■ INTERACTIVE QUESTION 10.8

a. In the light, the proton gradient across the thylakoid membrane is as great as 3 pH units. On which side is the pH lowest? inside thyl. space

b. What three factors contribute to the formation of this large difference in H^+ concentration between the thylakoid space and the stroma?

1) moving H+ into space by cyto.complex
2) H+ from photolysis
3) removing H+ on stroma side when NADPH forms

■ INTERACTIVE QUESTION 10.10

a. Where does the Calvin cycle take place in C_4 plants?

bundle sheath cells

b. How can C_4 plants successfully perform the Calvin cycle in hot, dry conditions when C_3 plants would be undergoing photorespiration?

they fix CO_2 w/ different enzyme that ignores O_2 then deliver CO_2 to bundle sheath cells where Calvin cycle occurs (away from ↑O_2).

■ INTERACTIVE QUESTION 10.7

a. On the diagram ~~above~~ on last page, sketch the path that electrons from P700 take during cyclic electron flow.

b. Why is neither oxygen nor NADPH generated by cyclic electron flow?

b/c the e⁻ end up right back at PI.

c. How, then, is ATP produced by cyclic electron flow?

As e⁻ travel back through the short ETC, they lose potential energy which is used to increase H+ gradient.

TEST YOUR KNOWLEDGE

MULTIPLE CHOICE: *Choose the one best answer.*

1. Which of the following is mismatched with its location?
   a. light reactions—grana
   b. electron transport chain—thylakoid membrane
   c. Calvin cycle—stroma
   d. ATP synthase—double membrane surrounding chloroplast
   e. splitting of water—thylakoid space

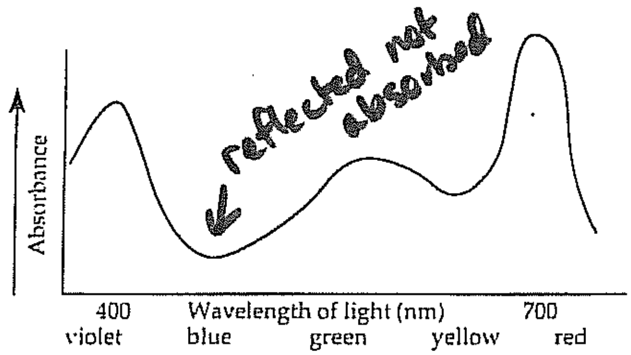
2. Photosynthesis is a redox process in which
   a. CO_2 is reduced and water is oxidized.
   b. $NADP^+$ is reduced and RuBP is oxidized.
   c. CO_2, $NADP^+$, and water are reduced.
   d. O_2 acts as an oxidizing agent and water acts as a reducing agent.
   e. G3P is reduced and the electron transport chain is oxidized.

3. Blue light has more energy than red light. Therefore, blue light
   a. has a longer wavelength than red light.
   b. has a shorter wavelength than red light.
   c. contains more photons than red light.
   d. has a broader electromagnetic spectrum than red light.
   e. is absorbed faster by chlorophyll *a*.

4. A spectrophotometer can be used to measure
   a. the absorption spectrum of a substance.
   b. the action spectrum of a substance.
   c. the amount of energy in a photon.
   d. the wavelength of visible light.
   e. the efficiency of photosynthesis.

5. Accessory pigments within chloroplasts are responsible for
   a. driving the splitting of water molecules.
   b. absorbing photons of different wavelengths of light and passing that energy to P680 or P700.
   c. providing electrons to the reaction-center chlorophyll after photo-excited electrons pass to $NADP^+$.
   d. pumping H^+ across the thylakoid membrane to create a proton-motive force.
   e. anchoring chlorophyll *a* within the reaction center.

6. Below is an absorption spectrum for an unknown pigment molecule. What color would this pigment appear to you?



   a. violet
   b. blue
   c. green
   d. yellow
   e. red

7. Noncyclic electron flow in the chloroplast results in the production of
   a. ATP only.
   b. ATP and NADPH.
   c. ATP and G3P.
   d. ATP and O_2.
   e. ATP, NADPH, and O_2.

8. The chlorophyll known as P680 has its electron "holes" filled by electrons from
   a. photosystem I.
   b. photosystem II.
   c. water.
   d. NADPH.
   e. accessory pigments.

9. CAM plants avoid photorespiration by
   a. fixing CO_2 into organic acids during the night; these acids then release CO_2 during the day.
   b. performing the Calvin cycle at night.
   c. fixing CO_2 into four-carbon compounds in the mesophyll, which release CO_2 in the bundle-sheath cells.
   d. using PEP carboxylate to fix CO_2 to ribulose bisphosphate (RuBP).
   e. keeping their stomata closed during the day.

