# Biochemistry

# Metabolism

22.11.2018 – 11.12.2018

## Photosynthesis

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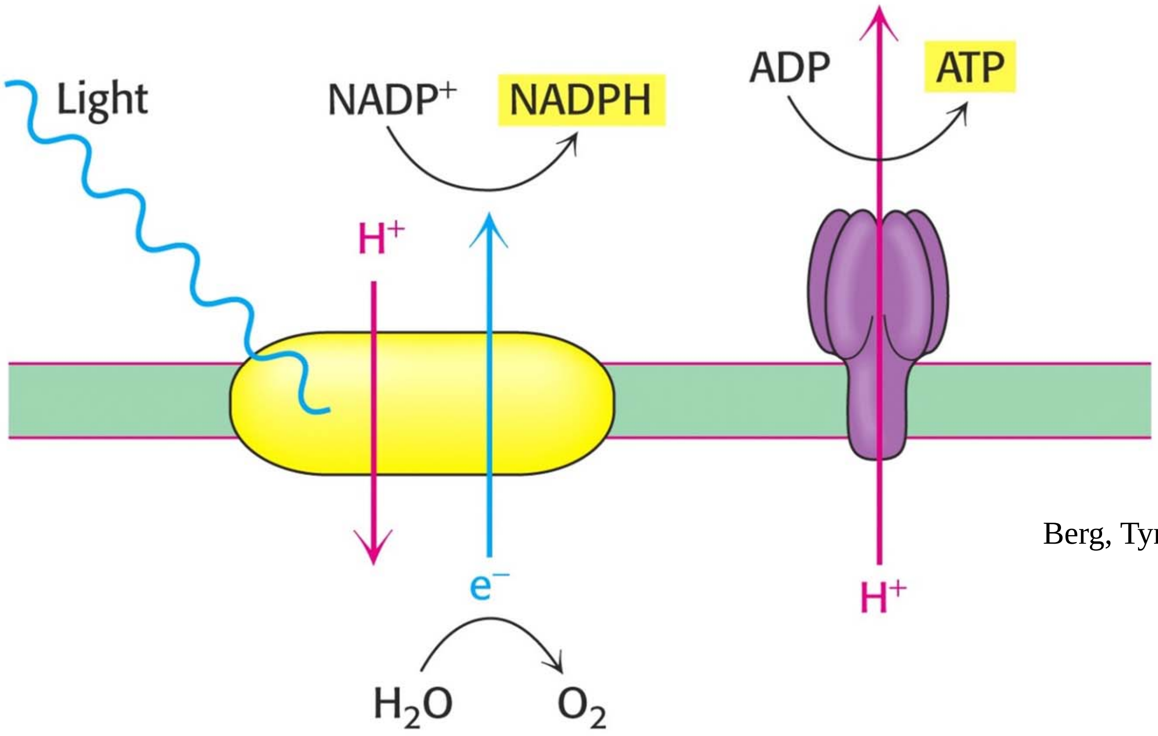
# Photosynthesis

Light reaction:

- Light absorption, generation of a high energy electron and oxidation of water
- Electron transport from water to $NADP^+$ and generation of a proton-motive force
- Synthesis of ATP

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"Dark reaction":

- Conversion of $CO_2$ to carbohydrates consuming ATP and NADPH (Calvin Cycle)

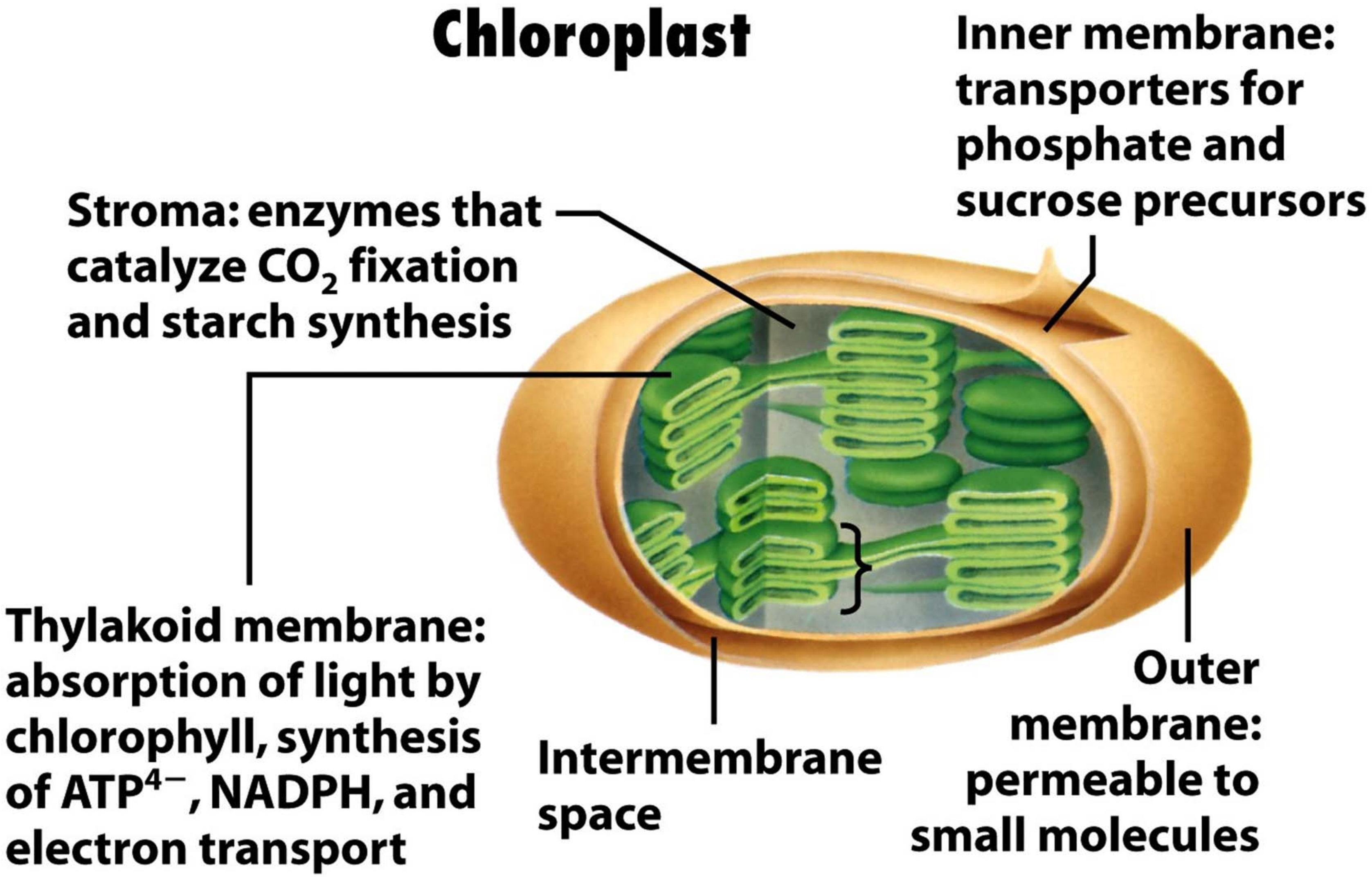


**Figure 12-29 part 2**
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Photosynthesis is localized to the thylakoid membranes

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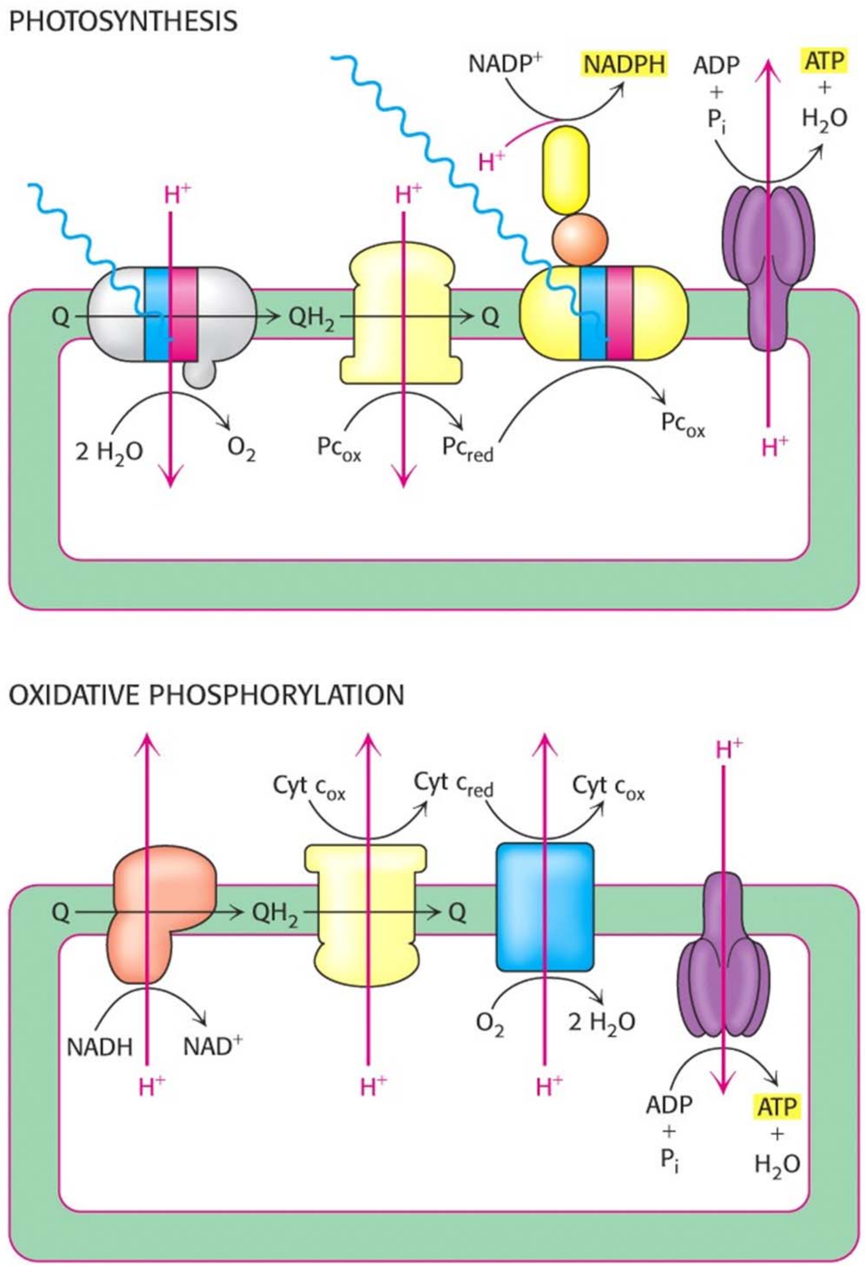
# Comparison of photosynthesis and oxidative phosphorylation

