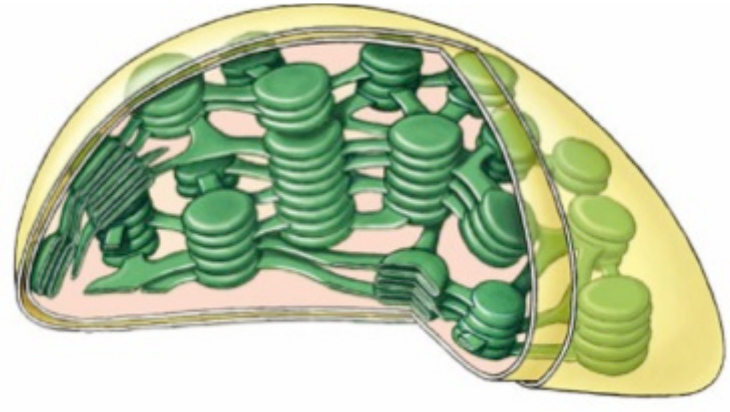
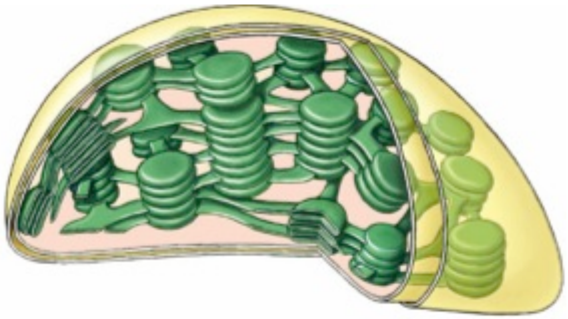


Ch. 8 - Photosynthesis
Life from Light and Air

Objectives



- State the overall equation for photosynthesis.
- Describe the role of **light** and **chlorophyll** in photosynthesis.
- Describe the structure and function of a **chloroplast**.
- Describe what happens in the **light-dependent reactions**.
- Describe what happens in the **light-independent reactions**.

8.2

http://www.youtube.com/watch?v=pdgkuT12e14

Plants are energy producers

- Like animals, plants need **energy** to live
- Plants use sunlight to produce their own food (and energy)
- Plants are **producers** (**autotrophs**)
- Animals are **consumers** (**heterotrophs**)

How do plants make energy and food?

- Plants use the **energy** from the **sun**
  - to generate **ATP** (and **electrons**)
  - to make **sugars** (glucose, sucrose, cellulose, starch, and more)

Building plants from sunlight and air

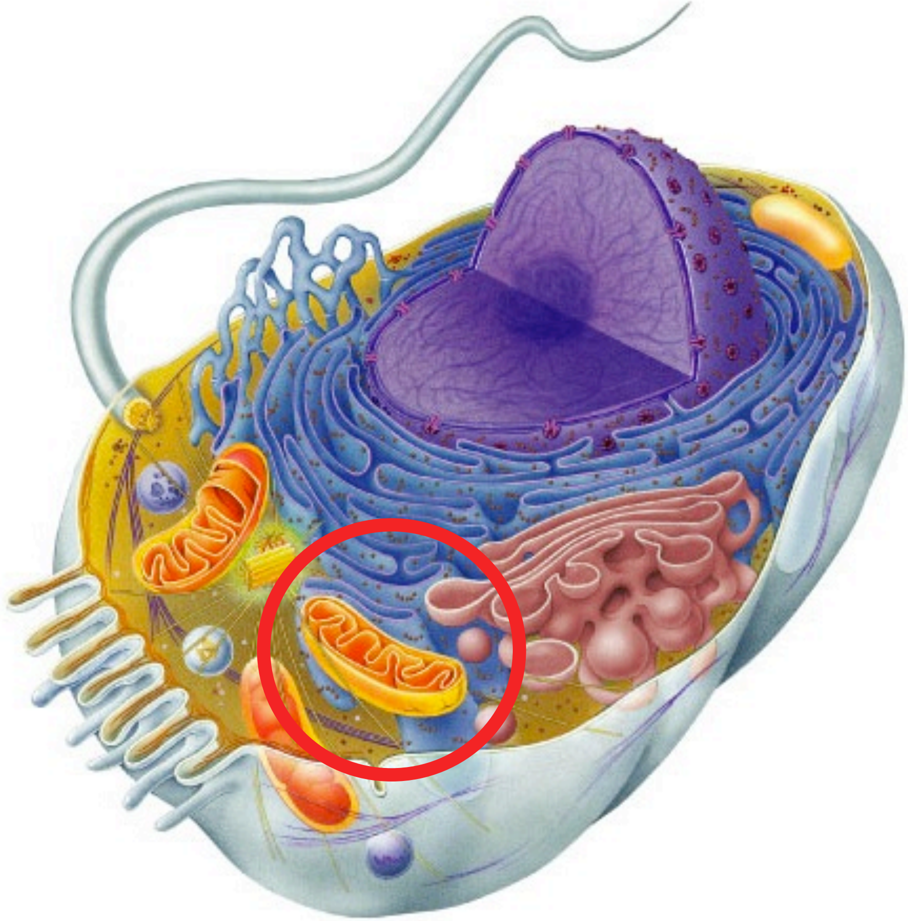
TWO processes

1. ENERGY-building (**Light-Dependent**) reactions
   - collect solar energy
   - use it to *make* **ATP**
2. SUGAR-building (**Light-Independent**) reactions
   - *use* **ATP**
   - collect CO_2 (from air) and H_2O
   - use all to build **sugars**

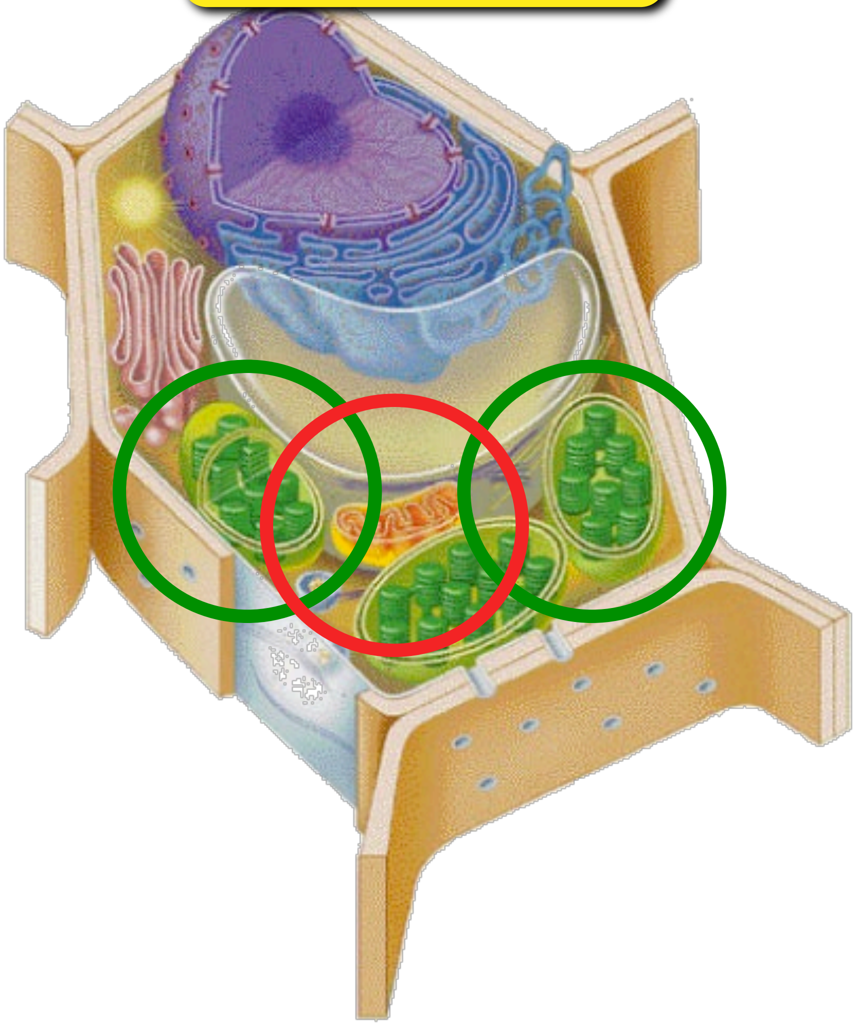
$$6CO_2 + 6H_2O + \text{sun energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

