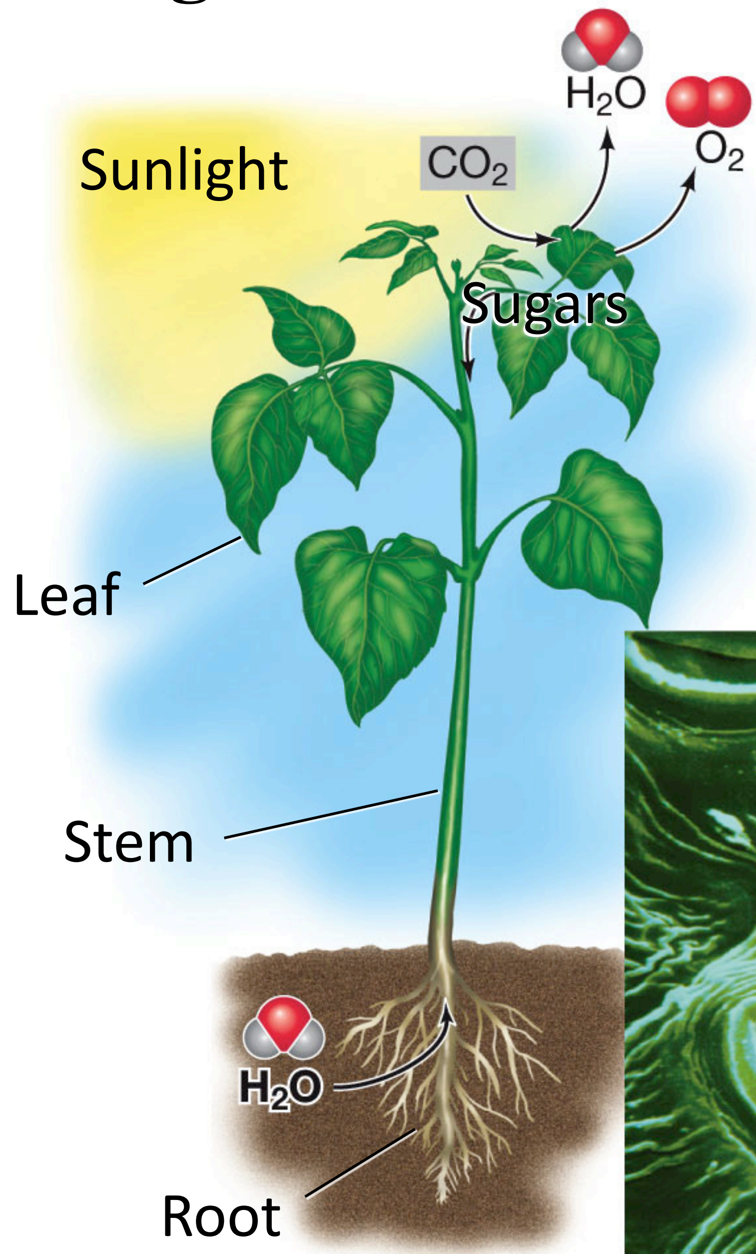
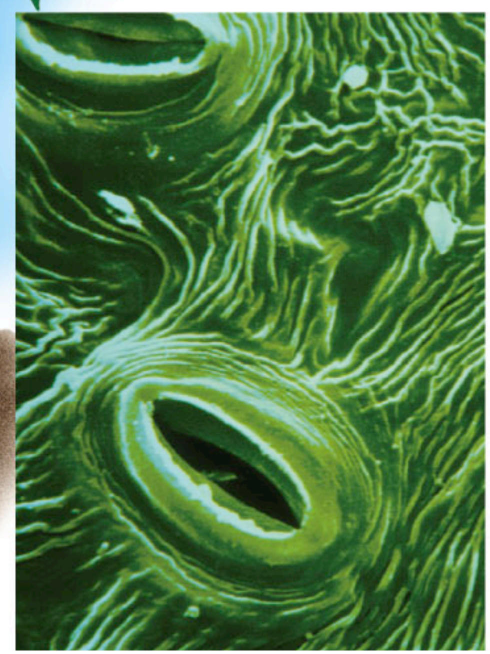
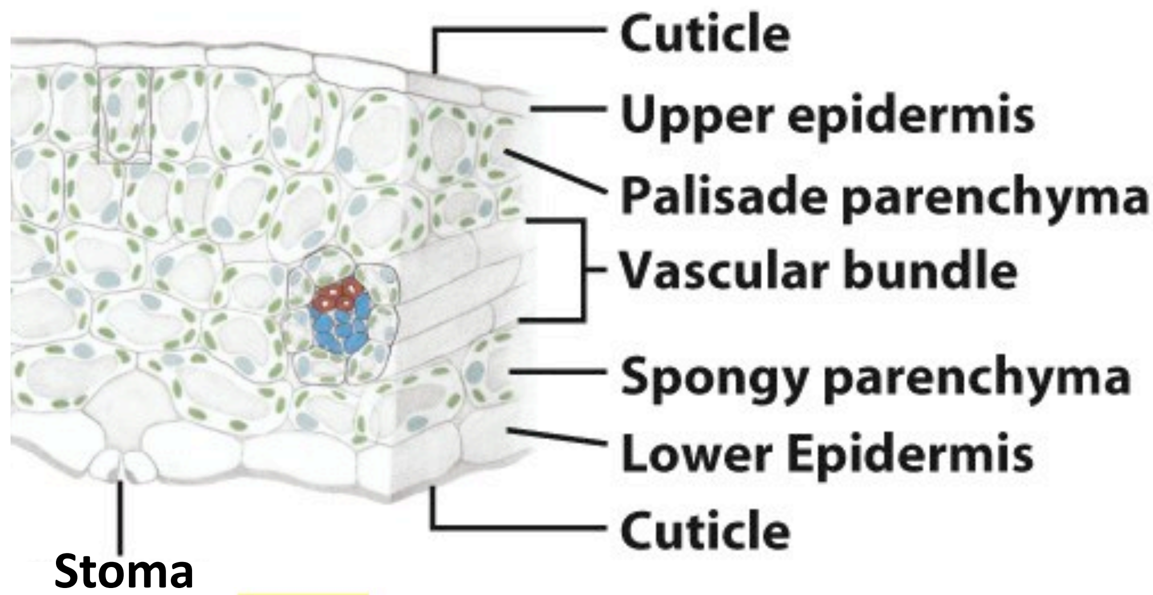
Photosynthesis: Energy From Sunlight

