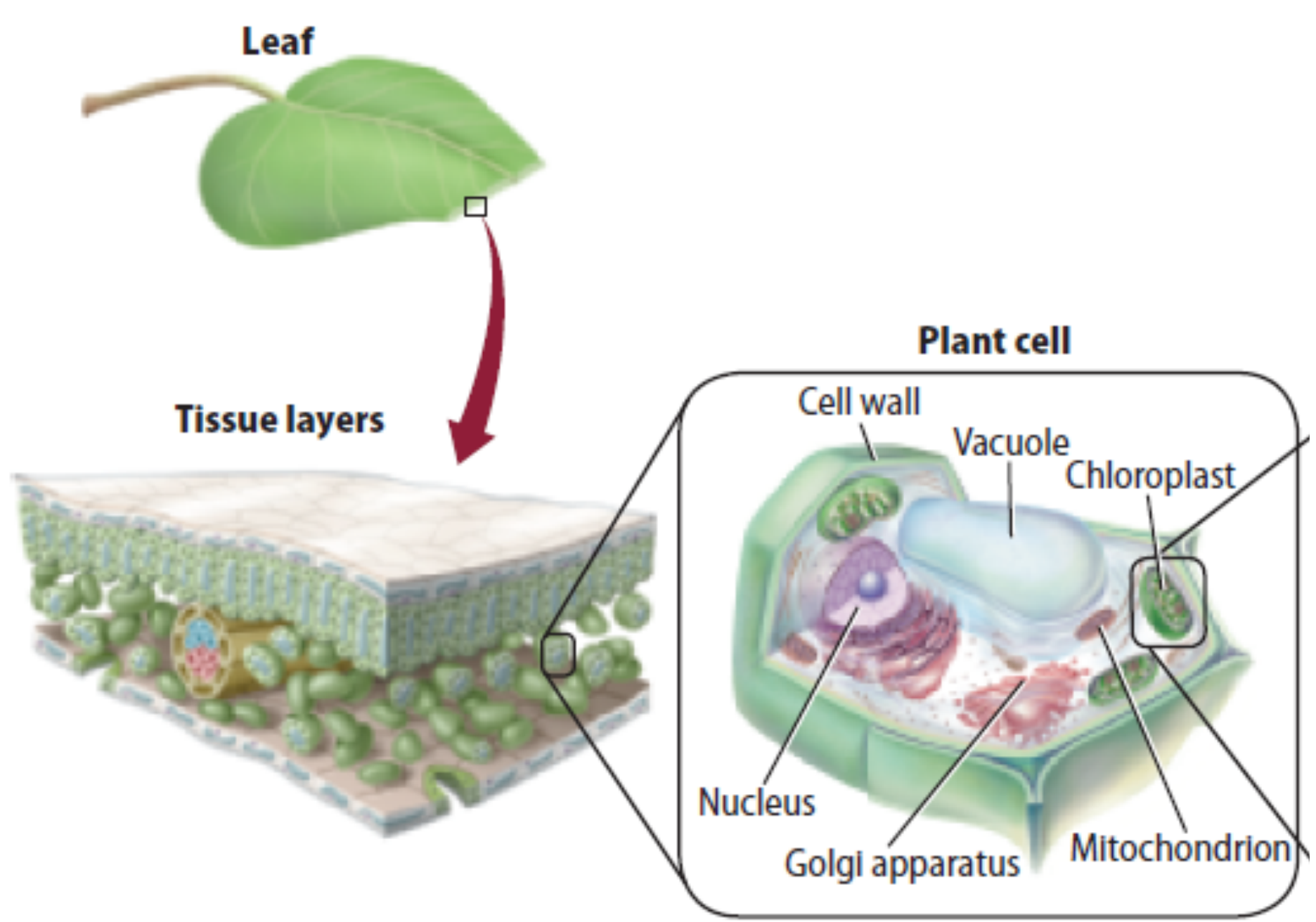
8.2- Photosynthesis

Overview of Photosynthesis

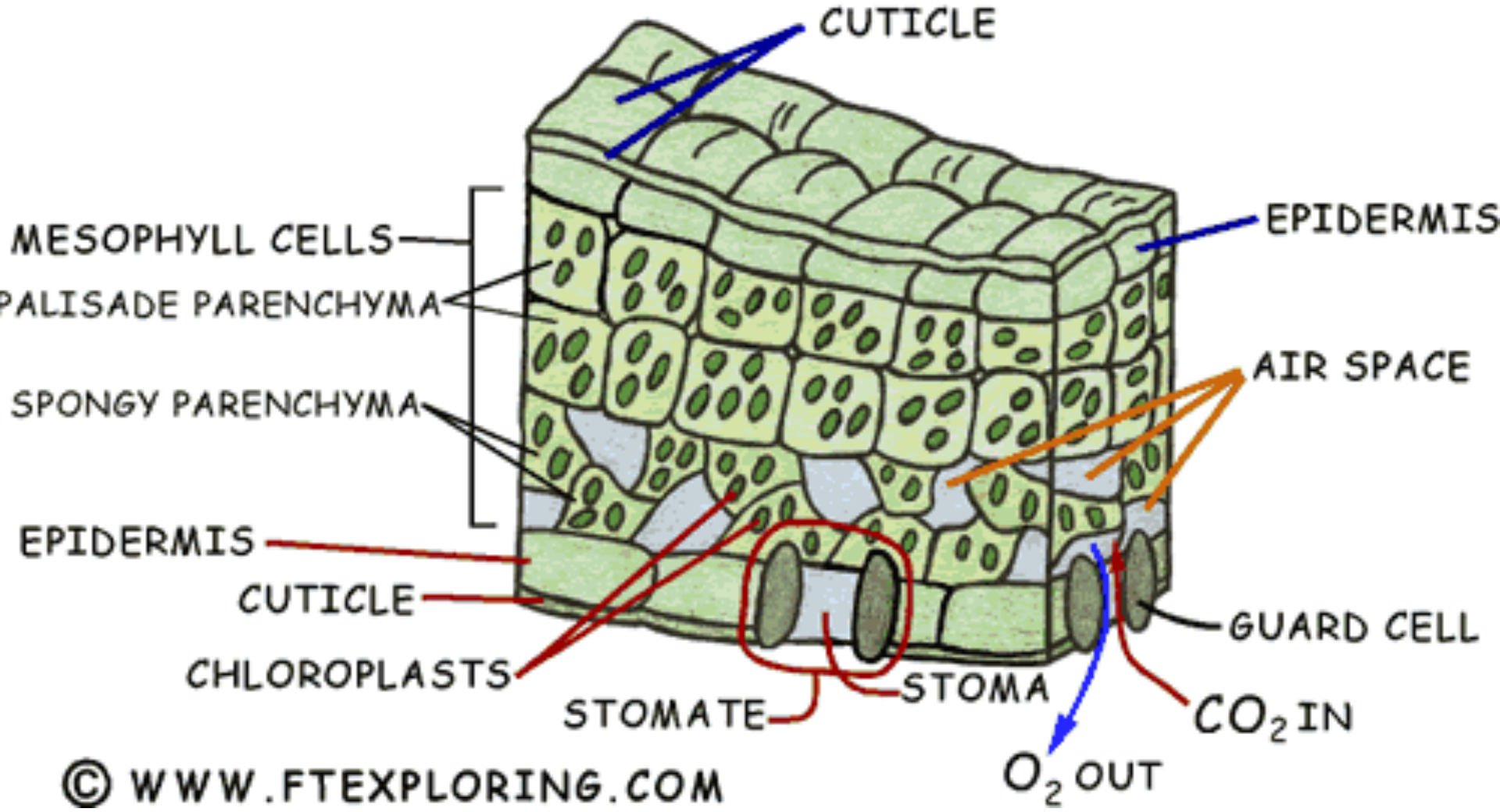
Light energy is trapped and converted into chemical energy during photosynthesis.