Chloroplasts are only in plants

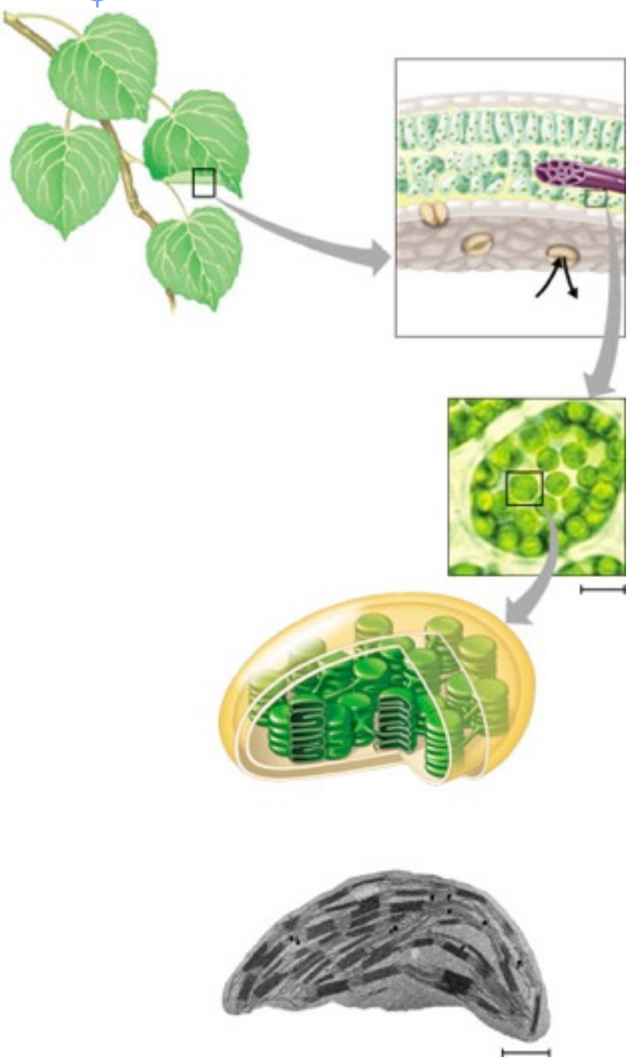
animal cells

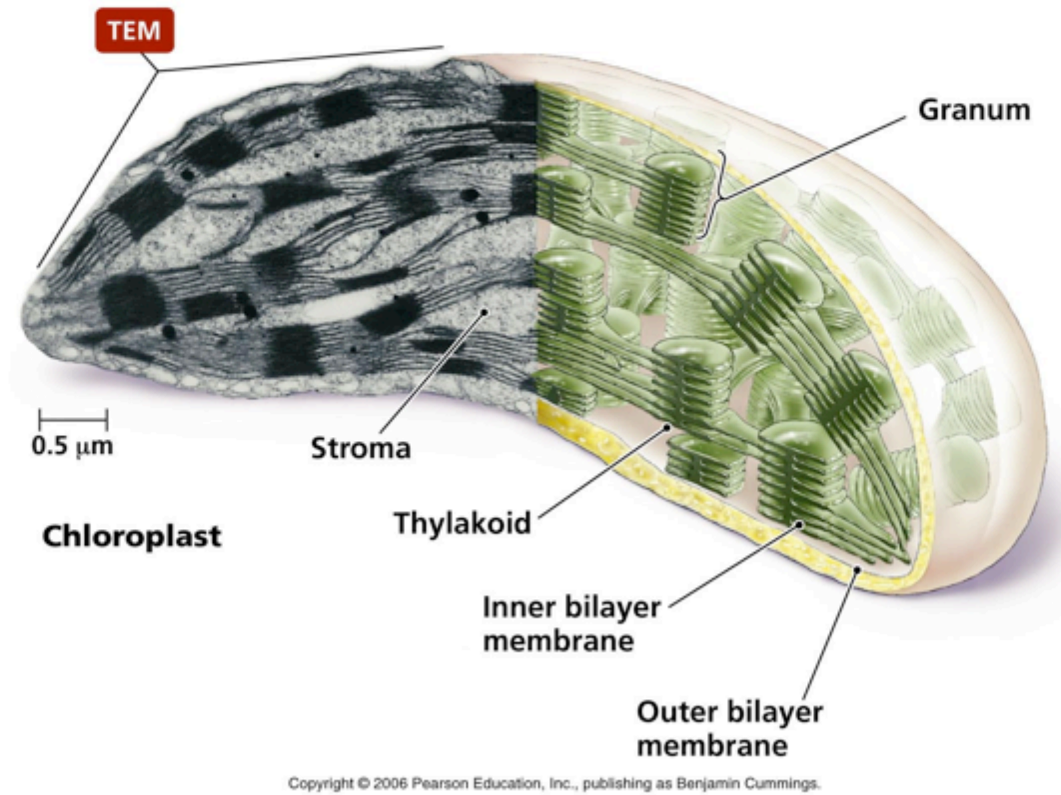


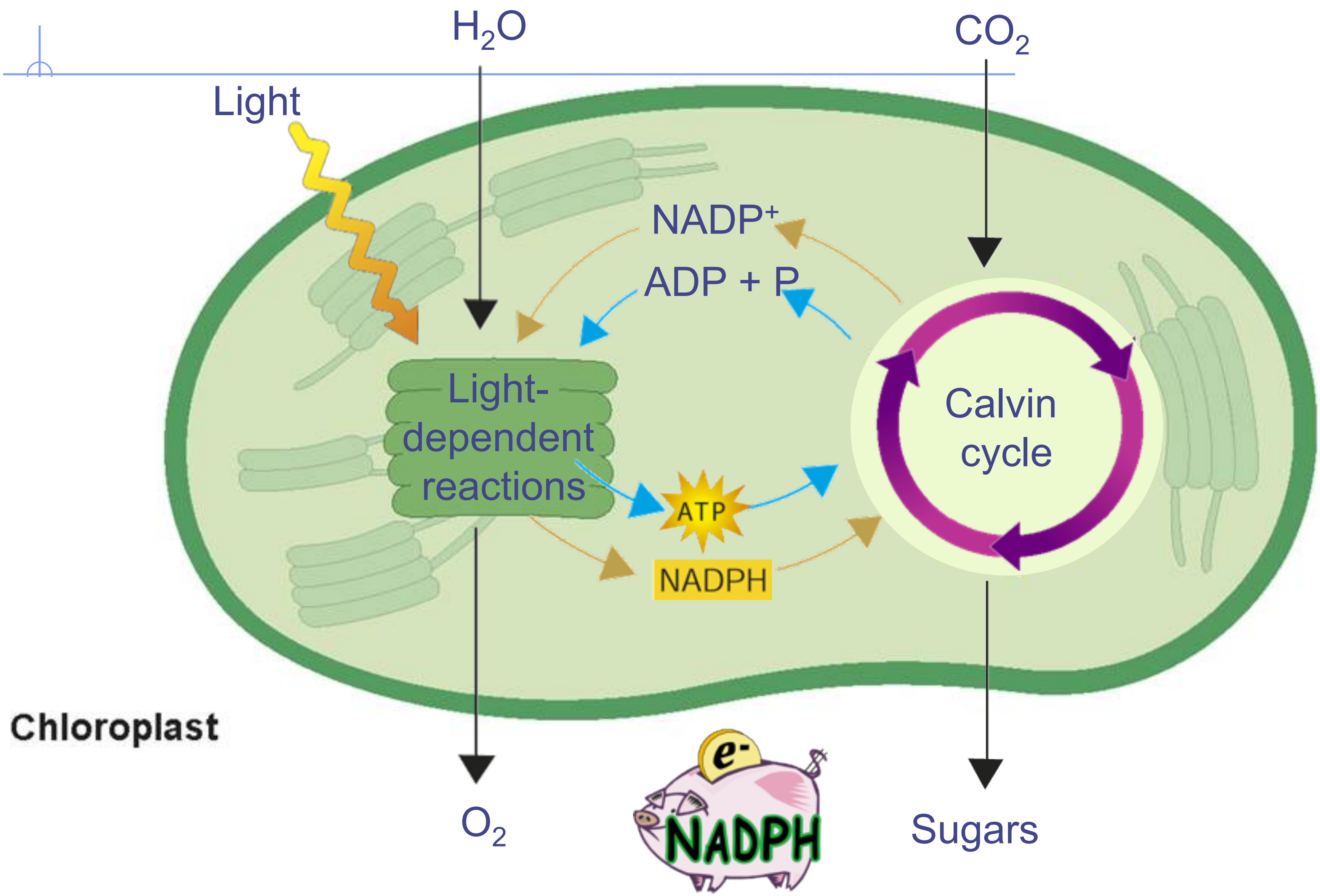
plant cells



Chloroplasts

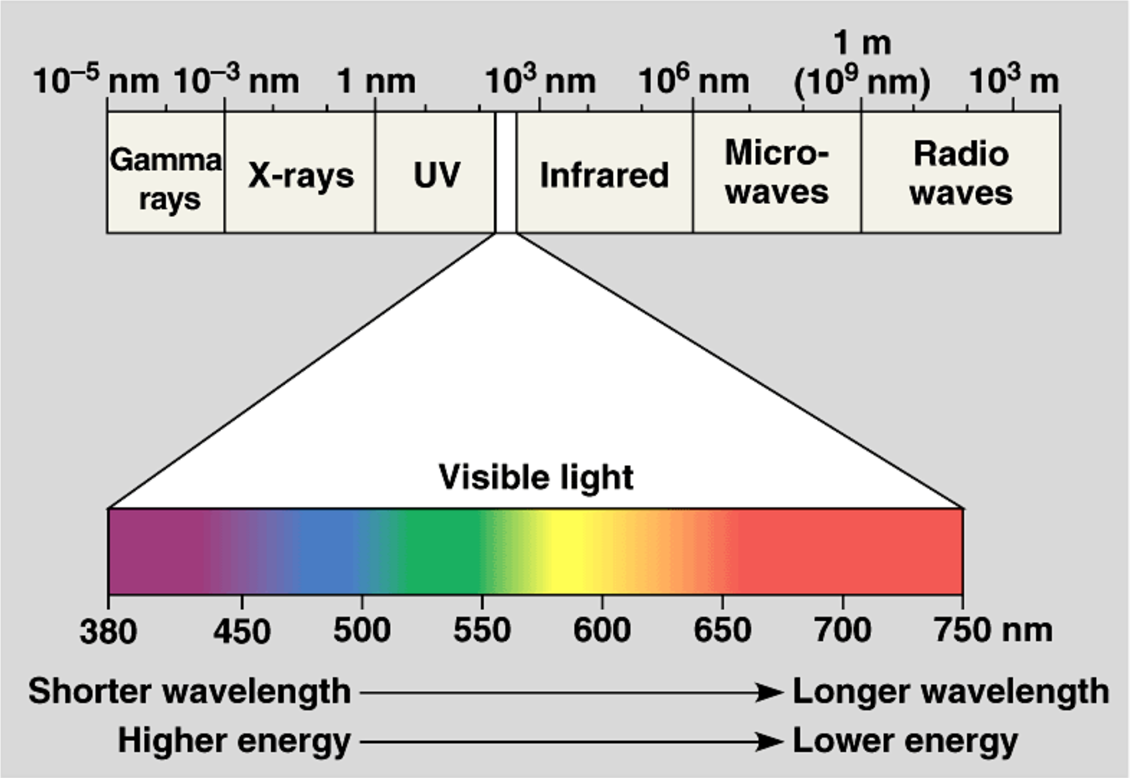





H_2O
CO_2
Light
$NADP^+$
ADP + P
Light-dependent reactions
ATP
NADPH
Calvin cycle
Chloroplast
O_2
e-
NADPH
Sugars

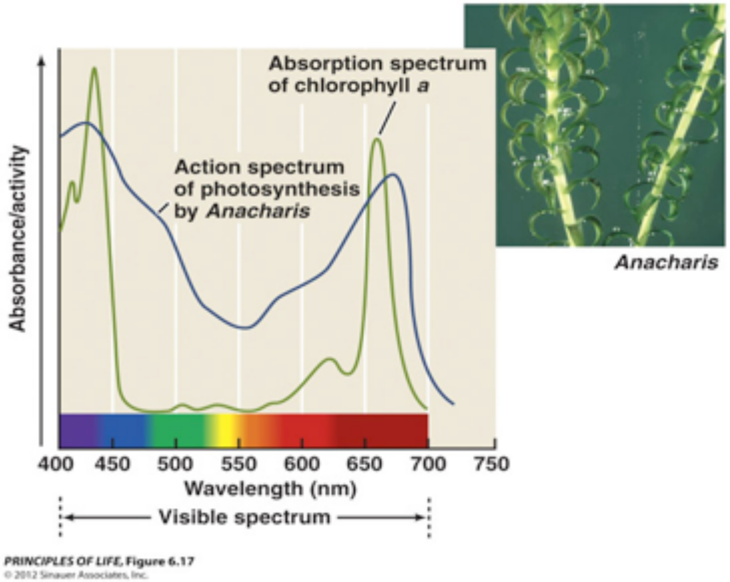
A Look at Energy from Light

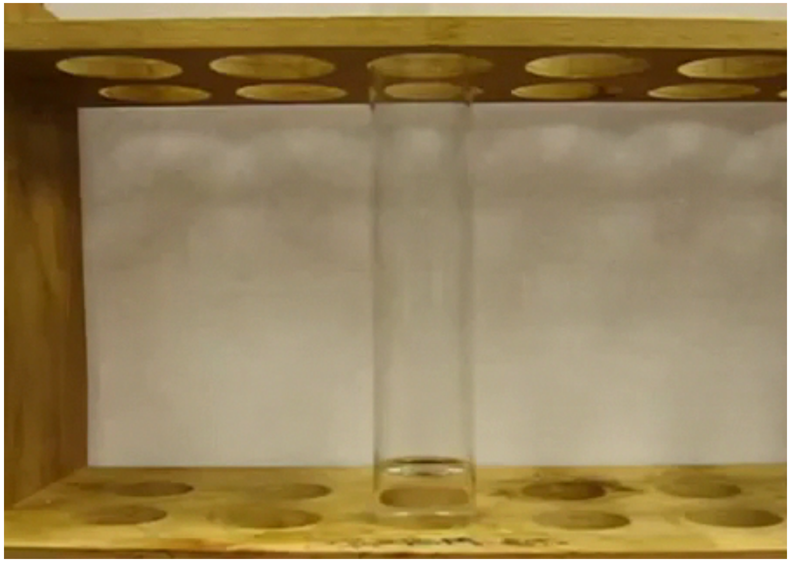
- How does sunlight provide energy to plants/trees?



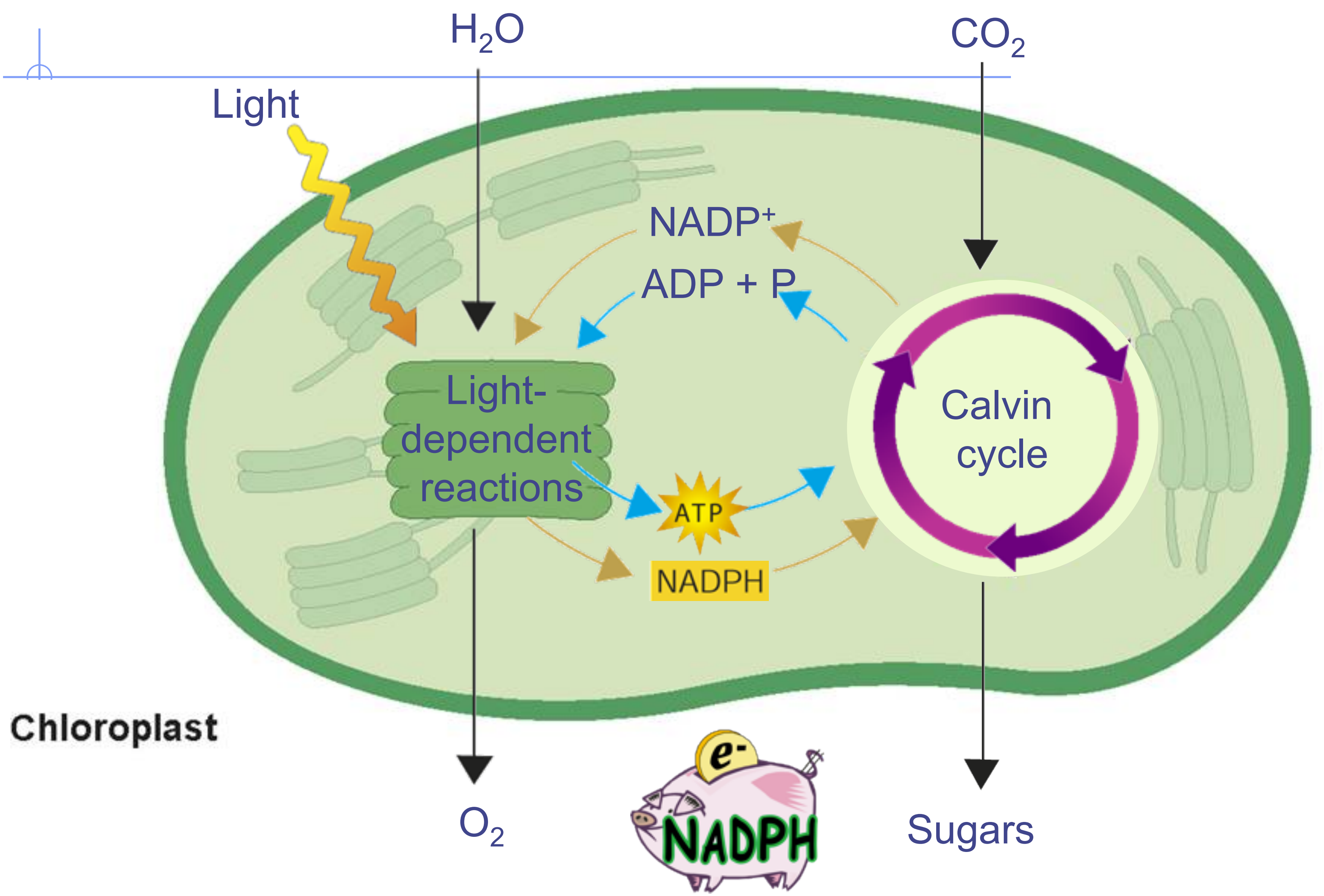
Absorption Spectrum

- Photosynthesis gets energy by absorbing wavelengths of light
- **chlorophyll *a*** absorbs **red** and **blue** wavelengths and *not* **green**
- accessory pigments: chlorophyll b, carotenoids, xanthophylls