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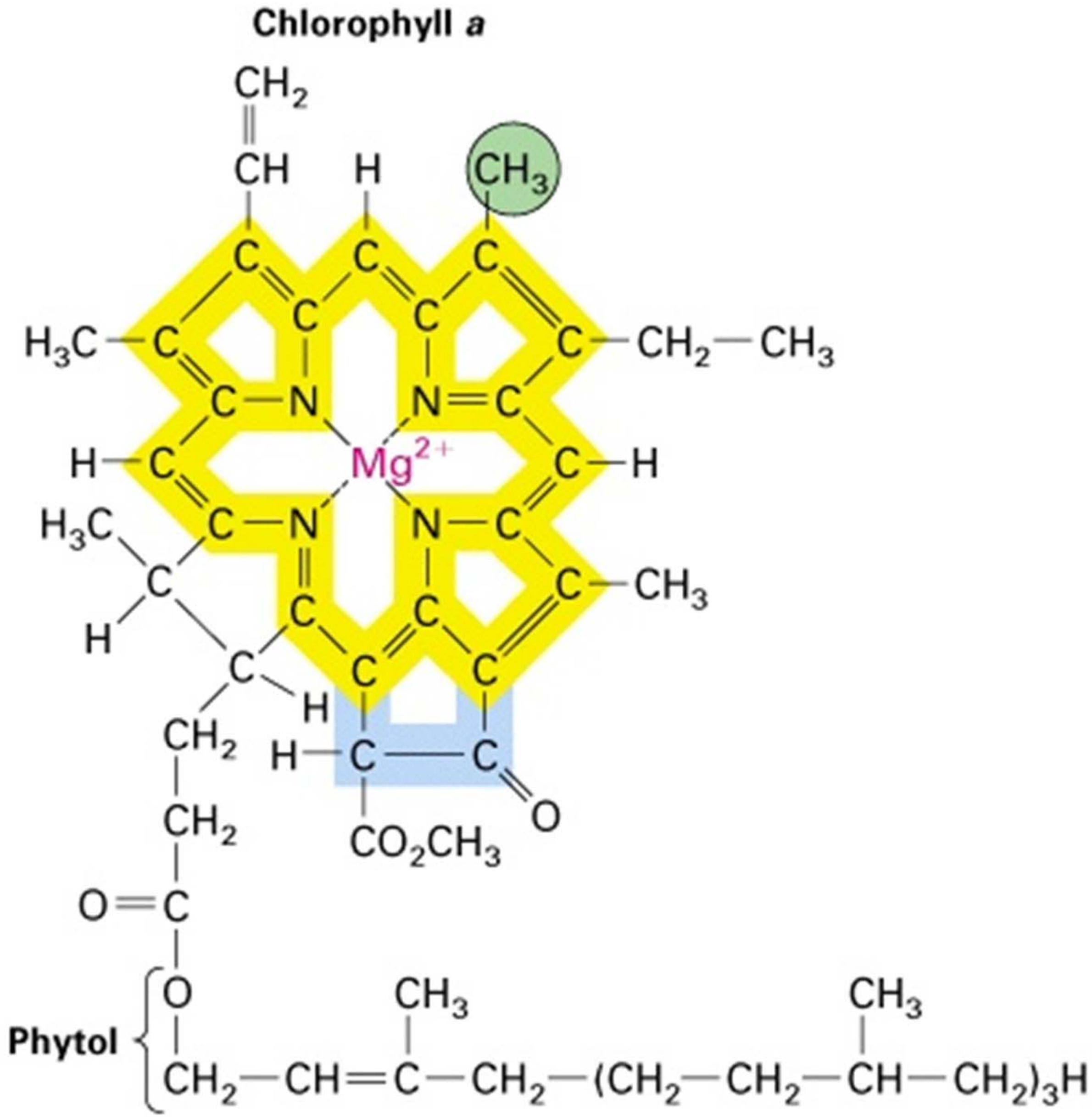
# Chlorophyll a is the main pigment capturing energy of light

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Energy diagram indicating the electronic quantum states of chlorophyll and their most important modes of interconversion

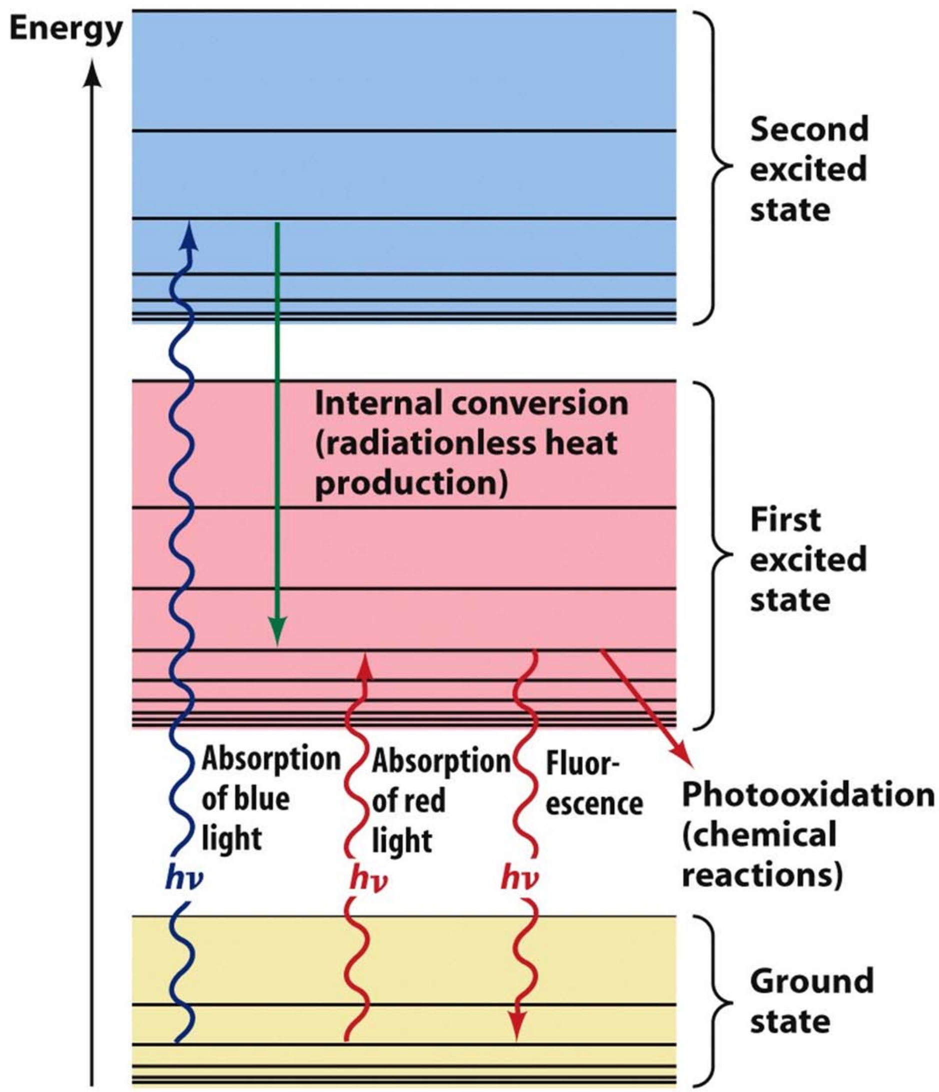


Figure 24-4
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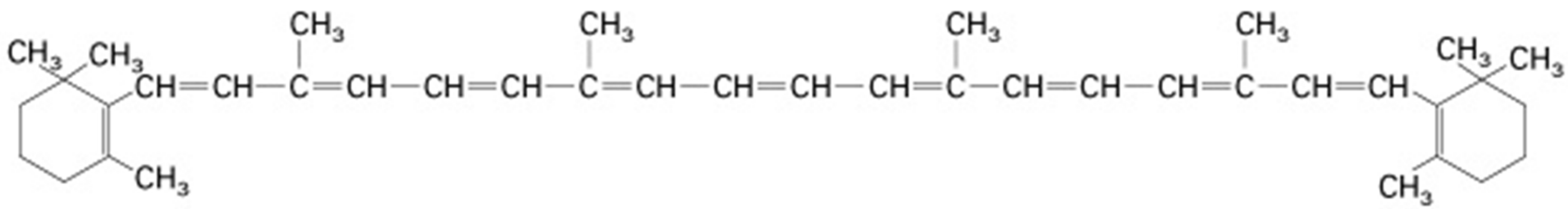
Other light-absorbing pigments, such as carotenoids, extend the range of light that can be absorbed and used for photosynthesis




β-Carotene

The action spectrum of photosynthesis matches the absorption spectra of chlorophyll a and b and of β-carotene