$$6CO_2 + 6H_2O \xrightarrow{\text{light}} C_6H_{12}O_6 + 6O_2$$

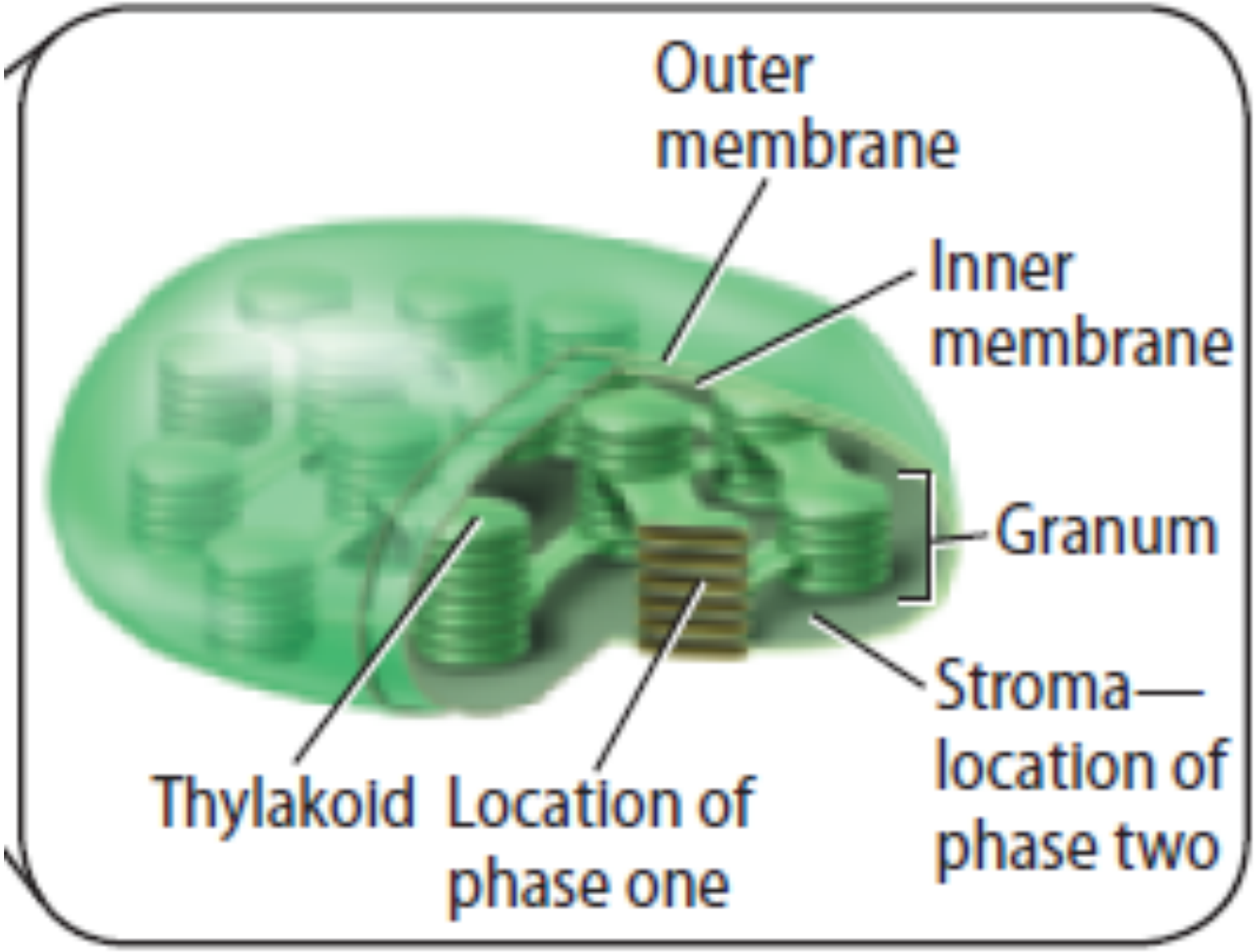
Anabolic- building larger molecules


Leaf
Tissue layers
Plant cell
Cell wall
Vacuole
Chloroplast
Nucleus
Golgi apparatus
Mitochondrion