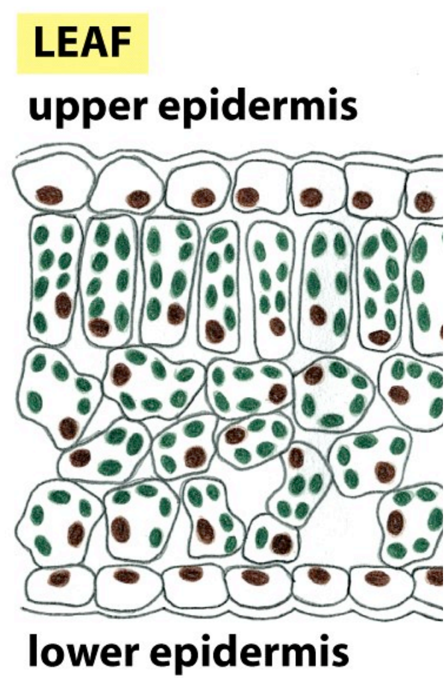
The Ingredients For Photosynthesis



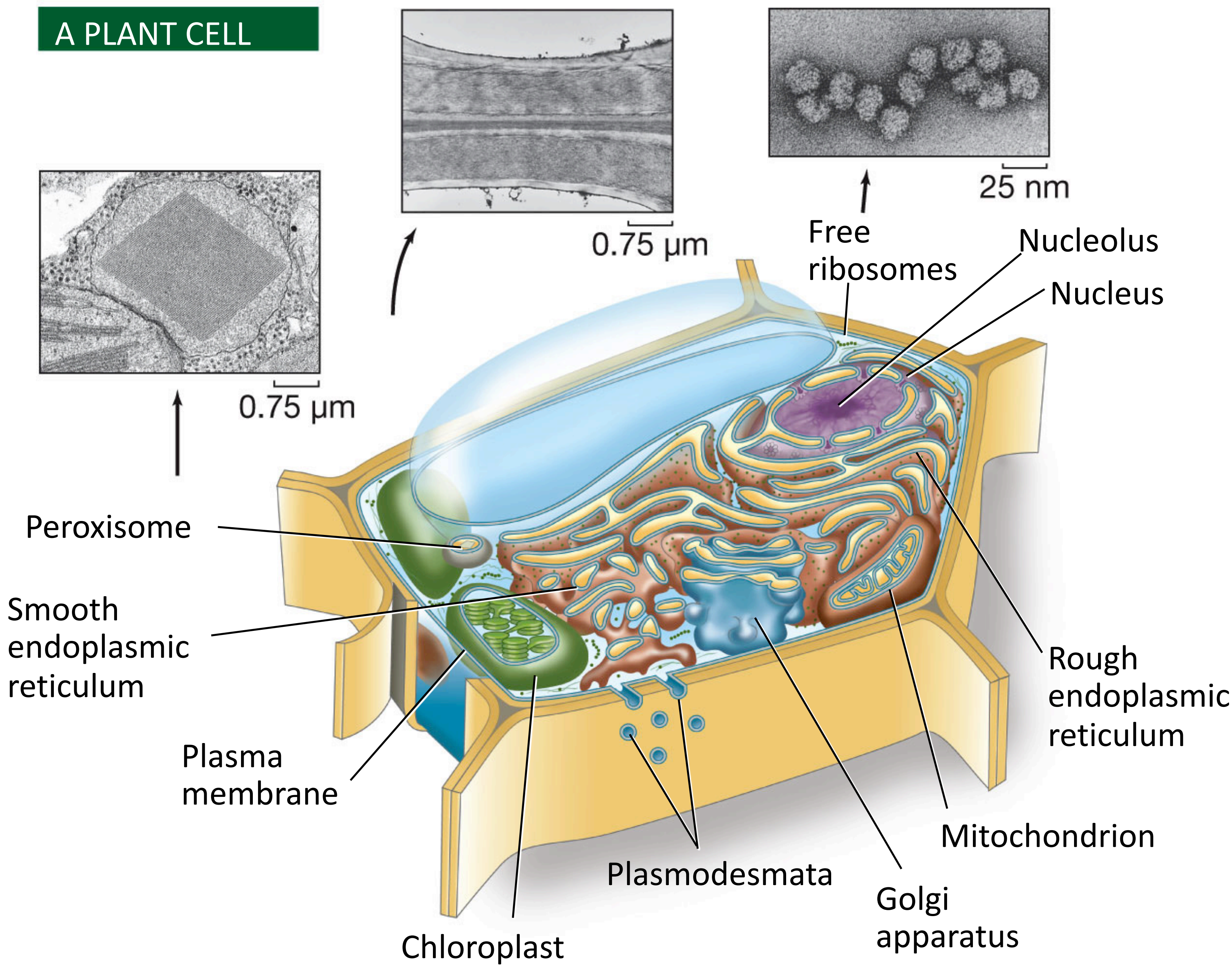


Leaves: Plant Solar Collectors

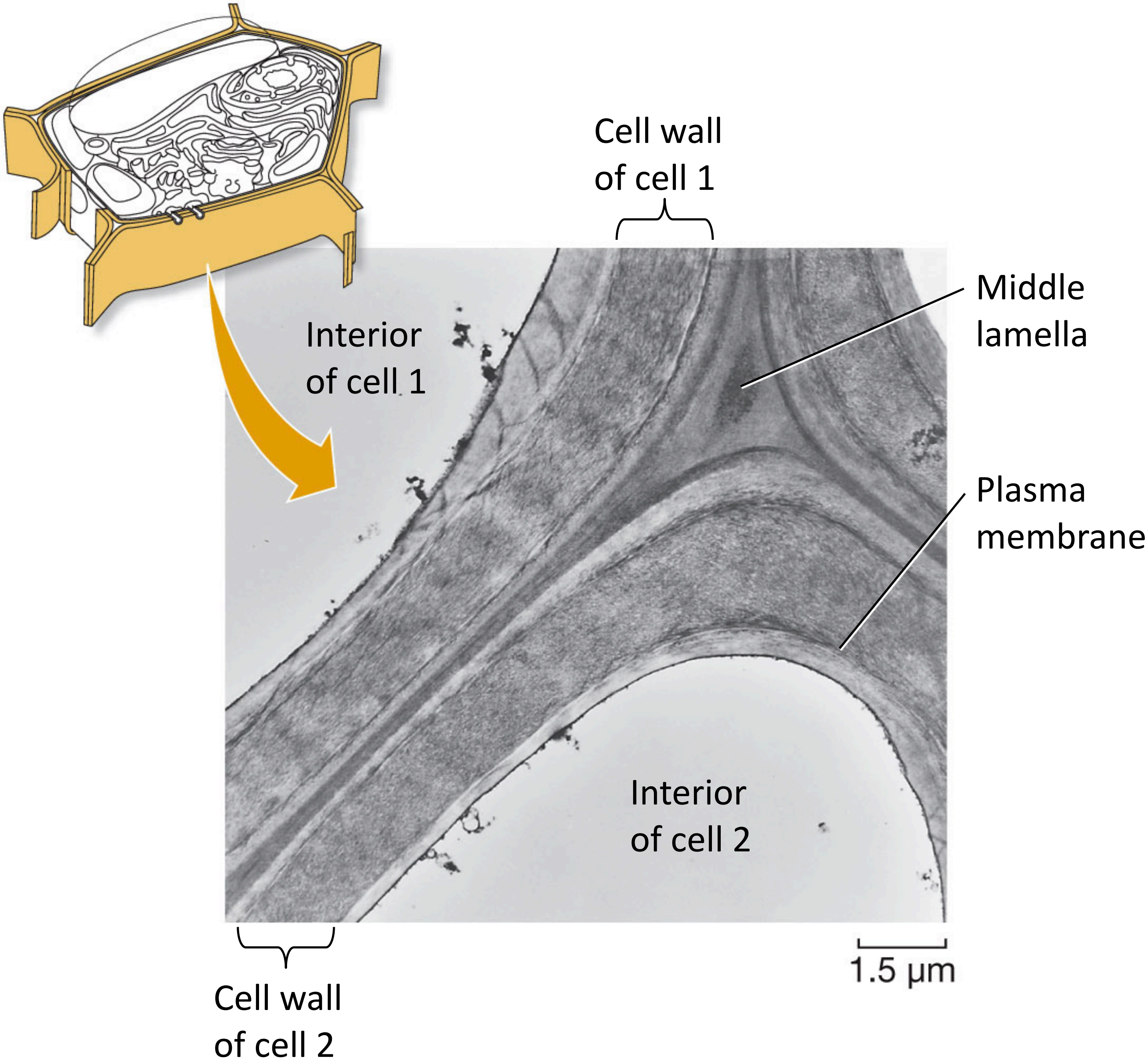




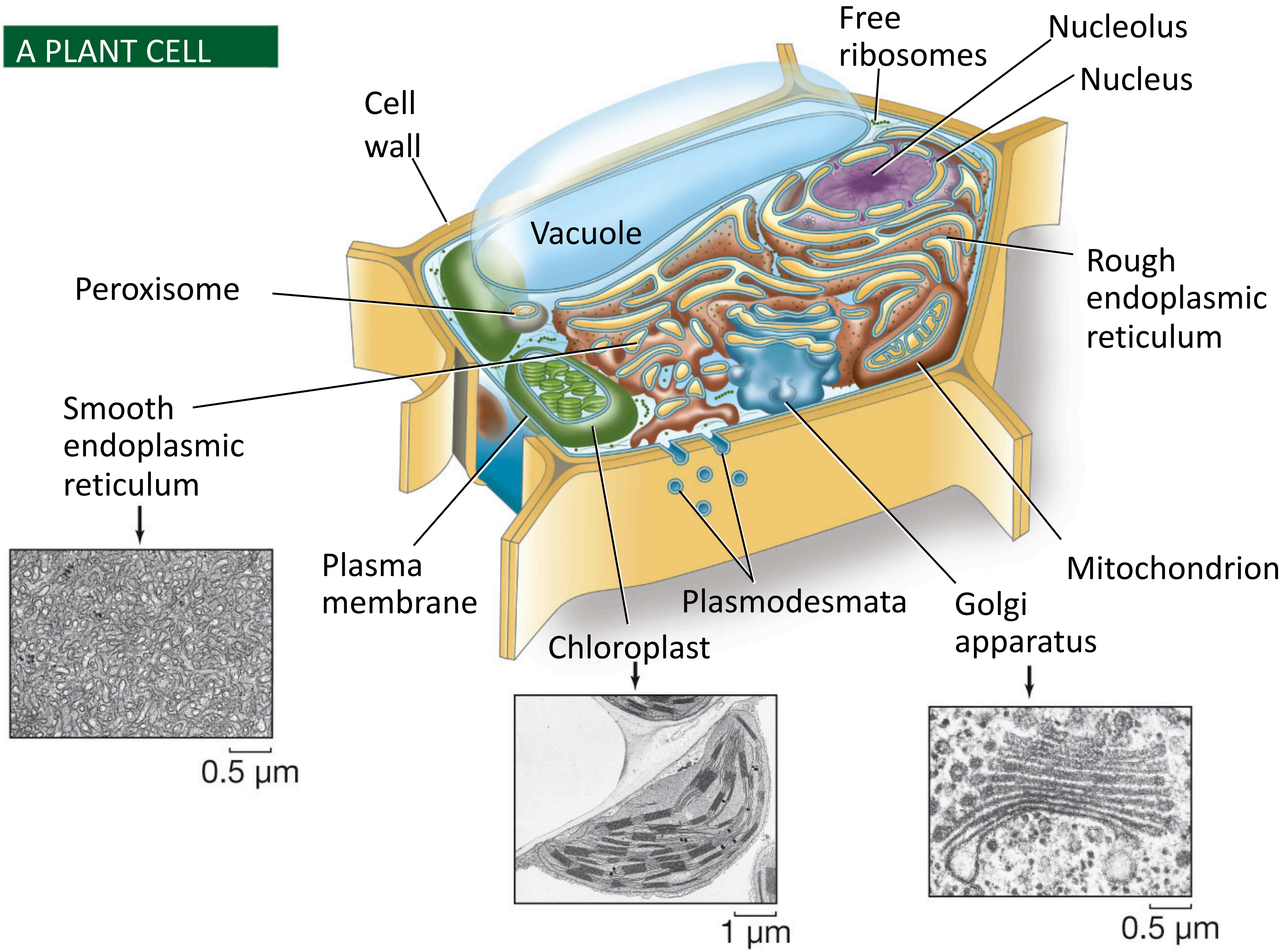
Plant Cell Structure



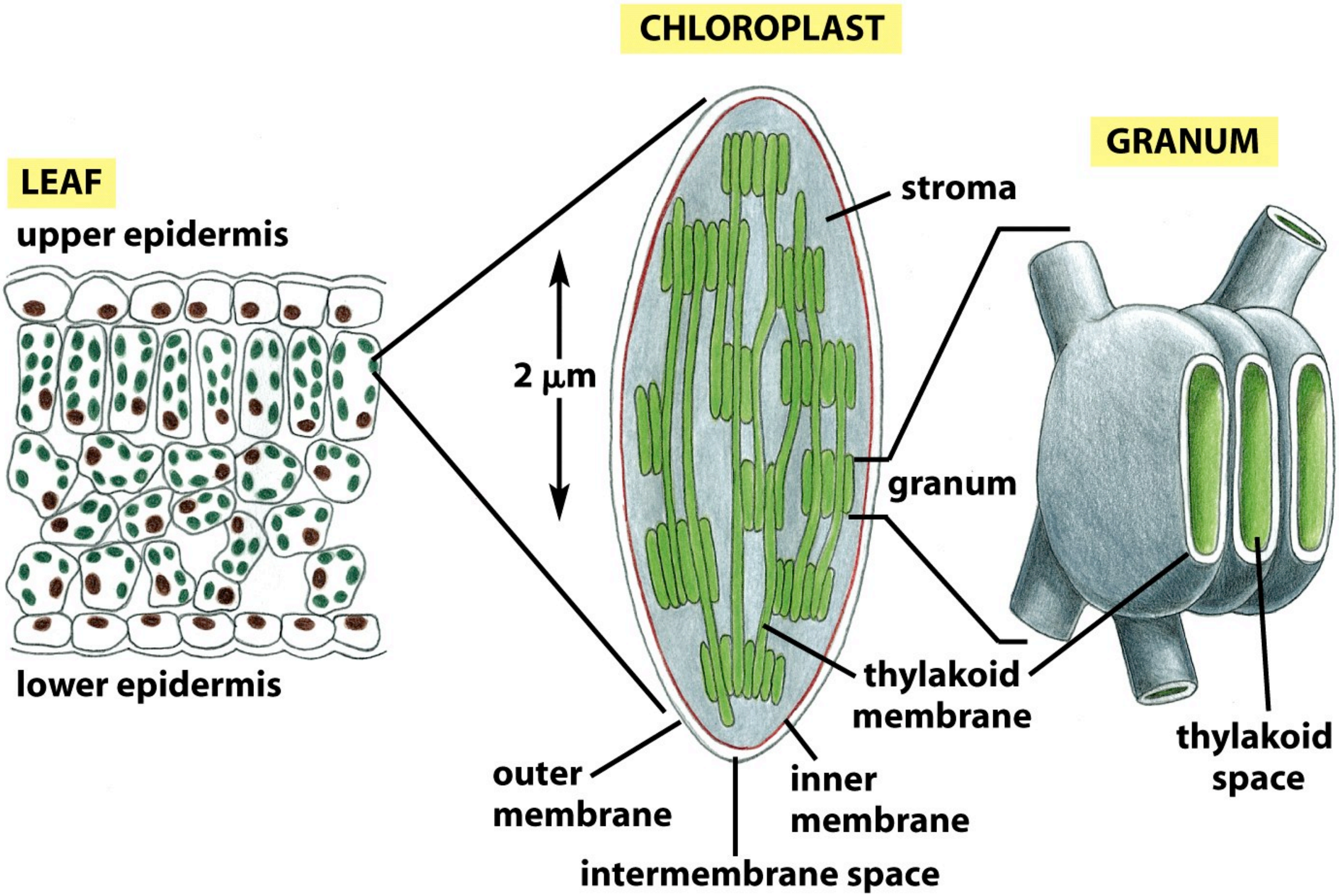
The Plant Cell Wall



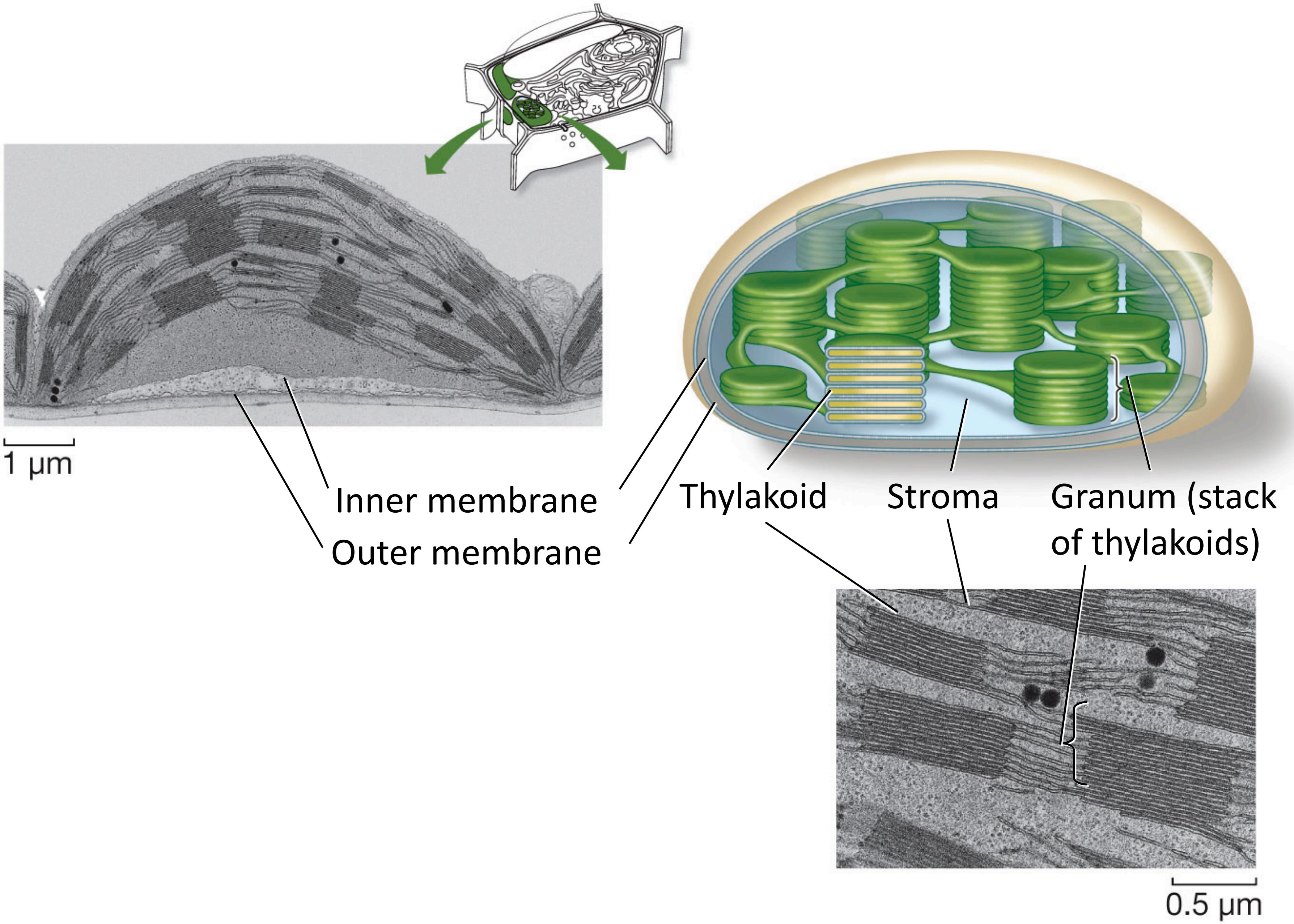
Plant Cell Structure



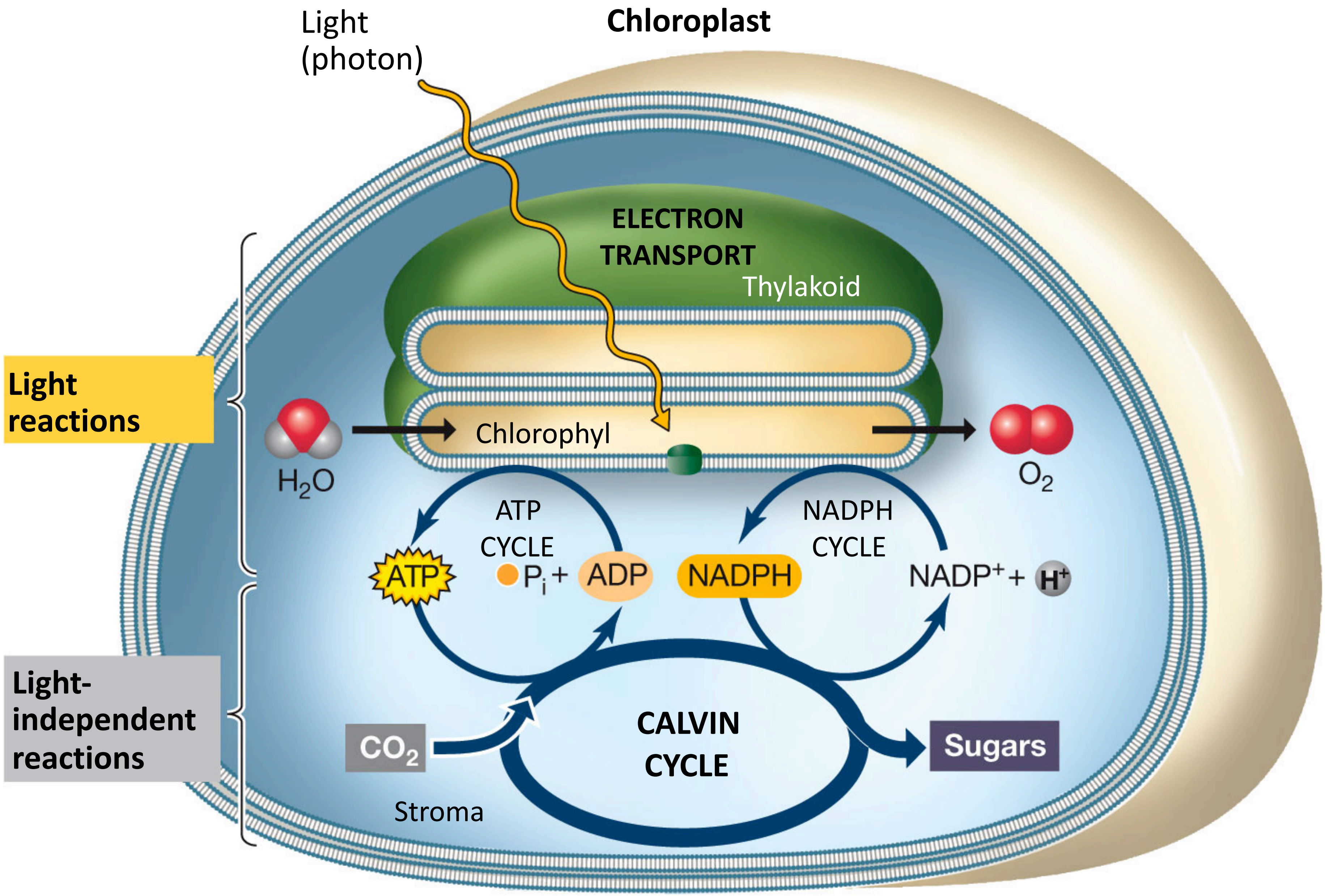
The Photosynthetic Reactions Are Carried Out By Chloroplasts



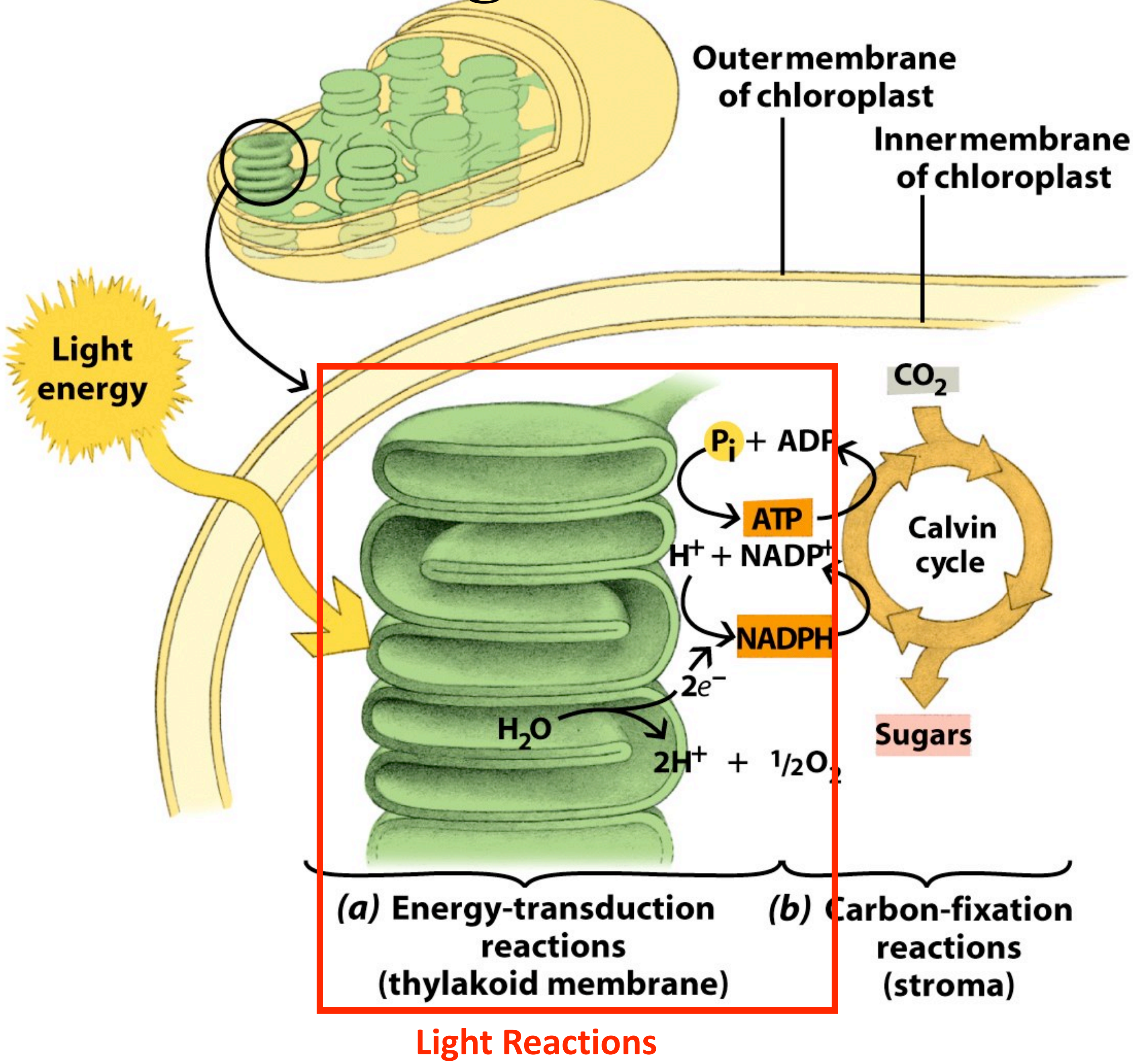
Chloroplast Structure



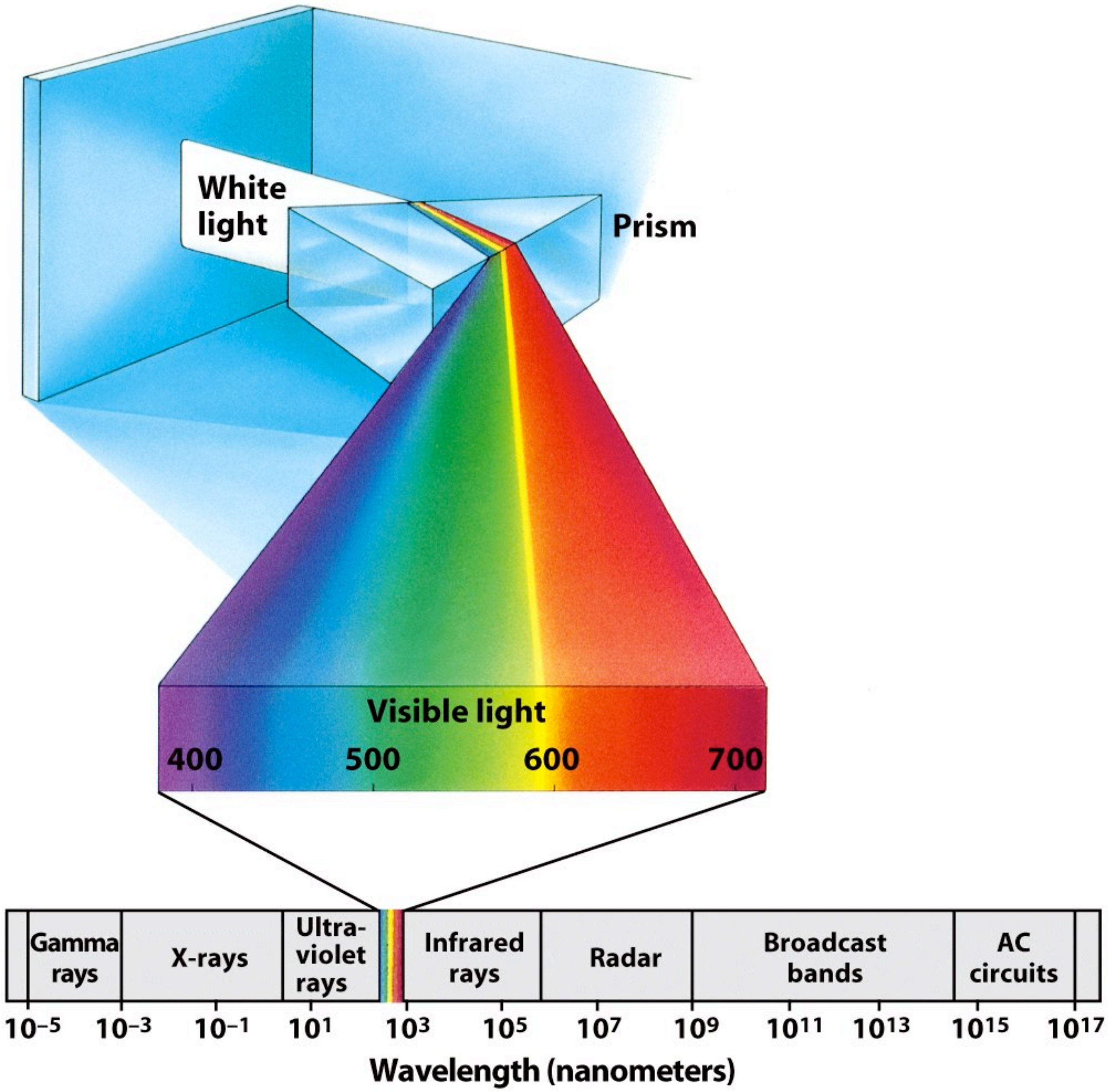
Photosynthesis Is A Two-Step Process



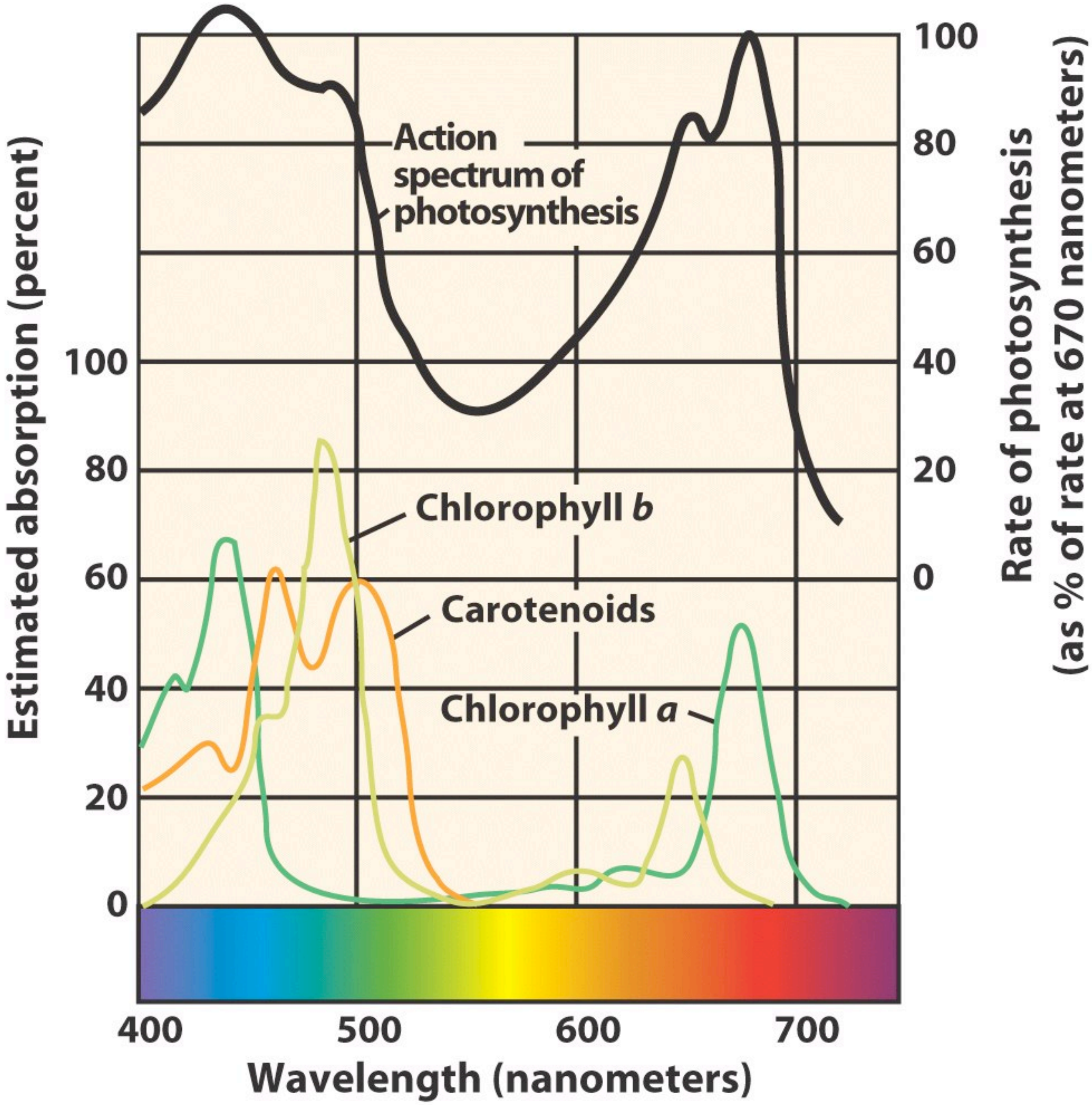
The Light Reactions



The Electromagnetic Spectrum



Action Spectrum Of Photosynthesis



Chlorophyll

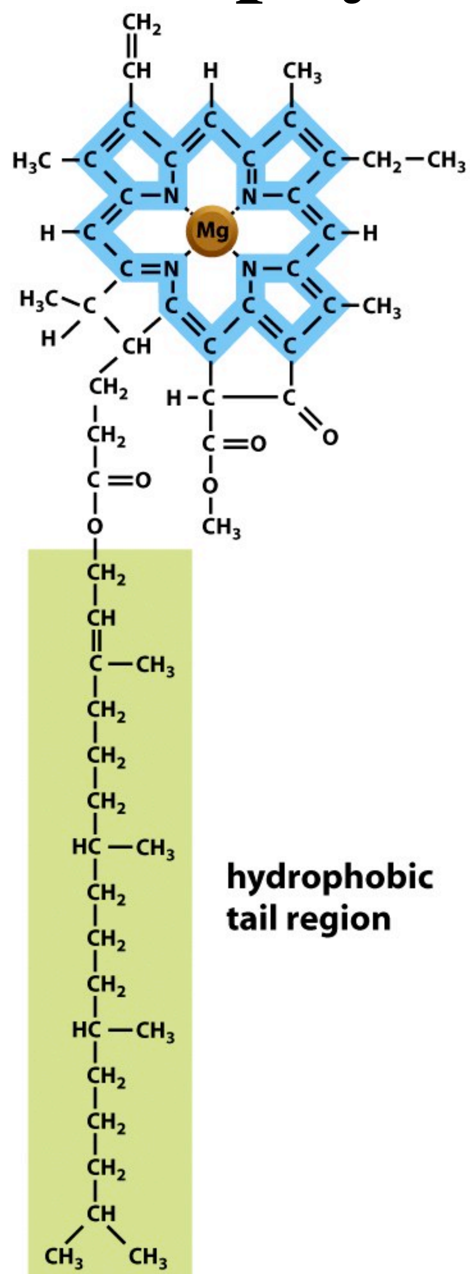
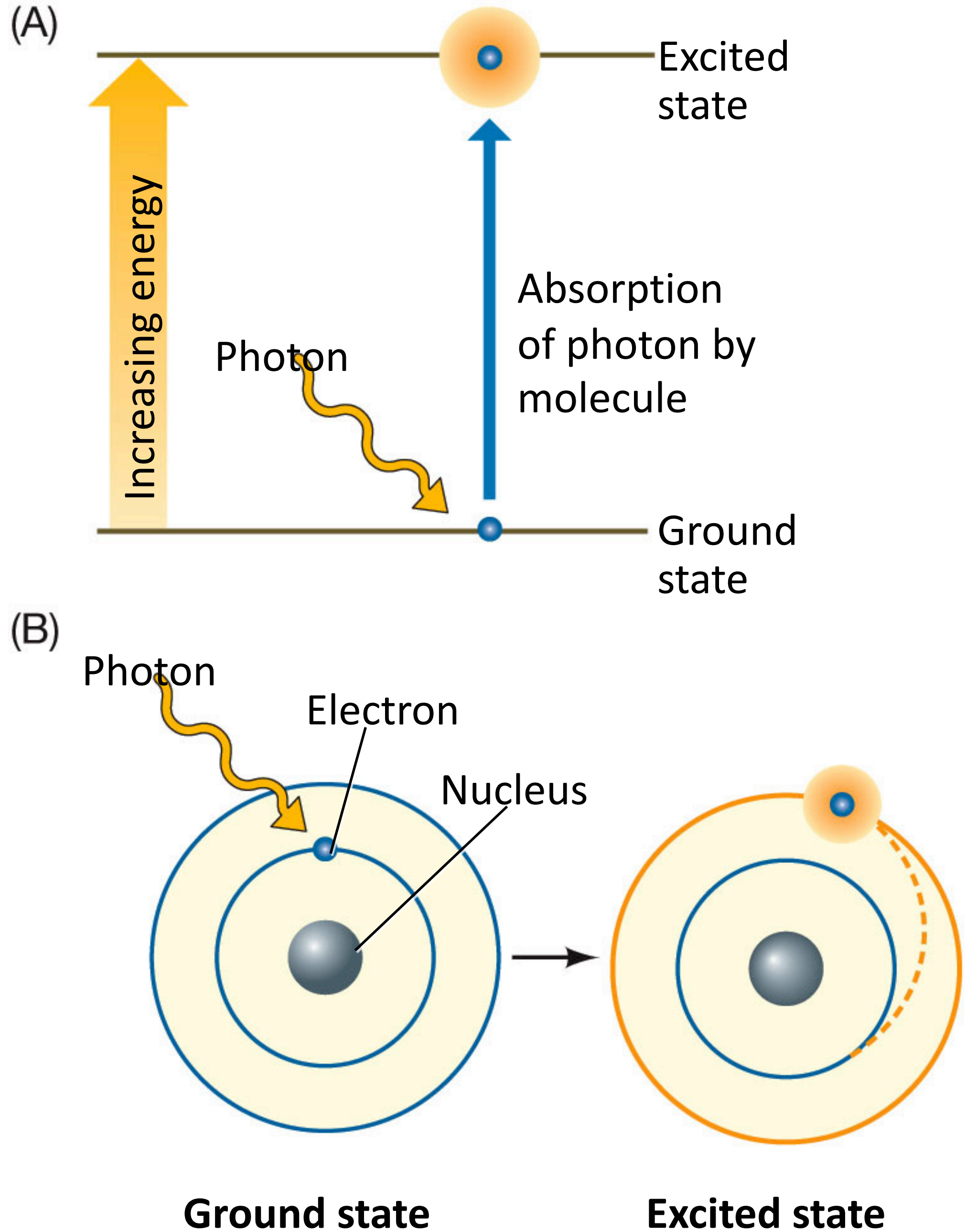
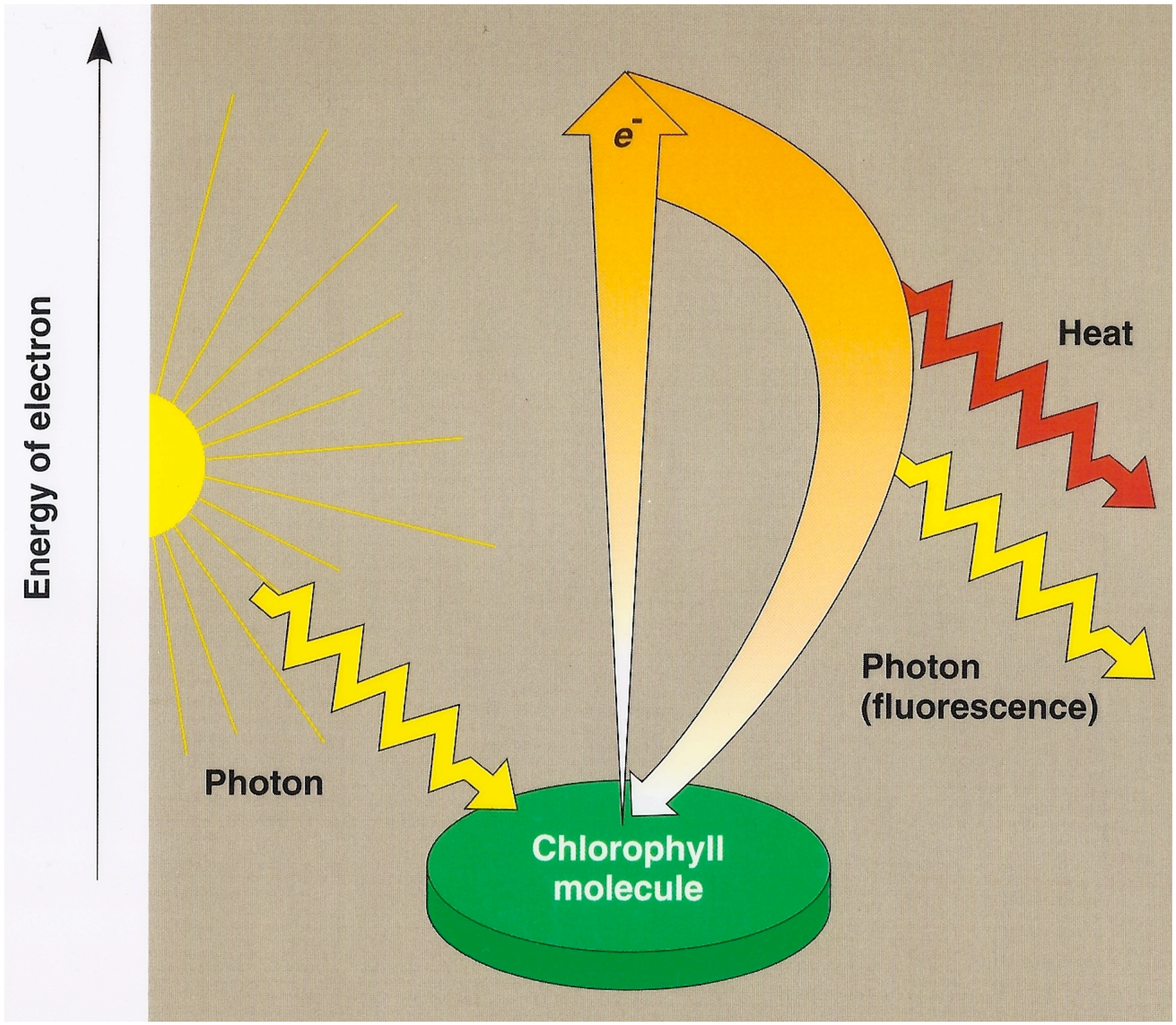


