

CHEM-643 Intermediary Metabolism

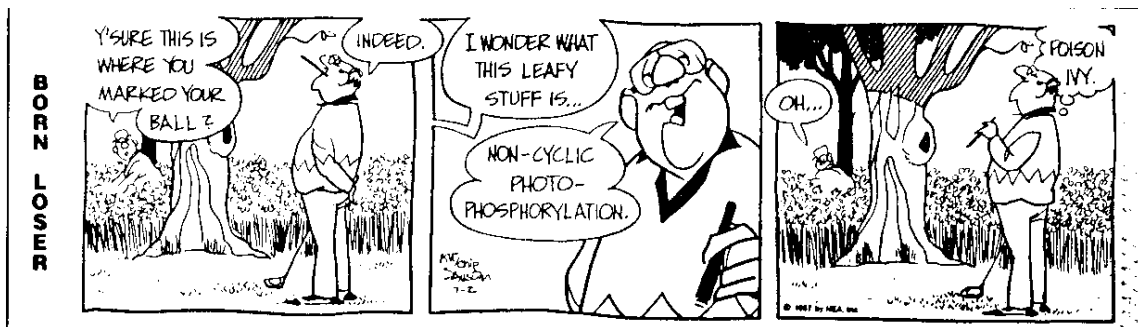
Monday, 30 September 2013

Individual/Group Quiz on Photosynthesis Case Study Problem

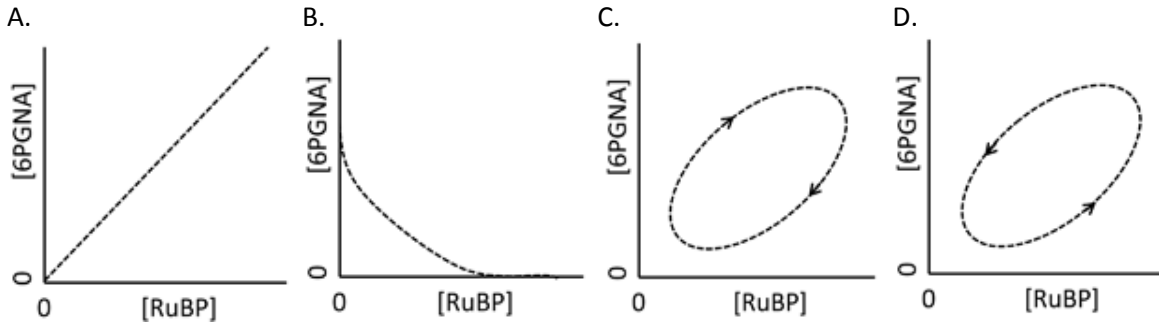
This quiz contains 14 multiple choice questions. To do well you should be familiar with glycolysis, the Betz and Chance experiment, oxidative phosphorylation, fermentation, ATP metabolism, metabolic regulation, photosynthesis, Calvin Cycle, Pentose Phosphate Pathway, Hatch-Slack Pathway, radioisotopic tracers, phase plane plots, light and dark reactions of photosynthesis, carbon isotope fractionation, the Bassham experiment, and general principles of metabolism. Common sense will help too.

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. 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, around 9:25 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. In the Bassham experiment, many metabolic intermediates were isolated from the algae at each time point before and after the light-dark transition. If a phase plane plot were constructed for RuBP (ribulose-1,5 bis-phosphate, a Calvin-Benson Cycle intermediate) and 6PGNA (6-phosphogluconate, a pentose phosphate pathway intermediate), which of the following would be most likely?



___ 2. If Bassham and associates had measured a metabolite sample for its ^{32}P and ^{14}C content and found 1000 dpm for each and then stored the sample for a month before deciding to remeasure the radioactivity, which of the following results should they expect?

	Original values (dpm)	A	B	C	D
^{32}P	1000	500	250	1000	1000
^{14}C	1000	1000	1000	500	1000

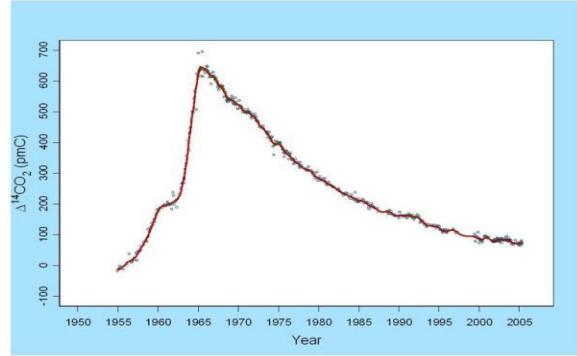
___ 3. In the photosynthesis experiment with algae, if it were possible to remove every molecule of 3PGA that contained a radioactive atom, what percentage would the unlabeled 3PGA be of the total 3PGA?

