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Readings

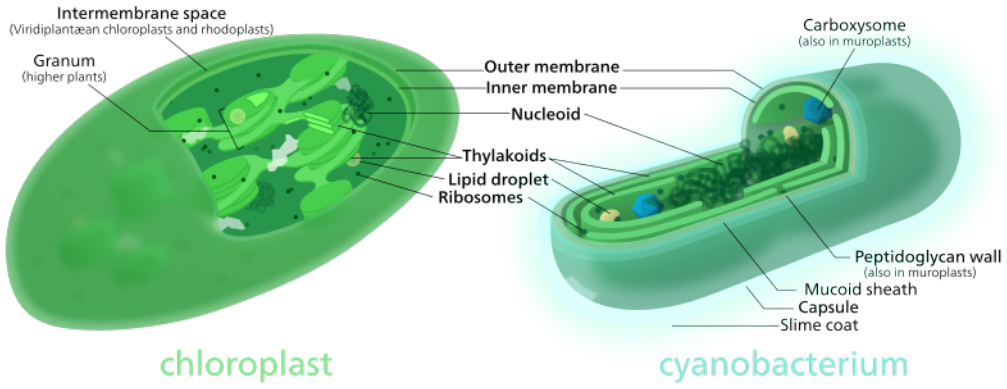
- PDF (Openstax)
- 8.1Overview (OpenStax CNX)
- 8.2 Light-dependent Pathways (OpenStax CNX)

Learning Objectives

1. Explain how the evolution of photosynthesis altered the atmosphere of the early earth and influenced the development of organisms.
2. Discuss the nature of light, and give two reasons why visible light wavelengths are so well suited for life on earth; explain the physical basis for the green appearance of leaves.
3. Name the major photosynthetic pigments, and list the various events that can happen when pigments interact with light.
4. Describe the chloroplast structure.
5. Describe the composition of the two main photo systems in photosynthesis, and explain how antenna pigments differ in function from reaction center pigments.
6. Discuss the series of events that occur in the light-dependent reactions of photosynthesis, including the process of photophosphorylation, and list the main products of these reactions.

Photosynthesis and Food

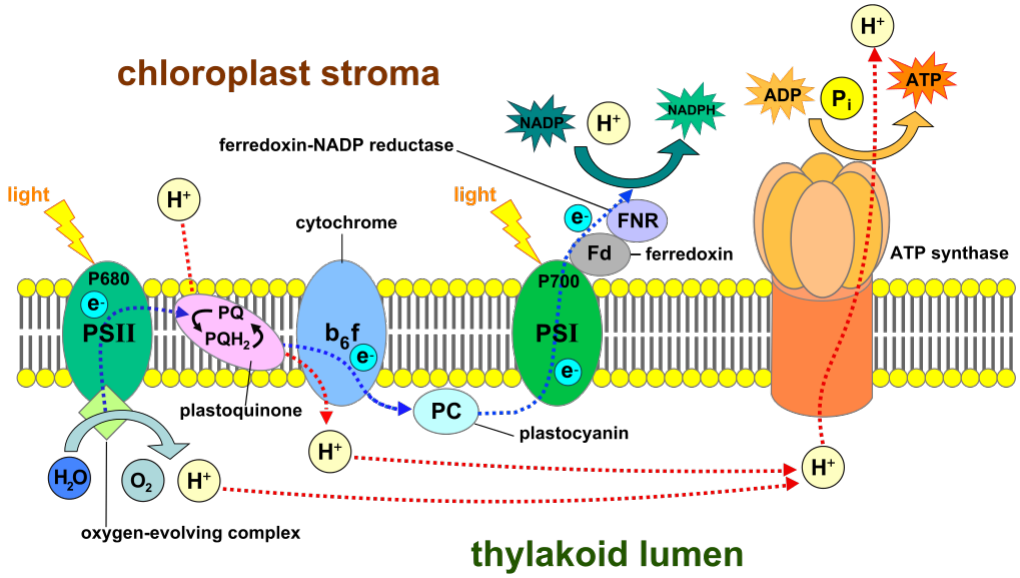
Chloroplasts and Cyanobacteria



Relationship between chloroplasts and cyanobacteria. Credit: Kelvinsong [CC-BY-SA 3.0]

Chloroplasts arose through a second endosymbiotic event in plants and various protists. These light harvesting organelles share similarity in structure and genome to photoautotrophic cynaboacteria.

