

CHEM-643 Intermediary Metabolism

Monday, 4 October 2010

Individual/Group Quiz on Photosynthesis Case Study Problem, Are you what you eat?

This quiz contains 12 multiple choice questions. To do well you should be familiar with photosynthesis, Calvin Cycle, Hatch-Slack Pathway, radioisotopic tracers, phase plane plots, light and dark reactions of photosynthesis, carbon isotope fractionation, the Bassham experiment, and general principles of metabolism.

First, without discussion with the other members of your group, mark your answer sheet with the letter corresponding to the answer you think is best for each question. If you are unsure of your answer, you may record two letters with the first being your preferred answer for possible partial credit. Correct answers are worth 4 points. If you put down two answers, you will get 3 points if the first of the two is correct and 2 points if the second of the two is correct. Do not expose your answers to your neighbors. Your total score will be the sum of the individual and group parts.

When everyone in your group is finished, but no later than 9:30 AM, discuss your answers quietly and come to consensus. Record your group's answer by scratching off the corresponding place on the "lottery ticket" answer sheet. If you do not get the correct answer on the first try, make a second choice. Each question is worth 4 points if you get the correct answer on the first try, 2 points on the second try, and 1 point on the third try. If you think more than one might be correct, pick the *best* answer.

\_\_\_\_\_ 1. Plants

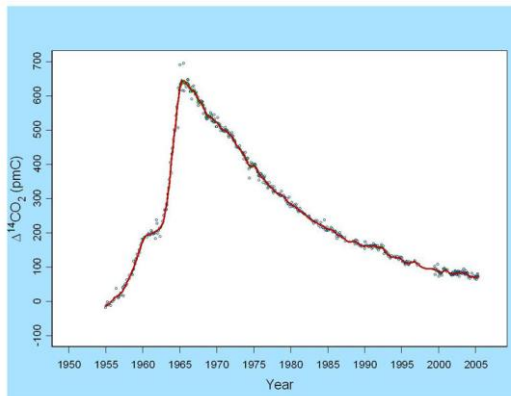
- A. Consume both CO<sub>2</sub> and O<sub>2</sub> at night, but not in the day.
- B. Consume CO<sub>2</sub> in the day and consume O<sub>2</sub> at night.
- C. Produce O<sub>2</sub> during the day and consume CO<sub>2</sub> at night.
- D. Produce both CO<sub>2</sub> and O<sub>2</sub> in the day, but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

\_\_\_\_\_ 2. A news item in the Wilmington News Journal this past week reported that honey producers were concerned that imported honey diluted with inexpensive corn syrup was being sold as pure honey and the FDA was not prosecuting the importers for false advertizing. If the  $\delta^{13}\text{C}$  value of the imported honey were between that of C3 and C4 plants, you could conclude:

- A. The honey was not pure.
- B. Probable adulteration needs to be confirmed by analyzing the sugars present.
- C. The honey was produced by bees feeding on the pollen from C3 and C4 plants.
- D. Very little, because one would expect  $\delta^{13}\text{C}$  values of pure domestic honey in that range.

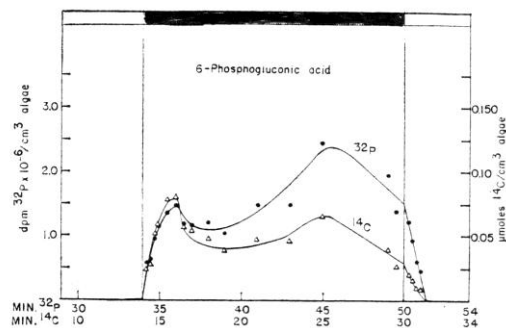
- \_\_\_\_\_ 3. Ribulose biphosphate carboxylase (Rubisco) is perhaps the most abundant enzyme in the biosphere. On the order of 50% of the soluble protein in a green leaf is this enzyme. If you were going to study the process that was responsible for the high production of this enzyme, which of the following would be the most likely to provide insight:
- Efficiency of translation of the Rubisco mRNA
  - Metabolic regulation of Rubisco activity.
  - RNA splicing to form mature mRNA
  - Transcription initiation at the promoter

- \_\_\_\_\_ 4. The curve at the right displays the amount of  $^{14}\text{CO}_2$  remaining in the atmosphere as the result of atmospheric atomic bomb testing in the 1950s and 60s. If a 100 year old tree were cut down in 2005 and the  $^{14}\text{C}$  content of each annual growth ring was measured and plotted, the resulting graph of  $^{14}\text{C}$  vs time would:



- Look like a saturation curve with highest values in 2005.
- Look much like the graph at the right.
- Be flat corresponding to the highest point in 1968.
- Be flat corresponding to 2005 levels.

