Chapter 7:
PHOTOSYNTHESIS

1. Overview of Photosynthesis

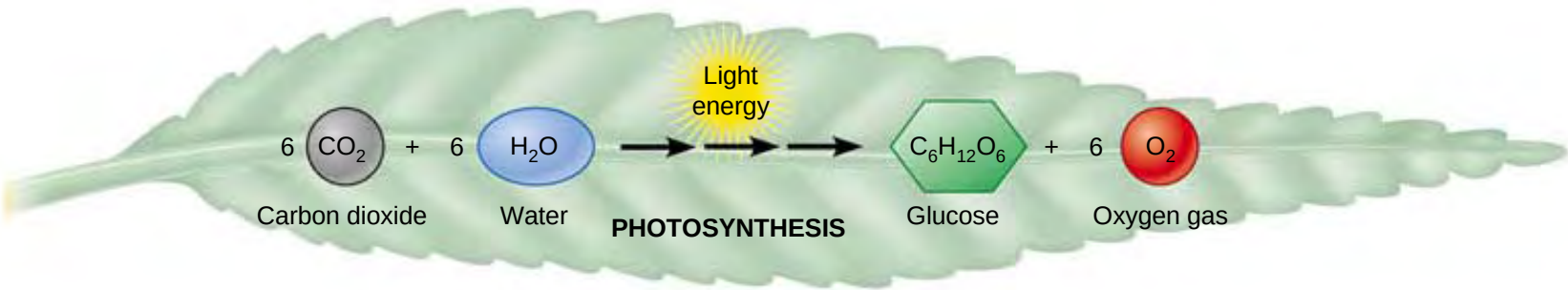
2. The “Light” Reactions

3. The “Dark” Reactions

1. Overview of Photosynthesis

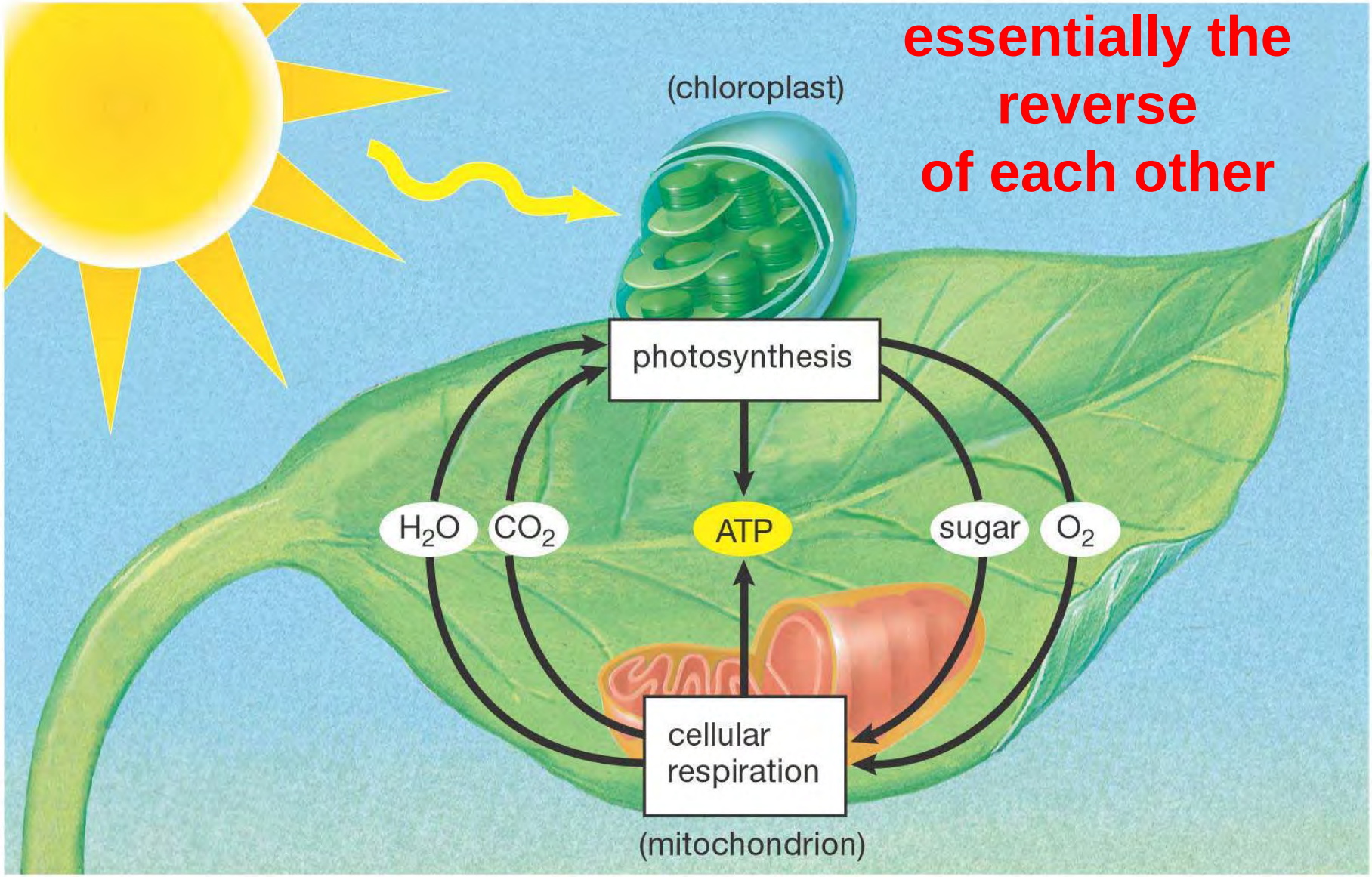
What is Photosynthesis?

The process of converting light energy (kinetic) into energy stored in the covalent bonds of glucose molecules (potential).

