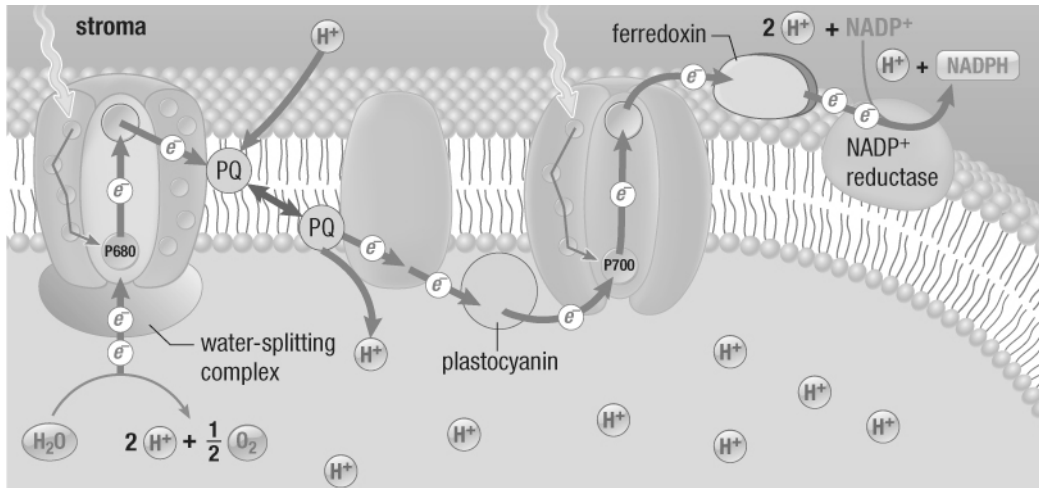


Section 5.2: Pathways of Photosynthesis

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1. In photosystem II, the antenna complex absorbs a photon and transfers its energy to the reaction centre chlorophyll P680. This causes one of the P680 electrons to go from a low-energy ground state to a high-energy excited state. The excited electron is transferred to the primary acceptor. P680 now carries a positive charge and removes an electron from a water molecule, splitting the water molecule in the process. From there, the photon-absorption cycle starts again, and the low-energy electron that was obtained by P680 from water receives the energy to become a high-energy electron that is then transferred to the primary acceptor.

2.



3. Light energy is essential for photosynthesis because electrons need a boost of energy from photons of light at photosystems I and II in order for the electron transport to continue.

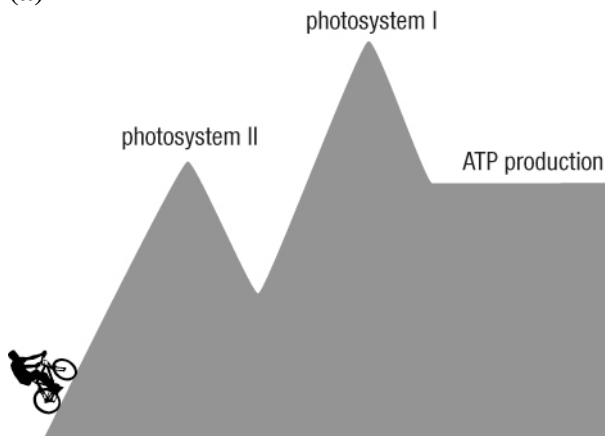
4. Three steps that contribute to the buildup of the proton gradient across the thylakoid membrane are 1) the splitting of water inside the membrane by $P680^+$ which increases the concentration of protons in the lumen, 2) the transport of protons into the membrane during electron transport by plastoquinone (PQ) as it moves from photosystem II to the cytochrome complex and back again, and 3) the depletion of protons in the stroma outside the thylakoid by $NADP^+$ reduction.

5. Protons move through the thylakoid membrane from the lumen to the stroma because there is a higher concentration of protons inside the lumen than outside. They move through the ATP synthase complex releasing free energy that it used to phosphorylate ADP (chemiosmosis).

6. Table 1

Electron transport chains in mitochondria	Electron transport chains in chloroplasts
begins with high-energy NADH	begins with low energy H_2O
ends with low-energy H_2O	ends with high-energy NADPH
located in inner membrane	located in thylakoid membrane

7. (a)



(b) The analogy of a cyclist travelling along a path over two hills is a good one. The cyclist begins at the bottom of the first hill and must work hard, expending energy, to get to top. Having reached the top of this hill, he stops pedalling and spontaneously coasts downhill a short distance, releasing a small amount of energy. Before he gets to the starting level, he reaches the base of another hill and must once again expend energy to get to the top of this hill, which is even higher than the first. Once he reaches the top, he can coast downhill again, but the bottom of the second hill is higher than the start of the first. In this analogy, the energy to climb uphill is supplied by the cyclist rather than photons of light, but as in photosynthesis, the downhill parts of the pathway can happen spontaneously as energy is released.

8. (a) The light-dependent reactions would still be supplying the NADPH and ATP that the Calvin cycle requires, even though it is occurring very slowly.

(b) This situation might arise if the plant is in a very hot or very dry environment. The stomata of the leaf may close to conserve water, which would also block the intake of carbon dioxide.

9. Cyclic electron transport is likely working much harder in a leaf with an unusually high amount of ATP and relatively little NADPH than the linear electron transport chain, since cyclic electron transport creates ATP, but not NADPH. Photosystem II does not factor into cyclic electron transport, so photosystem I is absorbing more light energy than photosystem II.

10. Answers may vary. Sample answer: Animals don't need or use rubisco because they don't need to fix carbon dioxide since they obtain carbon that is already fixed by consuming other organisms.