Light Harvesting

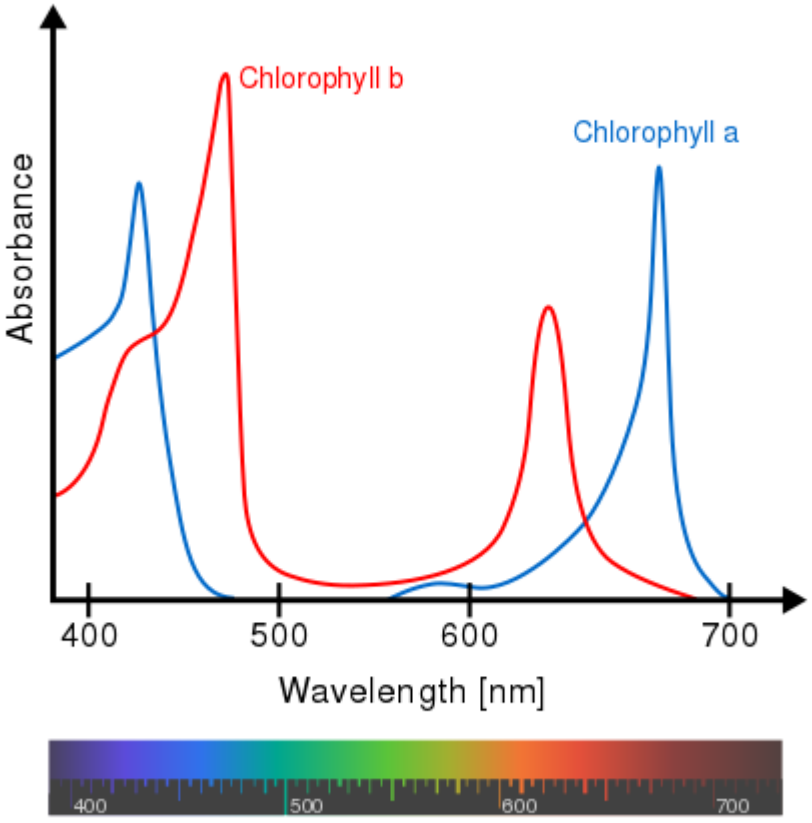


Energy capture at the thylakoid membrane. Credit: Somepics [CC-BY-SA 4.0]

The thylakoid membranes of chloroplasts and cyanobacteria provide additional surface area for energy capture of light to occur. The light-dependent reactions in chlorplasts utilize two

protein complexes referred to as **Photosystem I** (PSI) and **Photosystem II** (PSII)located on the thylakoid membranes. At the center of each photosystem complexes are **photopigments** optimized to absorb specific wavelengths of light. When light is absorbed in a photosystem, an electron is excited and transferred to the electron transport chain. In PSII, the electron is regenerated by splitting of two water molecules into $4H^+ + 4e^- + O_2$. As the electrons move through the ETC, protons are pumped into the thylakoid space. The ETC leads to the reduction of a high energy electron carrier $NADP^+$ to **NADPH**. Since this pathway uses consumes water in a chemical reaction, the apparent loss of water in the thylakoid space is referred to as chemiosmosis.

PSI is also known as the cyclic pathway since the excited electron runs through a closed circuit of the ETC to regenerate the lost electron. This closed circuit also generates a proton gradient through powering of a proton pump but does not lead to the reduction of NADPH. As with the ETC-powered proton pump in mitochondria, the proton gradient is used to power ATP-synthase in producing ATP molecules.



Absorbance spectra of the two most prominent pigments found in plants. Credit: Daniele Pugliesi,M0tty [CC-BY-SA 3.0]