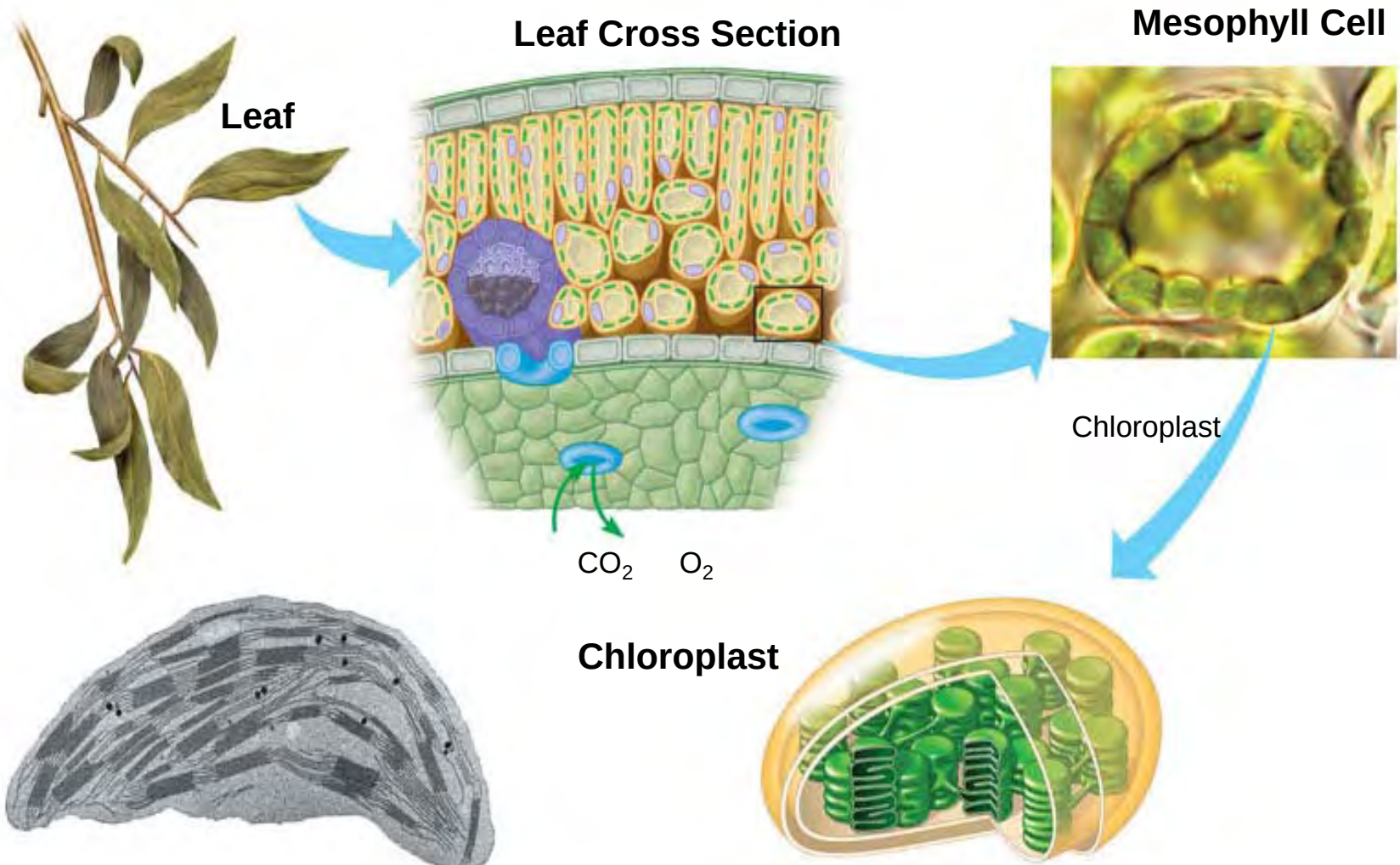


- **carried out by photo<u>autotrophs</u>**
  - **<u>plants</u>, phytoplankton, cyanobacteria (any photosynthetic organism)**
- **the basis of almost all ecosystems**
  - **all "food energy" ultimately comes from the sun**
  - **source of all atmospheric oxygen (O_2)**

