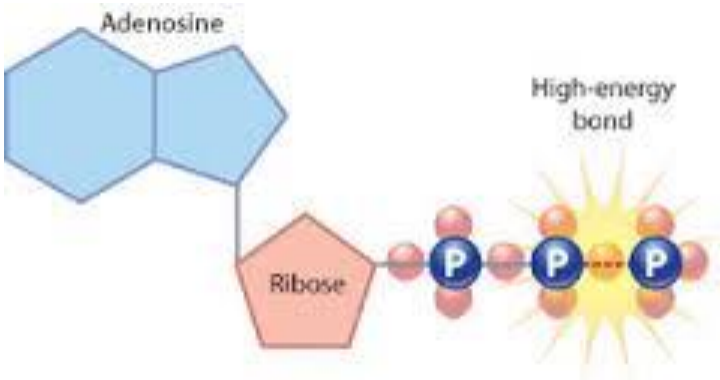
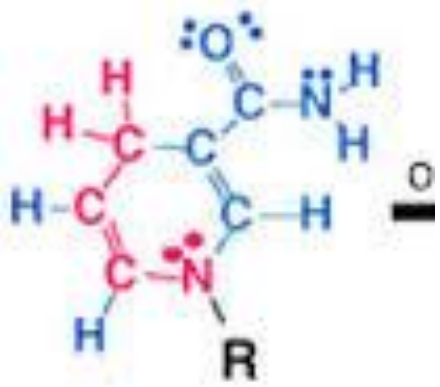
CELL ENERGY

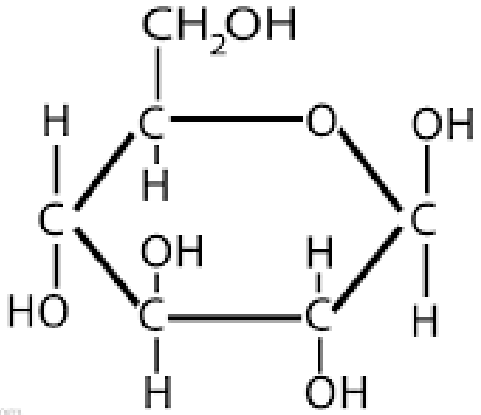
Unit 4

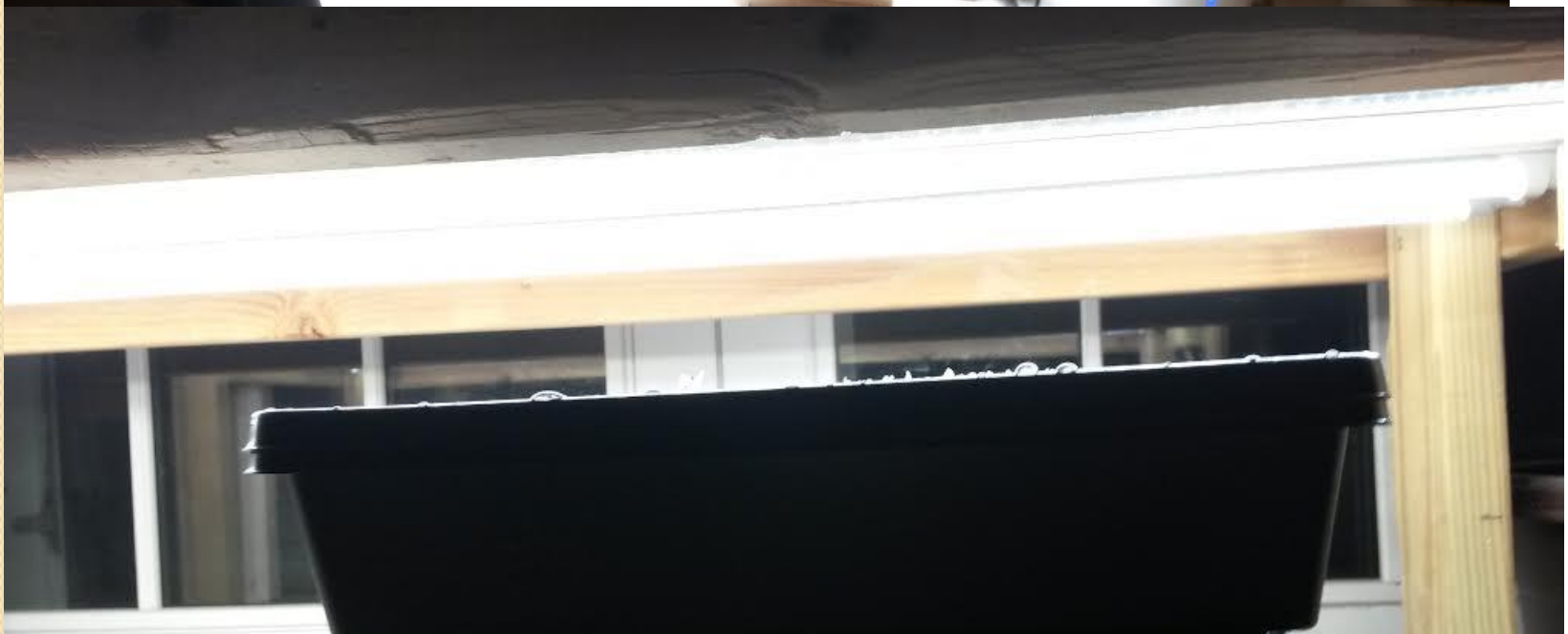




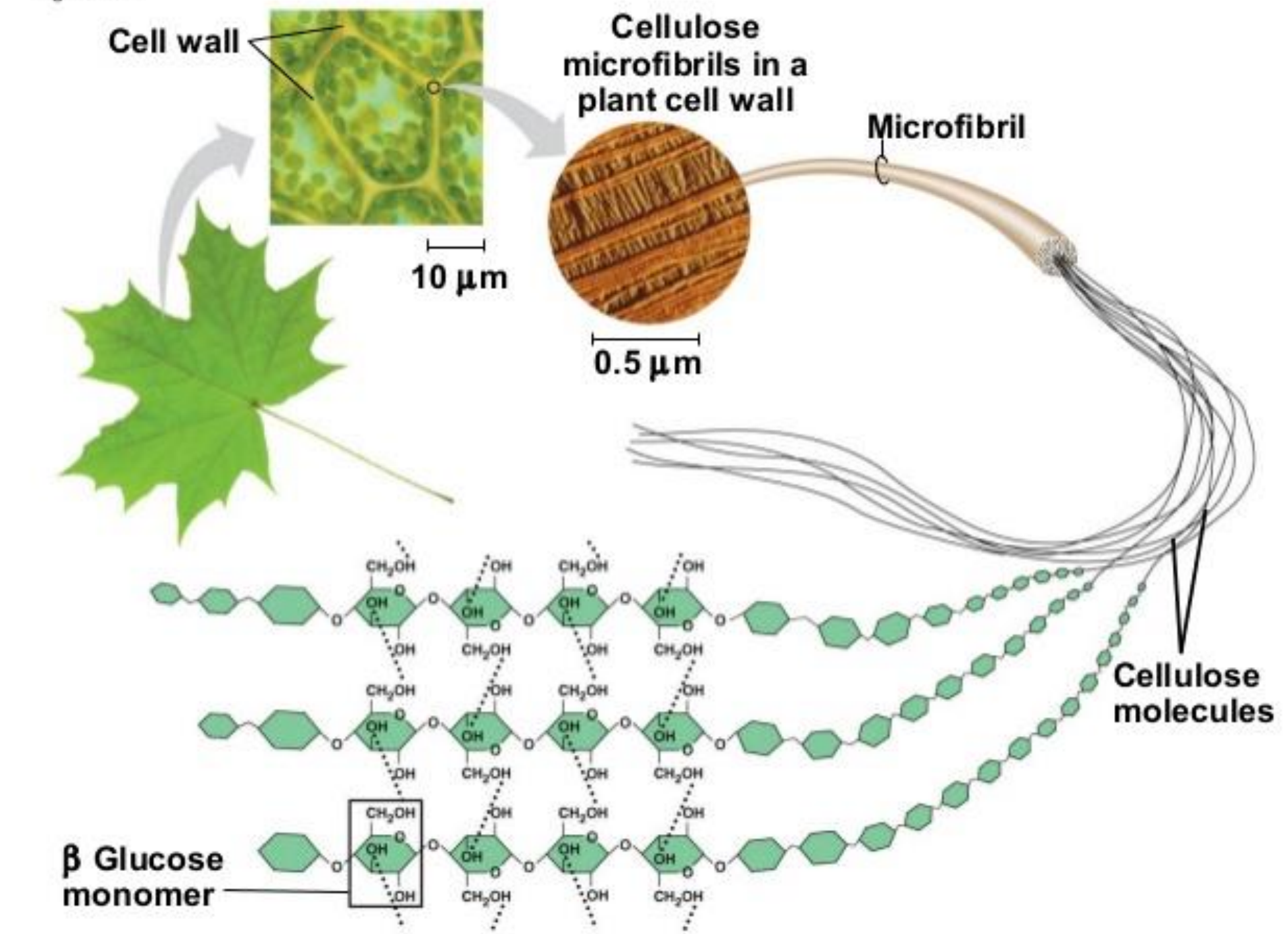
NADH

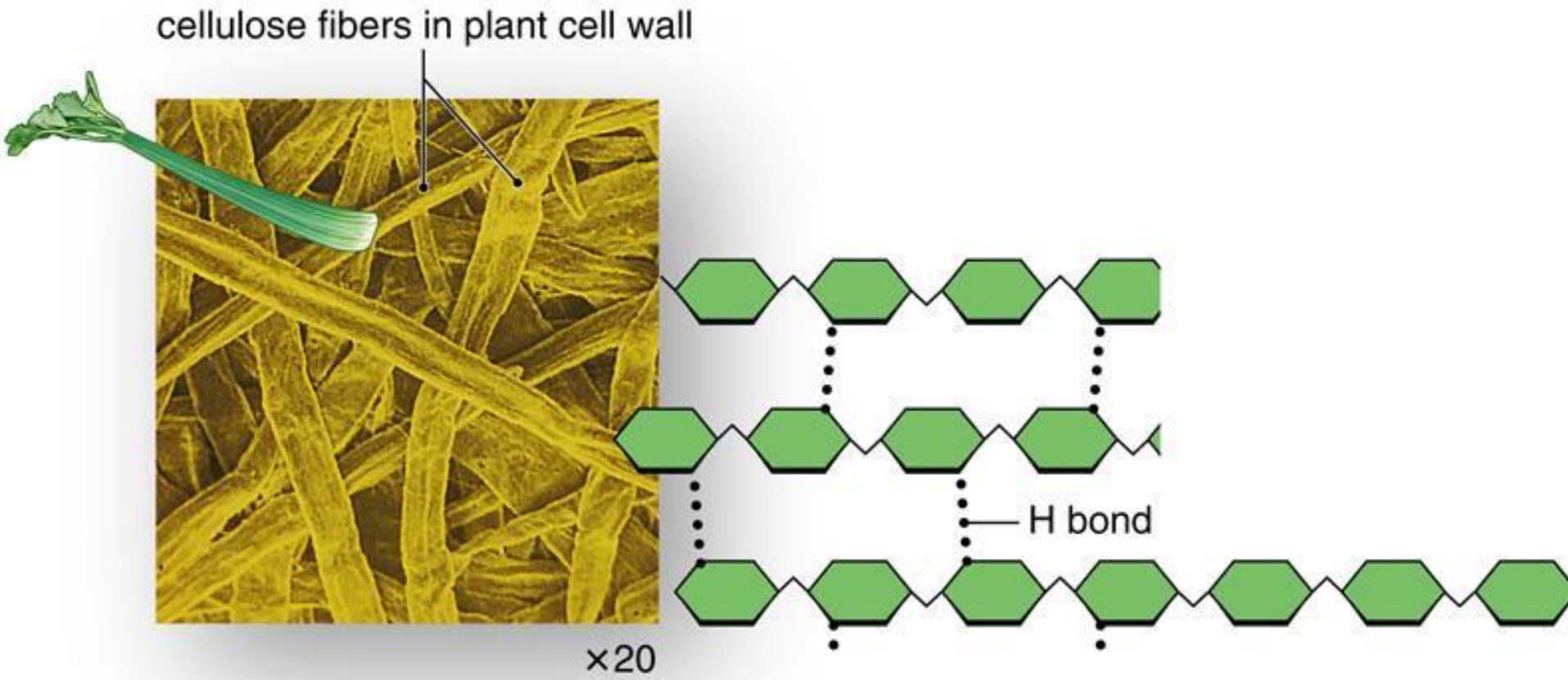
Glucose





?



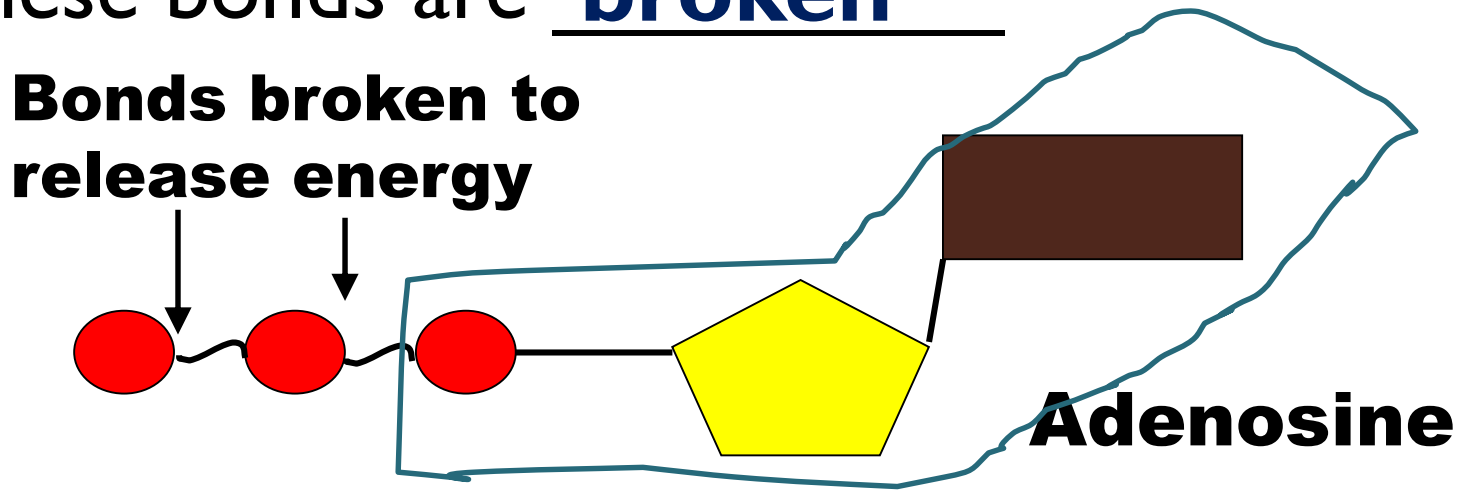


Cellulose structure

ENERGY?

- Energy is used by all cells to:
  - Perform cell jobs or do work
  - Run chemical reactions of metabolism
- Organisms get energy through **food**
  - They either make their own food or eat food
  - **Autotrophs** (producers) make their own food, usually through **photosynthesis**
  - **Heterotrophs** (consumers) eat autotrophs or other heterotrophs

- The main form (molecule) of energy accepted for cell use is **ATP**
- Outline the **nucleotide** below
- Energy is stored in covalent bonds when 1 or 2 **Phosphate groups** join the nucleotide
- Energy for cell use is released when these bonds are **broken**

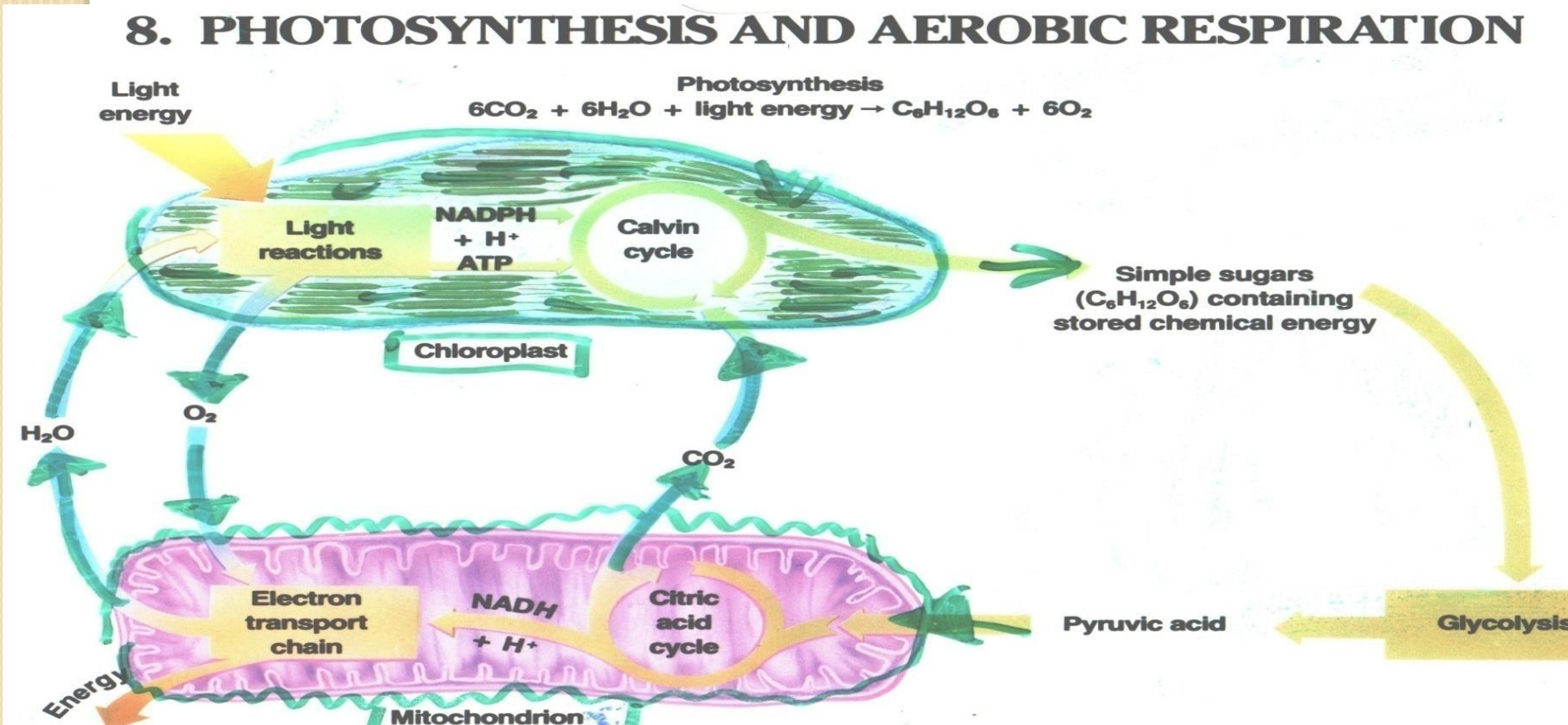


When an ADP molecule is recharged with energy and capped with a phosphate group =

phosphorylation

Lets Review a couple "**SUPERHERO**" cell organelles

- **Mitochondria** and **chloroplasts** are **complementary** organelles that both use **membranes with enzyme assembly lines** to process energy in opposite ways



MITOCHONDRIA VS. CHLOROPLASTS

MITOCHONDRIA

- Found in plant & animal cells
- Has own **DNA**
- Has inner membrane
- Converts **glucose** into **ATP**

CELLULAR RESPIRATION!!!

