

CHEM-527 Introductory Biochemistry  
Second Hourly Examination - Version A  
Thursday, November 14, 2013  
Dr. White Instructor

Name \_\_\_\_\_

If you feel any question is unclear or ambiguous, clearly explain your answer or interpretation.

Do not expose your answers to the scrutiny of your neighbors. Please fold under each page before you go on to the next.

- Write your name on every page.
- There are 8 pages to this examination including this page.
- A maximum score on this examination is 120 points.
- You will be provided with metabolic pathway sheets for glycolysis, gluconeogenesis, the pentose phosphate pathway, the citric acid cycle, and beta oxidation of fatty acids.
- This examination will assess your learning, problem-solving skills, and ability to communicate clearly. Parts are intended to be challenging even to the best students in the class.
- Writing reflects how you think. Better quality answers will receive higher marks. Therefore organize your thoughts before you write and draw. Among the “right answers” I will read, some will be better than others because they:
  - show greater depth of understanding,
  - provide a more logical structure,
  - use appropriate examples,
  - include appropriate illustrations,
  - avoid extraneous or inaccurate information, and
  - choose words with precision.
- Strive to write not that you may be understood, but rather that you cannot possibly be misunderstood. Stream of consciousness answers are rarely well organized or clearly presented..

Breakdown of the Exam by sections:

I.	Short Answer	20 Points
II.	Multiple Choice	20 Points
III.	<u>Problems and Short Essay</u>	<u>80 Points</u>
Total		120 Points

**Part I. Short Answer “Bloom’s Basement” (20 points, 1 point each)**

- \_\_\_\_\_ 1. Name of lipid used for energy stored in adipose tissue.
- \_\_\_\_\_ 2. Cell membranes are destroyed by this enzyme found in some snake venoms.
- \_\_\_\_\_ 3. Common name for a C<sub>18:1</sub> fatty acid.
- \_\_\_\_\_ 4.  $\frac{RT}{ZF} \ln \frac{[ion]_{in}}{[ion]_{out}}$  is the mathematical expression for \_\_\_\_\_.
- \_\_\_\_\_ 5. Mediated transport that does not require energy input.
- \_\_\_\_\_ 6. Na<sup>+</sup> to K<sup>+</sup> ratio transported by the Na,K-ATPase
- \_\_\_\_\_ 7. The neurotoxin Sarin inhibits hydrolysis of this neurotransmitter.
- \_\_\_\_\_ 8. G-Proteins bind and hydrolyze this molecule
- \_\_\_\_\_ 9. A second messenger derived from ATP
- \_\_\_\_\_ 10. Galactose and glucose, monosaccharides differing in stereochemistry at carbon 4, are \_\_\_\_\_ of each other.
- \_\_\_\_\_ 11.  $\alpha$ - and  $\beta$ -D-glucose differing in the stereochemistry at carbon 1 are \_\_\_\_\_.
- \_\_\_\_\_ 12. Insoluble  $\beta$  (1-4) glucose polymer.
- \_\_\_\_\_ 13. Lipid redox carrier in the electron transport chain
- \_\_\_\_\_ 14. Cytochrome oxidase reduces what?
- \_\_\_\_\_ 15. Class of enzymes that phosphorylate using ATP
- \_\_\_\_\_ 16. Vitamin precursor to NAD(P).
- \_\_\_\_\_ 17. The  $\Delta G^{0'}$  for hydrolysis of ATP to ADP and P<sub>i</sub> is very similar to that for hydrolysis of this other metabolic intermediate/functional group.
- \_\_\_\_\_ 18. Coenzyme associated with decarboxylation of  $\alpha$ -ketoacids.
- \_\_\_\_\_ 19. Reductive biosynthetic (anabolic) reactions use this cofactor.
- \_\_\_\_\_ 20. Sedoheptulose-7-phosphate is part of this pathway.

**Part II. Multiple Choice Questions (20 points, 3 points each correct answer, 2 points for a brief correct explanation of your answer for each.)**

- \_\_\_\_\_ 1. The Calvin Cycle is composed of photosynthetic
- A. "Dark" reactions that normally operate only at night.
  - B. "Dark" reactions that normally operate only in day light.
  - C. "Light" reactions that normally operate only at night.
  - D. "Light" reactions that normally operate only in day light.