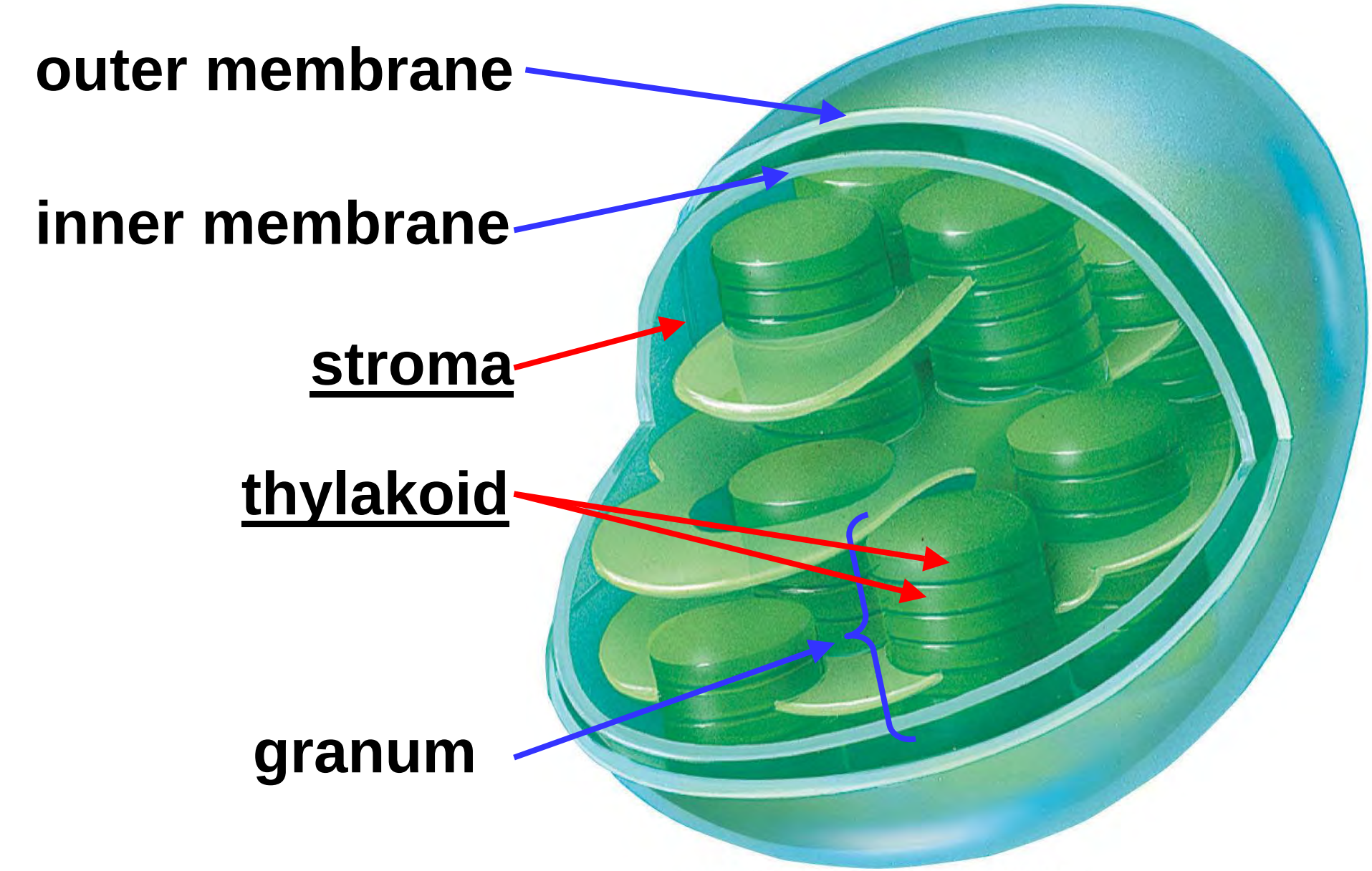
Photosynthesis vs Respiration



Photosynthesis occurs in Chloroplasts

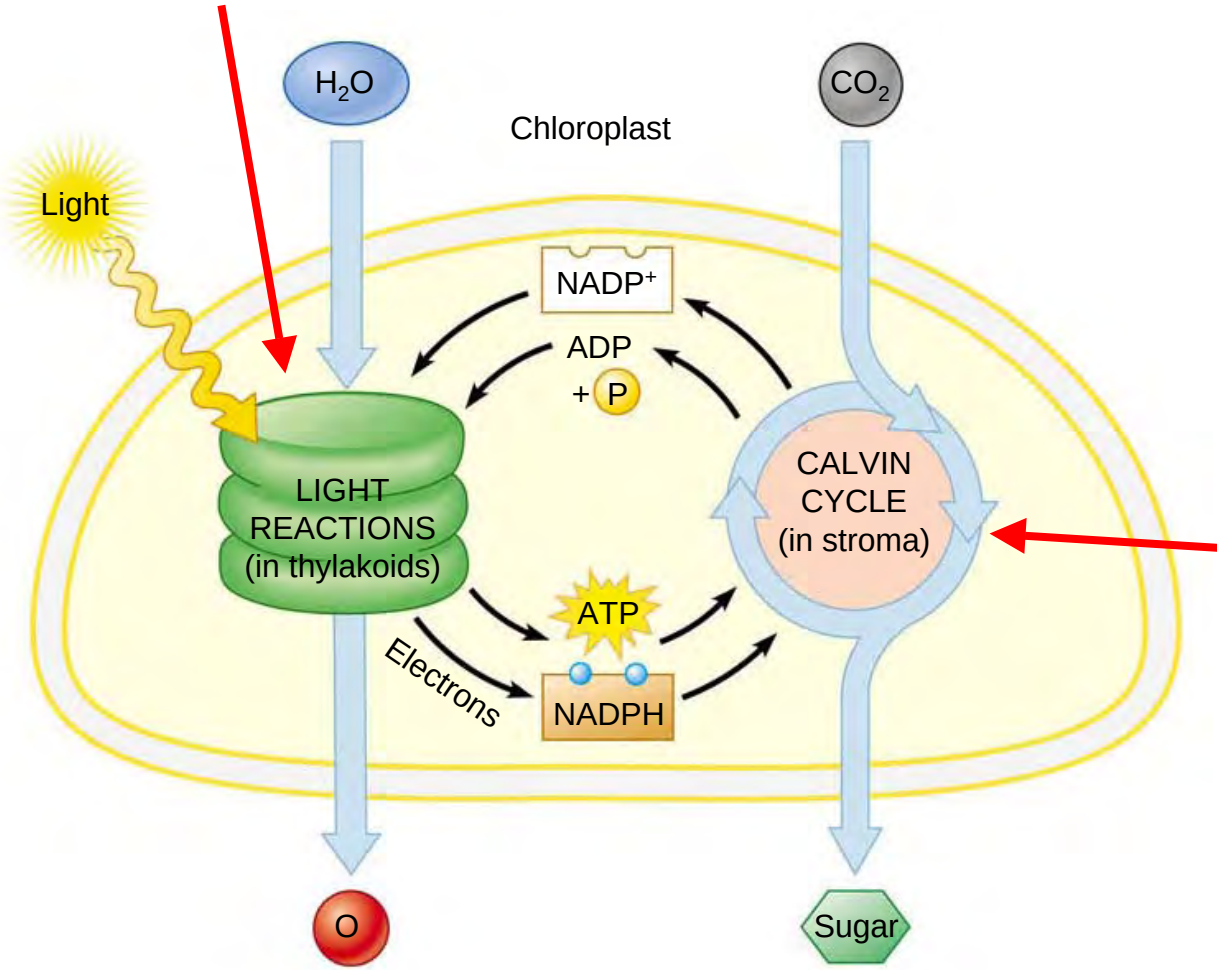


The Chloroplast



Photosynthesis consists of 2 sets of Reactions

The light-dependent or “Light” Reactions:



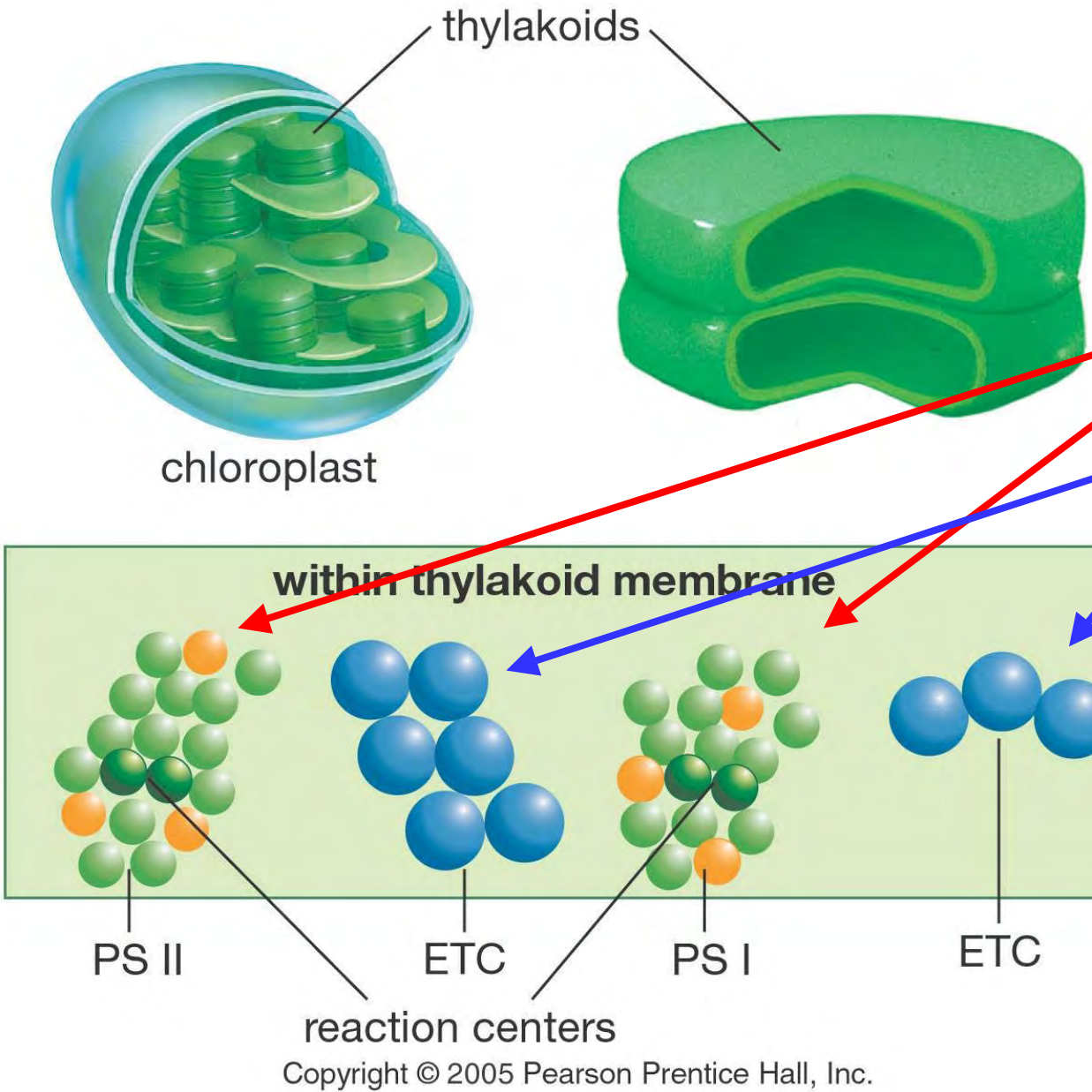
- **convert sunlight energy into chemical energy (stored in ATP & NADPH)**