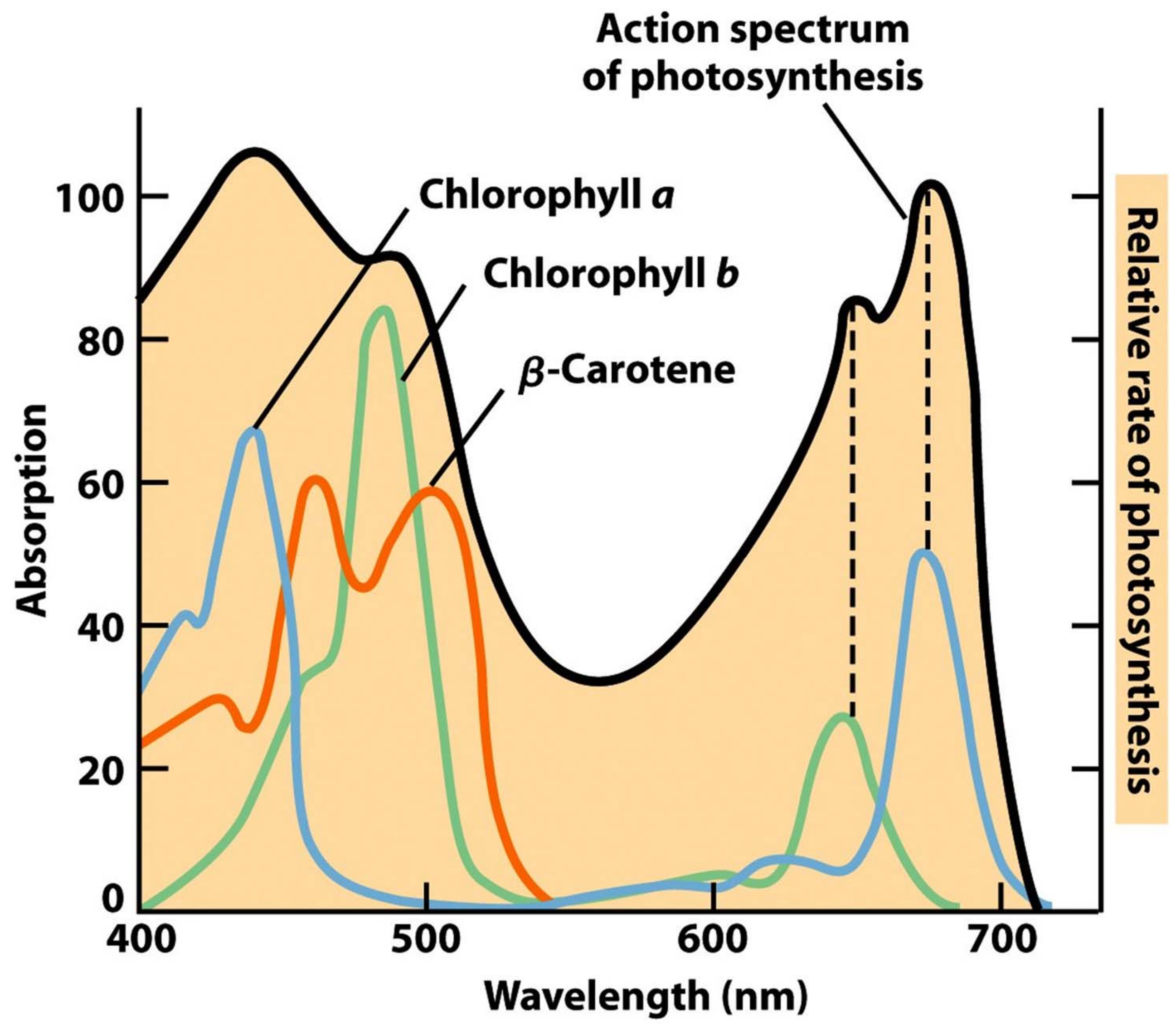



Figure 12-32
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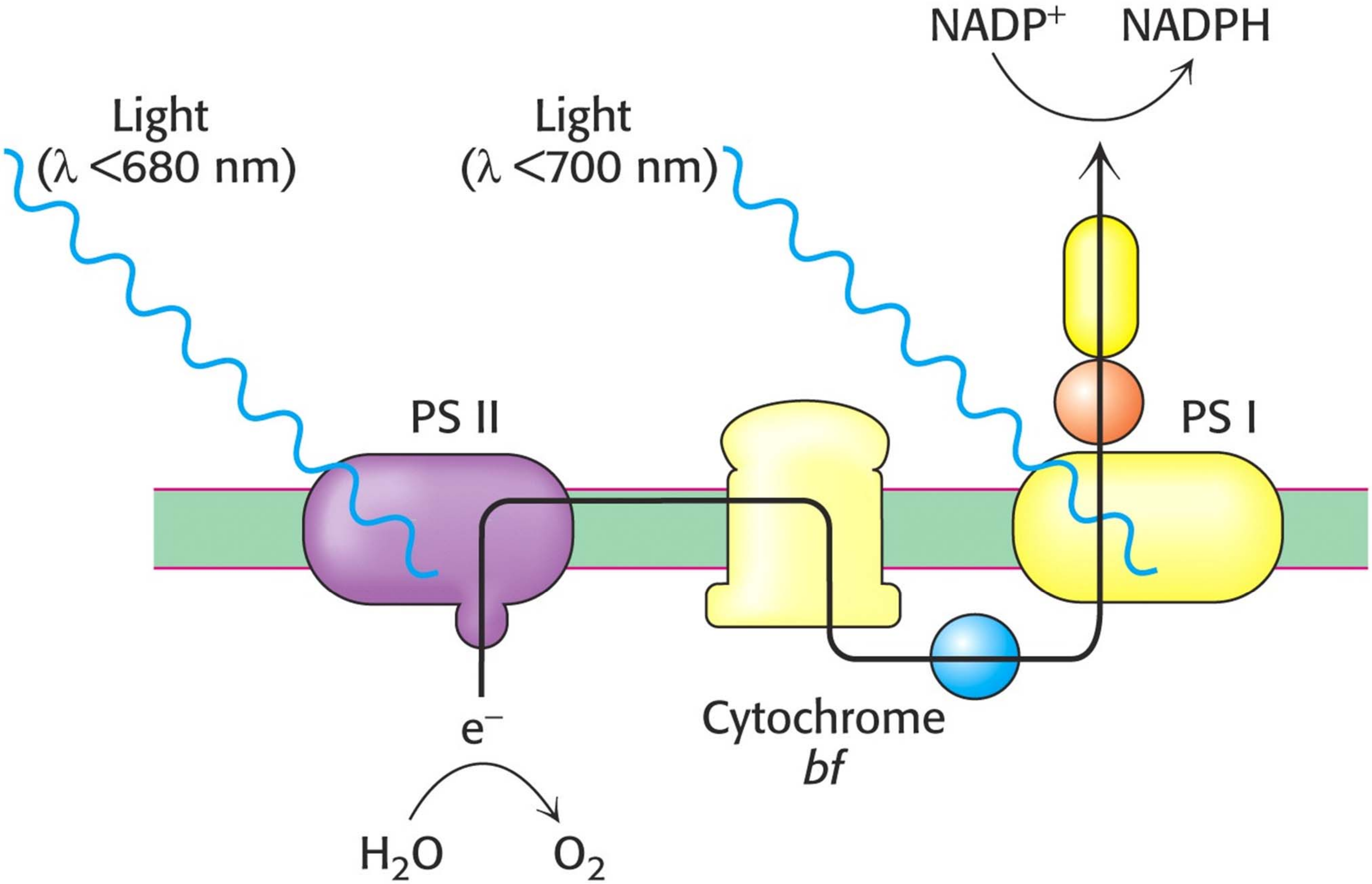
The absorption of photons from two distinct photosystems (PSI and PSII is required for complete electron flow from $H_2O$ to $NADP^+$

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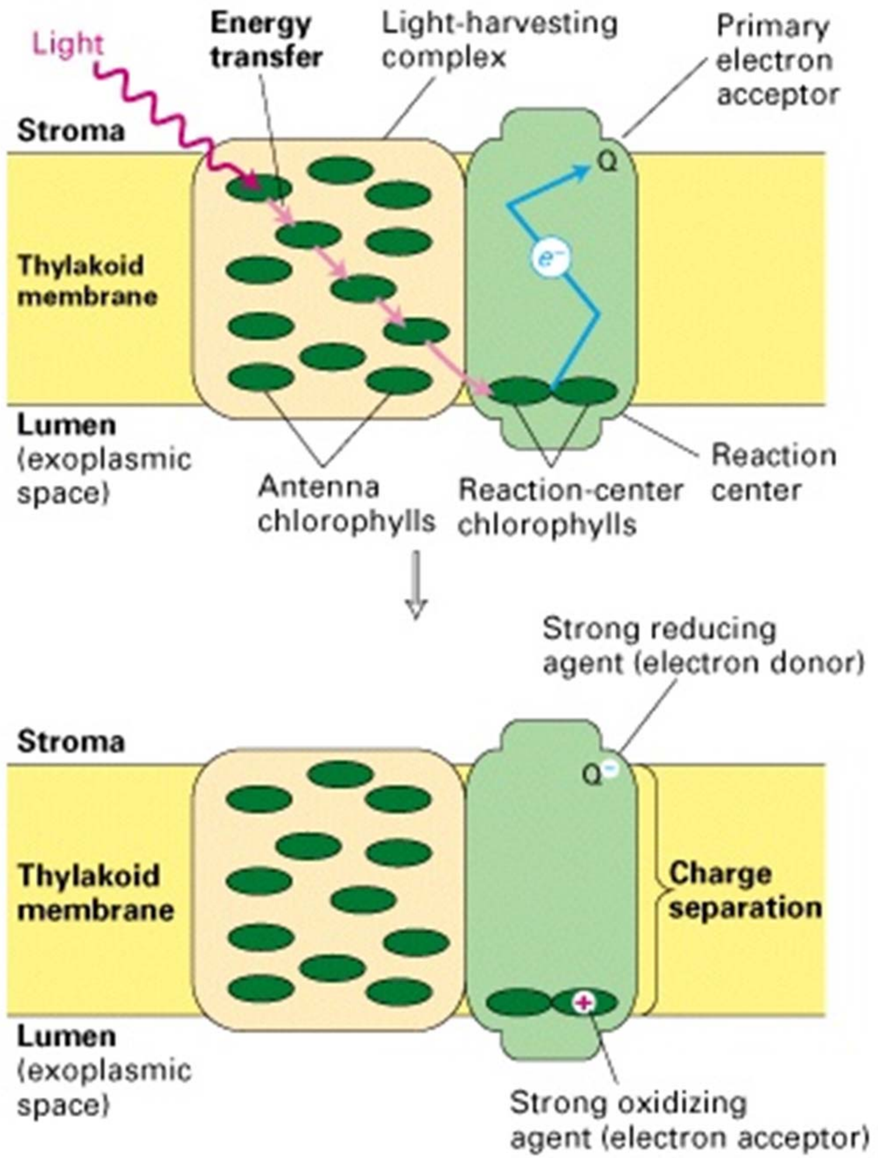
# Light absorption by reaction-centre chlorophylls causes a charge separation across the thylakoid membrane

