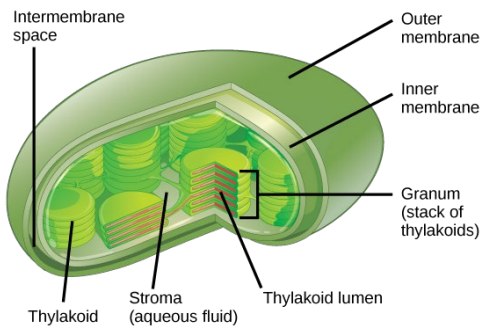


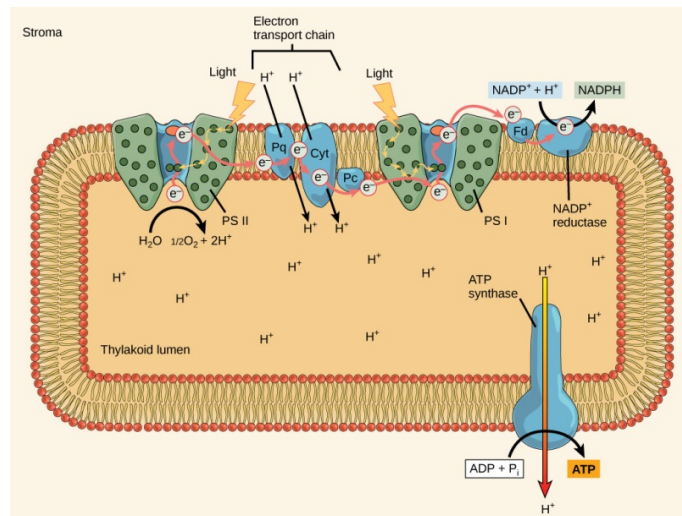
Biology 2eUnit 2: **The Cell**Chapter 8: **Photosynthesis****Visual Connection Questions**

1. On a hot, dry day, the guard cells of plants close their stomata to conserve water. What impact will this have on photosynthesis?



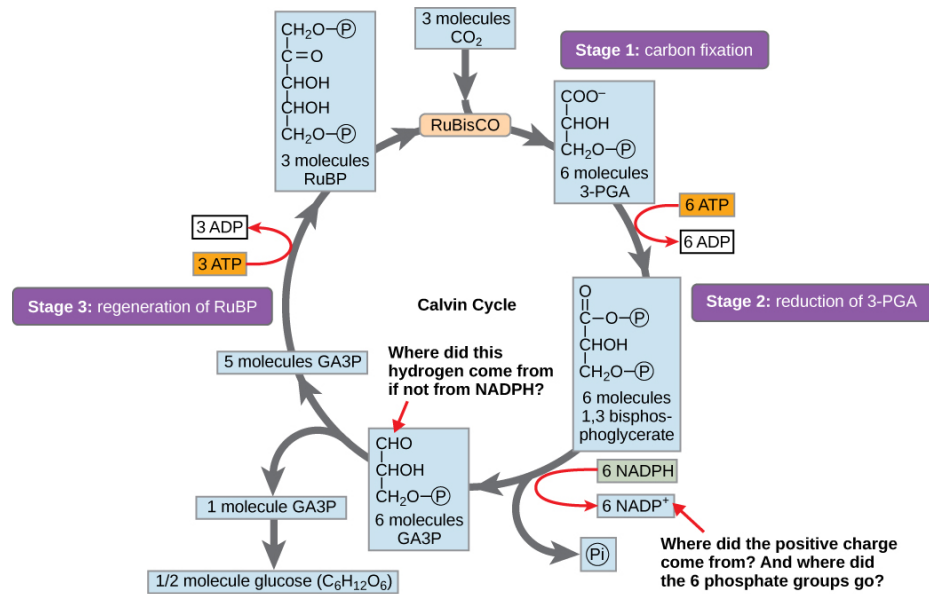
Levels of carbon dioxide (a necessary photosynthetic substrate) will immediately fall. As a result, the rate of photosynthesis will be inhibited.