“Dark” Reactions (Calvin cycle):

- **use chemical energy from light reactions to make glucose**

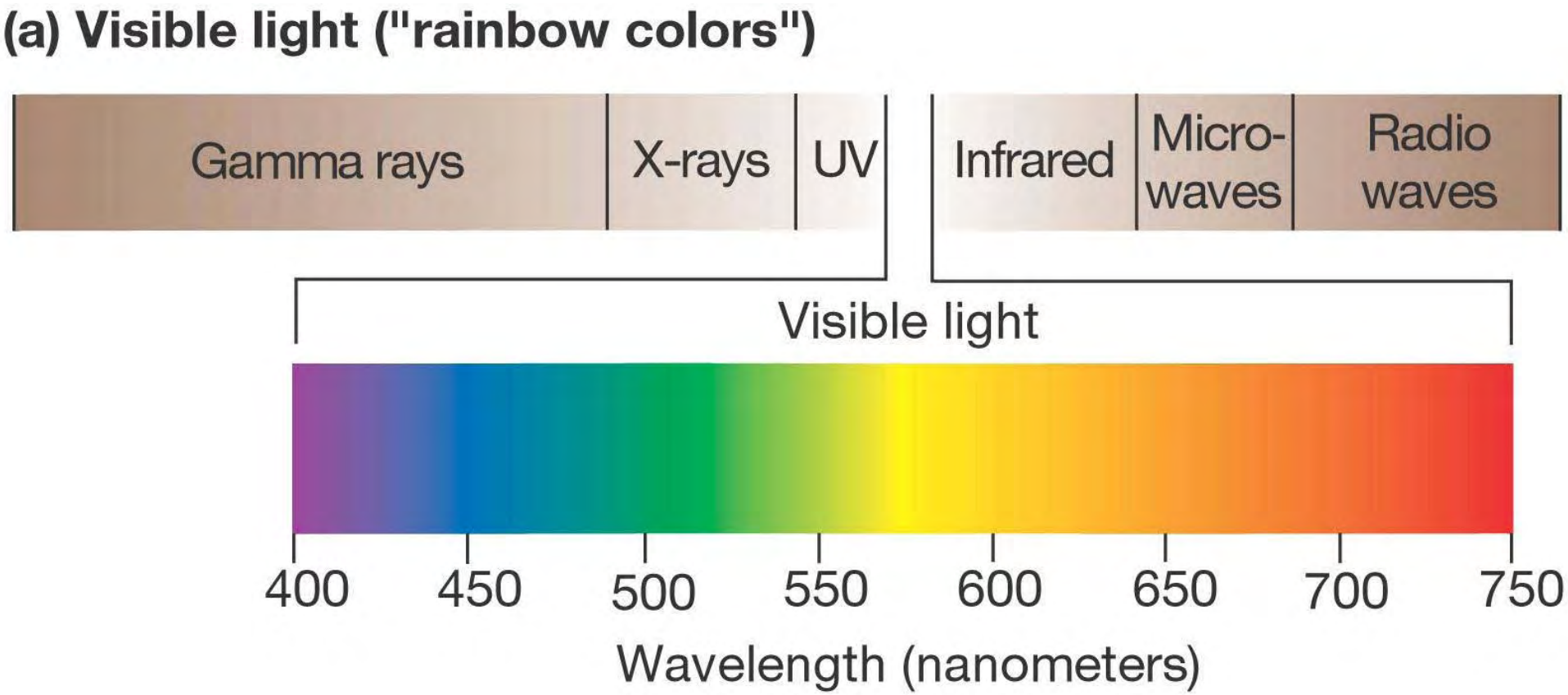
2. Light-dependent ("Light") Reactions

Light Reactions occur in Thylakoids



A variety of light-absorbing <u>pigments</u> & <u>electron transport proteins</u> are embedded within the thylakoid membrane

The Pigments absorb “Visible” Light



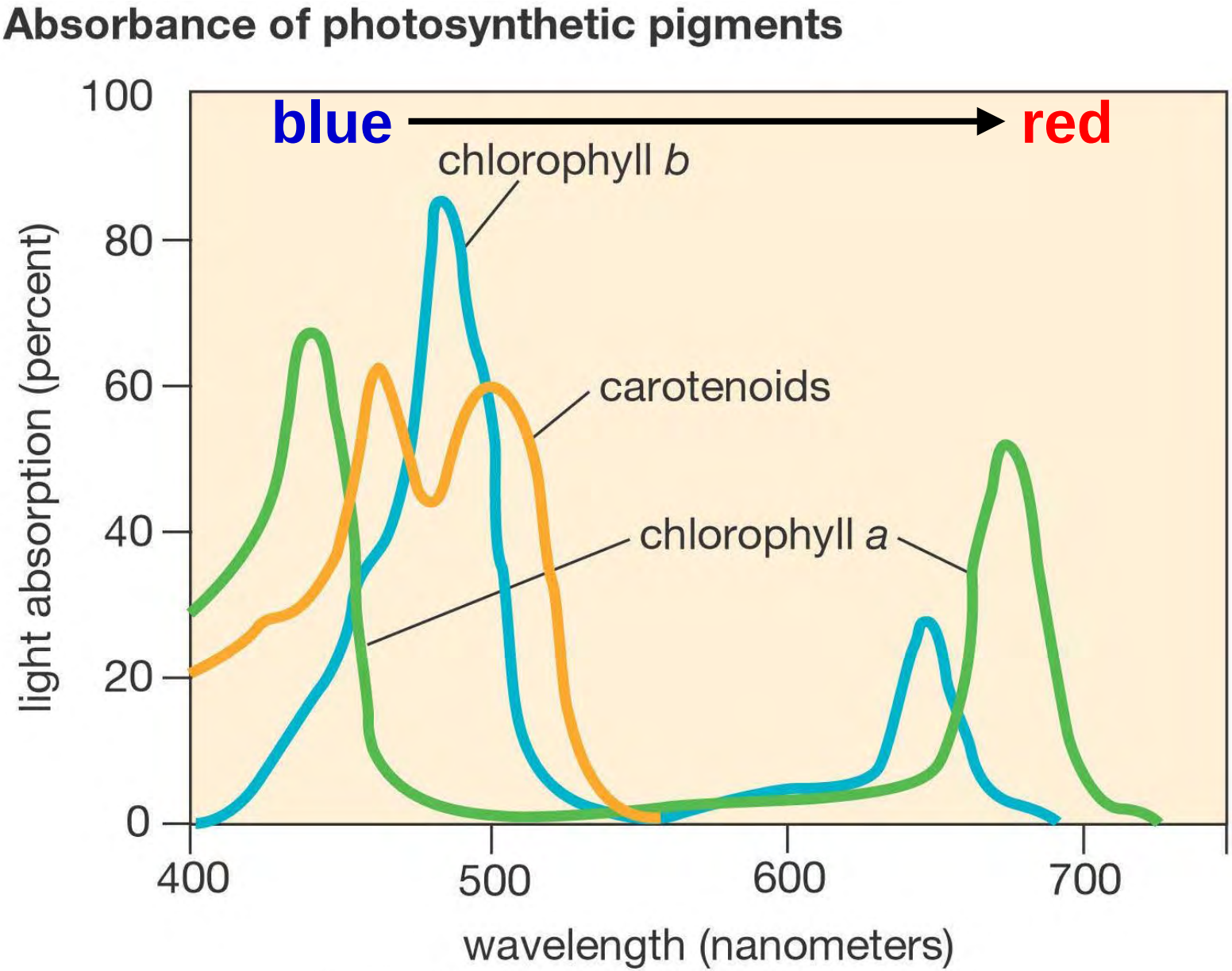
Chlorophyll a & b:

- **the major pigments (<u>absorb</u> red, blue…, <u>reflect</u> green)**

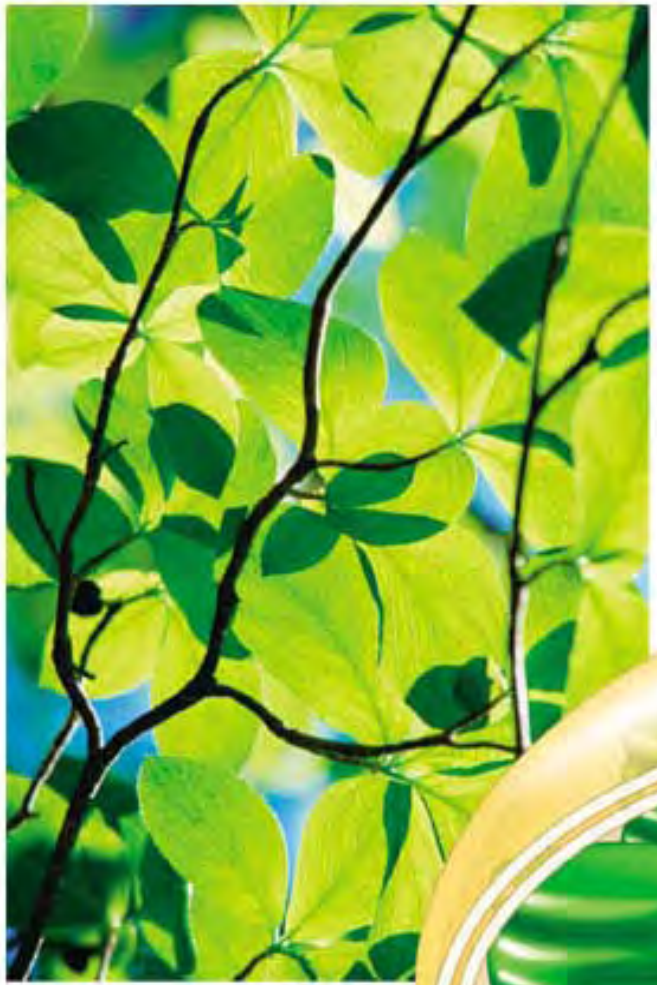
Carotenoids (e.g., β-carotene)