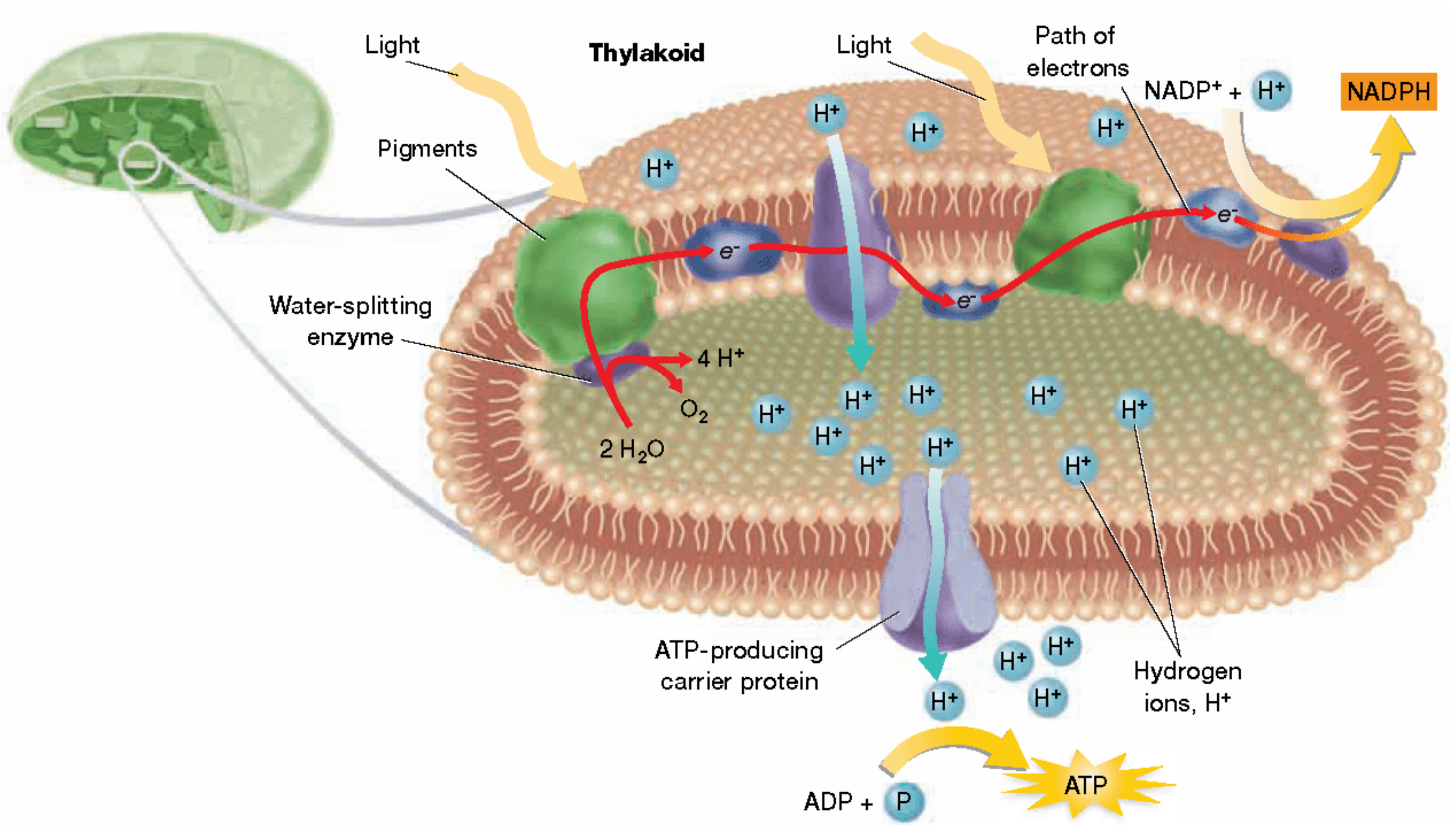


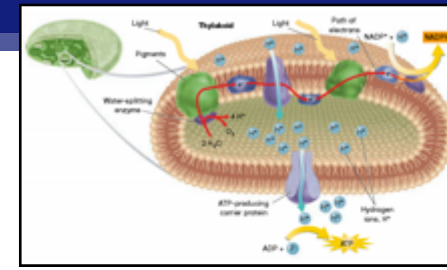


http://www.youtube.com/watch?v=u6jD0hJO-28

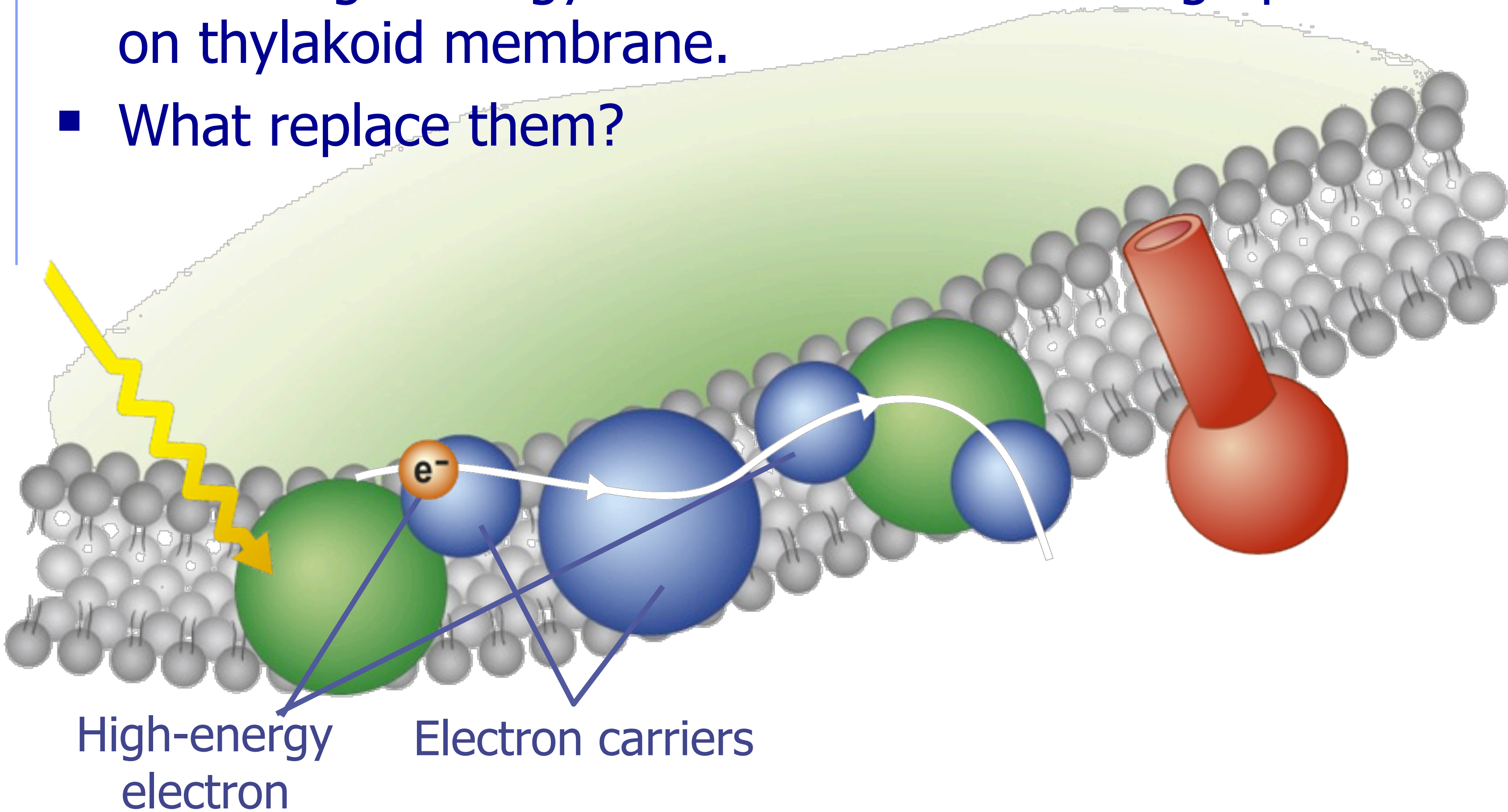

H$_2$O
CO$_2$
Light
NADP$^+$
ADP + P
Light-dependent reactions
Calvin cycle
ATP
NADPH
Chloroplast
e-
NADPH
O$_2$
Sugars

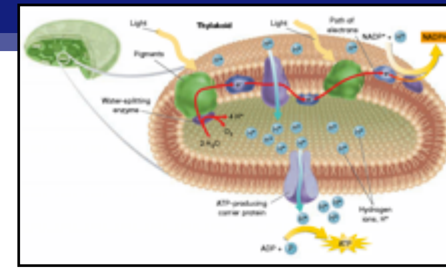
Light-Dependent Reactions: ETC



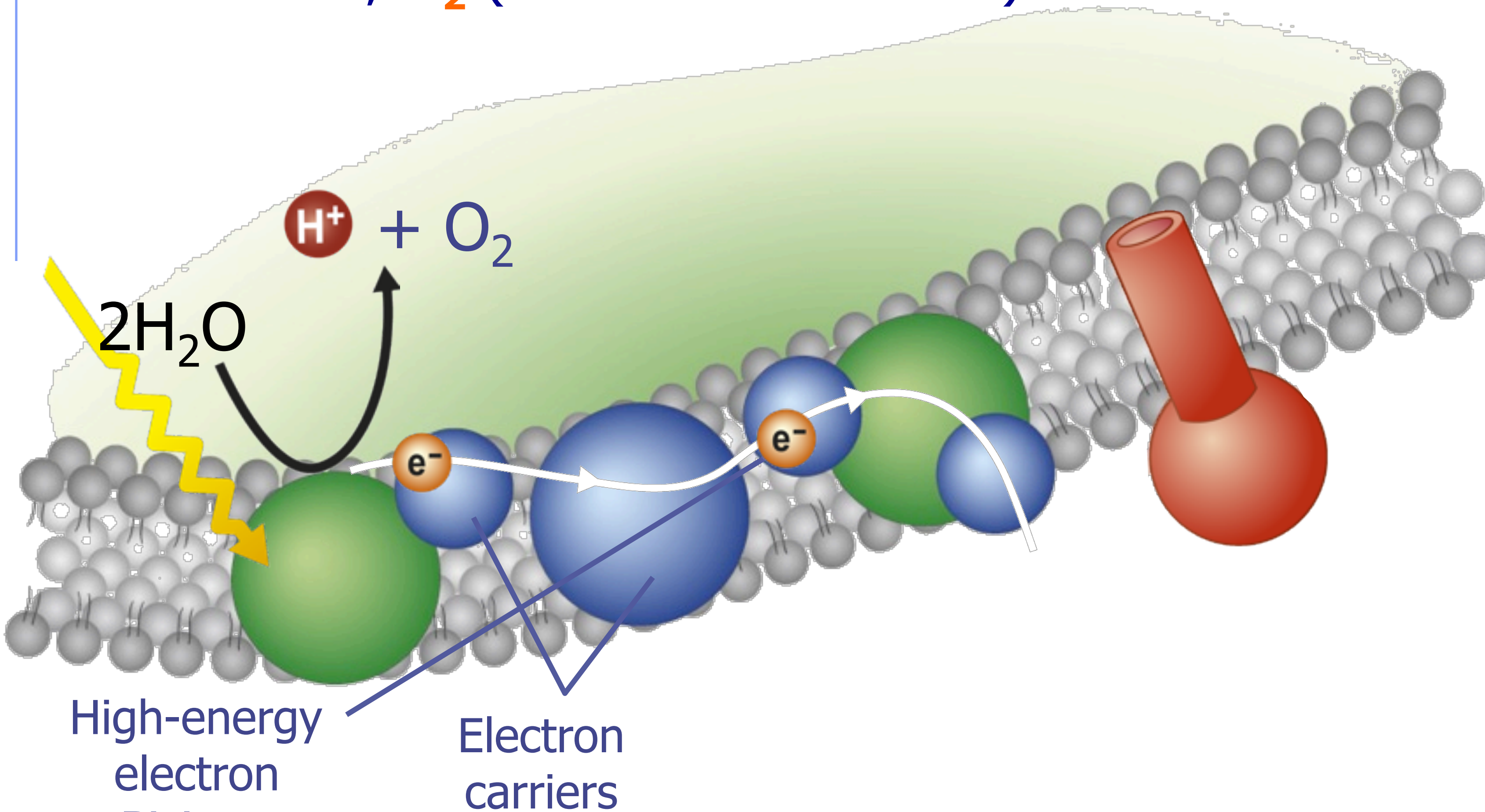


- **Sunlight** excites the electrons in chlorophyll.
- These high-energy **electrons** move through proteins on thylakoid membrane.
- What replace them?