CHLOROPLASTS

- Found only in plant cells
- Has own **DNA**
- Has inner membranes
- Converts **light energy** into **chemical stored energy** (glucose)

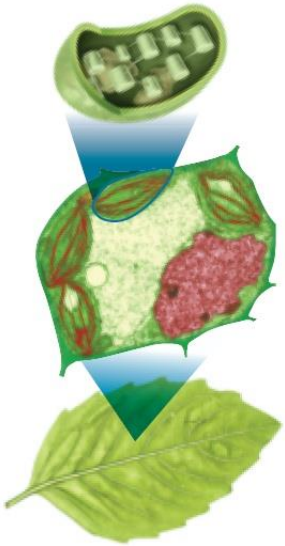
PHOTOSYNTHESIS!!!

Photosynthesis

Reactants

Carbon Dioxide

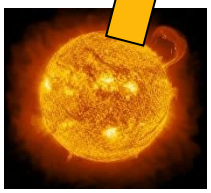
Water



Products

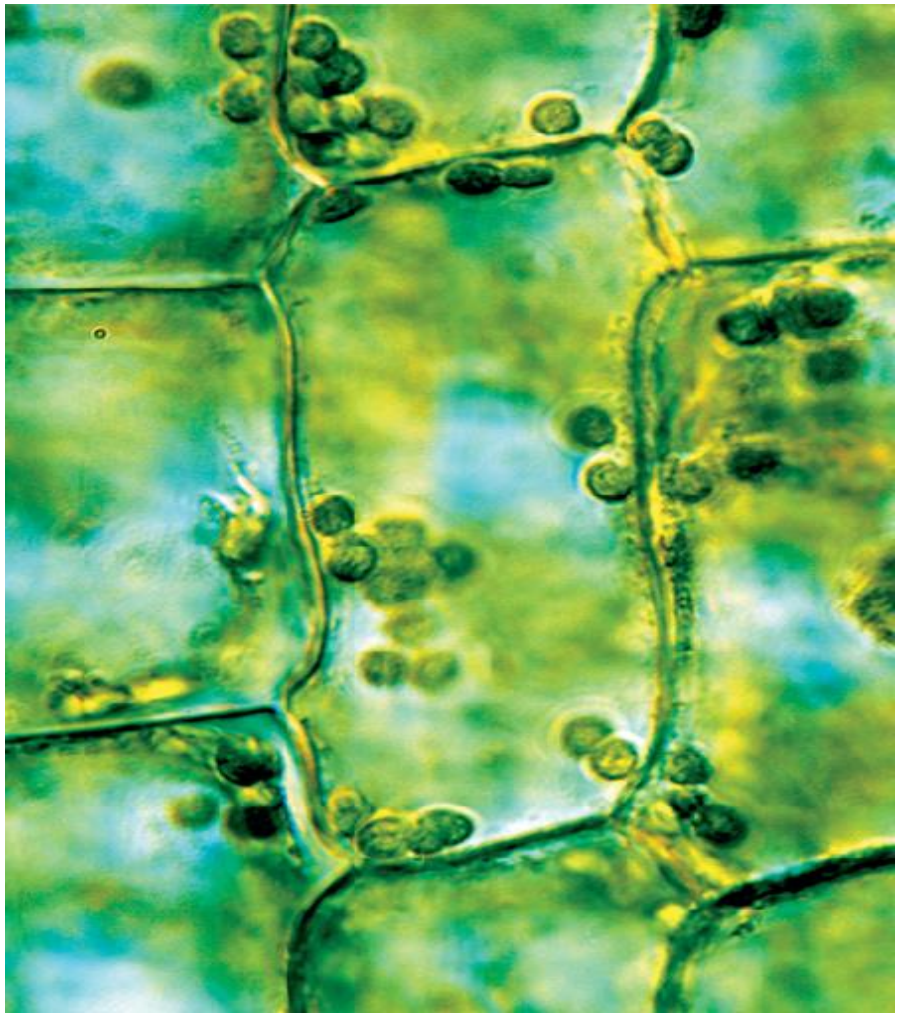
Oxygen

Sugar



Light Energy

Can you see WHERE Photosynthesis reactions will occur?



- The location and structure of chloroplasts

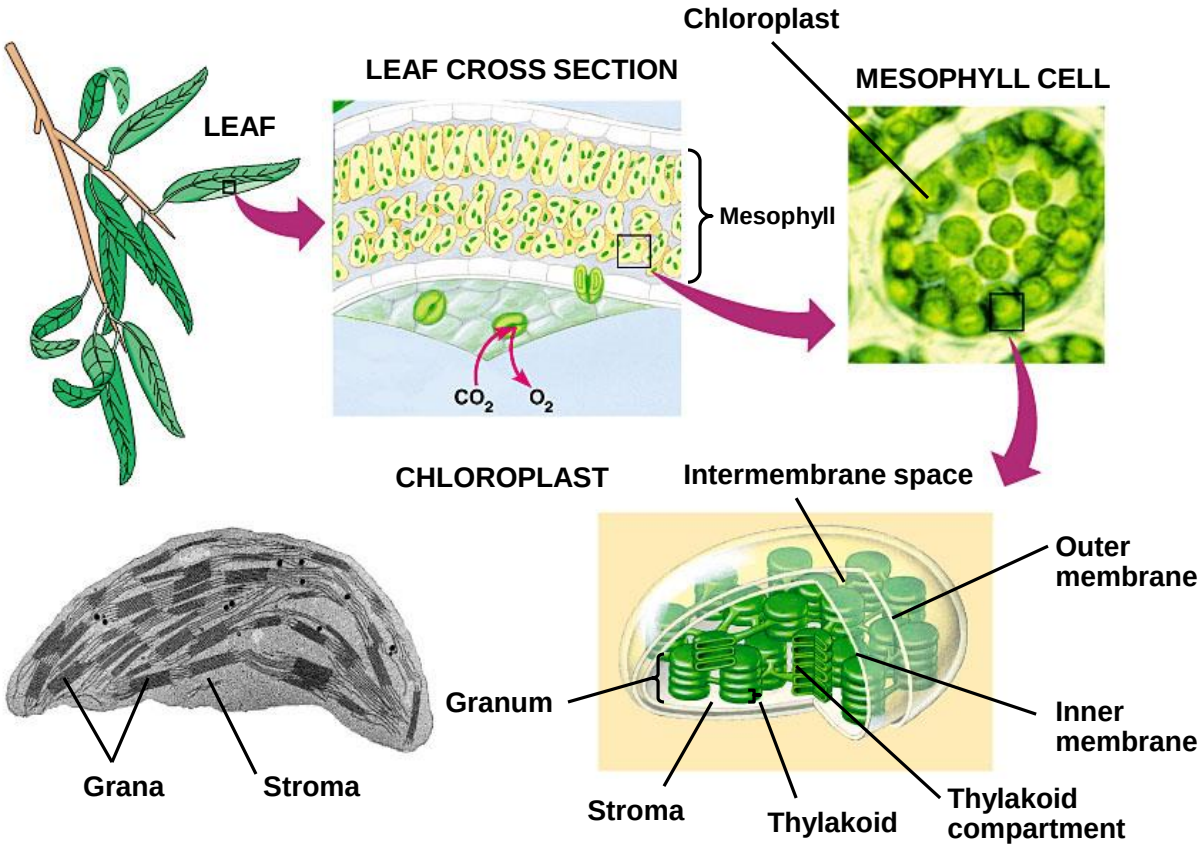
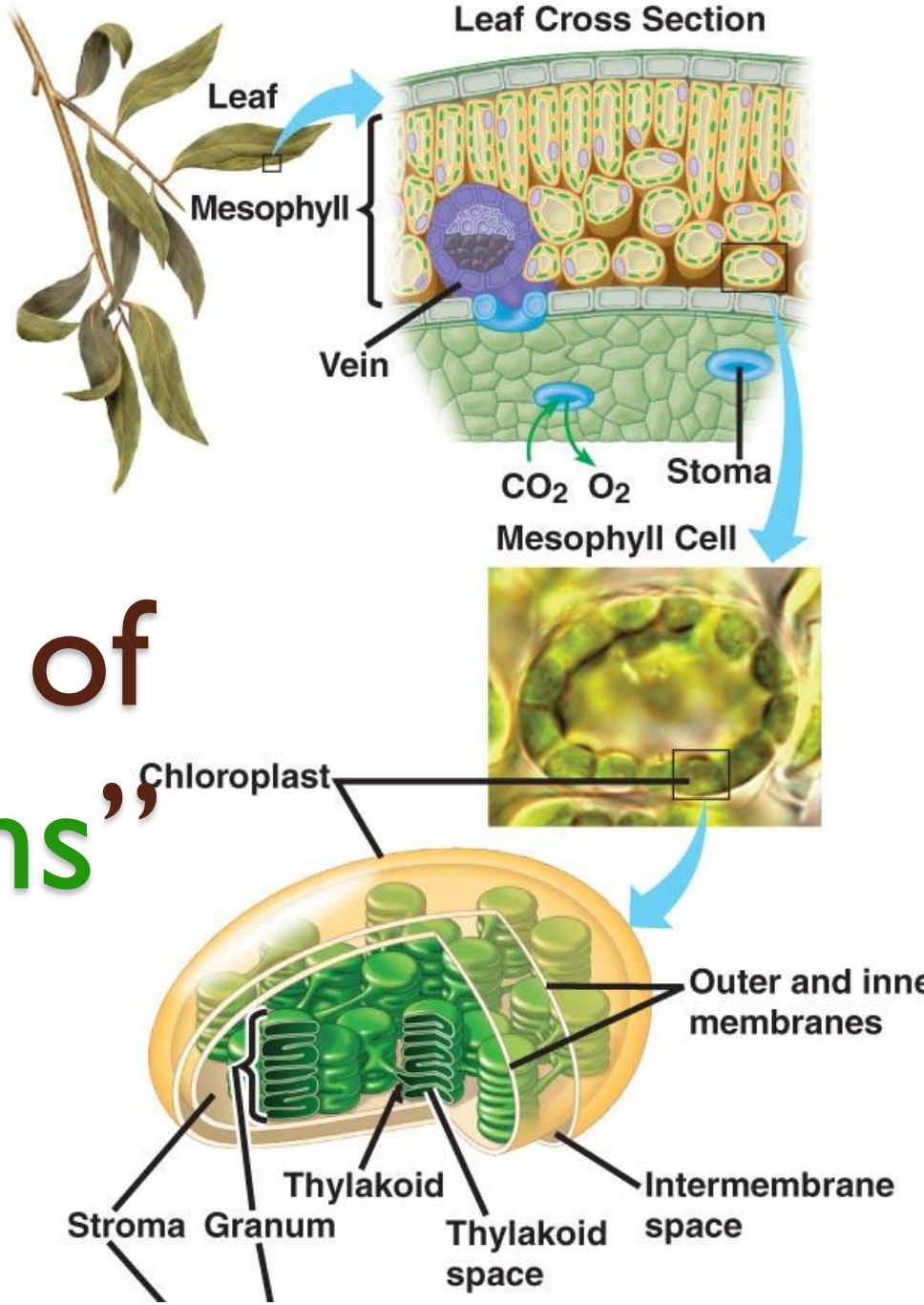
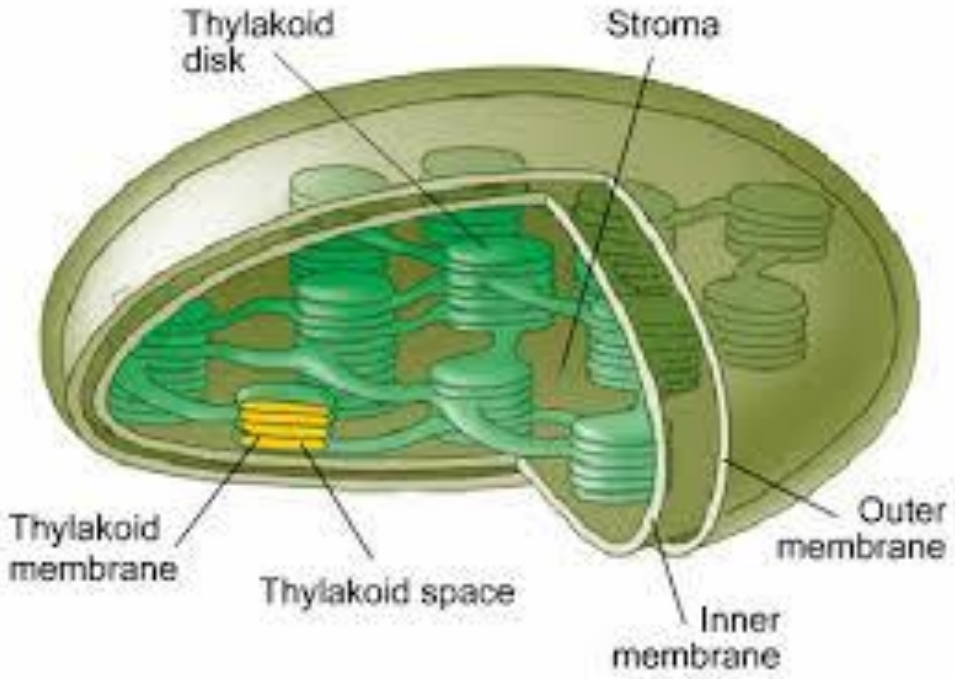


Figure 7.2

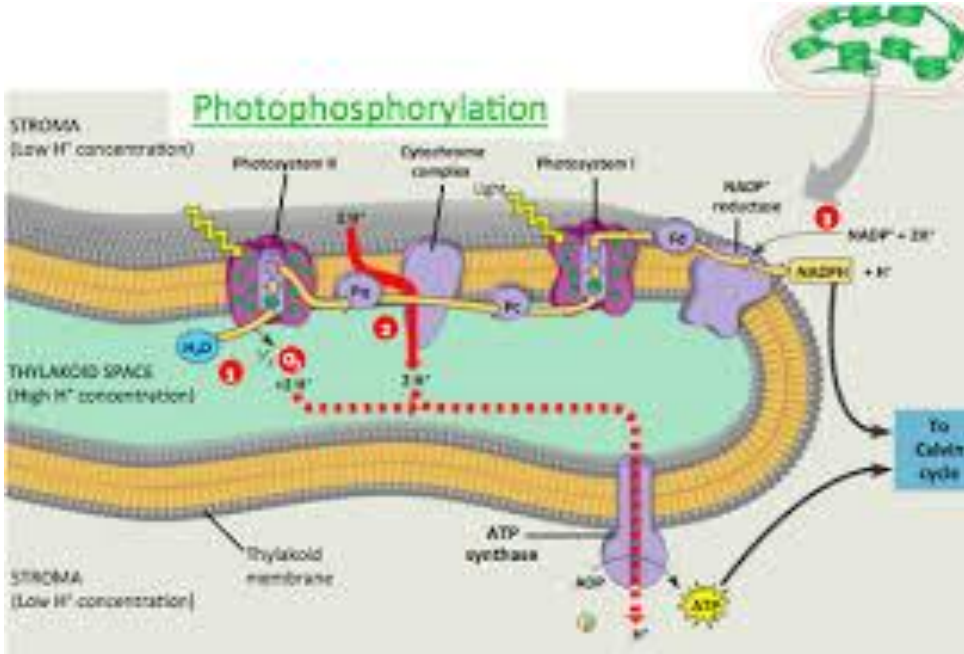
Can you find the grana? … AKA stack of "green coins"



