Monday, January 5th

Happy New Year! We are half way through…!

Today you will take a second semester "pre- and post-"assessment, to see where we are with content we have seen or will tackle this semester. Upon completion, please pick up:

- Chapter 10 (Photosynthesis) Chemiosmosis
- Chapter 10 Homework-*yellow sheet*

CRASH COURSE: Ps

Tuesday, January 6th

Please pick up a computer from the cart in the BACK of the room. Pick up the **Cancer Web quest** off of the top of the cart.

- You may start while you wait for others.
- If you have headphones or ear buds, they may come in handy so feel free to use them.
- Please complete the web quest in the time allotted. If you need extra time, you may need to work on your own.

Wednesday, January 7th

Please continue your **Cancer Web quest**.

You will have plenty of time to finish today. If you need additional time, you will work on your own.

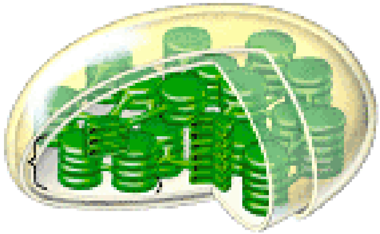
- If you finish, grab a book and the **chapter 10 reading guide**, OR
- Read through the **Chemiosmosis** packet you were provided and start coloring.

Today I will…

1. *Recall factors that disrupt the cell cycle.*
2. *Describe various causes of cancer in animals.*
3. *Provide various cancer prevention strategies.*

Thursday, January 8th

Photosynthesis:
Life from Light and Air



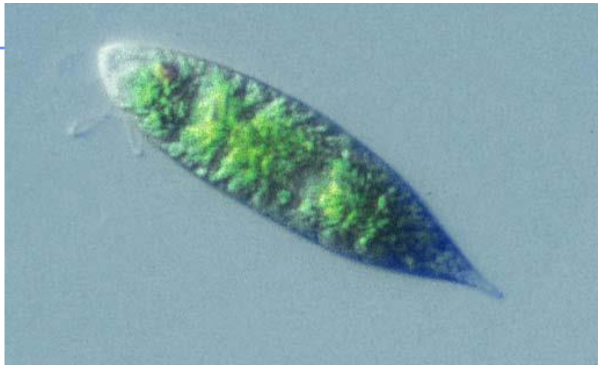
Review the formula for Photosynthesis.

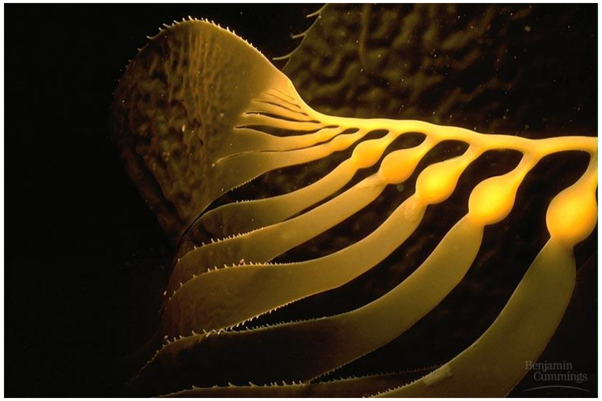
Energy needs of life

- All life needs a constant input of energy
  - Heterotrophs (Animals)
    - get their energy from "eating others"
      - eat food = other organisms = organic molecules
    - make energy through respiration
  - Autotrophs (Plants)
    - get their energy from "self"
    - get their energy from sunlight
    - build organic molecules (food) from CO_2
    - make energy & synthesize sugars through photosynthesis

Energy needs of life

- Heterotrophs
  - consumers
  - animals
  - fungi
  - most bacteria
- Autotrophs
  - producers
  - plants
  - photosynthetic bacteria (blue-green algae)





How are they connected?

Heterotrophs

making energy & organic molecules from ingesting organic molecules

glucose + oxygen → carbon dioxide + water + energy

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O + ATP$$

exergonic

Autotrophs

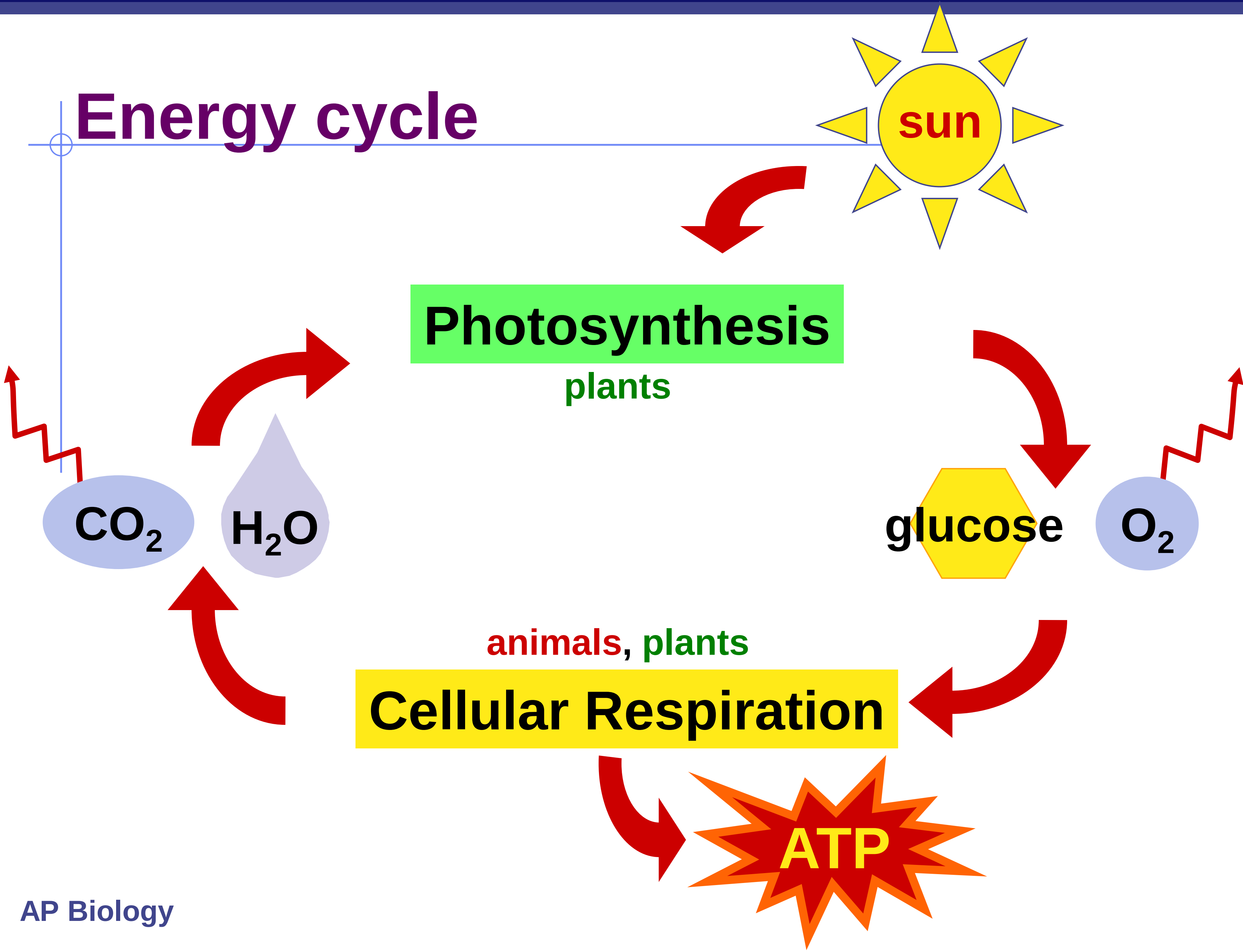
making energy & organic molecules from light energy

carbon dioxide + water + energy → glucose + oxygen

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

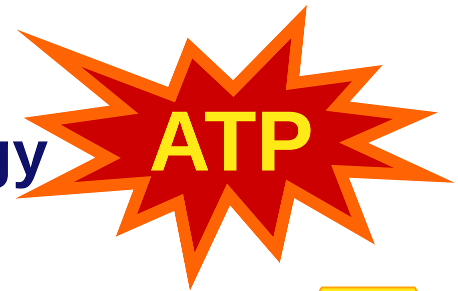
endergonic

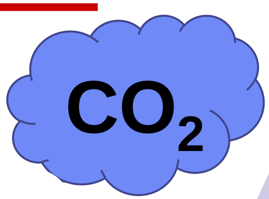
Energy cycle

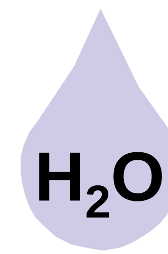


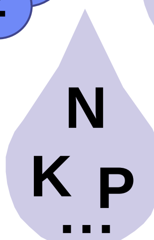
What does it mean to be a plant

- **Need to…**
  - collect **light** energy
    - transform it into chemical energy
  - store **light** energy
    - in a stable form to be moved around the plant & also saved for a rainy day
  - need to get **building block atoms** from the environment
    - C,H,O,N,P,K,S,Mg
  - produce all **organic molecules** needed for growth
    - carbohydrates, proteins, lipids, nucleic acids









Plant structure

- Obtaining raw materials
  - sunlight
    - leaves = solar collectors
  - CO_2
    - stomates = gas exchange
  - H_2O
    - uptake from roots
  - nutrients
    - N, P, K, S, Mg, Fe…
    - uptake from roots

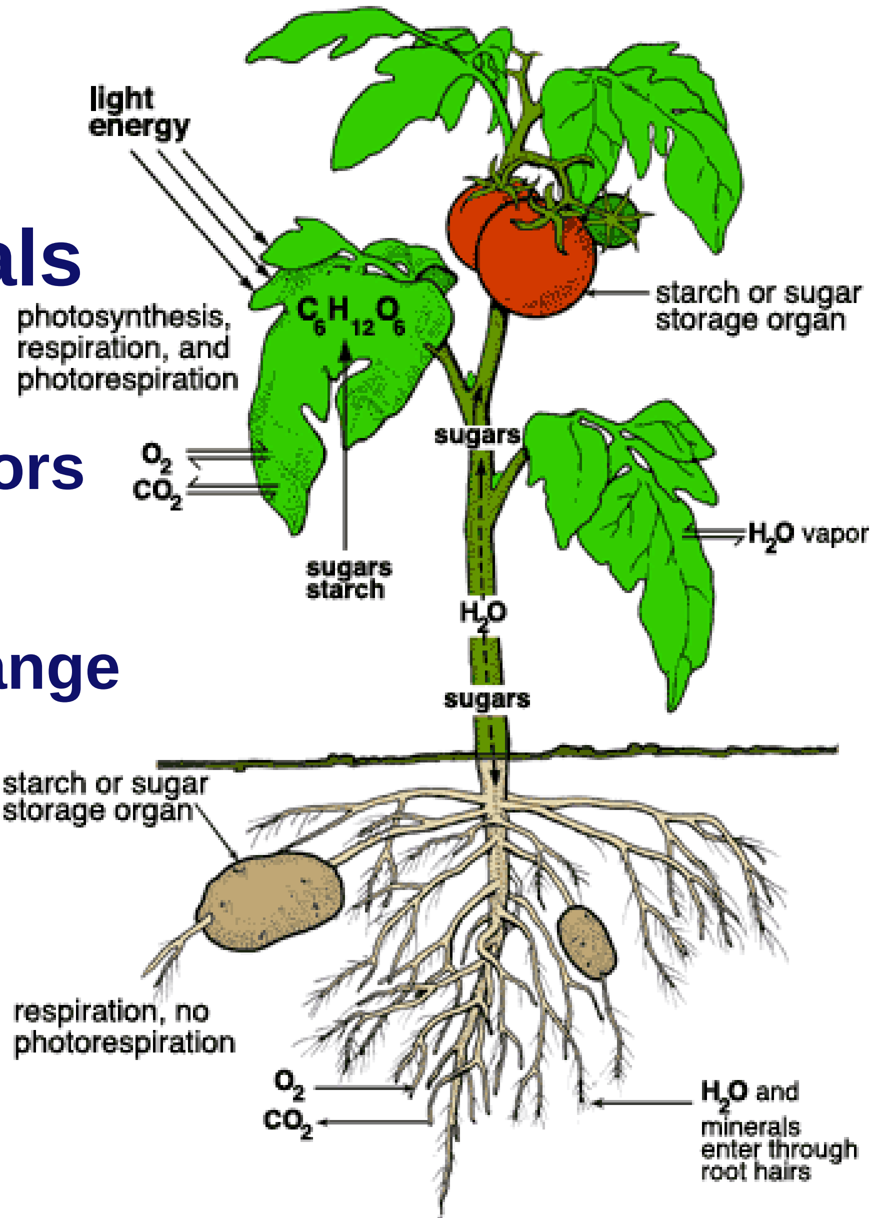
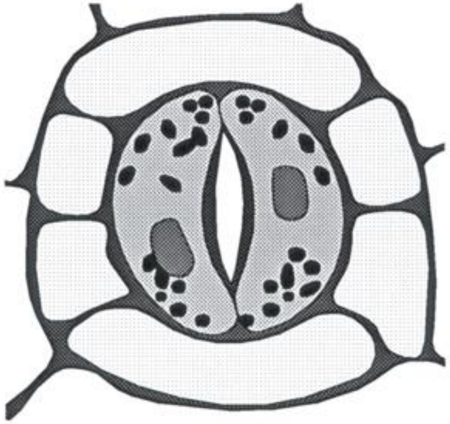
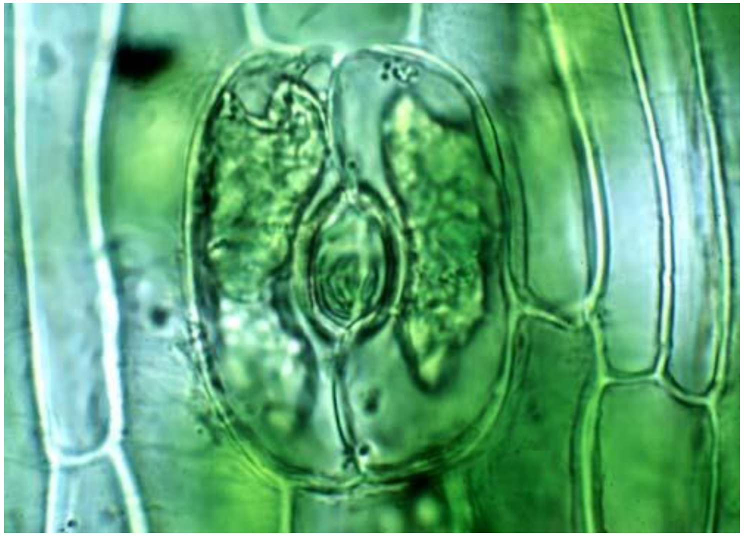


Figure 24. Photosynthesis, respiration, leaf water exchange, and translocation of sugar (photosynthate) in a plant.