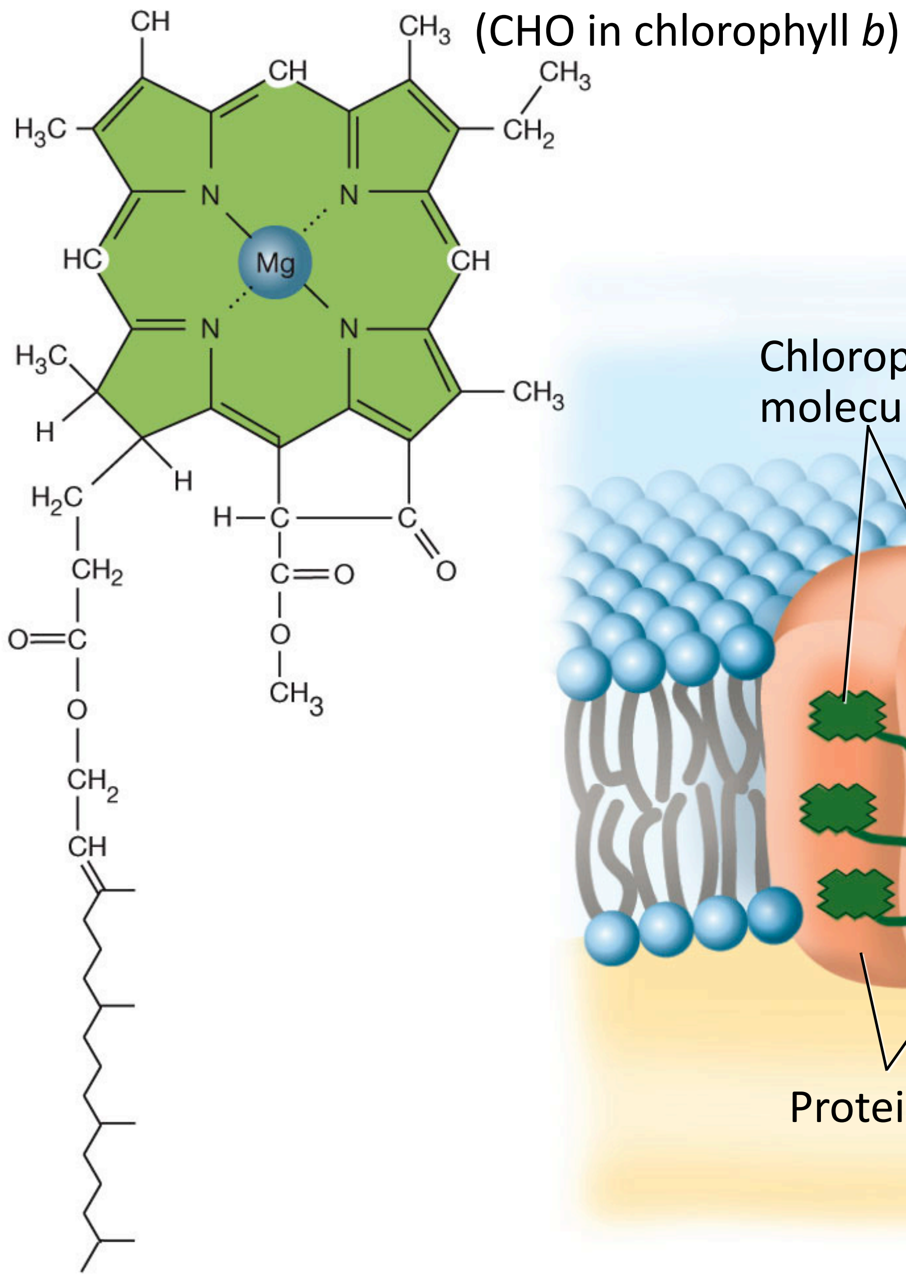
Figure 10.5 Exciting An Atom

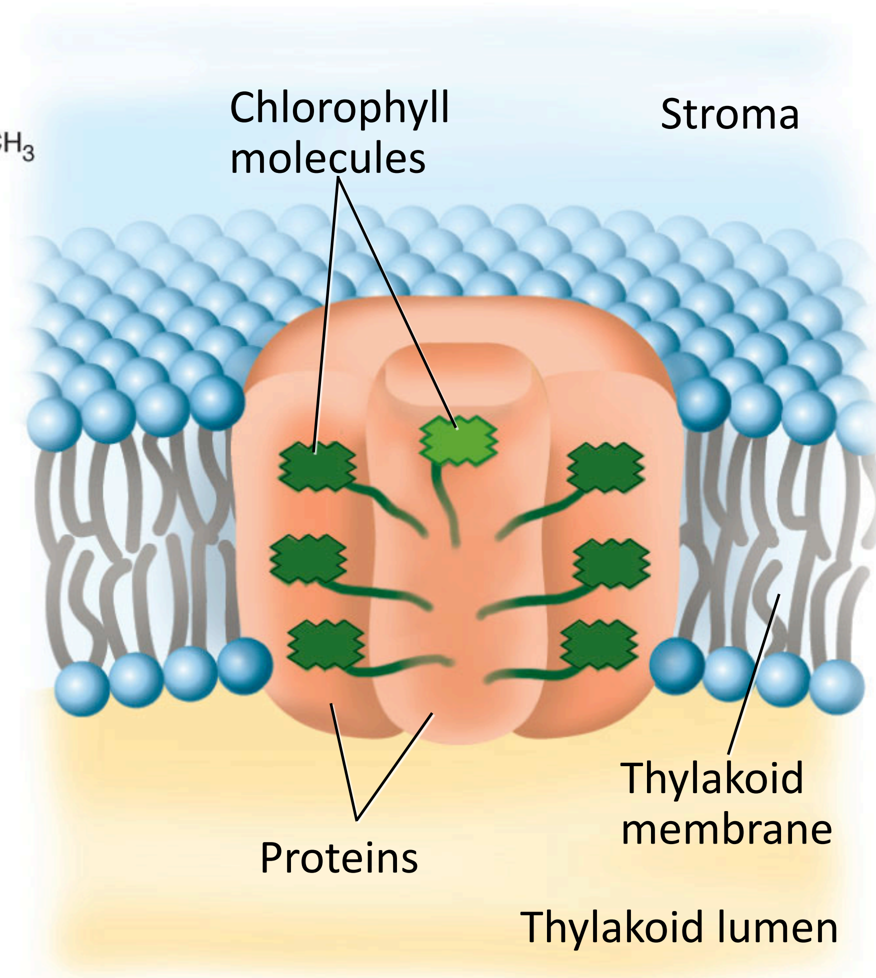


Photoexcitation Of Chlorophyll



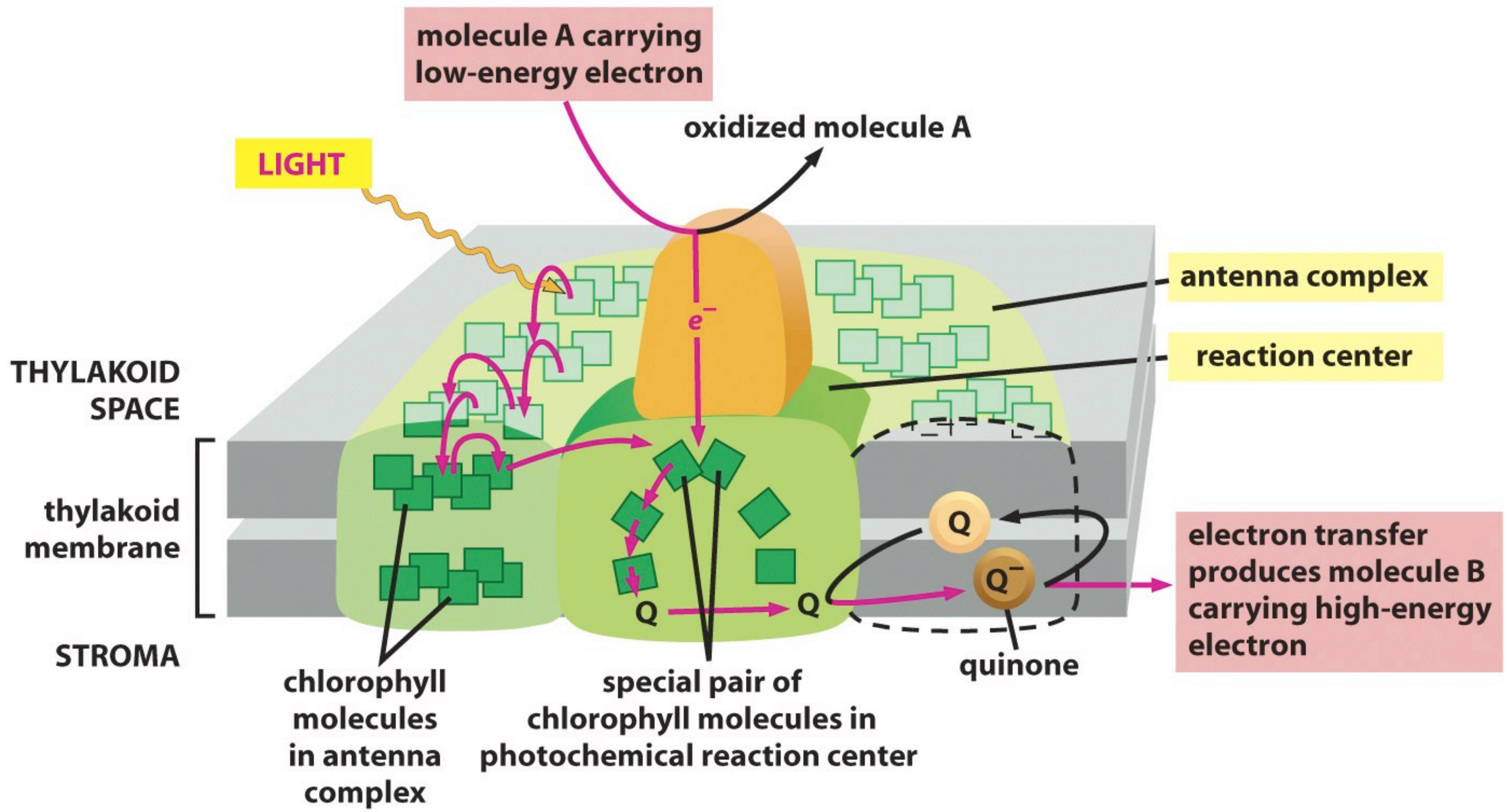
Chlorophyll Molecules Are Found In Large Protein Complexes



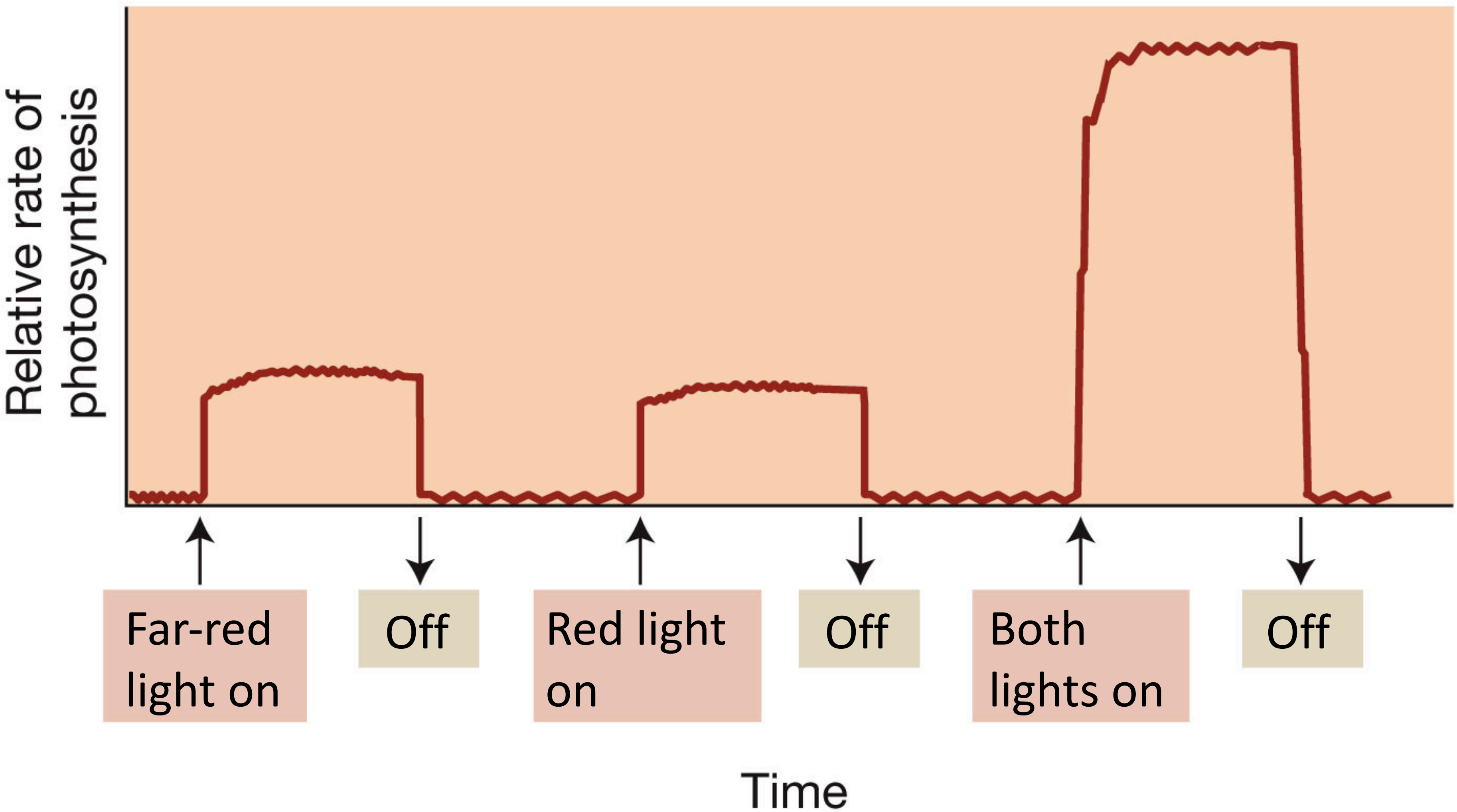


Photosystems Consist Of Two Parts

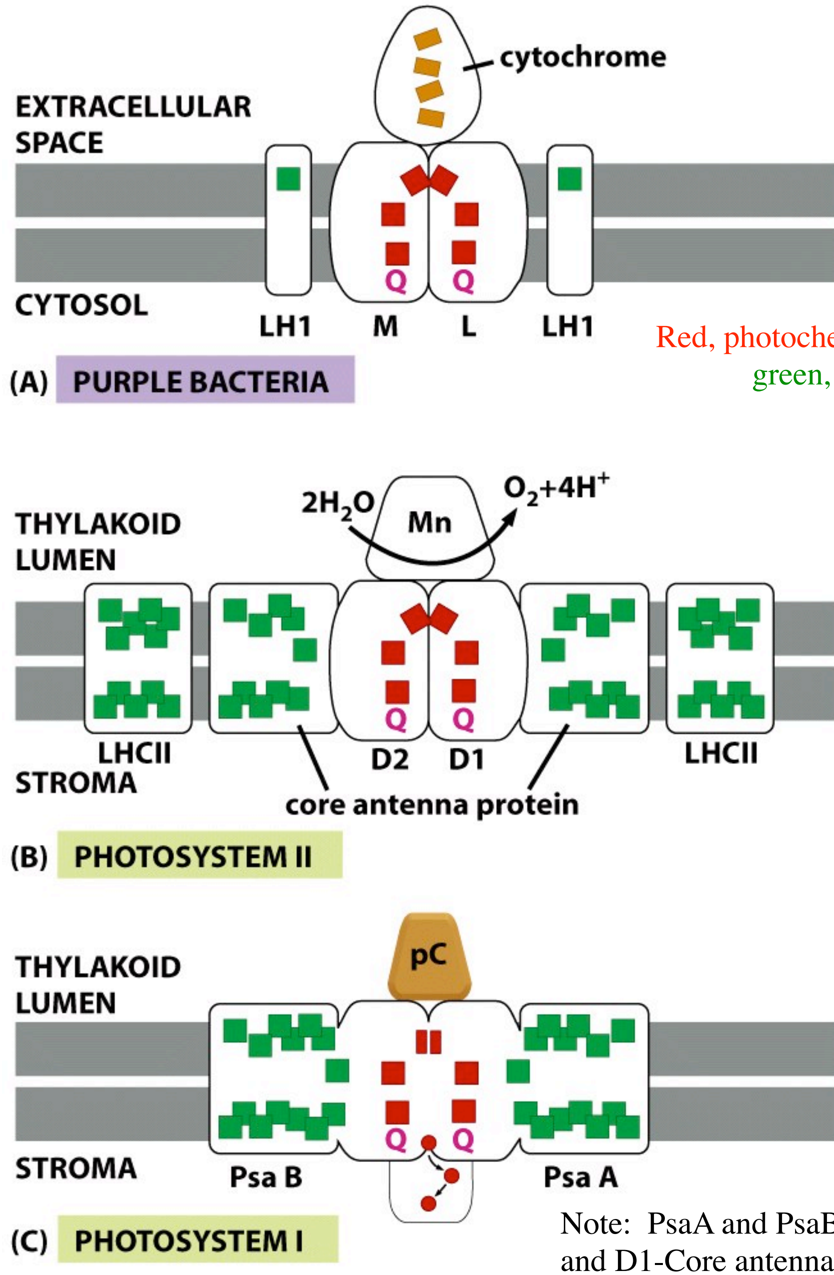
1. Photosynthetic Reaction Center
2. Antenna Complex