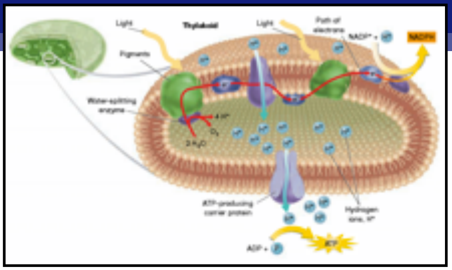


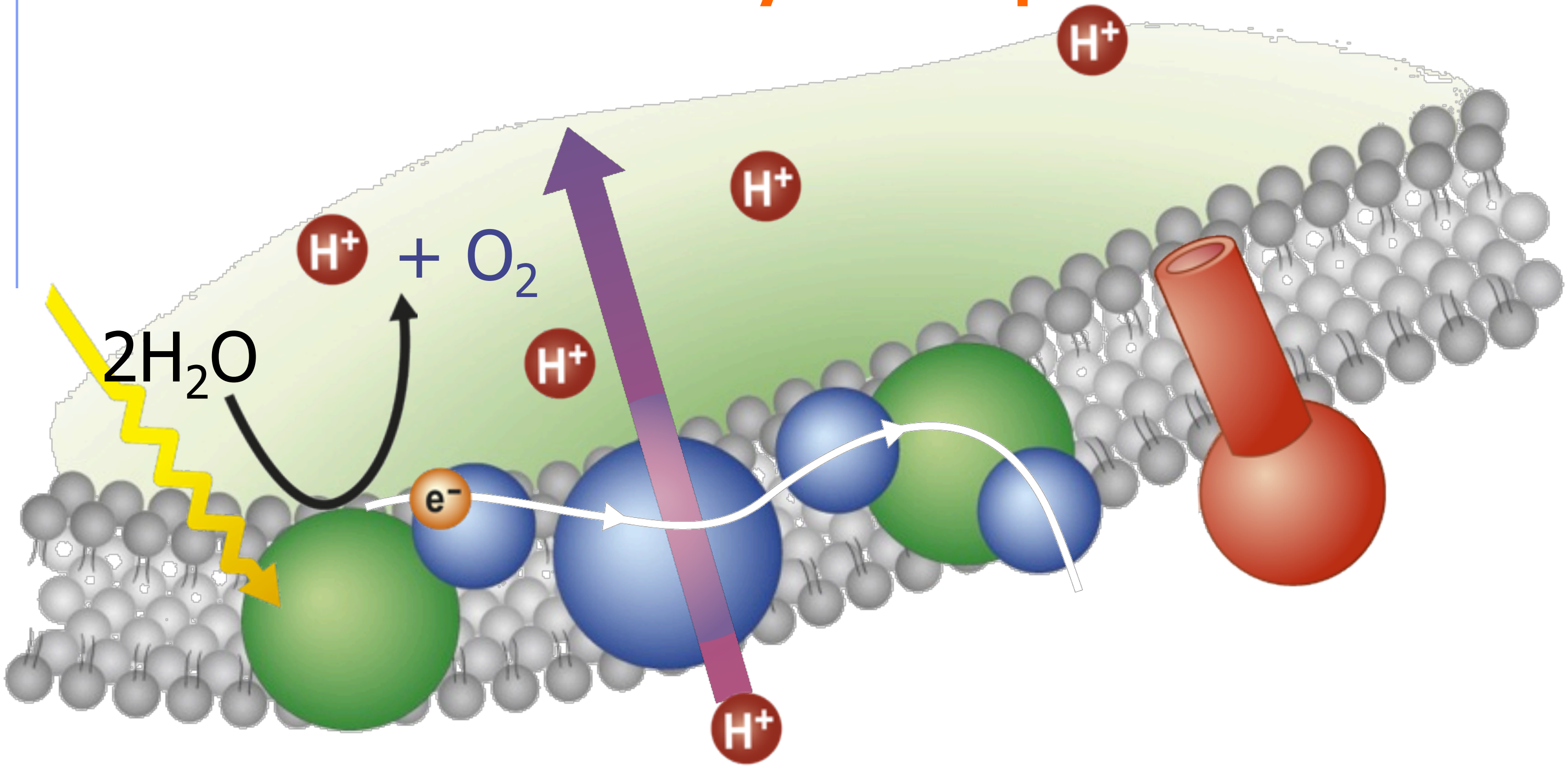


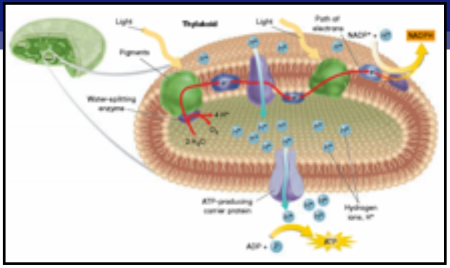
- **Water** molecules splits into…
- **electrons**, **O_2** (released into the air) and **H^+**



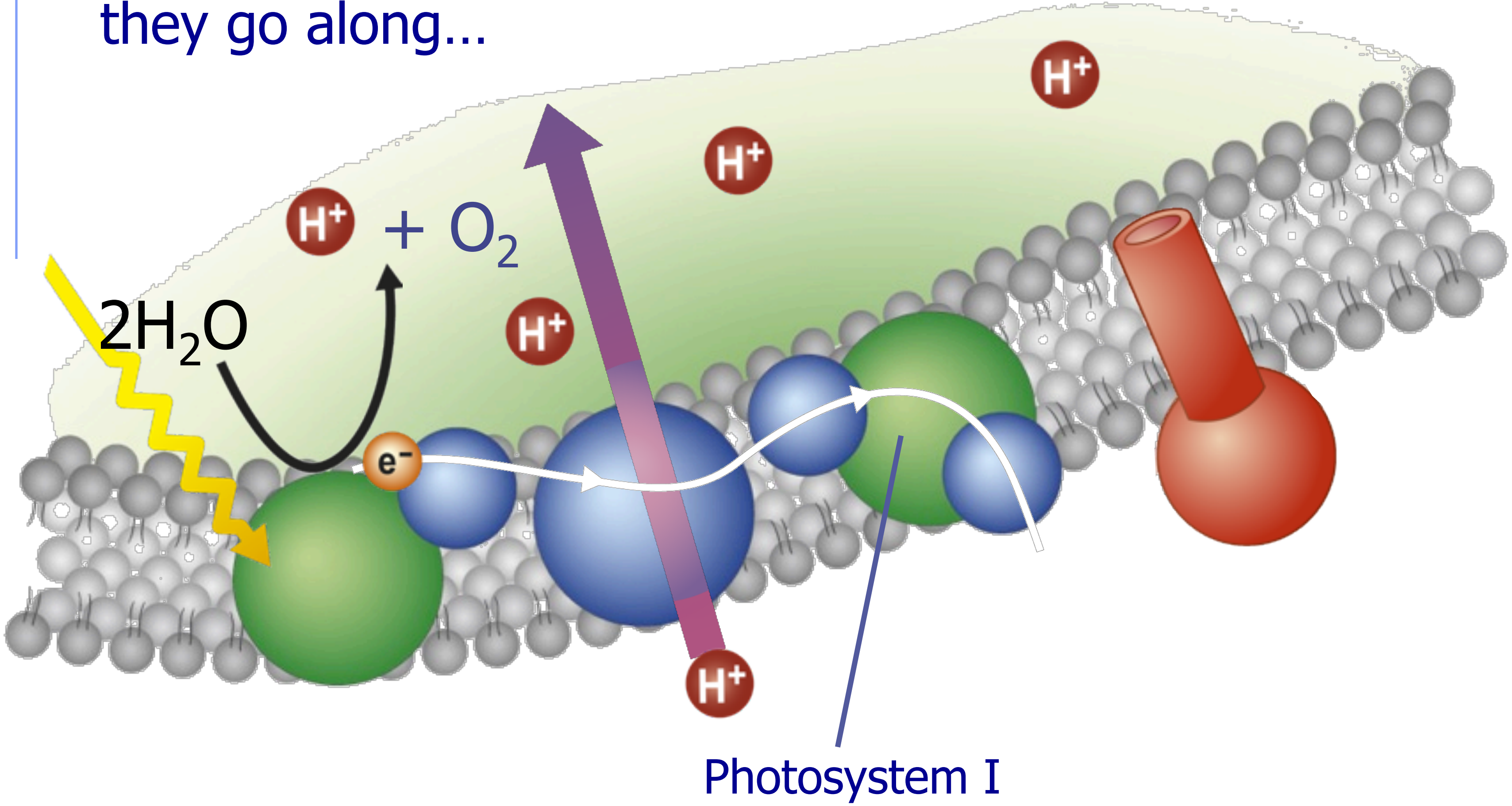
- Electrons power pumps to transport H^+ ions from the **stroma** into the inner **thylakoid space**.