The energy of the absorbed light is used to strip an electron from a chlorophyll molecule of the reaction centre to a primary electron acceptor thereby acquiring a positive charge (generation of a strong oxidizing- and a strong reducing agent)

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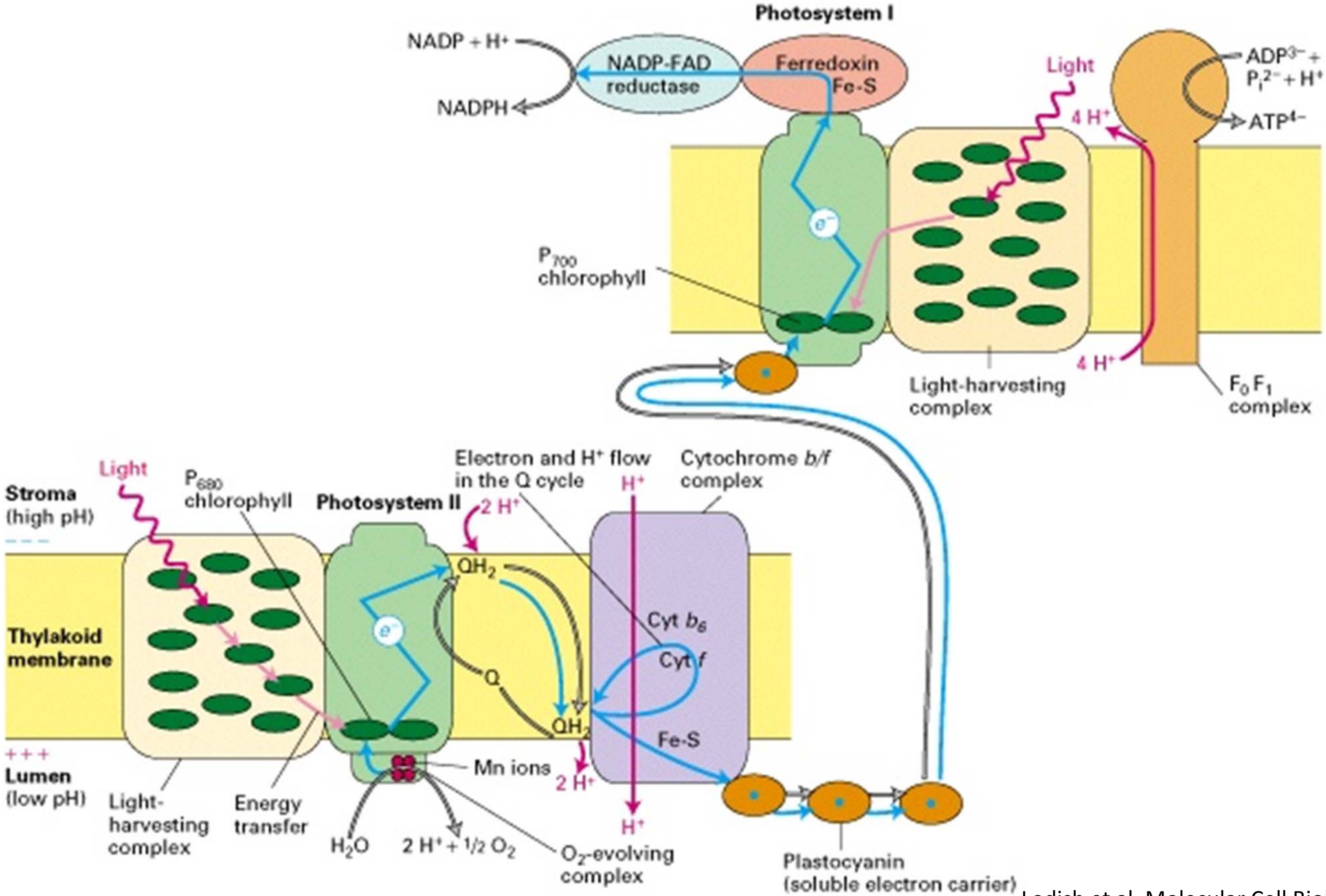
# Subsequent electron flow and coupled proton movement

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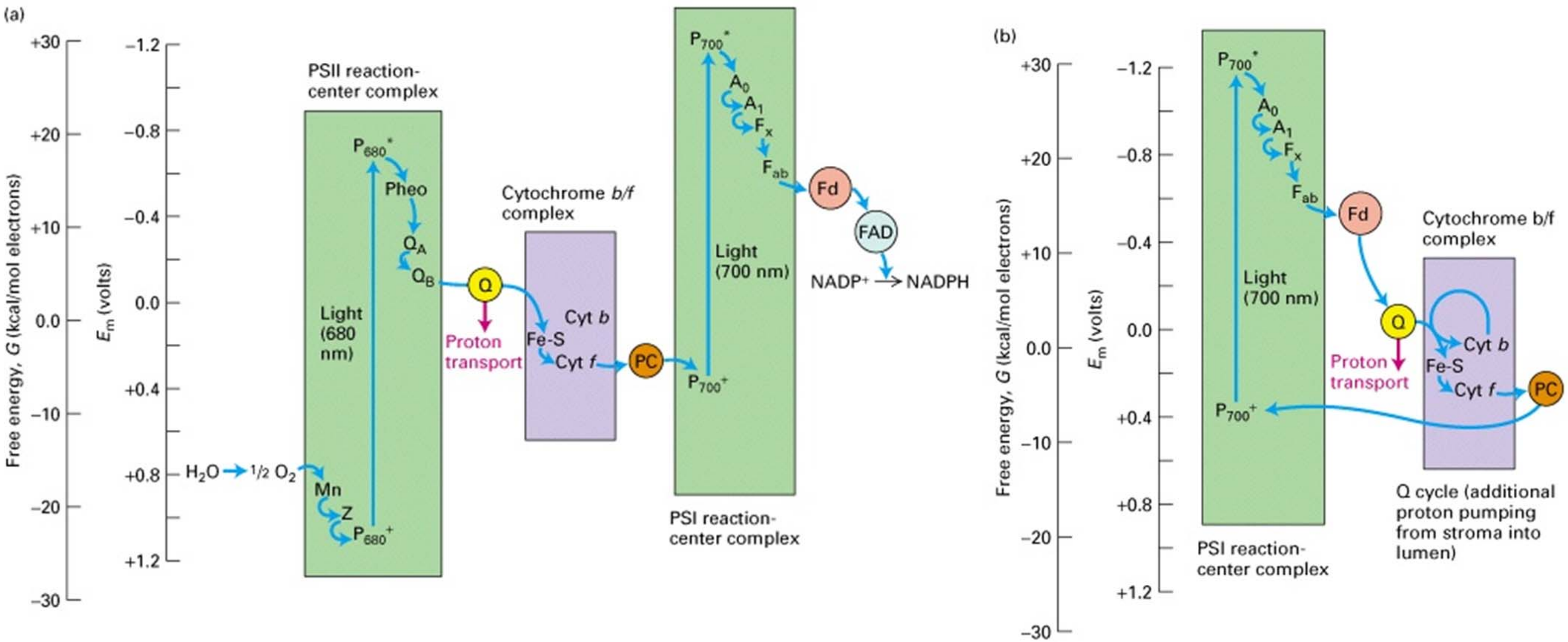
# Pathway of electron flow from $H_2O$ to $NADP^+$ in photosynthesis

