Photosynthesis Concept Questions

1. Explain why almost all organisms depend on photosynthesis to satisfy their energy needs. (Photosynthesis produces glucose which is used by most cells as energy.)

2. Photosynthesis can be thought of as a process that converts the energy in sunlight to glucose. Describe the three energy conversions that occur during photosynthesis. (Solar energy is converted to the chemical energy of the electrons; chemical energy of electrons is converted to ATP; the energy in ATP is converted to the chemical energy in glucose.)

3. Describe the relationship between the processes of photosynthesis and cellular respiration. (The two are the reverse of one another.)

4. Identify where each of the reactants in photosynthesis comes from and where the products are produced. (For terrestrial plants, water is acquired from the soil via the roots and CO_2 is taken from the atmosphere through the stomata. O_2 is released when water is split in the light reactions and glucose is made from the G3P produced from the Calvin cycle.)

5. Explain the cause of the change of color of leaves in the fall. (As the sun becomes lower in the sky less blue light reaches plants, so they produce less chlorophyll as it absorbs predominantly blue light. The disappearance of chlorophyll allows other pigments to be seen and the leaves change color.)

6. The Calvin cycle requires ATP and NADPH, products of the light reactions. A student in the class claims that the light reactions do not depend on the Calvin cycle and, with continual light, could continue producing ATP and NADPH. Provide reasoning to support or refute the claim. (The light reactions could not continue producing ATP and NADPH without the ADP and NADP+ produced by the Calvin cycle.)

7. Identify the *exact* locations of chlorophyll and the ETC. (Chlorophyll molecules are embedded in the thylakoid membrane. The ETC is also in the thylakoid membrane, between the two photosystems.)

8. Describe the events of the light reactions. (Students should understand that light energy is trapped and harvested by chlorophyll molecules. High energy electrons are stripped from chlorophyll molecules and passed through an electron transport system to make ATP. The electrons are then re-energized by light and used to reduce $NADP^+$ to NADPH.)

9. Identify the molecule in photosynthesis that is similar in function to NADH. (NADPH)

10. Describe the purpose of the electron transport chain in photosynthesis. (It makes ATP.)

11. Explain how the electrons accepted by the ETC become high energy. (The energy comes from absorbing the energy of a photon.)

12. Electrons from the photosystems are used to reduce CO_2. Explain why the photosystems never "run out" of electrons. (Photosystem II gets replacement electrons from water while photosystem I gets them from photosystem II via the electron transport system.)

13. In an experiment, isolated chloroplasts are placed in an illuminated solution with the chemicals required to carry out ATP synthesis. Predict what would happen to the rate of photosynthesis if a

compound is added to the solution that makes the membranes freely permeable to hydrogen ions. (The rate of photosynthesis would slow and eventually stop because the added chemical would not allow the formation of a proton gradient across the thylakoid membrane. ATP synthase would be unable to produce ATP.)

14. Explain why the ATP produced in the chloroplasts is not available to the plant cell for cell work. (It is inside the chloroplasts and used in the Calvin cycle.)

15. When plants photosynthesize, they always make more glucose than they require for energy. Propose a reason for plants doing this. (Some glucose is needed for growth and some is stored times when light is unavailable.)

16. Explain how the products of the light reaction are used to reduce CO_2 in the Calvin cycle to form PGAL and describe what happens to this PGAL. (ATP provides the energy and NADPH provides the electrons to reduce CO_2. The Calvin cycle product, G3P (PGAL) is used to make glucose from which the plant can make polysaccharides and other molecules.)

17. Describe the function of the Calvin cycle. (The Calvin cycle fixes atmospheric carbon dioxide into organic carbon in the form of G3P (PGAL))

18. Identify the immediate energy source for the Calvin cycle. (The energy needed to perform the reduction in the Calvin cycle is provided by ATP produced in the light reactions.)

19. An experiment is designed to divert all the G3P (PGAL) produced during photosynthesis in a green plant. Predict the effect on the plant. (The cells of the plant would have no fuel for cellular respiration and would be unable to produce the energy needed for cell work. It would also be unable to synthesis cellulose.)

20. A solution of chlorophyll, carbon dioxide, and water is placed in a beaker and illuminated with light of sufficient intensity to support photosynthesis. Predict whether the mixture will produce sugar. Provide reasoning for your prediction. (No it will not. The production of glucose requires ATP and NADPH from the light reactions and the enzymes of the Calvin cycle.)