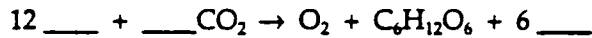


Fill-in-the-Blanks

(1) _____ obtain carbon and energy from the physical environment; their carbon source is (2) _____. (3) _____ autotrophs obtain energy from sunlight. (4) _____ autotrophs are represented by a few kinds of bacteria; they obtain energy by stripping (5) _____ from sulfur or other inorganic substances. (6) _____ feed on autotrophs, each other, and organic wastes; representatives include (7) _____, fungi, many protists, and most bacteria. Although energy stored in organic compounds such as glucose may be released by several pathways, the pathway known as (8) _____ releases the most energy.

9. In the space below, supply the missing information to complete the summary equation for photosynthesis:



10. Supply the appropriate information to state the equation (above) for photosynthesis in words:

(a) _____ molecules of water plus six molecules of (b) _____ (in the presence of pigments, enzymes, and ultraviolet light) yield six molecules of (c) _____ plus one molecule of (d) _____ plus (e) _____ molecules of water.

The two major sets of reactions of photosynthesis are the (11) _____ - _____ reactions and the (12) _____ - _____ reactions. (13) _____ and (14) _____ are the reactants of photosynthesis, and the end product is usually given as (15) _____. The internal membranes and channels of the chloroplast are the (16) _____ membrane system and are organized into stacks, called (17) _____. Spaces inside the thylakoid disks and channels form a continuous compartment where (18) _____ ions accumulate to be used to produce ATP. The semifluid interior area surrounding the grana is known as the (19) _____ and is the area where the products of photosynthesis are produced.

Choice

For questions 20–31, choose the area of the chloroplast that correctly relates to the listed structures and events.

a. thylakoid membrane system

b. stroma

20. _____ light-independent reactions

26. _____ carbon dioxide provides the carbon

21. _____ the coenzyme NADP⁺ picks up liberated hydrogen and electrons

27. _____ sunlight energy is absorbed

22. _____ granum

28. _____ where the first stage of photosynthesis proceeds

23. _____ sugars are assembled

29. _____ water molecules are split

24. _____ light-dependent reactions

30. _____ NADPH delivers the hydrogen reductant

25. _____ ATP production

31. _____ oxygen is formed

Fill-in-the-Blanks

The light-capturing phase of photosynthesis takes place on a system of (1) _____ membranes. A(n) (2) _____ is a packet of light energy. Thylakoid membranes contain (3) _____, which absorb photons of light. The principal pigments are the (4) _____, which reflect green wavelengths but absorb (5) _____ and (6) _____ wavelengths. (7) _____ are pigments that absorb violet and blue wavelengths but reflect yellow, orange, and red.

A cluster of 200 to 300 of these pigment proteins is a(n) (8) _____. When pigments absorb (9) _____ energy, an (10) _____ is transferred from a photosystem to a(n) (11) _____ molecule. (12) _____ refers to the attachment of phosphate to ADP or other organic molecules. Due to the input of light energy, electrons flow through a transport system that causes protons (H^+) simultaneously to be pumped into the thylakoid compartments. Electrons then end up in (13) _____ chlorophyll at the end of this transport chain. The flow of protons from the thylakoid compartment through (14) _____ drives the enzyme machinery that phosphorylates (15) _____, a sequence of events known as the (16) _____ theory of ATP formation.