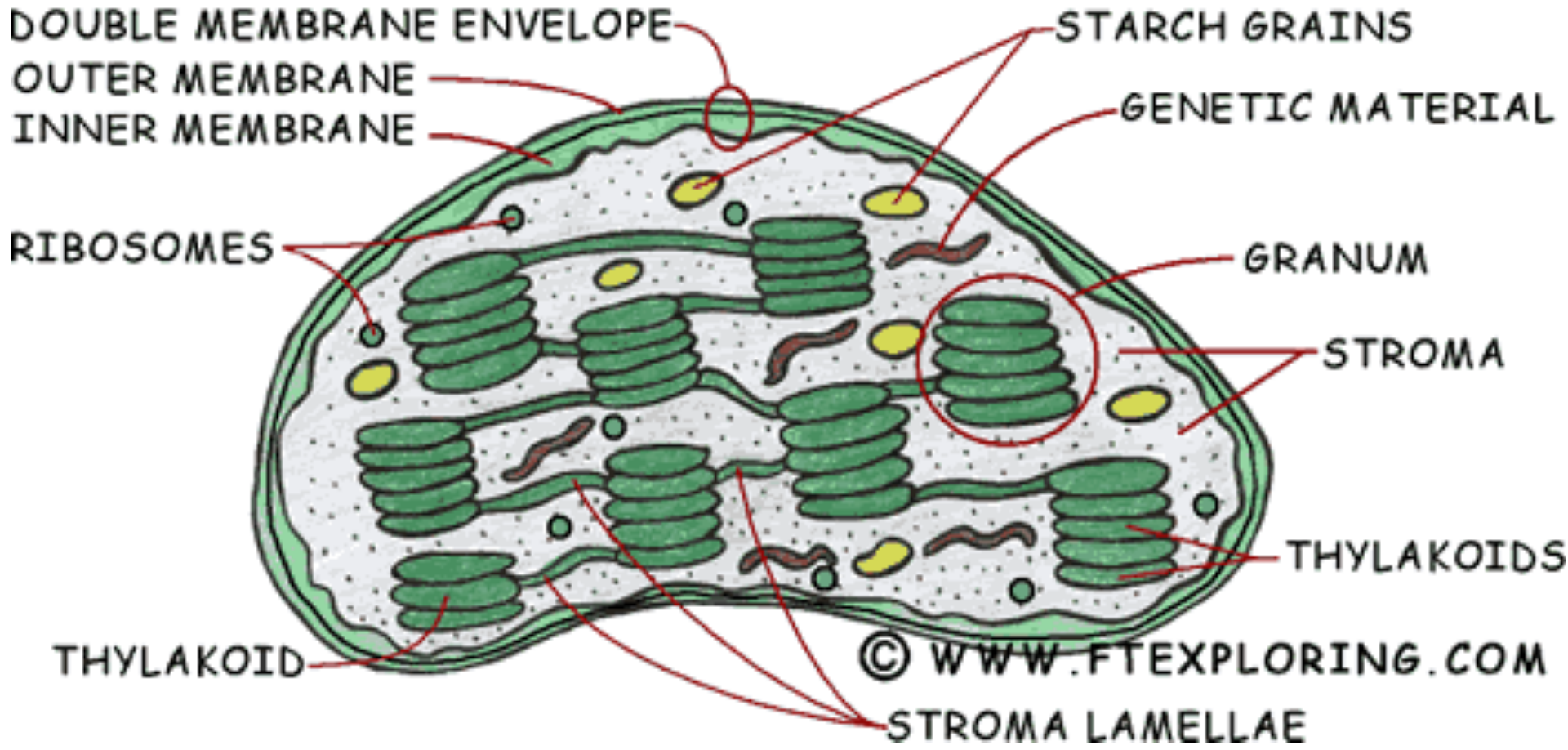
LEAF SECTION



Chloroplast



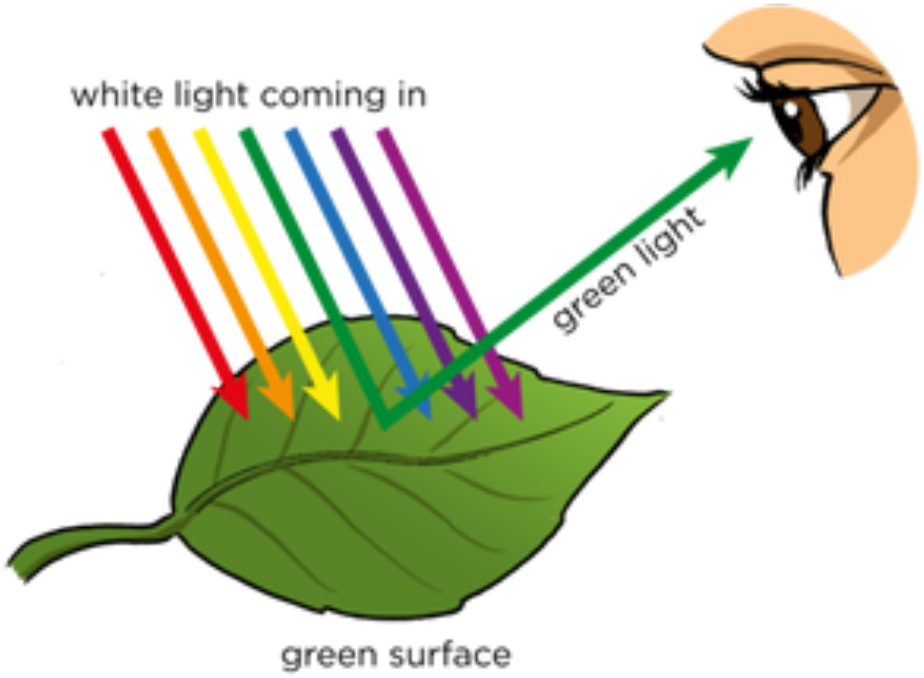
CHLOROPLAST

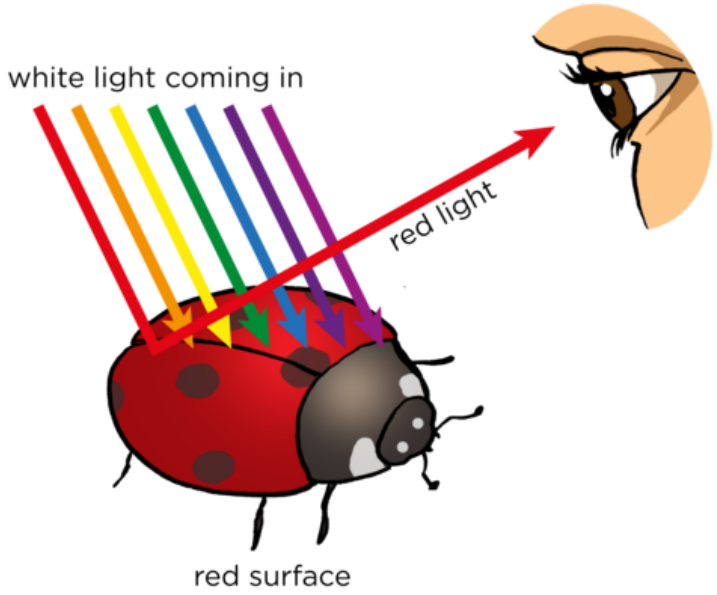


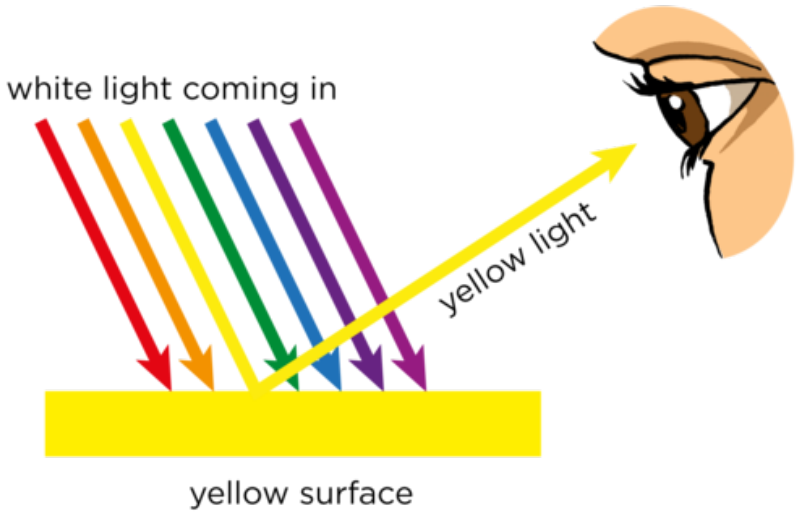
Pigments- Light-absorbing colored molecules

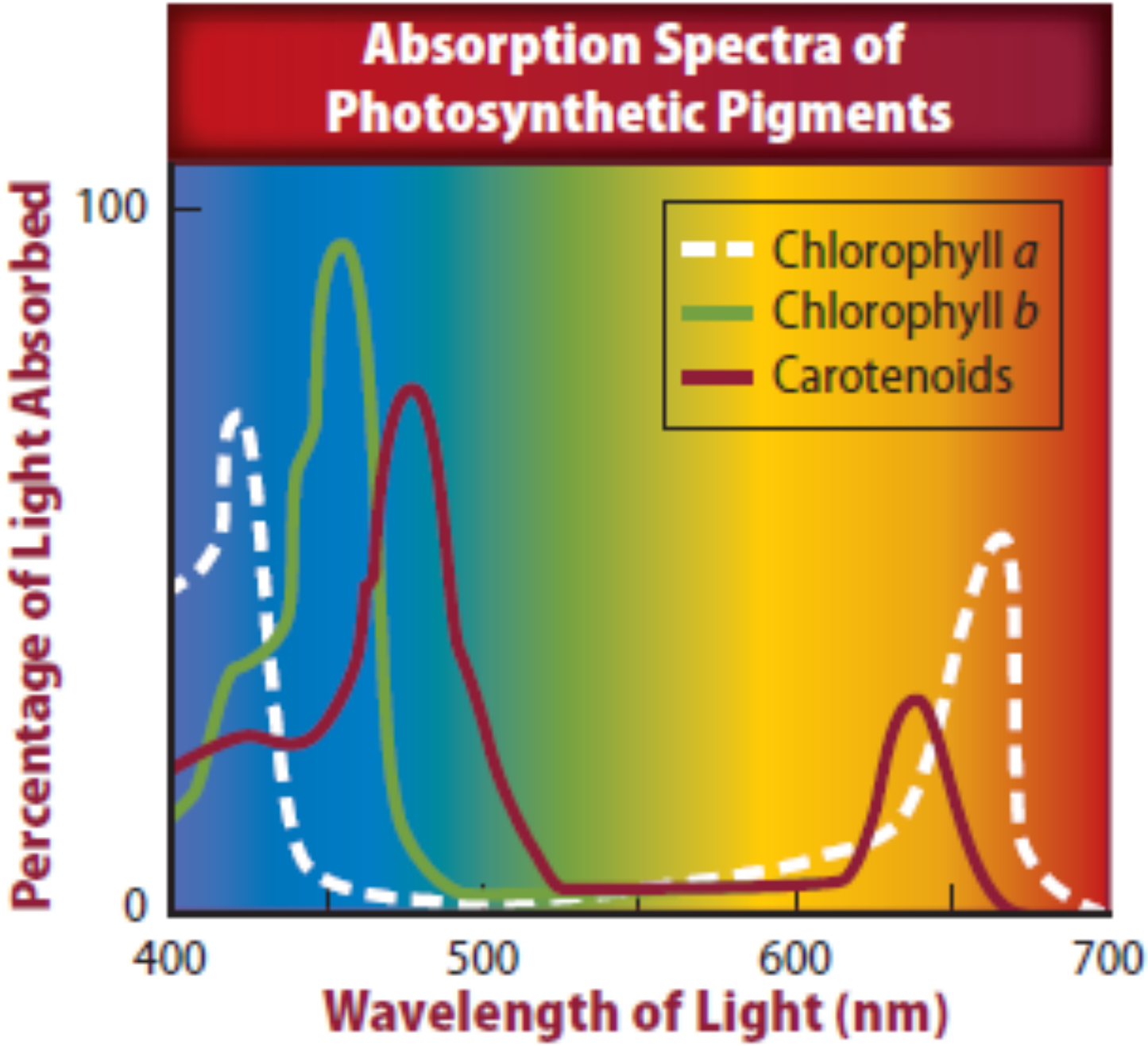
Different pigments absorb different wavelengths of light.

