AP Chapter 10 Study Guide: Photosynthesis

(Rob Hamilton)

Teacher's Note: *We will be jumping around and condensing the information found in chapter 10. We will examine light energy, the structure of the chloroplast, the light and dark reactions of photosynthesis and some interesting tricks xerophytes (plants adapted to hot dry environments) use to fix carbon. Much of what you read should be familiar because chloroplasts generate ATP in much the same way that mitochondria do. Go ahead and read about light on pgs 186-188 and answer the questions below.*

1. Visible light is just one small part of the electromagnetic spectrum. What range of wavelengths represent

   visible light? ________________________________

Circle one

2. Violet and blue light have **long** or **short** wavelengths.

3. Red and orange light have **long** or **short** wavelengths.

4. Violet and blue light have **higher** or **lower** energy.

5. Red and orange light have **higher** or **lower** energy.

6. Why do we humans perceive green plants as green in color? ____

   ____

7. What wavelengths of light are least useful for green plants? ____

   Why? ____

8. How is it possible for a green plant to absorb/use green light (550 nm) as indicate by the action spectrum in

   figure 10.9 (b)? ____

9. If you were to "intelligently design" a plant pigment, what color would you choose? ____________________

   Explain your response. ____

Enough about light……. Let's examine the organelle responsible for the conversion of light energy to chemical energy, without which, life on earth would be impossible. Read pgs 182-183.

10. Make a quick sketch of a chloroplast below: Label the inner & outer membrane, grana, stroma and a thylakoid and thylakoid space.

11. The light reactions of photosynthesis take place on a system of interconnected sacs called ________________

12. The reactions of the Calvin cycle occur in the dense fluid within the chloroplast called __________________

Now to the specific details of the light reactions of photosynthesis. Read pgs 188-193

13. What change occurs in a chlorophyll molecule when it is struck by a photon of light energy? _____________

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14. A photosystem is composed of two basic parts: __________________________ _______________________

and ______________________________ ________________________.

15. Where are photosystems found within the chloroplast? ____

16. What molecules are found in a light-harvesting complex? ____

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17. What is the role of a photosystem's reaction center? ____

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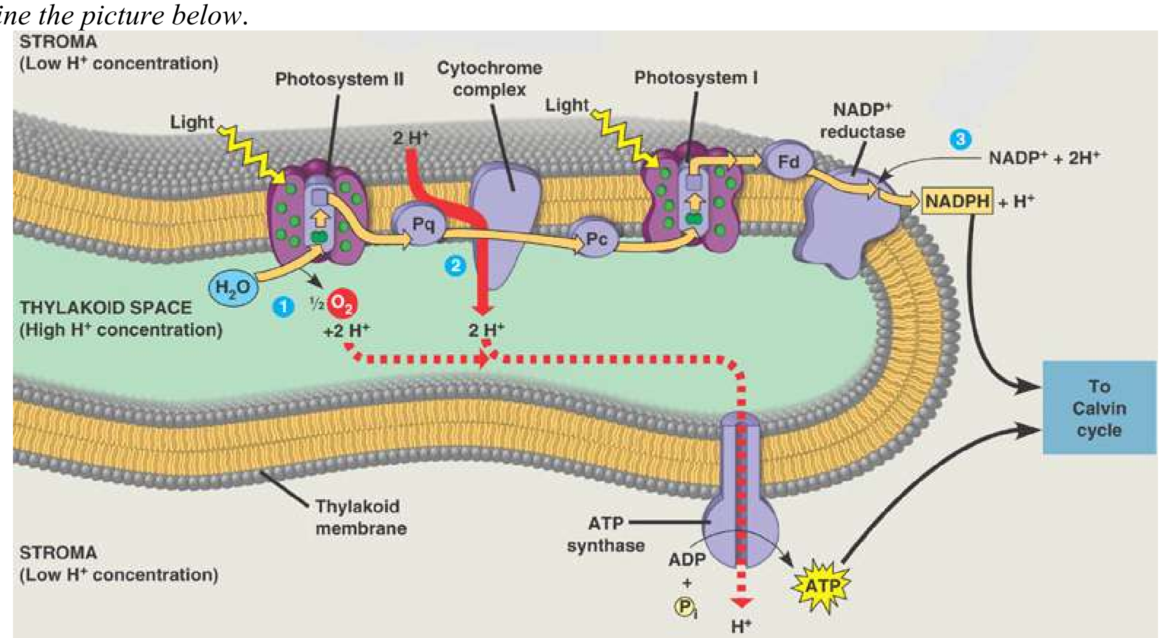
18. When the primary electron acceptor receives an electron from a photosystem, how is the lost electron replaced? ____

