CHEM-643 Intermediary Metabolism
Monday, 3 October 2011
Individual/Group Quiz on Glycolysis and Photosynthesis Case Study Problems

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, 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 8:25 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.

From http://olanessabuzz.blogspot.com/2011/07/cellular-respiration-concept-map.html

___ 1. When the substrate oscillations eventually stop after the abrupt +O_2 to –O_2 transition in a yeast suspension, the following is true:

A. Phosphofructokinase is strongly inhibited by ATP.
B. The rate of glucose utilization is half the rate of pyruvate formation.
C. Glycolysis stops.
D. Oxidative phosphorylation resumes.

___ **2.** In the presence of O_2, yeast:

A. Generate ATP exclusively by oxidative phosphorylation
B. Generate ATP by oxidative phosphorylation and substrate-level phosphorylation
C. Chemically convert NADH into ATP
D. Produce ethanol

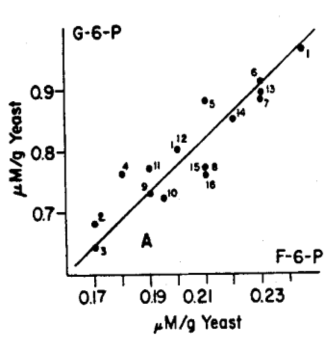
___ 3. In the absence of O_2, yeast:

A. Generate ATP exclusively by oxidative phosphorylation
B. Generate ATP by oxidative phosphorylation and substrate-level phosphorylation
C. Chemically convert NADH into ATP
D. Produce ethanol

___ 4. During glycolytic oscillations of yeast in an aerobic-anaerobic transition, what relationship is true throughout?

A. [ATP] = ½[ADP] + [AMP]
B. [ATP] + [ADP] + [AMP] = constant
C. [ATP] – [ADP] = [AMP]
D. ([ATP] + ½[ADP])/([ATP] + [ADP] + [AMP]) = 1

___ 5. A phase-plane plot (below) relating the concentrations of glucose-6-phosphate (G6P) and fructose-6-phosphate (F6P) in yeast cells is close to a straight line with a positive slope. This is because:



A. [G6P] = [F6P]
B. For every G6P used, one F6P is formed.
C. The hexose monophosphate isomerase reaction has a favorable -ΔG°'.
D. The high hexose monophosphate isomerase activity maintains the reaction near a steady-state equilibrium.

___ 6. Consider two identical photosynthesizing leaves of a C_4 plant (e.g. bean plant) placed in separate vessels containing air at atmospheric CO_2 concentrations. 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 $\delta^{13}C$ values for newly fixed carbon?

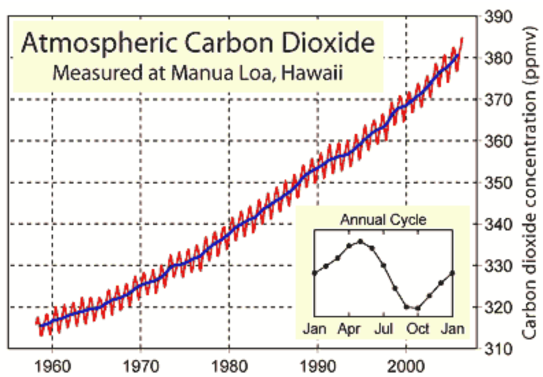
A. $\delta^{13}C$ atmospheric CO_2 = $\delta^{13}C$ Vessel 1 > $\delta^{13}C$ Vessel 2
B. $\delta^{13}C$ atmospheric CO_2 < $\delta^{13}C$ Vessel 1 < $\delta^{13}C$ Vessel 2
C. $\delta^{13}C$ atmospheric CO_2 = $\delta^{13}C$ Vessel 1 < $\delta^{13}C$ Vessel 2
D. $\delta^{13}C$ atmospheric CO_2 > $\delta^{13}C$ Vessel 1 > $\delta^{13}C$ Vessel 2

___ 7. Consider two identical photosynthesizing leaves of a C_3 plant (e.g. corn) placed in separate vessels containing air at atmospheric CO_2 concentrations. 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 $\delta^{13}C$ values for newly fixed carbon?