chlorophyll- Most common pigment in plants


white light coming in
green light
green surface


white light coming in
red light
red surface


white light coming in
yellow light
yellow surface


Absorption Spectra of Photosynthetic Pigments
Percentage of Light Absorbed
100
0
Chlorophyll a
Chlorophyll b
Carotenoids
400
500
600
700
Wavelength of Light (nm)

Chloroplasts contain

Thylakoids- flattened saclike membranes full of pigments

grana- stacks of thylakoids

Stroma- fluid filled space

Double membrane
1 thylakoid
Stack of granum
stroma

HTTPS://YOUTU.BE/1DN_ZDAZN0I

This is NOT an entertaining video clip, but it explains what you need to know

4 minutes

Photosynthesis occurs in **two phases**.

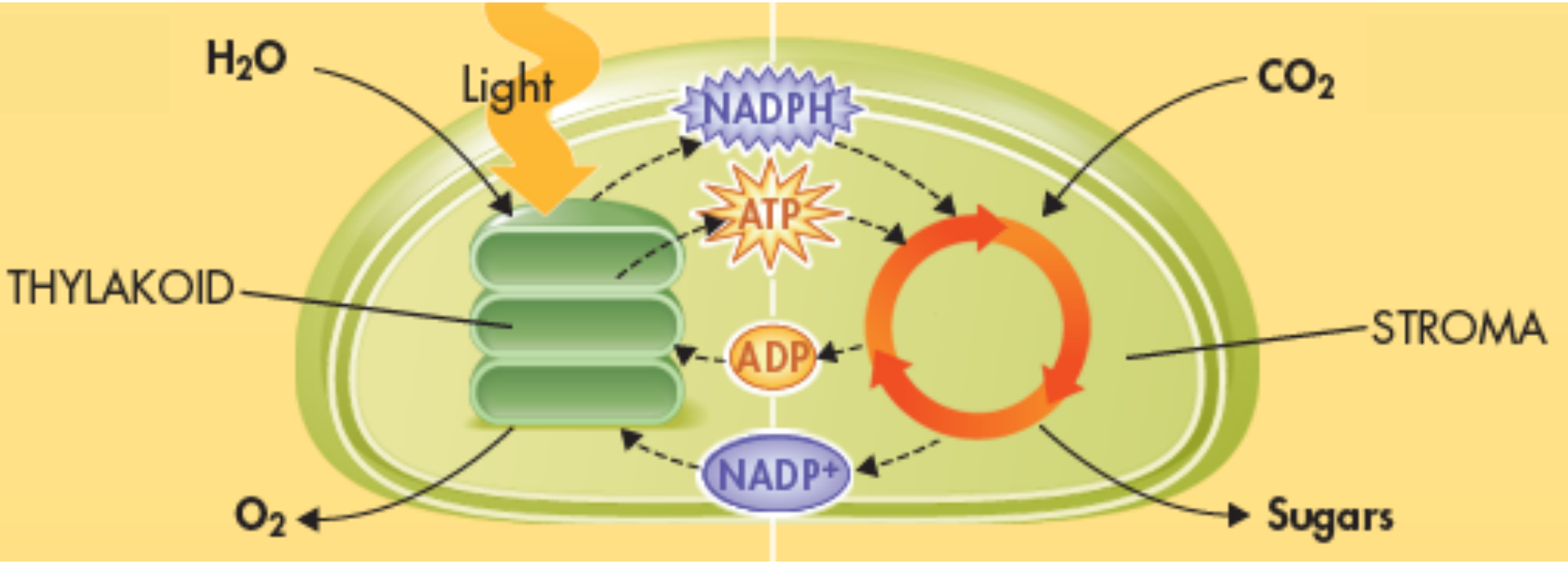
light-dependent phase- light energy is converted into chemical energy.

(light reactions- in the thylakoid)

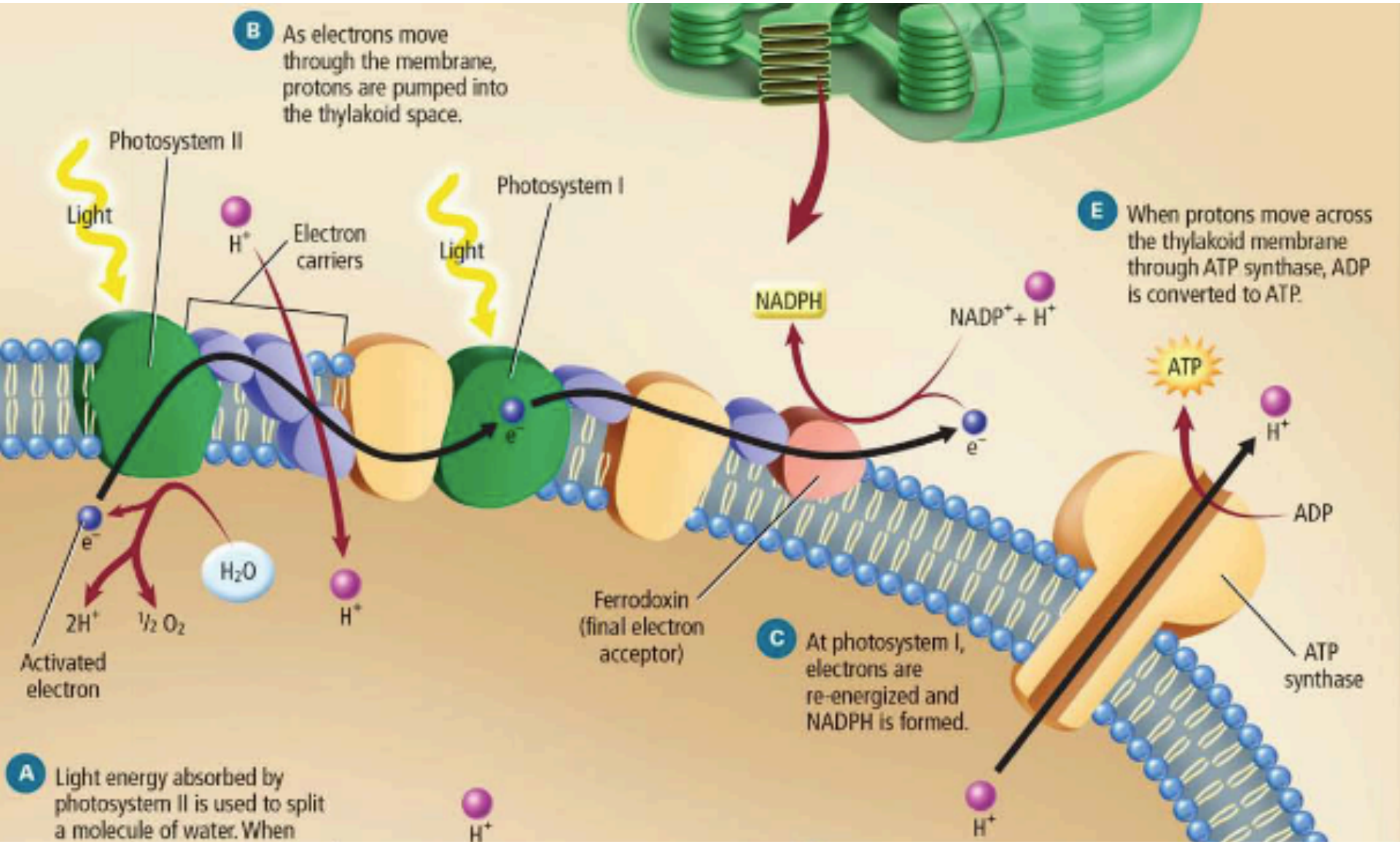
Photosynthesis occurs in **two phases**.