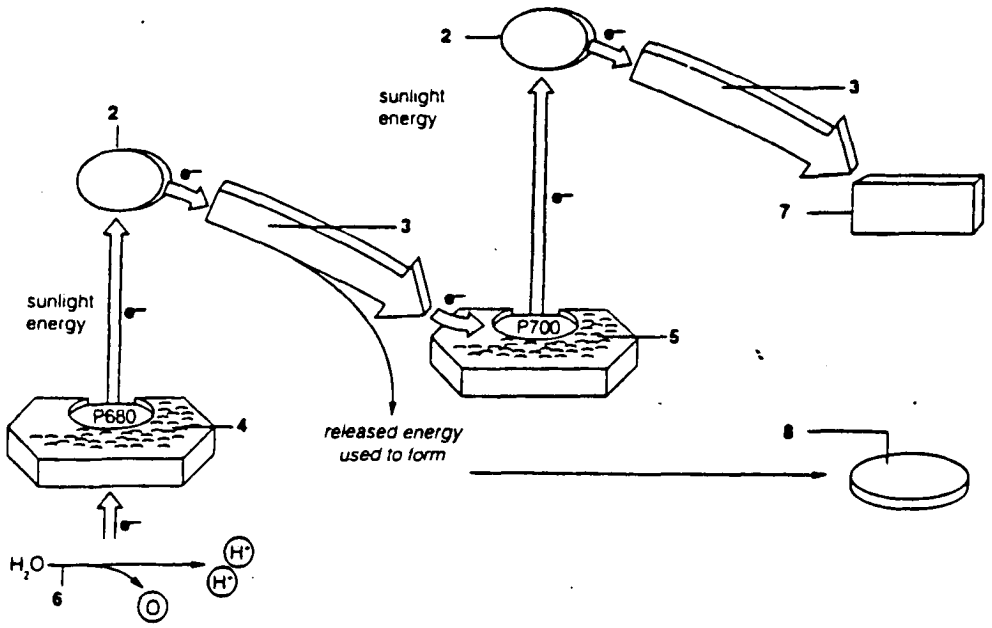
Matching

Choose the most appropriate answer.

- | | |
|--|--|
| 17. ___ chlorophylls | A. The main pigment of photosynthesis |
| 18. ___ chlorophyll <i>b</i> and carotenoids | B. Packets of energy that have an undulating motion through space |
| 19. ___ carotenoids | C. The two stages of photosynthesis occur here |
| 20. ___ violet-blue-green-yellow-red | D. Molecules that can absorb light |
| 21. ___ photons | E. Absorb violet and blue wavelengths but transmit red, orange, and yellow |
| 22. ___ chlorophyll <i>a</i> | F. Visible light portion of the electromagnetic spectrum |
| 23. ___ chloroplast | G. Pigments that transfer energy to chlorophyll <i>a</i> |
| 24. ___ phycobilins | H. Absorb violet-to-blue and red wavelengths; the reason leaves appear green |
| 25. ___ grana | I. Red and blue pigments |
| 26. ___ pigments | J. The site of the first stage of photosynthesis |

Labeling

The diagram below illustrates noncyclic photophosphorylation. Identify each numbered part of the illustration.



- 2. _____
- 3. _____
- 4. _____
- 5. _____
- 6. _____
- 7. _____
- 8. _____

Fill-in-the-Blanks

ATP forms in both the cyclic and noncyclic pathways. When (9) _____ flow through the membrane-bound transport systems, they pick up hydrogen ions (H⁺) outside the membrane and dump them into the (10) _____ compartment. This sets up H⁺ concentration and electric (11) _____ across the membrane. Hydrogen ions that were split away from (12) _____ molecules increase the gradients. The ions respond by flowing out through the interior of (13) _____ proteins that span the membrane. Energy associated with the flow drives the binding of unbound phosphate to ADP, the result being (14) _____. The above description is known as the (15) _____ theory of ATP formation.