- **accessory pigments (<u>absorb</u> green, blue, <u>reflect</u> red, yellow)**

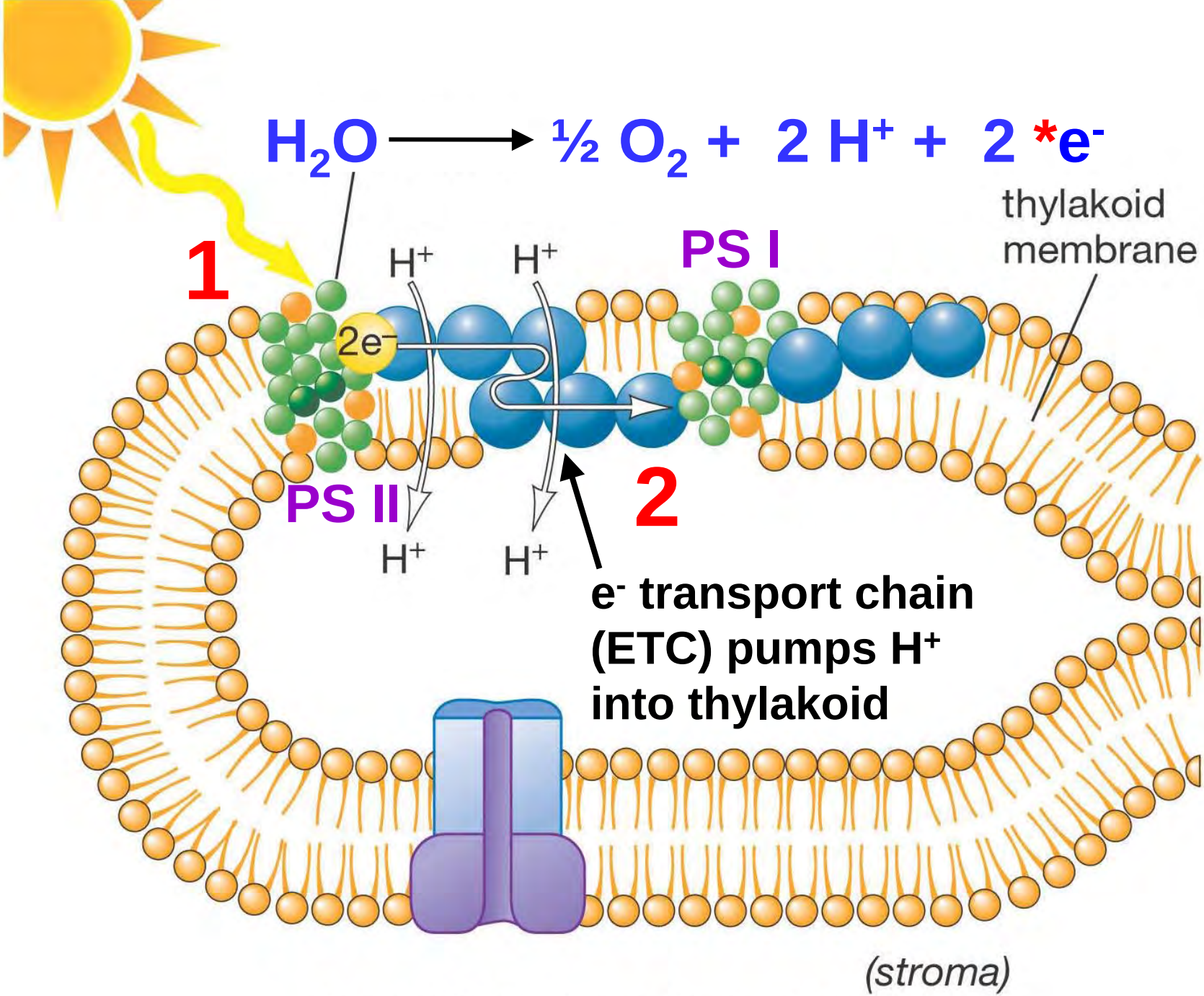
Absorption Range for each Pigment

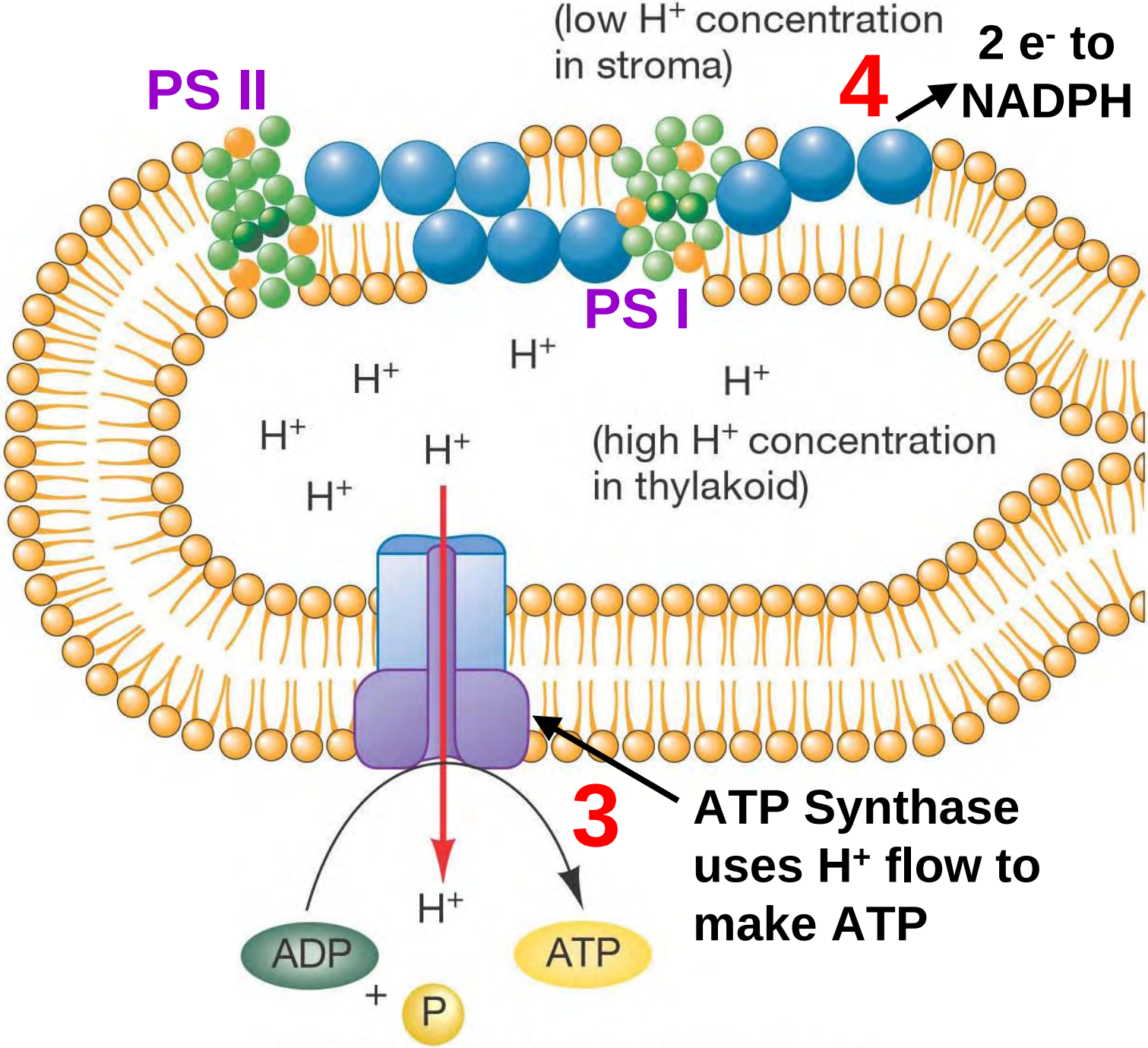


Chlorophyll absorbs “non-green” light energy



- **green light passes on through or is reflected, causing the leaves to appear green**





Light Energy absorbed by Pigments Fuels 4 General Steps of the "Light Reactions":

1) H_2O split to O, 2 H^+ & 2 high energy e^- ($*e^-$) in PS II

$$H_2O \xrightarrow{\text{sunlight}} O_2 + H^+ + *e^-$$

2) Energy released by a series of $*e^-$ transfers is used to generate H^+ gradient

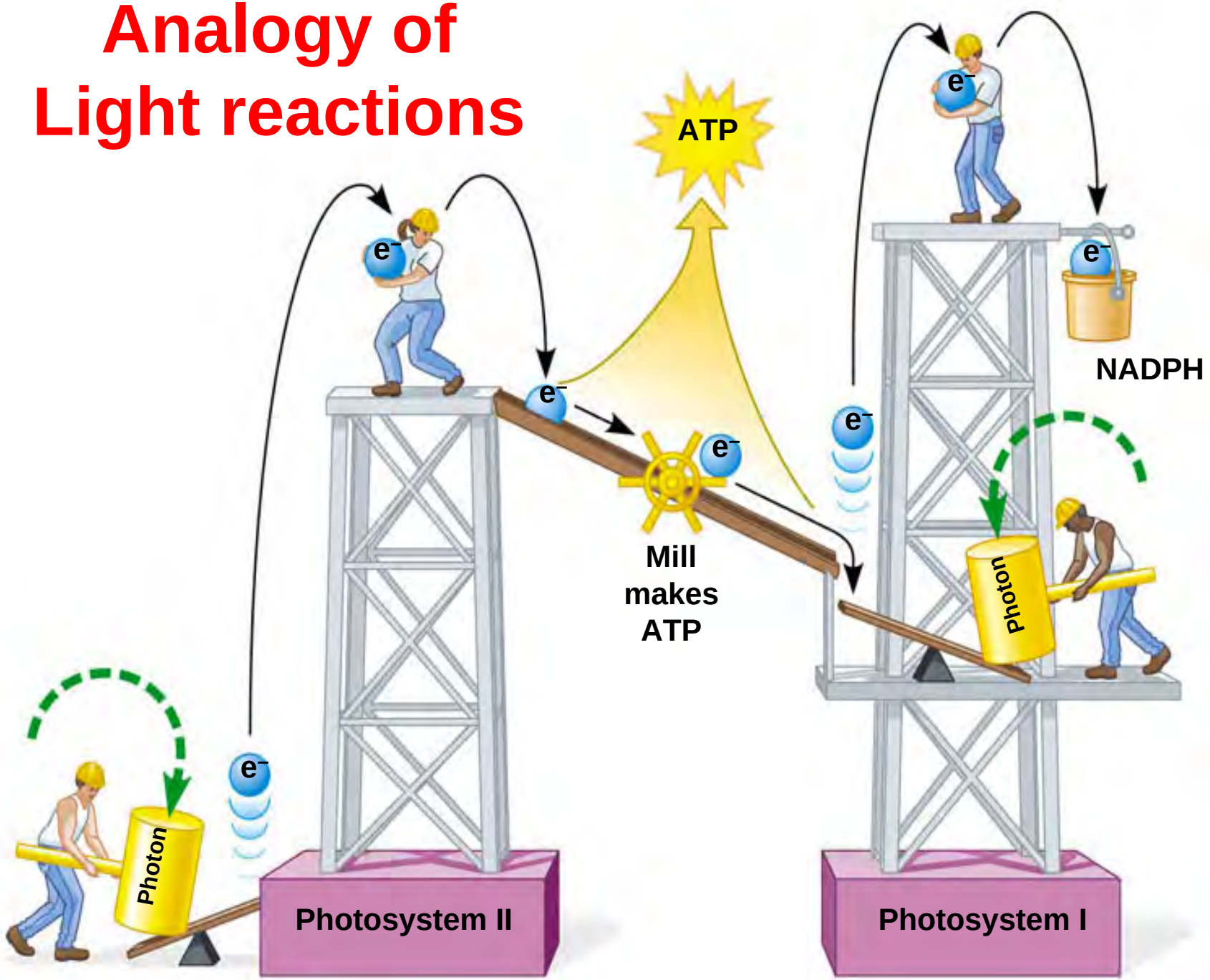
- H^+ accumulates inside the thylakoid membrane