Cyclic electron flow generates ATP but not NADPH

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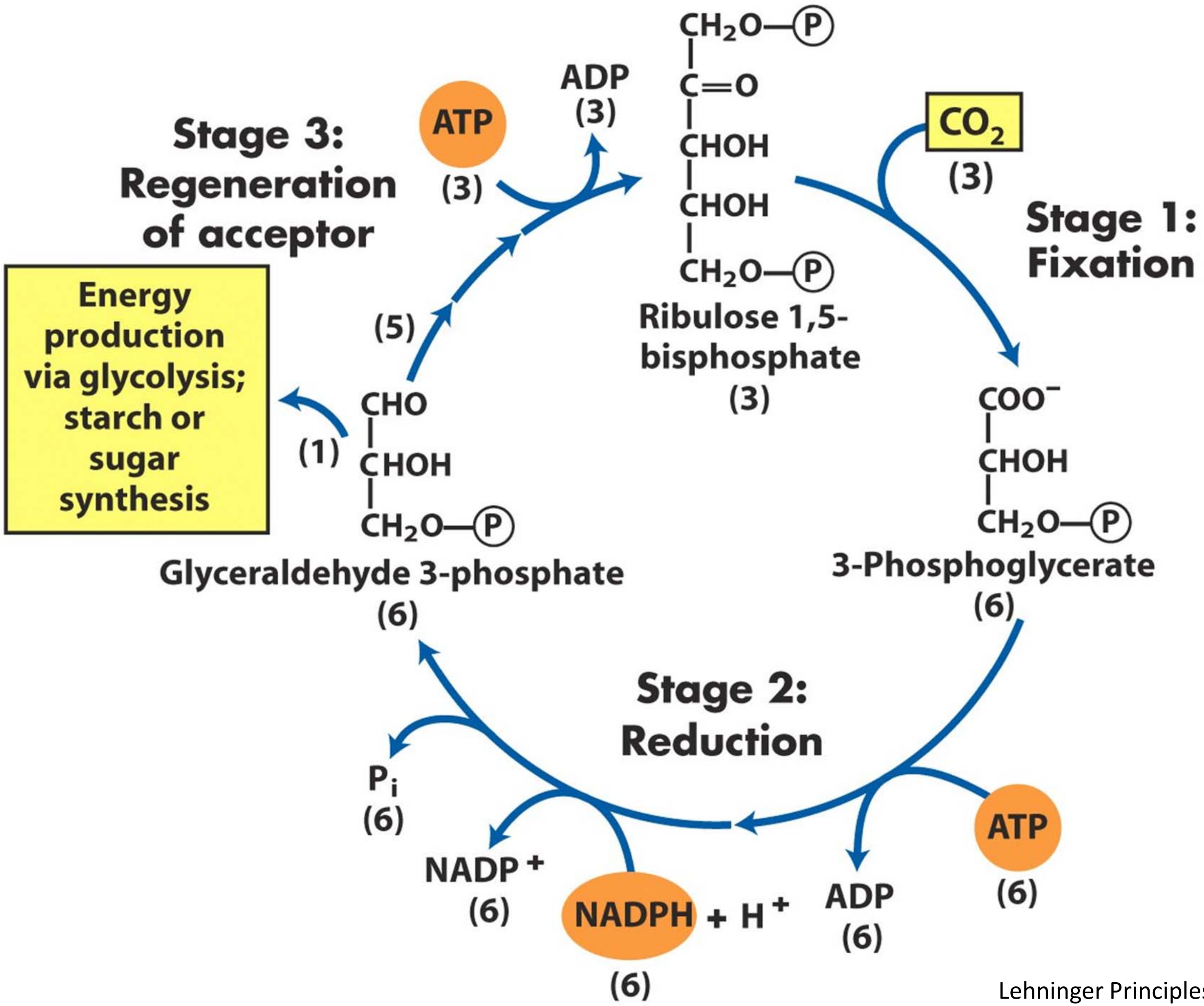
# The 3 stages of $CO_2$-fixation in photosynthesizing organisms

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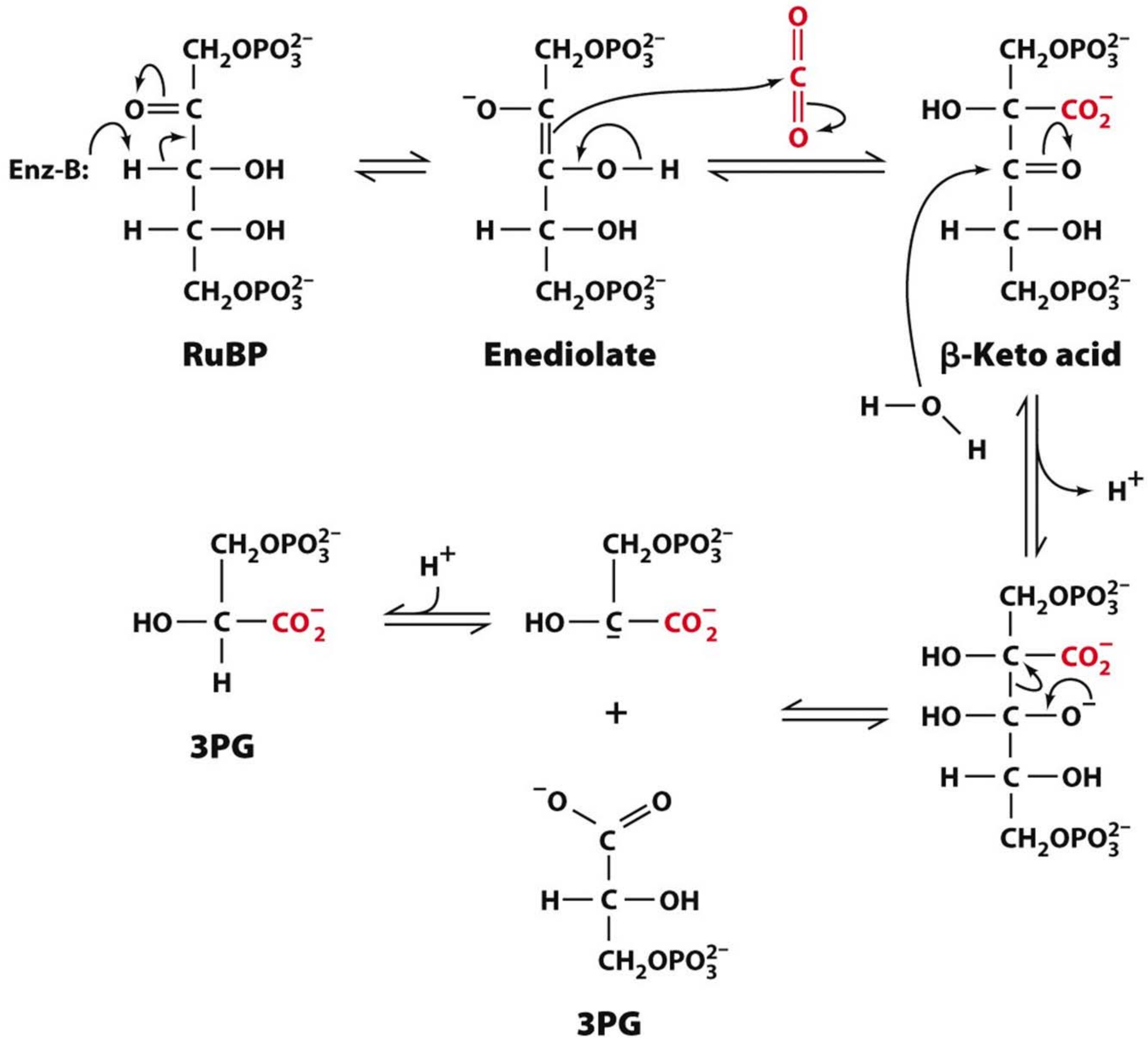
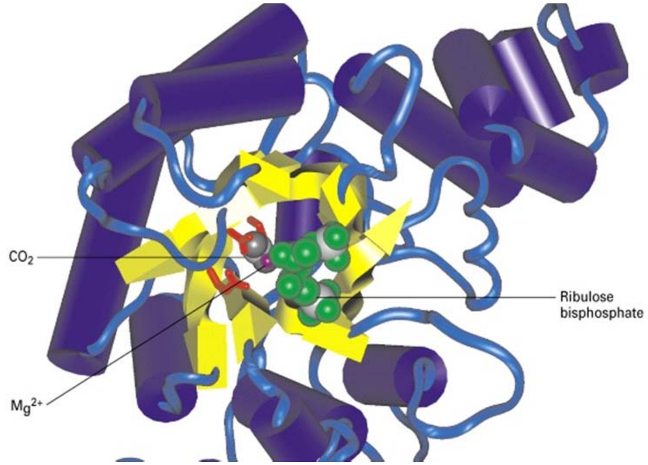
# Stage 1: RUBISCO catalyzed $CO_2$ fixation in the stroma of chloroplasts