Can you find the thylakoid membrane? …



This is where the action of photosynthesis takes place



Day 2

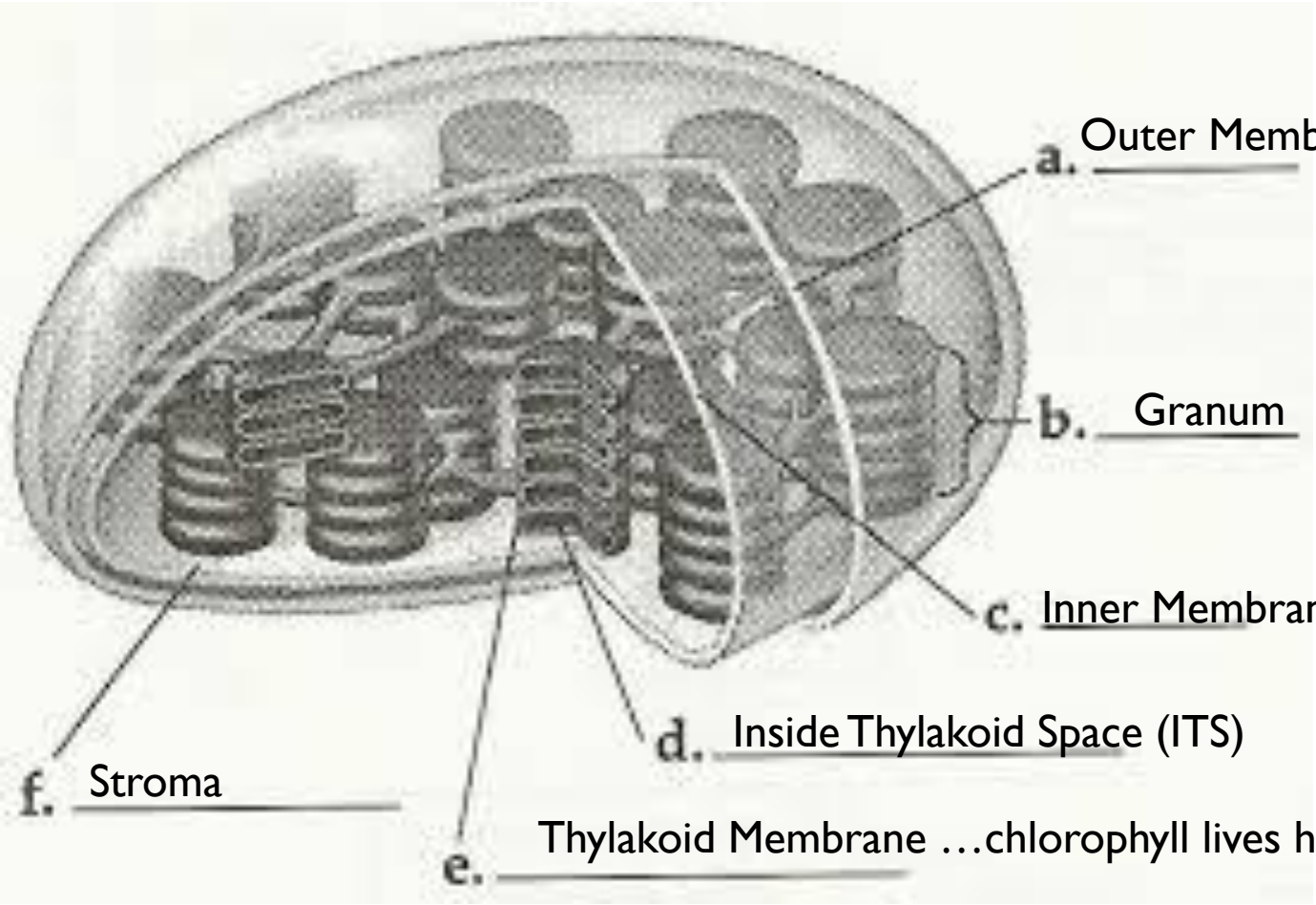
Day 3

Day 3

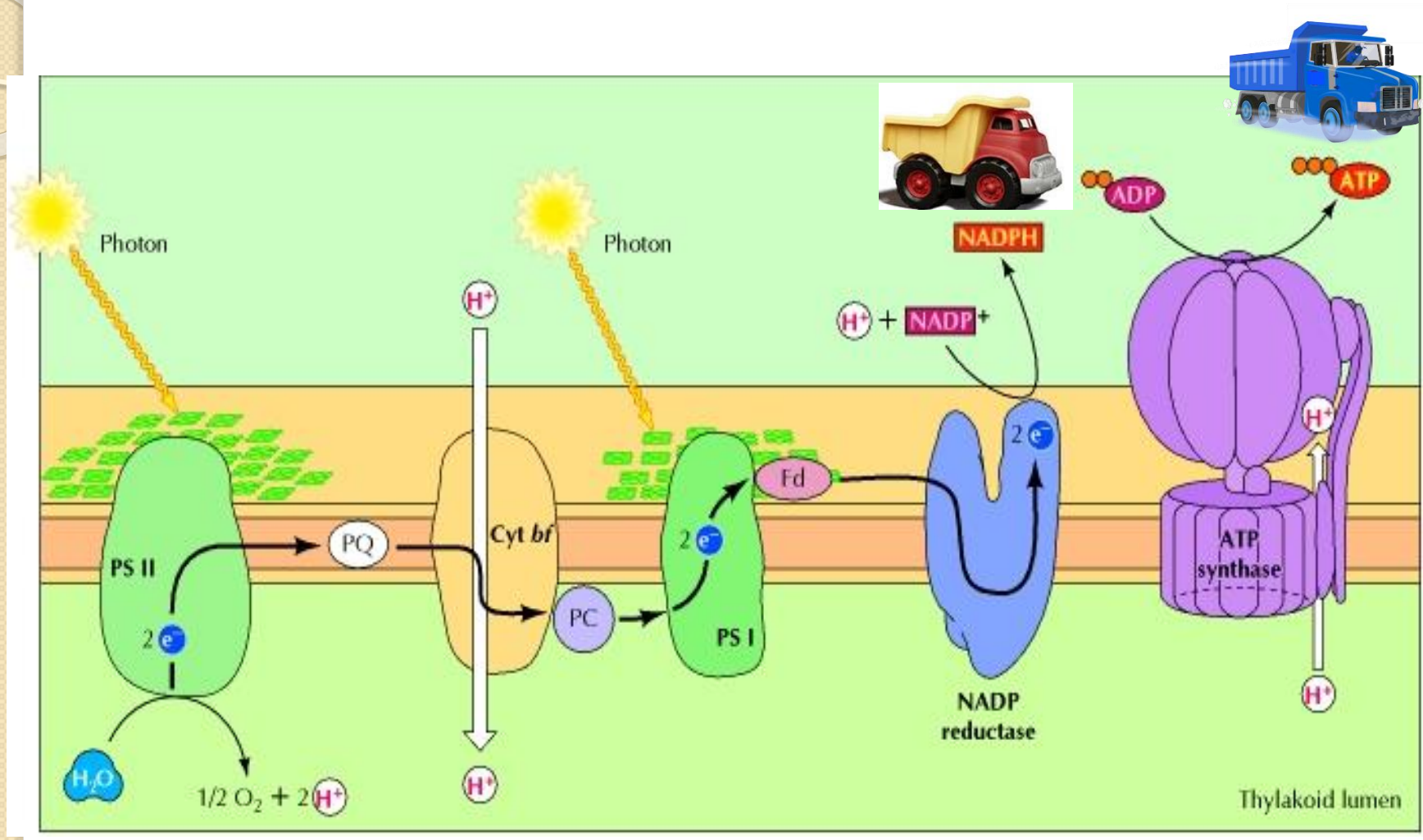
Thursday

Thursday

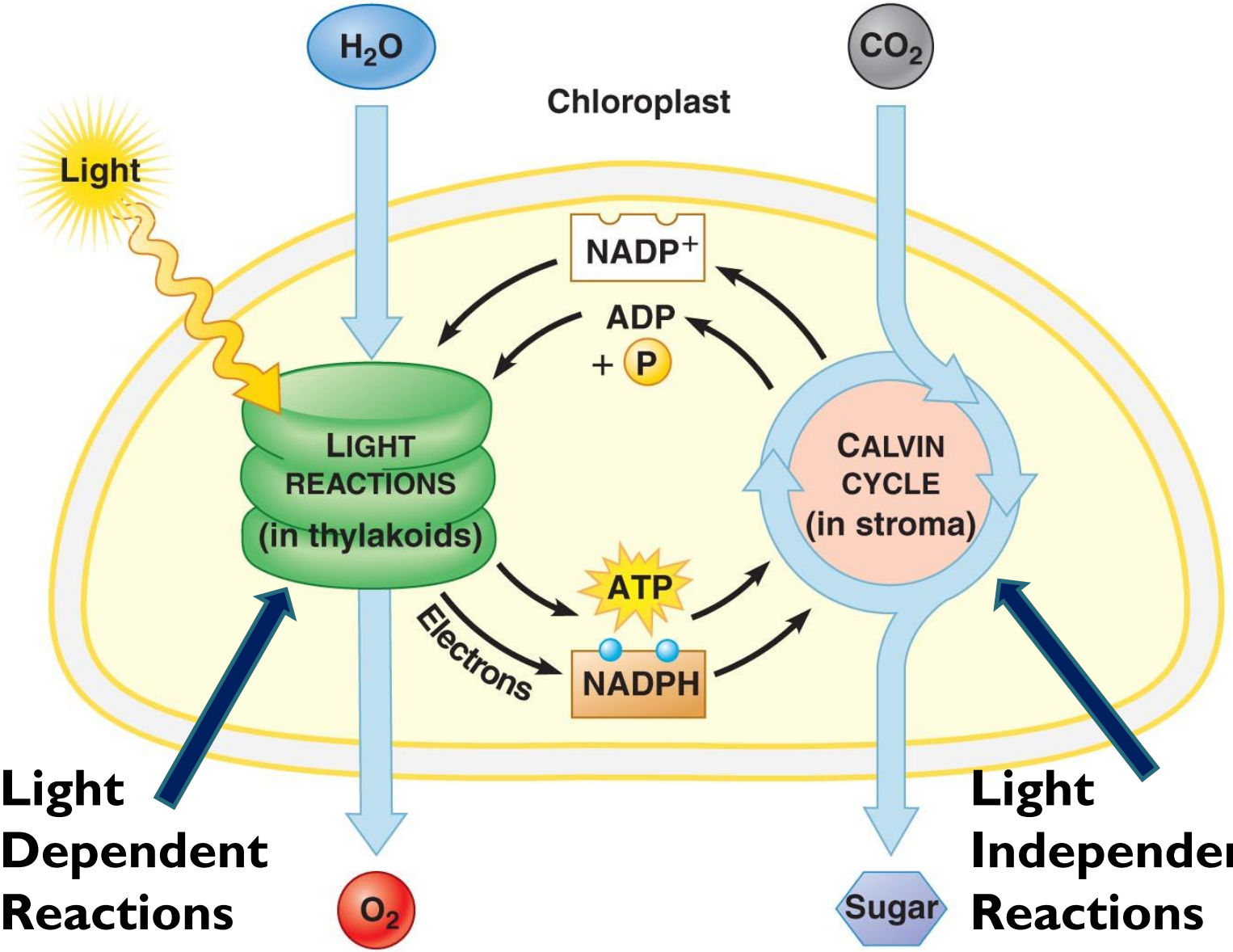
Let's label the chloroplast



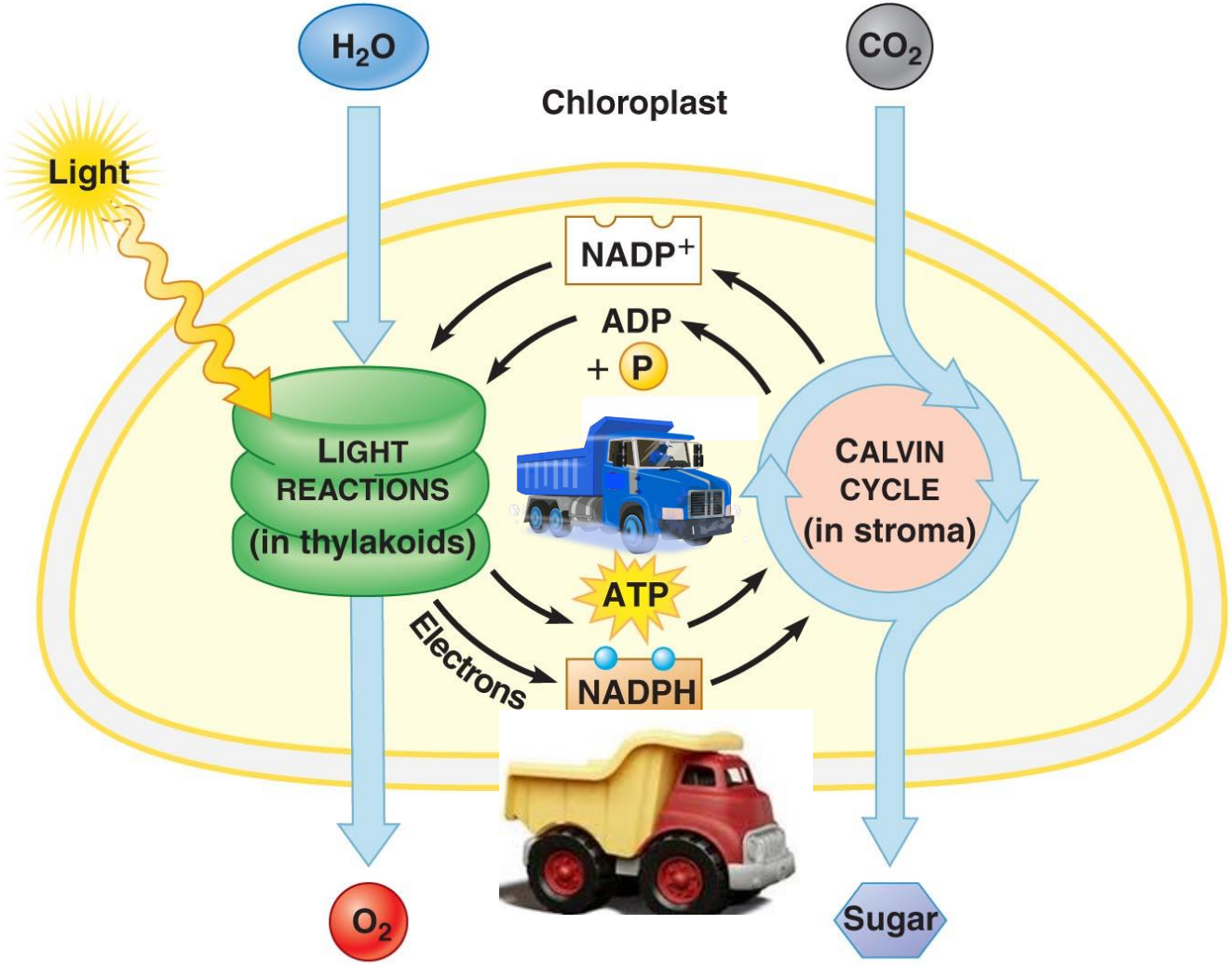
Let's find the ITS



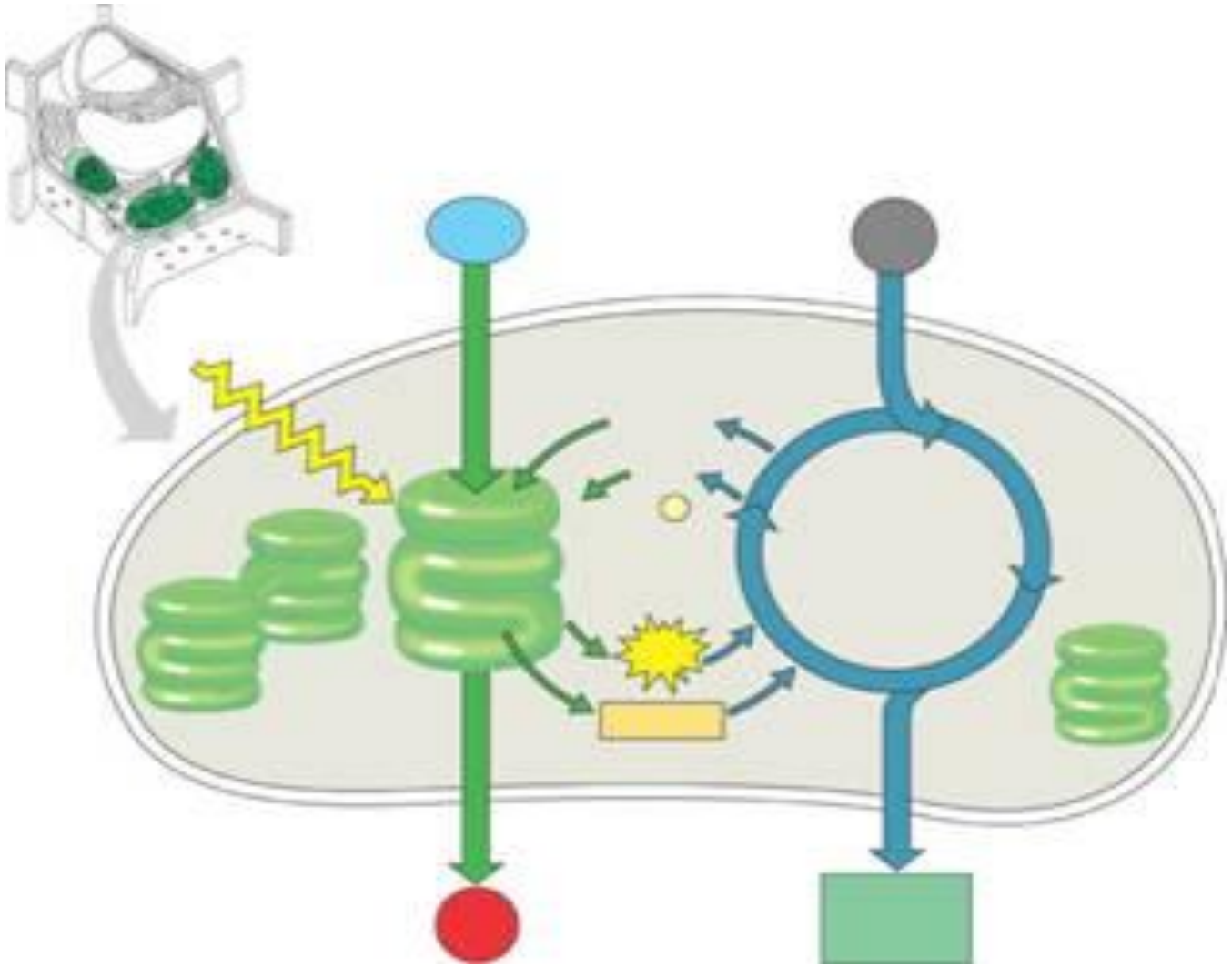
Photosynthesis occurs in 2 stages



Can you see who carries the energy and electrons from the light reactions to the Calvin cycle?

