

PHOTOSYNTHESIS REVIEW QUESTIONS FOR AP BIOLOGY

1. What is the primary function of photosynthesis?
2. (a) Name a gas released as by-product of the light dependent reactions of photosynthesis. (B) Name the molecule that is the source of this gas. (C) Why is oxygen removed from the molecule named in 2B?
- 3-4. Name two molecules that are produced during the light dependent reactions of photosynthesis and serve as temporary sites for energy storage.
5. When a molecule loses an electron, the molecule has been ? (oxidized or reduced or destroyed)
6. When a molecule gains an electron, the molecule has ? (gained energy or lost energy)
7. (A) True or False All electrons contain the same amount of energy. (B) If this statement were true, could life (at least as we know it) exist? Why?
8. When chlorophyll P680 absorbs sunlight, what subatomic particle actually has a change in energy content? (electron or proton or neutron)
9. When chlorophyll P680 loses an electron, from what atom does the chlorophyll receive an electron?
10. When chlorophyll P680 loses an electron, from what molecule does the chlorophyll receive an electron?
11. Which contains more energy: one molecule of NADP or one molecule of NADP-H ?
12. What is the name of the three carbon molecule that is a product of the Calvin cycle (= “dark” reactions)?
13. Name the molecule that is taken from the air and that provides the carbon for the production of carbohydrates during the Calvin cycle.
14. Which has the most energy: one photon of green light, one photon of red light, or one photon of blue light ?
15. Chlorophyll is green because it ? (absorbs, reflects, or transmits) green wave lengths of light.
16. In eukaryotic cells, photosynthesis occurs in organelles named ?
17. How many molecules of carbon dioxide must enter the Calvin cycle in order for the plant to produce a sugar containing 24 carbon atoms?
18. The term phosphorylation means:

19. True or False The Calvin cycle (= light-independent reactions) can occur in a plant that is in dark room so long as the materials carbon dioxide, ATP, and NADP-H are present.
20. Which contains more energy: three molecules of carbon dioxide or one molecule of phosphoglyceraldehyde (= PGAL) ?
21. "Packets" or "particles" of light are called ?
22. What would happen to humans and most other living organisms on Planet Earth if photosynthesis stopped?
23. What is the range of wavelengths of light that are visible to humans?
24. What is the wavelength of UV light? infrared?
25. Which has more energy, short wave lengths of electro-magnetic radiation or long wave lengths of electro-magnetic radiation?
26. Summarize, in one sentence, what happens during the light dependent reactions of photosynthesis.
27. Summarize, in one sentence, what happens during the light independent reactions of photosynthesis.
28. What happens to an electron in an atom if the electron gains energy? loses energy?
29. What happens to an electron in chlorophyll in Photosystem II when the electron absorbs light energy?
30. High energy electrons in Photosystem I are used to manufacture molecules of ?
31. High energy electrons in Photosystem II are used to manufacture molecules of ?

ANSWERS

1. The primary function of photosynthesis is to capture light energy, convert some of this light energy into chemical energy, and store this chemical energy in molecules of carbohydrates (such as phosphoglyceraldehyde, glucose, or starch).

2. (A) Oxygen is released as a by-product (= “waste material”) of photosynthesis. (B) The oxygen atoms are removed from water as the water is broken down during the light reactions. (C) Water is broken down to provide hydrogen atoms (which, in turn, provide electrons to replace electrons that are lost from chlorophyll P680). At this point, oxygen is of no value to the system and, consequently, is released from the chloroplast and from the leaf into the surrounding air.

3-4. Two high-energy molecules that are produced during the light reactions are adenosine triphosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADP-H). These two molecules temporarily store energy; they transfer energy into carbohydrates being produced during the light independent reactions (= Calvin cycle). The carbohydrates (PGAL, glucose, starch) can store energy for much longer periods of time.

5. When a molecule loses an electron, the molecule has been oxidized.

6. When a molecule gains an electron, the molecule has been reduced (and has gained energy that the electron brought.)

7. (A) False. Electrons vary tremendously in the amount of energy they contain. In this class, we typically do not use numbers or units to describe the energy levels of electrons. Instead, we simply refer to the electrons as being “low energy” or “high energy.” (B) If all electrons contained the same amount of energy (and could not gain or lose energy) life could not occur because living organisms must have energy available and this energy is captured and released primarily from electrons (in the reactions of photosynthesis and respiration.)

8. When chlorophyll P680 absorbs energy, an electron gains the energy. (Actually a series of electrons, one after the other, gains energy; however, if you understand what happens to one electron, then you understand what happens to each of the millions of other electrons in this series.)

9-10. When chlorophyll P680 loses an electron, the P680 molecule replaces this electron with an electron taken from an atom of hydrogen which has come out of a molecule of water. (Review: a hydrogen atom consists of one proton and one electron. If the electron is removed, only the proton remains. The proton will be used later, in Photosystem I, to join with an electron that is picked up by NADP. The result is the formation of NADP-H, one of products of the light-dependent reactions.)