Plants And Cyanobacteria Possess Two Photosystems



Comparative Photosystem Organization

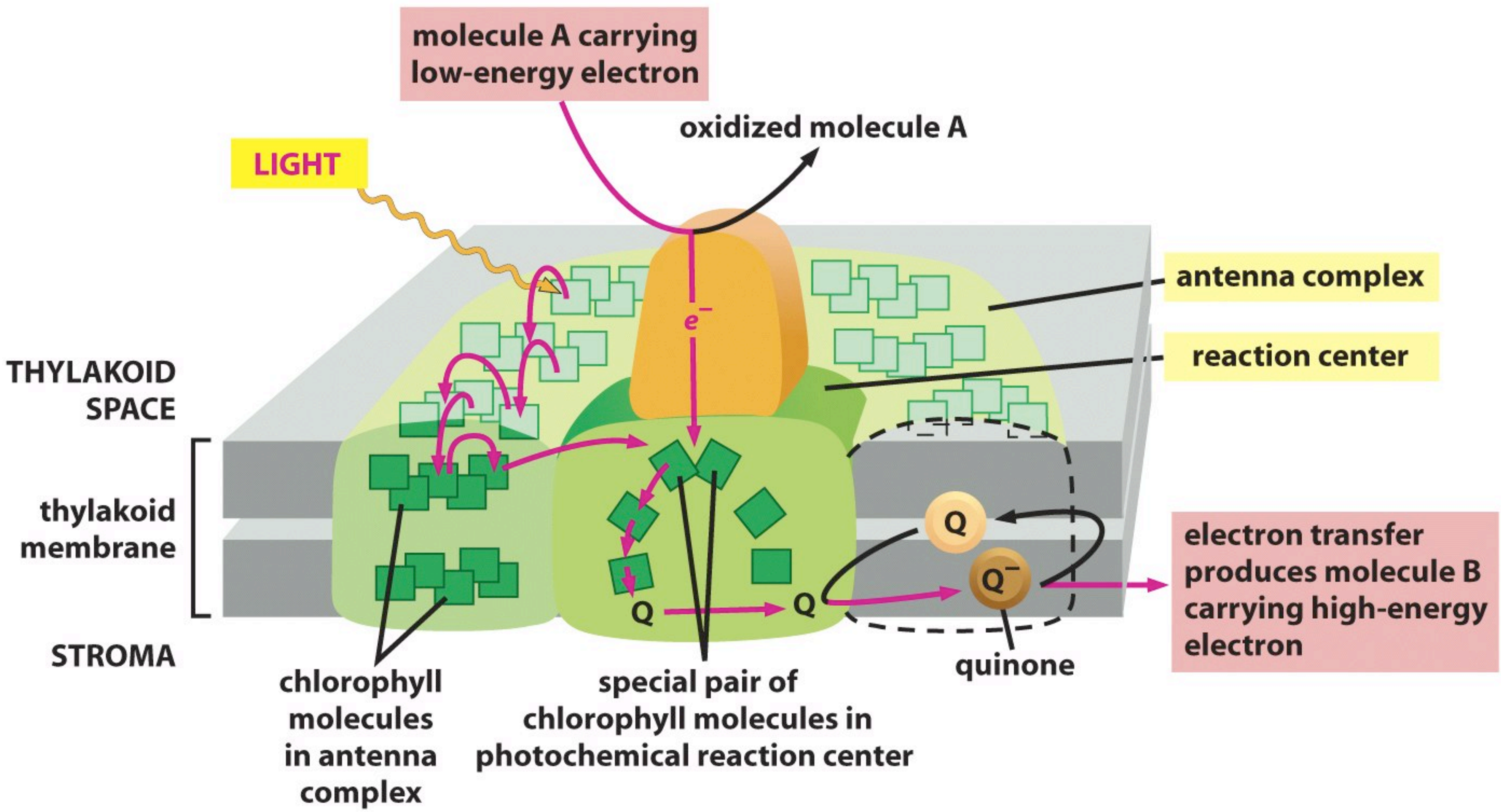


Red, photochemical reaction center molecules; green, light harvesting pigments

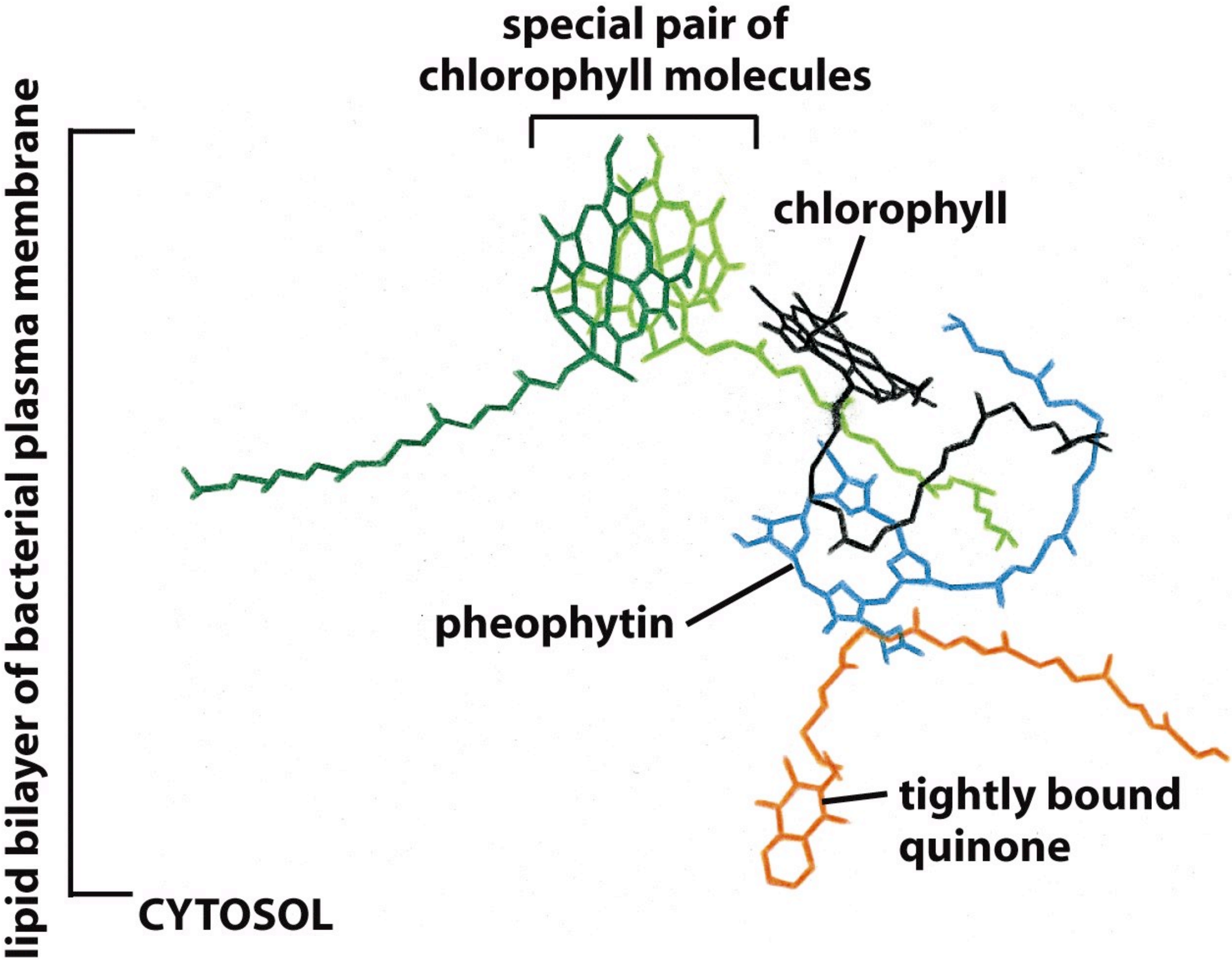
Note: PsaA and PsaB are like D2-Core antenna protein and D1-Core antenna protein fusions, respectively

Photosystems Consist Of Two Parts

1. Photosynthetic Reaction Center
2. Antenna Complex



Organization Of Pigment Molecules



Summary Electron Transfer Reactions Within the Reaction Center

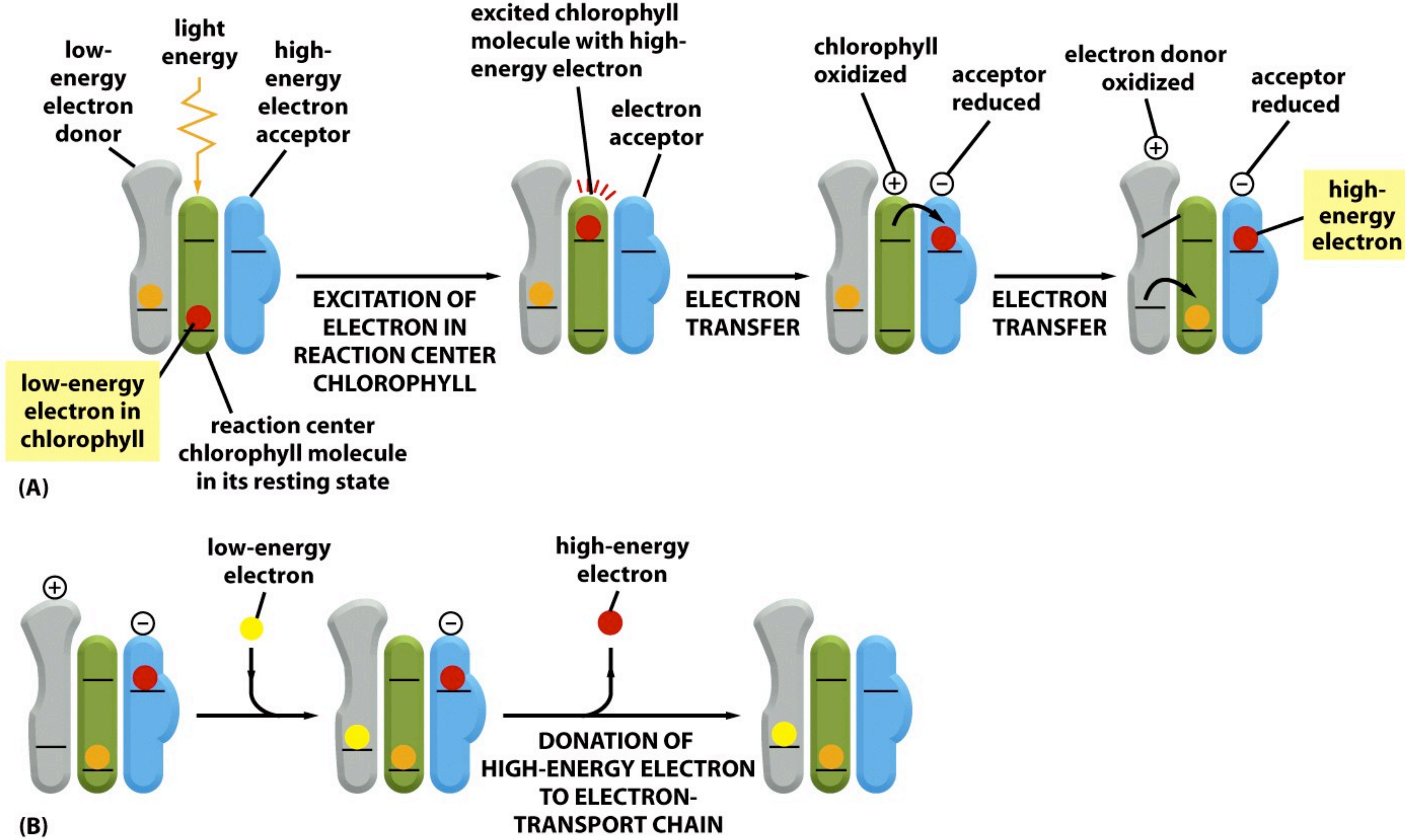
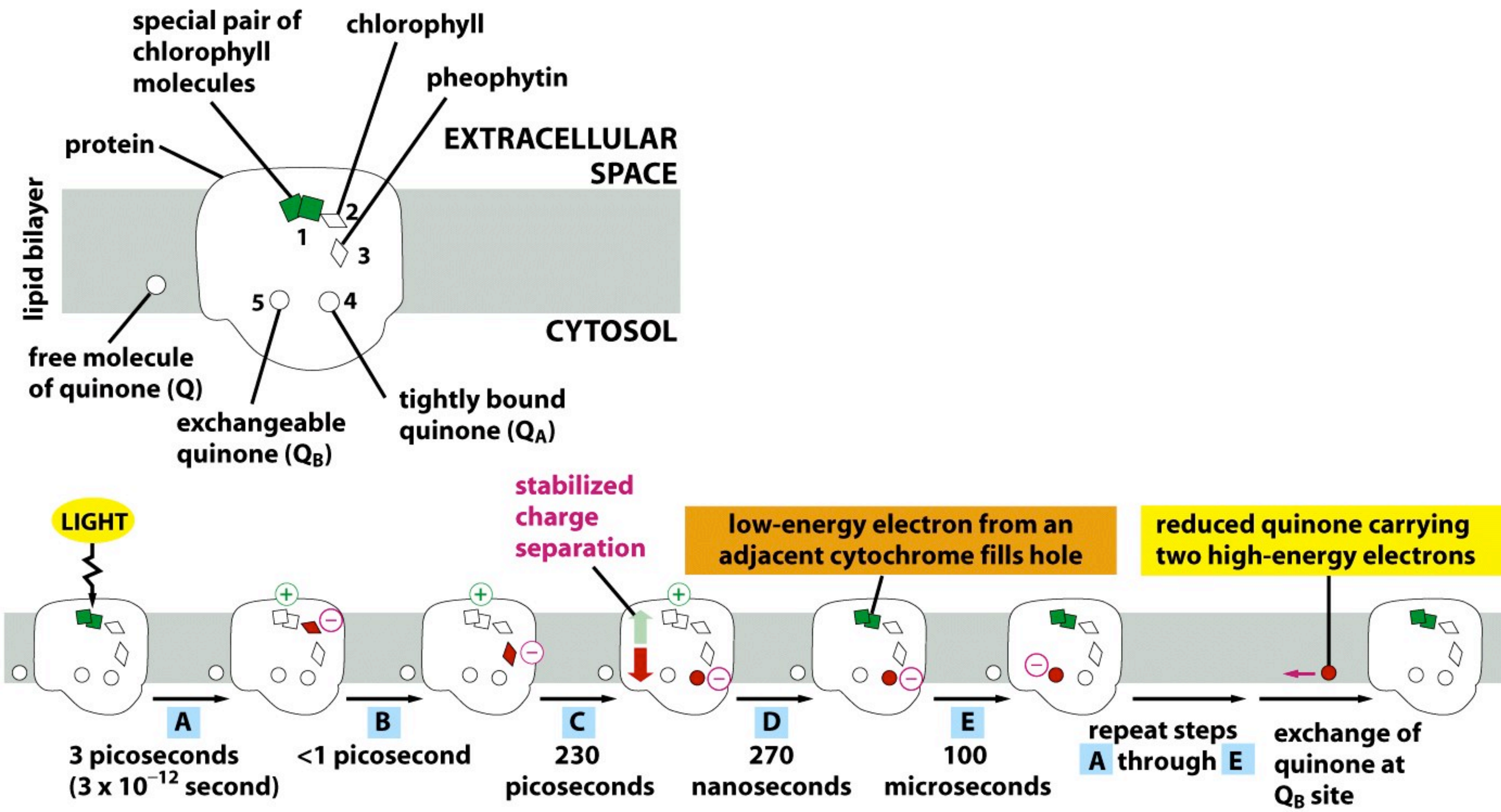


Figure 14-45 *Molecular Biology of the Cell* (© Garland Science 2008)

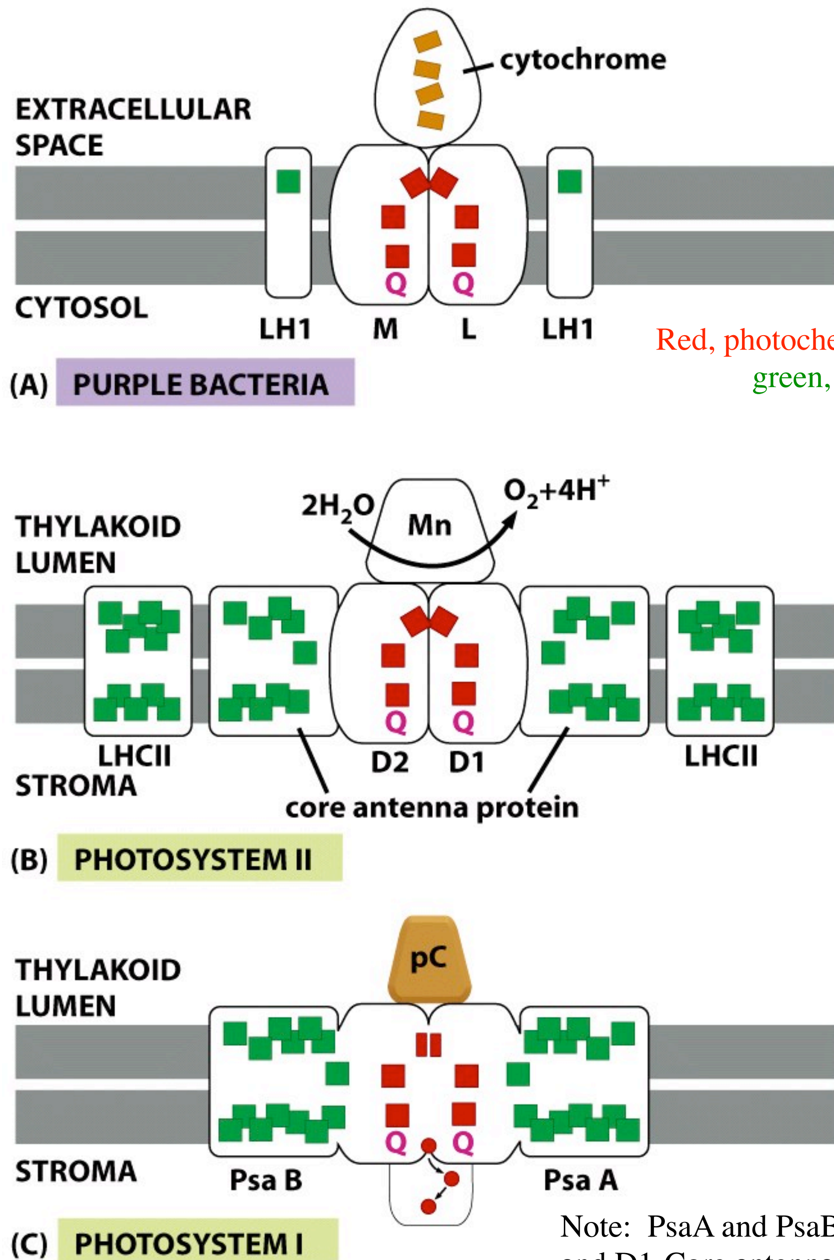
Electron Transfer Reactions Within A Purple Bacterial Photosystem



Need to capture 2 photons of light to reduce Quinone

Figure 14-46 *Molecular Biology of the Cell* (© Garland Science 2008)

Comparative Photosystem Organization



Red, photochemical reaction center molecules; green, light harvesting pigments

Note: PsaA and PsaB are like D2-Core antenna protein and D1-Core antenna protein fusions, respectively

Plant Photosystem II Structure

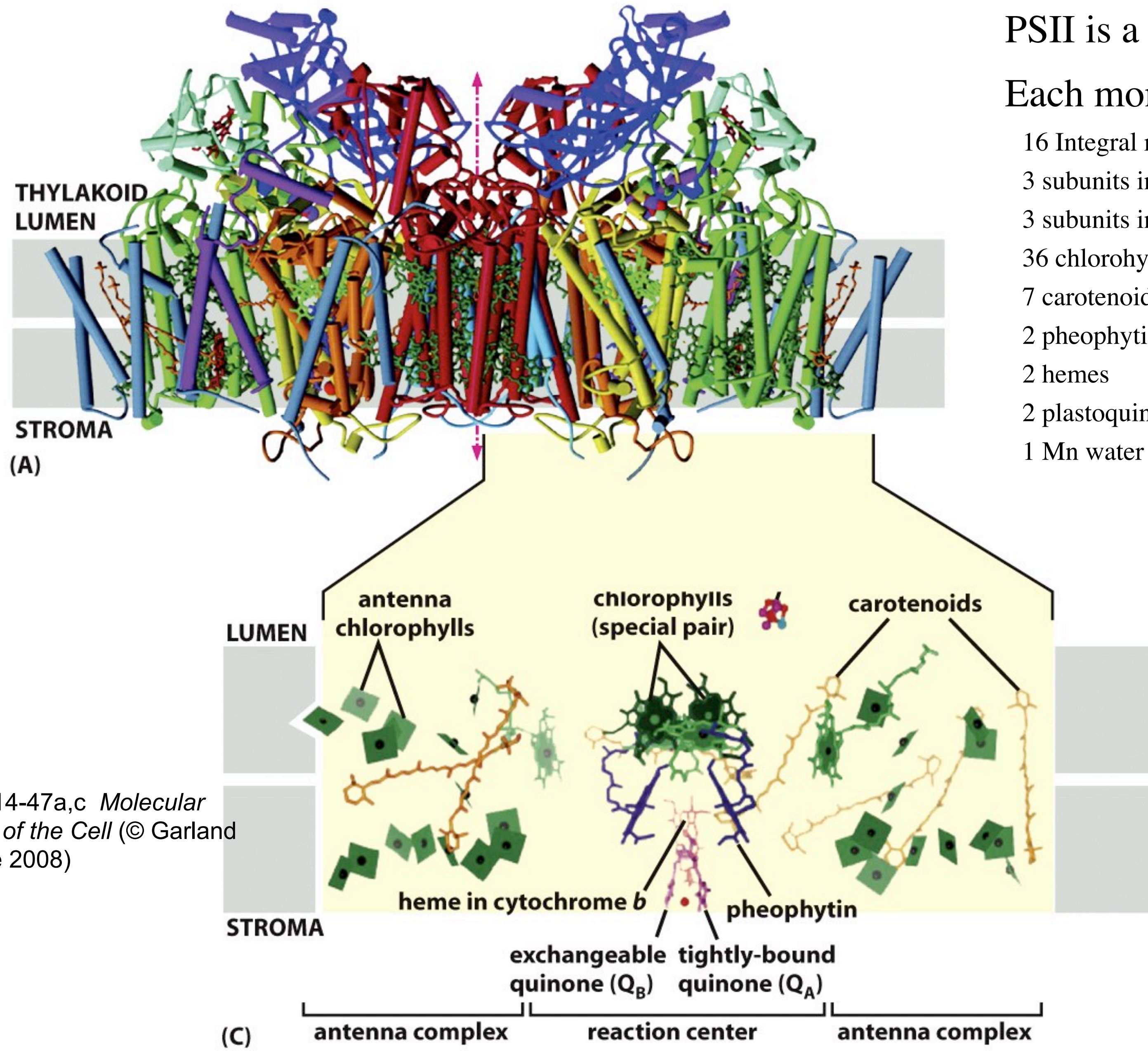


Figure 14-47a,c *Molecular Biology of the Cell* (© Garland Science 2008)

PSII is a dimer

Each monomer contains:

- 16 Integral membrane protein subunits
- 3 subunits in the lumen
- 3 subunits in the lumen
- 36 chlorohylls
- 7 carotenoids
- 2 pheophytins
- 2 hemes
- 2 plastoquinones
- 1 Mn water splitting complex

