ANSWERS TO EXERCISES

1. photosynthesis
   sunlight
   chemical
2. light-dependent
   chlorophyll
   oxygen
   ATP
3. light-independent
   stroma
   glucose
4. photosystems
   thylakoids
5. light-harvesting complex
   reaction center
   electron transport system
6. photosystem II
   chemiosmosis
   photosystem I
   photosystem II
   photosystem I
7. bundle-sheath cells
   photorespiration
   C_4
8. phenylenolpyruvate (PEP)
   oxaloacetic acid
   bundle-sheath cells
9. C_3
   ATP
   phenylenolpyruvate (PEP)
10. false, after
11. false, grana
12. false, stroma
13. true
14. false, photosystem II
15. false, lose
16. false, produces, uses
17. false, NADPH & ATP
18. true
19. independent
20. dependent
21. dependent
22. independent
23. dependent
24. independent
25. independent
26. dependent
27. dependent
28. dependent
29. independent
30. dependent
31. independent
32. dependent
33. b
34. c
35. a
36. b
37. b
38. c

39. You could set up one study where the plants got normal CO_2 and water containing radioactive oxygen (H_2O^*), and another study where the plants got normal (H_2O) and carbon dioxide containing radioactive oxygen (CO_2^*). In each study, you would collect the oxygen gas and the sugars produced by photosynthesis and determine where the radioactive oxygen atoms show up.

40. After keeping a group of plants in the dark for several days, expose them, in separate experiments, to light from bulbs of different colors but equal intensities for equal amounts of time, keeping the plants equally watered and at constant temperatures, and compare the amounts of oxygen gas each plant produces.

41. Since carotenoids are yellow and orange, those wavelengths are reflected by the pigments, which absorb all the other wavelengths including green. Since chlorophyll reflects green light, the carotenoids are able to capture light energy not absorbed by chlorophyll and channel this energy into the system used for photosynthesis.

42. A photon of light may be reflected off the pigment granule, giving the molecule a corresponding color when that photon hits our eyes. Or, a photon could be transmitted through the pigment molecule, passing through it virtually unchanged as though the pigment were transparent. Finally, a photon and its energy could be absorbed by a pigment molecule. If the photon energy is absorbed, the amount of energy in the pigment is increased from a lower to a higher state. In the example of chlorophyll, such "excitation" of the pigment makes it capable of initiating the chain of events in photosynthesis leading to the production of ATP and the splitting of water.

43. Crabgrass, a C_4 plant, has an enzyme, PEP carboxylase, which catalyzes the formation of oxaloacetate from carbon dioxide and phosphoenolpyruvate (PEP). Because PEP carboxylase has a higher affinity for CO_2 than does RuBP carboxylase, such plants can trap CO_2 more efficiently than C_3 plants. Since C_4 plants are found in dry environments, they keep their stomata closed much of the time to conserve water, and this results in a depletion of CO_2 in the leaves. However, since the C_4 plants trap CO_2 more efficiently, they continue to carry out the light independent reactions of photosynthesis at rates surpassing that of C_3 plants in dry, hot environments.

44. Photosynthetic humans would be different in anatomical, physiological, and behavioral ways. Since we would need to absorb light energy through our skin, we would be thinner and flatter, and probably have more than four appendages, so that our surface area would be greater relative to our volume. Our skin color would be transparent, so that more sunlight energy could pass through to the pigment granules beneath our skin. Since we would make our own food by photosynthesis, our digestive system would become much simpler. We wouldn't need a mouth or teeth, or stomachs filled with acid and specialized enzymes to digest complex animal bodies. Our excretory system would become simpler, since we wouldn't have to excrete fecal matter or urine. Our respiratory system would be reversed, since we would have to inhale carbon dioxide and exhale oxygen to keep photosynthesis going. Our behavior would change, since instead of avoiding the sun, we would seek it out as the source of energy needed to make our photosynthetic food. Can you think of other changes?
45. The C_4 plants are more competitive than the C_3 plants in adverse growing conditions such as low light intensities, very hot climates, and dry conditions. This means that humans could generate a greater yield of food production in the less than optimal farming areas of the world. This could, realistically, help to provide more food for a rapidly growing world population.
46. If a large meteorite struck the Earth and the resulting dust clouds lasted for months, the amount of sunlight reaching the surface would dwindle significantly, causing most vegetation to die off. This in turn would cause starvation and death of all the large herbivore dinosaurs. Without the large herbivores to feed upon, the large carnivorous dinosaurs also would find little food and would die off.
47. According to J.R. Hutchinson at Univ. of CA, Berkeley, the current theories about what killed the dinosaurs are called the "intrinsic gradualist" and "extrinsic catastrophist" theories. The intrinsic gradualists believe that the ultimate cause of the extinction was intrinsic (meaning of an Earthly nature) and gradual, taking some time to occur (several million years). The two main hypotheses resulting in intrinsic gradualism are increased volcanic activity (over a period of several million years, increased volcanism could have created enough dust and soot to block out sunlight, producing the climatic change) and plate tectonics (major changes in the organization of the continental plates were occurring at the time). The extrinsic catastrophists believe that the ultimate cause of the extinction was extrinsic (of an extraterrestrial nature) and catastrophic (fairly sudden and punctuated). The main hypothesis was proposed in 1980 by (among others) Luis and Walter Alvarez of the University of California at Berkeley. A large extraterrestrial object collided with the Earth, its impact throwing up enough dust to cause the climatic change. The iridium layer is what prompted the Alvarez team to blame an asteroid impact for the extinction — asteroids and similar extraterrestrial bodies are higher in iridium content than the Earth's crust, so they figured that the iridium layer must be composed of the dust from the vaporized meteor. No crater was found, but it was assumed that one existed that was about 65 million years old and 100 kilometers (about 65 miles) in diameter. Later research found a likely candidate for the crater at Chicxulub, on the Yucatan Peninsula of Mexico.
48. According to the author's of tombtown.com, the Dodo bird of Mauritius became extinct in 1681. Recently, a scientist noticed that a certain species of tree was becoming quite rare on Mauritius. In fact, all 13 of the remaining trees of this species are about 300 years old. No new trees had germinated since the late 1600s. Since the average life span of this tree was about 300 years, the last members of the species were extremely old. They would soon die, and the species would be extinct. It is not just a coincidence that the tree had stopped reproducing 300 years ago and that the Dodo had become extinct 300 years ago. The Dodo ate the fruit of this tree, and it was only by passing through the Dodo's digestive system that the seeds became active and could grow. Now, more than 300 years after one species became extinct, another was to follow.