Structure of the RUBISCO catalytic domain

Figure 24-34

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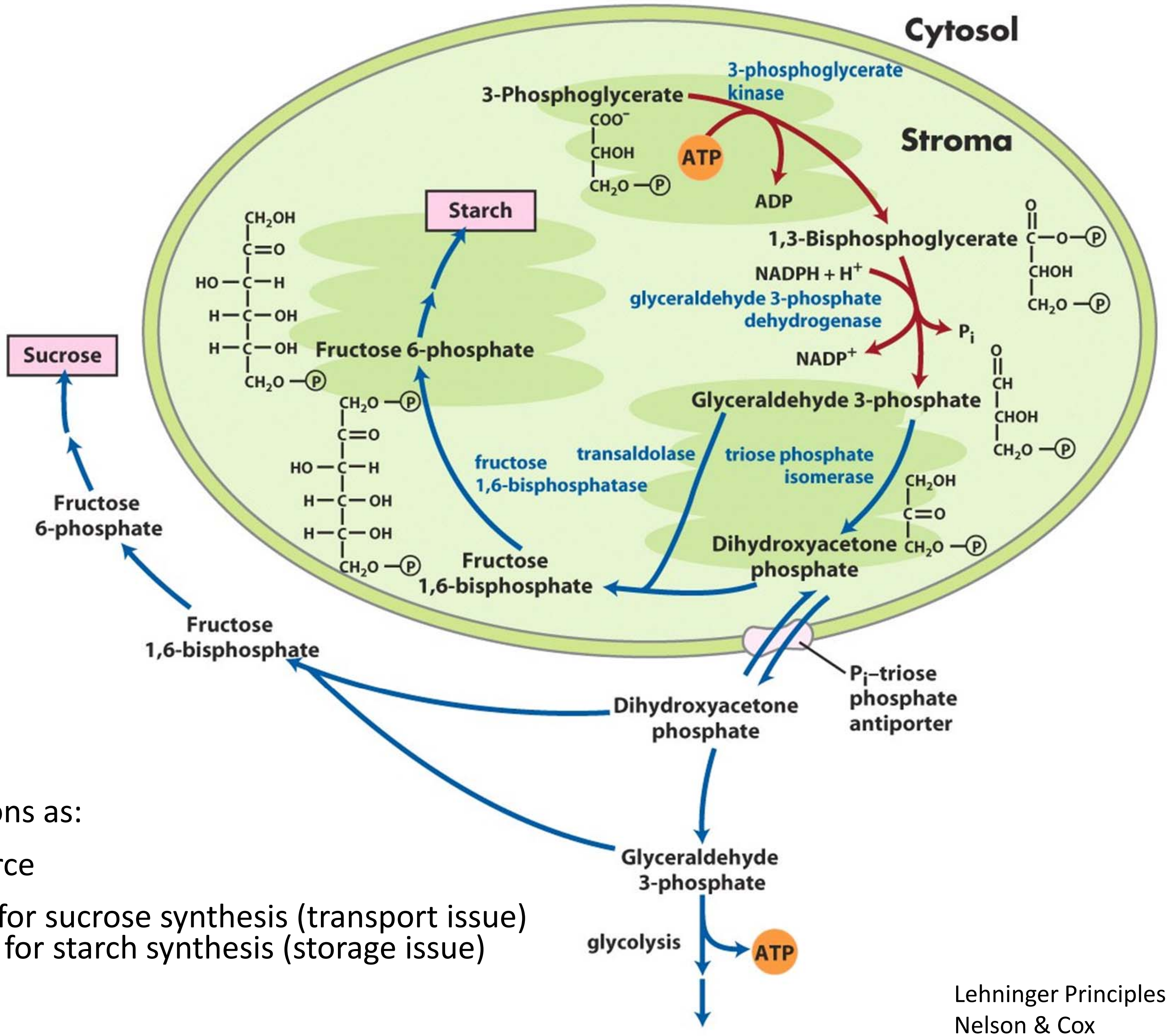
# Stage 2: conversion of 3-P-glycerate to GA3P (Start of the Calvin Cycle)




GA3P functions as:

i)energy source

ii) precursor for sucrose synthesis (transport issue)
iii) precursor for starch synthesis (storage issue)

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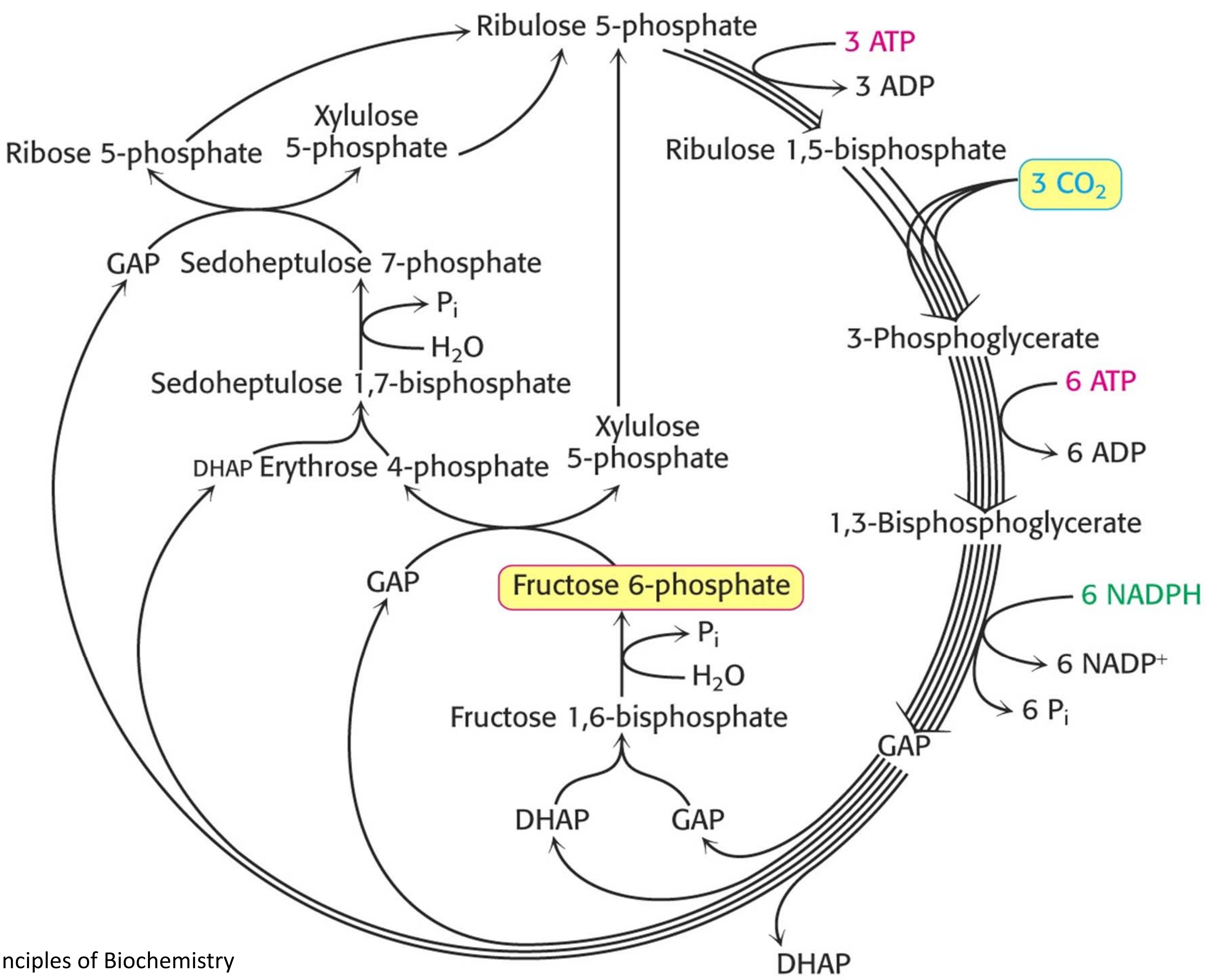
Stage 3: regeneration of ribulose 5-phosphate (remaining reactions of the Calvin Cycle)

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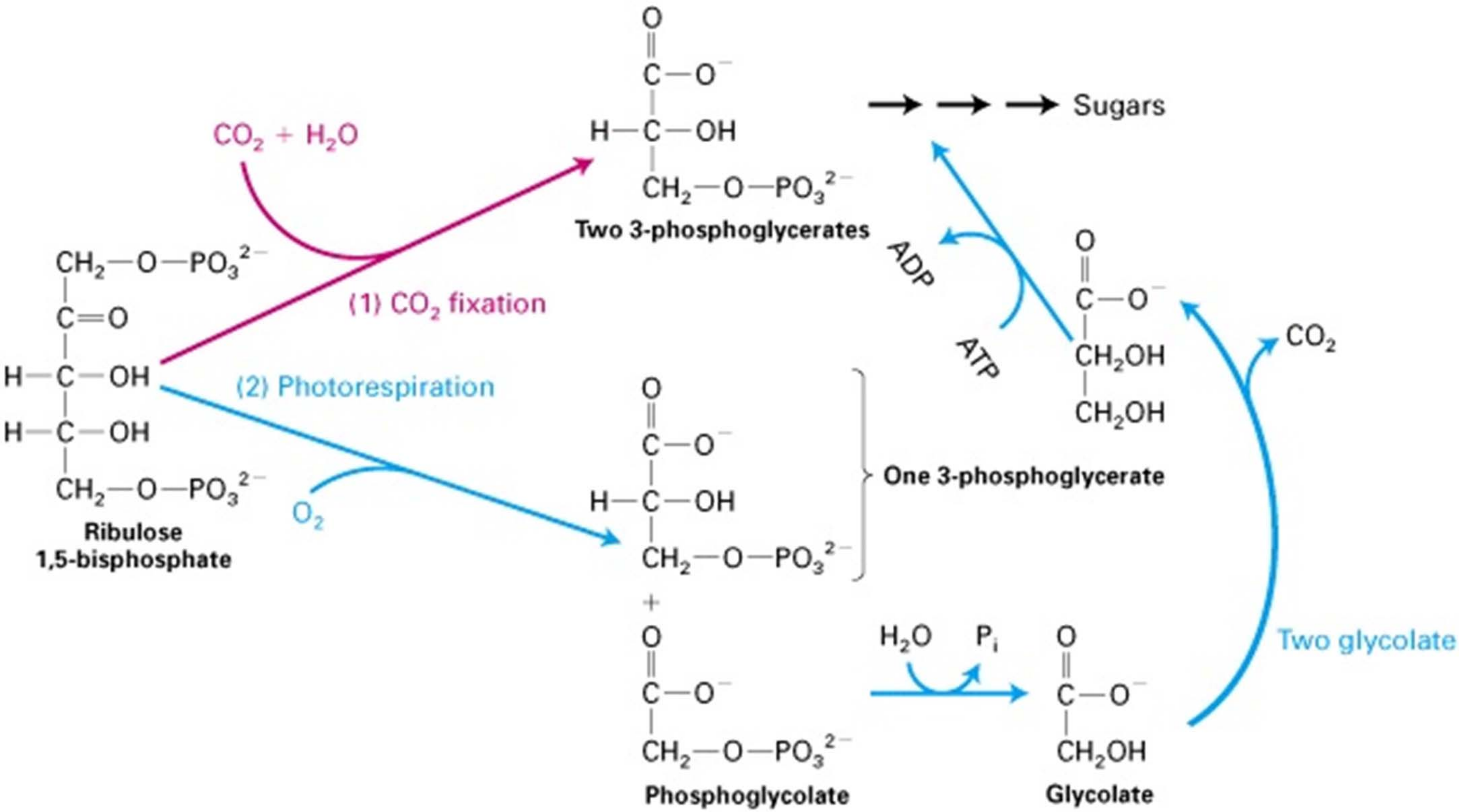
# During photorespiration $CO_2$ is released on expense of $O_2$-consumption