Stomates





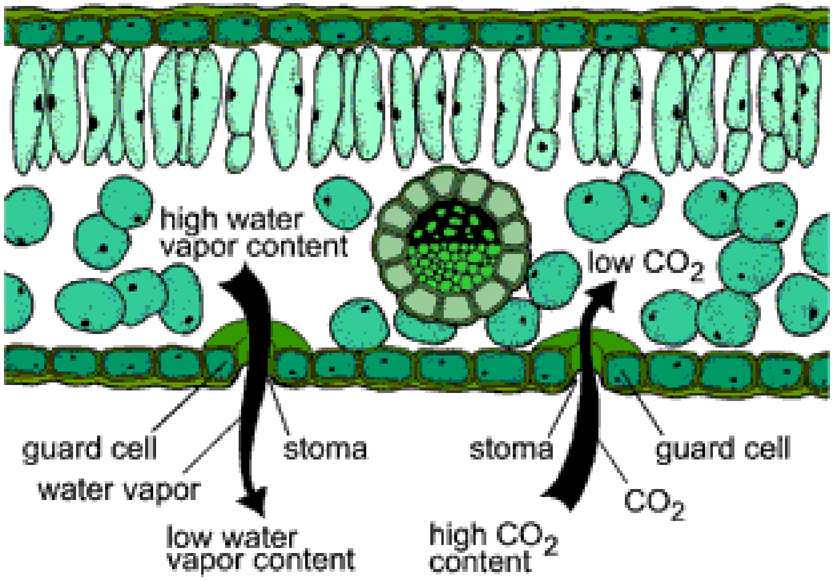
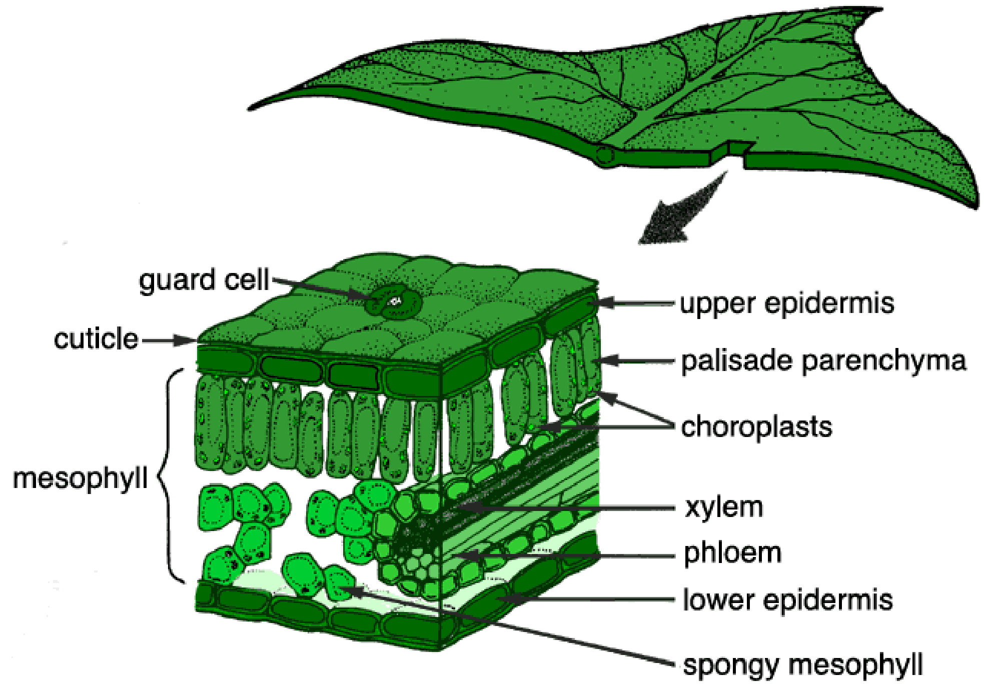
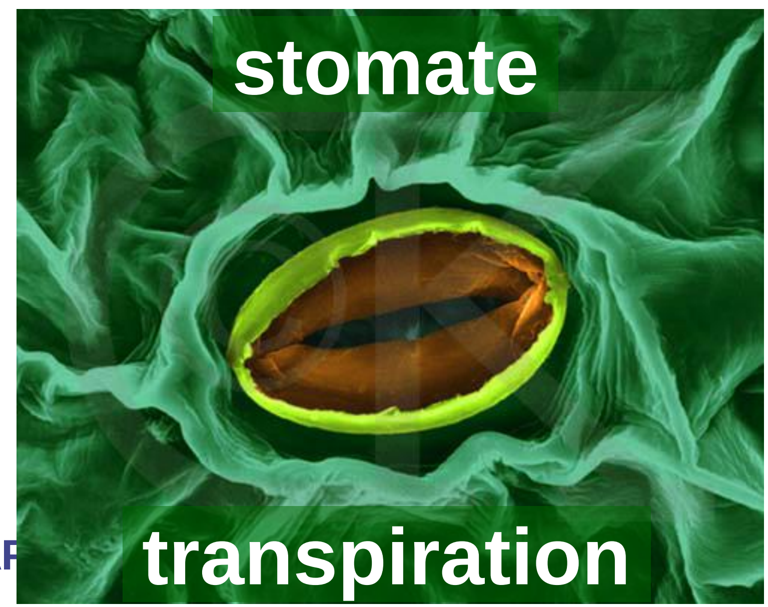
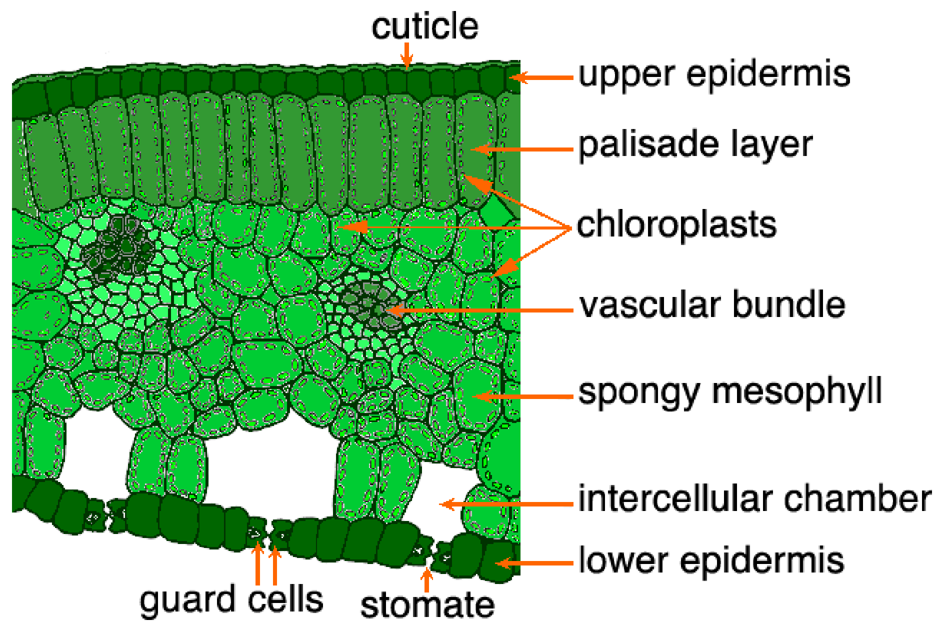


Figure 25. Stomata open to allow carbon dioxide (CO_2) to enter a leaf and water vapor to leave.

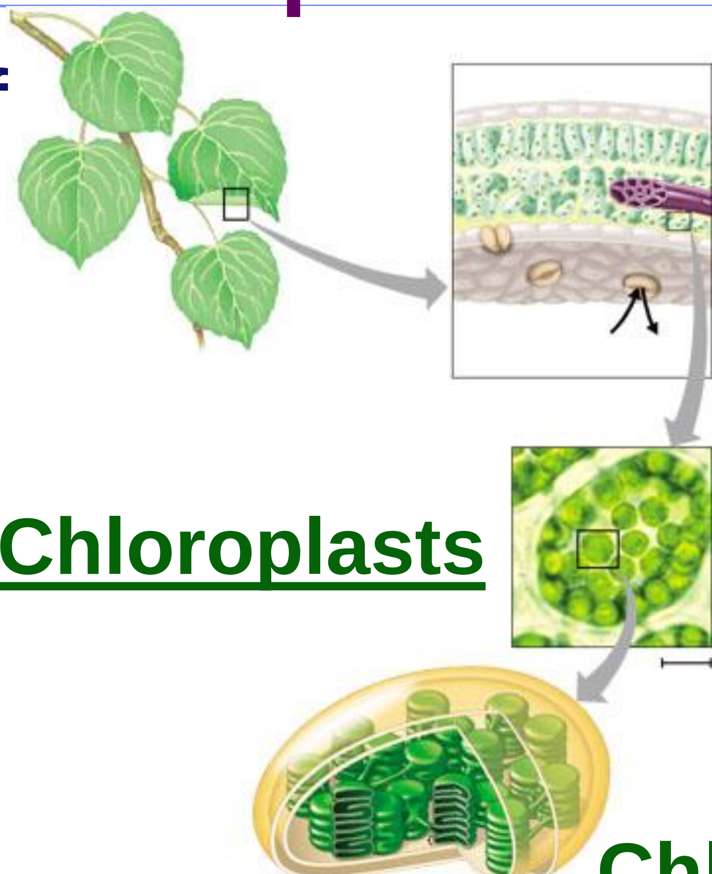






Chloroplasts

Leaf



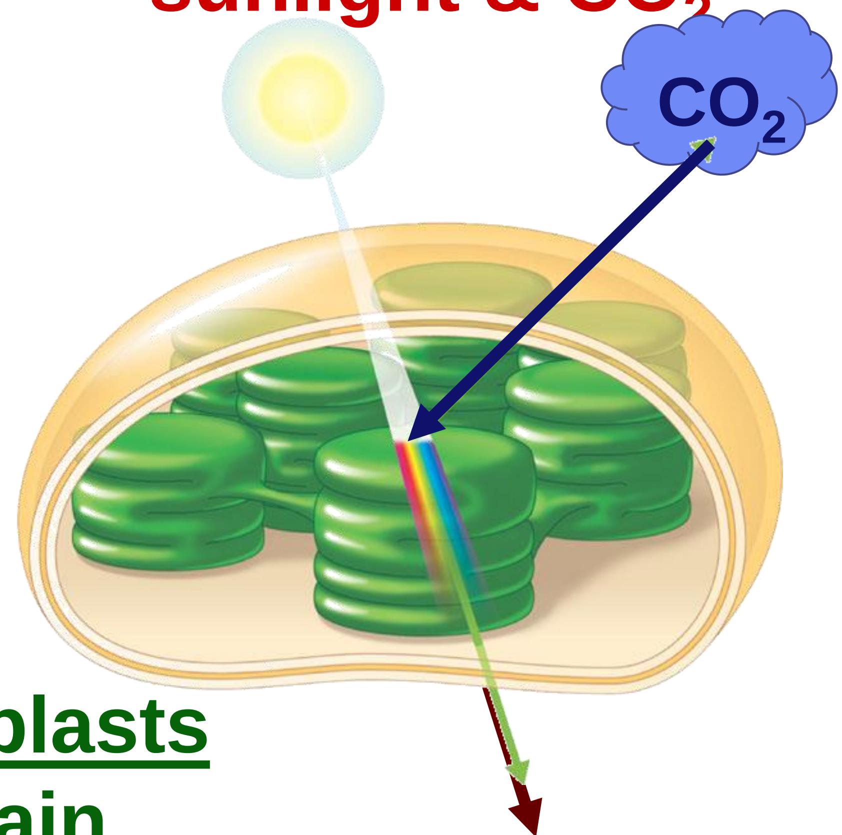
Leaf

Chloroplasts

Chloroplast

Chloroplasts contain Chlorophyll

absorb sunlight & CO_2



make energy & sugar

Friday, January 9th

QUESTION TO PONDER:

Describe the structure of a chloroplast.

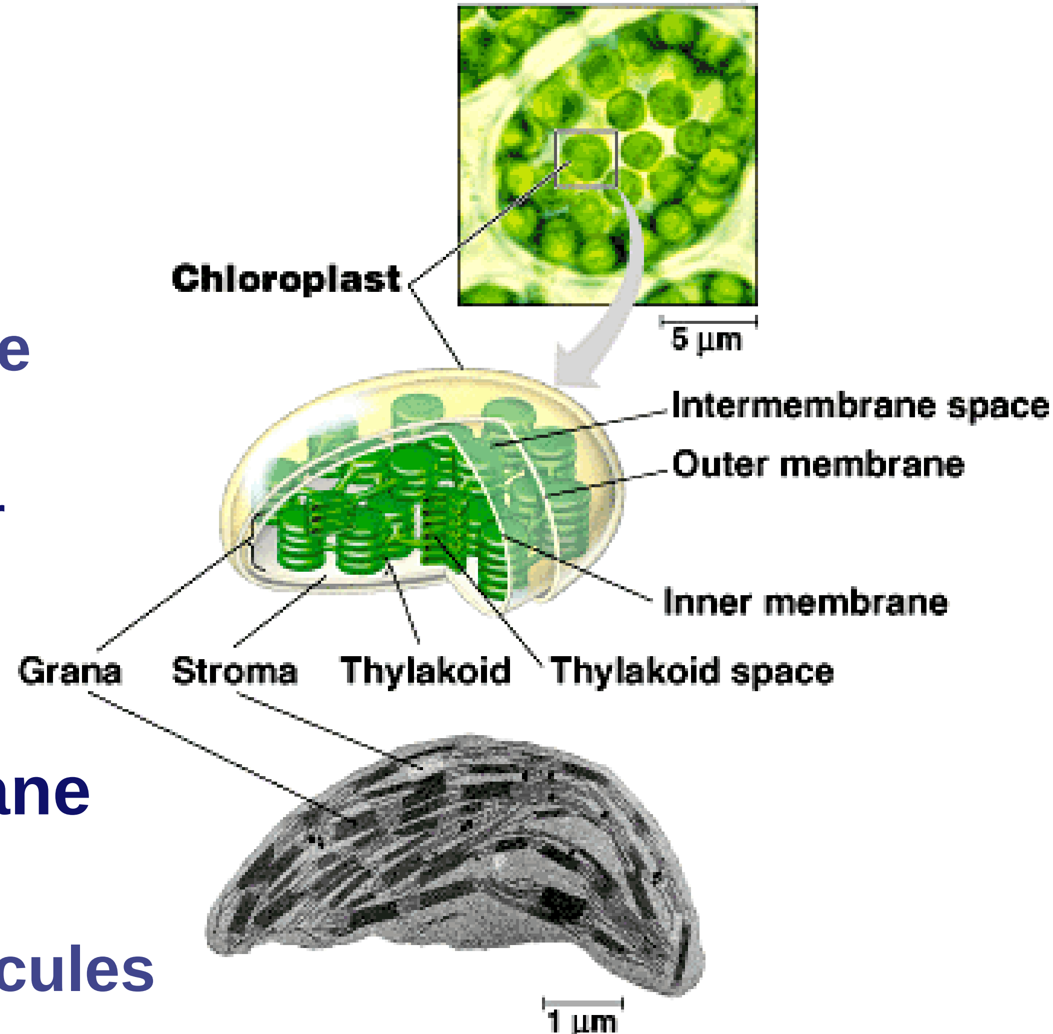
How is this structure similar to a mitochondrion?

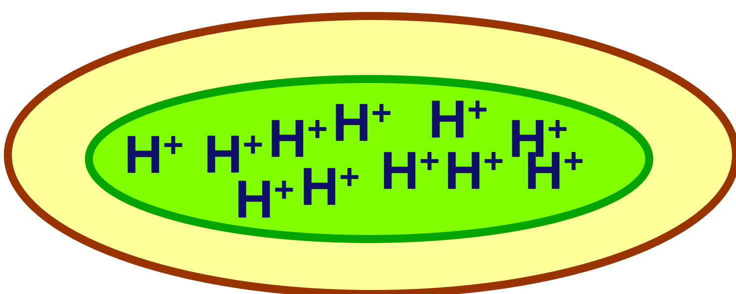
Today you will…

1. Describe the structure of a chloroplast and explain where the processes of Ps occur.
2. Begin to outline the steps of the light reactions.

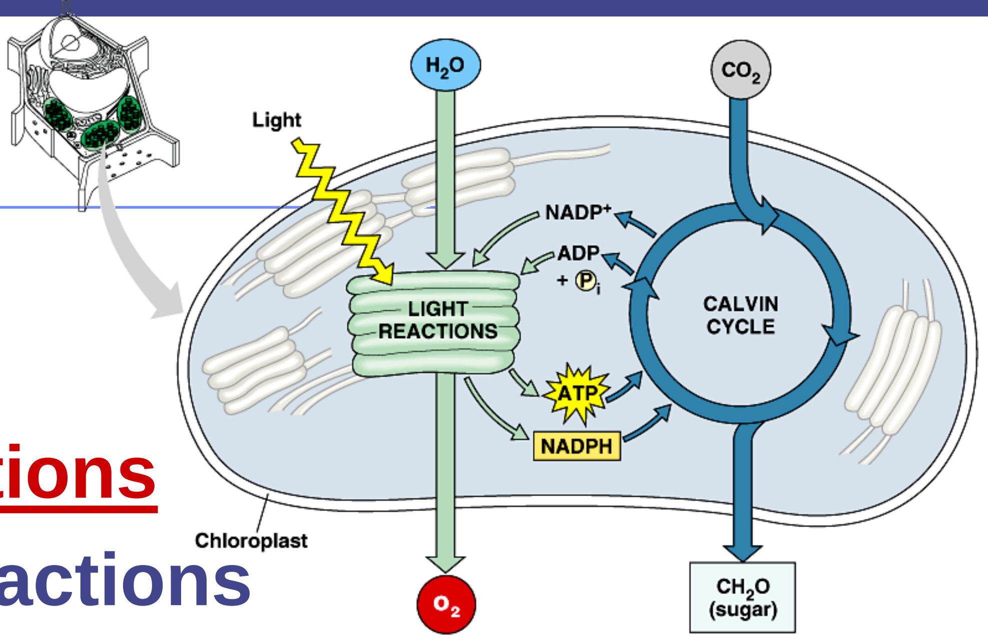
Plant structure

- Chloroplasts
  - double membrane
  - **stroma**
    - fluid-filled interior
  - **thylakoid sacs**
  - **grana stacks**
- Thylakoid membrane contains
  - chlorophyll molecules
  - electron transport chain
  - ATP synthase
    - H^+ gradient built up within thylakoid sac