19. Curiously, our author never mentions that the name of the reaction that splits the water molecule is called photolysis. What are the three products of photolysis? _____________________ ______________________ and _________________________________

Examine the picture below.



20. As electrons move down photosystem II's electron transport chain, what ions are pumped from the stroma into the thylakoid space? ___________________________

21. At the end of photosystem II's electron transport chain, the electron is pulled into photosystem I's reaction center and "reboosted." What is the name of the molecule that is the final electron acceptor at the end of photosystem I's electron transport chain? _________________________________

22. How do the captive hydrogen ions in the thylakoid space return to stroma? _____________________________

____

23. What are the two molecules produced in the light reaction that are needed for the Calvin cycle? __________ and _____________________

Now the stage is set for the production of sugar. Read pgs 193-195 and keep in mind that we are really not interested in intermediate molecules. Our interest lies in the initial reactants and the products of the Calvin cycle.

24. In order for glucose ($C_6H_{12}O_6$) to be produced, a carbon source is needed. What molecule supplies the carbon atoms for photosynthesis ____________________________________

25. What is the name of the enzyme that captures carbon dioxide for the Calvin cycle? ______________________

Note: *Rubisco is the most abundant protein in the known universe. Unfortunately the darn thing not only bonds to CO_2, but also will bond to O_2 which is more abundant in the atmosphere. The result of rubisco's bonding with oxygen is a counterproductive process that decreases photosynthetic output called photorespirations. (See the passage on pgs 195-196.) Why would an "intelligent designer" create an enzyme so poorly suited to its function? Why would natural selection not "weed out" organisms saddled with such an inefficient enzyme?*