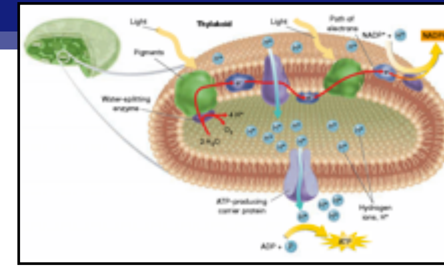




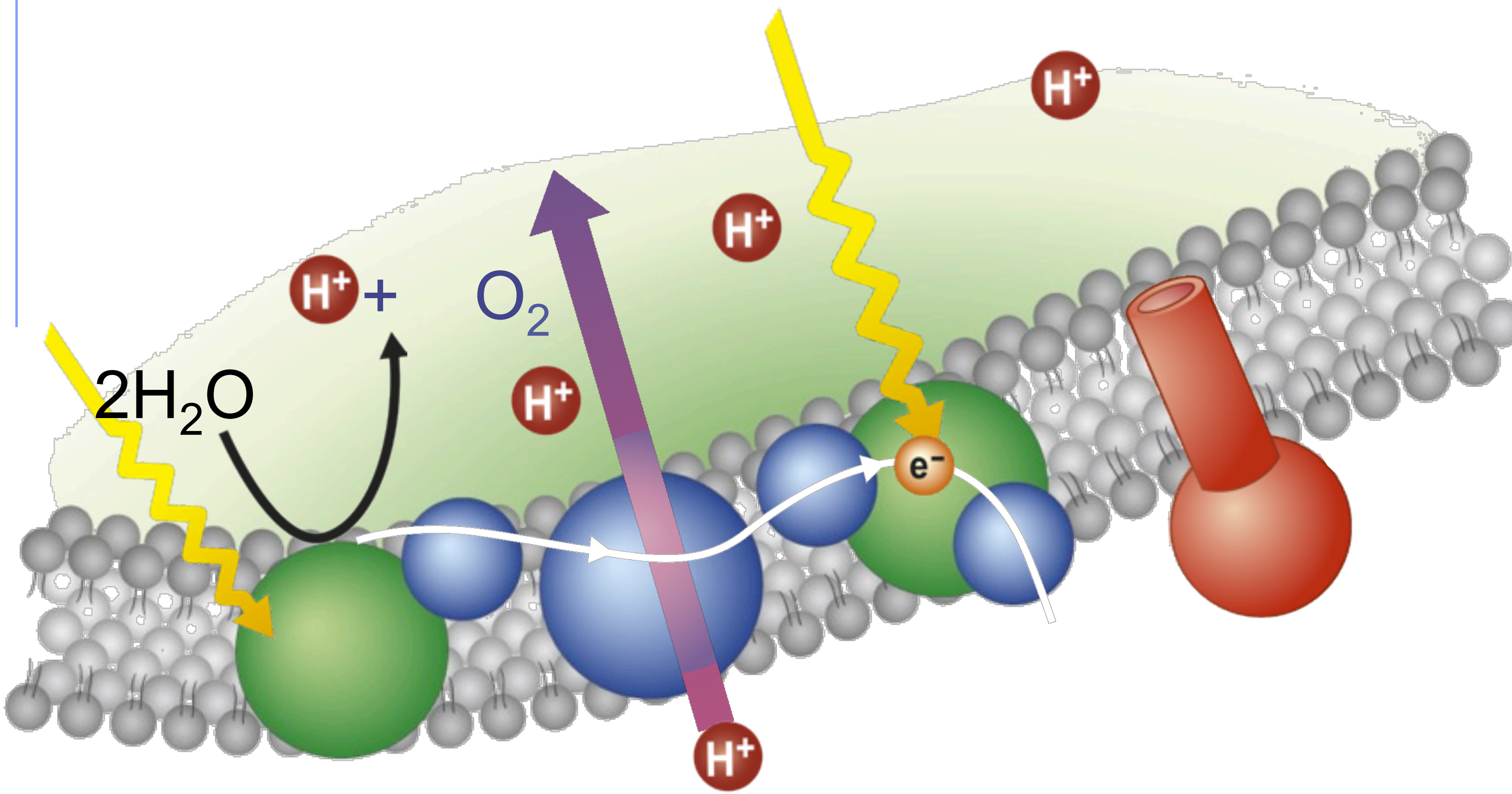


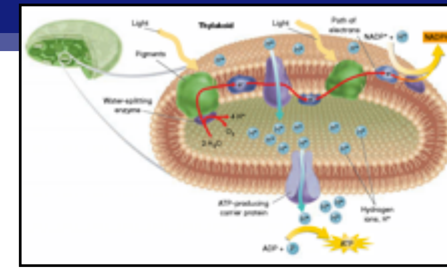
- High-energy electrons move through the ETC from **photosystem II** to **photosystem I**, losing energy as they go along…



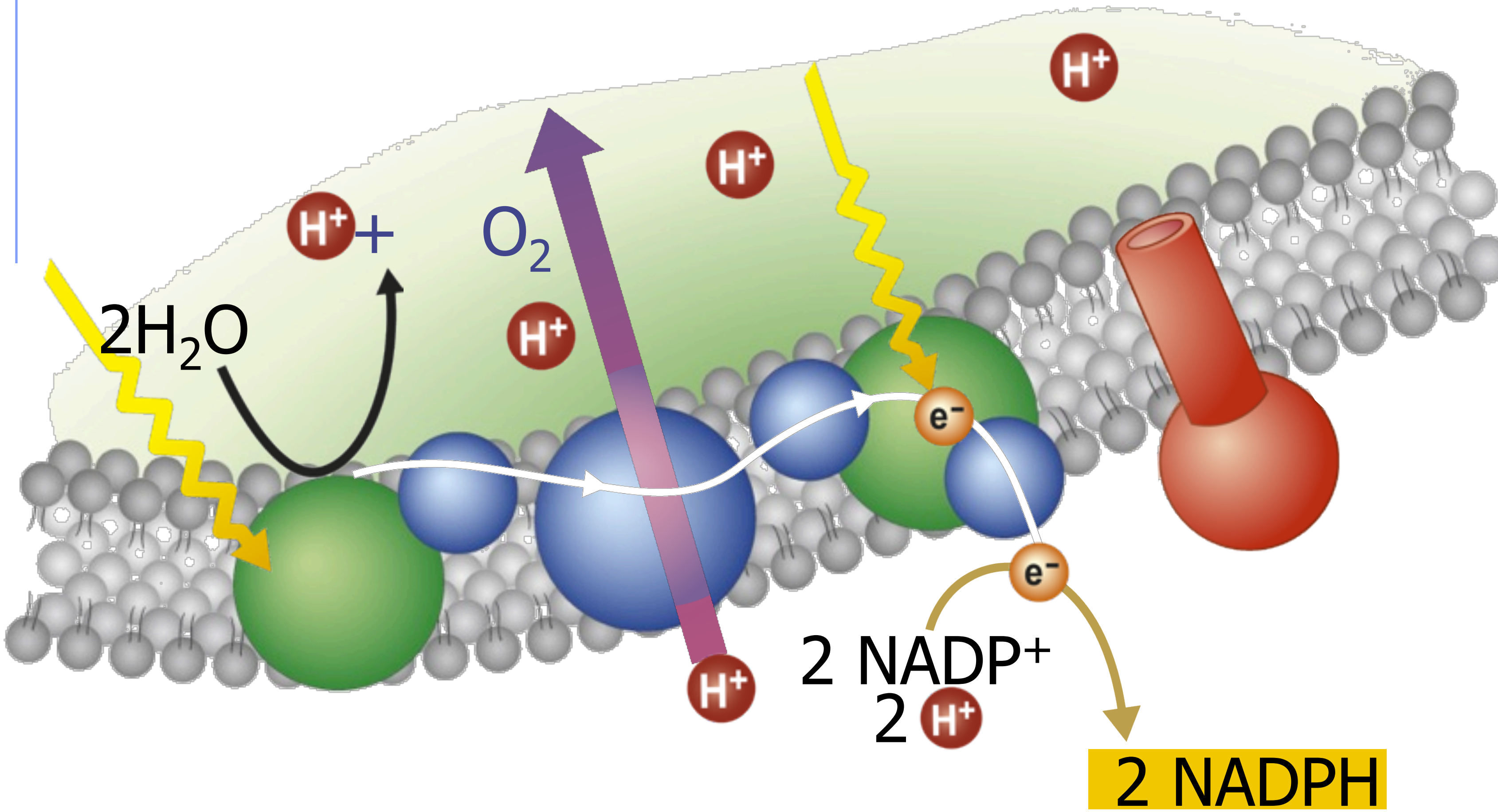


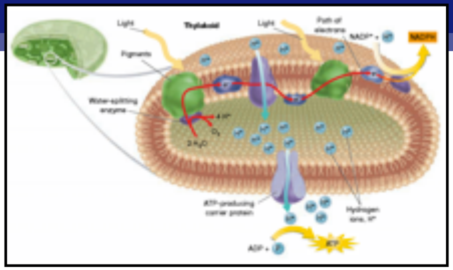
- **Sunlight** to re-energize the electrons.



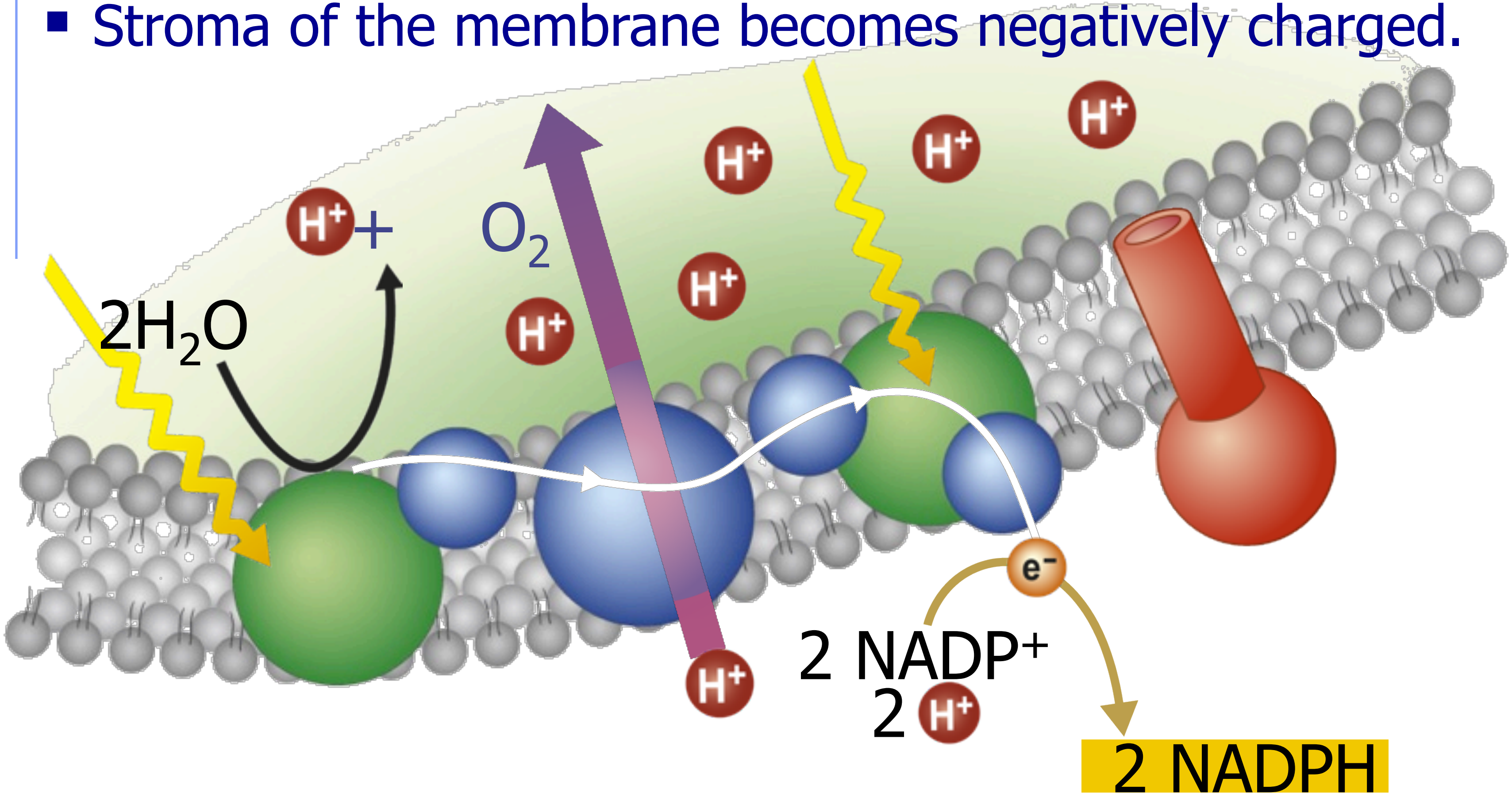


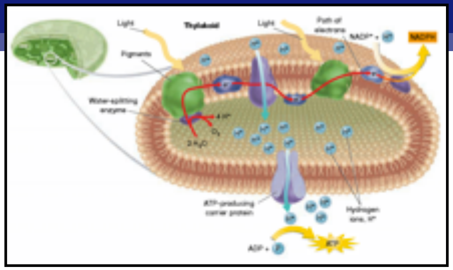
- **NADP+** then picks up these high-energy electrons, (along with H^+ ions) to becomes **NADPH**.