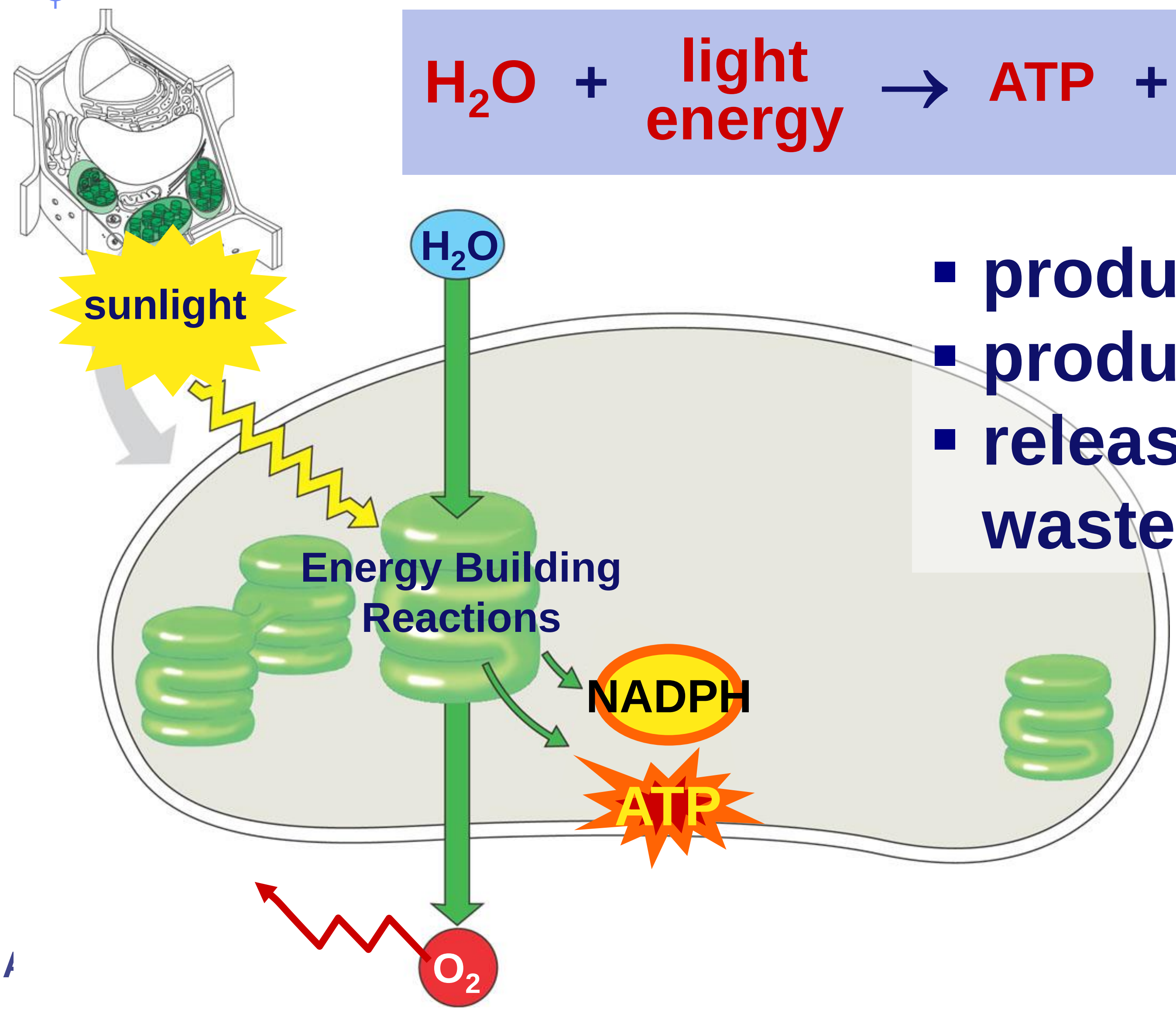
Photosynthesis



- **Light reactions**
  - **light-dependent reactions**
  - **energy production reactions**
    - **convert solar energy to chemical energy**
    - **ATP & NADPH**
- **Calvin cycle**
  - **light-independent reactions**
  - **sugar production reactions**
    - **uses chemical energy (ATP & NADPH) to reduce CO_2 & synthesize $C_6H_{12}O_6$**

Light Reactions

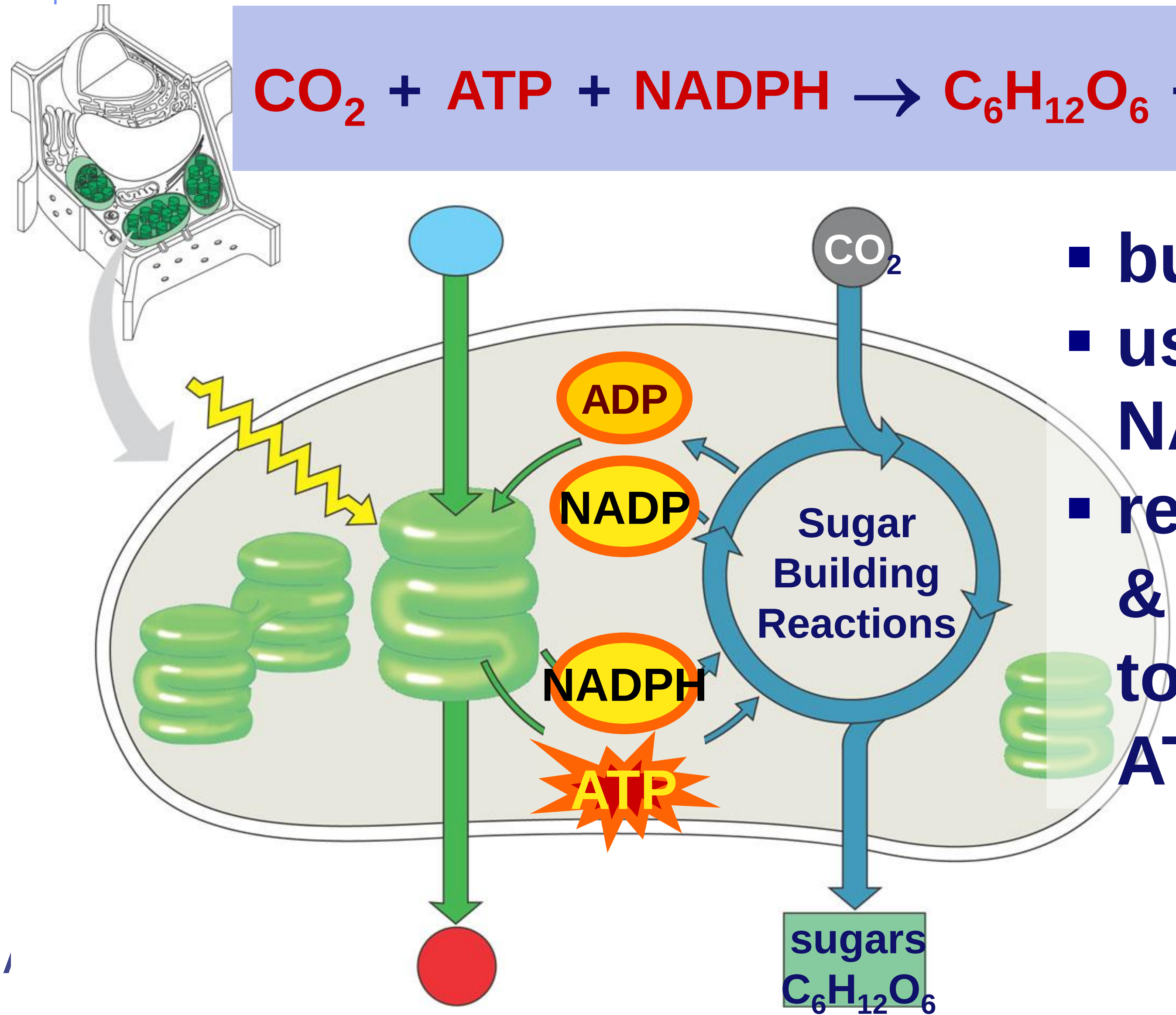
H_2O + light energy → ATP + NADPH + O_2



- produces ATP
- produces NADPH
- releases O_2 as a waste product

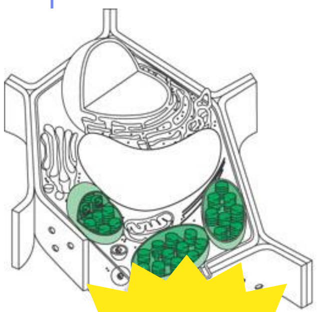
Calvin Cycle

CO_2 + ATP + NADPH → $C_6H_{12}O_6$ + ADP + NADP

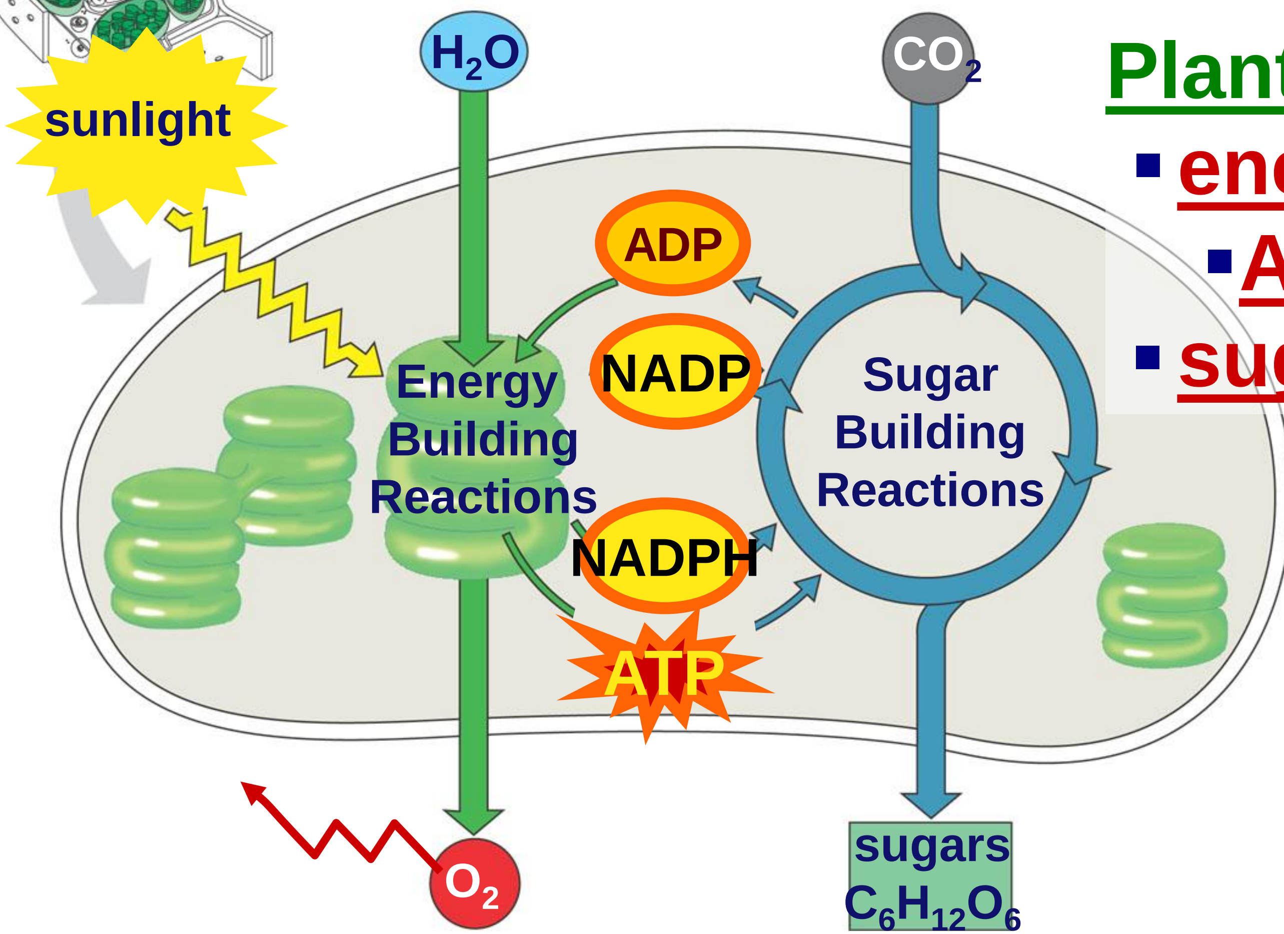


- builds sugars
- uses ATP & NADPH
- recycles ADP & NADP back to make more ATP & NADPH

Putting it all together

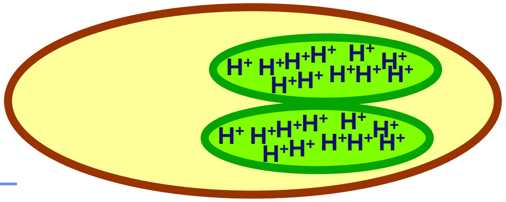


$$CO_2 + H_2O + \text{light energy} \rightarrow C_6H_{12}O_6 + O_2$$



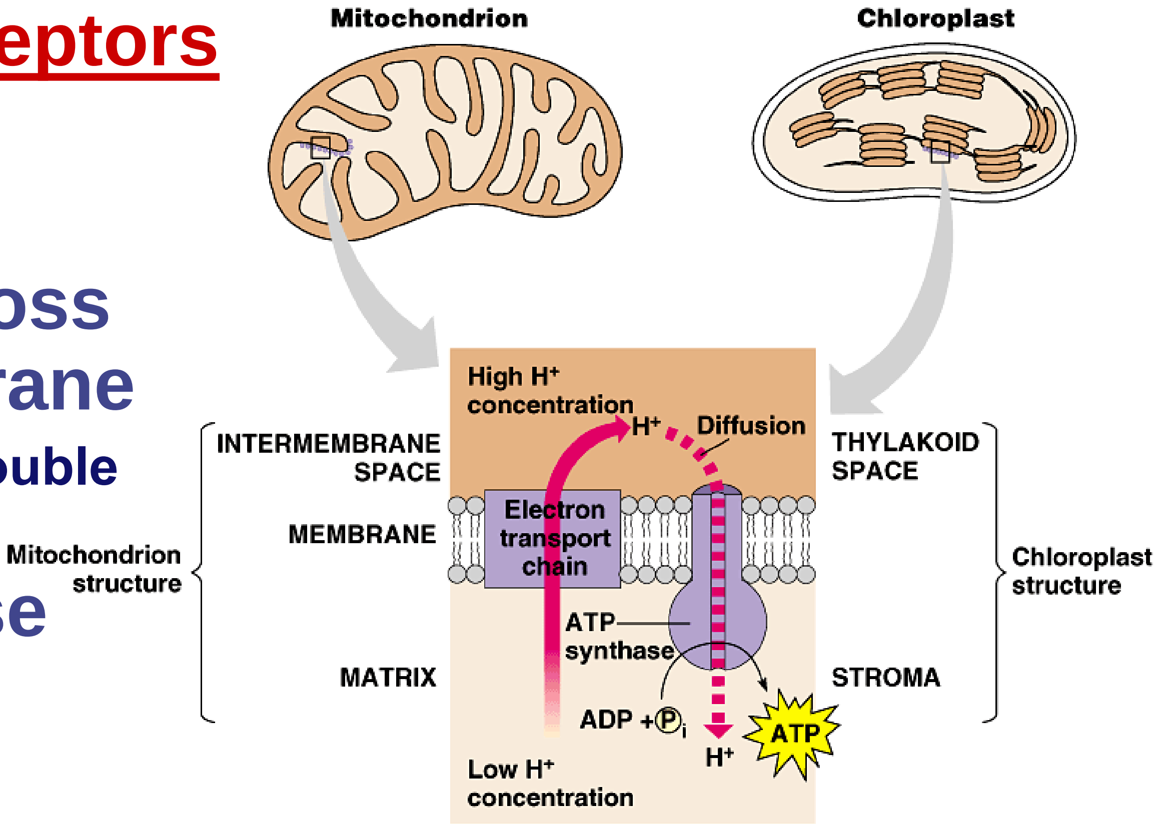
Plants make both:

- energy
  - ATP & NADPH
- sugars



Light reactions

- **Electron Transport Chain**
  - like in cellular respiration
- membrane-bound proteins in organelle
- **electron acceptors**
  - NADPH
- proton (H^+) gradient across inner membrane
  - Where's the double membrane?
- ATP synthase enzyme