2. What is the initial source of electrons for the chloroplast electron transport chain?



a. Water

3. Which of the following statements is true?



d. In photosynthesis, water and carbon dioxide are reactants. G3P and oxygen are products.

Review Questions

4. Which of the following components is *not* used by both plants and cyanobacteria to carry out photosynthesis?

a. chloroplasts

5. What two main products result from photosynthesis?

c. sugars/carbohydrates and oxygen

6. In which compartment of the plant cell do the light-independent reactions of photosynthesis take place?

b. stroma

7. Which statement about thylakoids in eukaryotes is *not* correct?

b. Thylakoids exist as a maze of folded membranes.

8. Predict the end result if a chloroplast's light-independent enzymes developed a mutation that prevented them from activating in response to light.

b. ATP and NADPH accumulation

9. How are the NADPH and GA3P molecules made during photosynthesis similar?

d. They both store energy in chemical bonds.

10. Which of the following structures is *not* a component of a photosystem?

a. ATP synthase

11. How many photons does it take to fully reduce one molecule of NADP⁺ to NADPH?

b. 2

12. Which complex is *not* involved in the establishment of conditions for ATP synthesis?

c. photosystem II

13. From which component of the light dependent reactions does NADPH form most directly?

b. photosystem I

14. Three of the same species of plant are each grown under a different colored light for the same amount of time. Plant A is grown under blue light, Plant B is grown under green light, and Plant C is grown under orange light. Assuming the plants use only chlorophyll *a* and chlorophyll *b* for photosynthesis, what would be the predicted order of the plants from most growth to least growth?

a. A, C, B

15. Plants containing only chlorophyll *b* are exposed to radiation with the following wavelengths: 10nm (x-rays), 450nm (blue light), 670nm (red light), and 800nm (infrared light). Which plants harness the most energy for photosynthesis?

b. Blue light irradiated plants

16. Which molecule must enter the Calvin cycle continually for the light-independent reactions to take place?

d. CO₂

17. Which order of molecular conversions is correct for the Calvin cycle?

c. RuBP + CO₂ → [RuBisCO] 3-PGA → G3P

18. Where in eukaryotic cells does the Calvin cycle take place?

c. chloroplast stroma

19. Which statement correctly describes carbon fixation?

a. the conversion of CO₂ into an organic compound

20. If four molecules of carbon dioxide enter the Calvin cycle (four “turns” of the cycle), how many G3P molecules are produced and how many are exported?

c. 8 G3P made, 1 G3P exported

Critical Thinking Questions

21. What is the overall outcome of the light reactions in photosynthesis?

The outcome of light reactions in photosynthesis is the conversion of solar energy into chemical energy that the chloroplasts can use to do work (mostly anabolic production of carbohydrates from carbon dioxide).

22. Why are carnivores, such as lions, dependent on photosynthesis to survive?

Because lions eat animals that eat plants.

23. Why are energy carriers thought of as either “full” or “empty”?

The energy carriers that move from the light-dependent reaction to the light-independent one are “full” because they bring energy. After the energy is released, the “empty” energy carriers return to the light-dependent reaction to obtain more energy. There is not much actual movement involved. Both ATP and NADPH are produced in the stroma where they are also used and reconverted into ADP, Pi, and NADP⁺.

24. Describe how the grey wolf population would be impacted by a volcanic eruption that spewed a dense ash cloud that blocked sunlight in a section of Yellowstone National Park.

The grey wolves are apex predators in their food web, meaning they consume smaller prey animals and are not the prey of any other animal. Blocking sunlight would prevent the plants at the bottom of the food web from performing photosynthesis. This would kill many of the plants, reducing the food sources available to smaller animals in Yellowstone. A smaller prey animal population means that fewer wolves can survive in the area, and the population of grey wolves will decrease.