3) H^+ gradient used to make ATP (chemiosmosis)

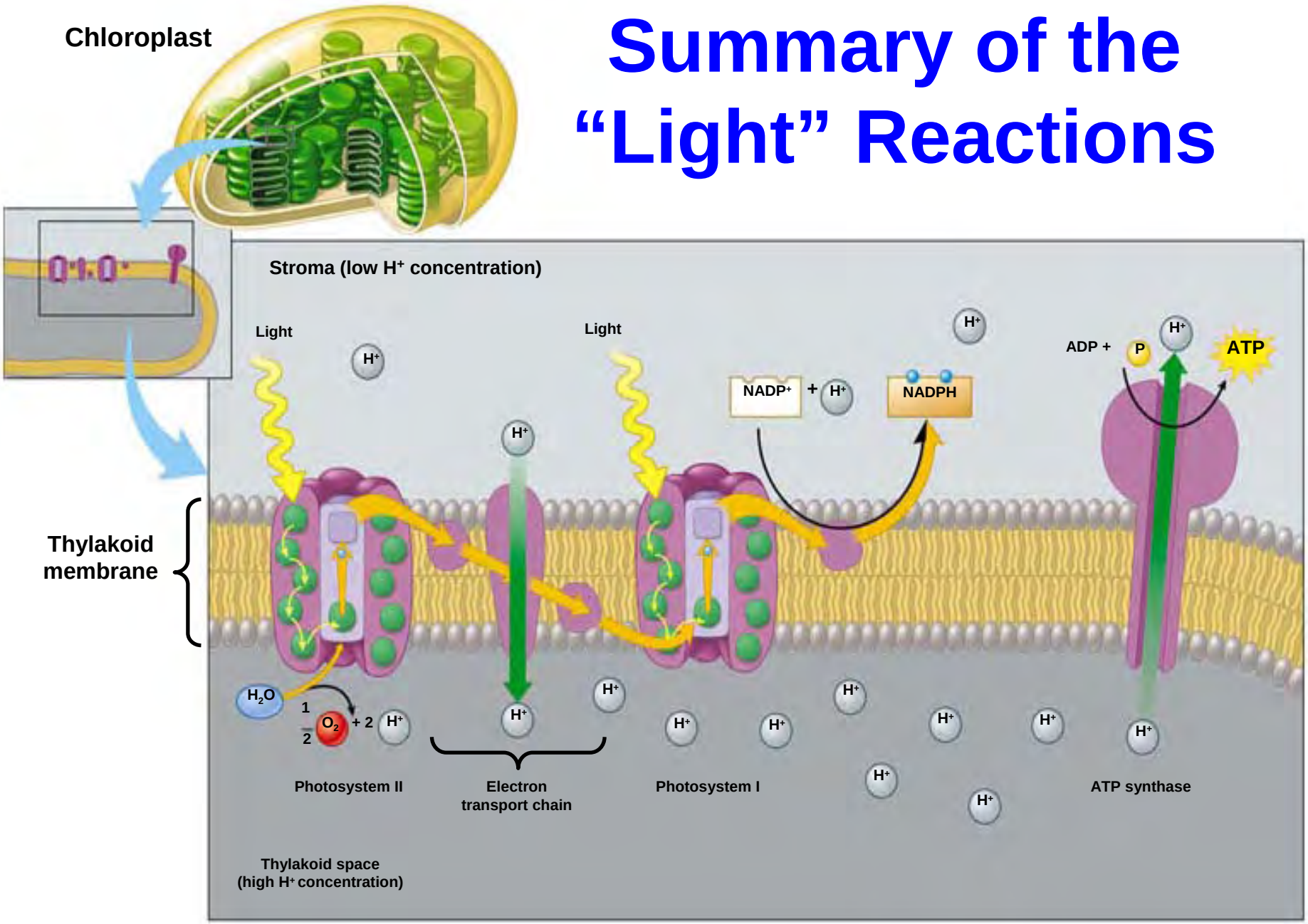
4) $*e^-$ "re-energized" in PS I, passed on to $NADP^+$

- $*e^-$ ends up in NADPH (an electron carrier)