Making ATP

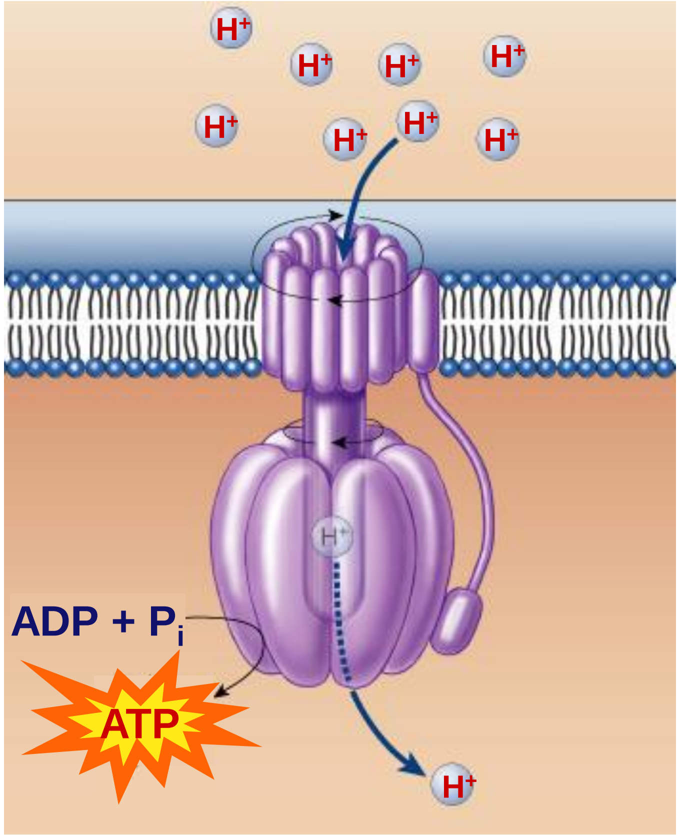
photosynthesis

sunlight

respiration

breakdown of $C_6H_{12}O_6$

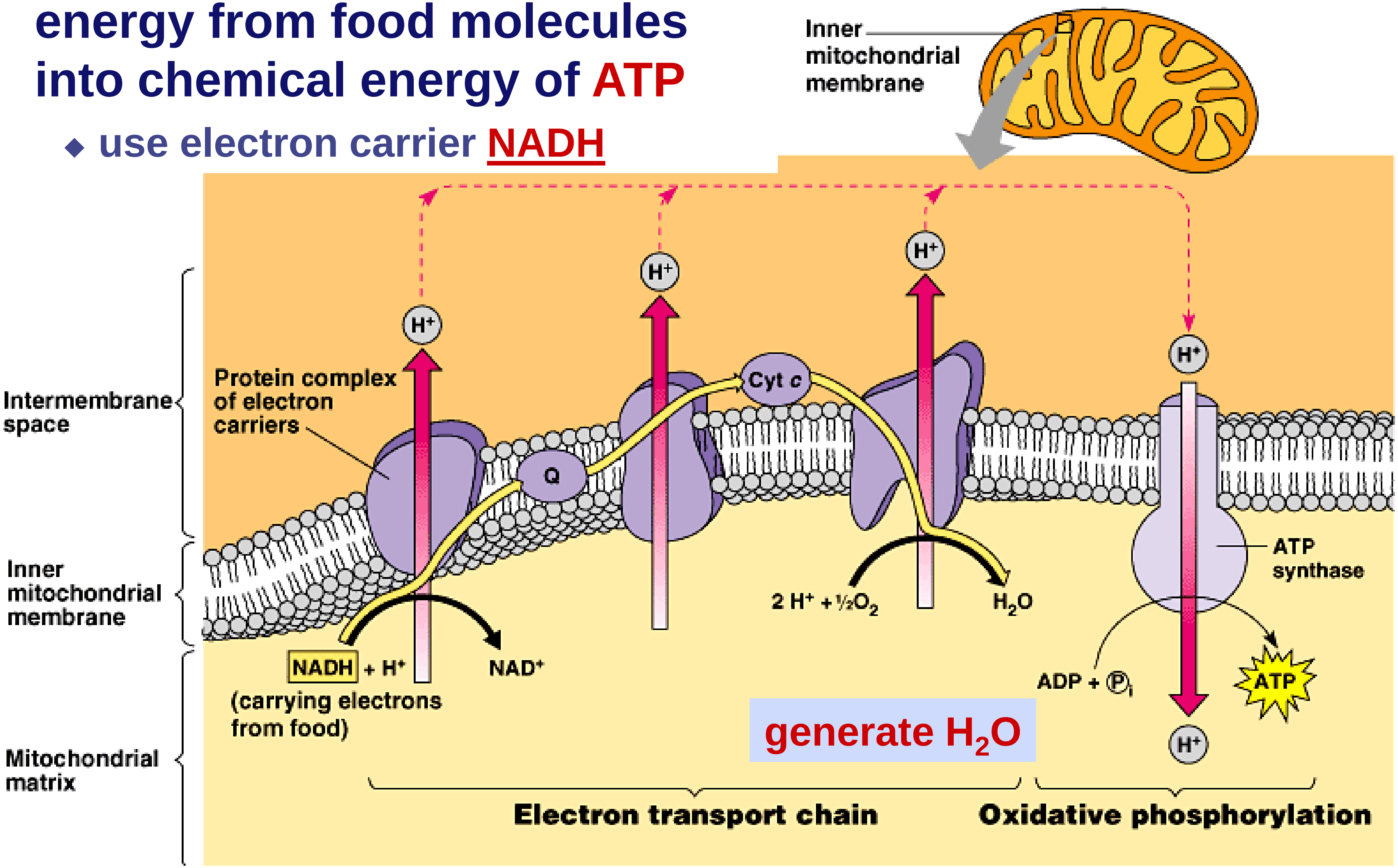
- moves the electrons
- runs the pump
- pumps the protons
- forms the gradient
- drives the flow of protons through ATP synthase
- attaches P_i to ADP
- forms the ATP



… that evolution built

ETC of Respiration

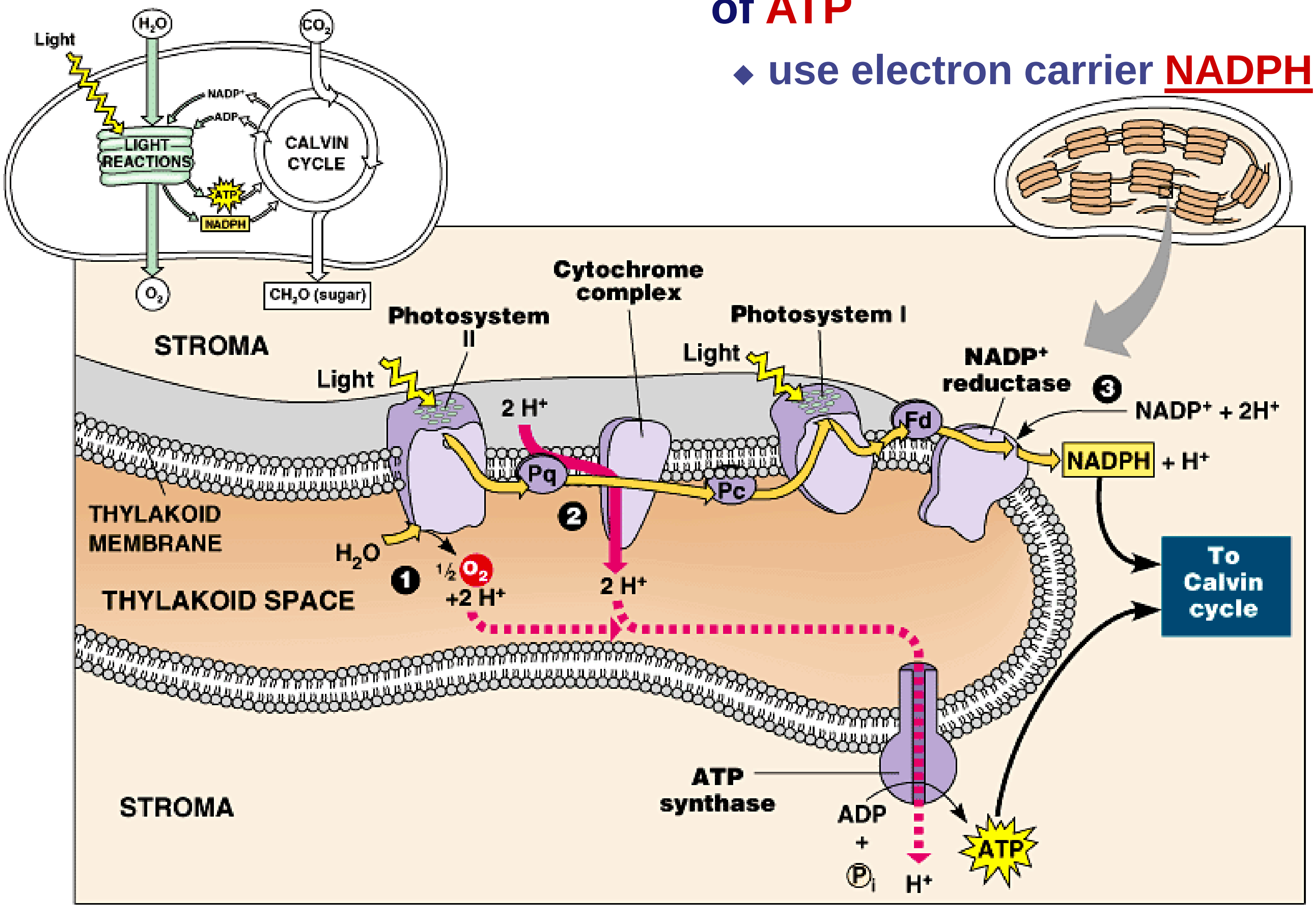
- **Mitochondria transfer chemical energy from food molecules into chemical energy of ATP**
  - use electron carrier **NADH**



generate H_2O

ETC of Photosynthesis

- <u>Chloroplasts</u> transform light energy into chemical energy of ATP
  - use electron carrier <u>NADPH</u>



Monday, January 12th

Question to Ponder

List the requirements for the light-reactions of Ps (photosynthesis).

Where do these reactions take place within the chloroplast?

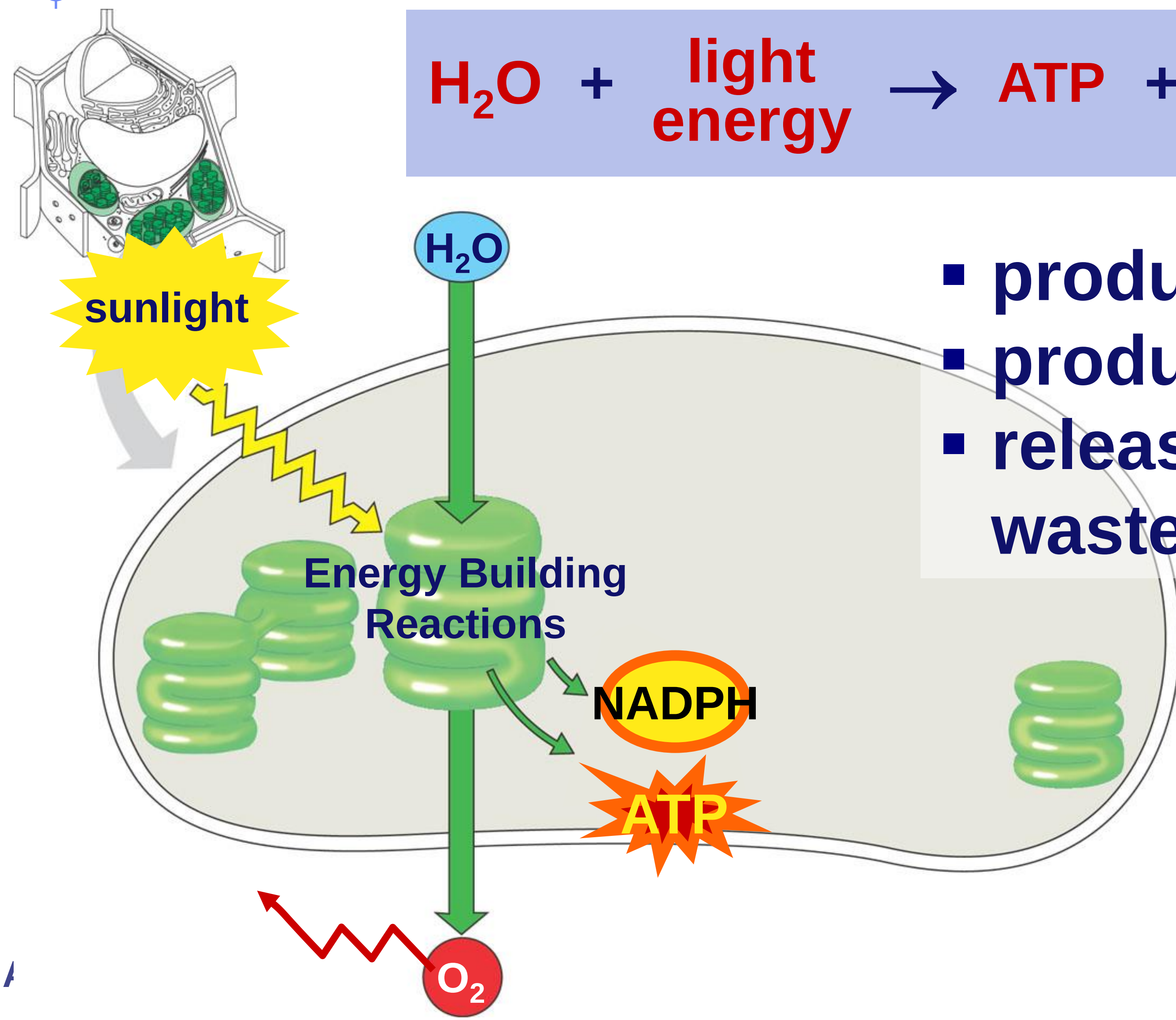
Today I will…

1. Review the light-dependent reactions.
2. Describe the visible light spectrum.
3. Differentiate between photosystems I & II.

