Photosynthesis
Chapter 10

1. Distinguish between autotrophs and heterotrophs. (An autotroph is able to produce organic molecules using CO_2 and solar energy. A heterotroph must consume other organisms to obtain organic molecules.)
2. Describe the pathway taken by the CO_2 molecules used in photosynthesis from the atmosphere into the chloroplasts inside lead cells. (CO_2 enters the leaves via stomata, and being a nonpolar molecule, can cross the leaf cell membrane and the chloroplast membranes to reach the stroma of the chloroplast.)
3. Describe photosynthesis as a redox process. (Photosynthesis reduces the carbon atoms in carbon dioxide to glucose. Water is oxidized.)
4. For the reactants and products in photosynthesis, identify the steps in which each is used or produced. (Water is used to provide electrons during the light reactions and oxygen is produced. Carbon dioxide is used during the Calvin cycle as a source of carbon and a 3 carbon sugar is produced (which is then used to make glucose, among other things).)
5. Describe the path taken by carbon dioxide to reach the chloroplasts inside leaf cells. (CO2 enters the leaves via stomata, and being a nonpolar molecule, can cross the leaf cell membrane and the chloroplast membranes to reach the stroma of the chloroplast.)
6. The Calvin cycle requires ATP and NADPH, products of the light reactions. Provide a response to the claim that the light reactions don't depend on the Calvin cycle and, with continual light, could just keep on producing ATP and NADPH. (The light reactions could not keep producing NADPH and ATP without the NADP+, ADP, and Ⓟi that the Calvin cycle generates. The two cycles are interdependent.)
7. Explain why the leaves of most plants appear green. (The chlorophyll molecules of chloroplasts absorb violet-blue and red light (the colors most effective in driving photosynthesis) and reflect or transmit green light.)
8. Describe the events that occur when a photon is absorbed by a photosystem. (The energy of the photon is passed from one chlorophyll molecule to another until it reaches the reaction center chlorophyll. The primary electron acceptor then accepts an energized electron from the reaction center chlorophyll. The electron is then passed either to an electron transport or to NADP+, depending on if this happened in PSII or PSI, respectively.)
9. Identify the color of light that is least effective in providing energy for photosynthesis. Justify your response. (Green, because green light is mostly transmitted and reflected—not absorbed—by photosynthetic pigments. In order to be used by photosynthesis, light must be absorbed.)
10. In an experiment, isolated chloroplasts placed in an illuminated solution with the required chemicals can produce ATP. Predict what would happen to the rate of ATP synthesis if a molecule is added to the solution that makes membranes freely permeable to hydrogen ions. (The rate of ATP synthesis would slow and eventually stop. Because the added compound would not allow a proton gradient to build up across the membrane, ATP synthase could not catalyze ATP production.)
11. Explain how the high number of ATP and NADPH used by the Calvin cycle is consistent with the high energy content of glucose. (Glucose is a high energy molecule because it is highly reduced (lots of C — H bonds), storing lots of potential energy in its electrons. To reduce CO2 to glucose, much energy and reducing power are required in the form of large

numbers of ATP and NADPH molecules, respectively.)

12. In an experiment, plant cells are exposed to a molecule that inhibits an enzyme of the Calvin cycle. Predict the effect of the molecule on the light reactions. (The light reactions would stop because they require ADP and $NADP^+$ from the Calvin cycle.)
13. Describe photosynthesis and cellular respiration as reverse processes.