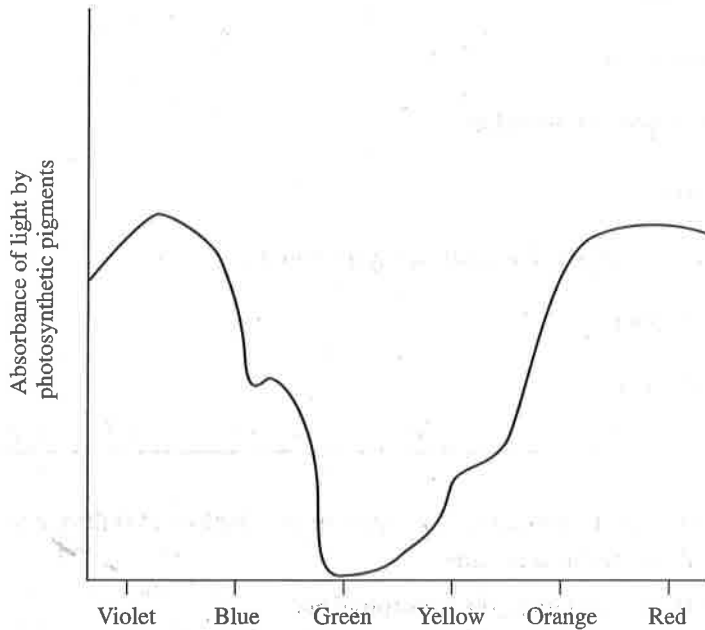


MULTIPLE-CHOICE QUESTIONS

1. The graph below shows an absorption spectrum for an unknown pigment molecule. What color would this pigment appear?



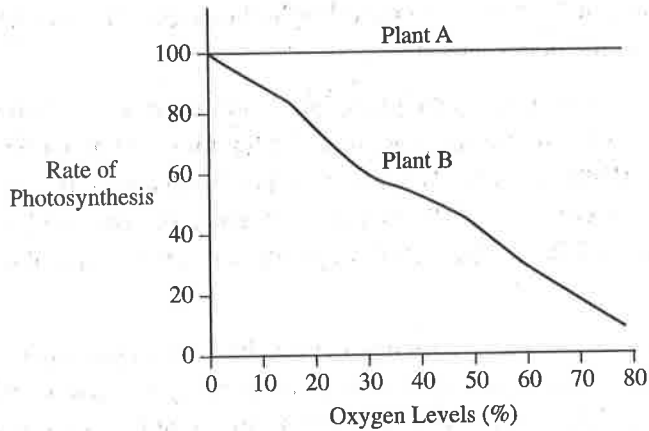
- (A) red
 (B) yellow
 (C) green
 (D) blue
2. Cyclic photophosphorylation results in the production of
- (A) ATP only
 (B) ATP and NADPH
 (C) NADPH only
 (D) ATP, NADPH, and sugar
3. Plants give off oxygen as a waste product of photosynthesis. This oxygen comes from
- (A) the Krebs cycle
 (B) the Calvin cycle
 (C) photolysis
 (D) photorespiration
4. How many turns of the Calvin cycle are required to produce one molecule of glucose?
- (A) 1
 (B) 2
 (C) 3
 (D) 6

Questions 5-11

Indicate which of the following events occurs during

- (A) light-dependent reactions
 - (B) light-independent reactions
5. Oxygen is released.
 6. Carbon gets reduced.
 7. Oxidative photophosphorylation
 8. ATP is produced.
 9. Electrons flow through an electron transport chain.
 10. Oxidation of NADPH
 11. Reduction of NADP^+
-
12. CAM plants keep their stomates closed during the daytime to reduce excess water loss. They can do this because they
 - (A) can fix CO_2 into sugars in the mesophyll cells.
 - (B) can use photosystems I and II at night
 - (C) modify rubisco so it does not bind with oxygen
 - (D) can incorporate CO_2 into organic acids at night
 13. Which of the following is NOT directly associated with photosystem II?
 - (A) harvesting light energy by chlorophyll
 - (B) release of oxygen
 - (C) splitting of water
 - (D) production of NADPH
 14. Where in the cell is ATP-synthase located?
 - (A) in the nuclear membrane
 - (B) in the thylakoid membrane of the chloroplast
 - (C) in the cristae membrane of mitochondria
 - (D) both B and C

15. This graph shows the rate of photosynthesis for two plants under experimental conditions.



From this graph, what is the best conclusion about the mechanism of photosynthesis in the two plants?