11. A molecule of NADP-H contains more energy than a molecule of NADP. The NADP picks up a high-energy electron and combines the electron with a proton to form the hydrogen atom that is the “H” of the NADP-H. Compare NADP to an empty Wells Fargo armored delivery truck while NADP-H is the Wells Fargo truck loaded with money (or, in the case of NADP-H, loaded with energy).

12. The name of the 3-carbon product of the Calvin cycle is phosphoglyceraldehyde (which is also called glyceraldehyde phosphate) and is commonly symbolized as PGAL.

13. Carbon dioxide, in the form of a gas, is removed from the environment of a plant (either from the surrounding air or water, depending on whether the plant lives in air or submerged in water), taken into leaves and chloroplasts, and used as a carbon source during the manufacture of carbohydrates (such as PGAL, glucose, and starch) in the Calvin cycle.

14. The shortest wavelengths (such as violet) have more energy than do the longer wavelengths of light such as red. Of the three colors of light listed here (blue, green, red), blue has the shortest wavelength and, consequently, the most energy. If we compare the wavelengths longer than light (such as radio waves) with wavelengths shorter than light (such as X-rays), the differences in energy level are easier to appreciate. X-rays (short wavelengths with high energy levels) are dangerous to living cells because the X-rays can damage DNA in the chromosomes. Conversely, the long wavelengths of radio waves (with their low energy levels) are apparently harmless to cells.

15. Chlorophyll is green because it reflects green wavelengths of light and these are what we see.

16. Photosynthesis occurs in cell parts called chloroplasts that occur primarily in plant cells that are exposed to light. (Would the root cells of a plant be able to use chloroplasts?)

17. For each carbon atom that is released from the Calvin cycle in a high-energy carbohydrate molecule, one carbon dioxide molecule must enter the cycle. To produce one molecule of PGAL (which contains 3 carbon atoms), 3 molecules of carbon dioxide must enter the cycle; to produce one molecule of glucose (with 6 carbon atoms), 6 molecules of carbon dioxide must enter the cycle; to produce a molecule containing 24 carbon atoms, 24 molecules of carbon dioxide must enter the cycle.

18. The term phosphorylation refers to the addition of a phosphate group to an atom or molecule. The addition of the phosphate involves the addition of large amounts of energy. This energy may come from light (as in the light reactions of photosynthesis) or from the breakdown of sugars (as in cellular respiration).

19. True. The Calvin cycle requires the input of carbon dioxide (as a source of carbon for building carbohydrates) and the availability of ATP and NADP-H to provide energy to reduce the carbon dioxides and construct high-energy carbohydrates. If these materials (carbon dioxide, ATP, and NADP-H) are available, the Calvin cycle can occur, even in darkness. Normally, however, what would happen to the quantities of ATP and NADP-H shortly after the plant is placed in darkness? (The light dependent reactions would shut down and no more ATP and NADP-H would be produced. When the available supplies of ATP and NADP-H are used up, the Calvin cycle would stop.)

20. One molecule of phosphoglyceraldehyde (= PGAL) contains more energy than three molecules of carbon dioxide. During the Calvin cycle (the light independent reactions) the low energy carbon atoms in carbon dioxide are reduced (i.e., they gain energy from ATP and NADP-H).

21. Packets or "bundles" of light energy are called photons.

22. If photosynthesis stopped, most living organisms on Planet Earth, including humans, would die due either (A) to a shortage of energy because no food molecules would be available or (B) to a shortage of oxygen for cellular respiration.

23. The wavelengths of light that are visible to humans range from approximately 400 nanometers (violet) to 700 nanometers (red). Some animals can see additional wavelengths. For example, some insects can see ultraviolet light.

24. Ultraviolet light (= UV light) has a shorter wavelength than violet (which has a wavelength of about 400 nanometers; infrared has a longer wavelength than red (which has a wavelength of about 700 nanometers).

25. The shorter wavelengths have more energy; therefore, UV light has more energy per photon than does infrared. One consequence of this is that the shorter wavelengths are more likely to be dangerous to living cells.

26. Light energy is absorbed by electrons that supply energy for the formation of molecules of ATP and NADP-H which are used as temporary energy storing molecules.

27. Molecules of carbon dioxide enter the Calvin cycle where the carbons are reduced by acquiring energy from ATP and NADP-H (from the light dependent reactions) and high energy molecules of PGAL are constructed.

28. If an electron gains energy it moves to an outer shell; if the electron gains enough energy, the electron may be driven out of the atom.

If an electron loses energy it moves to an inner shell (i.e., closer to the nucleus of the atom).

29. The electron gains so much energy (by absorbing photons) that the electron leaves the chlorophyll molecule. The electron is now described as a "high-energy electron" and can provide energy for the formation of molecules of ATP.

30. High energy electrons in Photosystem I are used to manufacture molecules of NADP-H.

31. High energy electrons in Photosystem II are used to manufacture molecules of ATP.