PLEASE TAKE OUT YOUR HOMEWORK

Light Reactions

H_2O + light energy → ATP + NADPH + O_2

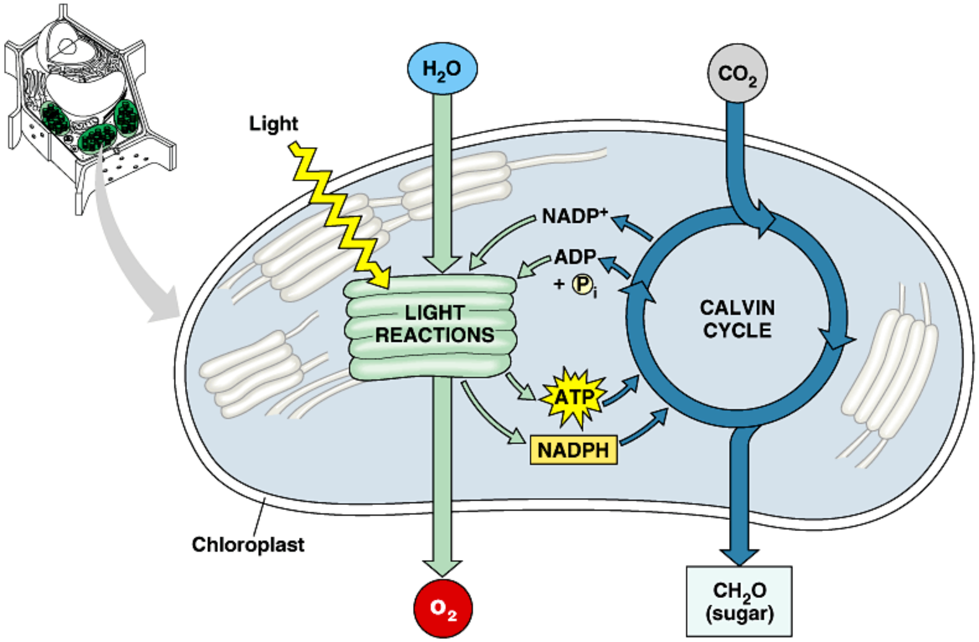


- produces ATP
- produces NADPH
- releases O_2 as a waste product

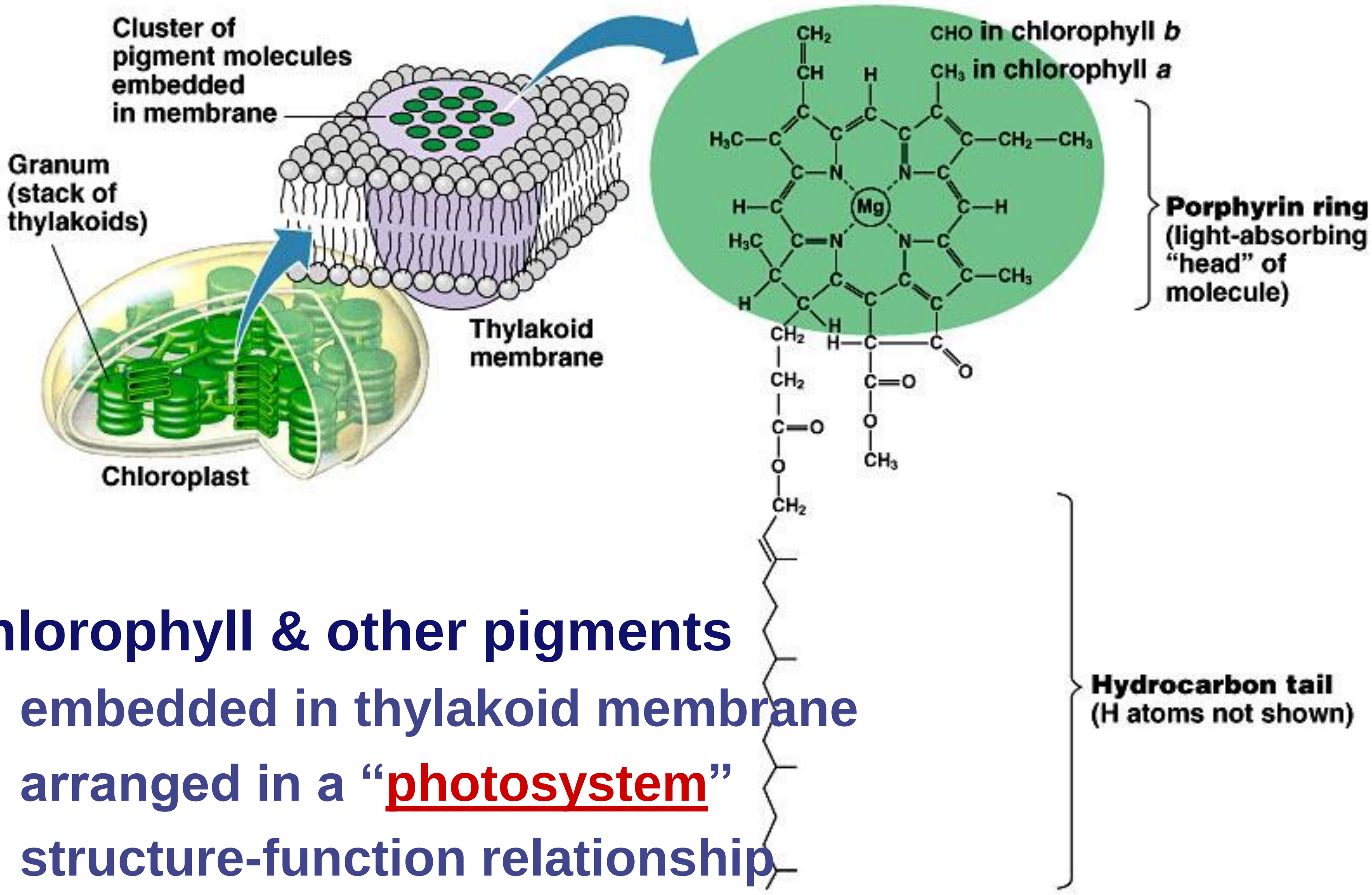
Photosystems of photosynthesis

Let's keep this straight…

LIGHT-REACTIONS animation



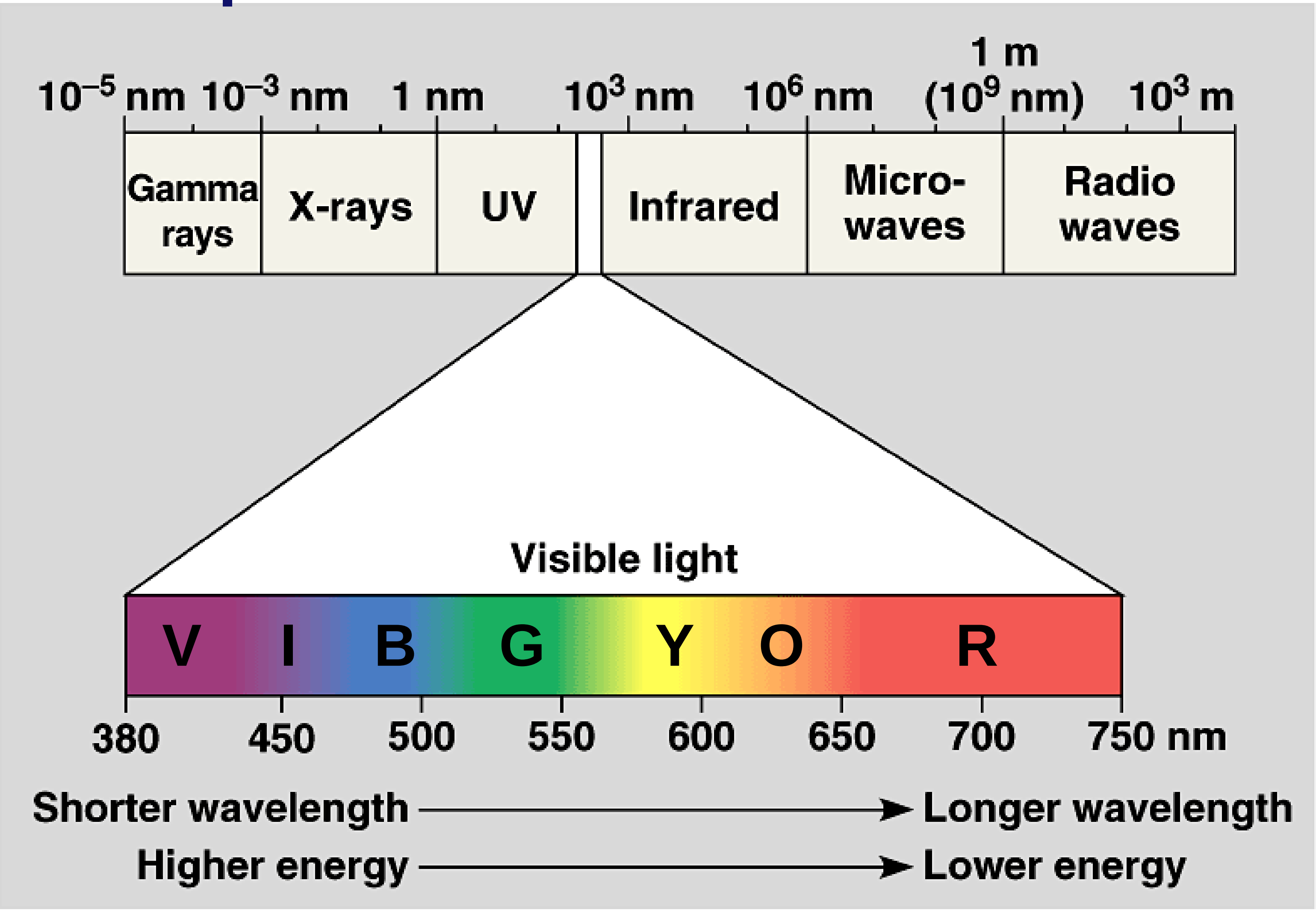
Pigments of photosynthesis



- **Chlorophyll & other pigments**
  - **embedded in thylakoid membrane**
  - **arranged in a "photosystem"**
  - **structure-function relationship**

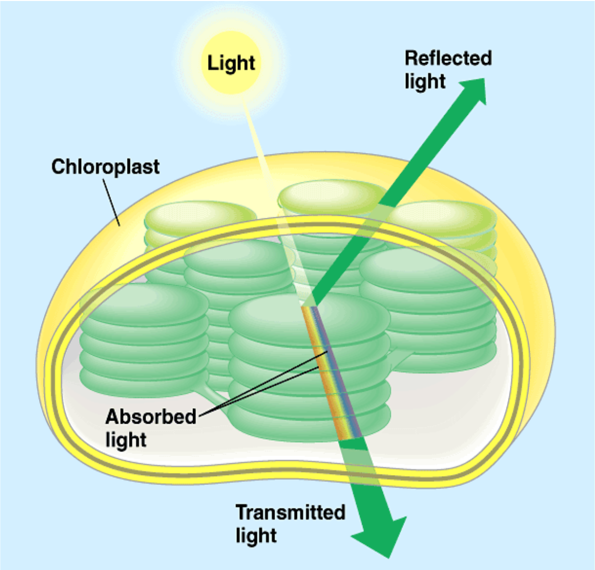
A Look at Light

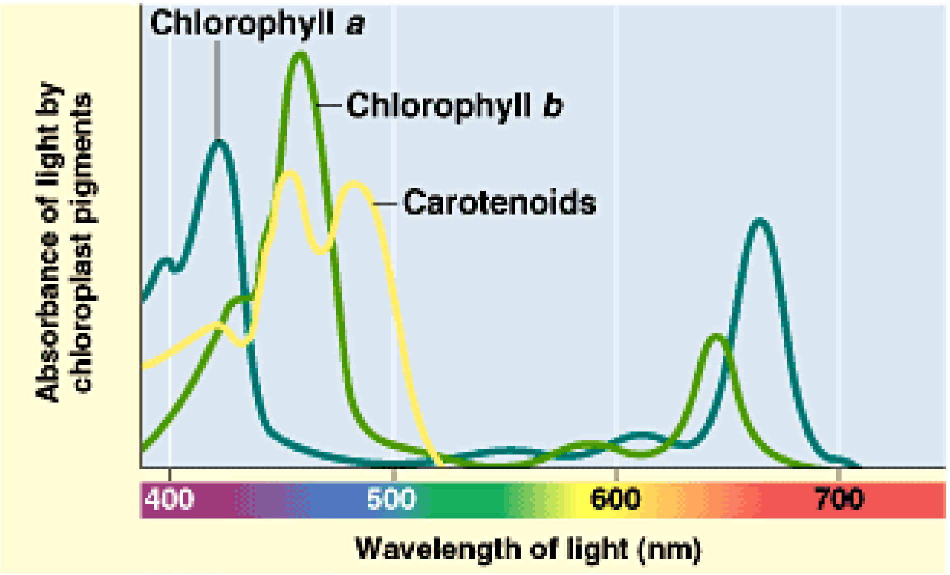
- The spectrum of color



Light: absorption spectra

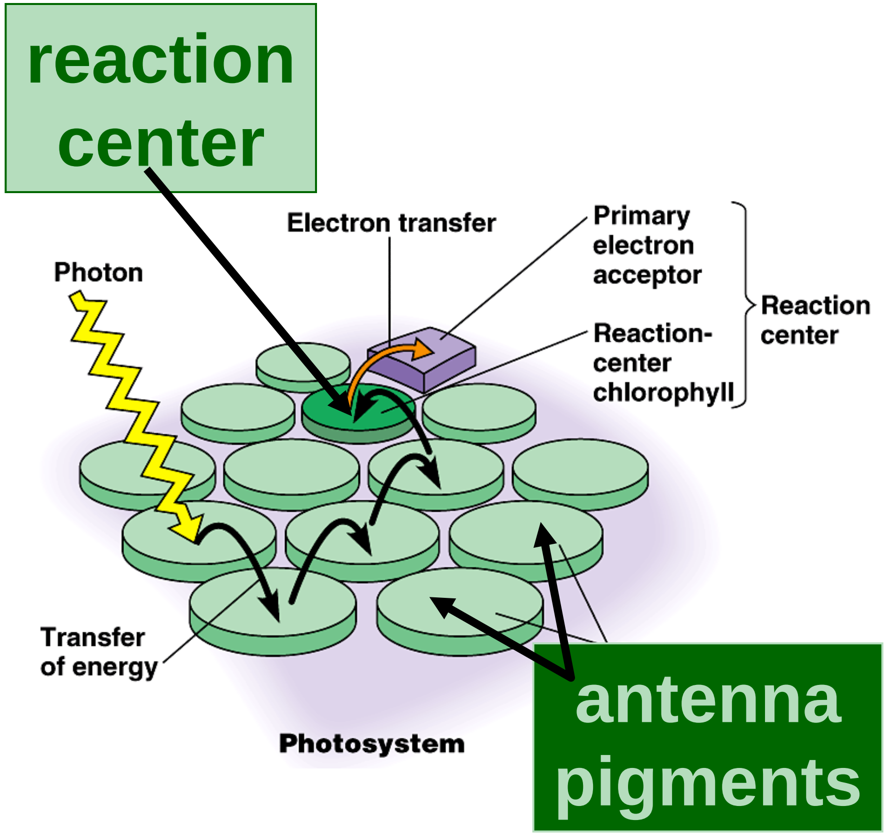
- Photosynthesis gets energy by **absorbing** wavelengths of light
  - chlorophyll *a*
    - absorbs best in red & blue wavelengths & least in green
  - other pigments with different structures absorb light of different wavelengths



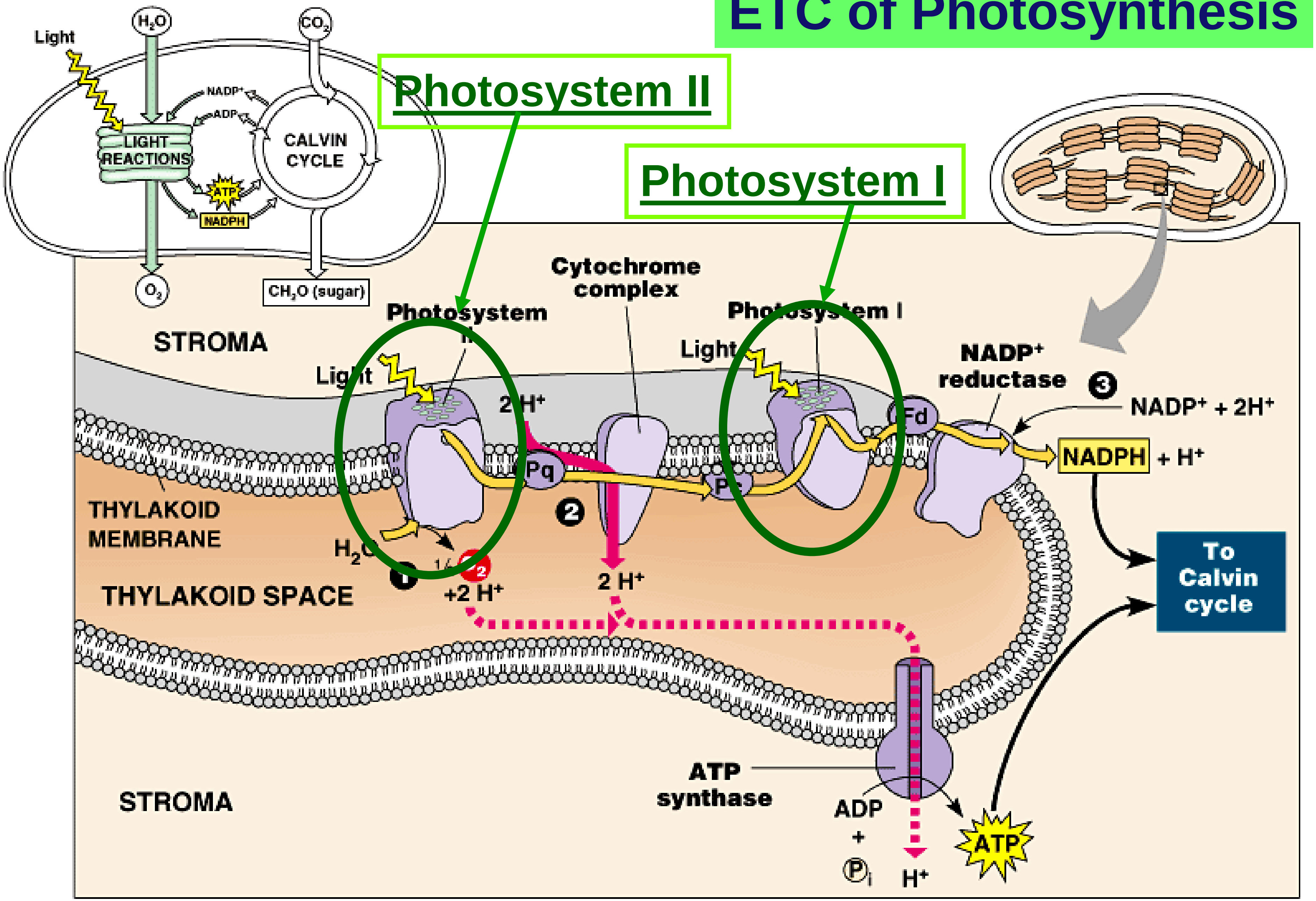


Photosystems of photosynthesis

- 2 photosystems in thylakoid membrane
  - collections of chlorophyll molecules
  - act as light-gathering "antenna complex"
  - Photosystem II
    - chlorophyll *a*
    - P_{680} = absorbs 680nm wavelength red light
  - Photosystem I
    - chlorophyll *b*
    - P_{700} = absorbs 700nm wavelength red light