A. $\delta^{13}C$ atmospheric CO_2 = $\delta^{13}C$ Vessel 1 > $\delta^{13}C$ Vessel 2
B. $\delta^{13}C$ atmospheric CO_2 < $\delta^{13}C$ Vessel 1 < $\delta^{13}C$ Vessel 2
C. $\delta^{13}C$ atmospheric CO_2 = $\delta^{13}C$ Vessel 1 < $\delta^{13}C$ Vessel 2
D. $\delta^{13}C$ atmospheric CO_2 > $\delta^{13}C$ Vessel 1 > $\delta^{13}C$ Vessel 2

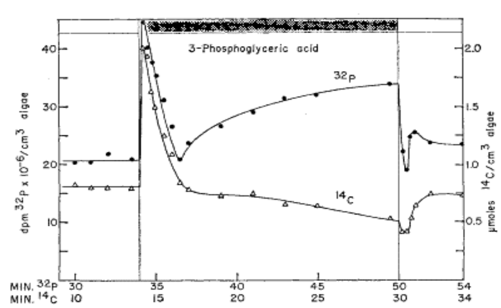
___ 8. The "Keeling Curve" (right) tracks atmospheric CO_2 concentrations over time. From this curve one can deduce:

A. The concentration of CO_2 in the atmosphere was near zero 300-400 years ago.
B. Global warming has caused an increase in CO_2 concentrations.
C. Manua Loa is in the northern hemisphere.
D. Globally, biological respiration is out pacing photosynthesis.



http://www.globalwarmingart.com/wiki/Carbon_Dioxide_Gallery

___ 9. The figure at the right from the Bassham experiment tracks the ^{32}P and ^{14}C in 3-Phosphoglycerate (3PGA) in a *Chlorella* suspension as a function of time after a light to dark transition in the presence of $^{32}P_i$ and $^{14}CO_2$. After 16 minutes of darkness:

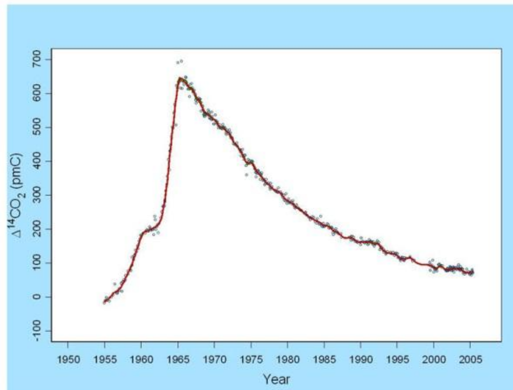


A. The concentration of 3PGA is less than when the lights were on.
B. The ratio $^{32}P/^{14}C$ in 3PGA would be similar to that in ATP
C. 3PGA is being converted to glyceraldehyde-3-phsophate in the Calvin Cycle.
D. 3PGA is derived primarily from ^{12}C starch via glycolysis.