light-independent phase- chemical energy is used to synthesize glucose.

(Calvin cycle- in the stroma)


H_2O
Light
NADPH
CO_2
ATP
THYLAKOID
STROMA
ADP
NADP+
O_2
Sugars

Phase One: Light Reactions



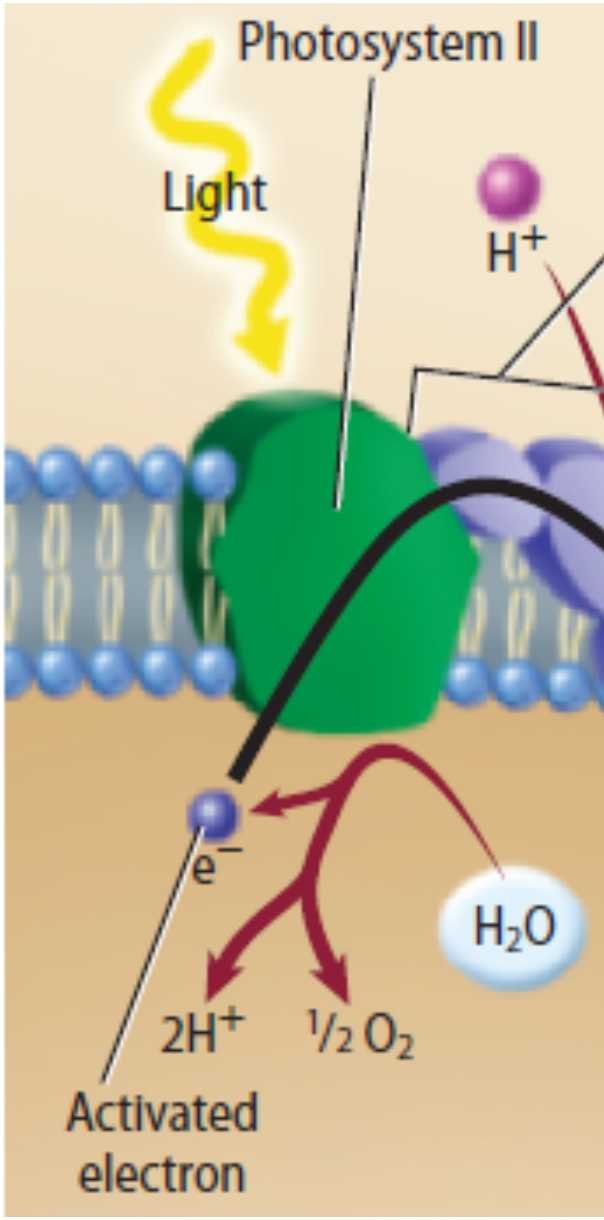
Light energy excites electrons in **photosystem II**

causes a water molecule to split –

1 electron into the electron transport system (ETC)

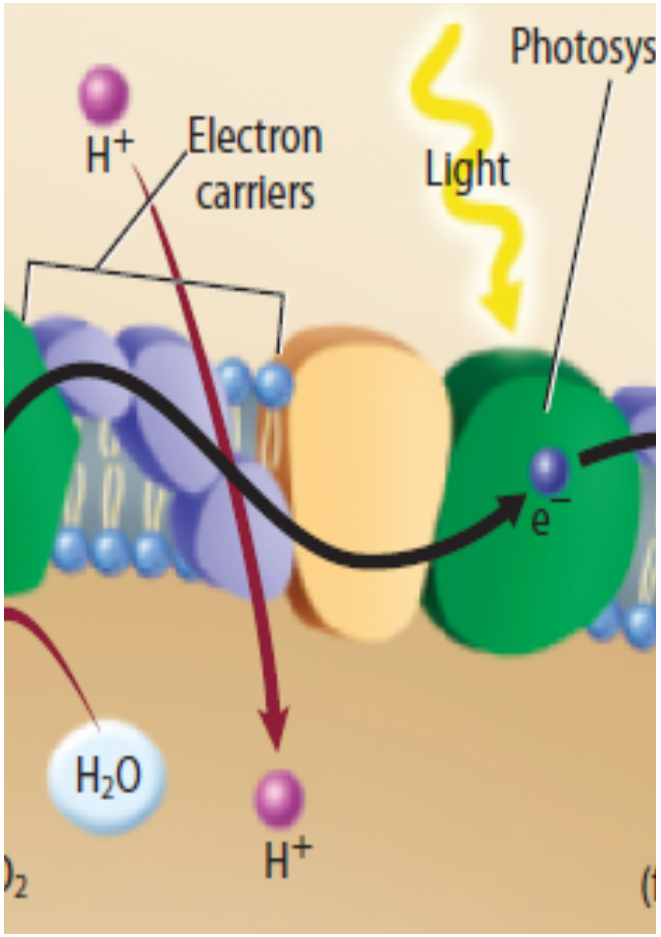
2 hydrogen ions (H^+) into the thylakoid space

1 oxygen as waste



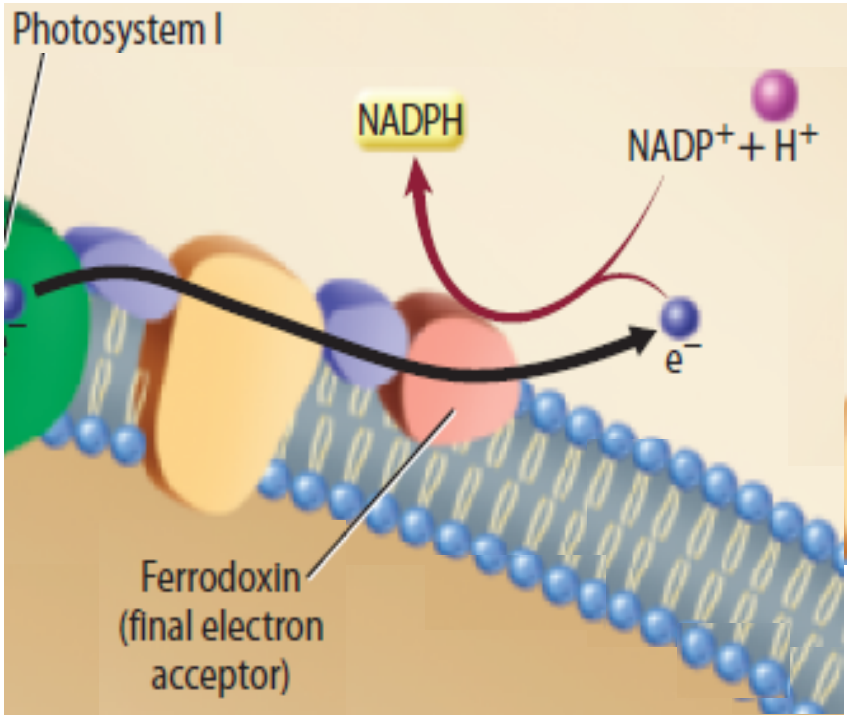
The activated electrons move from photosystem II to an acceptor molecule in the thylakoid membrane.