Plant Photosystem II Structure

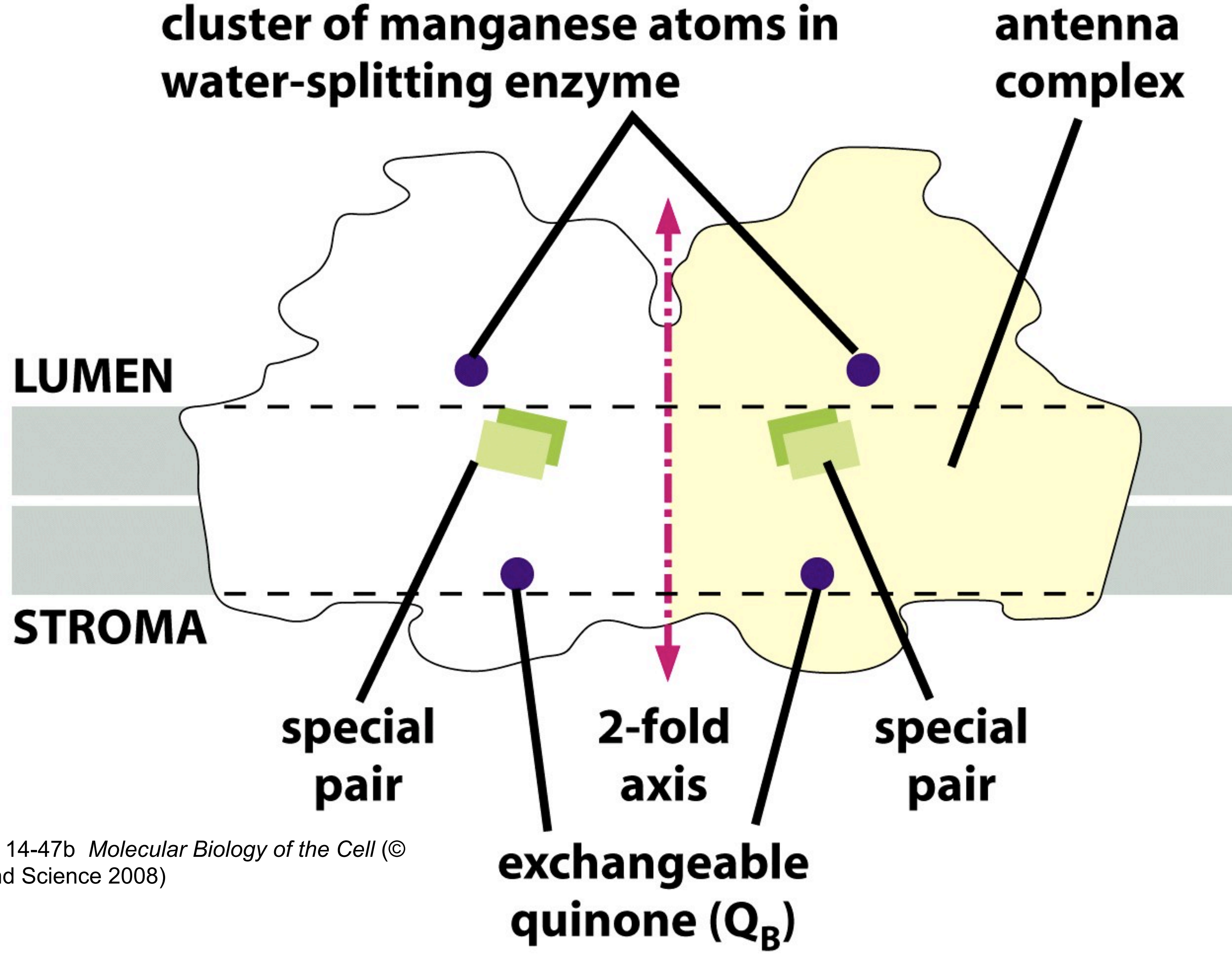
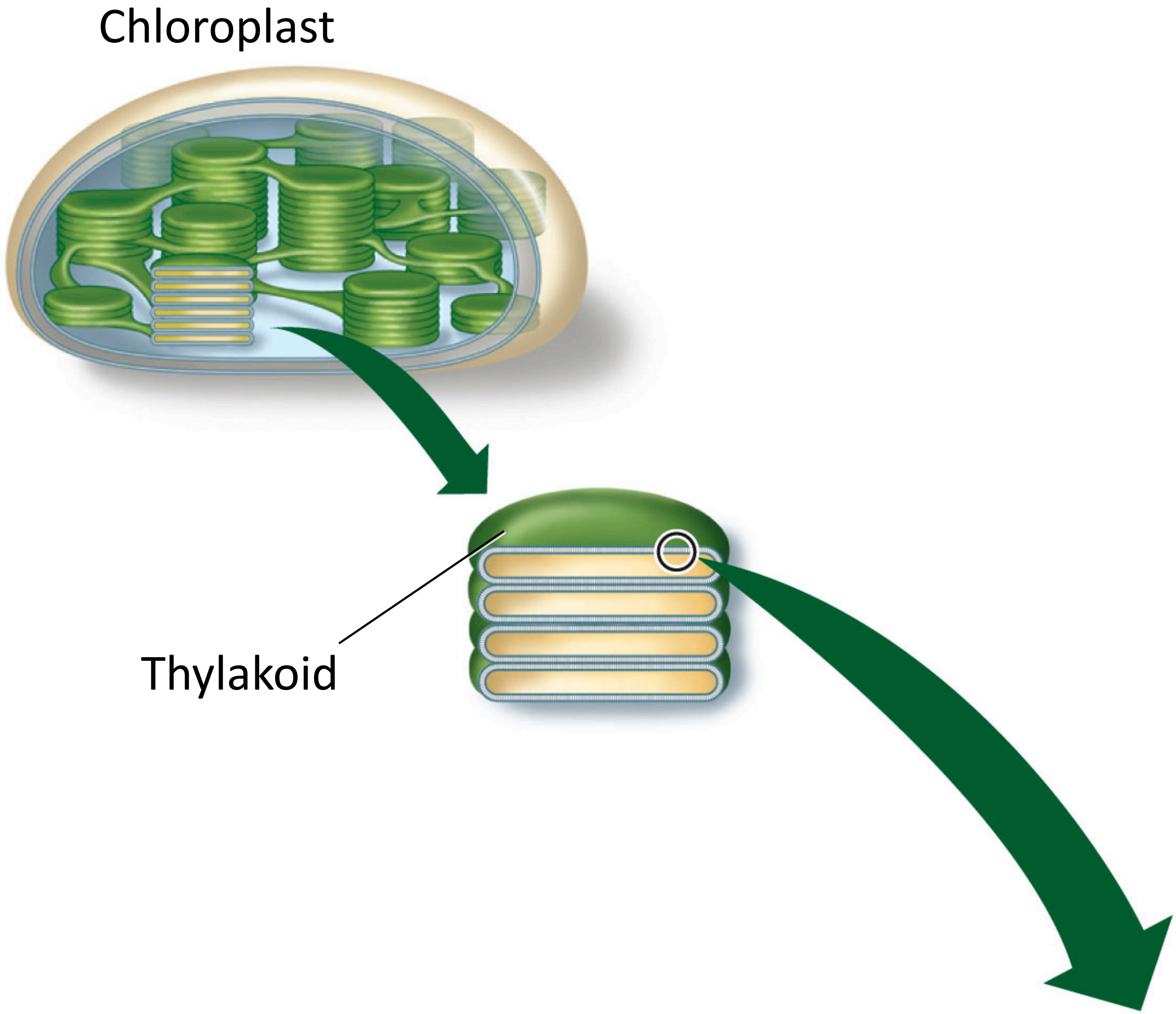


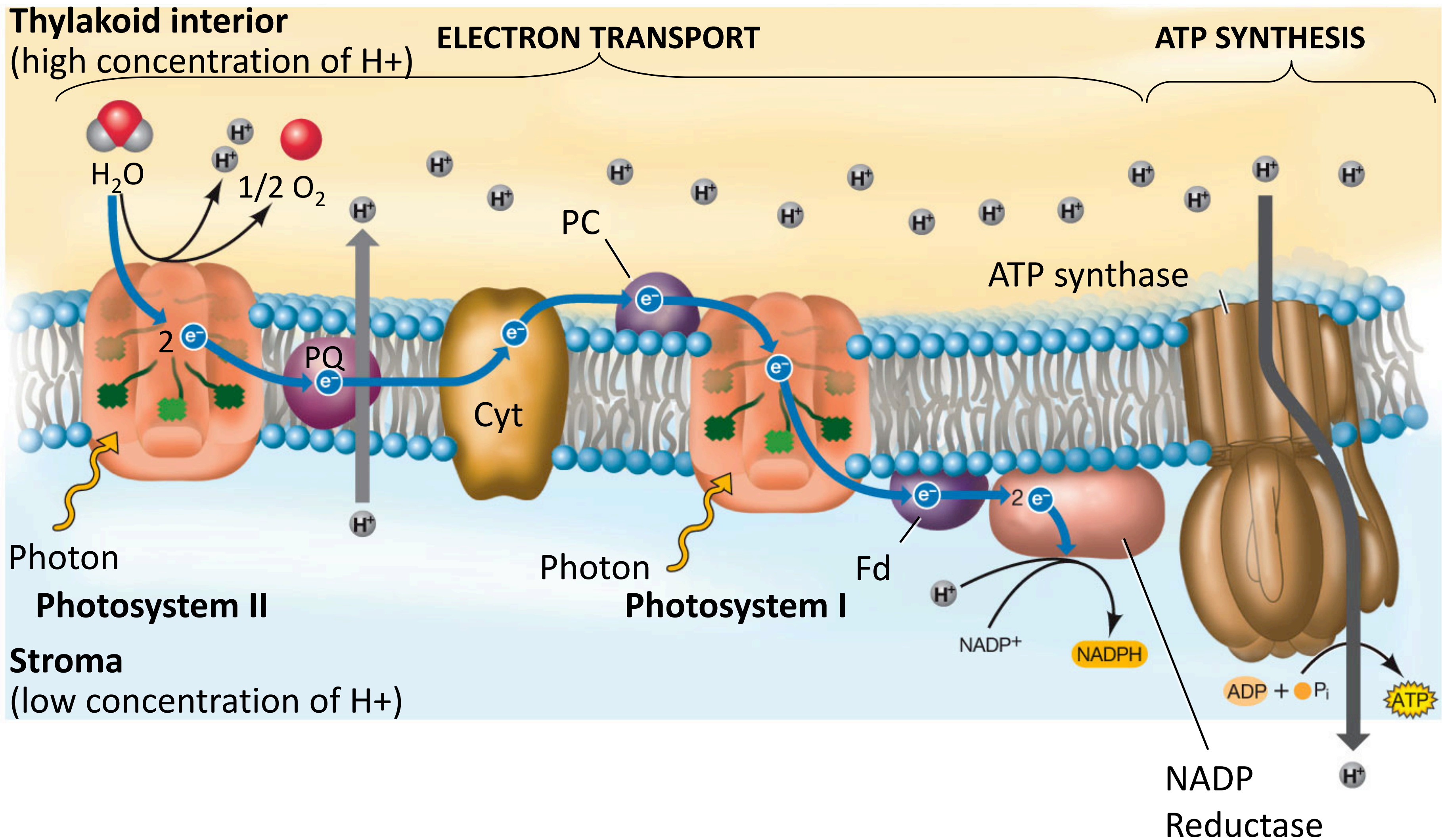
Figure 14-47b *Molecular Biology of the Cell* (© Garland Science 2008)

Light Reactions Take Place On Thylakoid Membranes



Electron Transport Pathway Of Photosynthesis

Mobile Carriers: Plastoquinone (PQ; organic molecule) and Plastocyanine (PC, Protein)
Large Complexes: Photosystem II, Photosystem I, Cytochrome B_6-*f* Complex (Cyt)



Topology Of Chloroplast Photosynthetic Components

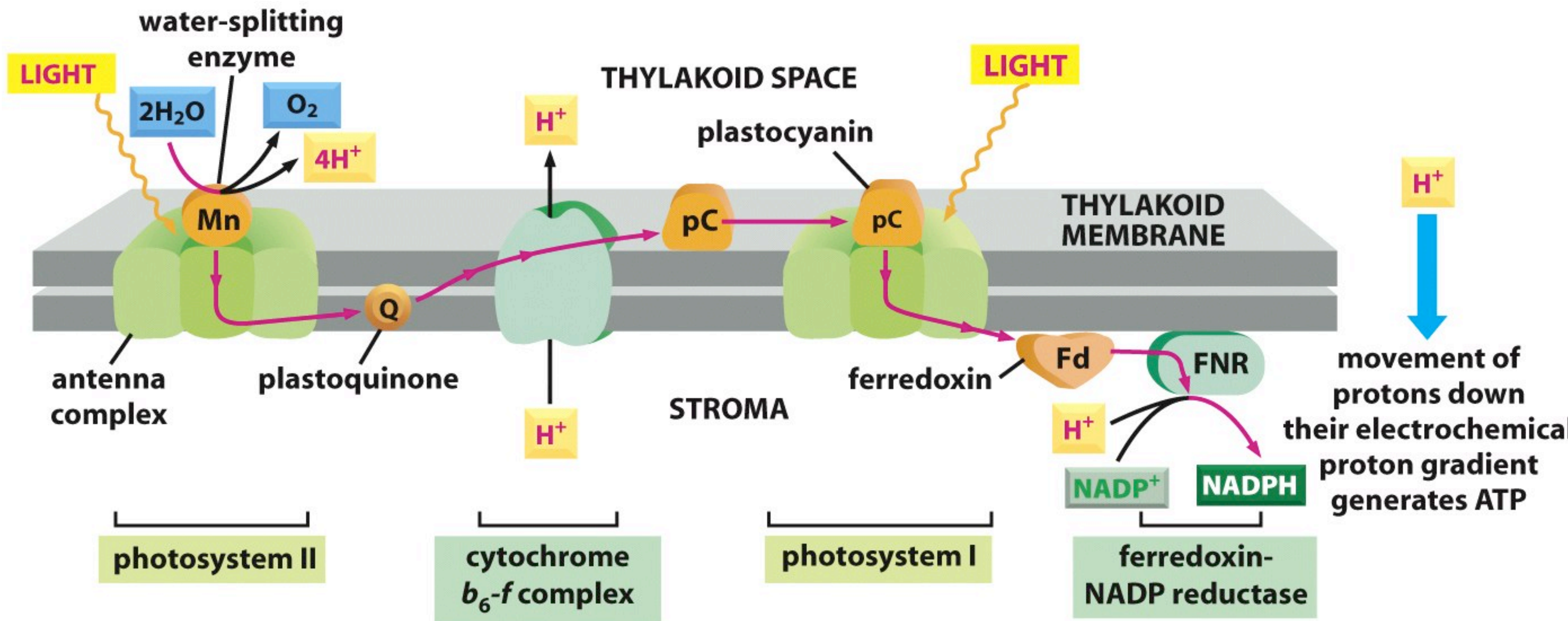


Figure 14-48 *Molecular Biology of the Cell* (© Garland Science 2008)

Energetics Of Non-Cyclic Photophosphorylation

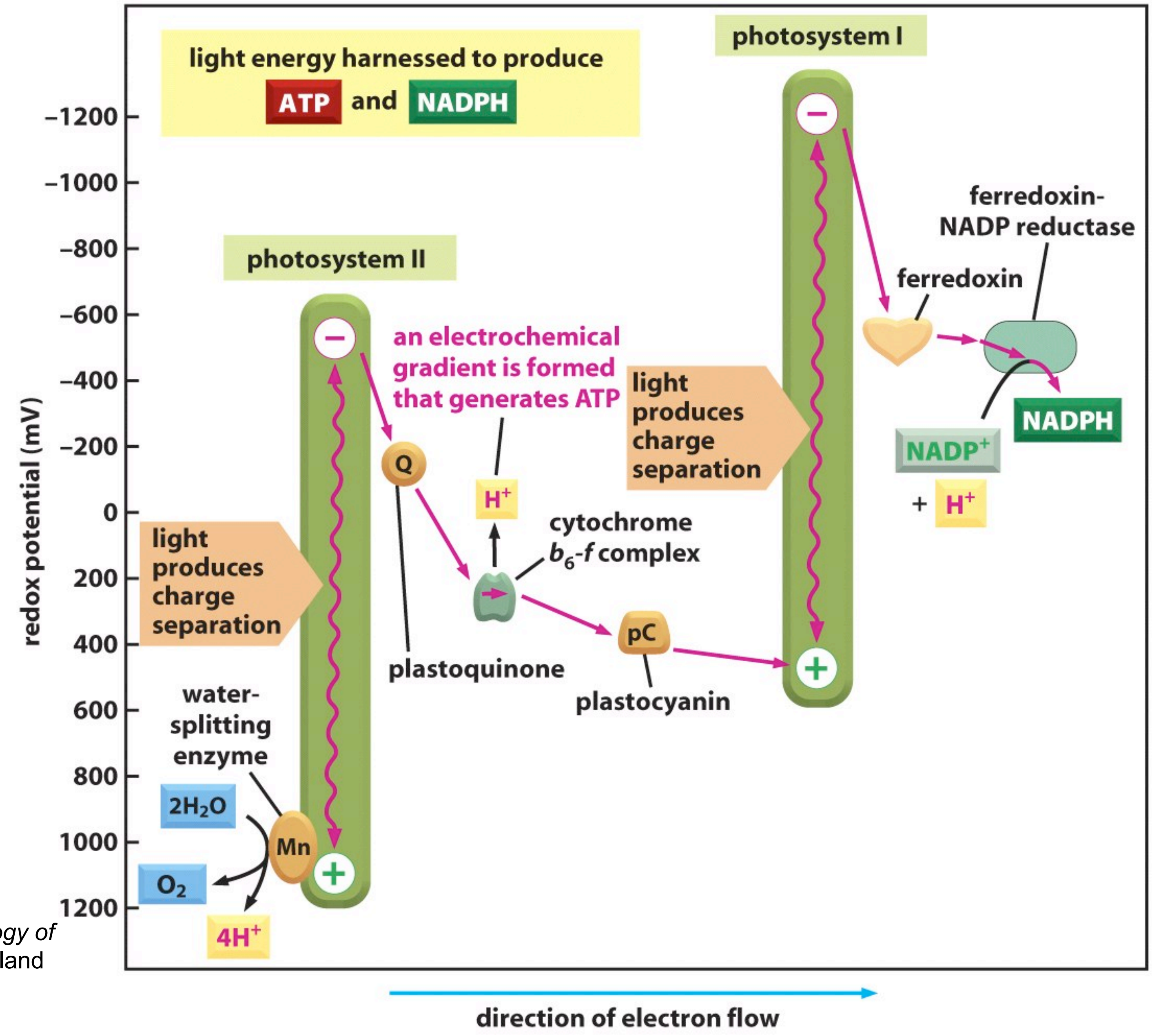


Figure 14-49 *Molecular Biology of the Cell* (© Garland Science 2008)

Cyclic And Non-Cyclic Photophosphorylation

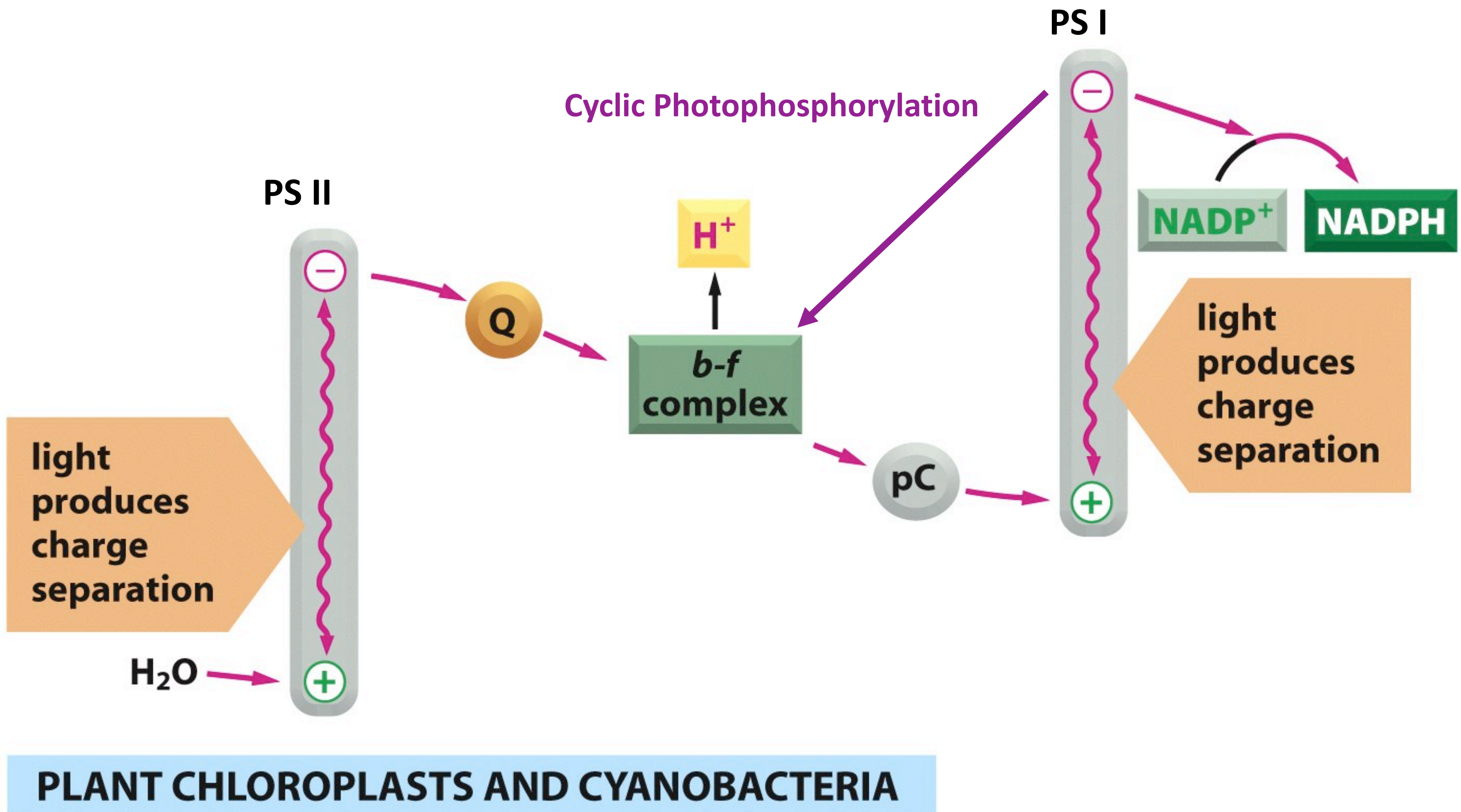
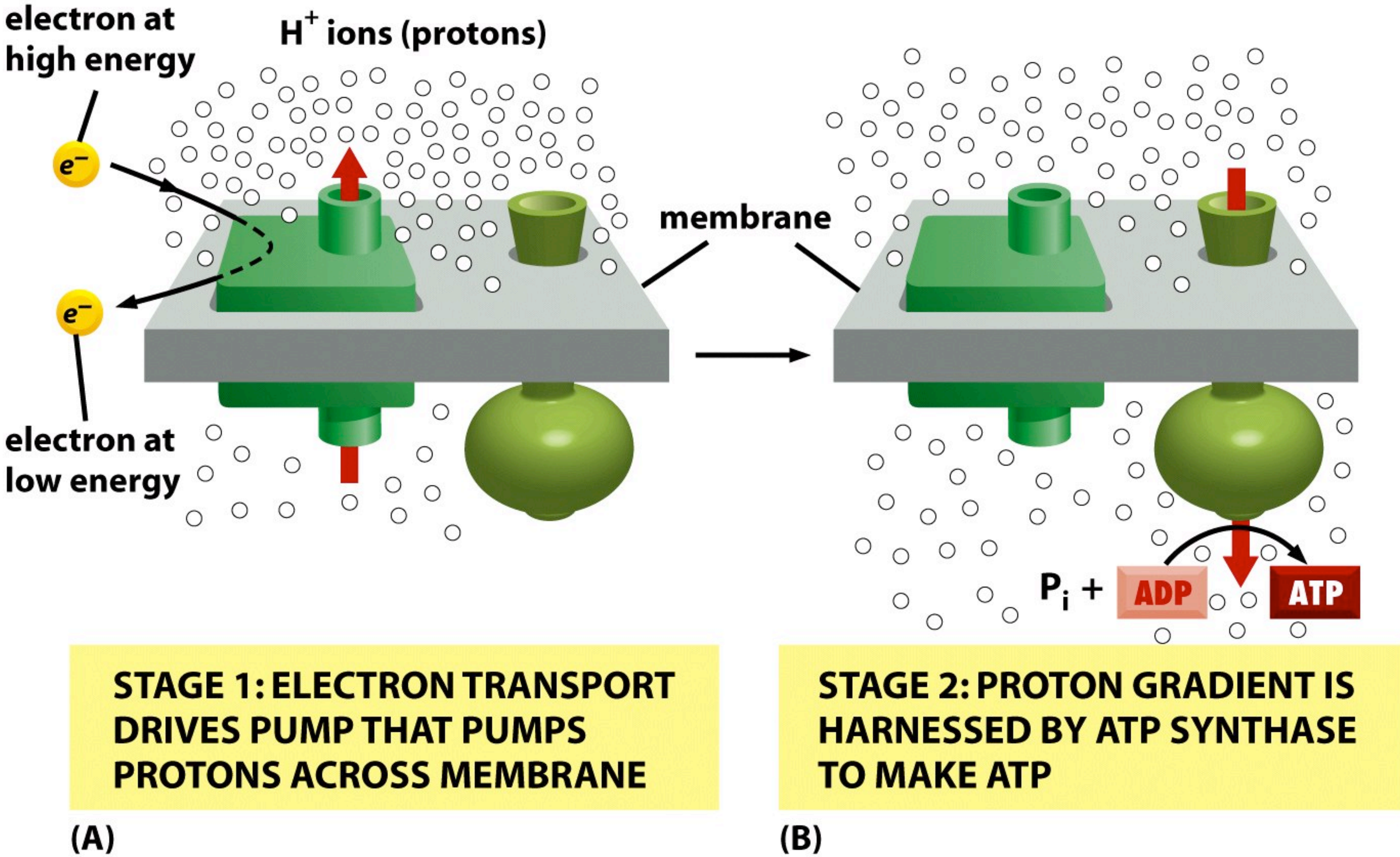


Figure 14-73 (part 2 of 3) *Molecular Biology of the Cell* (© Garland Science 2008)