Explanation:

- \_\_\_\_\_ 2. Plants
- A. Produce O<sub>2</sub> during the day and consume CO<sub>2</sub> at night.
  - B. Produce both CO<sub>2</sub> and O<sub>2</sub> in the day, but not at night.
  - C. Consume CO<sub>2</sub> in the day and consume O<sub>2</sub> at night.
  - D. Consume both CO<sub>2</sub> and O<sub>2</sub> at night, but not in the day.

Explanation:

- \_\_\_\_\_ 3. Photosynthesis in plants and respiration in animals often are depicted as opposite processes. However they actually have much in common. Which of the following is not something the two processes have in common?
- A. Obtain electrons from water.
  - B. Localization in an organelle bounded by two lipid membranes.
  - C. Electron transport chain that includes cytochromes.
  - D. ATP synthesis coupled to a proton gradient.

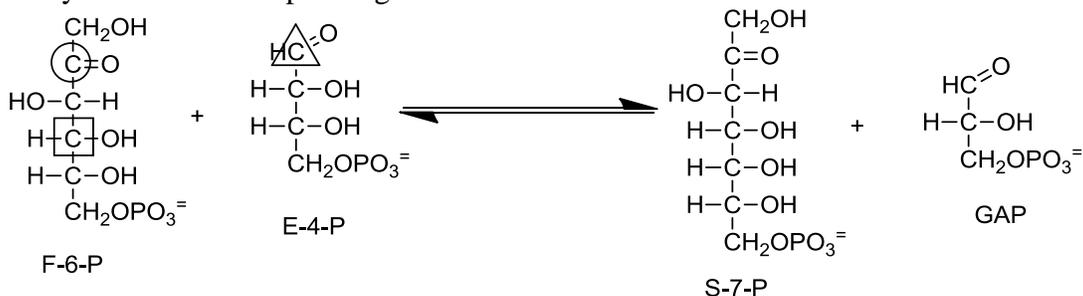
Explanation

- 4. Knowing that ascorbic acid can donate electrons to the electron transport chain and produce 1 ATP per oxygen atom consumed, it can be concluded that ascorbic acid
- A. Donates electrons to NADH
  - B. Donates electrons to CoQ (Ubiquinone)
  - C. Uncouples oxidative phosphorylation
  - D. Is oxidized in the reaction

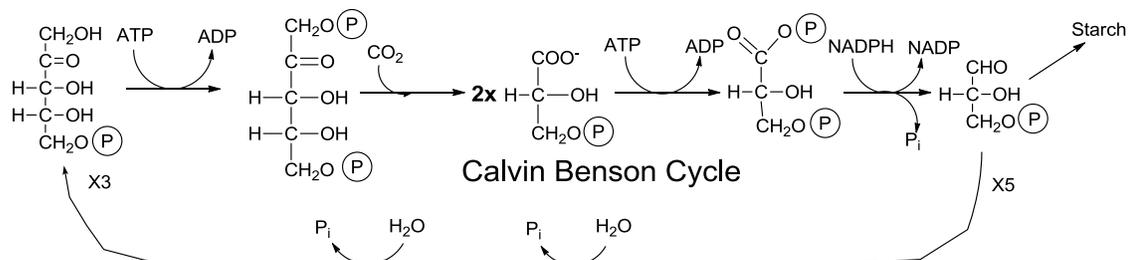
Explanation



3. (6 Points) In the Pentose Phosphate Pathway, carbon-carbon bonds are made and broken as 3 five-carbon intermediates get converted into three- and six-carbon glycolytic intermediates. One of the reactions is shown below with three carbon atoms marked with a circle, square, or triangle. Show where those carbon atoms end up in the products of the reaction using the same symbols for corresponding carbon atoms.