ETC of Photosynthesis



Tuesday, January 13th

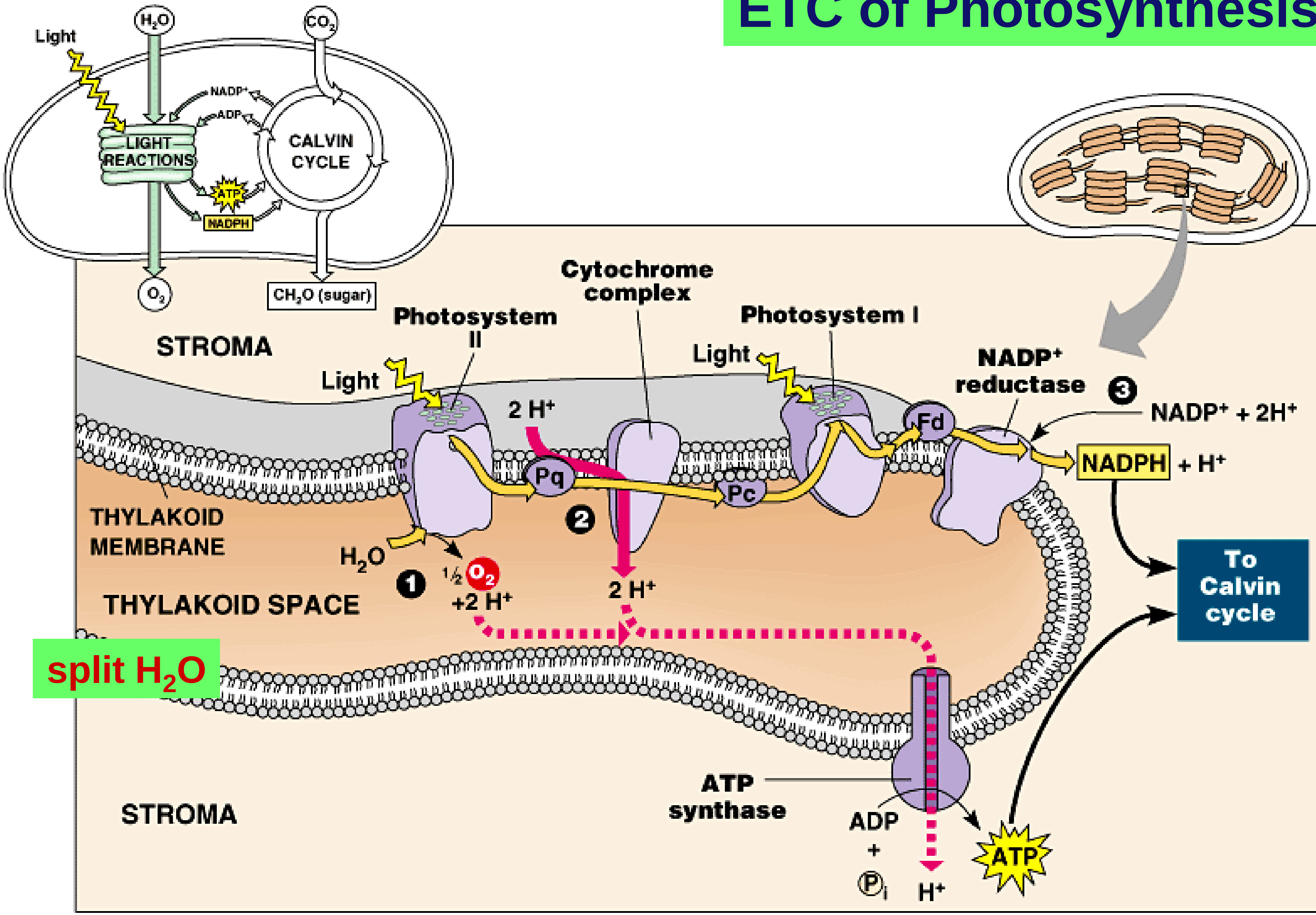
Photosynthesis summary

1. Where did the energy come from?
2. Where did the electrons come from?
3. Where did the H_2O come from?
4. Where did the O_2 come from?
5. Where did the O_2 go?
6. Where did the H^+ come from?
7. Where did the ATP come from?
8. What will the ATP be used for?
9. Where did the NADPH come from?
10. What will the NADPH be used for?

Grab a ½ sheet of paper off the front counter

…stay tuned for the Calvin cycle

ETC of Photosynthesis



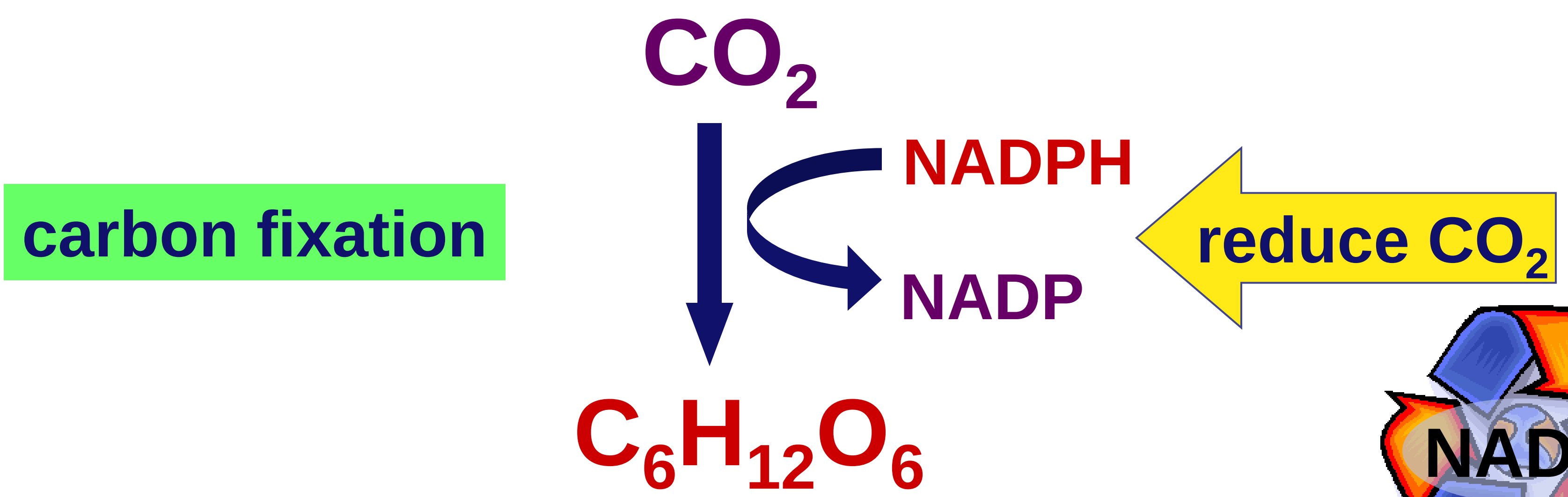
Light reactions

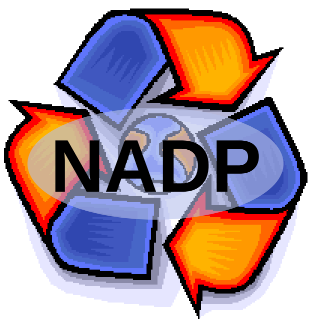
- Convert solar energy to chemical energy
  - ATP → energy
  - NADPH → reducing power
- What can we do now?

→ → build stuff *!!*

How is that helpful?

- Want to make $C_6H_{12}O_6$
  - synthesis
  - How? From what?
    What raw materials are available?





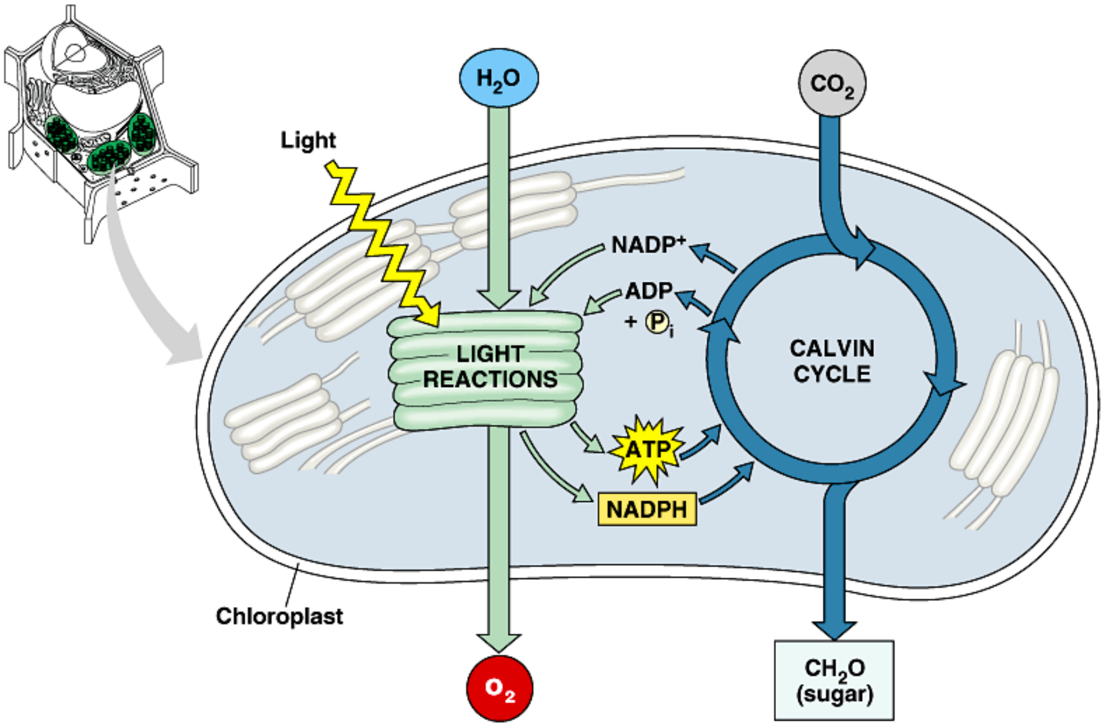
From $CO_2 \rightarrow C_6H_{12}O_6$

- CO_2 has very little chemical energy
  - fully oxidized
- $C_6H_{12}O_6$ contains a lot of chemical energy
  - reduced
  - endergonic

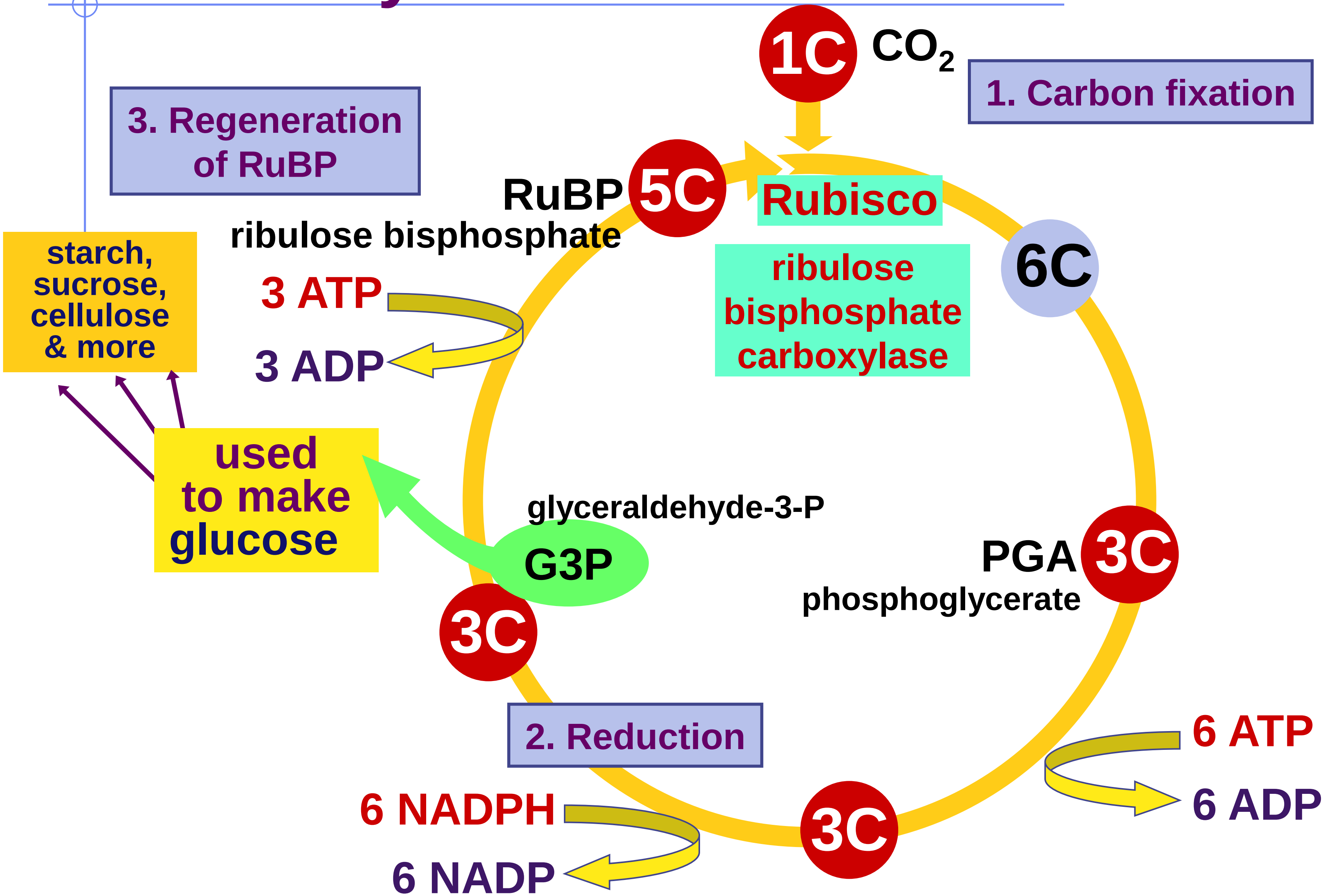
- Reduction of $CO_2 \rightarrow C_6H_{12}O_6$ proceeds in many small uphill steps
  - each catalyzed by specific enzyme
  - using energy stored in ATP & NADPH

From Light reactions to Calvin cycle

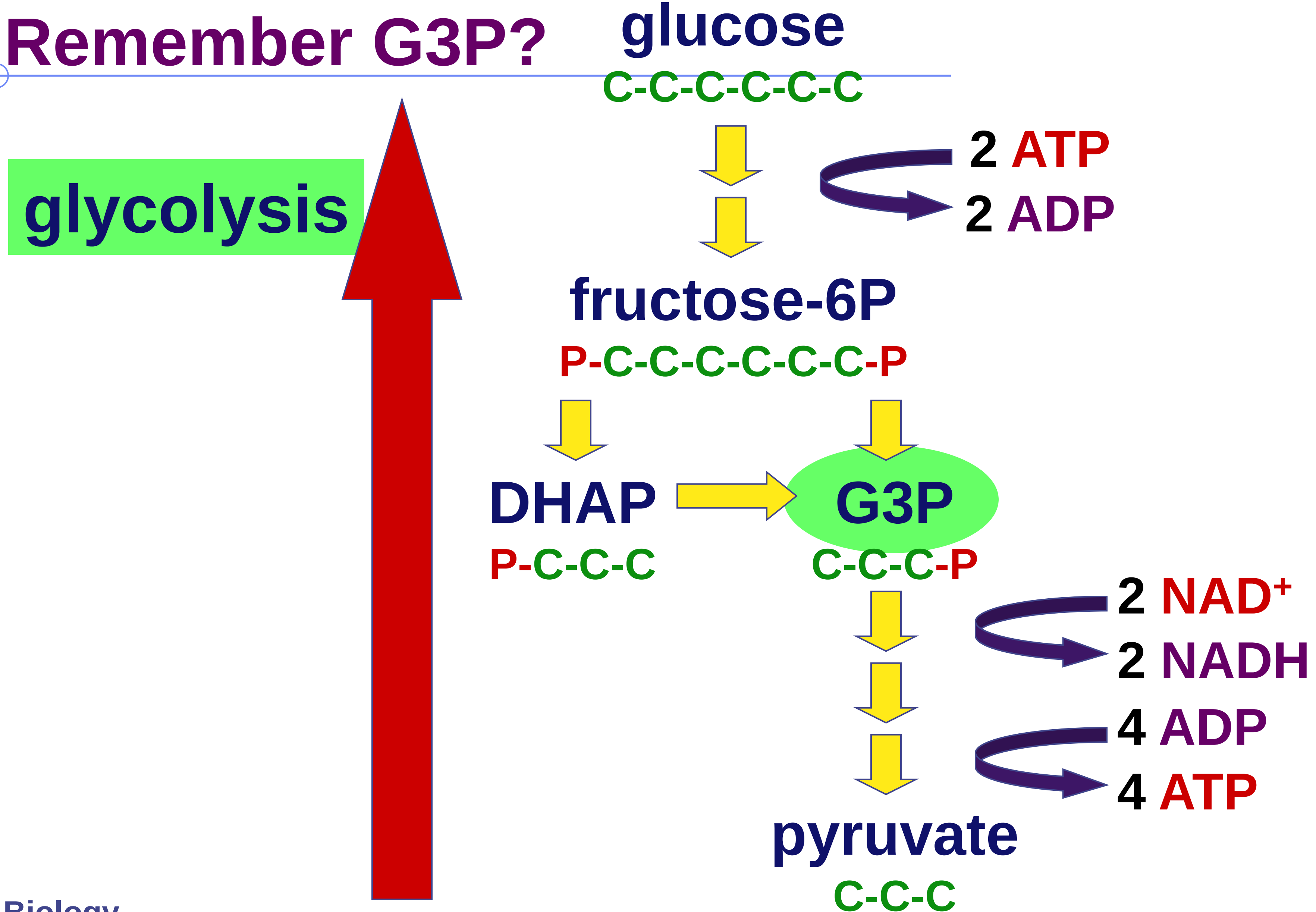
- Calvin cycle
  - chloroplast <u>stroma</u>
- Need products of light reactions to drive synthesis reactions
  - ATP
  - NADPH