Analogy of Light reactions



Summary of the "Light" Reactions



3. Light-independent ("Dark") Reactions

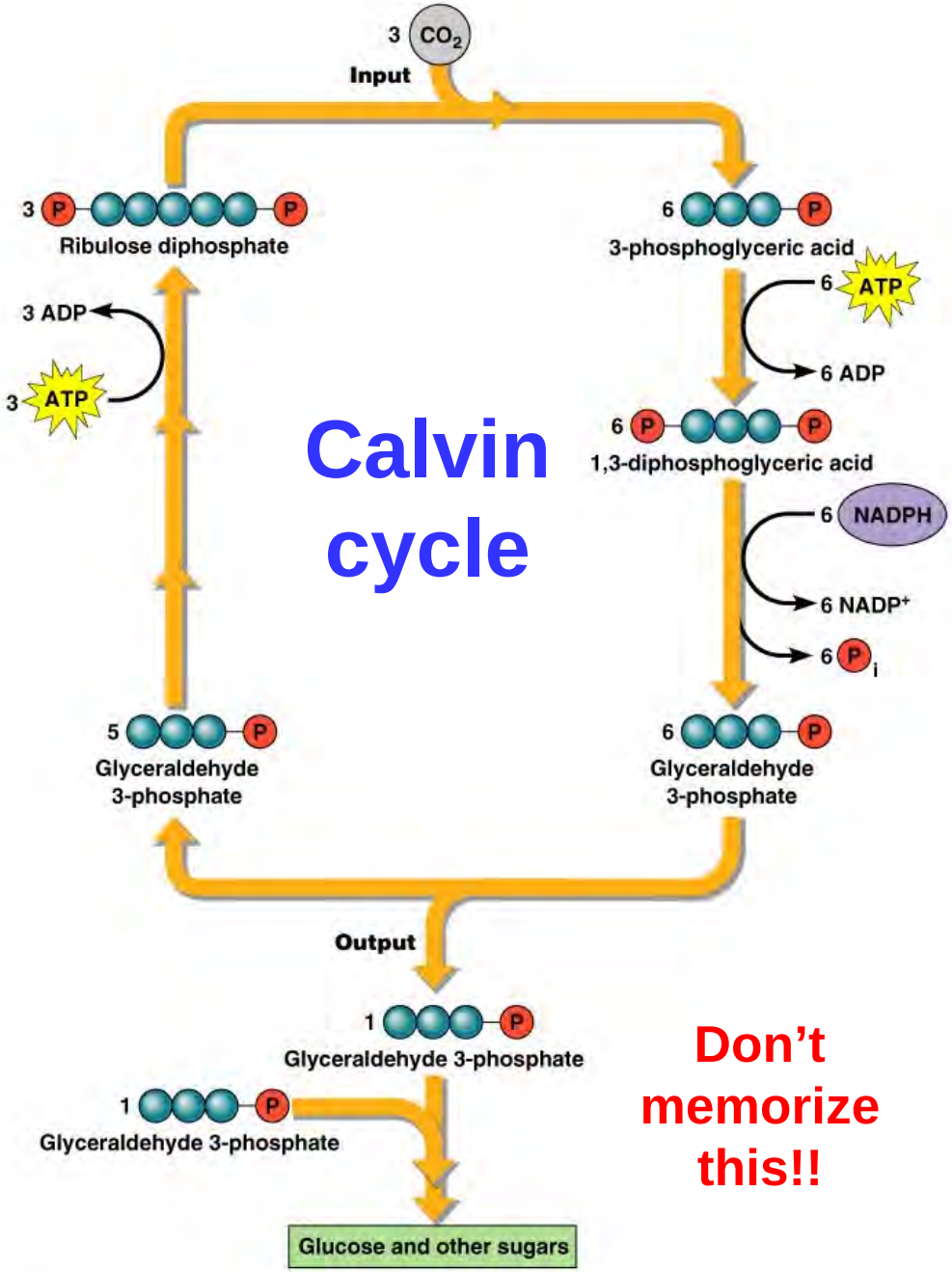
The “Dark” Reactions

A series of reactions called the Calvin cycle that synthesize glucose from CO_2 and H_2O:

$$CO_2 + H_2O \xrightarrow{\text{ATP, NADPH}} C_6H_{12}O_6 \text{ (glucose)}$$

- **uses energy stored in ATP and NADPH**
  - **produced by the light reactions**
- **can occur in dark (doesn’t require light directly)**
  - **also occurs during daylight!**
- **takes place in the stroma of chloroplasts**
  - **outside the thylakoids**

"Dark" Reactions

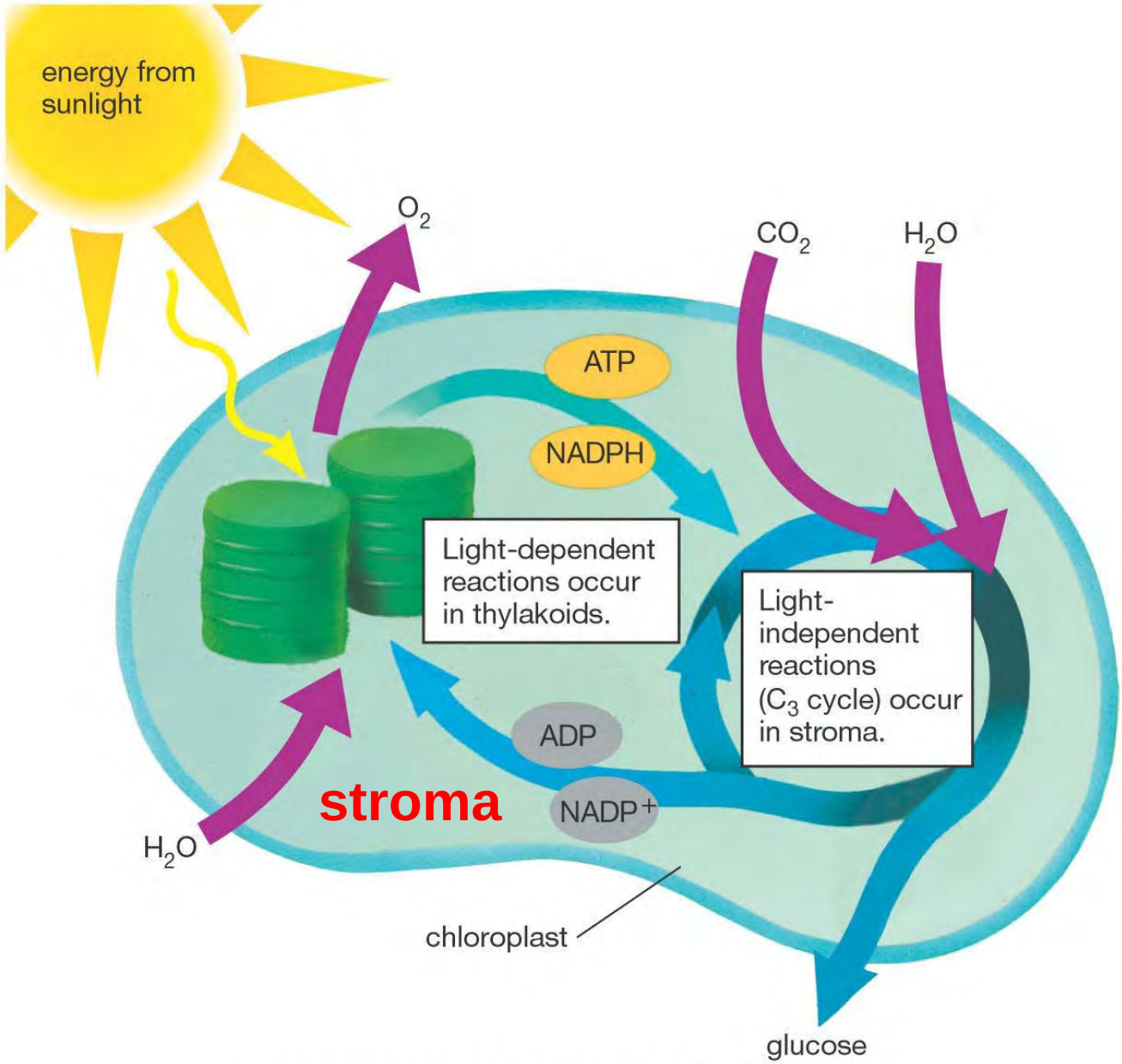


Involves an anabolic pathway known as the Calvin cycle:

- **endergonic reactions of this pathway are fueled by ATP & NADPH from the "light" reactions**
- **resulting sugars can be used as a source of energy or to build other organic molecules**

Don't memorize this!!

Summary of Photosynthesis



Key Terms for Chapter 7

- photoautotroph
- chloroplast, thylakoid, stroma
- chlorophyll, carotenoids
- ATP, NADPH
- electron transport chain (ETC)
- ATP synthase
- Light reactions, dark reactions, Calvin cycle

Relevant Review Questions:

1-6, 8-10, 12