- A. Negligible (<1%) B. 1% - 50% C. 50%-99% D. nearly 100%

___ 4. Conceptually, the most important similarity between the experiments with glycolysis in yeast and photosynthesis in algae is:

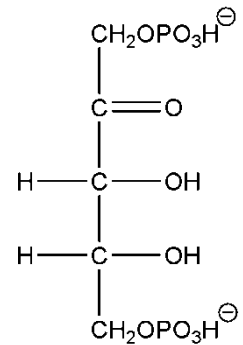
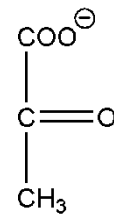
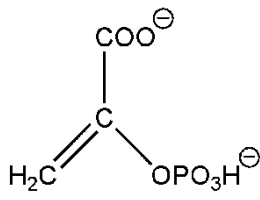
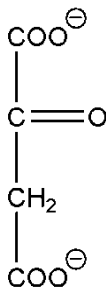
- A. Single-celled organisms were used as appropriate experimental organisms.
- B. Radioactivity was used to detect and quantitate metabolic intermediates.
- C. Regulation was studied by inducing an abrupt change from one metabolic state to another.
- D. Glycolysis operated in yeast and in algae.

___ 5. The curve at the right displays the amount of ^{14}C remaining in the atmosphere as the result of atmospheric atomic bomb testing in the 1950s and 1960s. If you could measure the ^{14}C content of proteins in your eye lens or lipids in your brain, they would have a higher ^{14}C specific radioactivity than proteins or lipids from your liver. A reasonable explanation would be:



- A. Molecules in the liver are synthesized and degraded relatively rapidly.
- B. ^{14}C compounds are specifically deposited in the eye and brain.
- C. The decay of ^{14}C is catalyzed by an enzyme in liver.
- D. Molecules in the liver are precursors to those in the brain.

___ 6. Which compound is the first to react with CO_2 in a C_4 plant via the Hatch-Slack Pathway?



___ 7. 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_2 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 $\text{CO}_2 = \delta^{13}\text{C}$ Vessel 1 < $\delta^{13}\text{C}$ Vessel 2
- B. $\delta^{13}\text{C}$ atmospheric $\text{CO}_2 < \delta^{13}\text{C}$ Vessel 1 < $\delta^{13}\text{C}$ Vessel 2
- C. $\delta^{13}\text{C}$ atmospheric $\text{CO}_2 = \delta^{13}\text{C}$ Vessel 1 > $\delta^{13}\text{C}$ Vessel 2
- D. $\delta^{13}\text{C}$ atmospheric $\text{CO}_2 > \delta^{13}\text{C}$ Vessel 1 > $\delta^{13}\text{C}$ Vessel 2 .

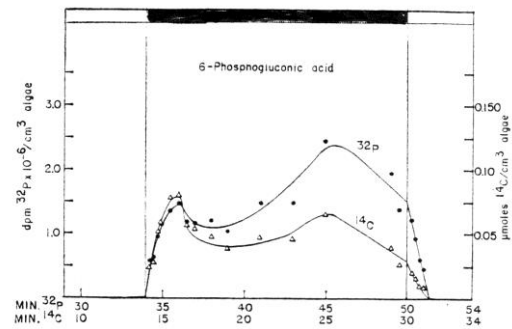
___ 8. In the Bassham experiment, the amount of the immediate increase in ^{32}P 3PGA after the light to dark transition would be.

- A. More or less stoichiometric to the RuDP present when the lights were turned off.
- B. Dependent on the production of ATP by dark reactions
- C. Due to an increase in the amount of free ^{32}P -phosphate available.
- D. Caused by activation of the glycolytic pathway.