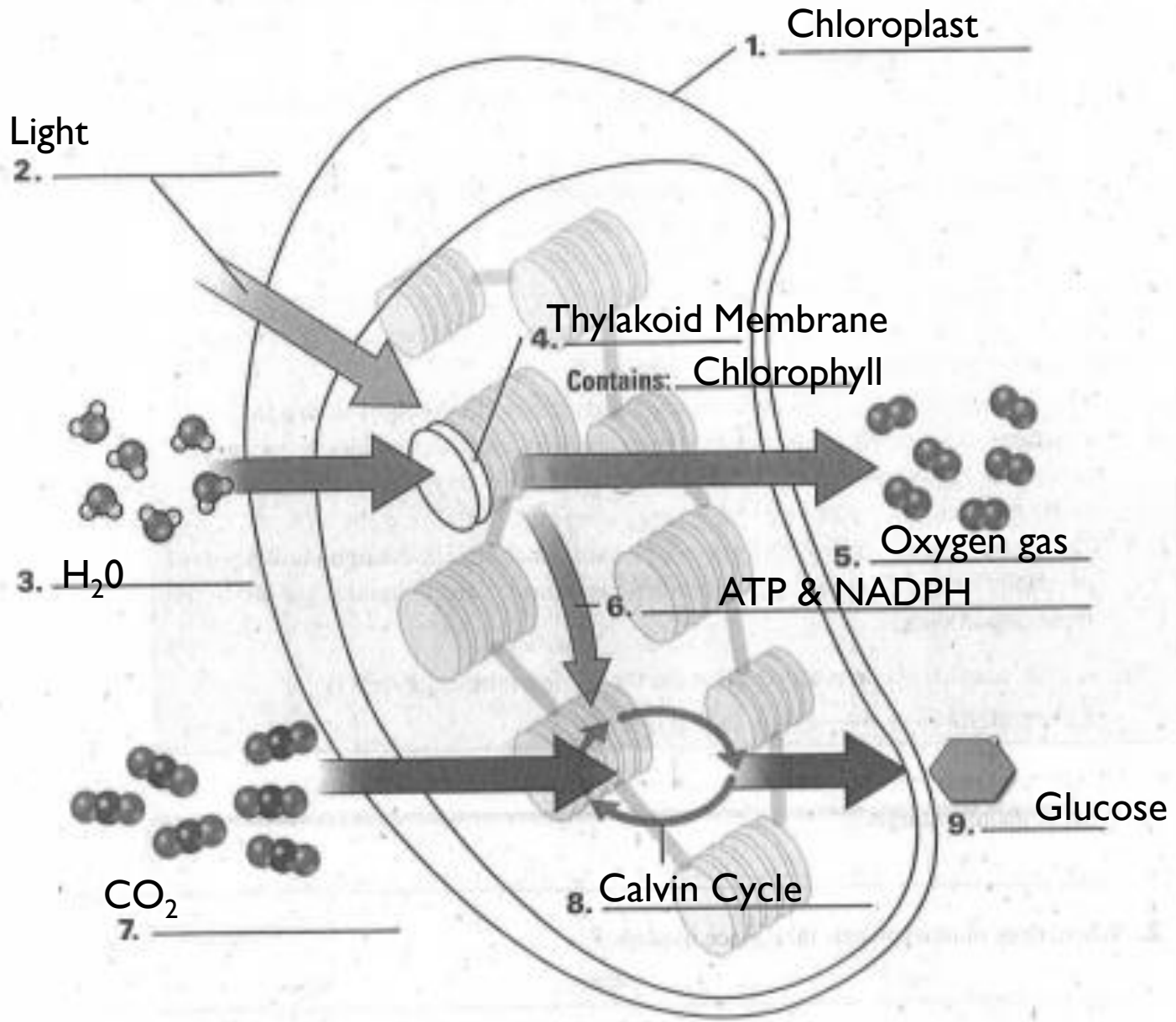


Let's label our diagram



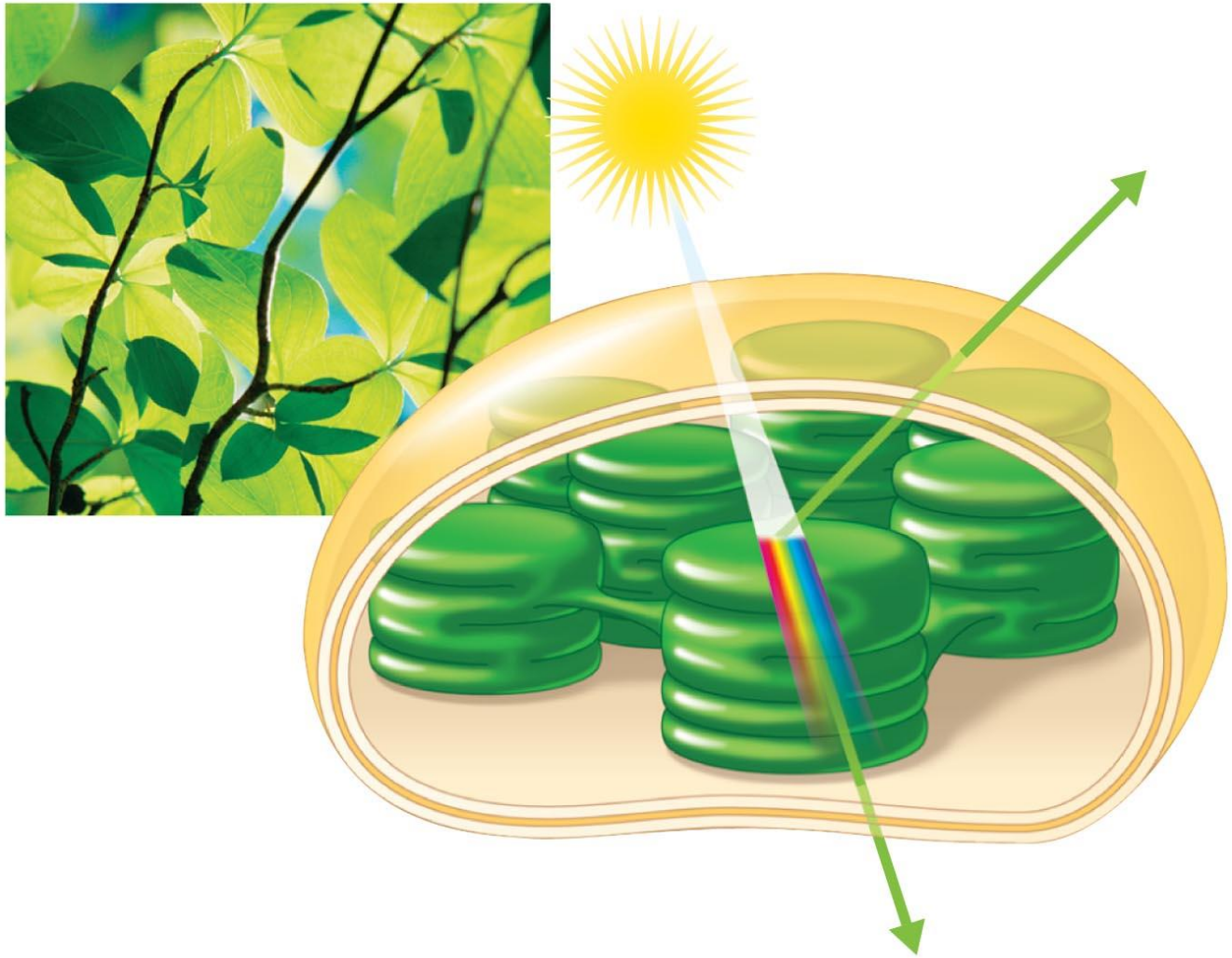
Photosynthesis:

$CO_2 + H_2O \xrightarrow{\text{light}} \text{Glucose} + O_2$



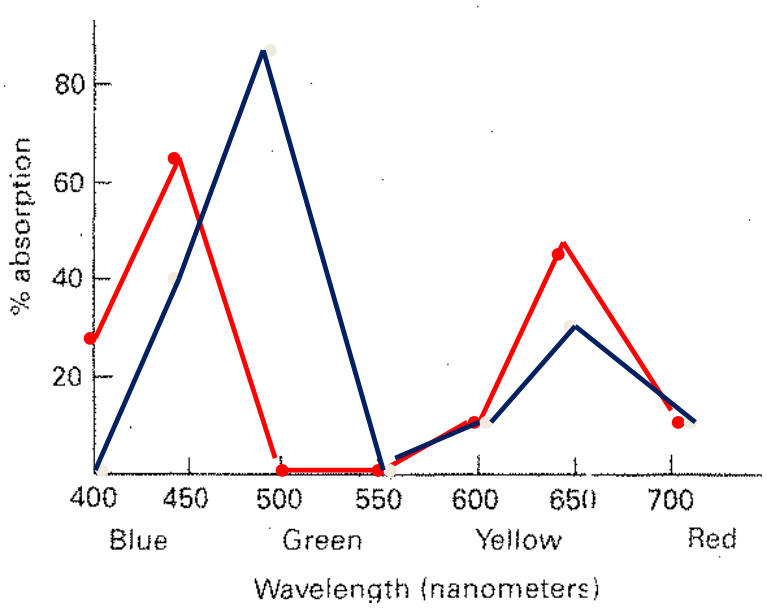
Stage One: Light Reactions

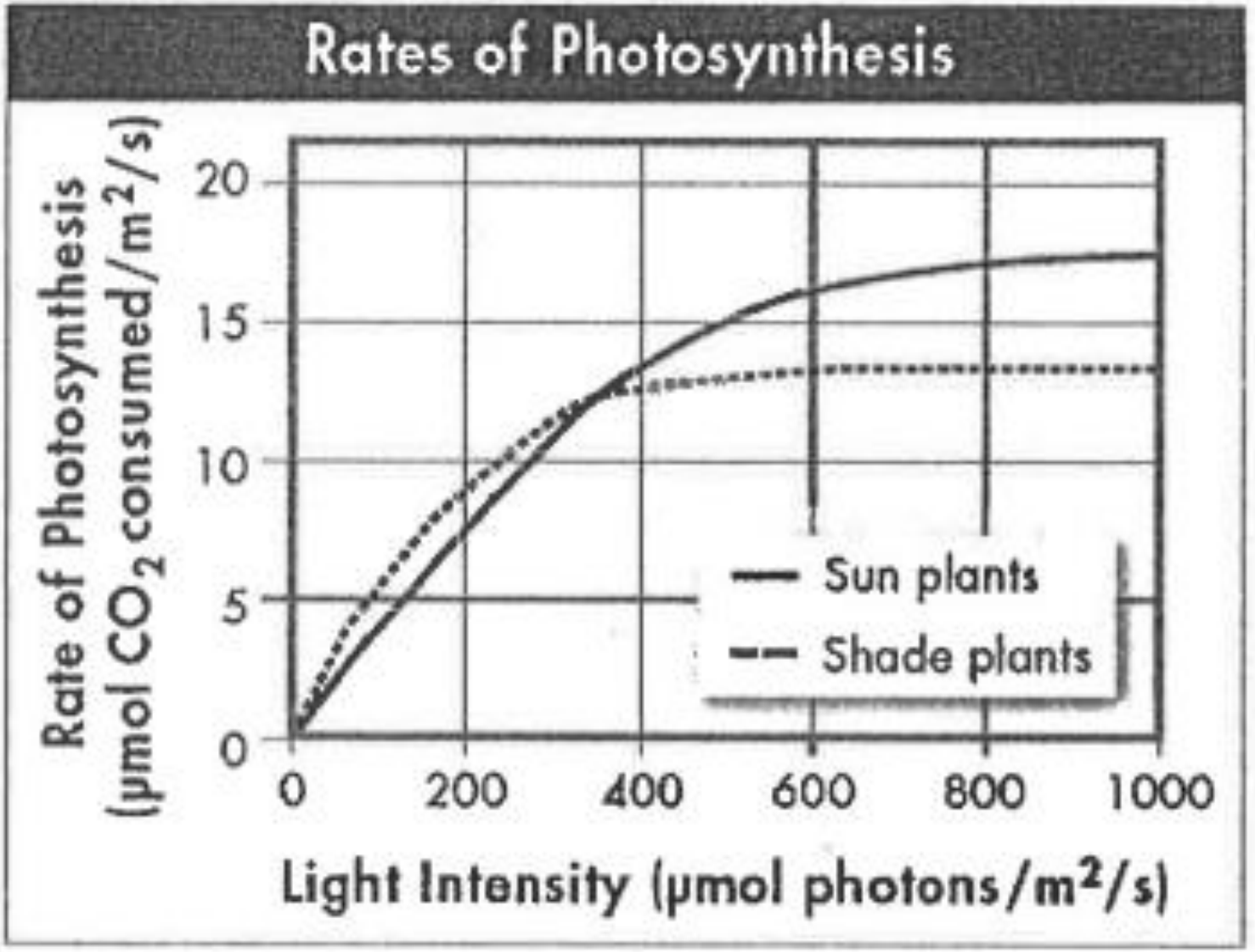
A. Light energy is captured



Are you a believer in ROYGBIV?

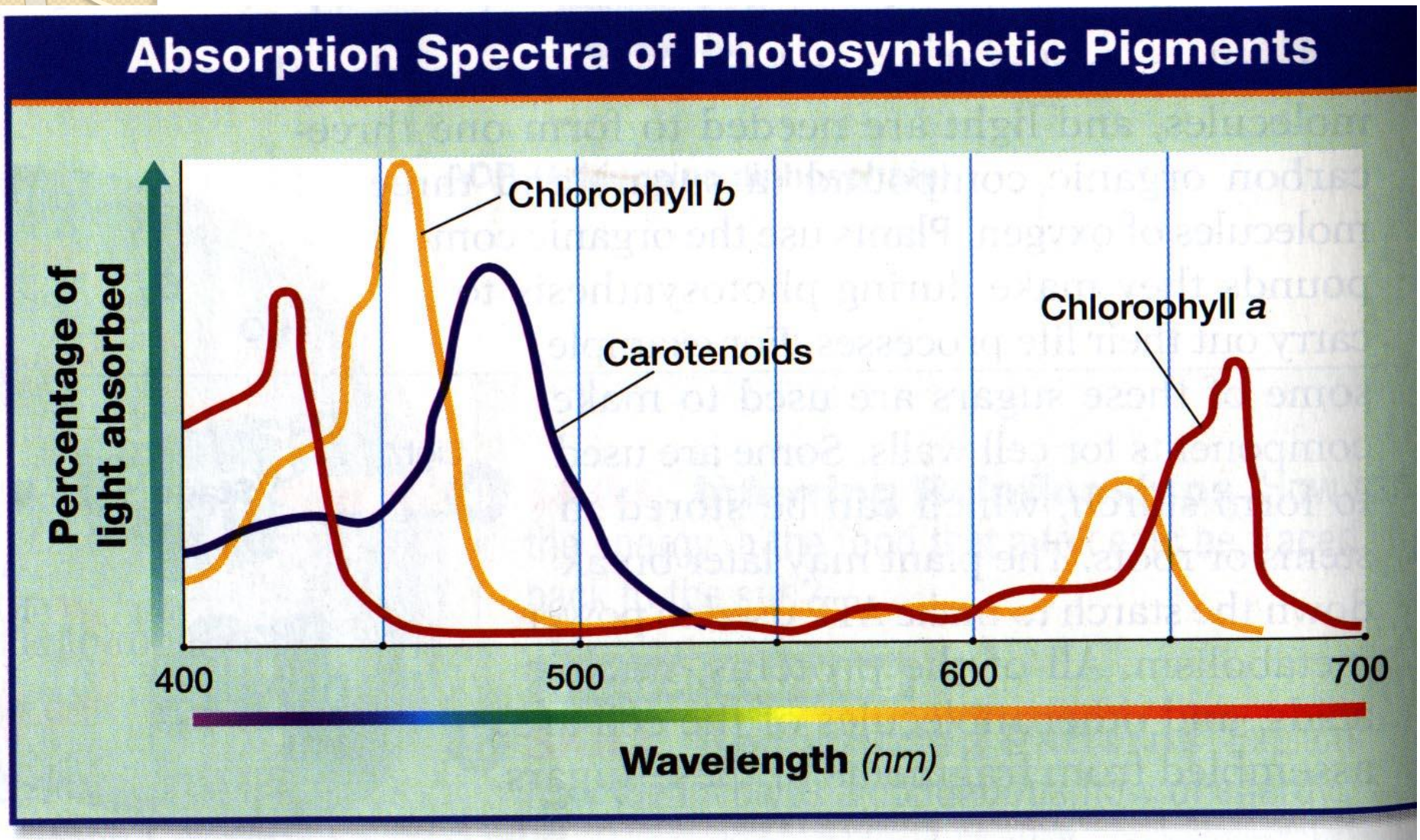
Wavelength	Chlorophyll A % Absorption	Chlorophyll B % Absorption
400 nanometers	30	0
450 nanometers	65	40
500 nanometers	0	85
550 nanometers	0	0
600 nanometers	10	10
650 nanometers	45	25
700 nanometers	10	10




Rates of Photosynthesis
Rate of Photosynthesis (μmol CO_2 consumed/m^2/s)
20
15
10
5
0
0
200
400
600
800
1000
Light Intensity (μmol photons/m^2/s)
Sun plants
Shade plants

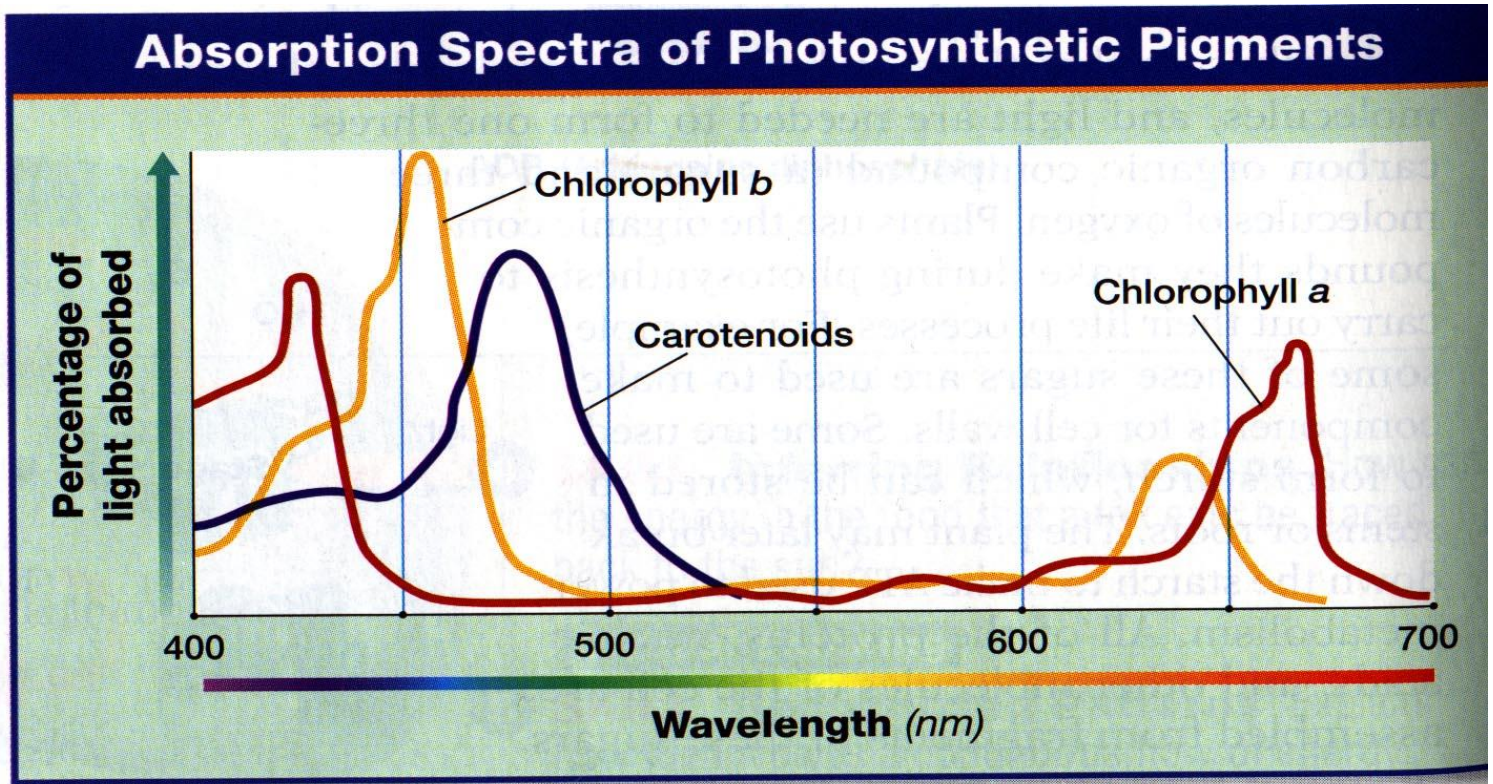
Why is my maple tree **RED** in the fall?