26. How does our book explain rubisco's duplicitous nature? ____

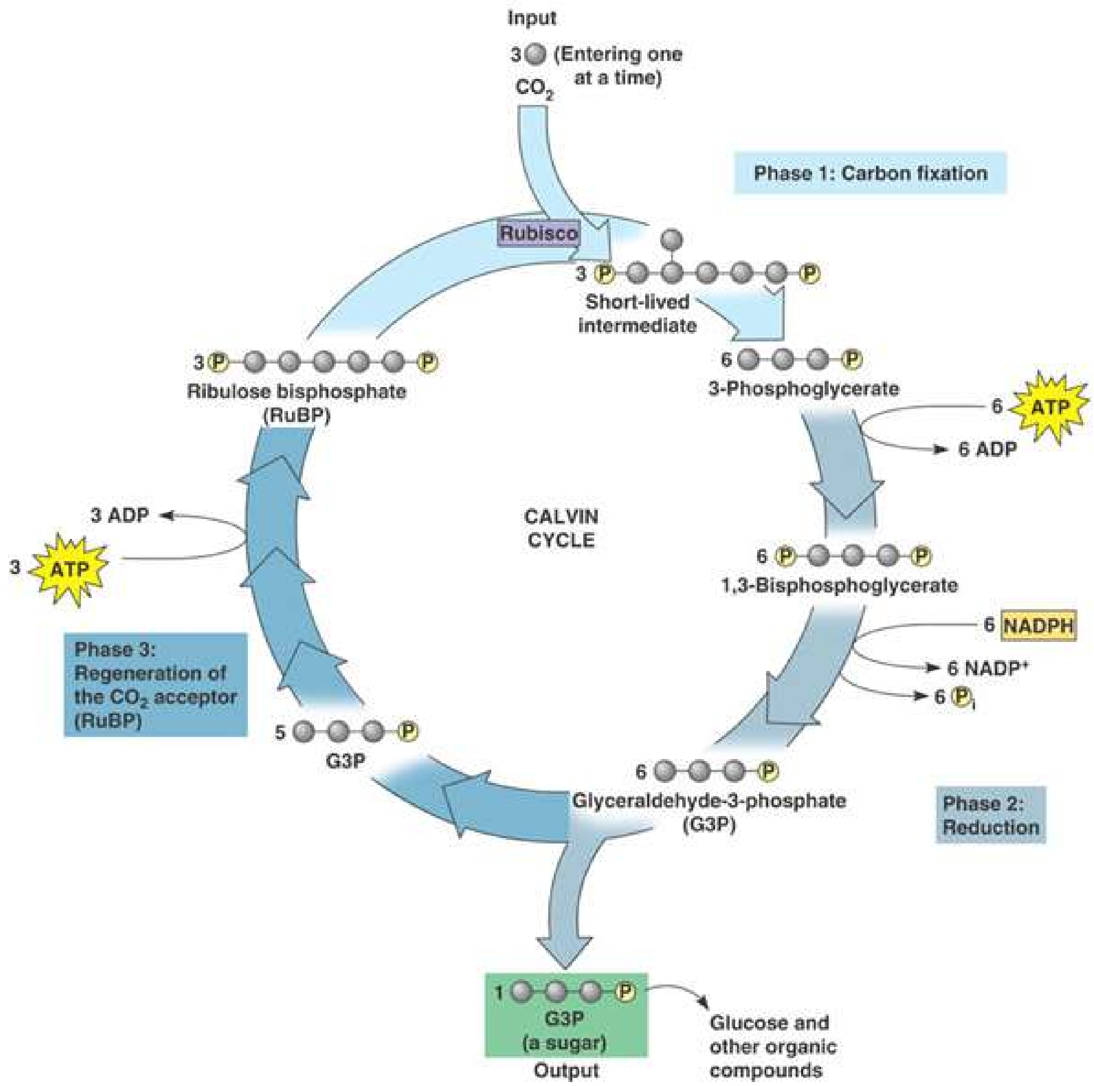
____

____

27. Once CO_2 is combined with the 5 carbon RuBP, the resulting 6 carbon molecule is immediately split into two, 3 carbon molecules called ____

28. The 3 carbon molecule is the phosphorylated by ___________________ and reduced by __________________ forming ____ or G3P

Notice: *You will probably have to read this passage several times while examining the diagram to fully understand the Calvin cycle. Don't worry…. Just remember that for every 3 molecules of CO_2, there are 6 molecules of G3P. But only one molecule of these 3 carbon sugars can be counted as a net gain of carbohydrate. The cycle began 15 carbons in the form of 3 molecules of the 5 carbon RuBP. Now there are 18 carbons worth of carbohydrate in the form of six molecules of G3P. One molecule of G3P can exit the cycle, but the other 5 must be recycled to regenerate the three molecules of RuBP to begin the cycle again.*



29. Three molecules of ATP are used to rearrange 5 molecules of G3P into 3 molecules of RuBP to restart the cycle. Therefore, to synthesize one molecule of 6 carbon glucose, the Calvin cycle uses ________ molecules of CO_2, _________ molecules of ATP, and _________ molecules of NADPH.

30. Why is a plant able to expend so many molecules of ATP for a single glucose molecule? ________________

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When plants face hot and dry conditions, they attempt to minimize water loss by closing their stomata. This has the unfortunate consequence of increasing the amount of oxygen and decreasing the amount of carbon dioxide in the leaf. This results in an increase in photorespiration which can drain away as much as 50% of the carbon fixed by the Calvin cycle.

31. Some plants minimize the cost of photorespiration by incorporating CO_2 into a 4 carbon molecule. The enzyme PEP carboxylase combines CO_2 and phosphoenolpyruvate forming __________________________, a 4 carbon molecule. PEP carboxylase had no attraction to O_2 and can efficiently fix carbon in hot, dry conditions while rubisco cannot. Plants that have PEP carboxylase are called ___________________________

32 Other plants close their stomates during the day to prevent water loss and open them during the night. (This is the exact opposite of most plants.) These plant up take CO_2 up during the night and incorporate it into a variety of organic acids. This method of carbon fixation is called ______________________________or CAM