacetate as part of gluconeogenesis **PEP carboxykinase**

The cofactor in pyruvate carboxylase **Biotin**

The cofactor of aminotransferases **Pyridoxal phosphate**