- What color of light does chlorophyll b pigment **capture** the most effectively?
- What color of light does chlorophyll b pigment **reflect** the most effectively?



Stage One: Light Reactions

A. Light energy is captured
   - Chlorophyll pigments capture **blue** and **red** colors
   - Carotenoid pigments add even more energy from **Blue-green** colors



Why is my maple tree **RED** in the fall?

Day 2

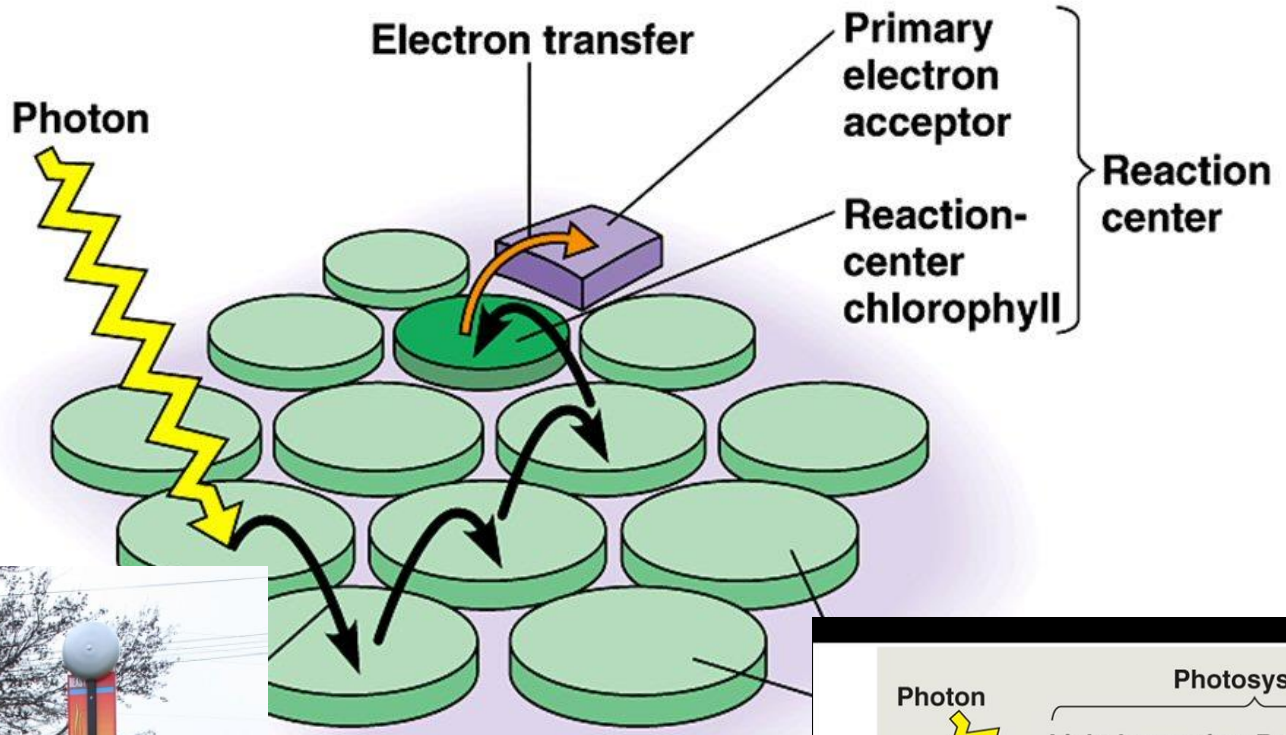
Day 3

Day 3

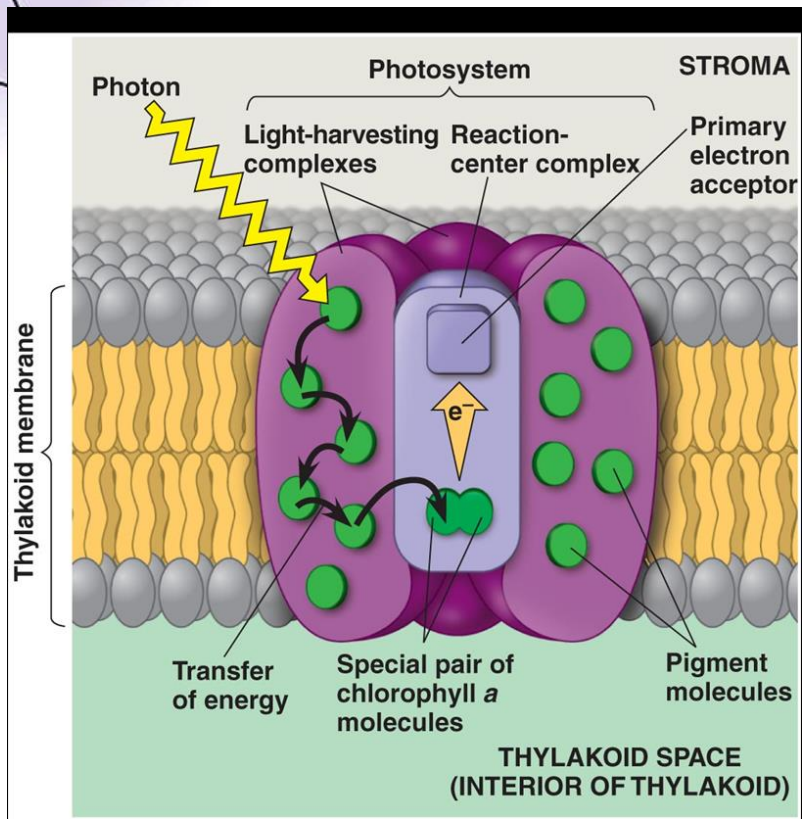
Thursday

Thursday

Time to harvest

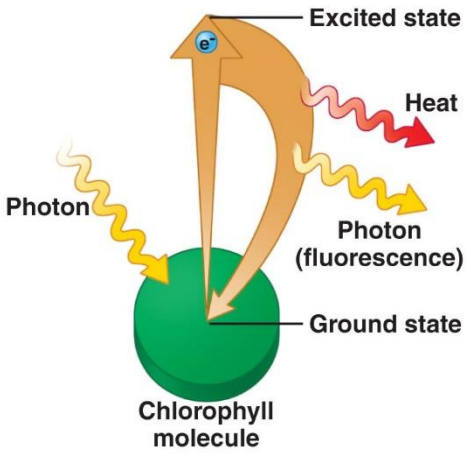


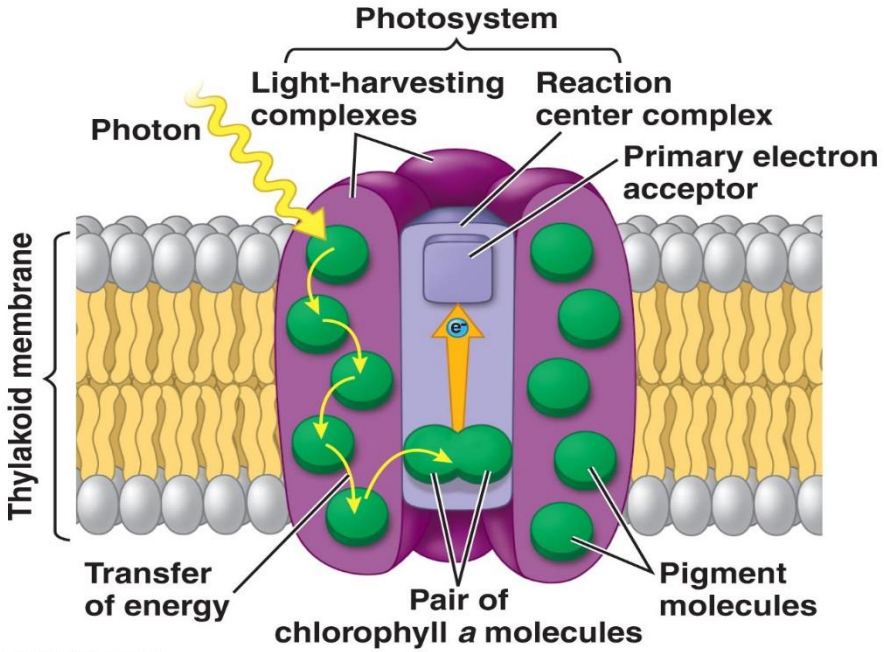
Photosystem



Stage One: Light Reactions

B. Energy plays "**frogger**" or "**Hot-potato**" across the chlorophyll molecules until it lands on the photosystem reaction center where it causes an energized electron to **jump away**.





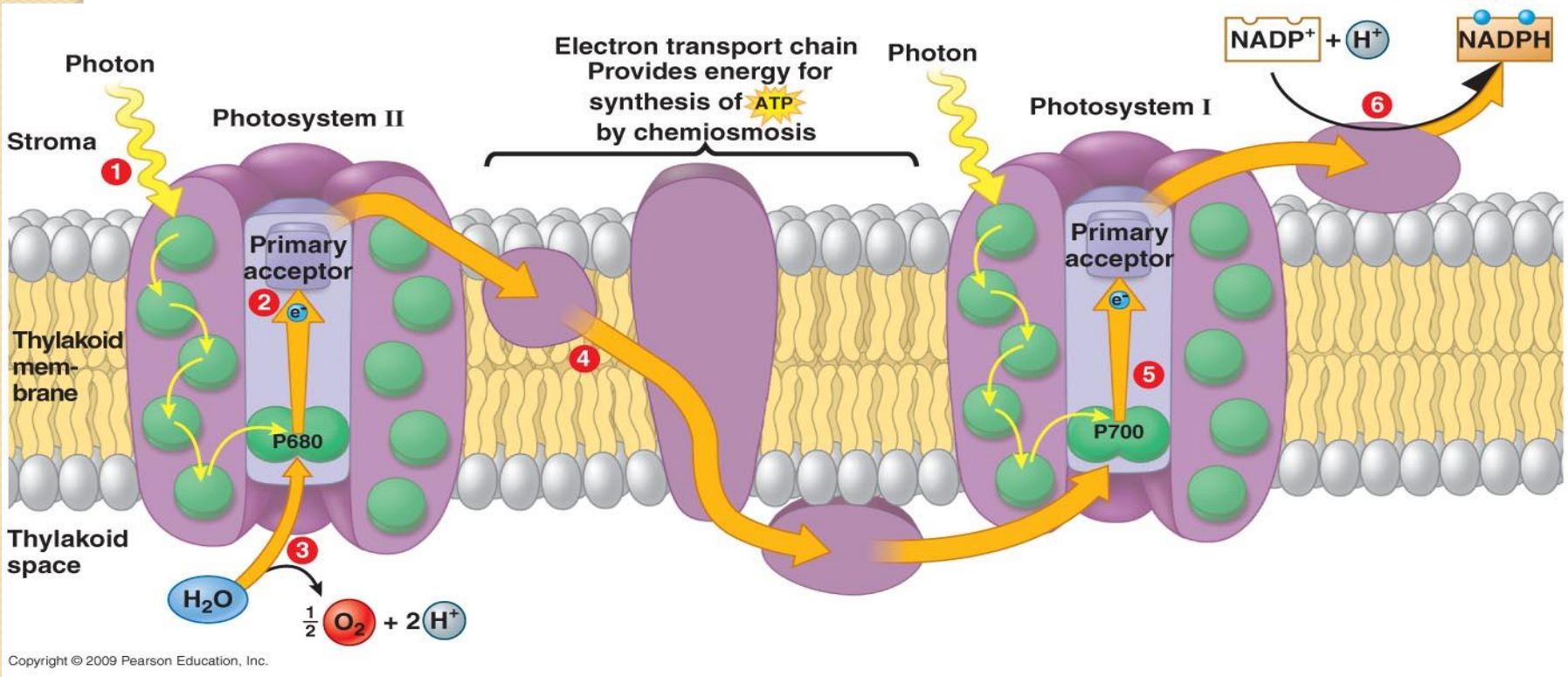
Ever seen chlorophyll get excited?

- Video
- Aurora borealis
- A quick recap of the key ideas

Stage One: Light Reactions

C. 2 photosystems linked by an electron transport chain (ETC) funnel energy and electrons into 2 types of "<u>energized electron dumptrucks</u>"

- ATP
- NADPH



Stage One: Light Reactions

C. 2 photosystems linked by an electron transport chain (ETC) funnel energy and electrons into 2 types of "<u>energized electron dumptrucks</u>"

- ATP
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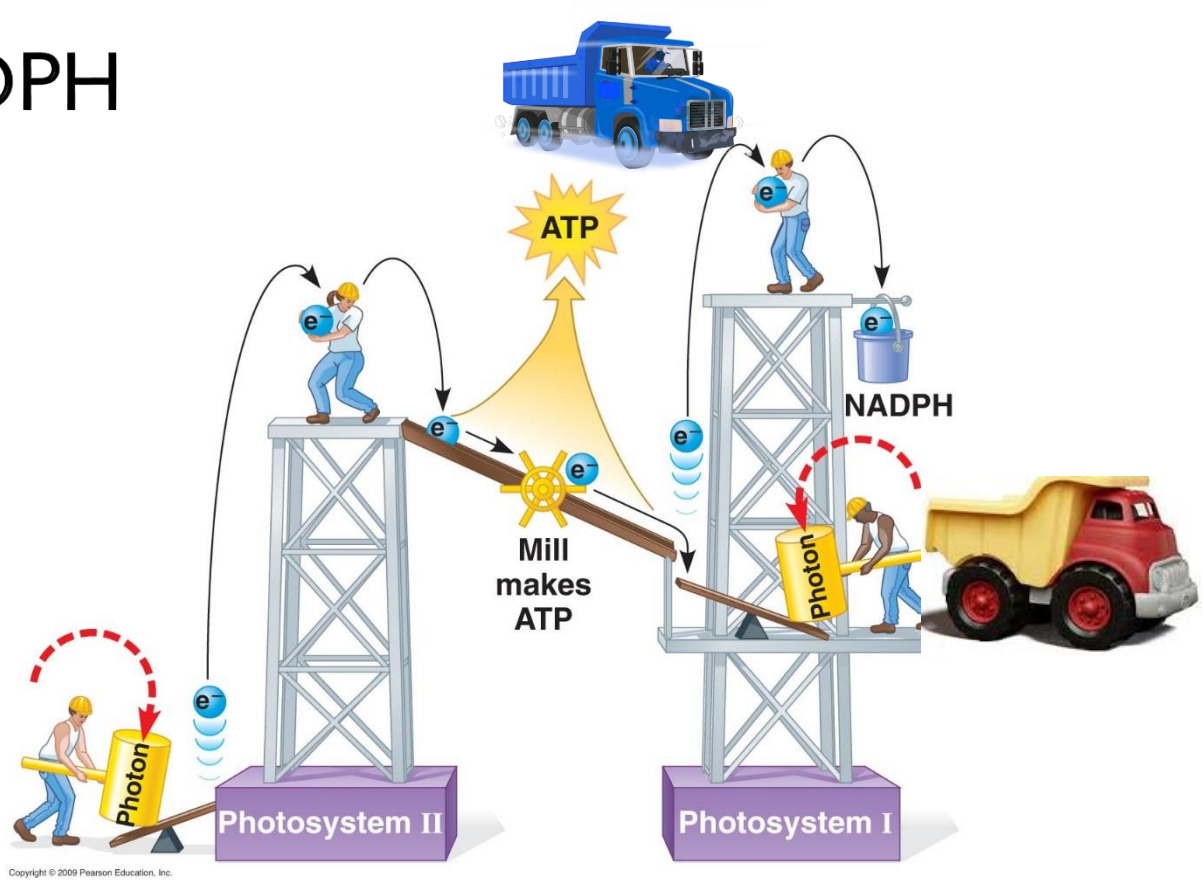
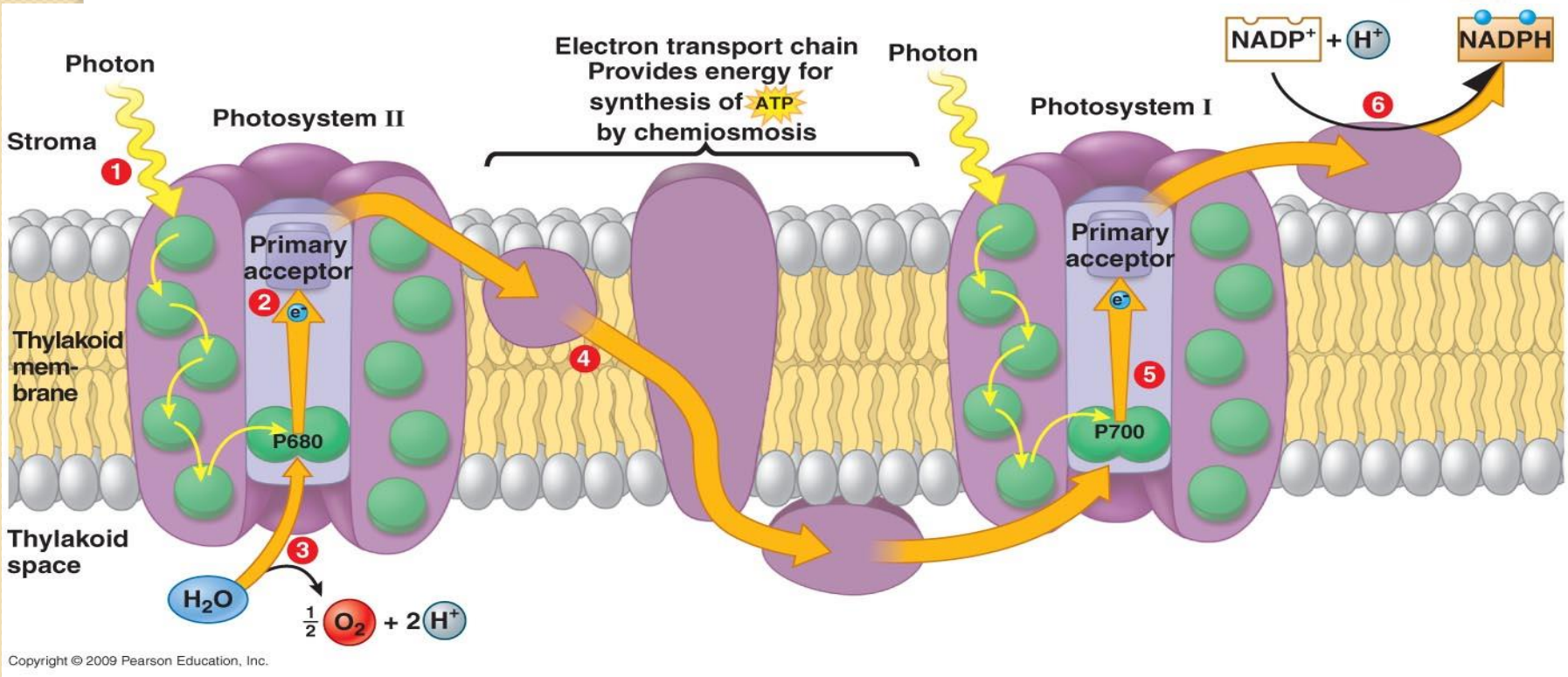