___ 10. Plants

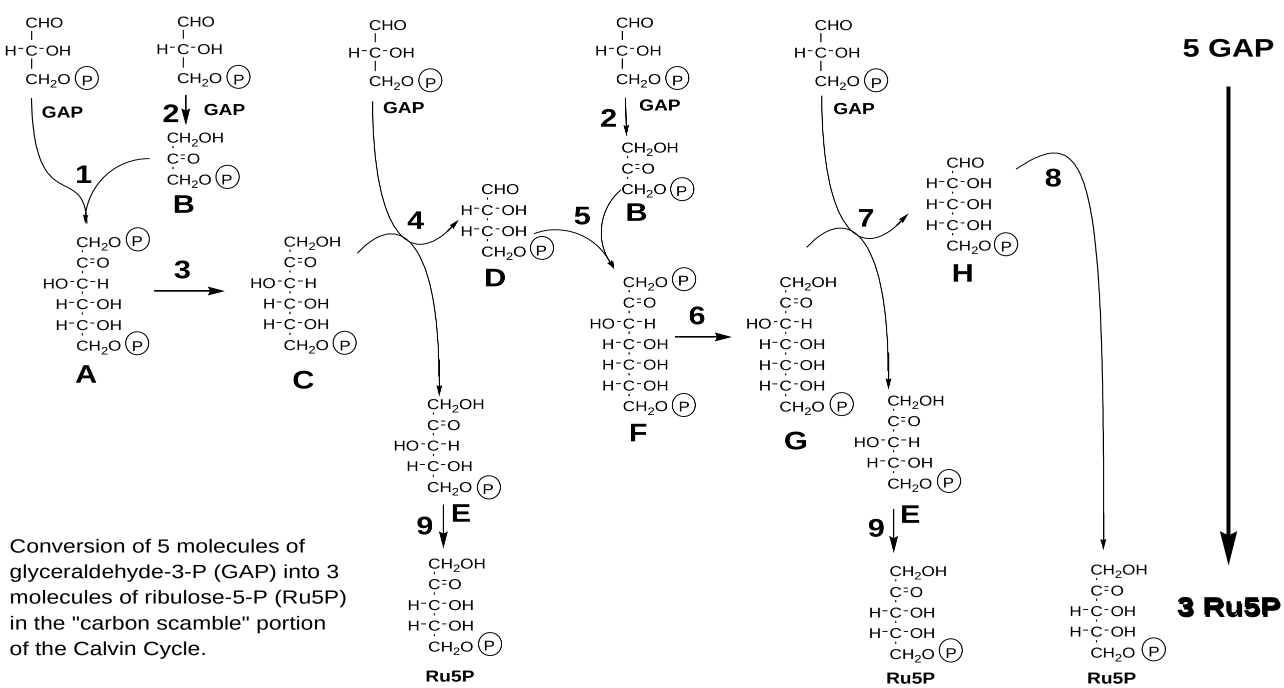
A. Consume both CO_2 and O_2 at night, but not in the day.
B. Consume CO_2 in the day and consume O_2 at night.
C. Produce O_2 during the day and consume CO_2 at night.
D. Produce both CO_2 and O_2 in the day, but not at night.

___ 11. The curve at the right displays the amount of $^{14}CO_2$ 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. ^{14}C compounds are specifically deposited in the brain.
B. The decay of ^{14}C is catalyzed by an enzyme in liver.
C. Molecules in the liver are synthesized and degraded relatively rapidly.
D. Molecules in the liver are precursors to those in the brain.

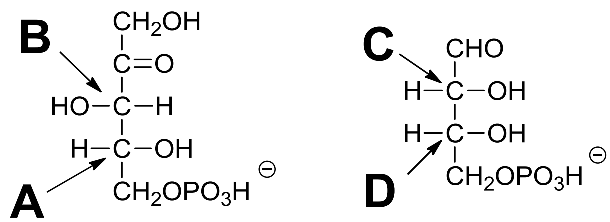
The following diagram should be used for the next two questions.



Conversion of 5 molecules of glyceraldehyde-3-P (GAP) into 3 molecules of ribulose-5-P (Ru5P) in the "carbon scamble" portion of the Calvin Cycle.

____ 12. $NaBH_4$ irreversibly inhibits lysine-dependent aldolases. Which of the following reactions would be inhibited by this treatment?
A. 1 & 5 B. 2 & 6 C. 3 & 7 D. 4 & 8

____13. Consider Reaction 4 only [GAP + C → D + E]. If the middle carbon (#2) of GAP were labeled, where would the label be found in compound D or E?



___ 14. The half-life of ^{14}C is about 5700 years. What percent of the ^{14}C originally present in a 57,000 year old fossil would remain today?
A. ~0.01% B. ~0.1% C. ~1% D. ~10%