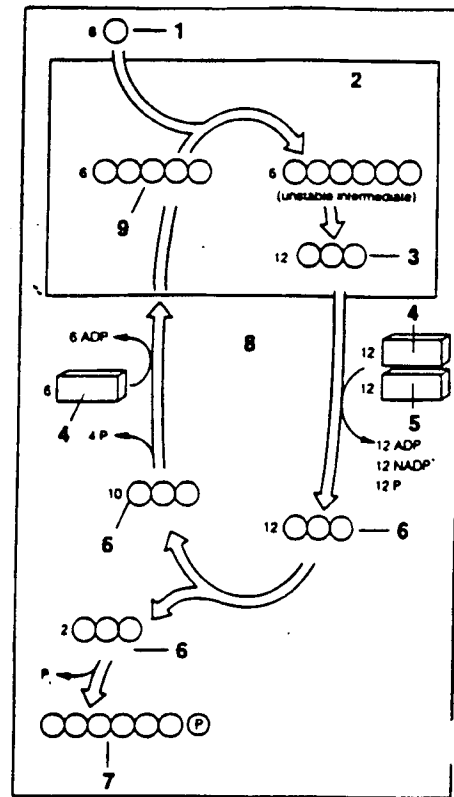
The noncyclic pathway also produces (16) _____ by using (17) _____ from water and H⁺ ions from the thylakoid compartment to reduce NADP⁺.

Label and Match

Identify each part of the illustration below. Complete the exercise by matching and entering the letter of the proper function description in the parentheses following each label.

1. _____ ()
2. _____ ()
3. _____ ()
4. _____ ()
5. _____ ()
6. _____ ()
7. _____ ()
8. _____ ()
9. _____ ()

- A. A three-carbon sugar, the first sugar produced; goes on to form sugar phosphate and RuBP
- B. Typically used at once to form carbohydrate end products of photosynthesis
- C. A five-carbon compound produced from PGALs; attaches to incoming CO_2
- D. A compound that diffuses into leaves; attached to RuBP by enzymes in photosynthetic cells
- E. Includes all the chemical reactions that "fix" carbon into an organic compound
- F. Three-carbon compounds formed from the splitting of the six-carbon intermediate compound
- G. A molecule that was reduced in the noncyclic pathway; furnishes hydrogen atoms to construct sugar molecules
- H. A product of the light-dependent reactions; necessary in the light-independent reactions to energize molecules in metabolic pathways.
- I. Includes all the chemistry that fixes CO_2 ; converts PGA to PGAL and PGAL to RuBP and sugar phosphates



Self-Quiz

- 1. The electrons that are passed to NADPH during noncyclic photophosphorylation were obtained from _____ .
- water
 - CO₂
 - glucose
 - sunlight
2. The cyclic pathway of the light-dependent reactions functions mainly to _____ .
- fix CO₂
 - make ATP
 - produce PGAL
 - regenerate ribulose biphosphate
3. Chemosynthetic autotrophs obtain energy by oxidizing such inorganic substances as _____ .
- PGA
 - PGAL
 - sulfur
 - water
- 4. The ultimate electron and hydrogen acceptor in noncyclic photophosphorylation is _____ .
- NADP⁺
 - ADP
 - O₂
 - H₂O
- 5. C4 plants have an advantage in hot, dry conditions because _____ .
- their leaves are covered with thicker wax layers than those of C3 plants
 - their stomates open wider than those of C3 plants, thus cooling their surfaces
 - special leaf cells possess a means of capturing CO₂ even in stress conditions
 - they also are capable of carrying on photorespiration
- 6. Chlorophyll is _____ .
- on the outer chloroplast membrane
 - inside the mitochondria
 - in the stroma
 - in the thylakoid membrane system
- 7. Which of the following is applicable to C3 plants?
- At the end of carbon fixation, the intermediate compound is PGA
 - At the end of carbon fixation, the intermediate compound is oxaloacetate
 - They are more sensitive to cold temperatures than are C4 plants
 - Corn, crabgrass, and sugarcane are examples of C3 plants.
- 8. Plant cells produce O₂ during photosynthesis by _____ .
- splitting CO₂
 - splitting water
 - degradation of the stroma
 - breaking up sugar molecules
- 9. Plants need _____ and _____ to carry on photosynthesis.
- oxygen; water
 - oxygen; CO₂
 - CO₂; H₂O
 - sugar; water
- 10. The two products of the light-dependent reactions that are required for the light-independent chemistry are _____ and _____ .
- CO₂; H₂O
 - O₂; NADPH
 - O₂; ATP
 - ATP; NADPH