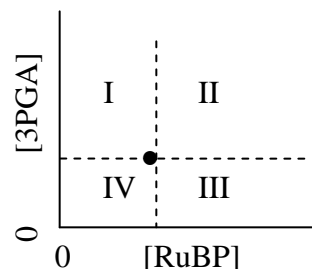
- \_\_\_\_\_ 5. The curve at the right displays the amount of  $^{14}\text{C}$  and  $^{32}\text{P}$  in (PGNA) 6-phosphogluconate in Bassham's experiment. It shows that:



- After 15 min of darkness  $\geq 60\%$  of the carbon in PGNA comes from starch.
- The oxidative part of the pentose phosphate pathway operates only in the dark.
- PGNA is not part of the Calvin Cycle.
- All of the above.

- \_\_\_\_\_ 6. If  $\text{CO}_2$  were suddenly removed from an actively photosynthesizing algal suspension, which of the following would you expect?
- An increased concentration of ribulose 1,5 biphosphate, RuBP.
  - Activation of the TCA Cycle to replace the missing  $\text{CO}_2$ .
  - A rapid decrease in glycolysis.
  - An increased rate in the synthesis of starch.

7. The point on the graph to the right represents the concentrations of 3PGA and RuBP at the moment the lights were turned off in Bassham's experiment. Plot the point corresponding to their concentrations about 30 sec later. In which quadrant would the new point be located?
- A. I      B. II      C. III      D. IV



8. Ignoring photorespiration, the ratio of ATP:NADPH consumed per each CO<sub>2</sub> fixed by the Calvin Cycle is \_\_\_ in C<sub>3</sub> plants:
- A. 1:1      B. 2:1      C. 3:2      D. 1:2

9. The light-dark switch in photosynthesis occurs almost instantaneously and is driven by the redox state in an elegant manner by the simultaneous formation (or reduction) of disulfide bonds in regulated enzymes. In some cases the oxidized (-S-S-) state is active and the reduced (-SH HS-) state is inactive while the reverse is true for other enzymes. In other words some enzymes are activated by the same reactions that inhibit others. Ribulose biphosphate carboxylase (Rubisco) and Glucose-6-phosphate dehydrogenase are redox-sensitive enzymes in plants. Based on this information, predict their respective states when in the light.

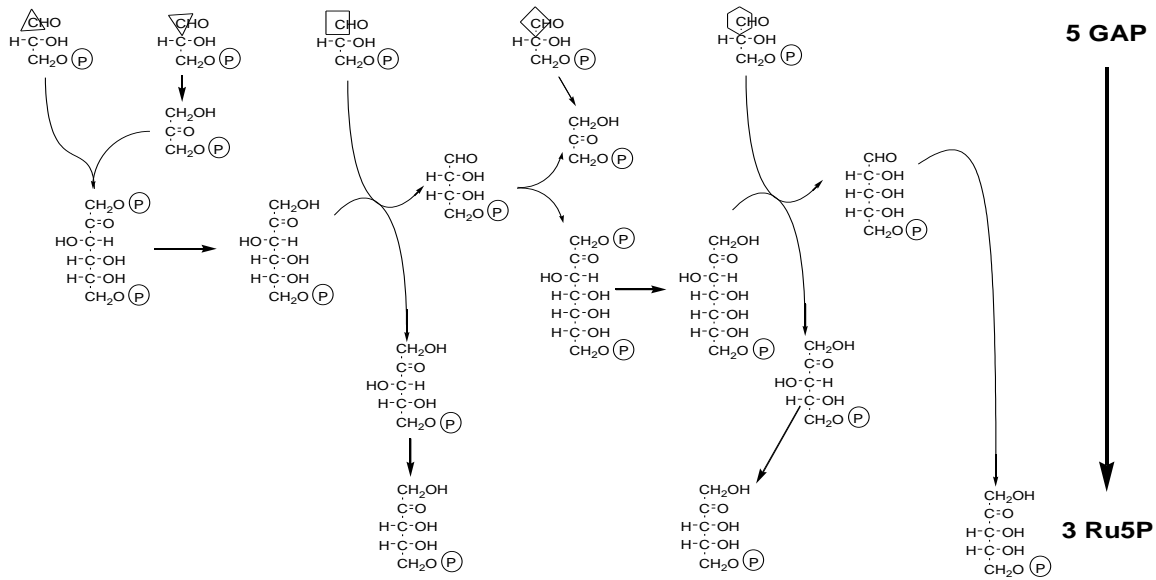
	A	B	C	D
<b>Rubisco</b>	-S-S-	-S-S-	-SH HS-	-SH HS-
<b>G-6-PDH</b>	-S-S-	-SH HS-	-S-S-	-SH HS-