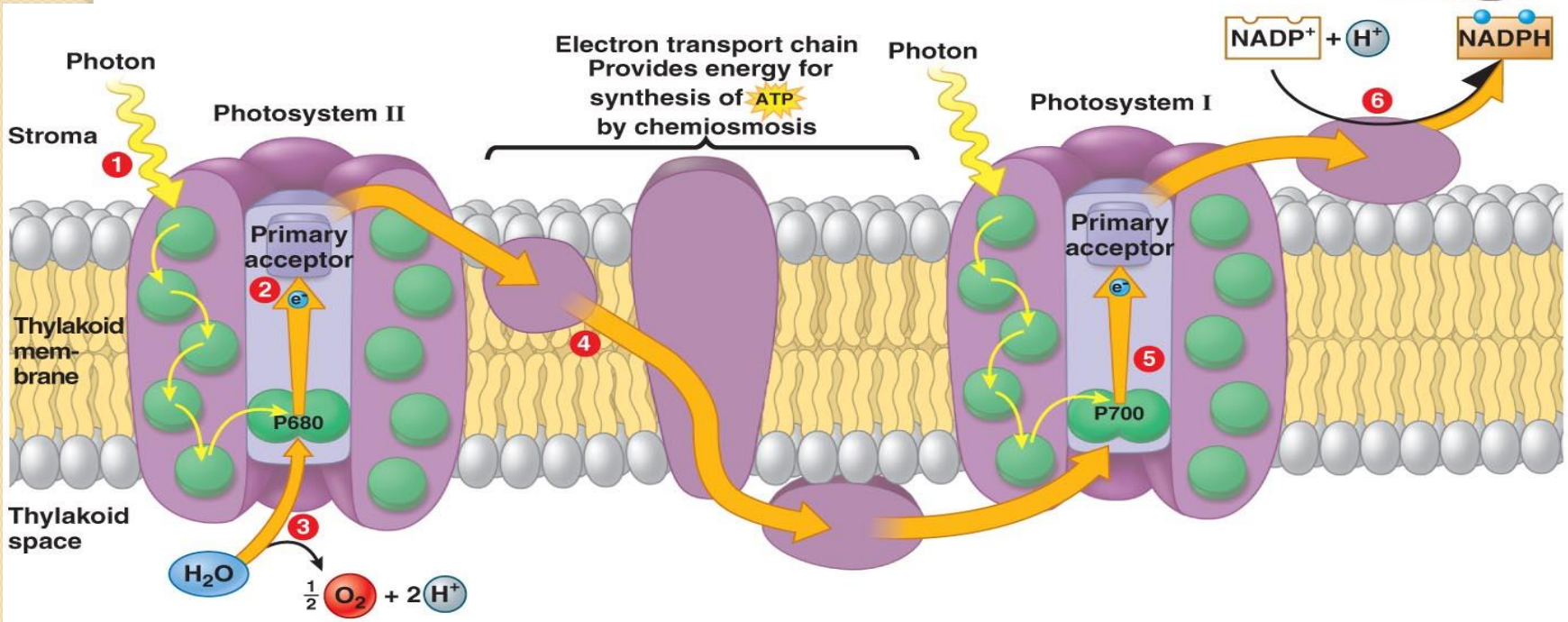
Can you see what H_2O is doing in the photosynthesis reaction?



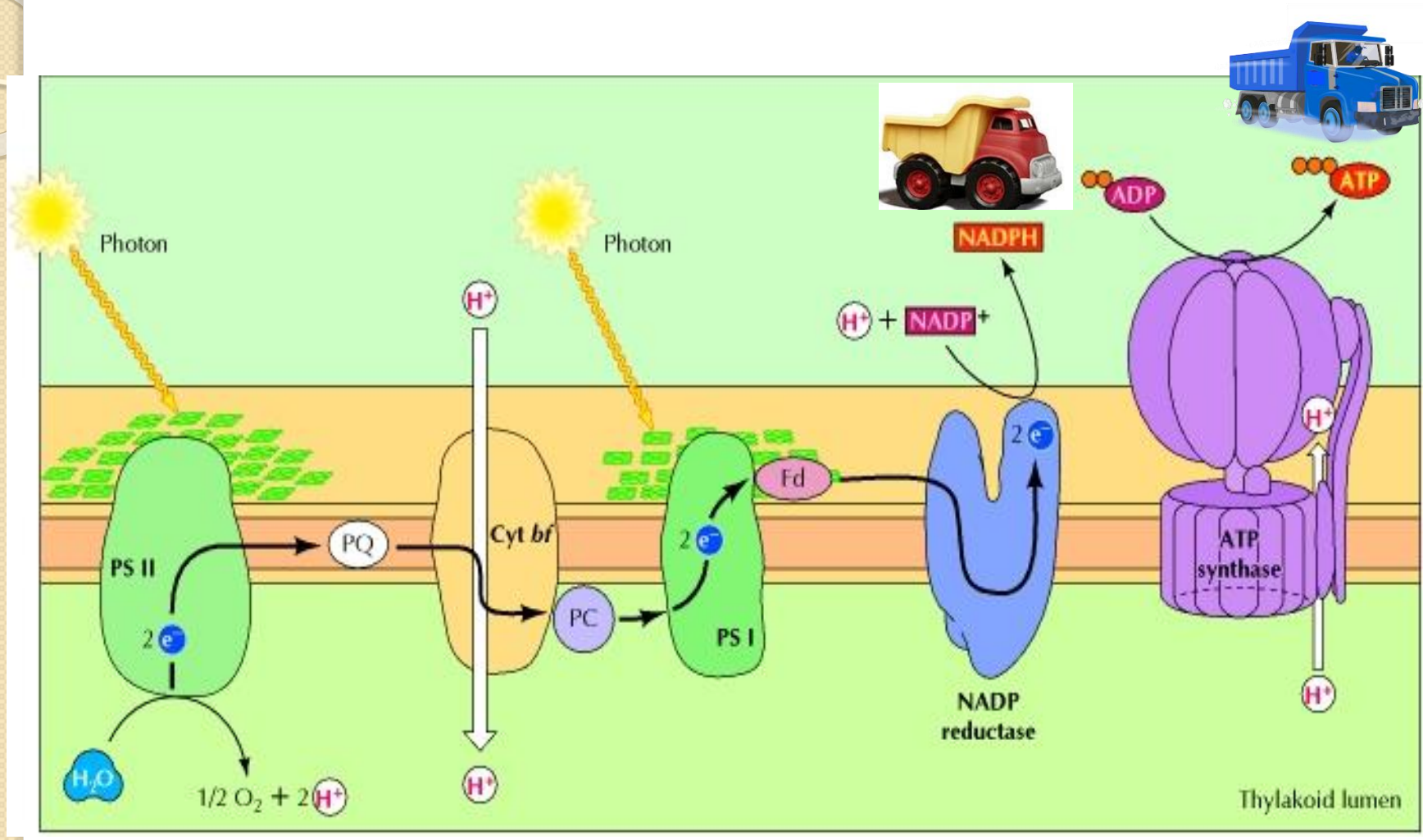
Stage One: Light Reactions

D. H_2O is split apart to donate an **electron** to replace the one energized and ejected by photosystem 2..

- **Oxygen** is the waste product released by the plant



Let's Review

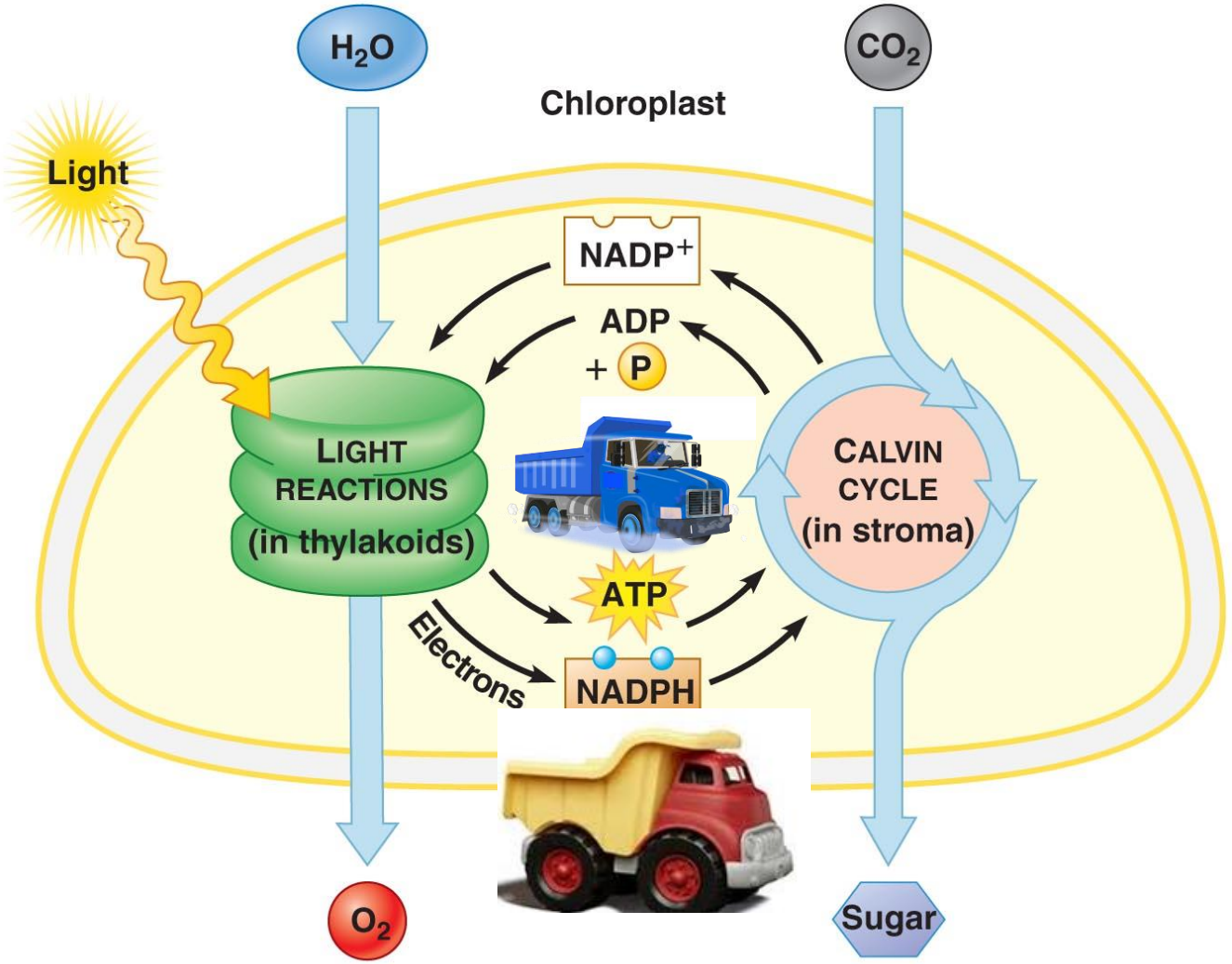

Photon
Photon
H+
H+ + NADP+
NADPH
ADP
ATP
PS II
2 e−
PQ
Cyt bf
PC
2 e−
Fd
PS I
2 e−
NADP reductase
ATP synthase
H+
H+
H2O
1/2 O2 + 2 H+
H+
Thylakoid lumen

Thursday

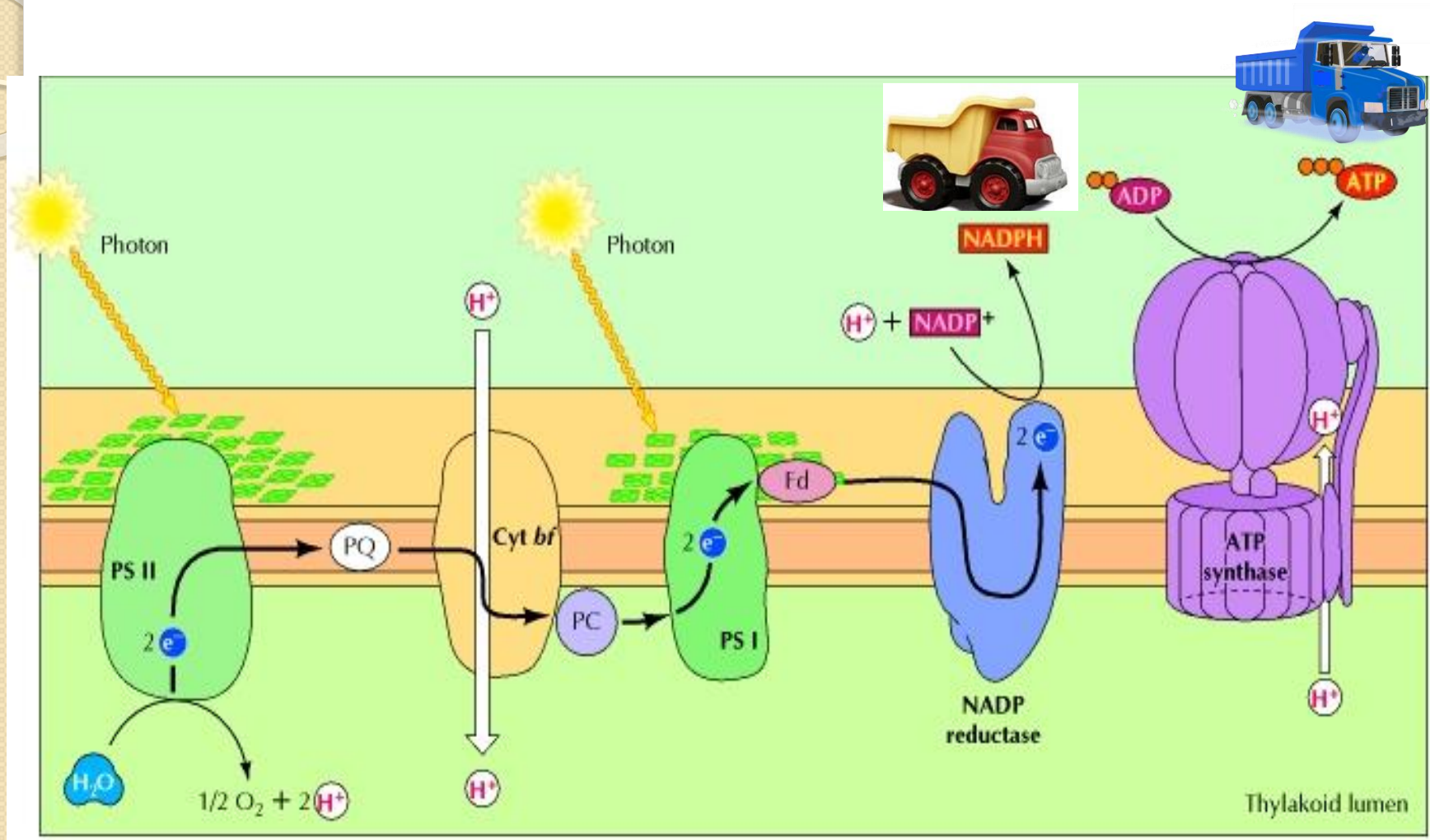
Thursday

Time to harvest

Where in the chloroplast are we going next?