The electron acceptor molecule transfers the electrons along a series of electron carriers to photosystem I.



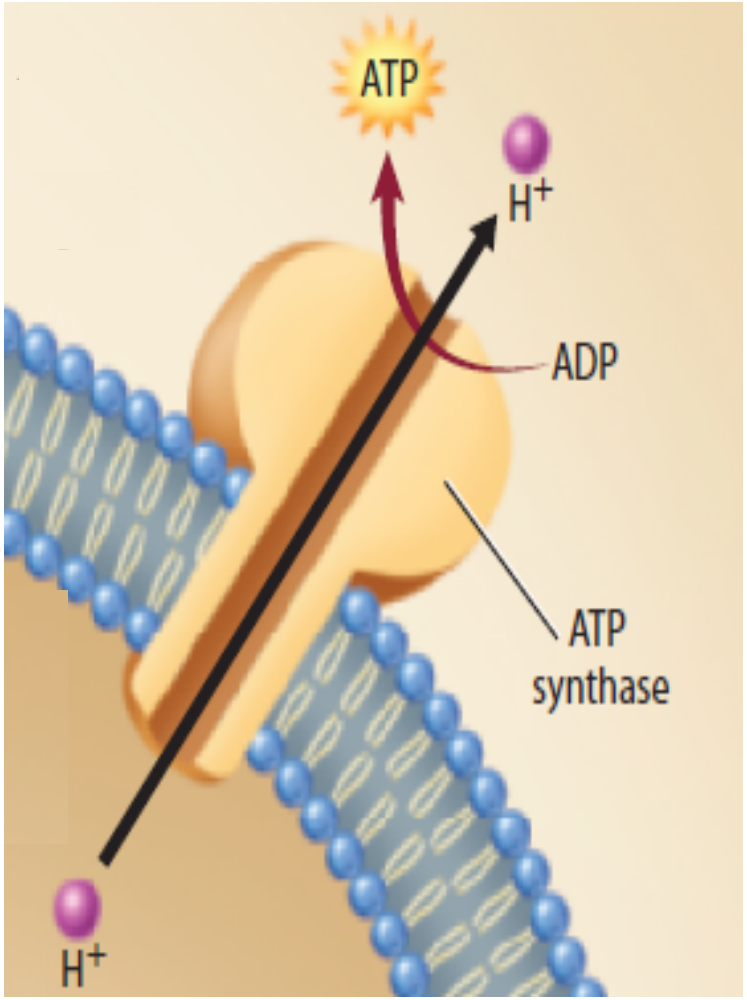
In the presence of light, **photosystem I transfers electrons to** a protein called **ferrodoxin**.

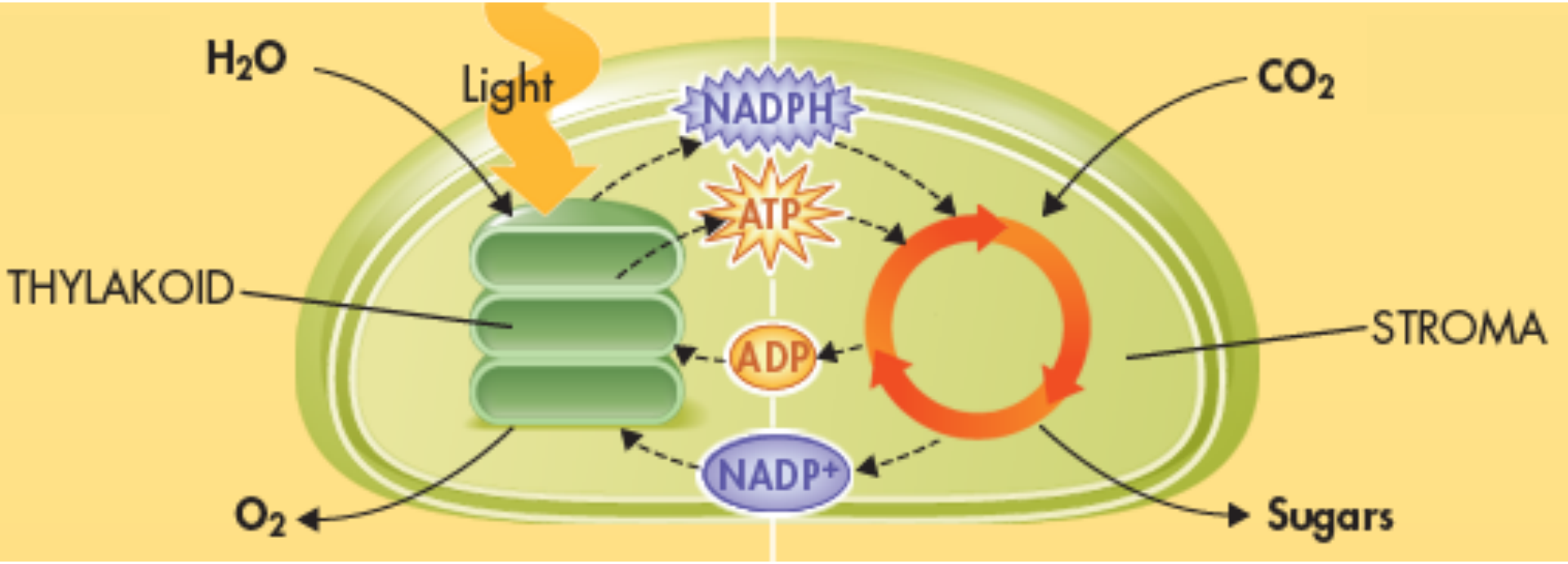
Ferrodoxin transfers the electrons to the carrier molecule **$NADP^+$**, forming the energy storage molecule **NADPH**.