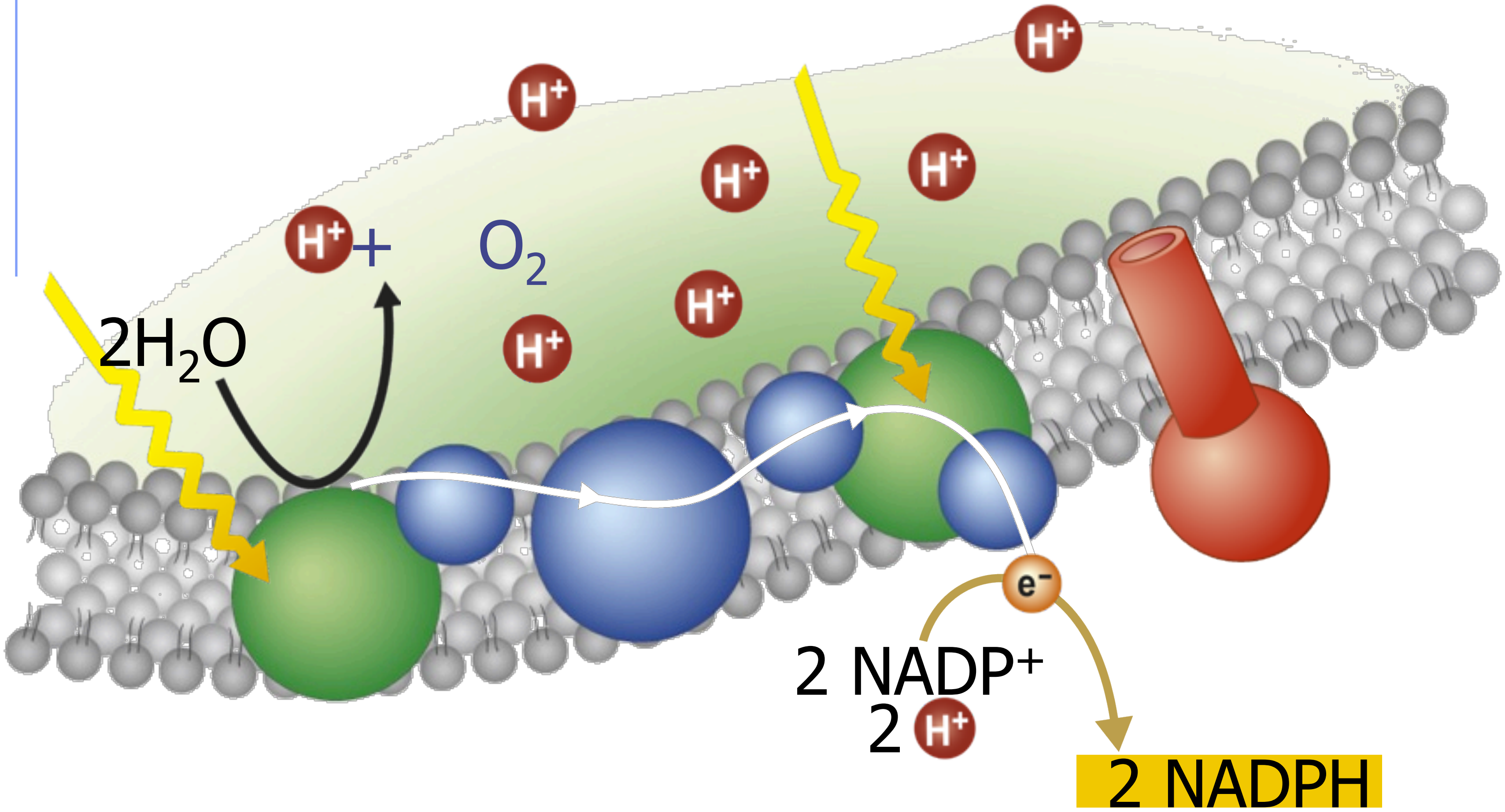


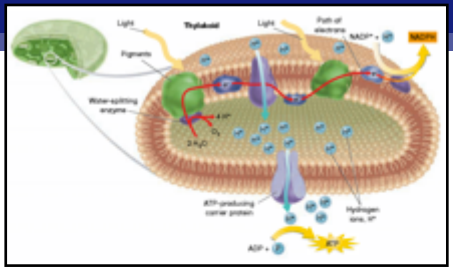
- Thylakoid space fills up with positively charged hydrogen ions…
- Stroma of the membrane becomes negatively charged.



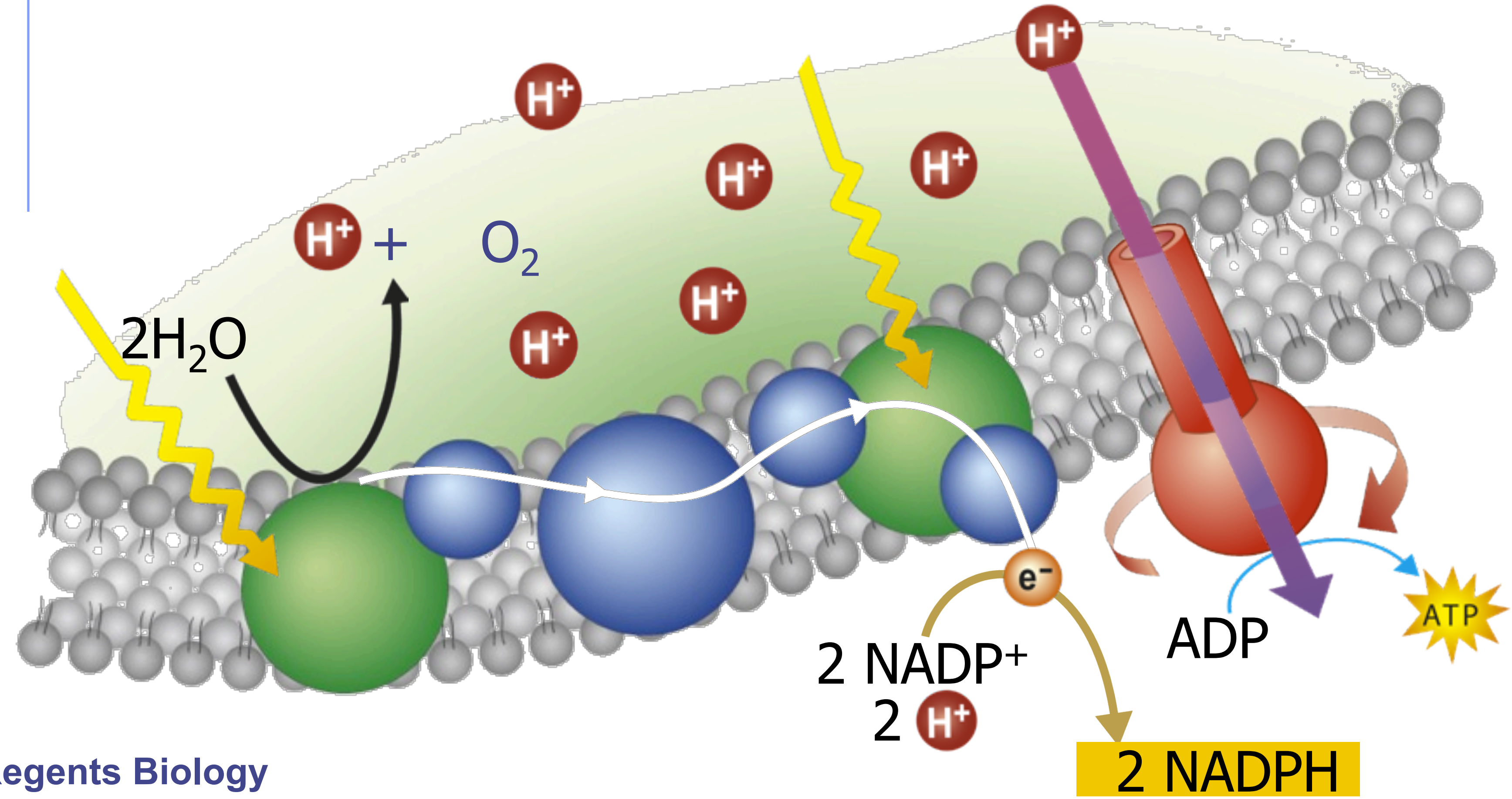


- As protons diffuse through ATP synthase, **ATP** is made.



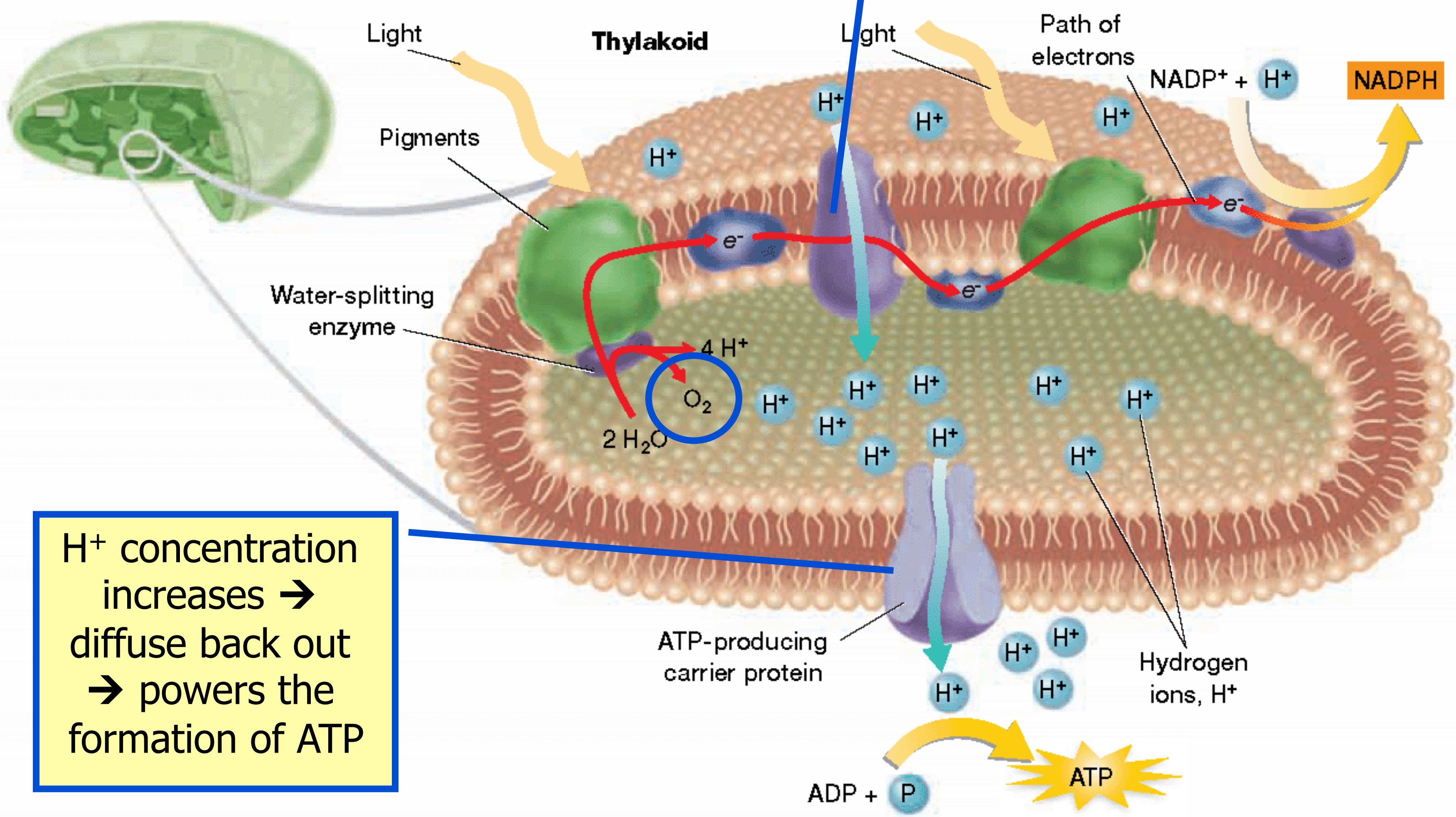


- Light-dependent electron transport produces not only high-energy electrons but ATP as well.

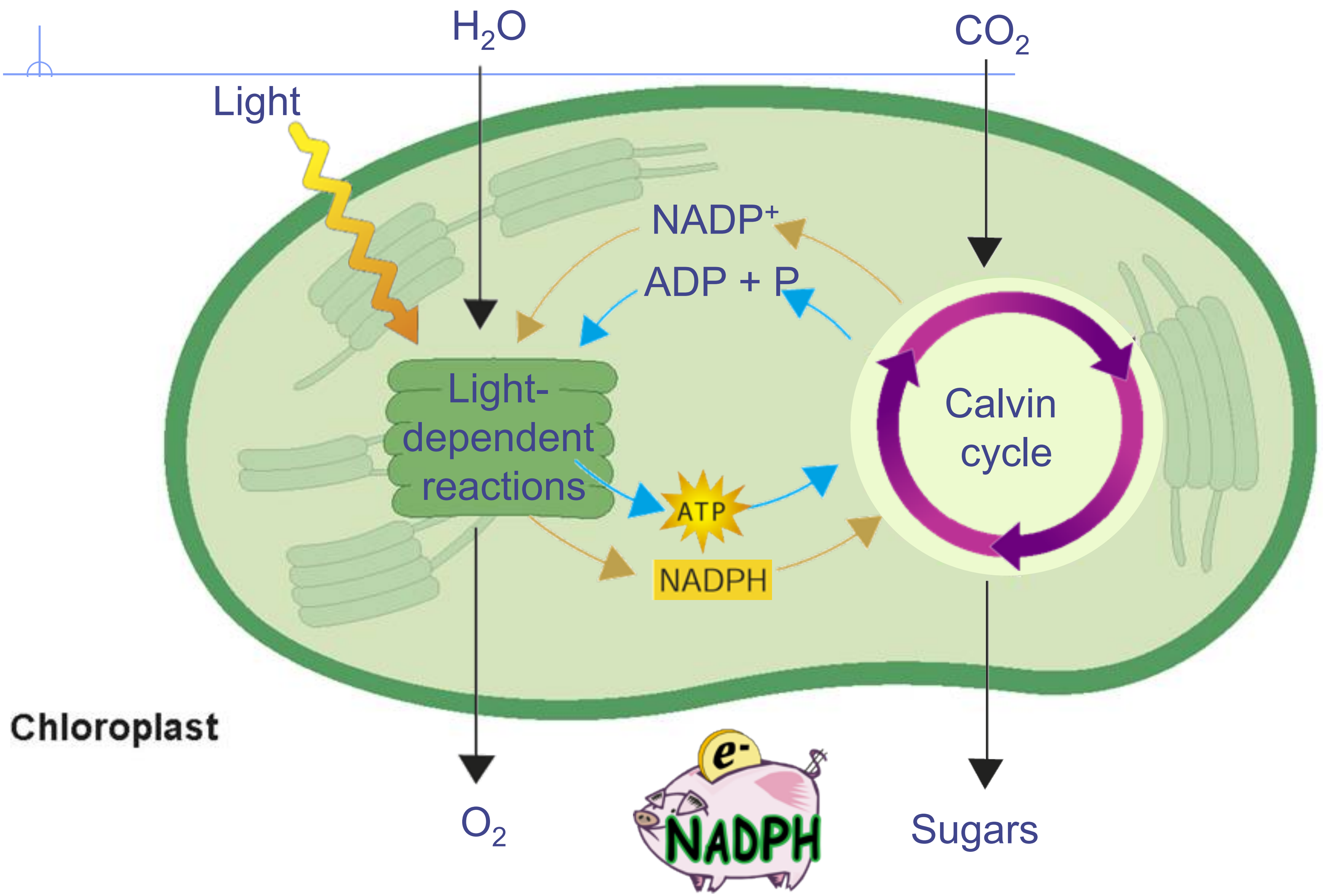


ETC

Excited electrons lose energy passing through this protein. Protein uses this energy to pump H^+ into thylakoid.