Chemiosmotic ATP Generation



ATP Synthase

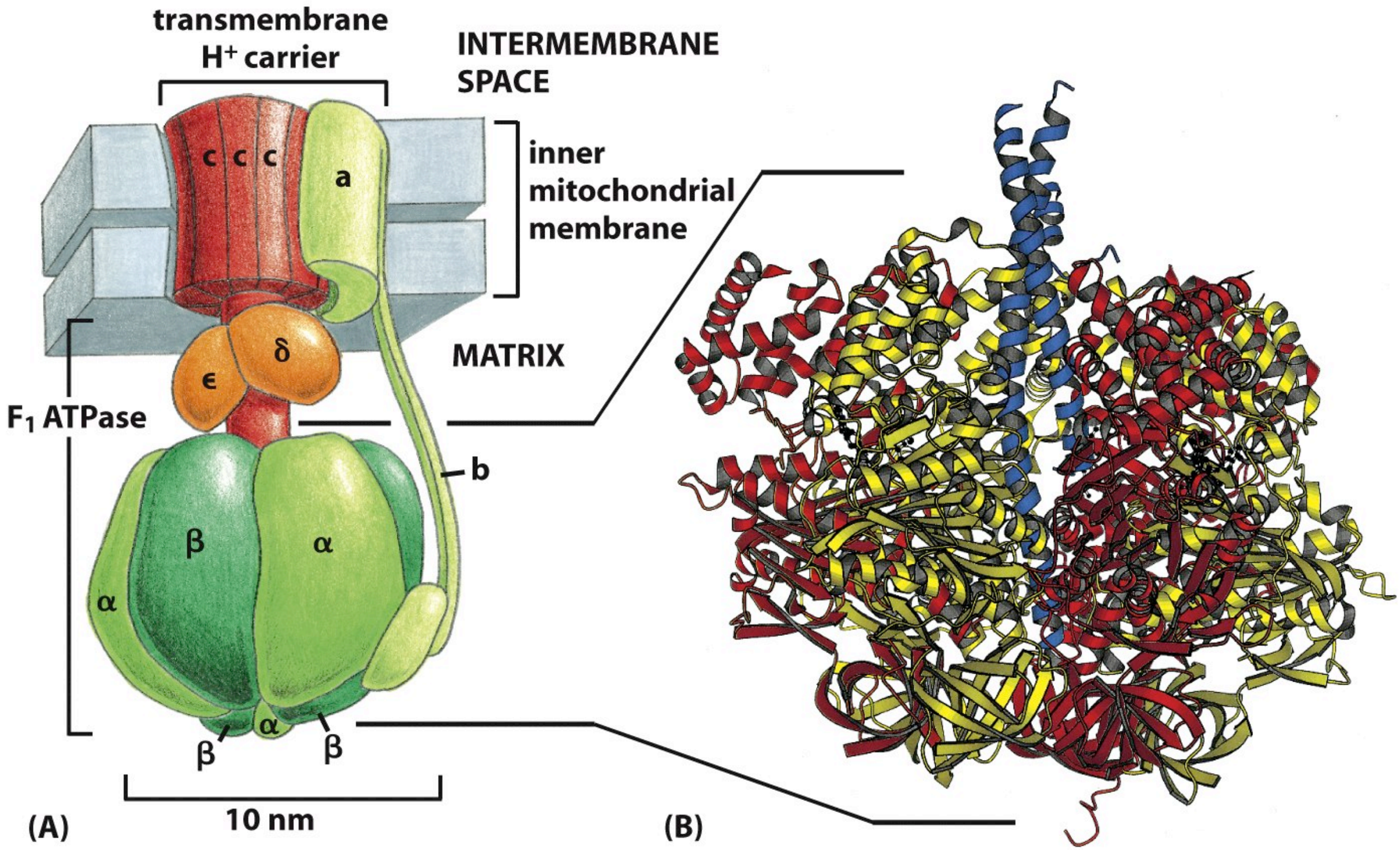


Figure 14-15 *Molecular Biology of the Cell* (© Garland Science 2008)

Chemiosmotic ATP Synthesis

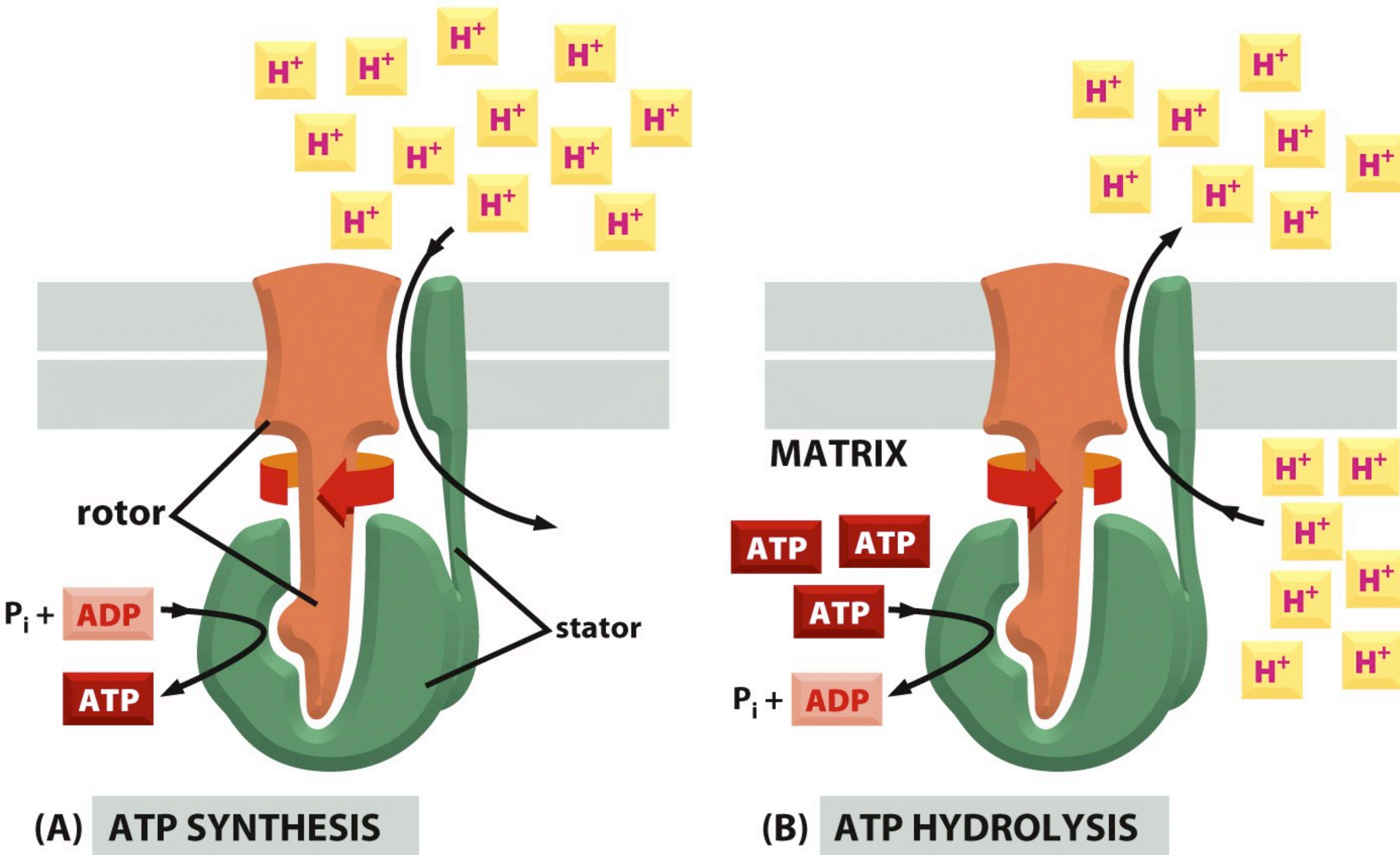
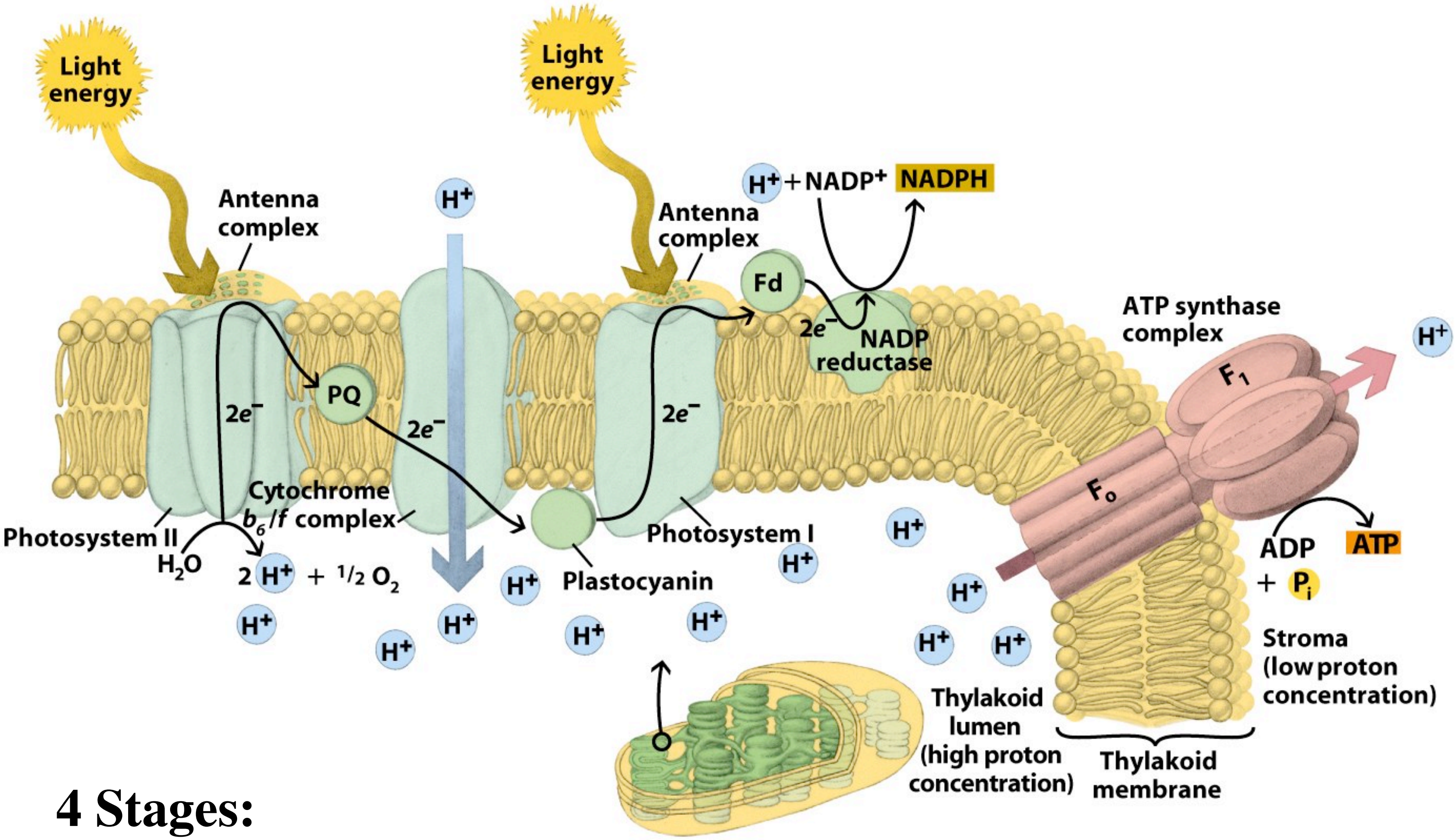


Figure 14-19 *Molecular Biology of the Cell* (© Garland Science 2008)

Non-Cyclic Photophosphorylation Summary



4 Stages:

1. Light energy is used to energize an electron that can drive electron transport system
2. Electron transport system generates proton gradient across thylakoid membrane
3. Electron transport system reduces $NADP^+$
4. Proton gradient is used to chemiosmotically generate ATP

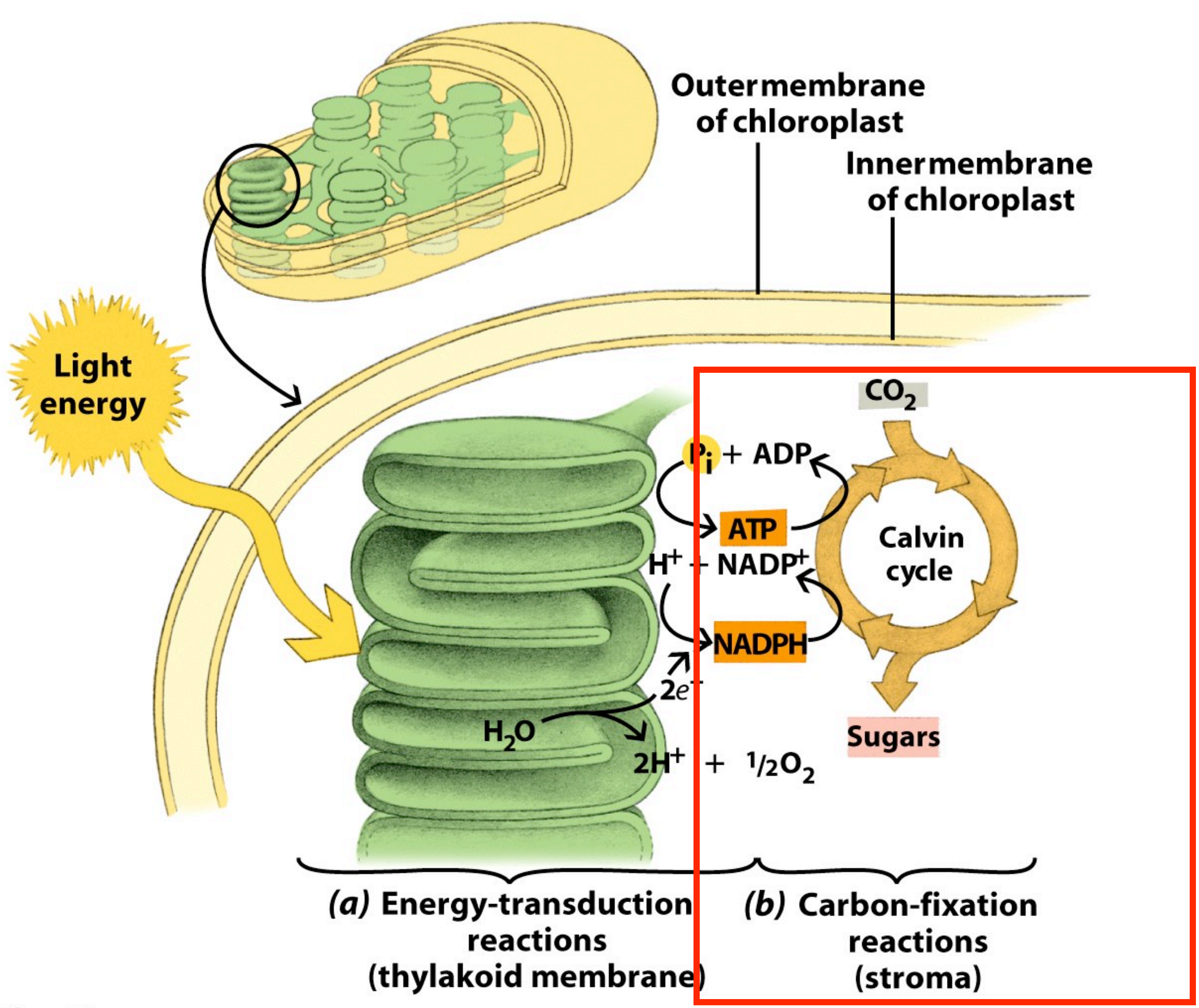


Figure 7-9
Biology of Plants, Seventh Edition

Dark Reactions

Ribulose 1-5-Bisphosphate Carboxylase-Oxygenase (RuBisCO): The First Step Of The Dark Reactions

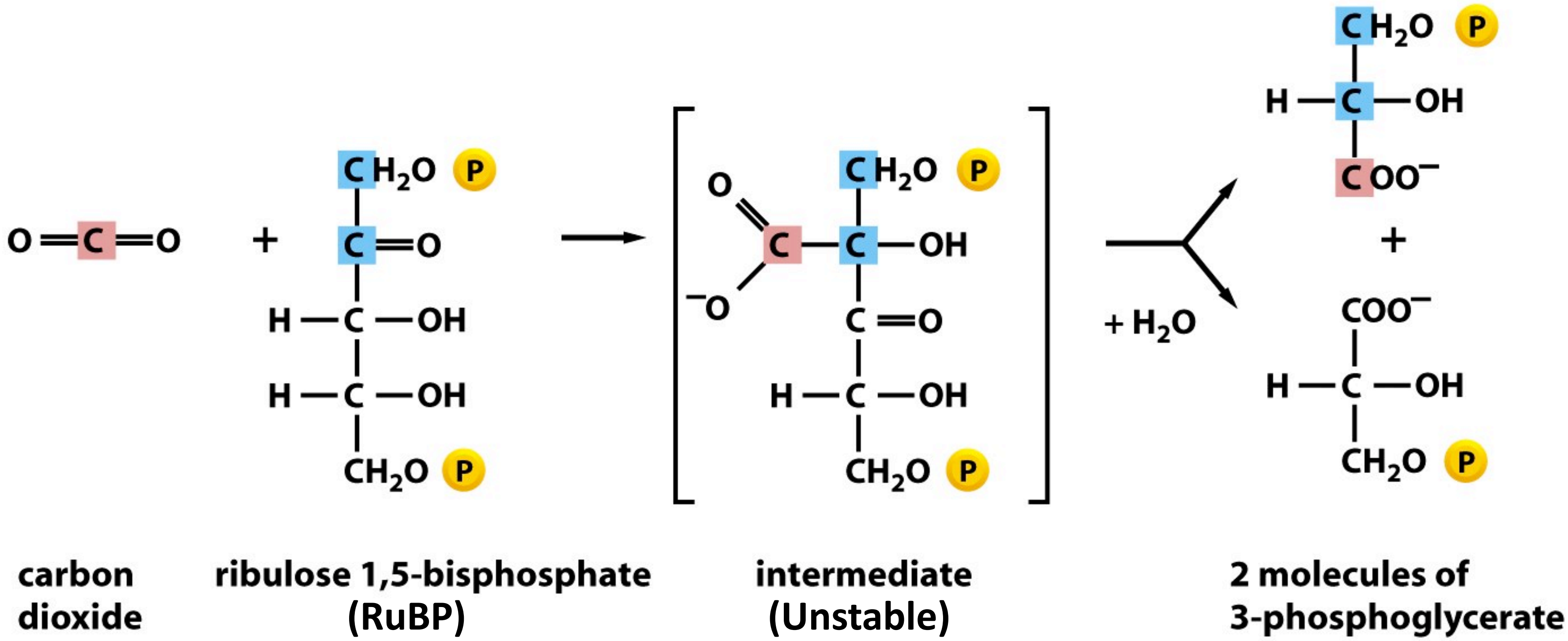
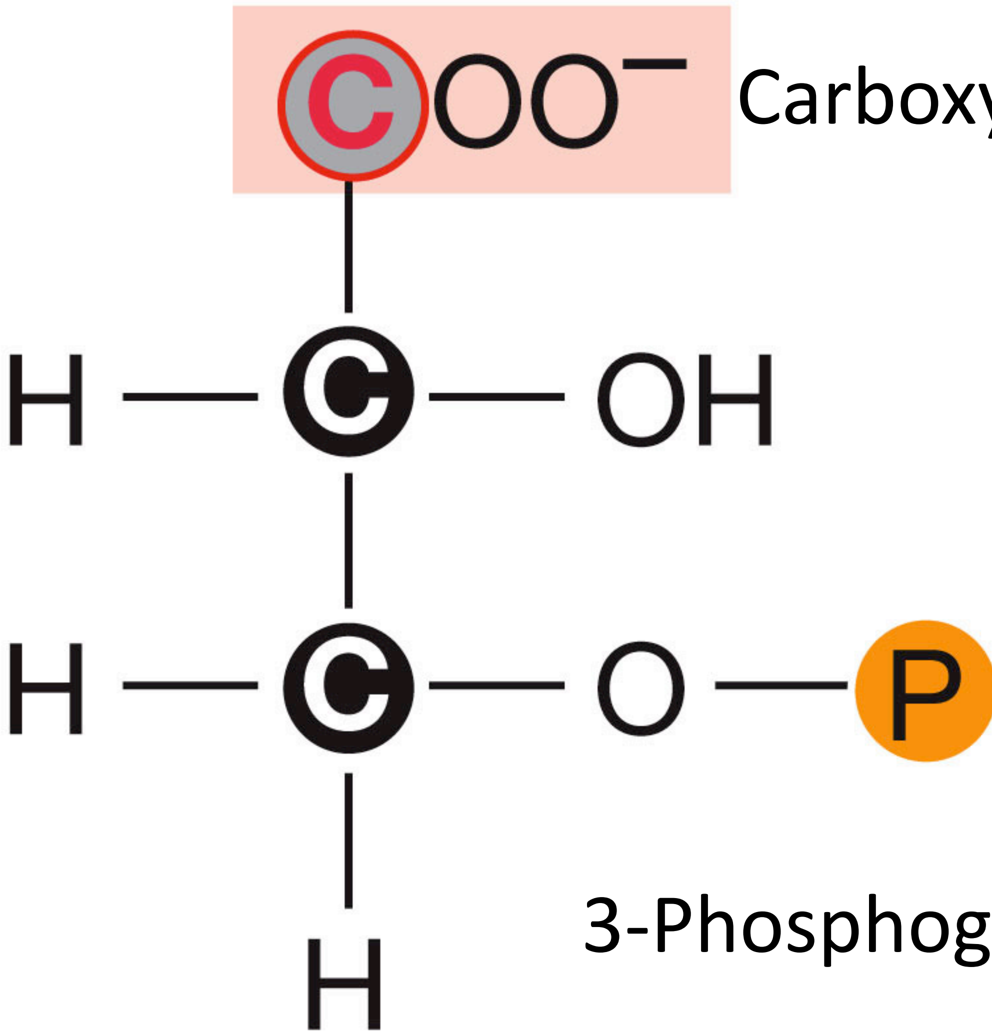


Figure 14-39 *Molecular Biology of the Cell* (© Garland Science 2008)

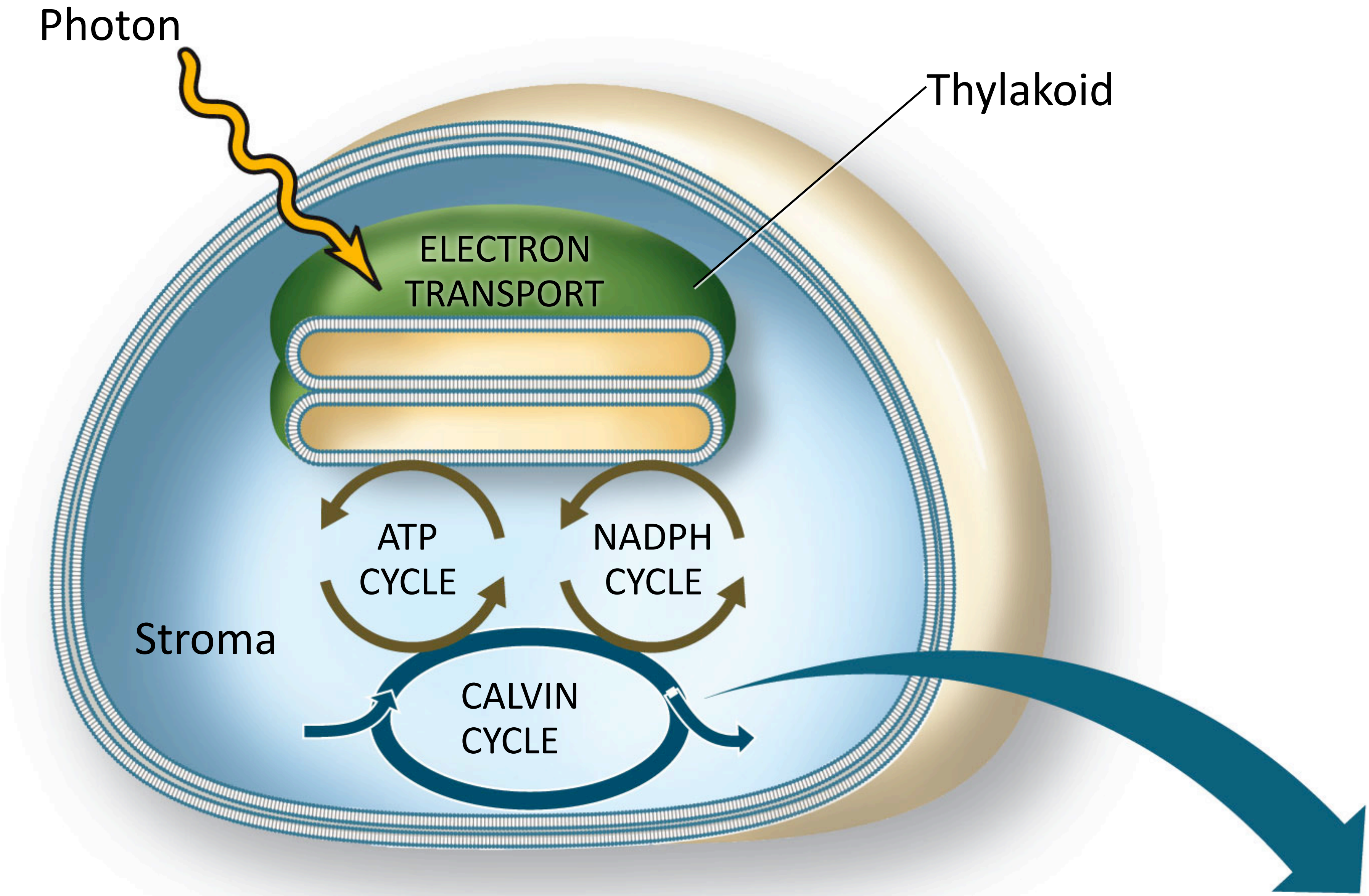
The First Stable Product Containing Fixed Carbon From Carbon Dioxide