10. Electrons that flow through the two photosystems have their highest potential energy in
    a. water.
    b. P680.
    c. NADPH.
    d. the electron transport chain.
    e. photo-excited P700.

11. Chloroplasts can make carbohydrate in the dark if provided with
    a. ATP and NADPH and CO_2.
    b. an artificially induced proton gradient.
    c. organic acids or four-carbon compounds.
    d. a source of hydrogen.
    e. photons and CO_2.

12. In the chemiosmotic synthesis of ATP, H^+ diffuses through the ATP synthase
    a. from the stroma into the thylakoid space.
    b. from the thylakoid space into the stroma.
    c. from the cytoplasm into the matrix.
    d. from the cytoplasm into the stroma.
    e. from the matrix into the stroma.

13. In C_4 plants, the Calvin cycle
    a. takes place at night.
    b. only occurs when the stomata are closed.
    c. takes place in the mesophyll cells.
    d. takes place in the bundle-sheath cells.
    e. uses PEP carboxylase instead of rubisco because of its greater affinity for CO_2.

14. How many "turns" of the Calvin cycle are required to produce one molecule of glucose?
    a. 1
    b. 2
    c. 3
    d. 6
    e. 12

15. In green plants, most of the ATP for synthesis of proteins, cytoplasmic streaming, and other cellular activities comes directly from
    a. photosystem I.
    b. the Calvin cycle.
    c. oxidative phosphorylation. mitochondria
    d. noncyclic photophosphorylation.
    e. cyclic photophosphorylation.

16. The six molecules of G3P formed from three turns of the Calvin cycle are converted into SKIP
    a. three molecules of glucose.
    b. three molecules of RuBP and one G3P.
    c. one molecule of glucose and four molecules of 3-phosphoglycerate.
    d. one G3P and three four-carbon intermediates.
    e. none of the above, since three molecules of G3P result from three turns of the Calvin cycle.

17. A difference between chemiosmosis in photosynthesis and respiration is that in photophosphorylation
    a. NADPH rather than NADH passes electrons to the electron transport chain.
    b. ATP synthase releases ATP into the stroma rather than into the cytosol.
    c. light provides the energy to push electrons to the top of the electron chain, rather than energy from the oxidation of food molecules.
    d. an H^+ concentration gradient rather than a proton-motive force drives the phosphorylation of ATP.
    e. both a and c are correct.

18. NADPH and ATP from the light reactions are both needed
    a. in the carbon fixation stage to provide energy and reducing power to rubisco.
    b. to regenerate three RuBP from five G3P (glyceraldehyde 3-phosphate).
    c. to combine two molecules of G3P to produce glucose.
    d. to convert 3-phosphoglycerate to G3P.
    e. to reduce the H^+ concentration in the stroma and contribute to the proton-motive force.

19. What portion of an illuminated plant cell would you expect to have the lowest pH?
    a. nucleus
    b. vacuole
    c. chloroplast
    d. stroma of chloroplast
    e. thylakoid space

20. How does cyclic electron flow differ from noncyclic electron flow?
    a. No NADPH is produced by cyclic electron flow.
    b. No O_2 is produced by cyclic electron flow.
    c. The cytochrome complex in the electron transport chain is not involved in cyclic electron flow.
    d. Both a and b are correct.
    e. a, b, and c are correct.

21. What does rubisco do?
    a. reduces CO_2 to G3P
    b. regenerates RuBP with the aid of ATP
    c. combines electrons and H^+ to reduce $NADP^+$ to NADPH
    d. adds CO_2 to RuBP in the carbon fixation stage
    e. transfers electrons from NADPH to 1,3-bisphosphoglycerate to produce G3P

22. What are the final electron acceptors for the electron transport chains in the light reactions of photosynthesis and in cellular respiration?
    a. O_2 in both
    b. CO_2 in both
    c. H_2O in the light reactions and O_2 in respiration
    d. $NADP^+$ in the light reactions and NAD^+ or FAD in respiration
    e. $NADP^+$ in the light reactions and O_2 in respiration

23–28.
Indicate if the following events occur during
a. respiration
b. photosynthesis
c. both respiration and photosynthesis
d. neither respiration nor photosynthesis

C 23. Chemiosmotic synthesis of ATP
A 24. Reduction of oxygen $O_2 \rightarrow H_2O$
B 25. Reduction of CO_2 $CO_2 \rightarrow$ sugars
A 26. Reduction of NAD^+ $NAD^+ \rightarrow NADH$
D 27. Oxidation of $NADP^+$ already oxidiz
A 28. Oxidative phosphorylation

INTERACTIVE QUESTION 10.6

Fill in the steps of noncyclic electron flow in the diagram below. Circle the important products that will be used to provide chemical energy and reducing power to the Calvin cycle.