25. How does the closing of the stomata limit photosynthesis?

The stomata regulate the exchange of gases and water vapor between a leaf and its surrounding environment. When the stomata are closed, the water molecules cannot escape the leaf, but the leaf also cannot acquire new carbon dioxide molecules from the environment. This limits the light-independent reactions to only continuing until the carbon dioxide stores in the leaf are depleted.

26. Describe the pathway of electron transfer from photosystem II to photosystem I in light dependent reactions.

A photon of light hits an antenna molecule in photosystem II, and the energy released by it travels through other antenna molecules to the reaction center. The energy causes an electron to leave a molecule of chlorophyll a to a primary electron acceptor protein. The electron travels through the electron transport chain and is accepted by a pigment molecule in photosystem I.

27. What are the roles of ATP and NADPH in photosynthesis?

Both of these molecules carry energy; in the case of NADPH, it has reducing power that is used to fuel the process of making carbohydrate molecules in light-independent reactions.

28. How and why would the end products of photosynthesis be changed if a plant had a mutation that eliminated its photosystem II complex?

Knocking out photosystem II would eliminate the production of oxygen and ATP during photosynthesis. Photosystem II splits water into oxygen atoms, hydrogen protons that remain in the thylakoid lumen, and hydrogen-derived electrons that move from the reaction center into the electron transport chain. The transfer of an electron through the electron transport chain provides the energy to pump more protons into the thylakoid lumen to maintain a higher concentration of protons there. Moving protons across the thylakoid membrane back to the stroma provides the energy for ATP synthase to produce ATP. Without this proton gradient, ATP will not be synthesized.

29. Why is the third stage of the Calvin cycle called the regeneration stage?

Because RuBP, the molecule needed at the start of the cycle, is regenerated from G3P.

30. Which part of the light-independent reactions would be affected if a cell could not produce the enzyme RuBisCO?

None of the cycle could take place, because RuBisCO is essential in fixing carbon dioxide. Specifically, RuBisCO catalyzes the reaction between carbon dioxide and RuBP at the start of the cycle.

31. Why does it take three turns of the Calvin cycle to produce G3P, the initial product of photosynthesis?

Because G3P has three carbon atoms, and each turn of the cycle takes in one carbon atom in the form of carbon dioxide.

32. Imagine a sealed terrarium containing a plant and a beetle. How does each organism provide resources for the other? Could each organism survive if it was the only living thing in the terrarium? Why or why not?

An energy cycle between a plant and a beetle would be as follows:

- A. Plant consumes carbon dioxide and releases oxygen as a by-product of photosynthesis
- B. Beetle consumes oxygen and releases carbon dioxide to create chemical energy during aerobic respiration
- C. Plant takes up carbon dioxide from the air
- D. Repeat cycle

The plant would also provide a carbon-based food source for the beetle.

1. The beetle is a heterotroph, and would not survive without the plant because it would deplete all the oxygen within the terrarium.
2. The plant is an autotroph and could survive without the beetle, but it would be unlikely to grow. Through photosynthesis, the plant can make and store its own energy in carbon-based molecules, and produce oxygen. The oxygen can then be used to power aerobic respiration in the plant, which releases carbon dioxide. However, since the plant essentially continues to reuse its own resources cycling between carbon- and oxygen-consuming pathways, its growth would be limited.

33. Compare the flow of energy with the flow of nutrients in a closed, sunny ecosystem consisting of a giraffe and a tree.

In the defined ecosystem, energy would radiate from the Sun, and be absorbed by the chlorophyll in the leaves of the tree. Photosynthesis would occur in the leaves, transforming the light energy into stored chemical energy in the covalent bonds of carbon molecules. The giraffe would eat the leaves of the tree, and digest the carbon molecules to release energy.

In the same ecosystem, nutrients would cycle between the tree and the giraffe. The giraffe would consume oxygen and release carbon dioxide as its cells perform aerobic respiration to create chemical energy. The tree will consume the released carbon dioxide during photosynthesis to create its own stored chemical energy, and release oxygen as a by-product.