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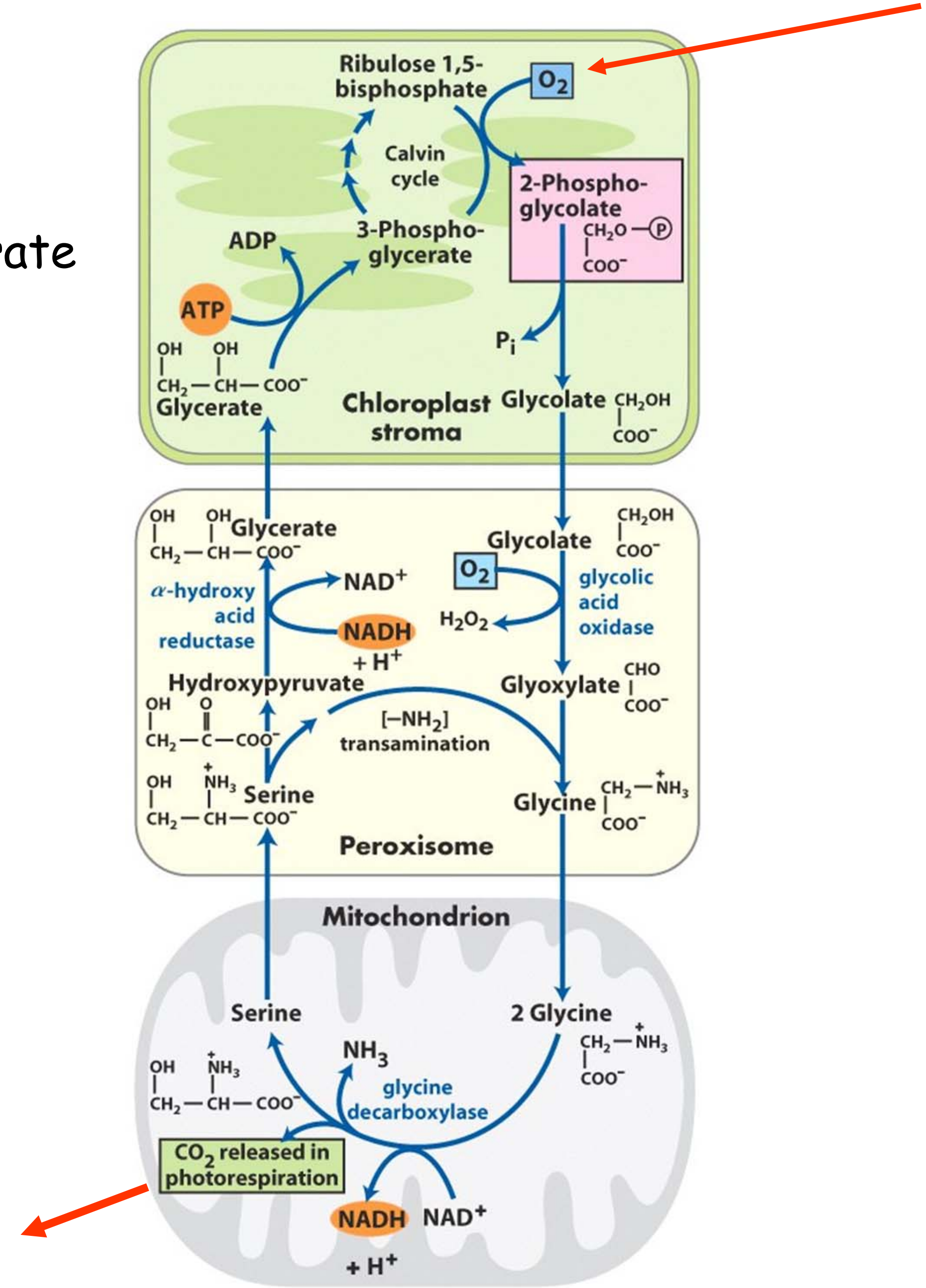
# Photorespiration

Recycling of phosphoglycolate to glycerate generates $CO_2$.
Note that it occurs in 3 different cell organelles.

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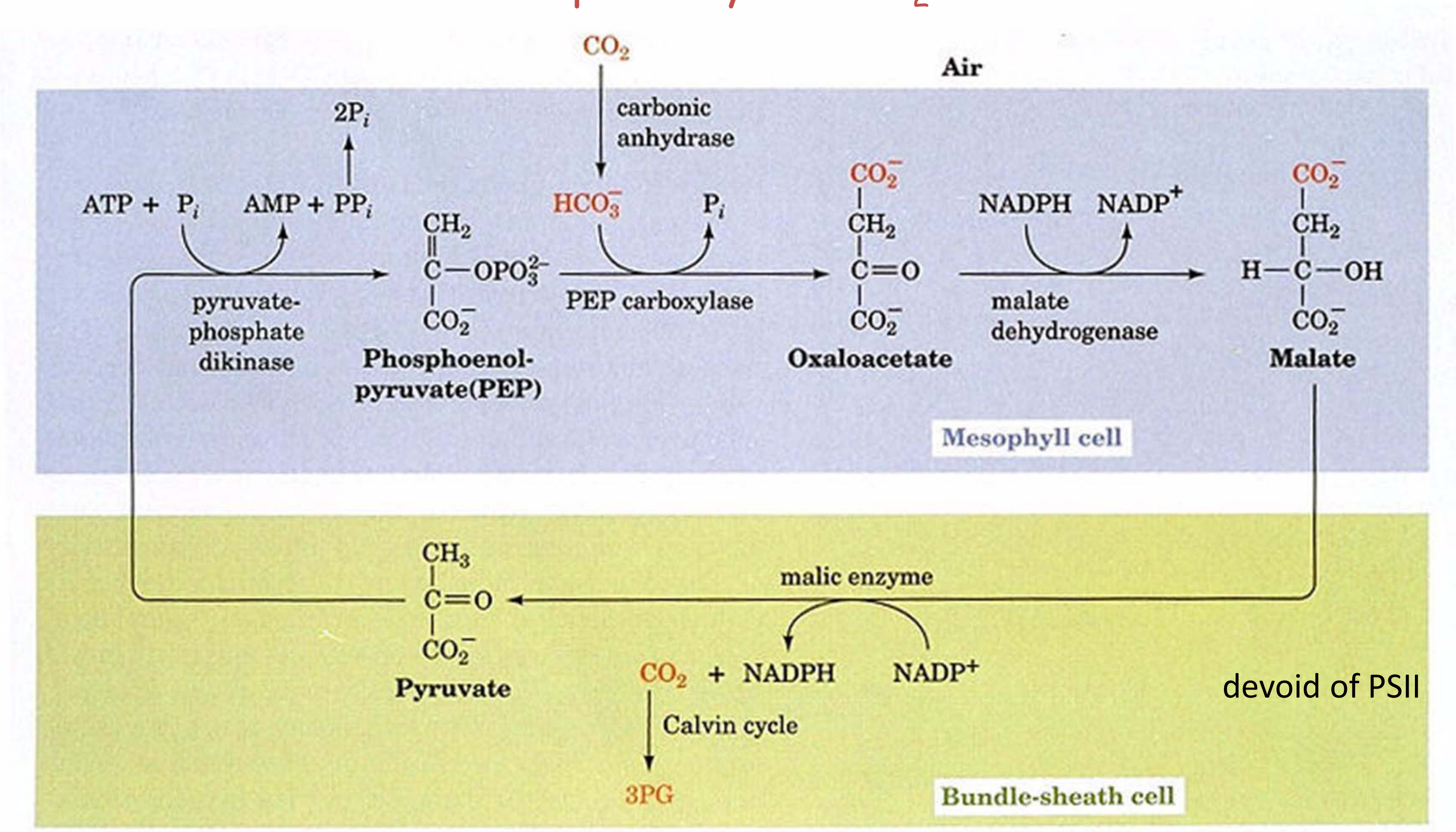
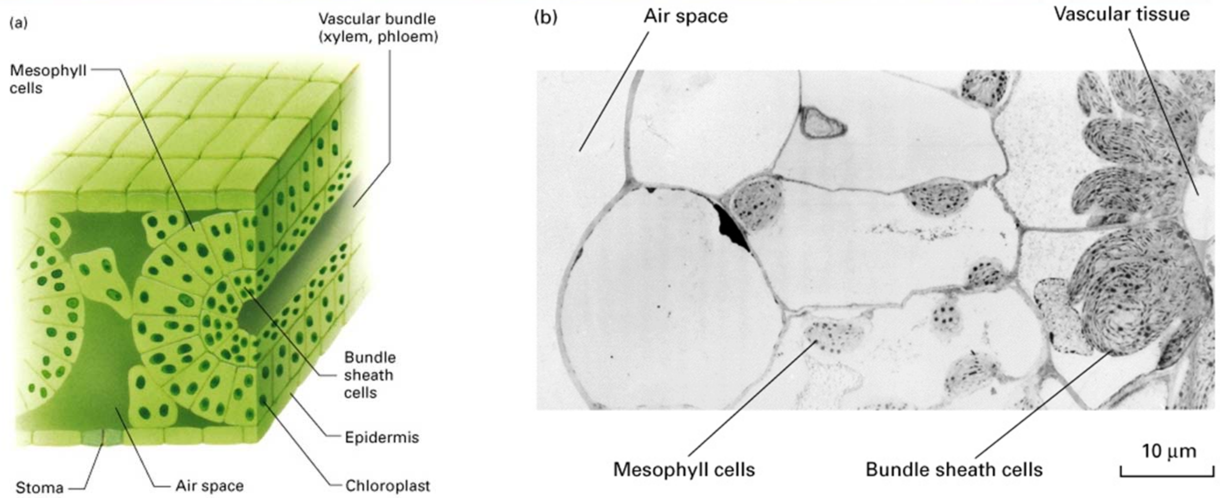
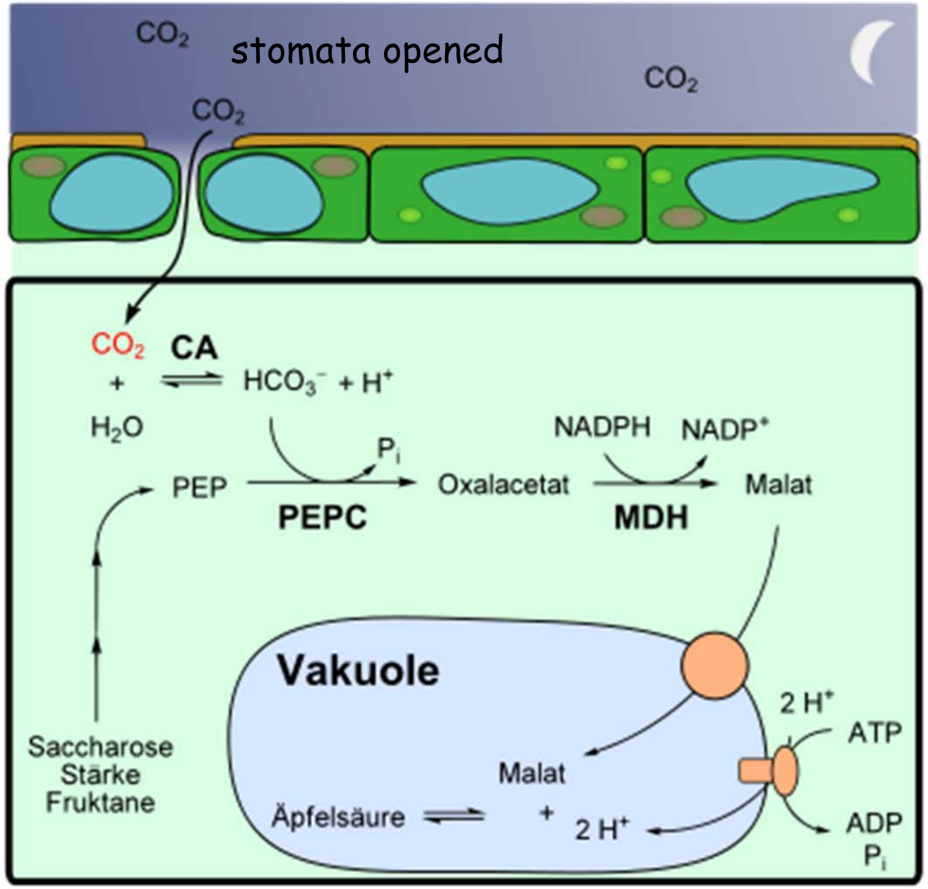
# The C4-pathway for $CO_2$-fixation