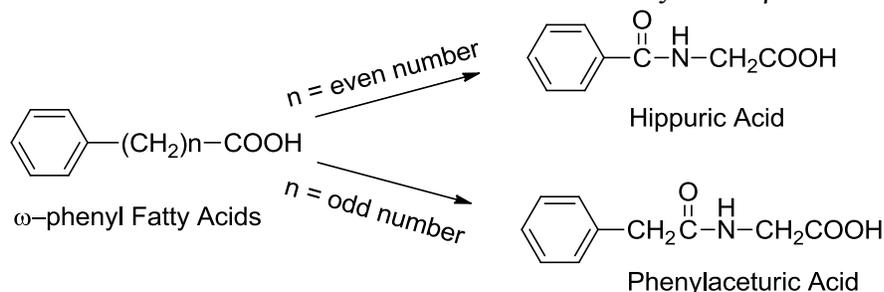


4. (12 Points Total) The following questions refer to part of the Calvin-Benson Cycle illustrated below.

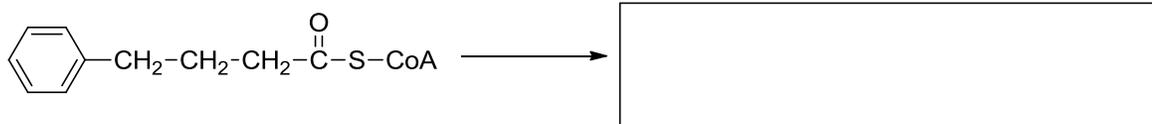


- a. (4 Points) How many ATPs and NADPHs are used per  $\text{CO}_2$  fixed in the Calvin-Benson Cycle? Explain your answer.
- b. (4 Points) The equation often associated with photosynthesis has oxygen in every molecule,
- $$6 \text{CO}_2 + 6 \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6 \text{O}_2,$$
- In this equation, where do the oxygens come from in glucose and molecular oxygen?
- c. (4 Points) Ribulose *bis*phosphate carboxylase-oxidase [Rubisco], the enzyme that combines carbon dioxide with ribulose 1,5-bisphosphate to form two molecules of 3-phosphoglycerate, is the rate limiting step in carbon fixation, yet it is present in much higher amounts than the other enzymes in the pathway—up to 50% of the protein. What is the explanation of this unusually high concentration of the enzyme?

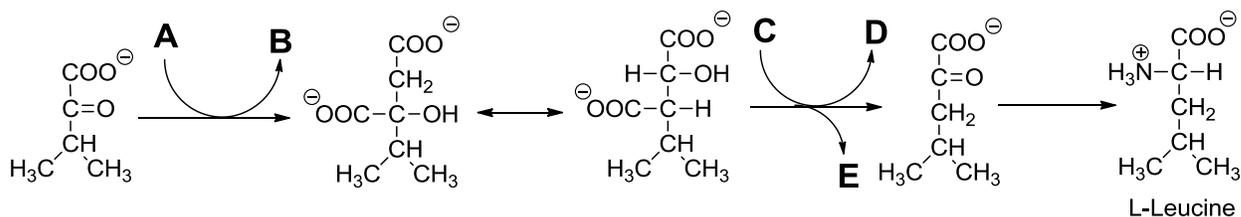
5. (16 Points Total) A little over a century ago, Franz Knoop studied the metabolism of a series of  $\omega$ -phenyl fatty acids by feeding them to animals and isolating the products in urine. As shown below, the products were either derivatives of benzoic acid or phenyl acetic acid depending upon whether the number of methylene groups was odd or even, respectively, as shown below. From these results he deduced the basic chemistry of the  $\beta$ -oxidation pathway.



- a. (2 Points) If the amide bond of hippuric acid were hydrolyzed, what would be the common name the nitrogen-containing product?
- b. (4 Points) Fatty acids are converted to their Coenzyme A thioesters before  $\beta$ -oxidation in the matrix of the mitochondrion. Consider the activated  $\omega$ -phenyl fatty acid below as it begins its travel through the  $\beta$ -oxidation pathway. Draw the structure of the first intermediate that would be formed.