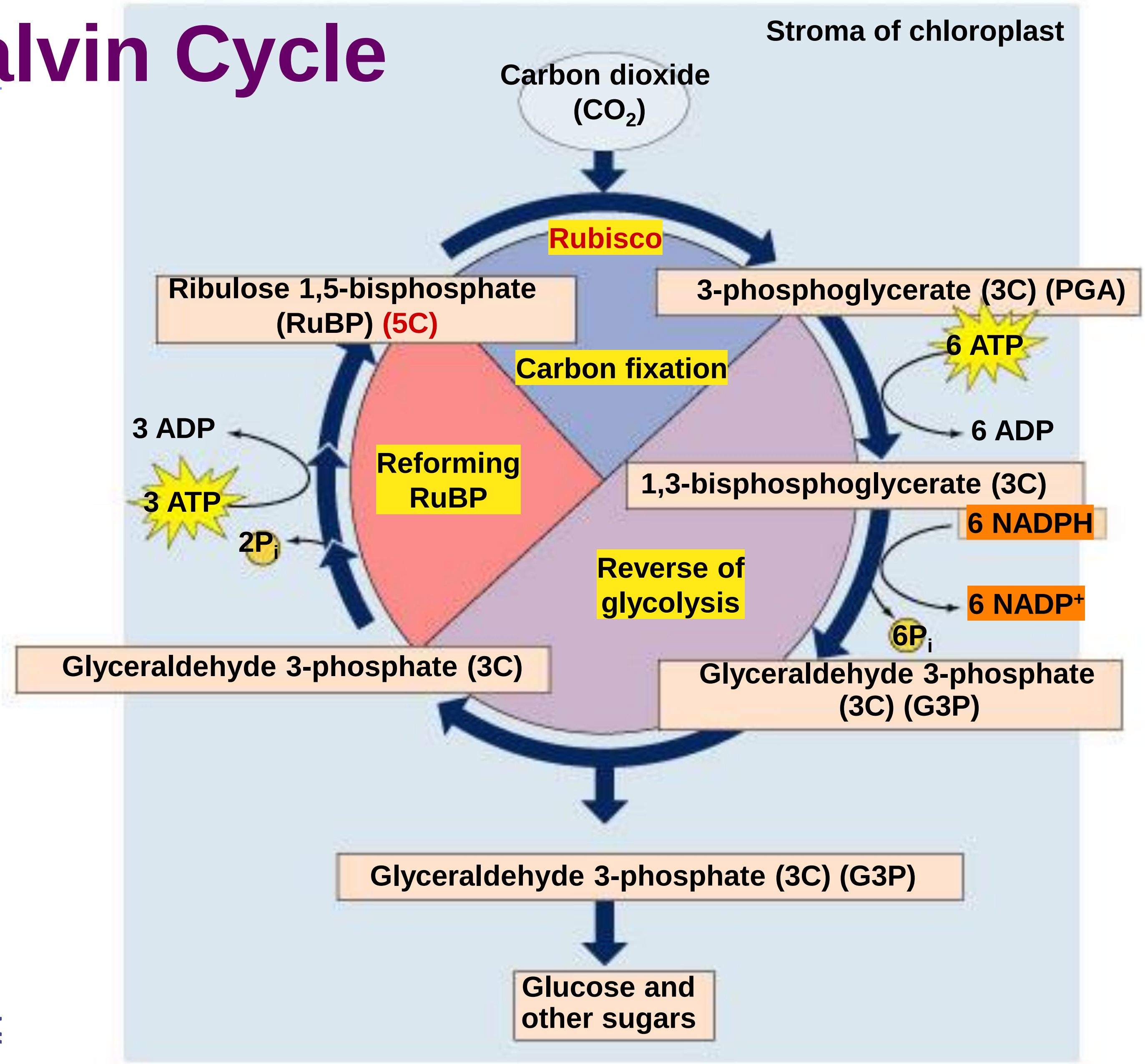
Calvin cycle



Remember G3P?



Calvin Cycle



To G-3-P and Beyond!

- **Glyceraldehyde-3-P**
  - end product of Calvin cycle
  - energy rich 3 carbon sugar
  - "C3 photosynthesis"

- **G-3-P = important intermediate**

G-3-P → → glucose → → carbohydrates

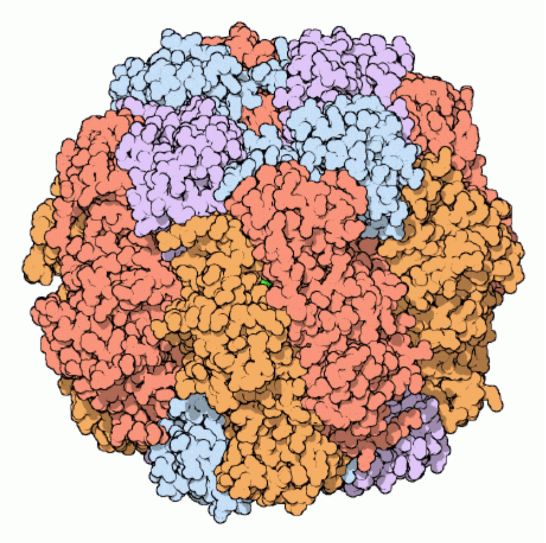
→ → lipids

→ → amino acids

→ → nucleic acids

Rubisco

- Enzyme which fixes carbon from air
  - ribulose bisphosphate carboxylase
  - the most important enzyme in the world!
    - it makes life out of air!
  - definitely the most abundant enzyme

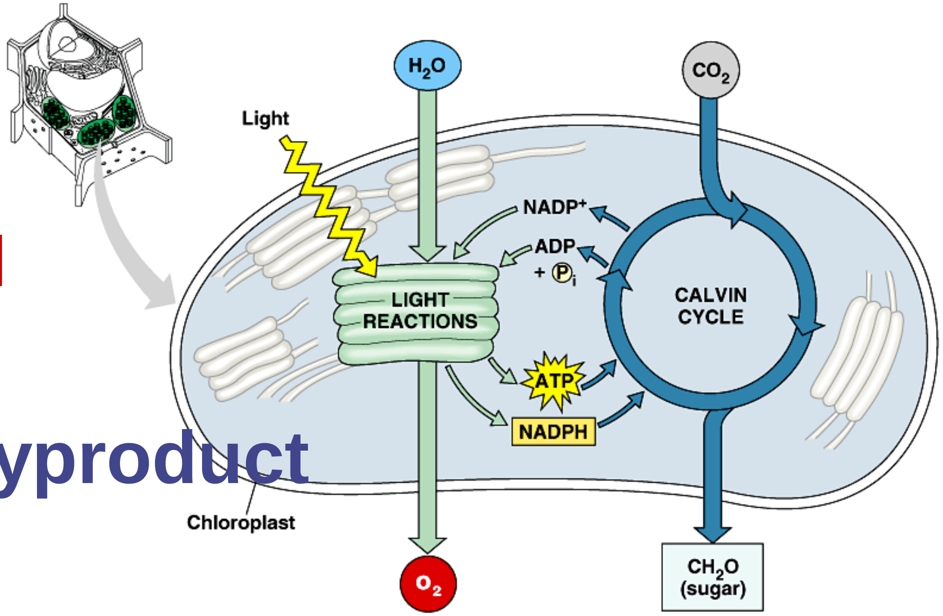


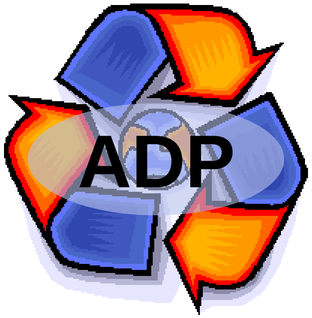
Accounting

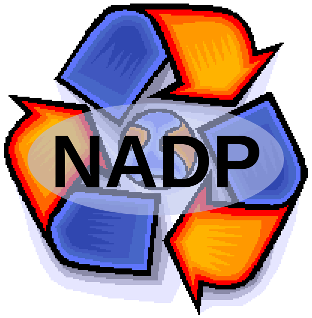
- **The accounting is complicated**
  - **3 turns of Calvin cycle = 1 G3P**
  - **3 CO_2 → 1 G3P (3C)**
  - **6 turns of Calvin cycle = 1 $C_6H_{12}O_6$ (6C)**
  - **6 CO_2 → 1 $C_6H_{12}O_6$ (6C)**
  - **<u>18</u> ATP + <u>12</u> NADPH → <u>1</u> $C_6H_{12}O_6$**
  - **any ATP left over from light reactions will be used elsewhere by the cell**

Photosynthesis summary

- Light reactions
  - produced ATP
  - produced NADPH
  - consumed H_2O
  - produced O_2 as byproduct
- Calvin cycle
  - consumed CO_2
  - produced G3P (sugar)
  - regenerated ADP
  - regenerated NADP







Wednesday, January 14th

Please take out the cancer webquest you completed using the *Inside Cancer* website.

<u>YOUR TASK:</u>

Complete **2** essays in-class using this resource.

- Use notebook paper.
- Due prior to leaving.
- Please pick up the **Cell Respiration** lab manual
  - 2nd and 3rd period: Meet in Room 803 (lab)
  - 4th period: Meet here

Thursday

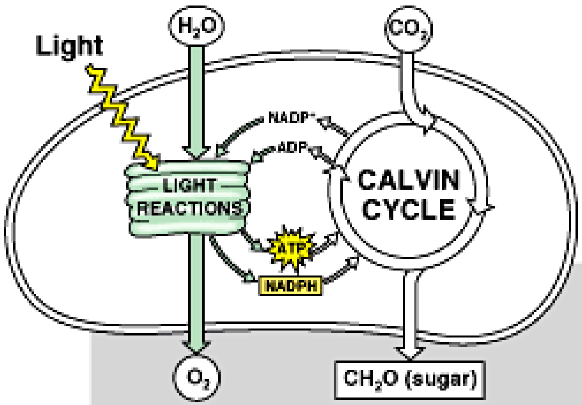
The poetic perspective…

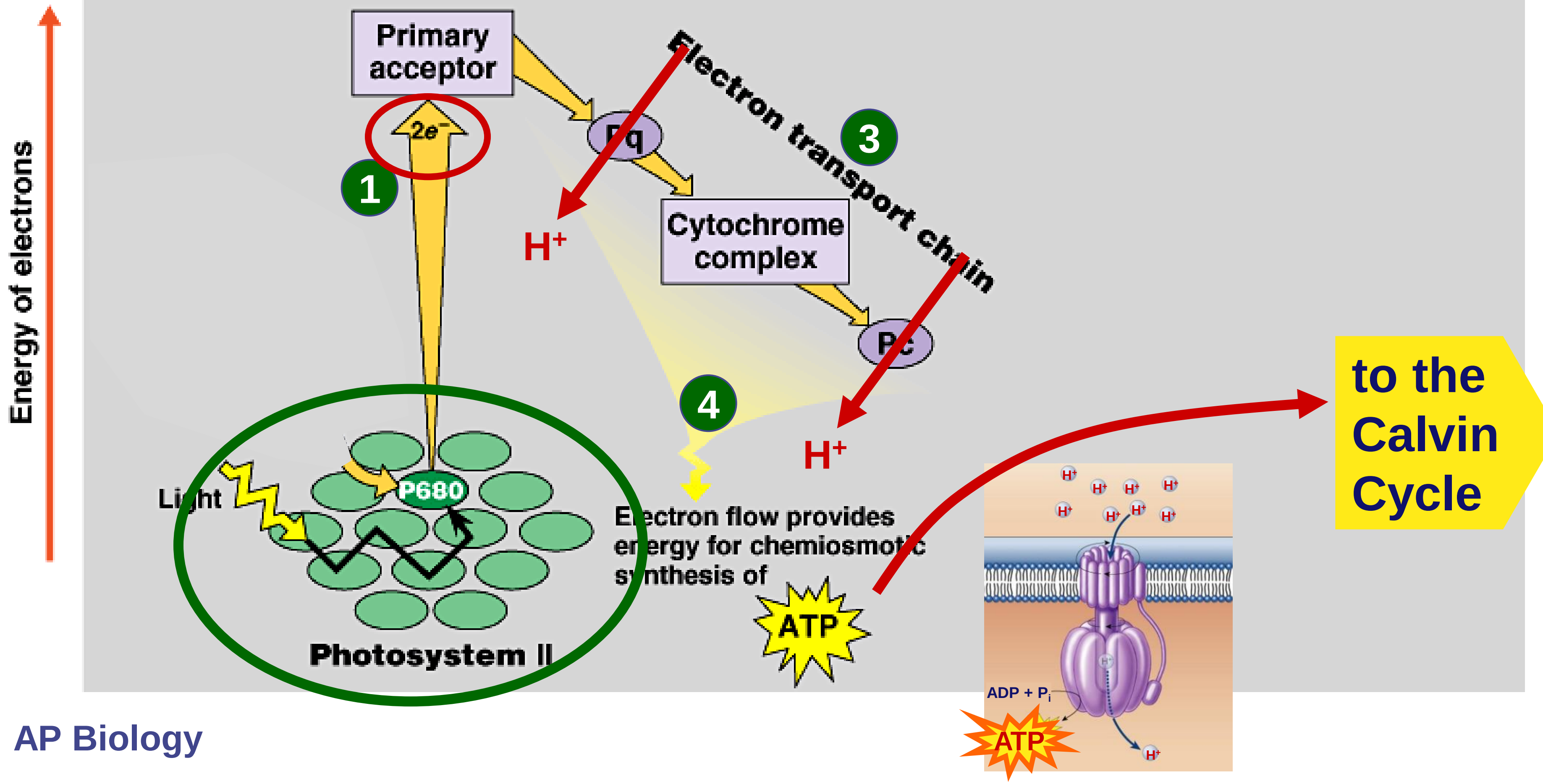
- **All the solid material of every <u>plant</u> was built by sunlight out of thin air**
- **All the solid material of every <u>animal</u> was built from plant material**

Then all the cats, dogs, rats, people & elephants… are really strands of air woven together by sunlight!