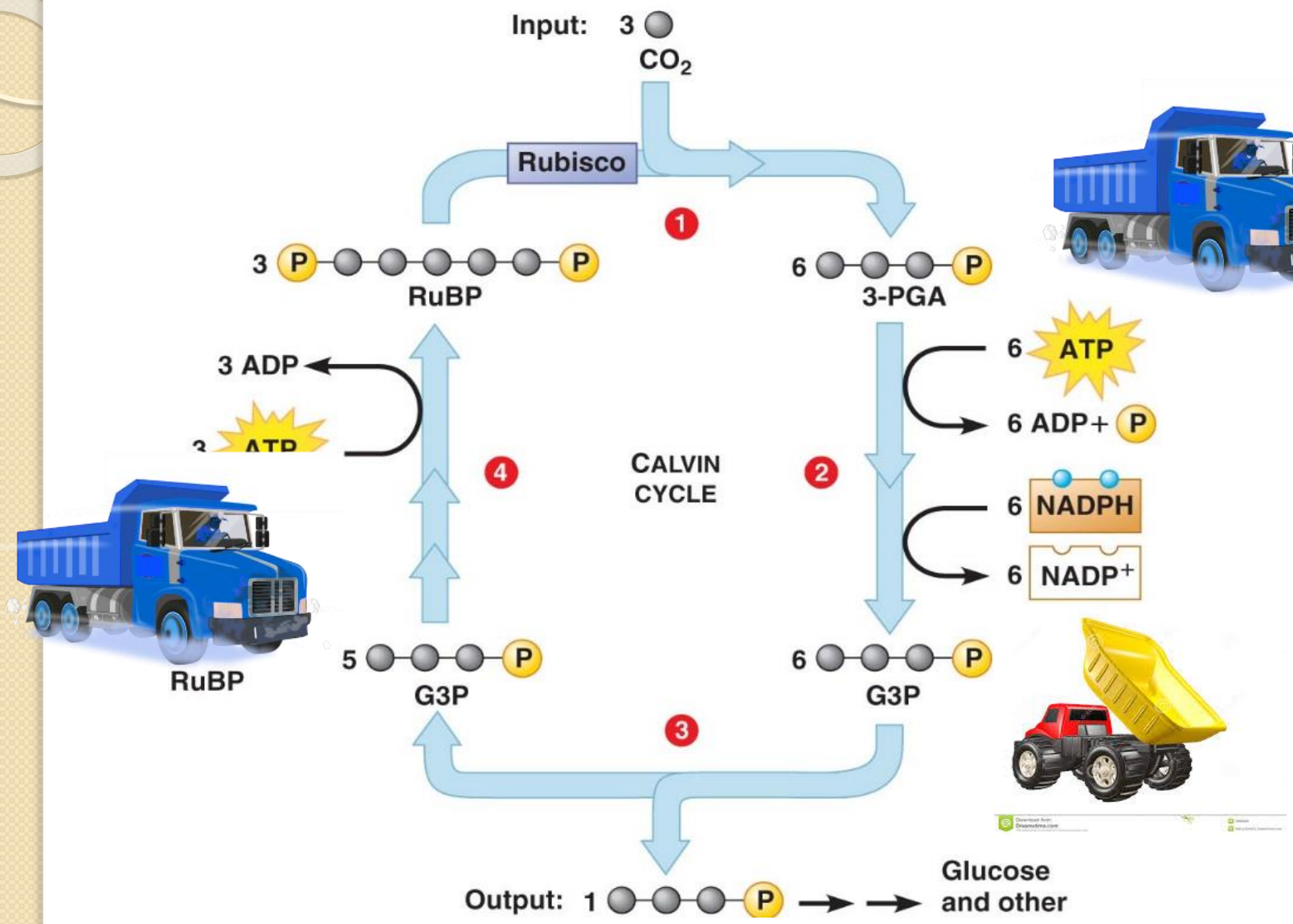


Does anyone see **phosphorylation**?



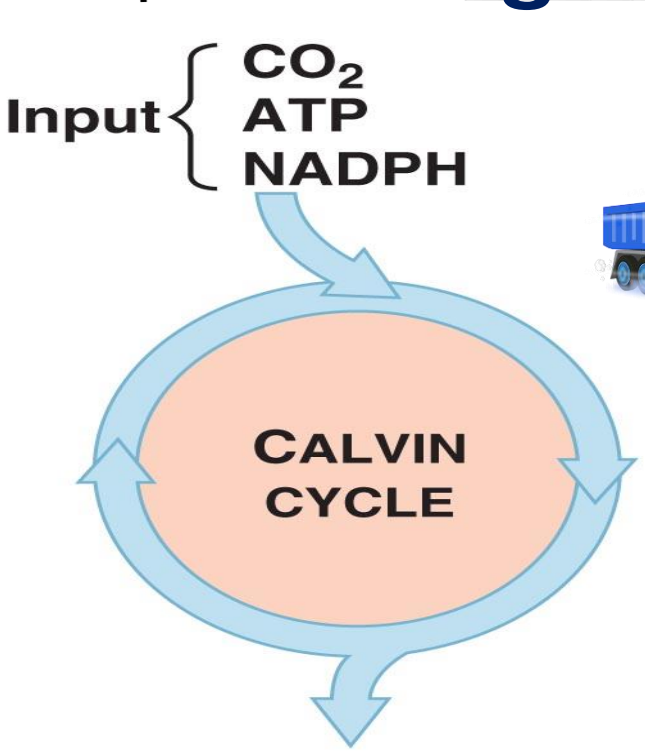
It works a little bit like this

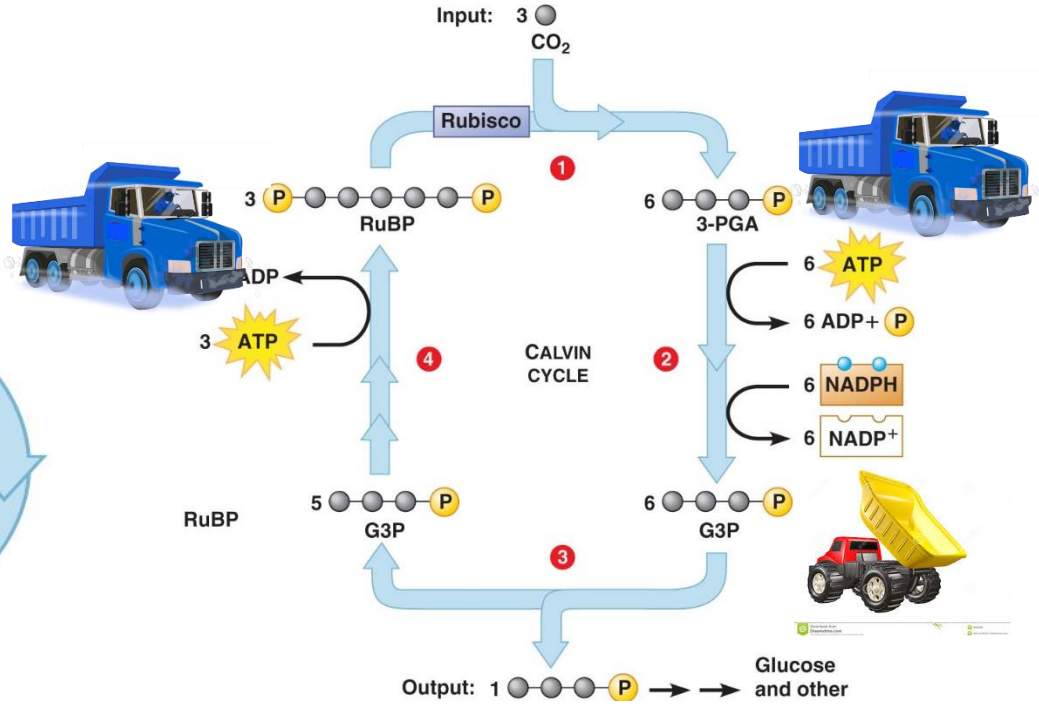
Calvin Cycle



Stage Two: Calvin Cycle

E. ATP and NADPH arrive to dump their energy and **electrons** into the Calvin Cycle (AKA **sugar factory**) These materials supercharge each **CO_2** that enters and several rounds of the Calvin cycle are needed to produce 1 **glucose** molecule



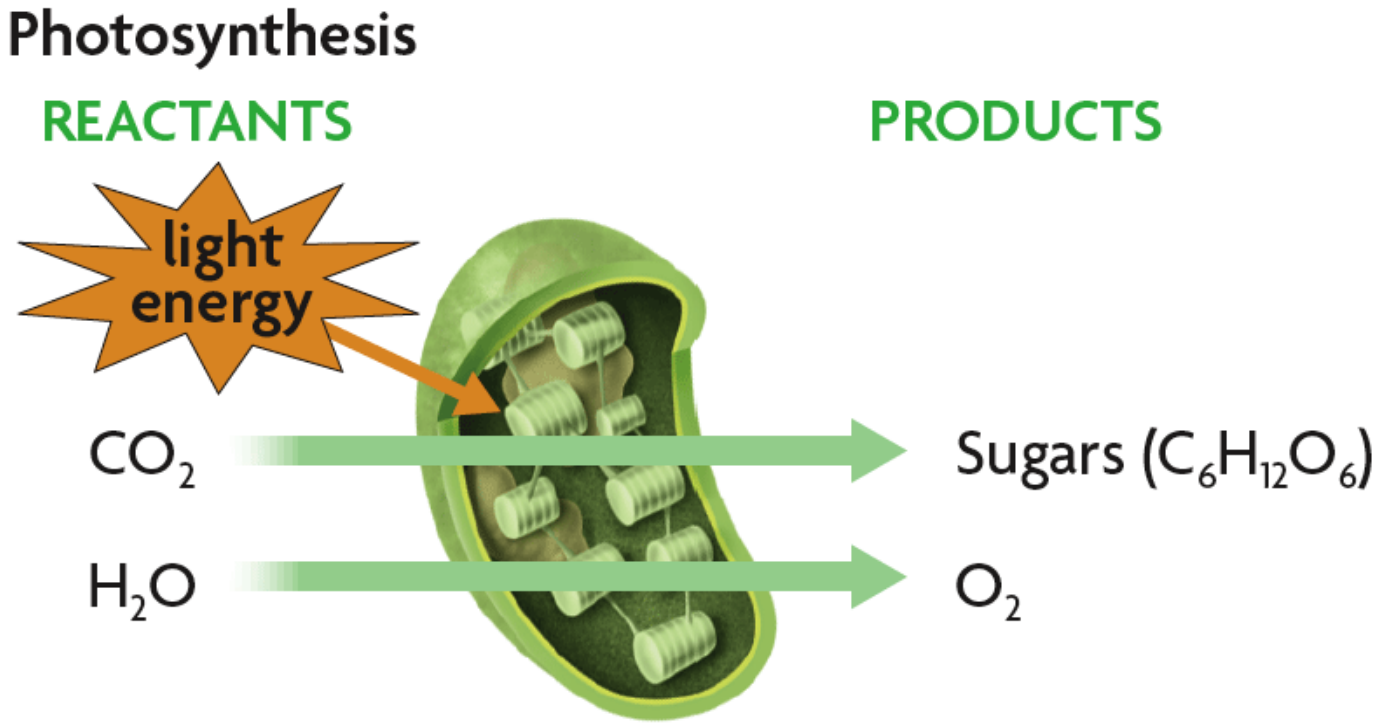


Lets review Photosynthesis

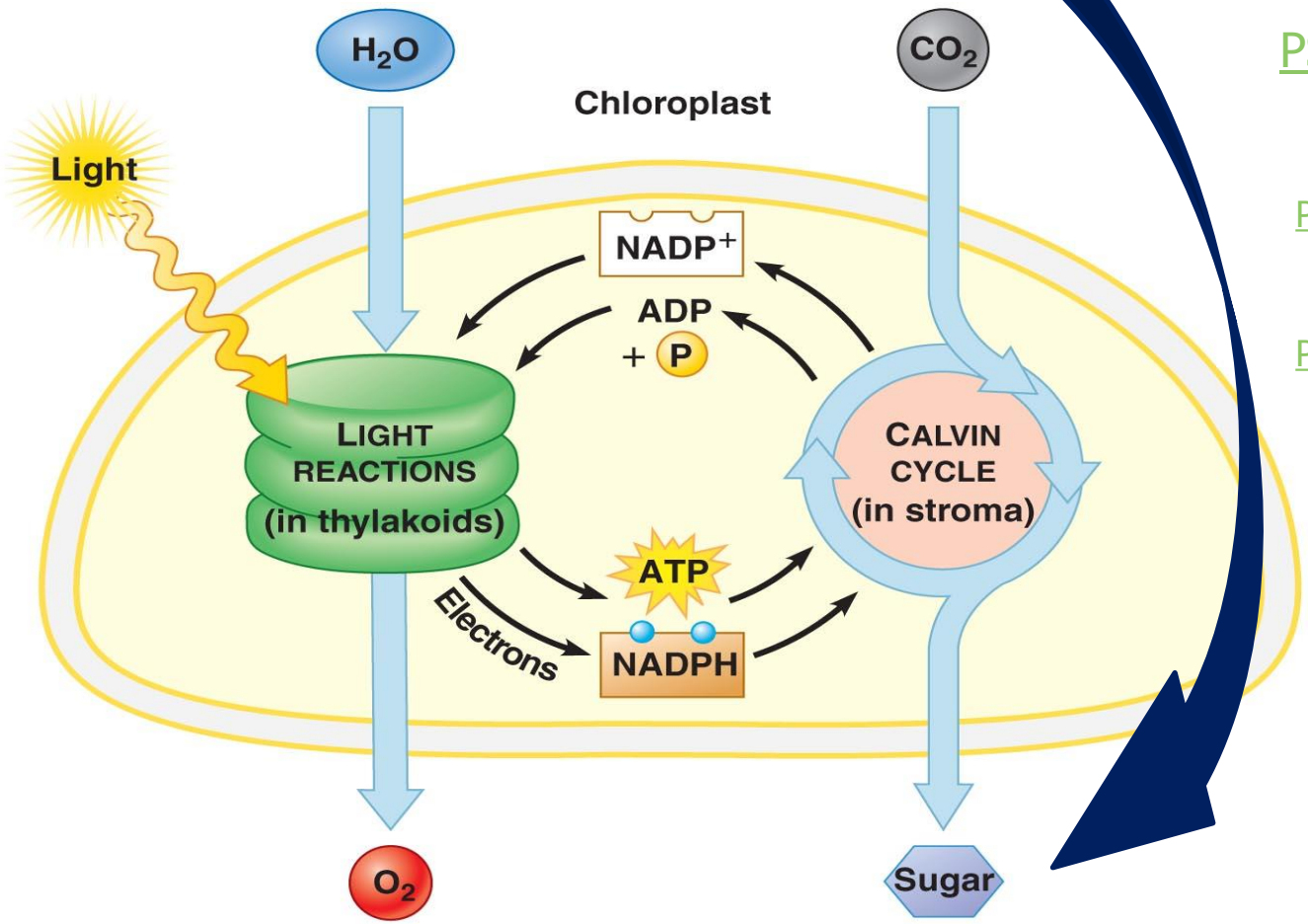
PS Review video

Light Rxn song

Calvin Cycle Song



Ultimately photosynthesis converts light energy into stored chemical energy,



PS song 1

PS song 2

PS song 3

PS song 4

What do Plants do with the **GLUCOSE** that they make?

1. Glucose is converted by a mitochondria during cellular respiration into ATP for various cell jobs such as **growth**

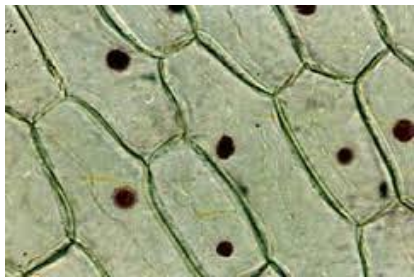
What do Plants do with the **GLUCOSE** that they make?

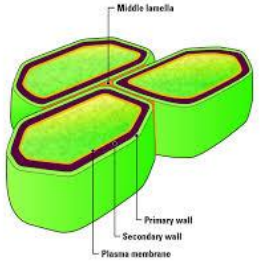
2. Glucose energy is used to make a variety of plant products:

a) Fats and oils for seeds

b) Fructose for the fruit

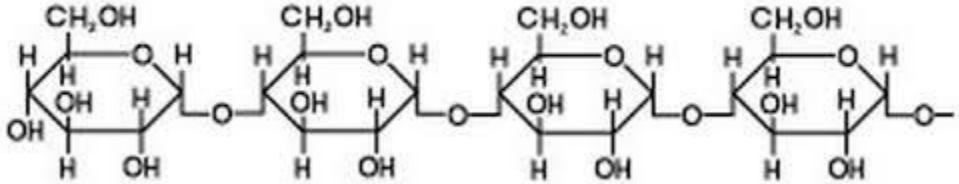
c) Cellulose for cell walls

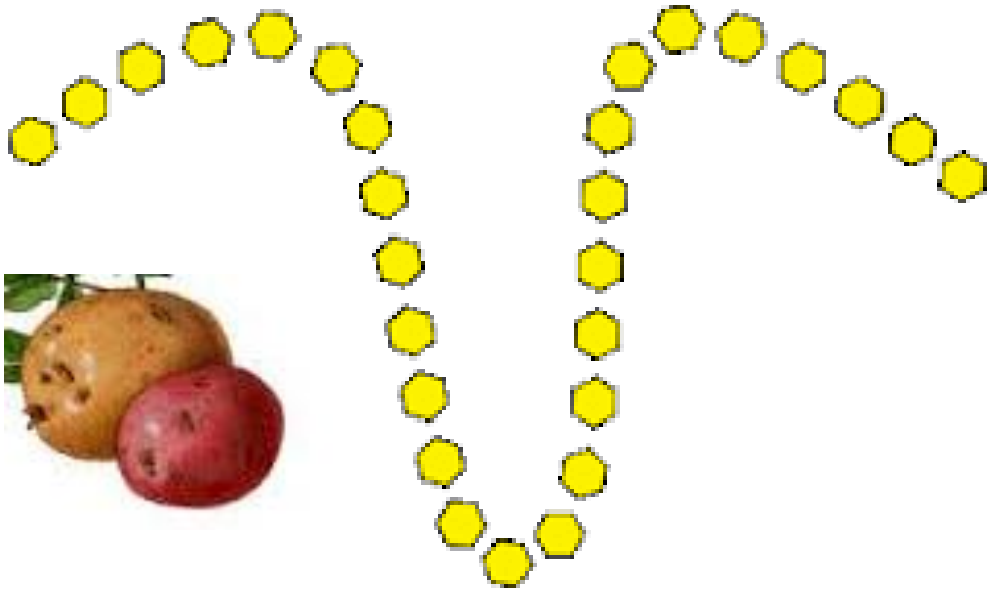




What do Plants do with the **GLUCOSE** that they make?