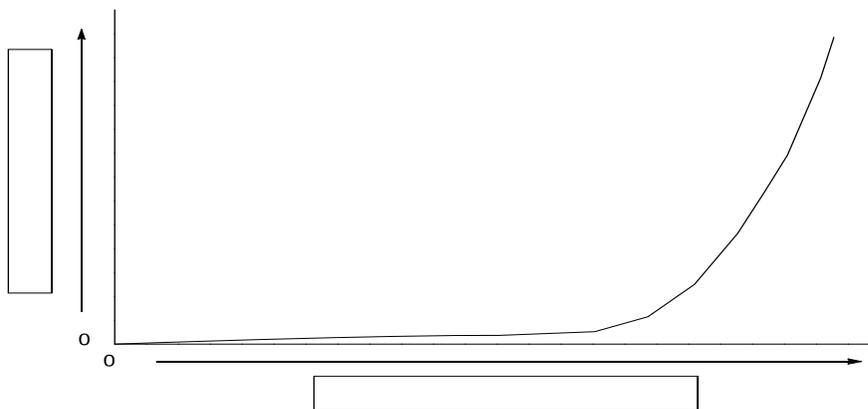


- c. (2 Points) How many acetyl CoA molecules would be produced in the oxidation of this  $\omega$ -phenyl fatty acid?
- d. (8 Points) For each acetyl CoA produced in the  $\beta$ -oxidation pathway and oxidized to  $\text{CO}_2$  and  $\text{H}_2\text{O}$  by the citric acid cycle how many ATPs will be generated using the accepted P:O ratios for oxidative phosphorylation. Show how you calculate the number you obtain.
6. (5 Points) One of the simplifying aspects of metabolism is that new pathways evolved from other pathways and retained the basic chemistry. Below are the last few steps in the biosynthesis of Leucine. Based on analogy with other pathways that you have seen, identify compounds A through E.

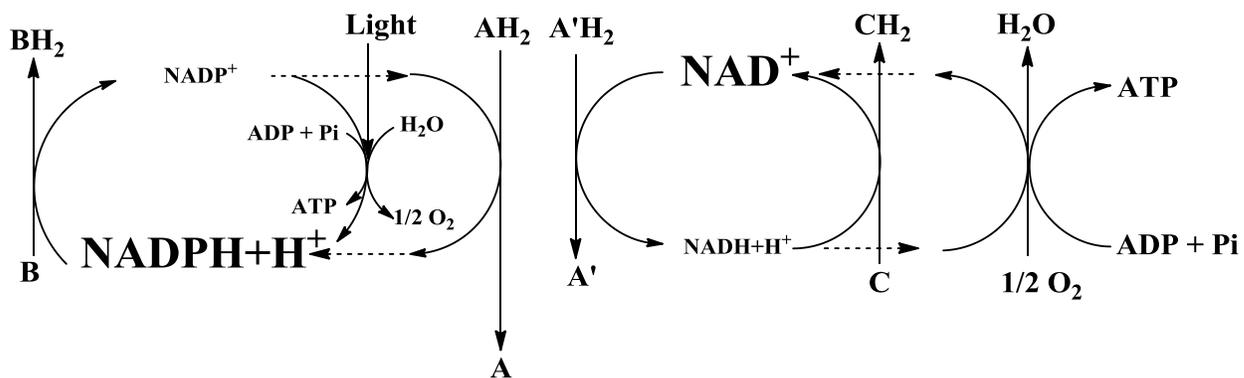


A. \_\_\_\_\_ B. \_\_\_\_\_ C. \_\_\_\_\_ D. \_\_\_\_\_ E. \_\_\_\_\_

7. (14 Points Total) The demonstration in class on October 3 included chicken eggs, a solution of riboflavin, and an ultraviolet light. If one were to plot the phenomenon observed, it could be graphed as below:



- (4 Points) In the boxes, provide appropriate labels for the axes.
  - (2 Points) Riboflavin is the precursor for what important coenzyme(s)?
  - (8 Points) In the space below, describe the demonstration and what one can conclude about eggs and riboflavin from the graph above. (If you can't remember, tell some of the story for partial credit.)
8. (11 Points Total) The following is a figure used in the class with some text elements removed. Please provide a title for this figure and a legend that explains what the figure is intended to convey.



- (3 Points) A title for the figure:
- (8 Points) Explanatory Figure Legend. You may add back text to the figure to supplement your description. You may use bullet points to deal with different aspects of the figure.