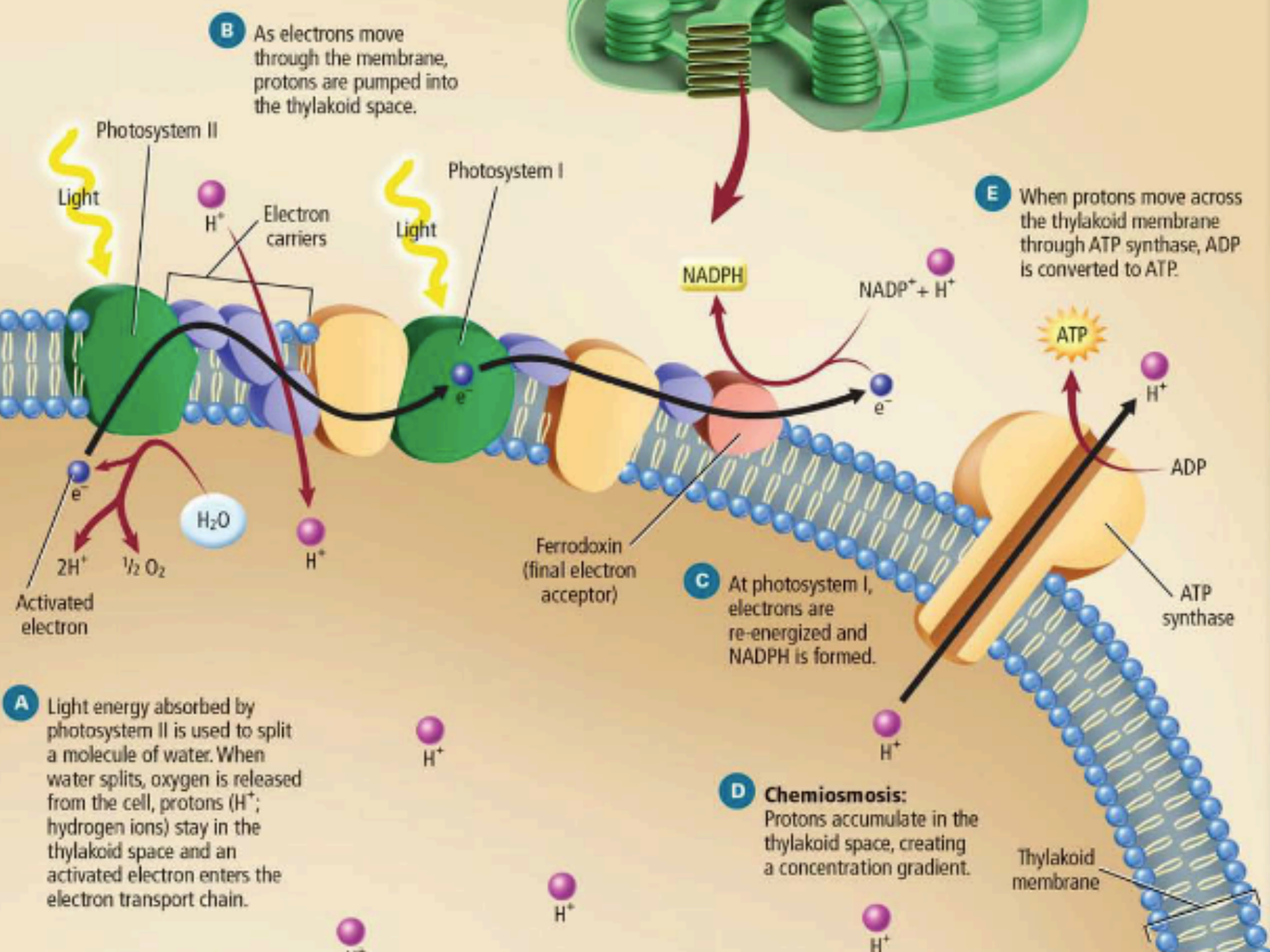


ATP is produced as protons flow through **ATP synthase** (**chemiosmosis**)

Remember: the water from photosystem II provided the protons




H_2O
Light
NADPH
CO_2
ATP
THYLAKOID
STROMA
ADP
NADP+
O_2
Sugars

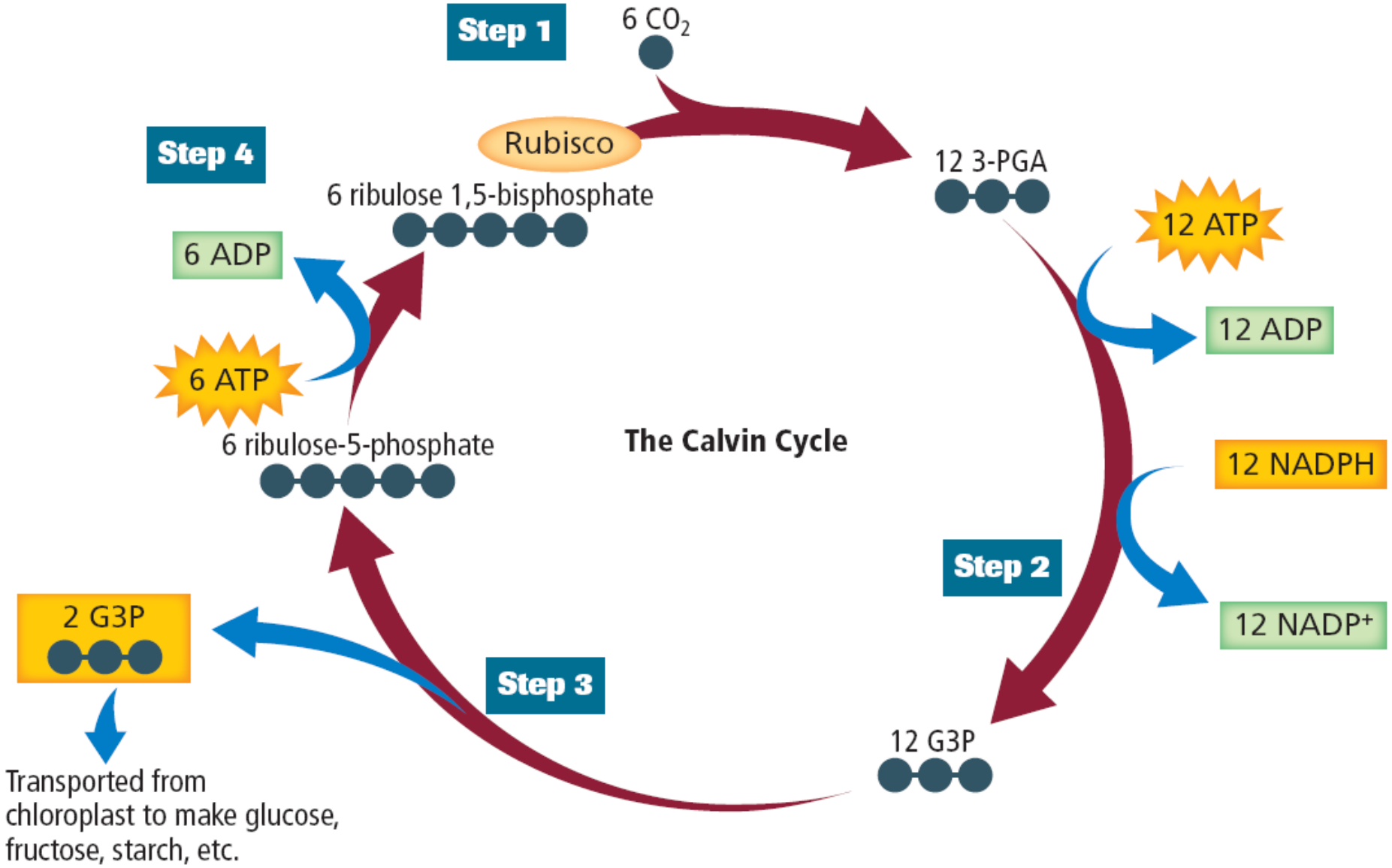

B As electrons move through the membrane, protons are pumped into the thylakoid space.
Photosystem II
Light
H+
Electron carriers
Light
Photosystem I
E When protons move across the thylakoid membrane through ATP synthase, ADP is converted to ATP.
NADPH
NADP+ + H+
ATP
H+
e−
e−
ADP
H2O
2H+
½ O2
H+
Ferrodoxin (final electron acceptor)
C At photosystem I, electrons are re-energized and NADPH is formed.
Activated electron
ATP synthase
A Light energy absorbed by photosystem II is used to split a molecule of water. When water splits, oxygen is released from the cell, protons (H+; hydrogen ions) stay in the thylakoid space and an activated electron enters the electron transport chain.
H+
D Chemiosmosis: Protons accumulate in the thylakoid space, creating a concentration gradient.
Thylakoid membrane
H+
H+