3. Glucose that isn't used right away is stored as **starch**

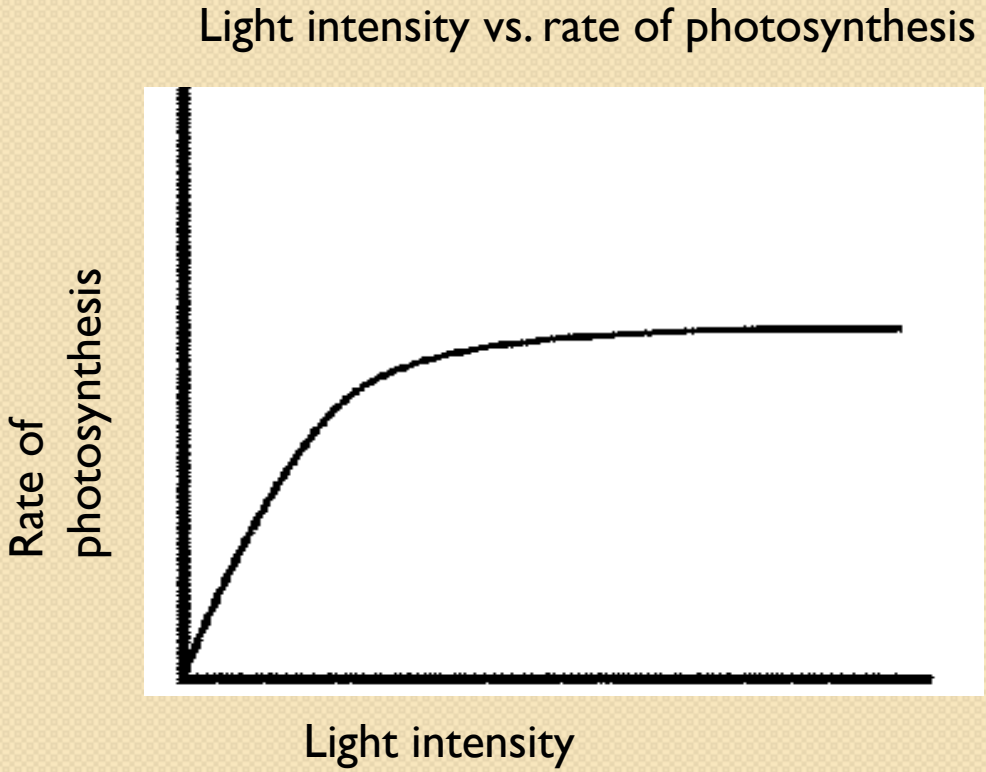




FACTORS THAT AFFECT PHOTOSYNTHESIS

SPEED UP PHOTOSYNTHESIS	SLOW DOWN PHOTOSYNTHESIS
• Increased light • Increased heat • Increased carbon dioxide • Increased water	• Decreased light • Excessive light or heat • Low temperatures • Low water levels • Low carbon dioxide levels • Water pollution

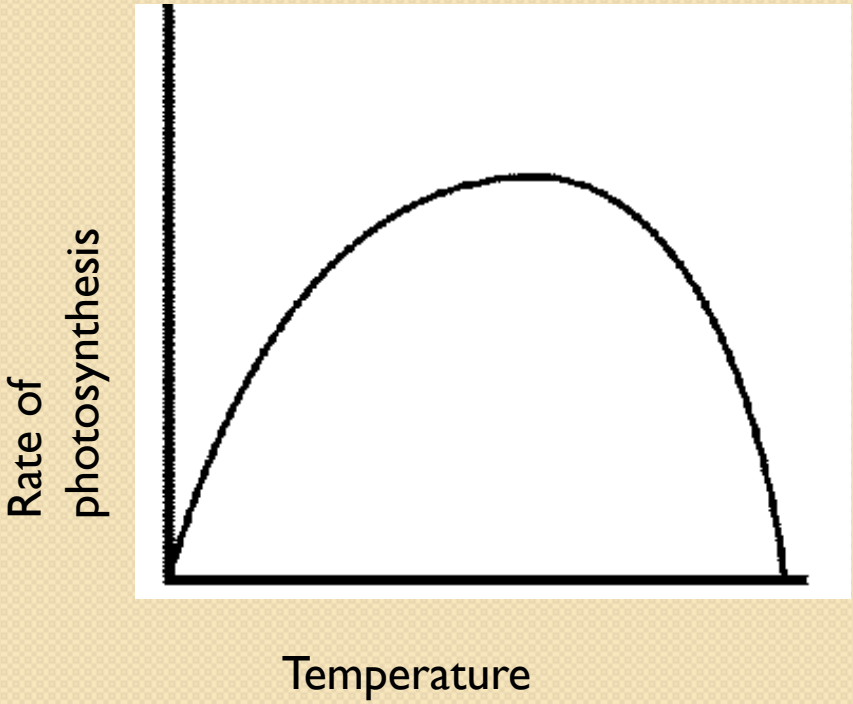
WHAT DOES THIS GRAPH SHOW US ABOUT PHOTOSYNTHESIS?



As light intensity increases, so does photosynthesis up to a certain point, then photosynthesis levels off

WHAT DOES THIS GRAPH SHOW US ABOUT PHOTOSYNTHESIS?

Temperature vs. rate of photosynthesis

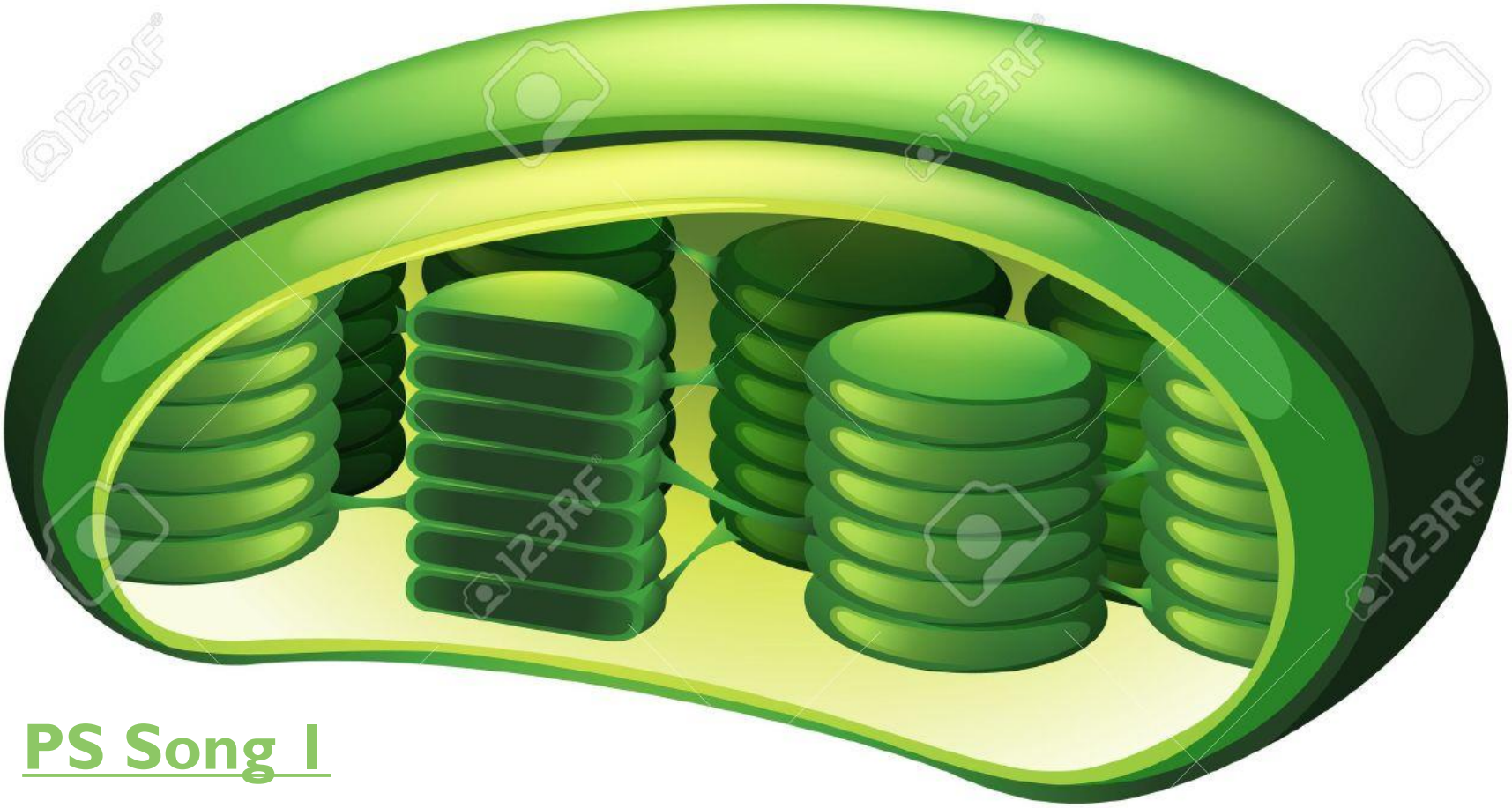


- Rate of photosynthesis peaks at a certain temperature; anything beyond that temperature range doesn't allow photosynthesis to happen at peak levels

PS Demo

PS and Light COLOR

PS powered bldg



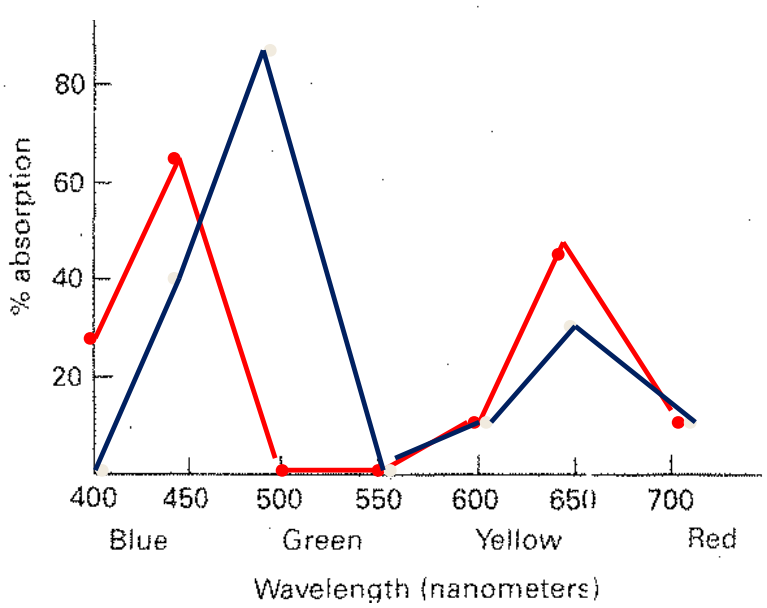
PS Song I

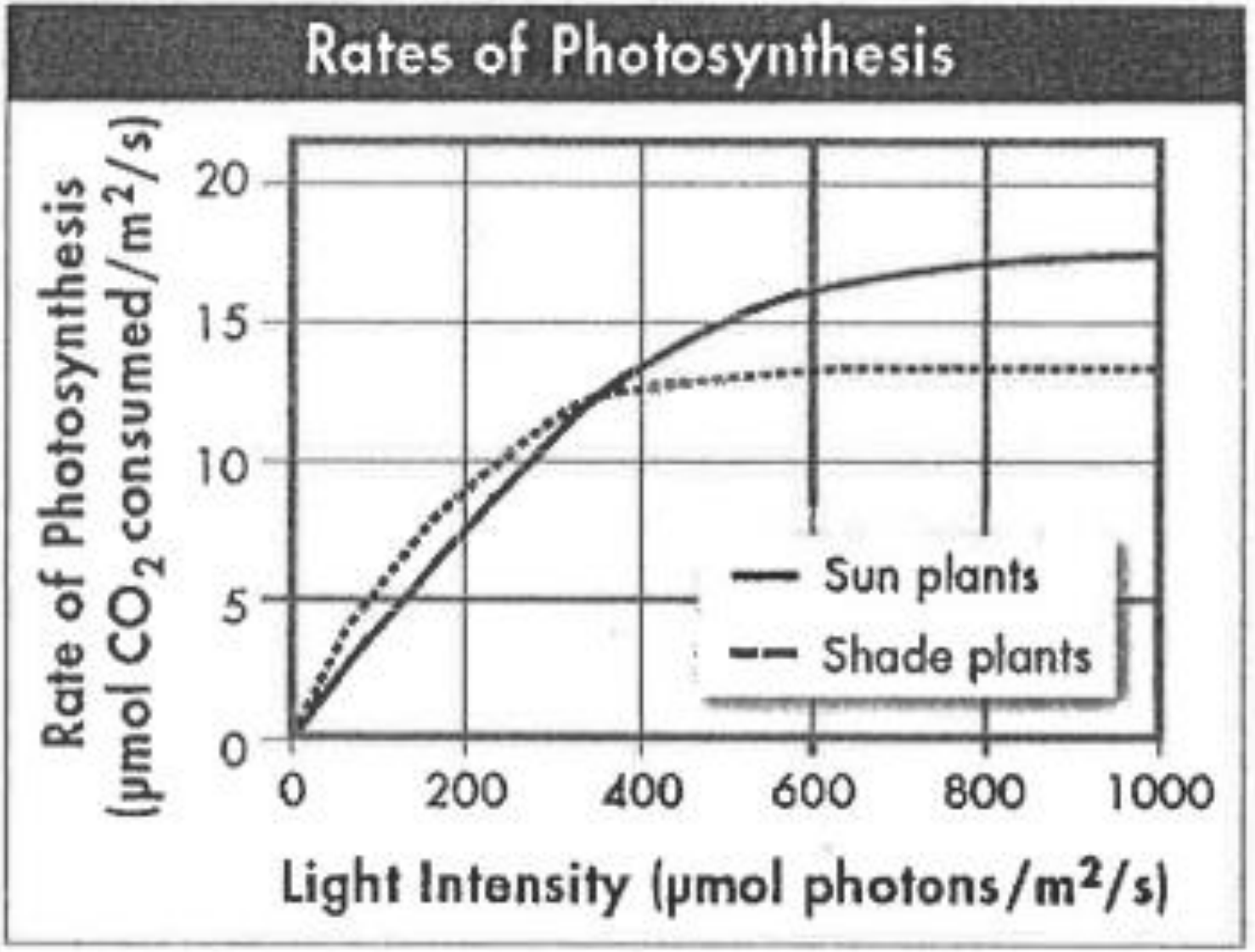
PS MS

PS Rap I

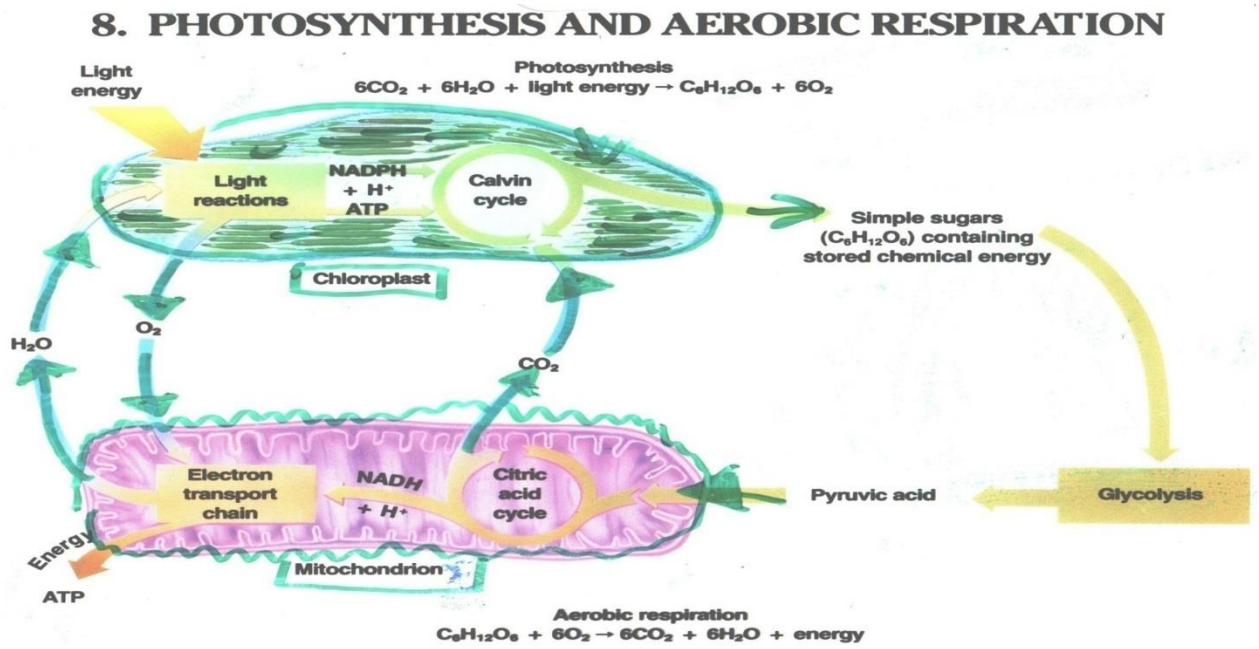
PS Rap TF

Wavelength	Chlorophyll A % Absorption	Chlorophyll B % Absorption
400 nanometers	30	0
450 nanometers	65	40
500 nanometers	0	85
550 nanometers	0	0
600 nanometers	10	10
650 nanometers	45	25
700 nanometers	10	10




Rates of Photosynthesis
Rate of Photosynthesis (μmol CO_2 consumed/m^2/s)
20
15
10
5
0
0
200
400
600
800
1000
Light Intensity (μmol photons/m^2/s)
Sun plants
Shade plants

- Mitochondria and chloroplasts are complementary organelles that both use **membranes with enzyme assembly lines** to process energy in opposite ways



Let's Compare Photosynthesis and Cellular Respiration

Topics	Photosynthesis	Cell Respiration
1) INPUT material?	CO_2 H_2O	Glucose O_2
2) OUTPUT material?	Glucose O_2	CO_2 H_2O
3) Energy direction?	Absorbed	Released
4) Energy TERM?	Endergonic	Exergonic
5) Chemical bonds are?	formed	broken
6) Organelle needed?	Chloroplast	Mitochondria
7) Cell type?	Plant Only	Both Plant & Animal

- What color of light does chlorophyll b pigment **capture** the most effectively?
- What color of light does chlorophyll b pigment **reflect** the most effectively?