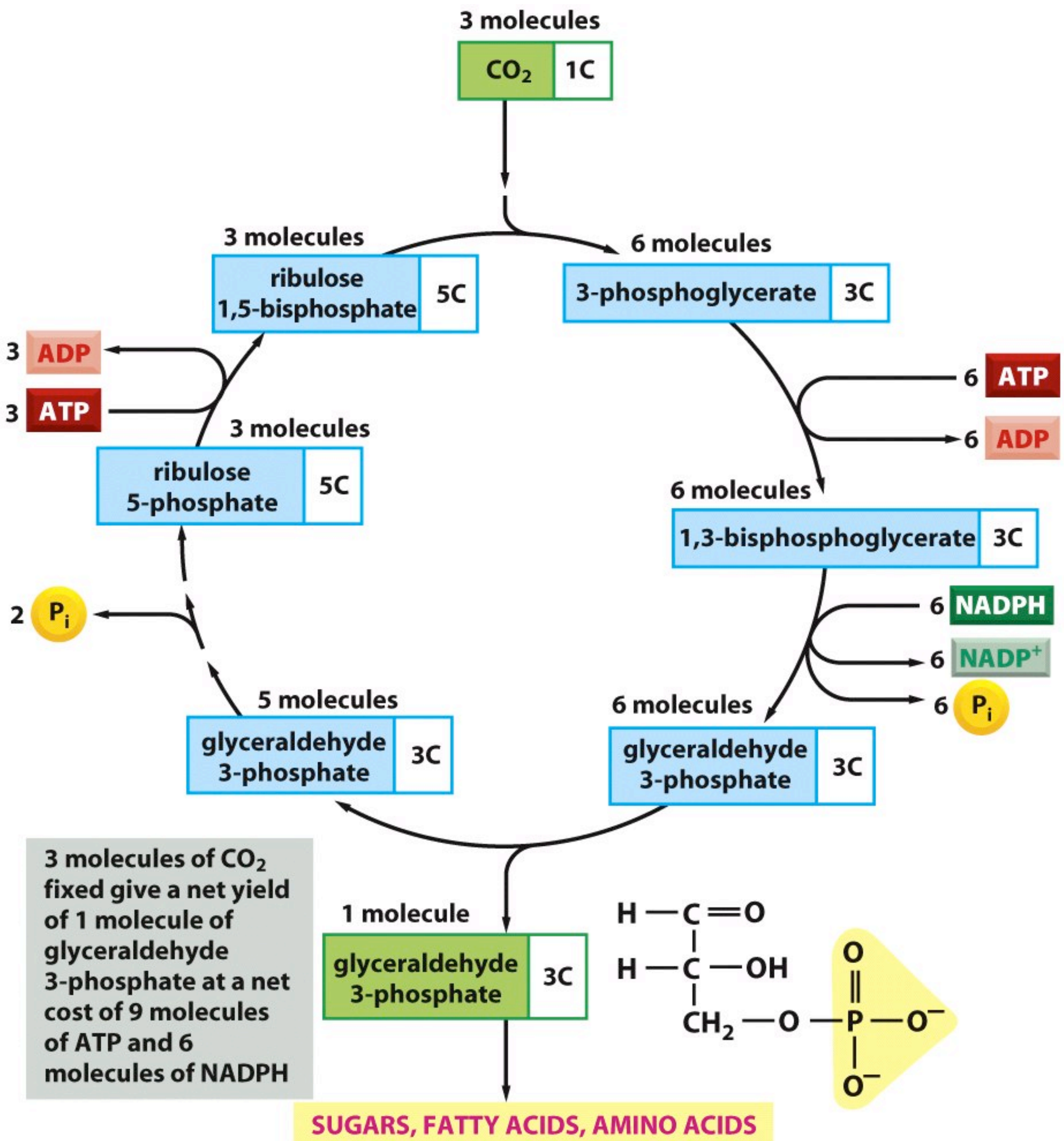
Carboxyl group

3-Phosphoglycerate (3PG)

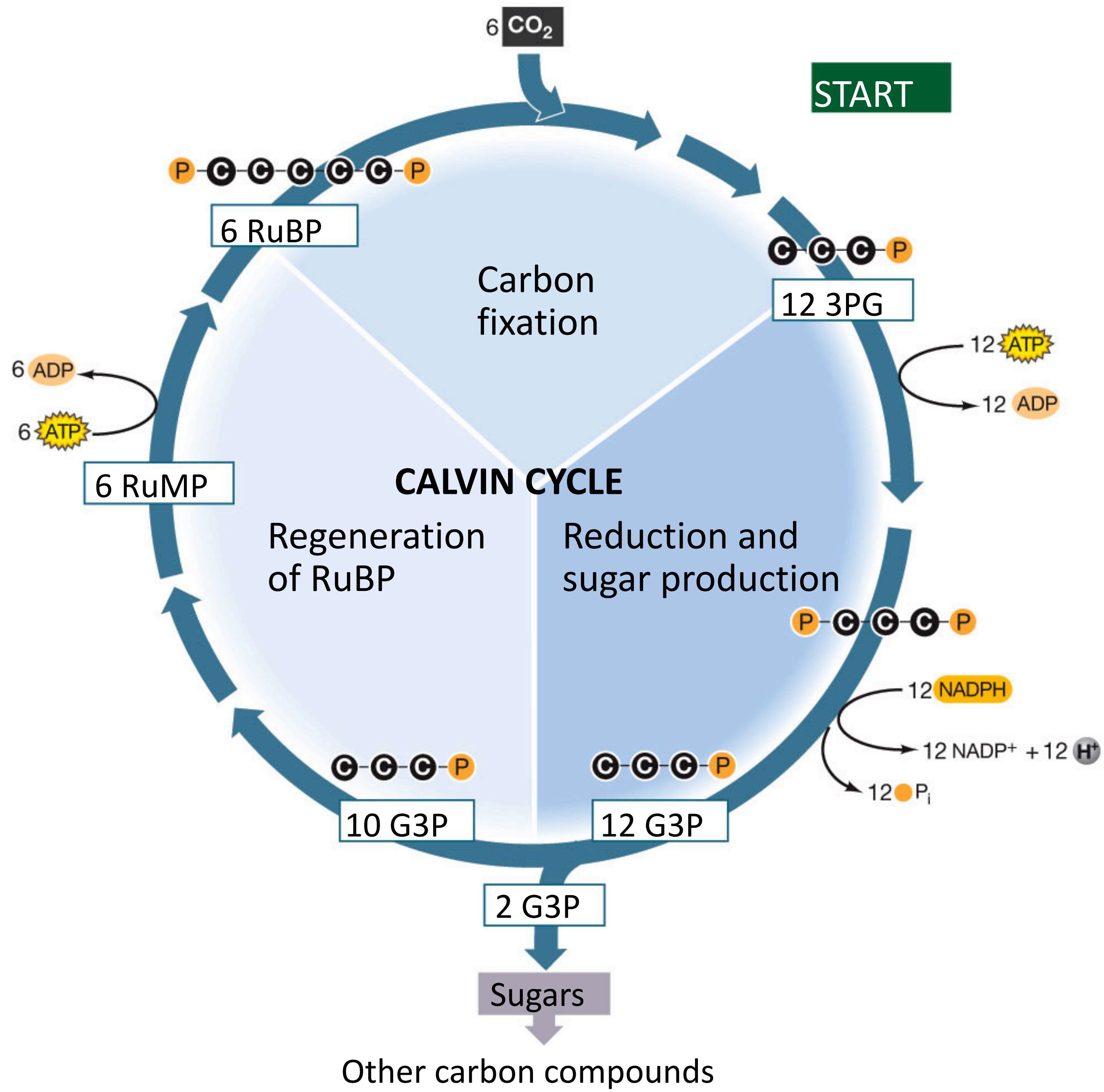
The Dark Reactions



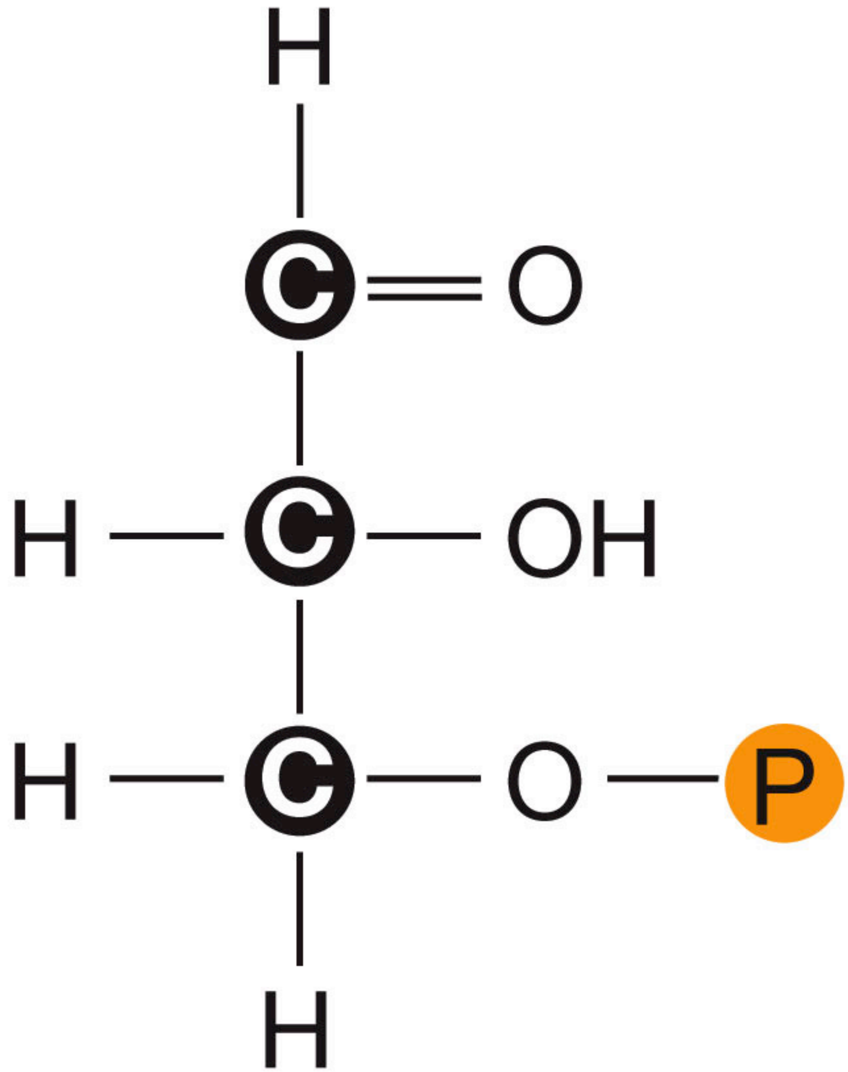
The Calvin Cycle



The Calvin Cycle

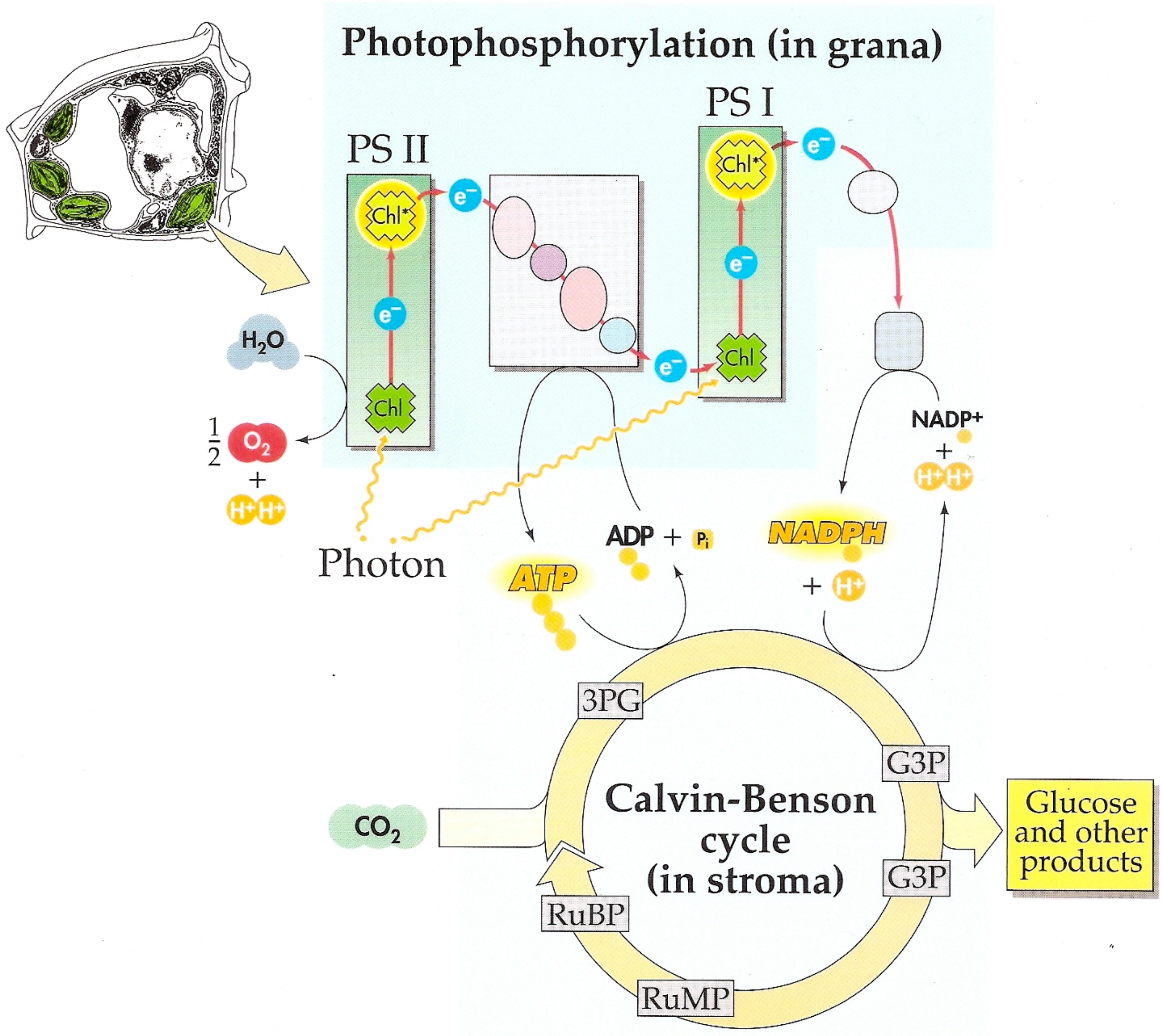


Used For All Plant Carbon Metabolism

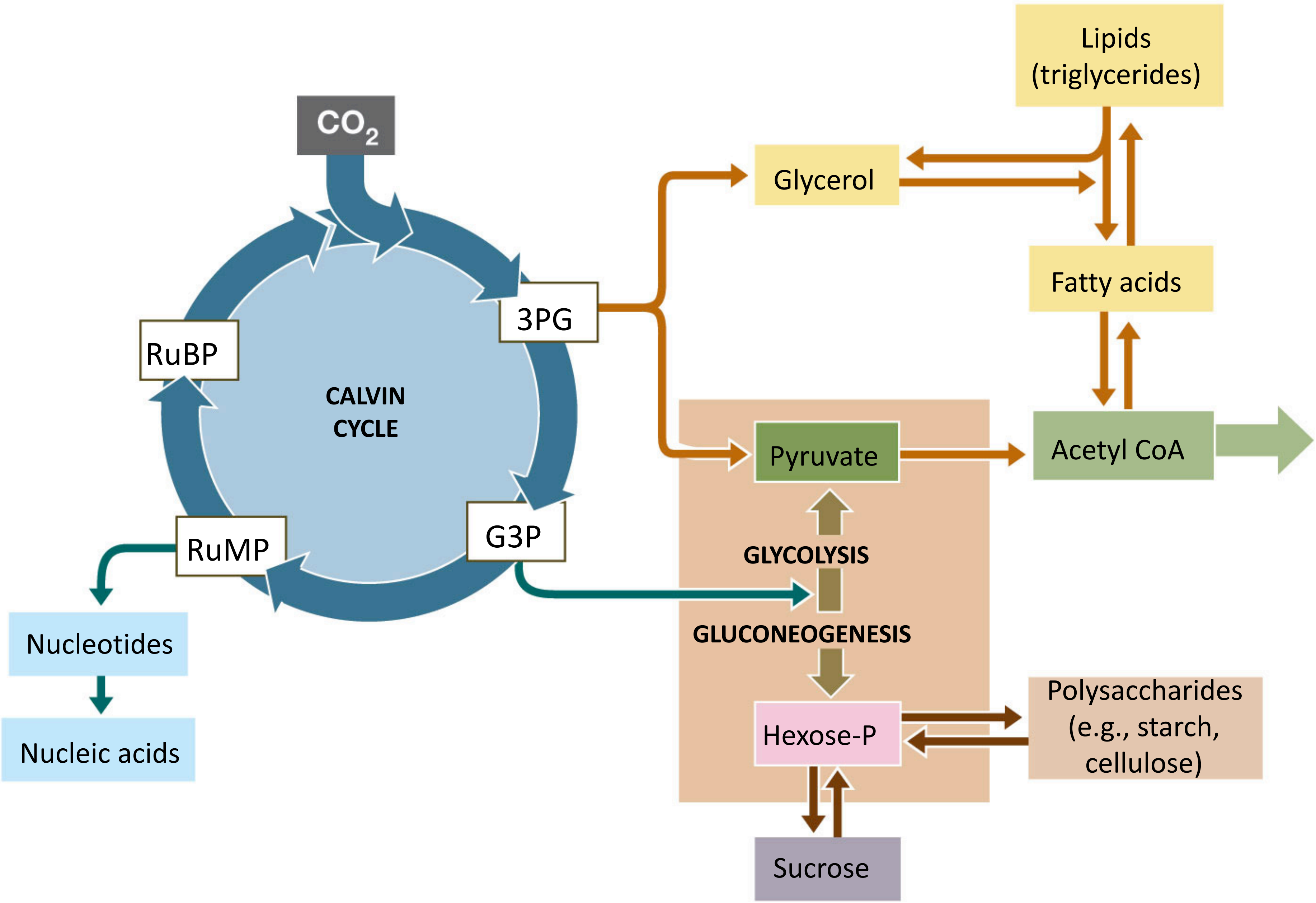


Glyceraldehyde 3-phosphate (G3P)