10. Predict whether or not Rubisco and G-6-PDH are active or inactive when their redox-active disulfides are oxidized (-S-S-).

	A	B	C	D
<b>Rubisco</b>	active	inactive	active	inactive
<b>G-6-PDH</b>	active	active	inactive	inactive

11. Consider two identical photosynthesizing leaves placed in separate vessels containing atmospheric carbon dioxide. Vessel 1 is sealed so new air cannot come in, while the Vessel 2 remains open to the air. Photosynthesis is allowed to continue until the CO<sub>2</sub> in Vessel 1 is used up. What can you predict about the  $\delta^{13}\text{C}$  values for newly fixed carbon?
- A.  $\delta^{13}\text{C}$  atmospheric CO<sub>2</sub> >  $\delta^{13}\text{C}$  Vessel 1 >  $\delta^{13}\text{C}$  Vessel 2  
 B.  $\delta^{13}\text{C}$  atmospheric CO<sub>2</sub> <  $\delta^{13}\text{C}$  Vessel 1 <  $\delta^{13}\text{C}$  Vessel 2  
 C.  $\delta^{13}\text{C}$  atmospheric CO<sub>2</sub> =  $\delta^{13}\text{C}$  Vessel 1 >  $\delta^{13}\text{C}$  Vessel 2  
 D.  $\delta^{13}\text{C}$  atmospheric CO<sub>2</sub> =  $\delta^{13}\text{C}$  Vessel 1 <  $\delta^{13}\text{C}$  Vessel 2

12. The figure below depicts the conversion of five molecules of glyceraldehyde-3-P into three molecules of ribulose-5-P. Starting with [1- $^{14}\text{C}$ ] glyceraldehyde-3-P, how would the  $^{14}\text{C}$  label be distributed among the five carbons of ribulose-5-P in one turn of the cycle?



- A.  $^{14}\text{C}$  in Carbon 3 >  $^{14}\text{C}$  in Carbon 1 +2 +4 +5  
 B.  $^{14}\text{C}$  in Carbon 1 >  $^{14}\text{C}$  in Carbon 2  
 C.  $^{14}\text{C}$  in Carbon 4 >  $^{14}\text{C}$  in Carbon 2  
 D.  $^{14}\text{C}$  in Carbon 5 >  $^{14}\text{C}$  in Carbon 4

<p>Name _____</p> <ol style="list-style-type: none"><li>1. _____</li><li>2. _____</li><li>3. _____</li><li>4. _____</li><li>5. _____</li><li>6. _____</li><li>7. _____</li><li>8. _____</li><li>9. _____</li><li>10. _____</li><li>11. _____</li><li>12. _____</li></ol>	<p>Name _____</p> <ol style="list-style-type: none"><li>1. _____</li><li>2. _____</li><li>3. _____</li><li>4. _____</li><li>5. _____</li><li>6. _____</li><li>7. _____</li><li>8. _____</li><li>9. _____</li><li>10. _____</li><li>11. _____</li><li>12. _____</li></ol>	<p>Name _____</p> <ol style="list-style-type: none"><li>1. _____</li><li>2. _____</li><li>3. _____</li><li>4. _____</li><li>5. _____</li><li>6. _____</li><li>7. _____</li><li>8. _____</li><li>9. _____</li><li>10. _____</li><li>11. _____</li><li>12. _____</li></ol>
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