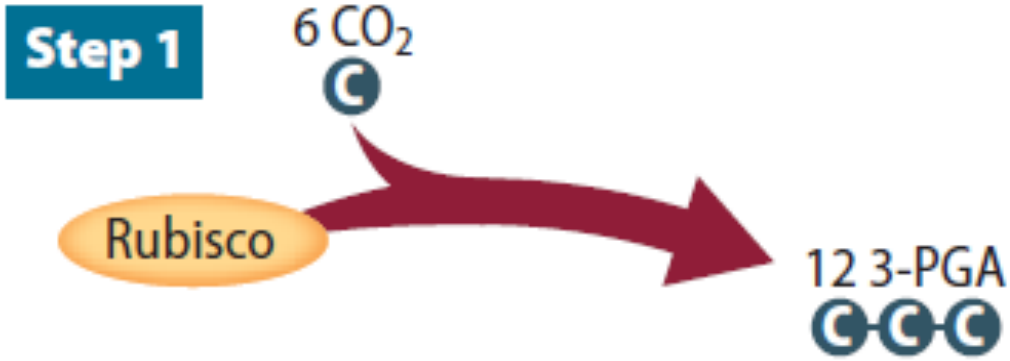
HTTPS://YOUTU.BE/WW33L0LD37I

TAYLOR SWIFT PARODY- PHOTOSYNTHESIS

Phase Two:

Calvin cycle- energy is stored in organic molecules (such as glucose.)





The first step is **carbon fixation**.

6 CO_2 molecules combine with 6 5-carbon molecules

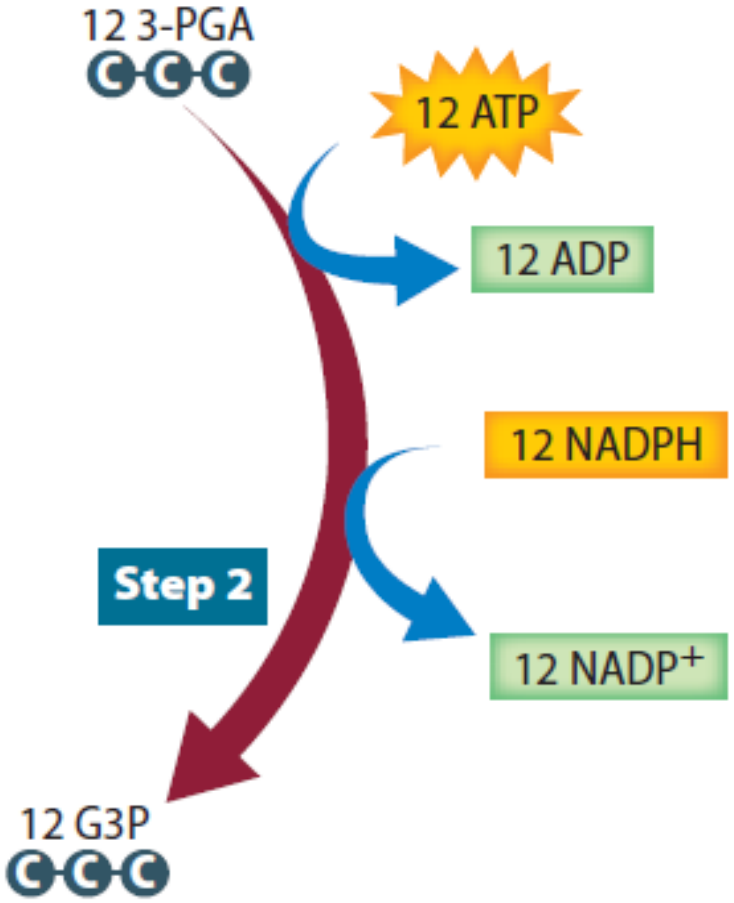
to form 12 3 carbon molecules (3-PGA)

second step-

chemical energy from ATP & NADPH

is transferred to the 3-PGA

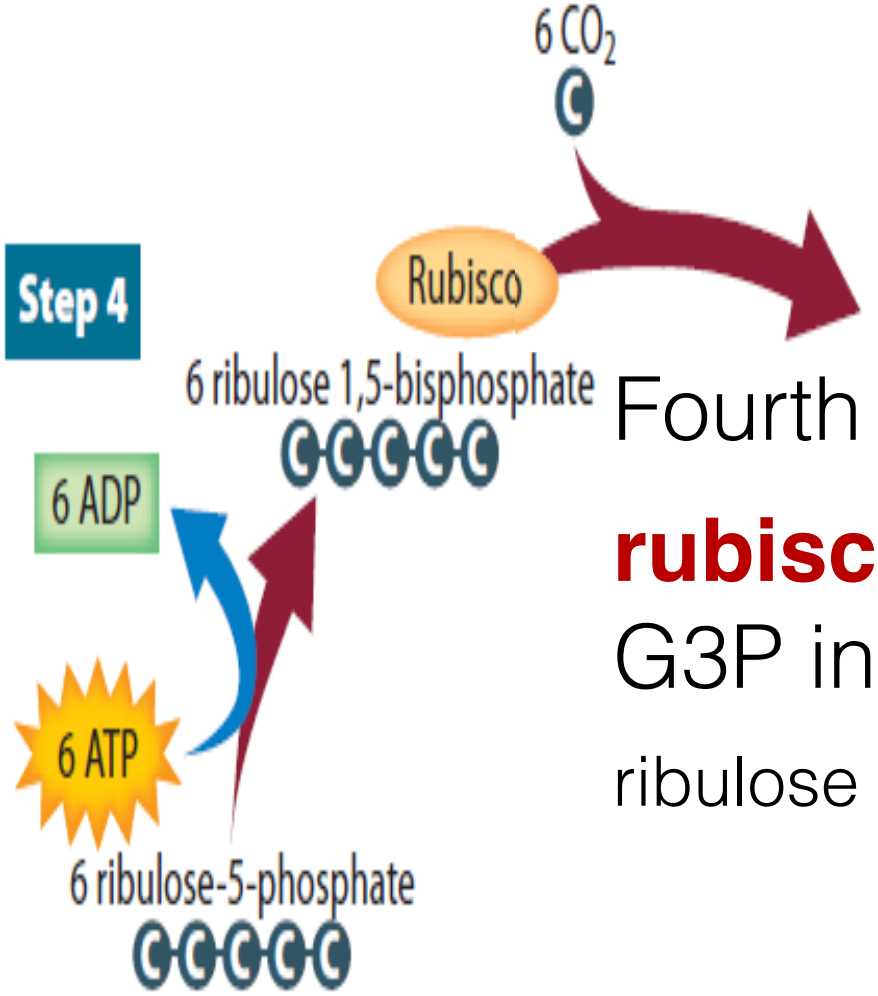
to form G3P



third step

2 G3P molecules leave the cycle to make glucose

(and other organic compounds.)



Fourth step

rubisco (enzyme) converts the G3P into 5-carbon molecules

ribulose 1, 5-bisphospates (RuBP).

These molecules combine with new CO_2 and continue the cycle.

Alternative Pathways

reduce water loss

C_4 plants- fix carbon into four-carbon compounds instead of three-carbon molecules

Also: different arrangement of cells within the leaves – separate CO_2 uptake from location of Calvin cycle

- Ex: sugar cane and corn

CAM plants Crassulacean acid metabolism (in desert plants.)

- Collect CO_2 at night and store it in organic compounds
- During the day, release CO_2 from organic compounds for the light-dependent cycle of photosynthesis