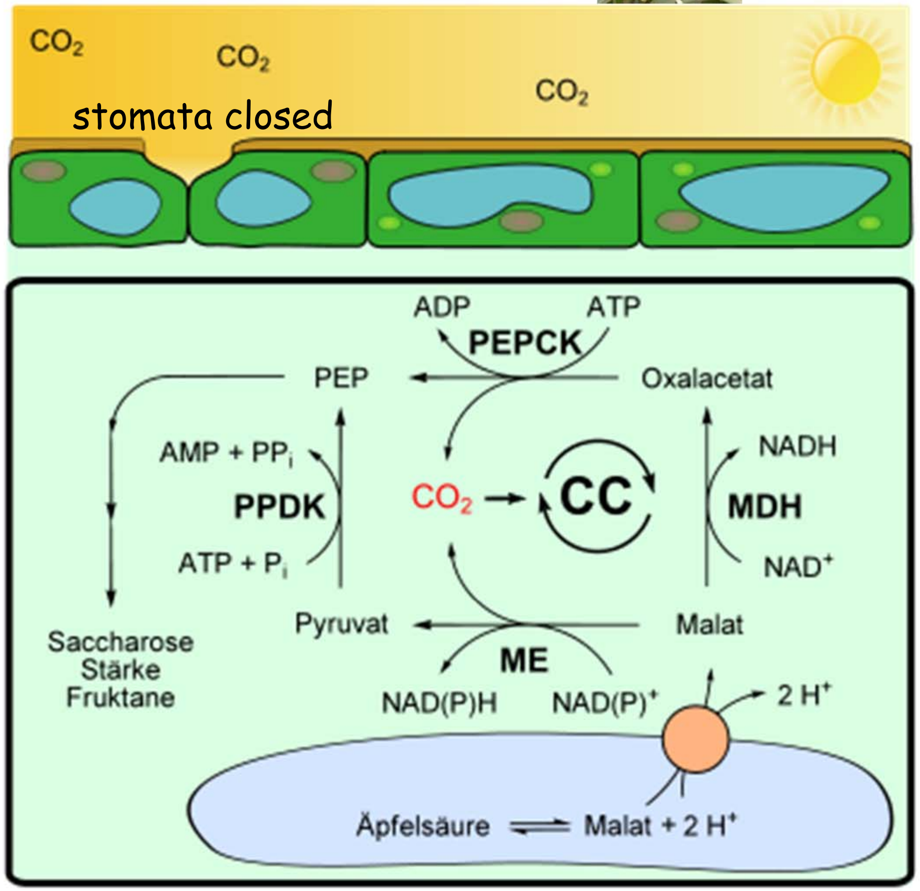

Leave structure of a $C_4$-plant



# CAM-photosynthesis: Crassulacean acid metabolism




Night: $CO_2$ is fixed as malate in mesophyll cells and stored in vacuoles.



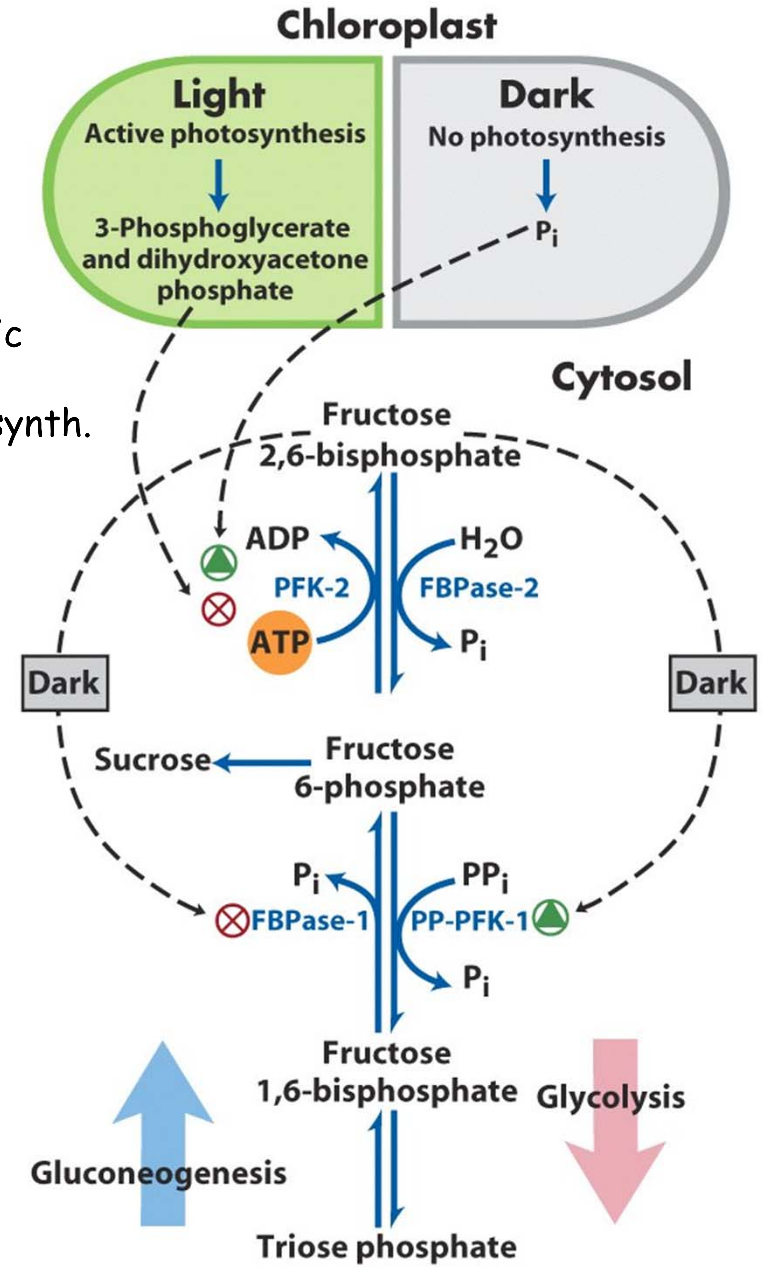

Day: malate is released from vacuoles into the stroma of chloroplasts where $CO_2$ is made available for the Calvin cycle.

Benefit: $CO_2$ concentration around RUBISCO during day and not night when photorespiration is the dominant reaction.

http://commons.wikimedia.org/wiki/File:CAM_cycle.svg?uselang=de

# Fructose 2,6-bisphosphate as regulator of sucrose synthesis

The concentration of the allosteric modulator F2,6BP is inversely proportional to the rate of photosynth.

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