- (A) A is a C-3 plant, and B is a C-4 plant.
 - (B) A is a C-4 plant, and B is a C-3 plant.
 - (C) A is a CAM plant, and B is a C-4 plant.
 - (D) A and B are both CAM plants.
16. Which one of the following is NOT required for photosynthesis to occur?
- (A) CO_2
 - (B) O_2
 - (C) ATP
 - (D) NADP
17. Which one is NOT correct about where the Calvin cycle occurs?
- (A) in the spongy mesophyll in C-3 plants
 - (B) in the mesophyll in C-4 plants
 - (C) in the palisade layer in C-3 plants
 - (D) in the bundle sheath in C-4 plants

Answers to Multiple-Choice Questions

1. **(C)** If light is absorbed, it is not reflected. Only reflected colors are seen. The graph shows that red and blue are most absorbed and that green is most reflected. Therefore the color of the pigment is green.
2. **(A)** Electrons undergoing cyclic phosphorylation move from P680 to P700 and then cycle back to P680. The sole purpose of cyclic photophosphorylation is the production of ATP. No NADPH is produced, and no oxygen is released. This process is necessary when the cell needs more ATP because ATP has been used up by the Calvin cycle. Sugar is produced during the light-independent reactions only, not during the light-dependent ones.
3. **(C)** Photolysis breaks apart water into oxygen, hydrogen ions, and electrons to provide electrons for the electron transport chain. The Krebs cycle is part of cell respiration, not photosynthesis. The Calvin cycle uses CO_2 from the atmosphere and hydrogen from photolysis to make sugar. Cyclic photophosphorylation does not cause photolysis. Photorespiration uses up oxygen; it does not produce oxygen.
4. **(D)** Since glucose is a 6-carbon molecule and each turn of the cycle absorbs 1 molecule of CO_2 , 6 turns of the Calvin cycle are needed to produce glucose. Three turns of the Calvin cycle produce 1 PGAL (phosphoglyceraldehyde), a 3-carbon molecule.
5. **(A)** Oxygen is released from the photolysis of water during the light-dependent reactions.
6. **(B)** Carbon is reduced when it enters the Calvin cycle in the dark reactions and combines with hydrogen to yield PGAL.
7. **(A)** Oxidative phosphorylation is a type of chemiosmosis and explains how ATP is formed during the light-dependent reactions. This is also the way in which energy is produced during aerobic respiration. A steep proton gradient provides the energy for the production of ATP.
8. **(A)** Energy is produced from the process of chemiosmosis, which occurs during the light-dependent reactions of photosynthesis.
9. **(A)** Electrons flow through the electron transport chain during the light reactions, and ATP and NADPH are produced.
10. **(B)** NADP gains a proton (is reduced) during the light-dependent reactions and carries the proton to the Calvin cycle of the light-independent reactions, where it loses the proton (is oxidized).
11. **(A)** NADP^+ (also written as NADP) is reduced in the light reactions when it gains hydrogen ions from water.
12. **(D)** During the night, CAM plants fix CO_2 into a variety of organic acids, like malic acid. These acids are stored in vacuoles until the daylight when the CO_2 is released into the Calvin cycle. The Calvin cycle occurs in the bundle-sheath cells, not the mesophyll cells. CAM plants use PEP carboxylase to fix CO_2 into malic acid initially. This is then pumped into the bundle-sheath cells, where CO_2 combines with normal, unmodified rubisco. Lenticels are openings in the stems of woody plants and do not have anything to do with photosynthesis.

13. **(D)** Photosystem II (PS II) is also known as P680. This photosystem absorbs light with an average wavelength of 680nm. When light is absorbed by P680, electrons from chlorophyll *a* become energized and move to a higher energy level and into an electron transport chain within the thylakoid membrane. Water splits apart during photolysis to provide electrons to replace those lost in chlorophyll *a*. Protons that were released from water during photolysis are pumped by the thylakoid membrane from the stroma into the thylakoid space. ATP is formed as protons flow down a steep gradient and through ATP-synthase channels.
14. **(D)** The ATP synthase is the enzyme located within the membranes of mitochondria and chloroplasts. It produces ATP during the light reaction of photosynthesis and during cell respiration.
15. **(B)** Plant A is not affected by the increase in the concentration of oxygen in the air because in C-4 plants, PEP carboxylase does not react with oxygen. Plant B is a C-3 plant because the increased oxygen levels cause the plant to undergo photorespiration and to carry out less photosynthesis.
16. **(B)** All of the choices are required for photosynthesis to occur except oxygen, which is released as a by-product of photosynthesis.
17. **(B)** In C-3 plants, the Calvin cycle occurs in all photosynthetic cells in both the palisade and mesophyll layers. However, in C-4 plants, the light reactions occur in only the mesophyll cells while the Calvin cycle occurs in the bundle-sheath cells.

FREE-RESPONSE QUESTION

Directions: Answer all questions. You must answer the question in essay—not outline—form. You may use labeled diagrams to supplement your essay, but diagrams alone are *not* sufficient. Before you start to write, read each question carefully so that you understand what the question is asking.

The rate of photosynthesis varies with different environmental conditions such as light intensity, wavelength of light, temperature, and so on.

- a. Devise an experiment to demonstrate that ONE environmental condition will alter the rate of photosynthesis.
- b. State your hypothesis, the procedure, how you would collect the data, the results you expect.
- c. The scientific theory behind your expectations.

Typical Free-Response Answer

This experiment will test the hypothesis that wavelengths of light will alter the rate of photosynthesis. The organism chosen for this experiment is elodea, which is inexpensive, readily available, and easy to take care of. Elodea merely requires an aerated, freshwater tank and sunlight.

REMEMBER

1. Make sure you answer the question asked.
2. State why you chose the organism.
3. The experimental and the control must be identical in all ways except the one you are testing.