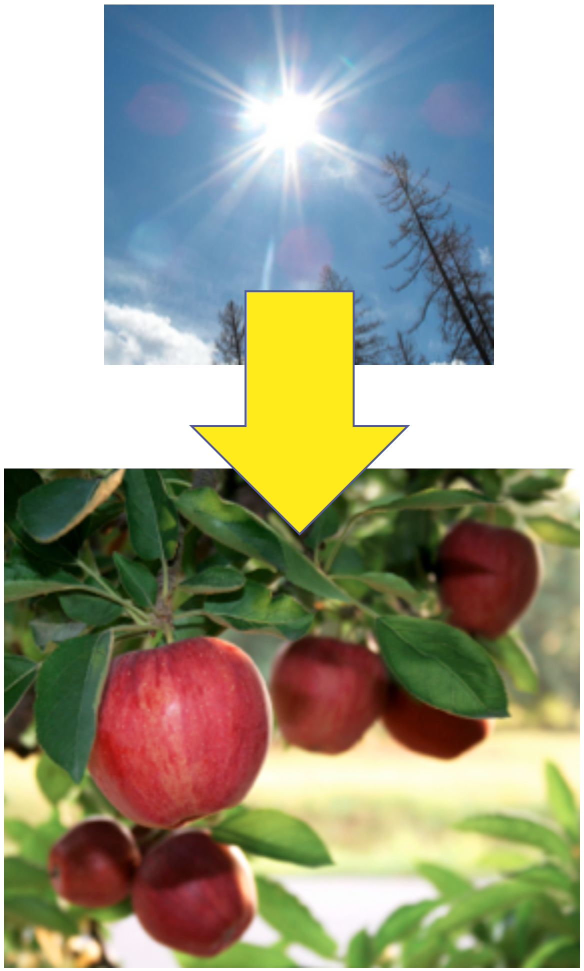
H⁺ concentration increases → diffuse back out → powers the formation of ATP



H_2O
CO_2
Light
$NADP^+$
ADP + P
Light-dependent reactions
ATP
NADPH
Calvin cycle
Chloroplast
O_2
e-
NADPH
Sugars

To the Light-Independent Reactions

Solar **energy** + 6 CO_2 + 6 H_2O → $C_6H_{12}O_6$ + 6 O_2



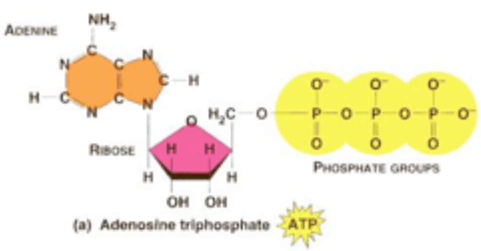
To summarize…

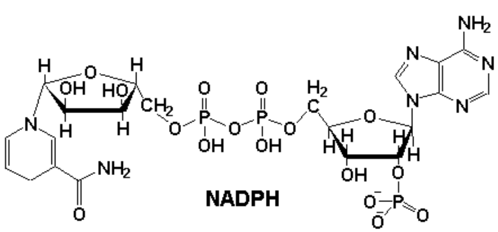
- In the light reactions, light provides energy to make a (little bit) ATP and generate a lots of electrons
- In the **light-independent reactions (Calvin Cycle)**, CO_2 provides carbon atoms to make **sugars** in which chemical energy is stored.

The transfer of CO_2 to organic compounds is called **carbon dioxide fixation**.

Calvin Cycle/Light-independent Reactions

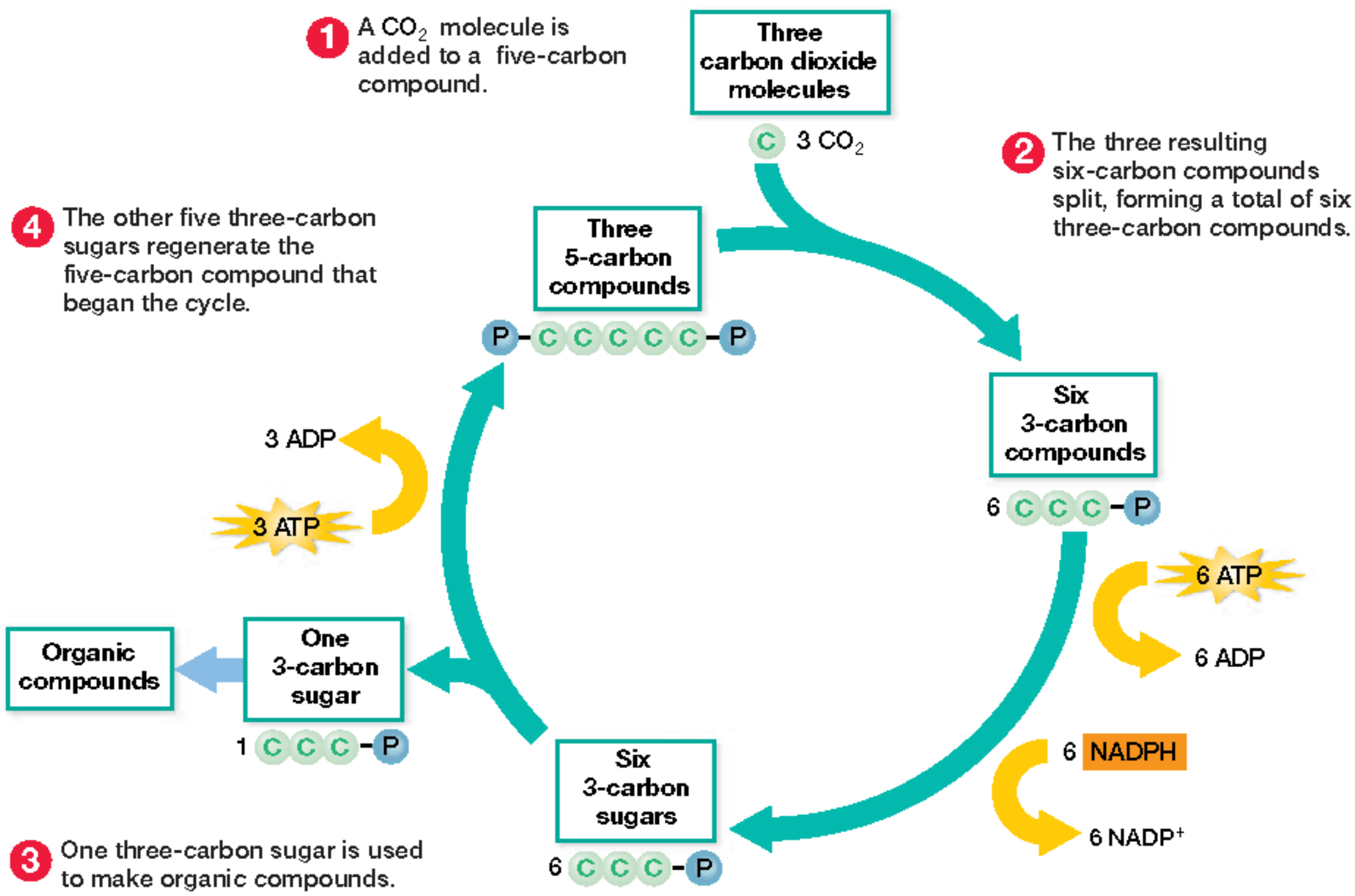
- **ATP** and **NADPH** contain lots of chemical energy
- but not stable enough to store that energy for more than a few minutes…
- During the Calvin Cycle, plants use the energy that ATP and NADPH contain to build **high-energy compounds** that can be stored for a long time.



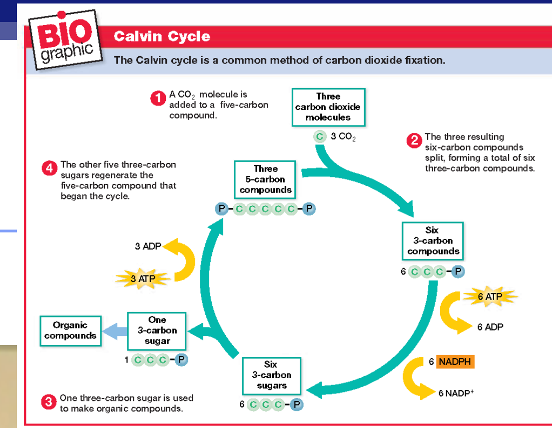


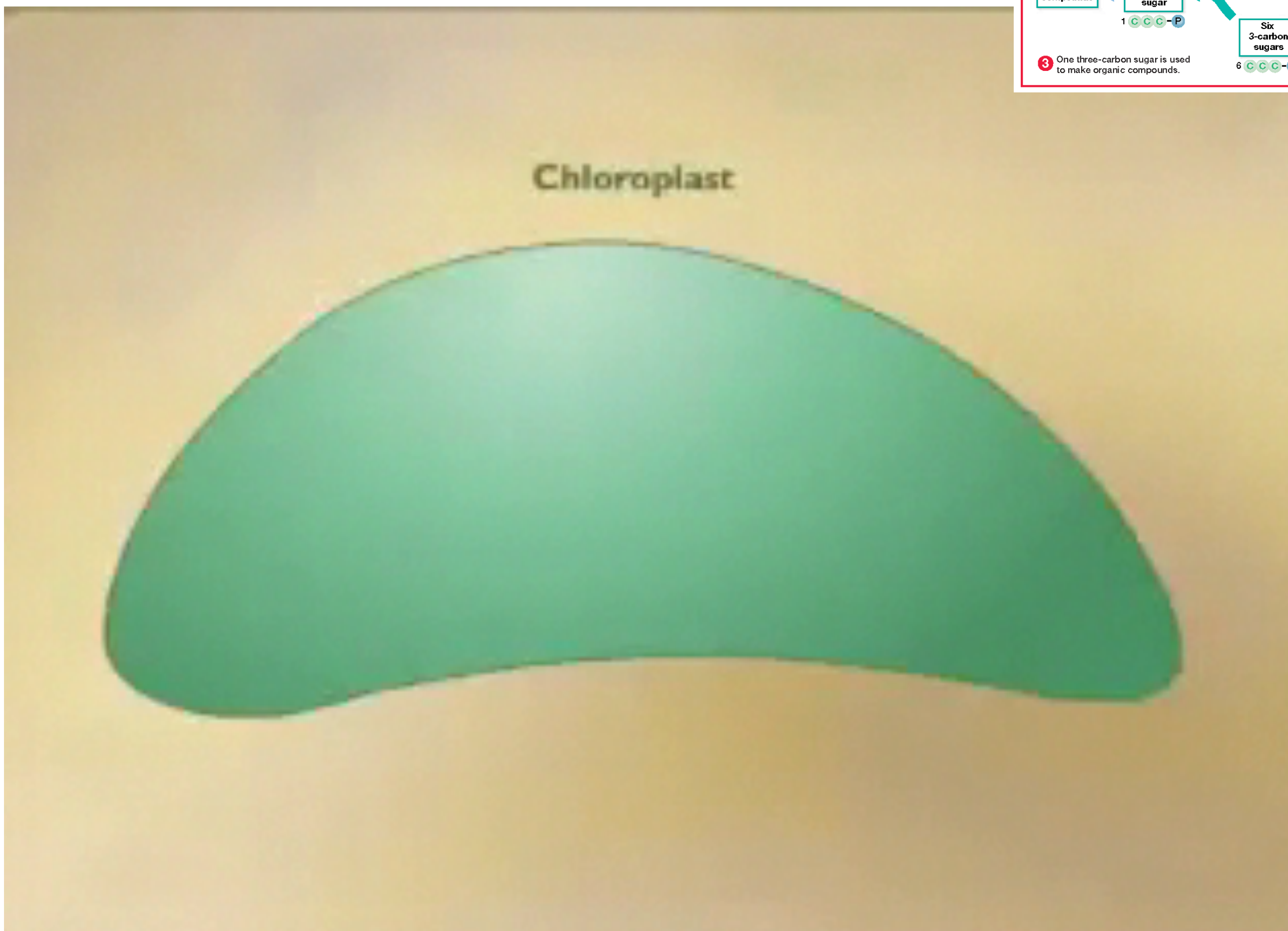
Calvin Cycle

The Calvin cycle is a common method of carbon dioxide fixation.