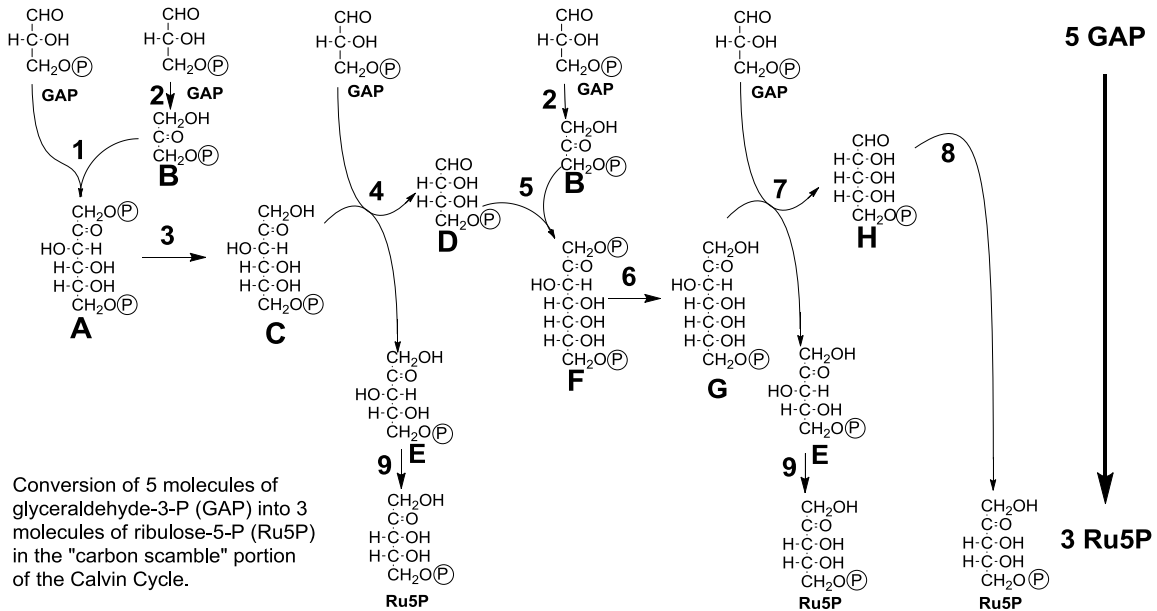
- ___ 9. The carbon atoms in nylon
- Include essentially no ^{14}C .
 - Would have a significantly different $\delta^{13}\text{C}$ than gasoline.
 - Are derived directly by chemical synthesis from atmospheric CO_2 .
 - Are derived from corn starch and cellulose.
- ___ 10. If CO_2 were suddenly removed from an actively photosynthesizing algal suspension, which of the following would you expect?
- Activation of the TCA Cycle to replace the missing CO_2 .
 - A rapid decrease in glycolysis.
 - An increased concentration of ribulose 1,5 bisphosphate, RuBP.
 - An increased rate in the synthesis of starch.
- ___ 11. The light-to-dark switch in photosynthesis occurs almost instantaneously and is driven by the redox state in an elegant manner by the simultaneous formation of disulfide bonds in regulated enzymes. In some cases the oxidized (-S-S-) state is active and the reduced (-SH HS-) is inactive, while the reverse is true for other enzymes. In other words some enzymes are activated by the same signal that inhibits others. Ribulose bisphosphate carboxylase (Rubisco) and Glucose-6-phosphate dehydrogenase (G-6-PDH) are redox-sensitive enzymes in plants. Based on this information, predict their respective states when in the light.

	A	B	C	D
Rubisco	-S-S-	-S-S-	-SH HS-	-SH HS-
G-6-PDH	-S-S-	-SH HS-	-S-S-	-SH HS-

- ___ 12. The curve at the right displays the amount of ^{14}C and ^{32}P in (PGNA) 6-phospho-gluconate 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.



Questions 13 and 14 refer to the figure below.



13. The figure above is incomplete because it is missing some reactants, products, and coenzymes. It also is misleading because it suggests that all of the reactions are irreversible, which is not the case. Examine the reactions and decide which of the following are in fact effectively irreversible?

- A. 1 & 5 B. 4 & 7 C. 3 & 6 D. 2 & 8

14. Consider Reaction 4 only [GAP + C → D + E] in the representation of the "Carbon scramble" Part of the Calvin Benson Cycle. If the aldehyde carbon (#1) of GAP were labeled, where would the label be found in compound D or E?