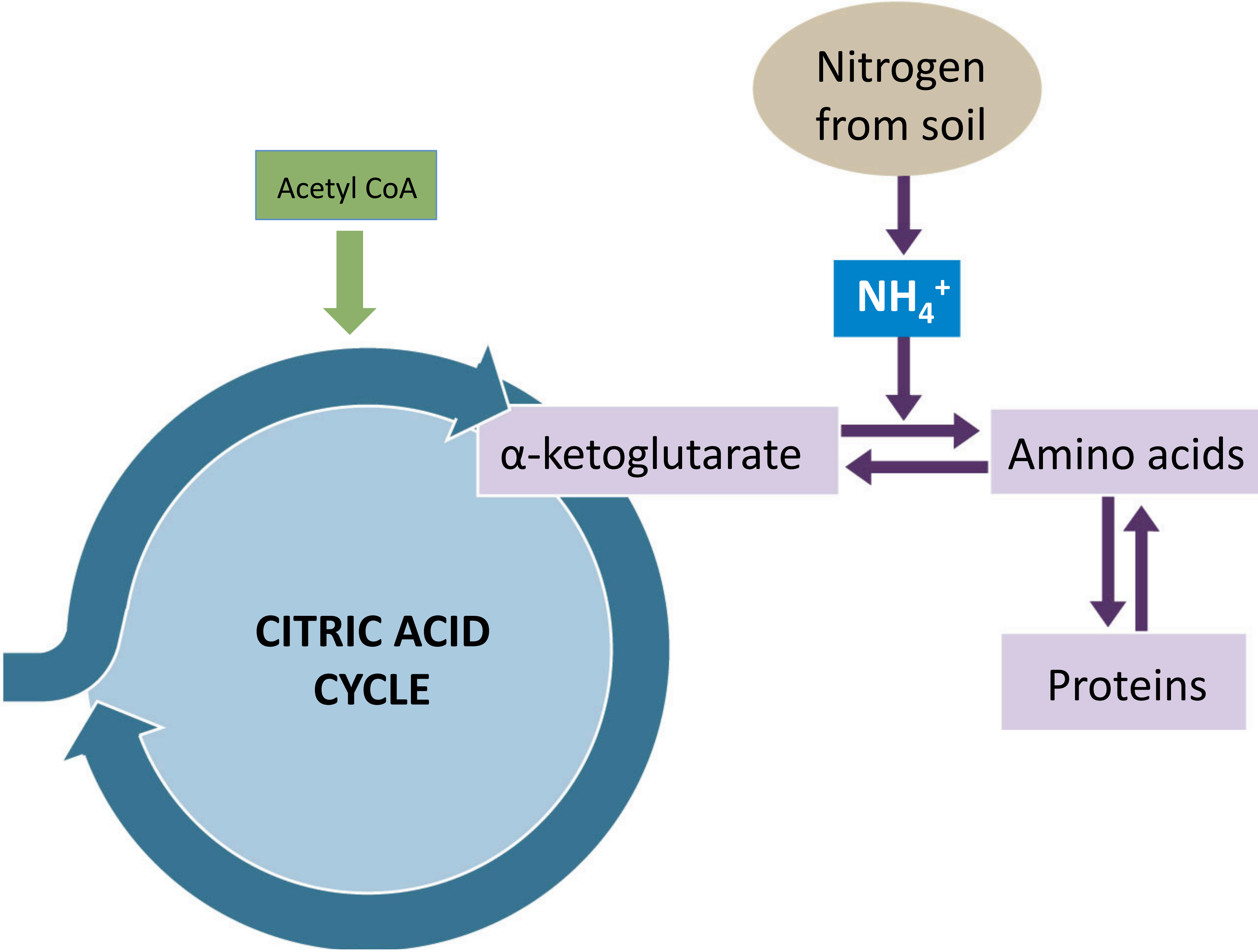
Overview Of Photosynthetic Reactions



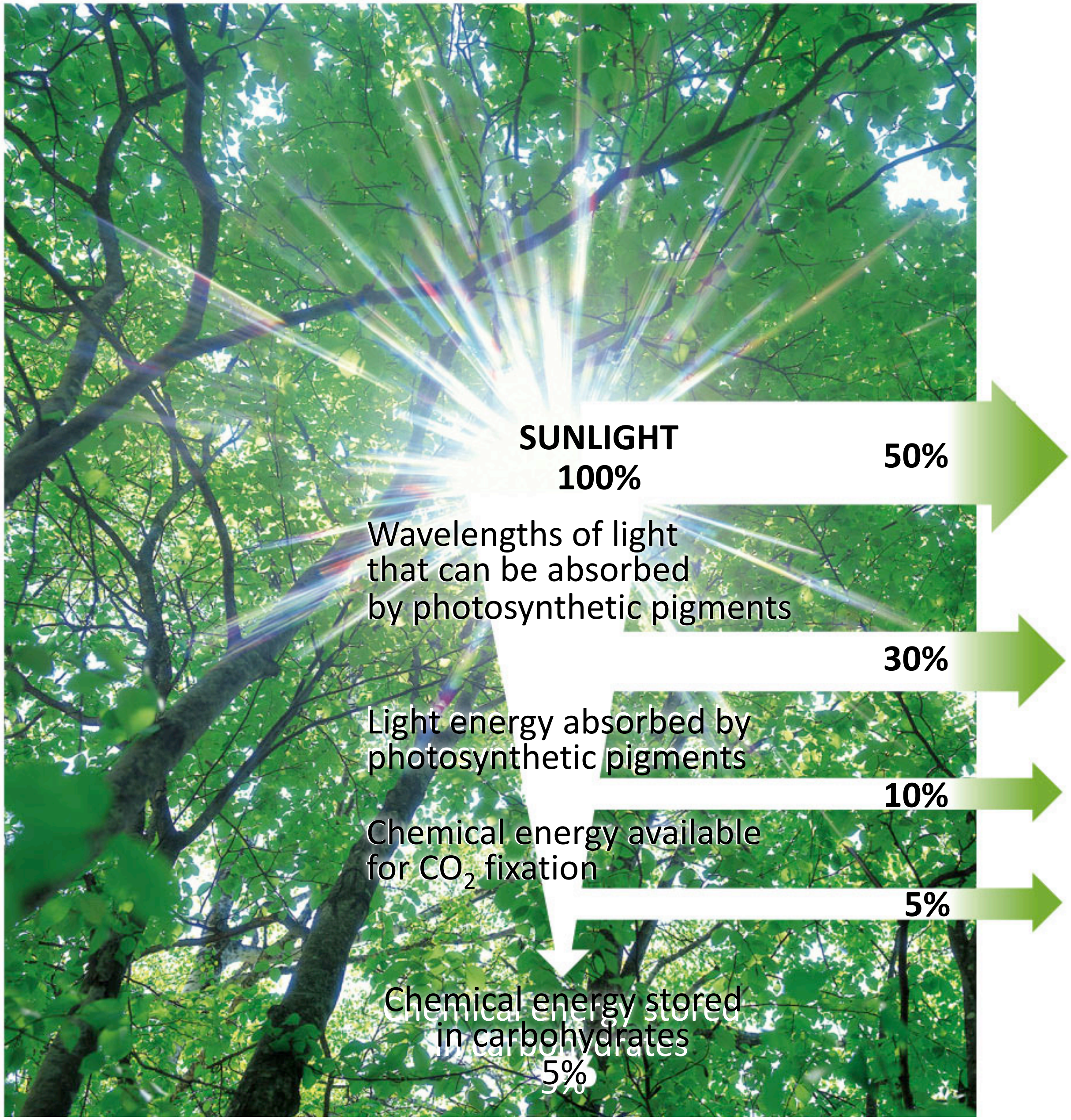
Metabolic Interactions In A Plant Cell



Metabolic Interactions In A Plant Cell



Energy Losses During Photosynthesis



ENERGY LOSS

Wavelengths of light not part of absorption spectrum of photosynthetic pigments (e.g., green light)

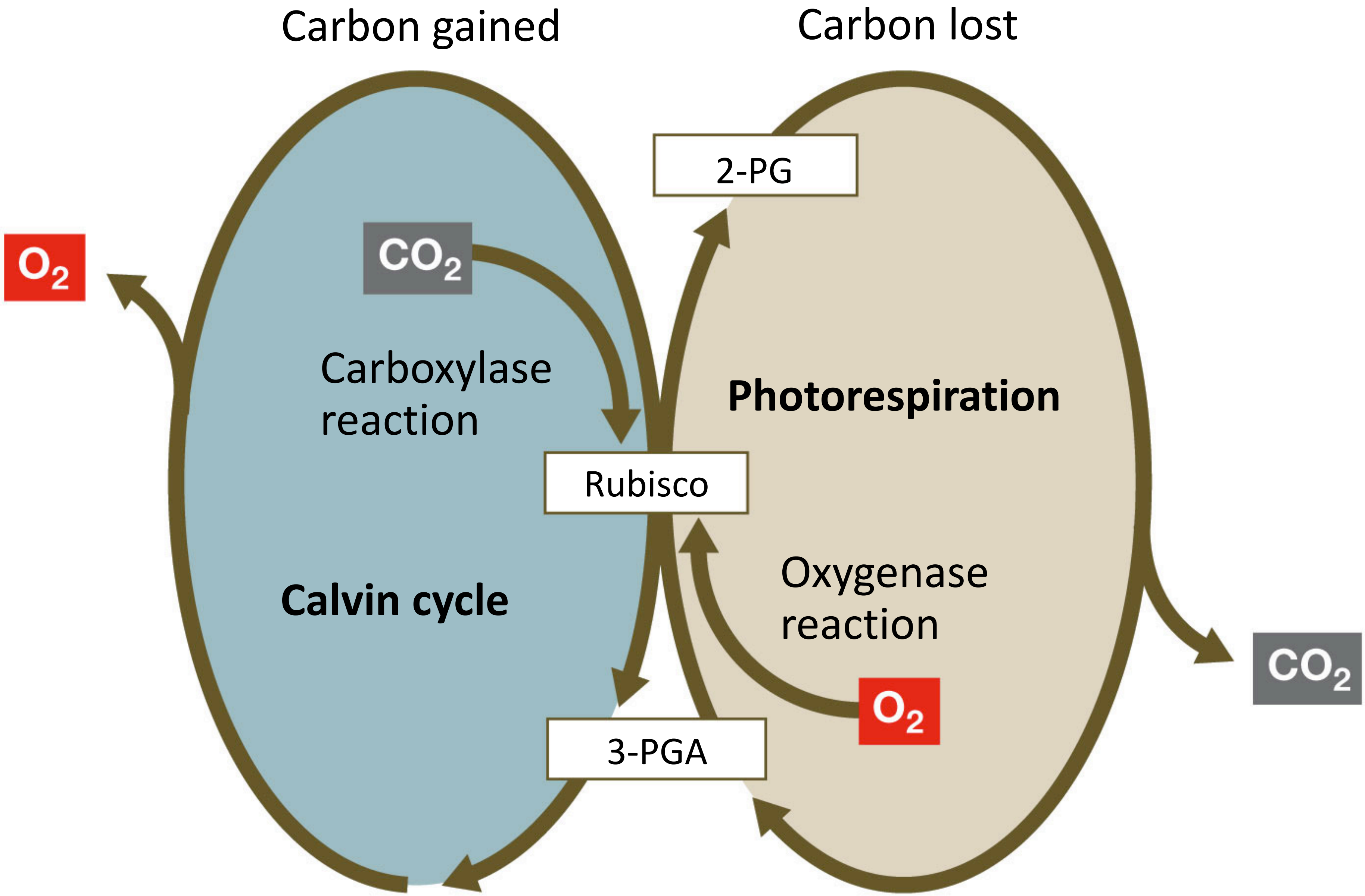
Light energy not absorbed due to plant structure (e.g., leaves not properly oriented to sun)

Inefficiency of light reactions converting light to chemical energy

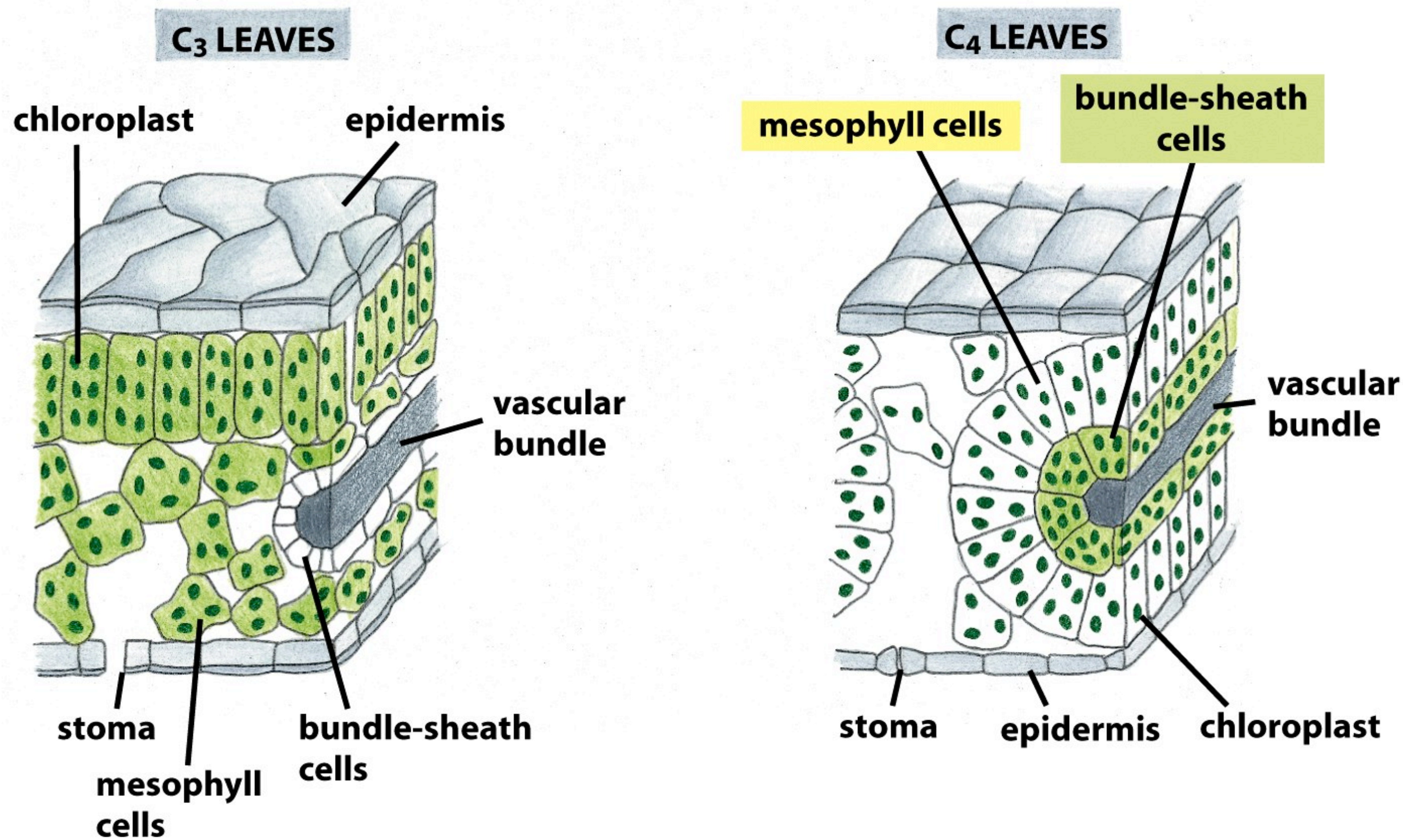
Inefficiency of CO_2 fixation pathways

Net chemical energy stored in carbohydrates from sunlight: ***5%***

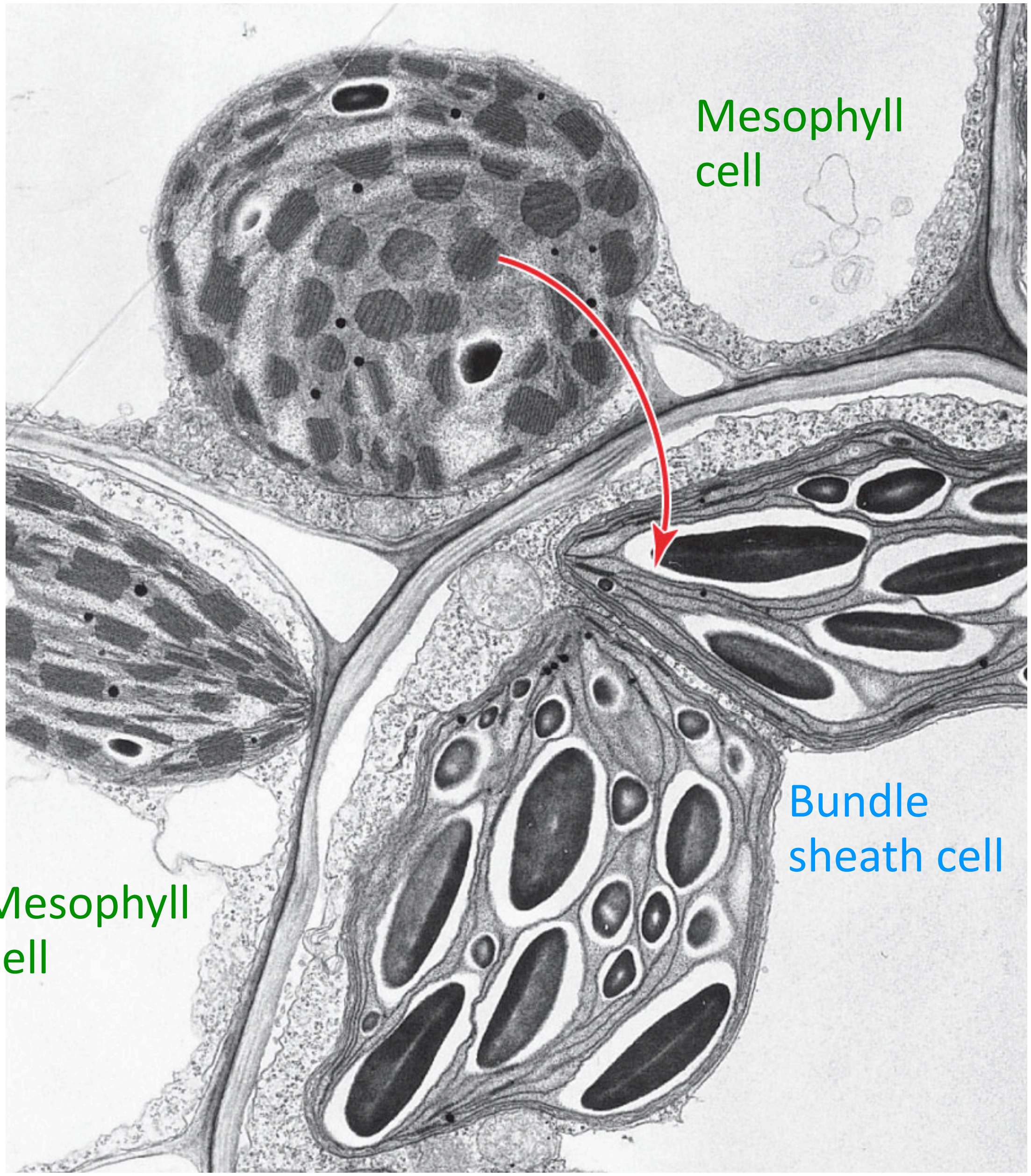
Photorespiration



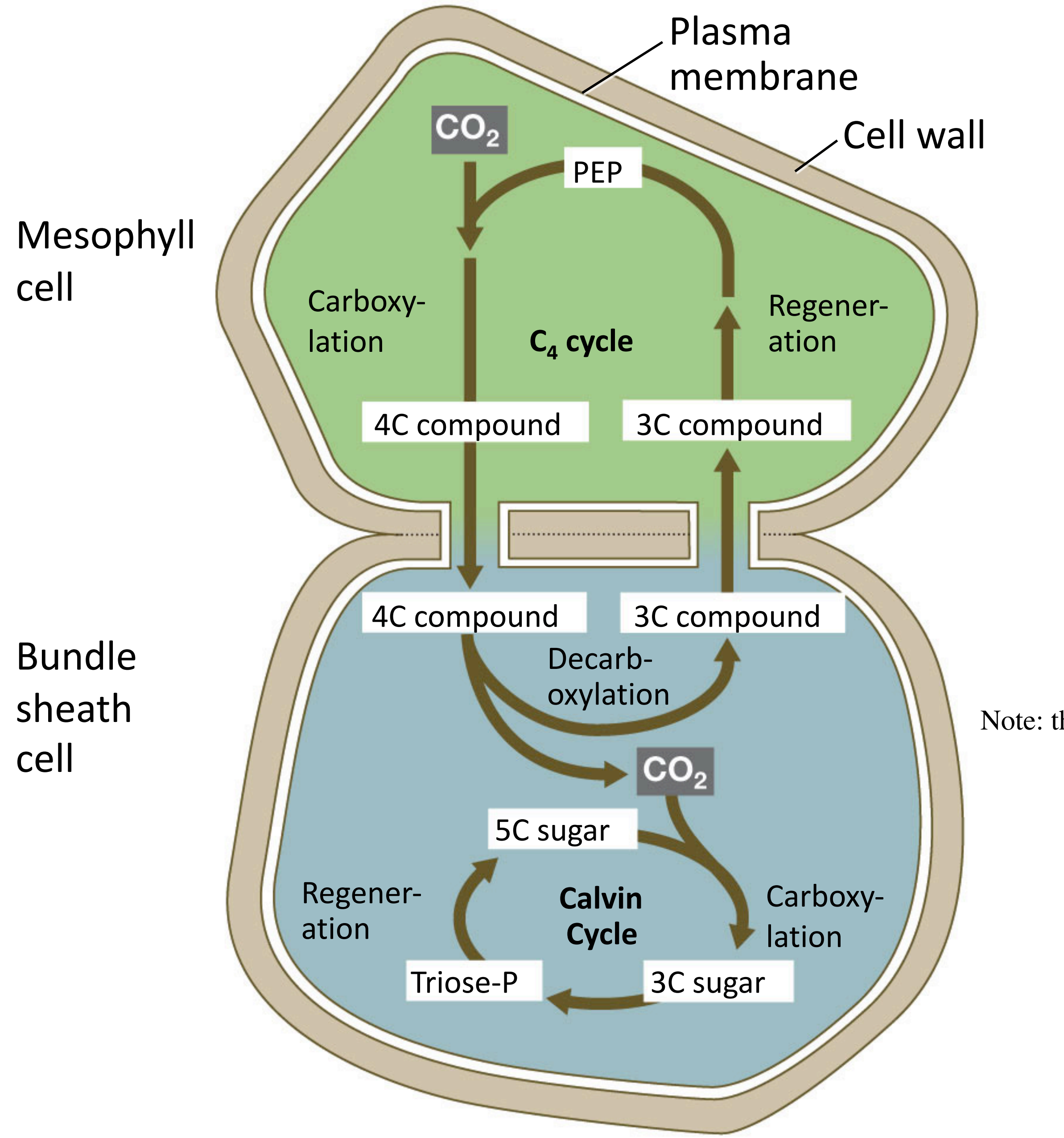
C_3 and C_4 Leaves Have Different Anatomy



The Anatomy and Biochemistry of C_4 Carbon Fixation



The Anatomy and Biochemistry of C_4 Carbon Fixation



Note: the Calvin Cycle that occurs in Bundle Sheath Cells is the standard dark reactions occurring in all plants

The CAM C_4 Pathway

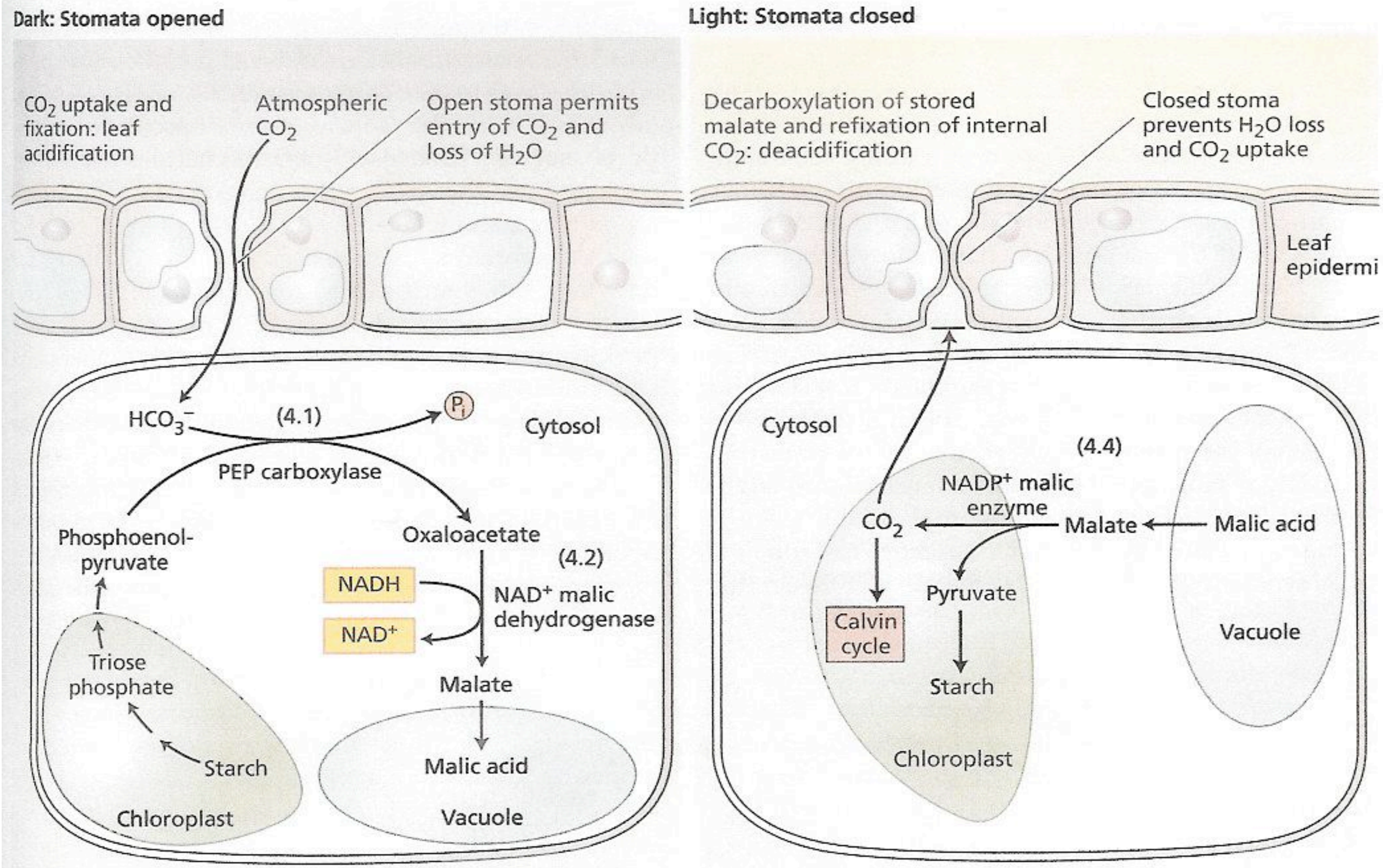


FIGURE 8.14 Crassulacean acid metabolism (CAM). Temporal separation of CO_2 uptake from photosynthetic reactions: CO_2 uptake and fixation take place at night, and decarboxylation and refixation of the internally released CO_2 occur during the day. The adaptive advantage of CAM is the reduction of water loss by transpiration, achieved by stomatal closure during the day. See Table 8.4 for a description of numbered sections.