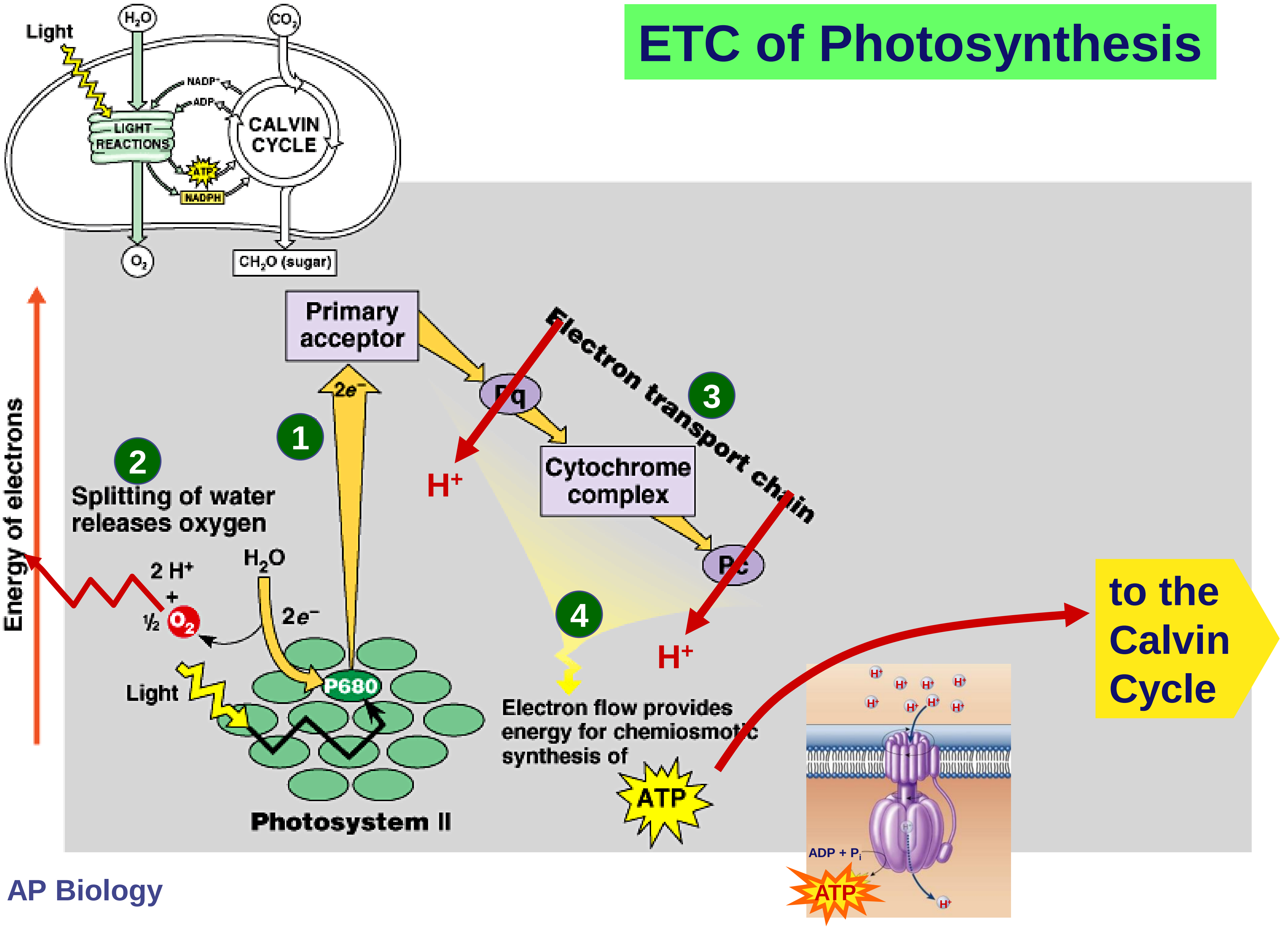
Old Light - Rxn notes

ETC of Photosynthesis

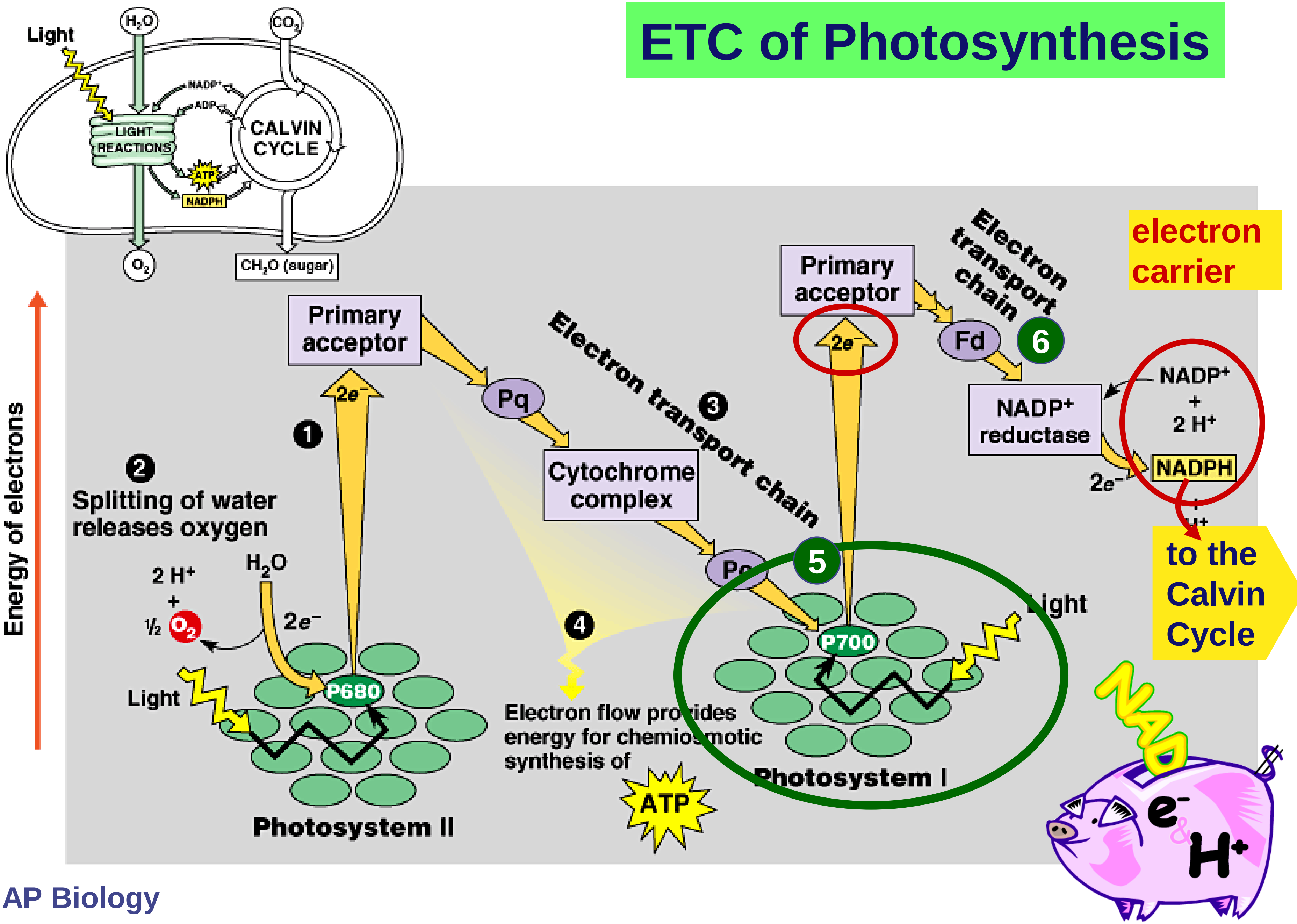




ETC of Photosynthesis



ETC of Photosynthesis



ETC of Photosynthesis

- ETC produces from light energy
  - ATP & NADPH
    - go to Calvin cycle
- PS II absorbs light
  - excited electron passes from chlorophyll to "primary electron acceptor"
  - need to replace electron in chlorophyll
  - enzyme extracts electrons from H_2O & supplies them to chlorophyll
    - splits H_2O
    - O combines with another O to form O_2
    - O_2 released to atmosphere
    - and we breathe easier!

Experimental evidence

- **Where did the O_2 come from?**
  - radioactive tracer = O_{18}

Experiment 1

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

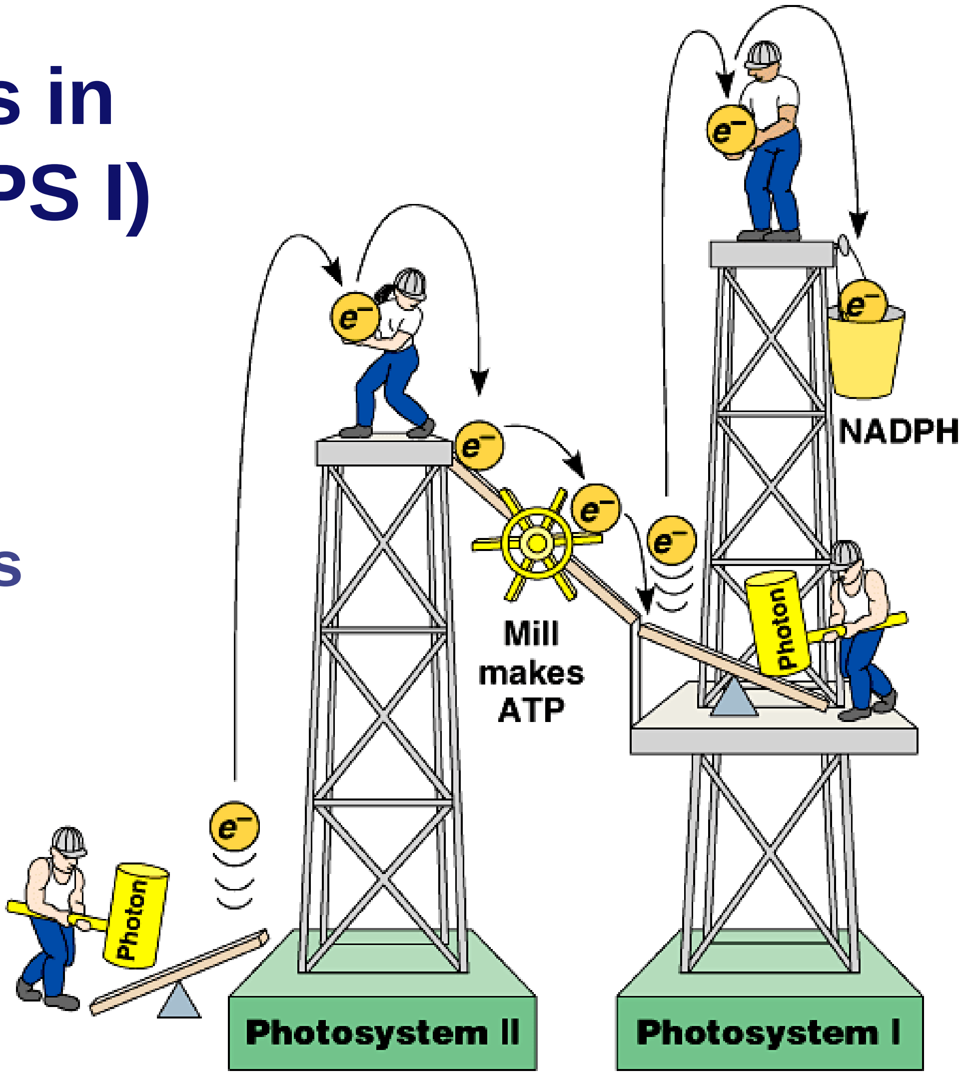
Experiment 2

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

Proved O_2 came from H_2O not CO_2 = plants split H_2O

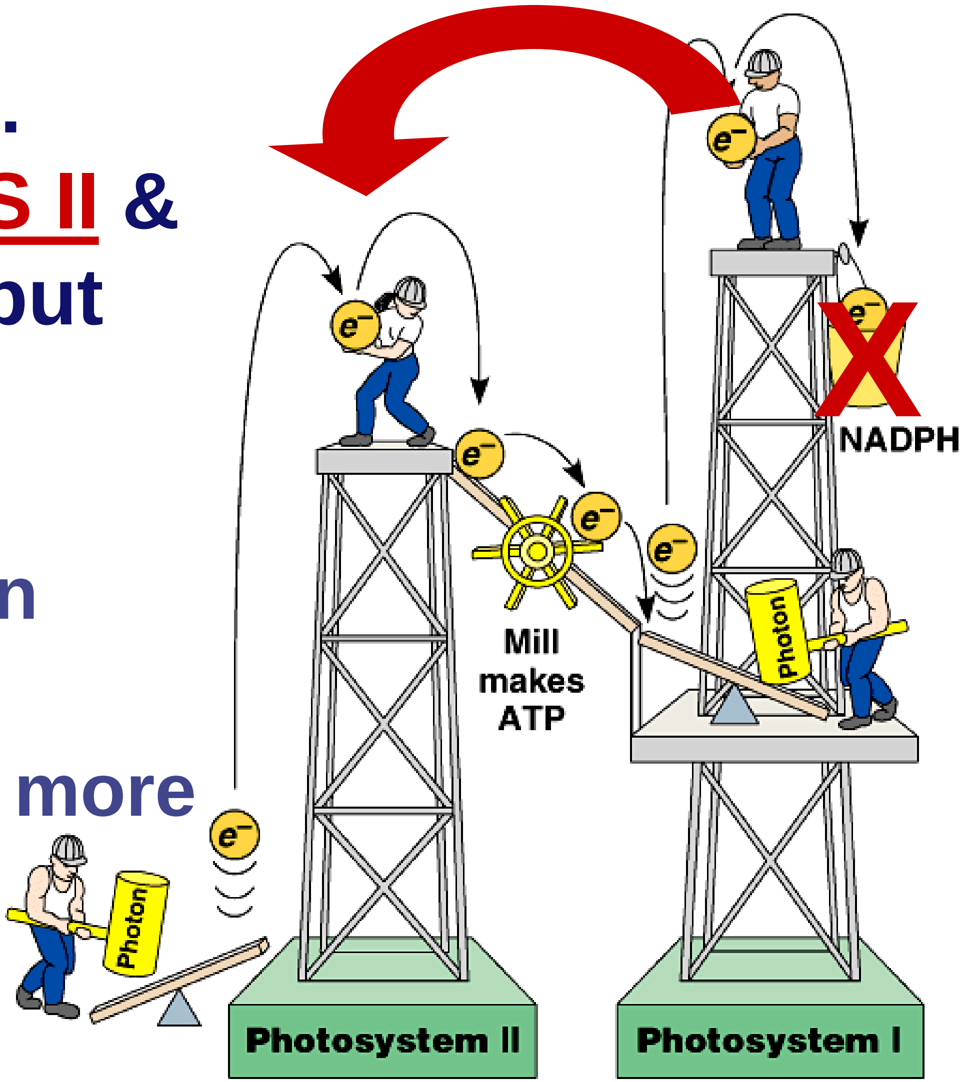
Noncyclic Photophosphorylation

- **Light reactions elevate electrons in 2 steps (PS II & PS I)**
  - **PS II** generates energy as **ATP**
  - **PS I** generates reducing power as **NADPH**



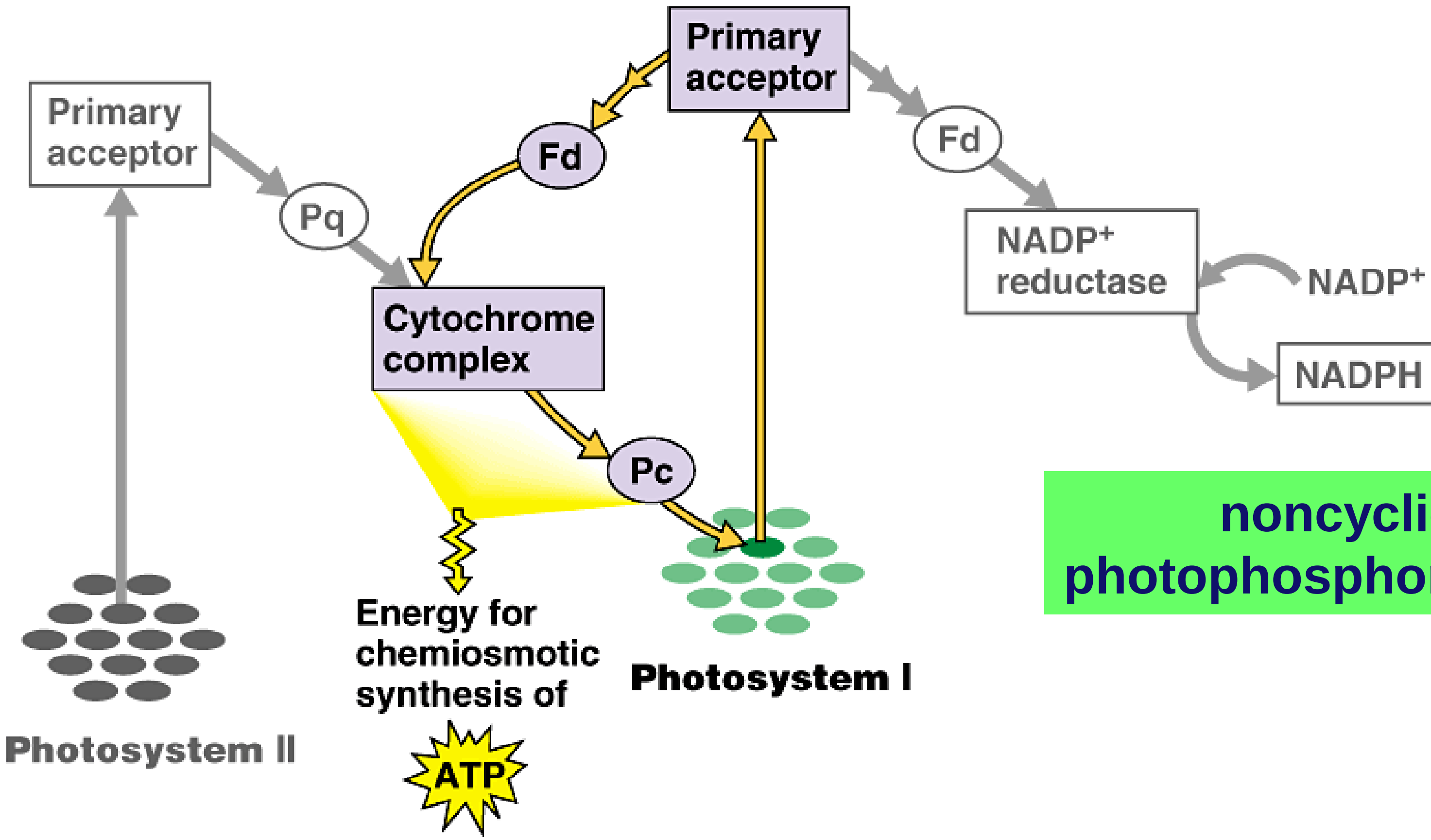
Cyclic photophosphorylation

- If PS I can't pass electron to NADP… it cycles back to PS II & makes more ATP, but no NADPH
  - coordinates light reactions to Calvin cycle
  - Calvin cycle uses more ATP than NADPH



Photophosphorylation

cyclic photophosphorylation



noncyclic photophosphorylation

Photosynthesis summary

Where did the energy come from?

Where did the electrons come from?

Where did the H_2O come from?

Where did the O_2 come from?

Where did the O_2 go?

Where did the H^+ come from?

Where did the ATP come from?

What will the ATP be used for?

Where did the NADPH come from?

What will the NADPH be used for?

…stay tuned for the Calvin cycle