The Calvin Cycle

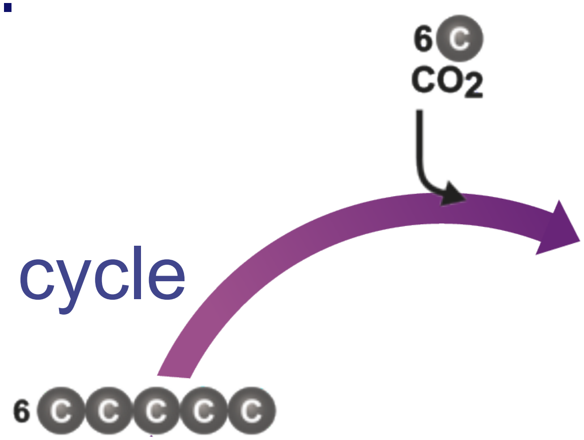




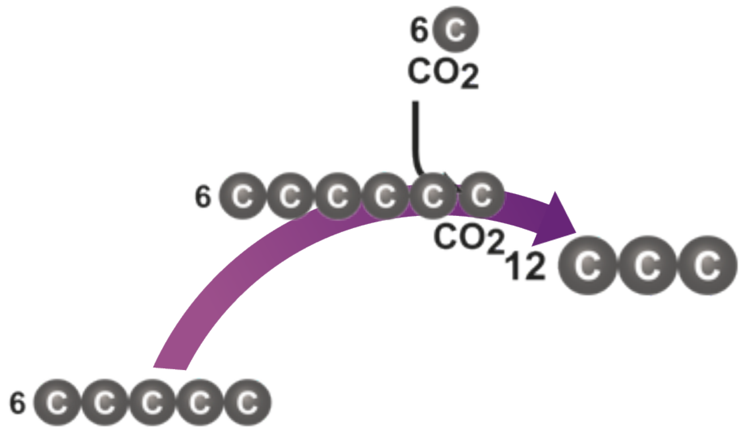
http://www.youtube.com/watch?v=E_XQR800AgM

- 6 carbon dioxide molecules enter the cycle from the atmosphere and combine with six 5-carbon molecules.

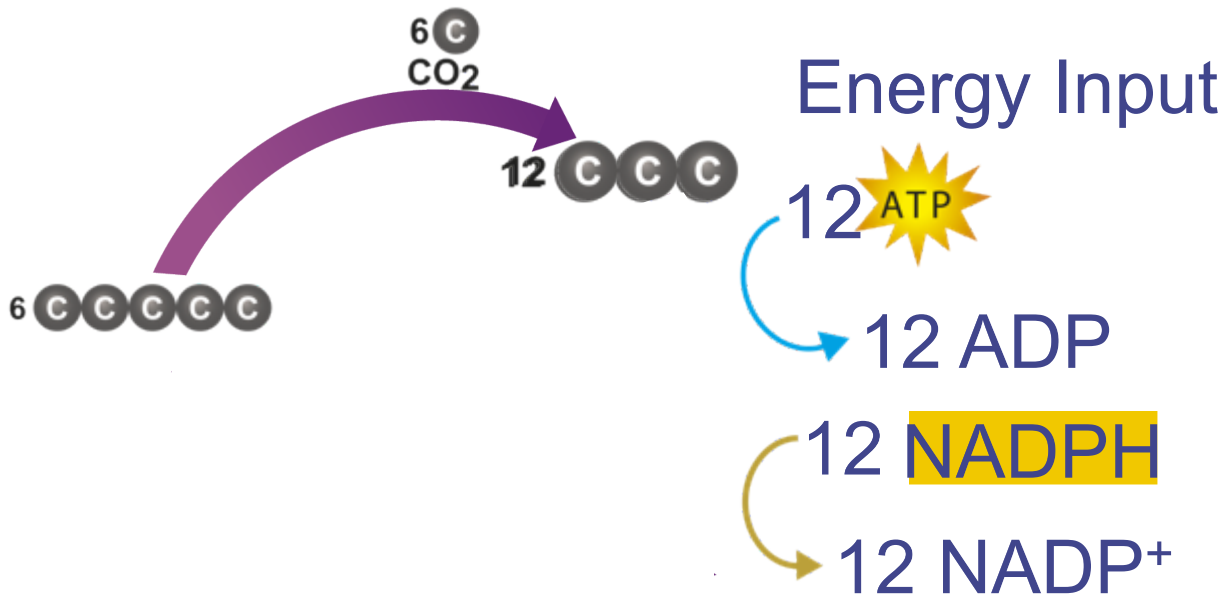
CO_2
enters the cycle



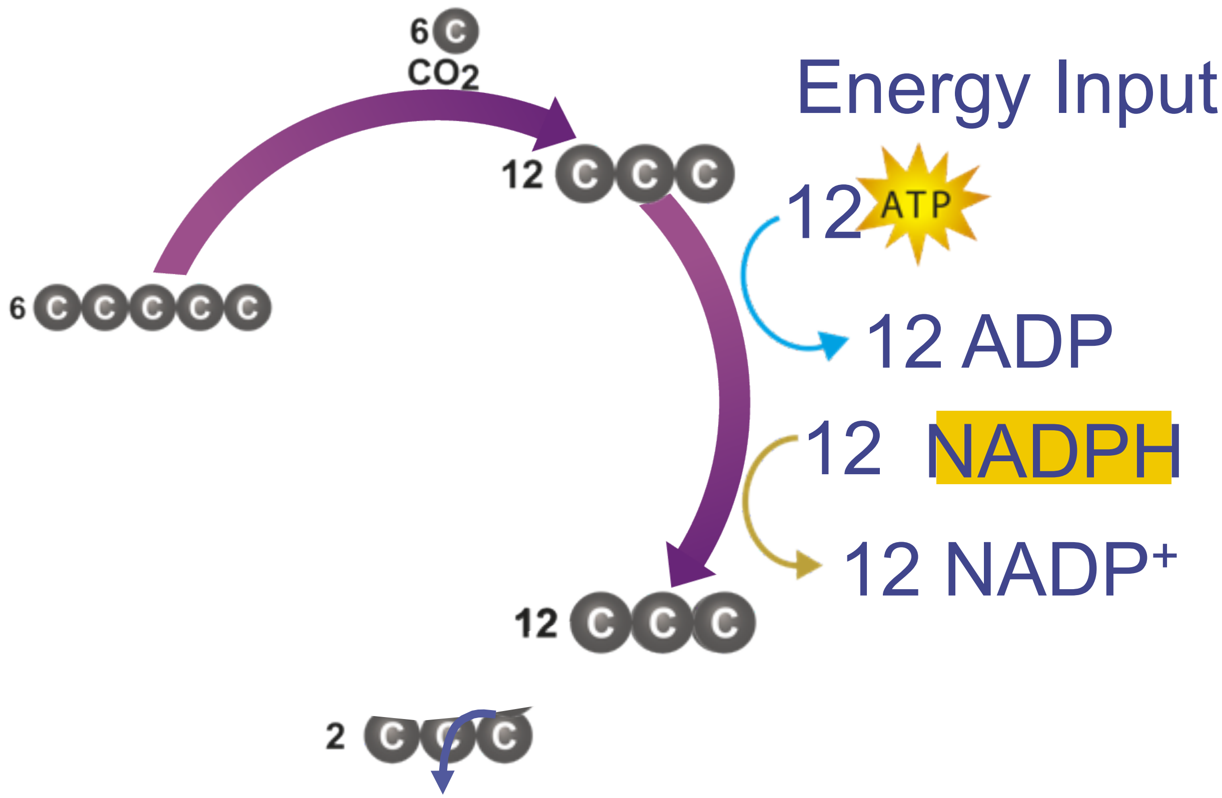
- The result is twelve 3-carbon molecules, which are then converted into higher-energy forms.



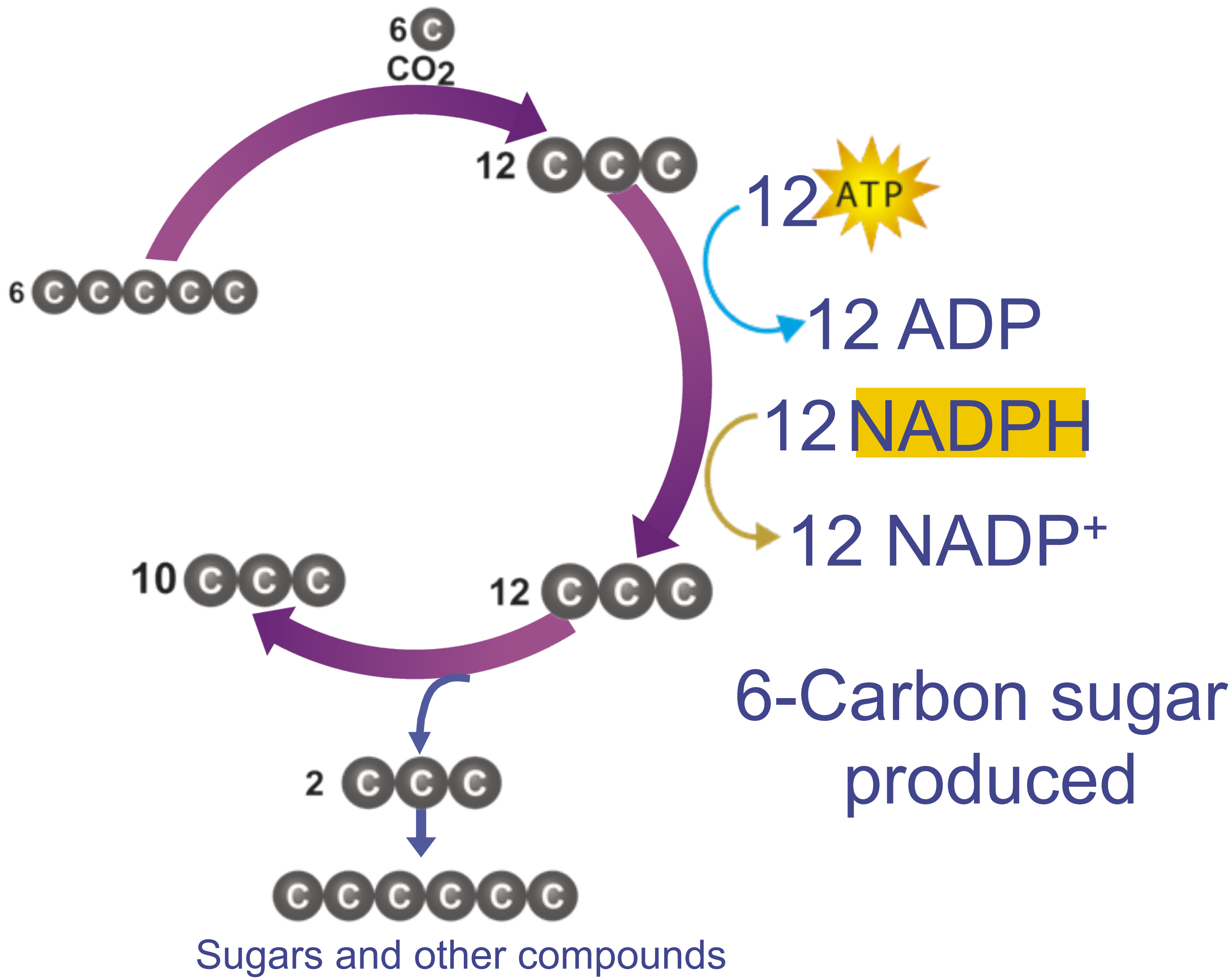
- The energy for this conversion comes from ATP and high-energy electrons from NADPH.



- Two of twelve 3-carbon molecules are removed from the cycle.



- The molecules are used to produce sugars, lipids, amino acids and other compounds.



- The 10 remaining 3-carbon molecules are converted back into six 5-carbon molecules, which are used to begin the next cycle.