

1. **Pick up** Name Folder

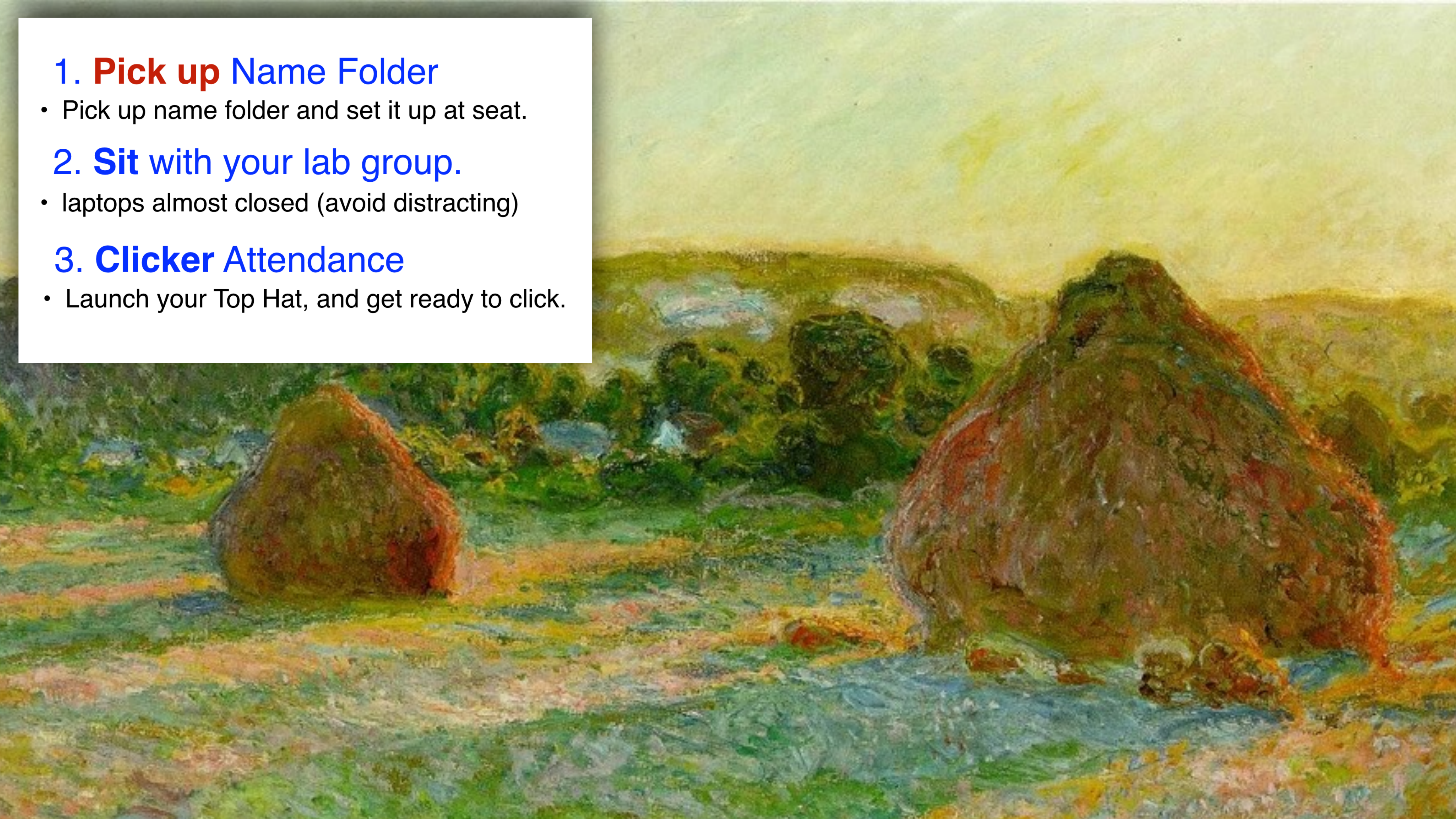
- Pick up name folder and set it up at seat.

2. **Sit** with your lab group.

- laptops almost closed (avoid distracting)

3. **Clicker** Attendance

- Launch your Top Hat, and get ready to click.



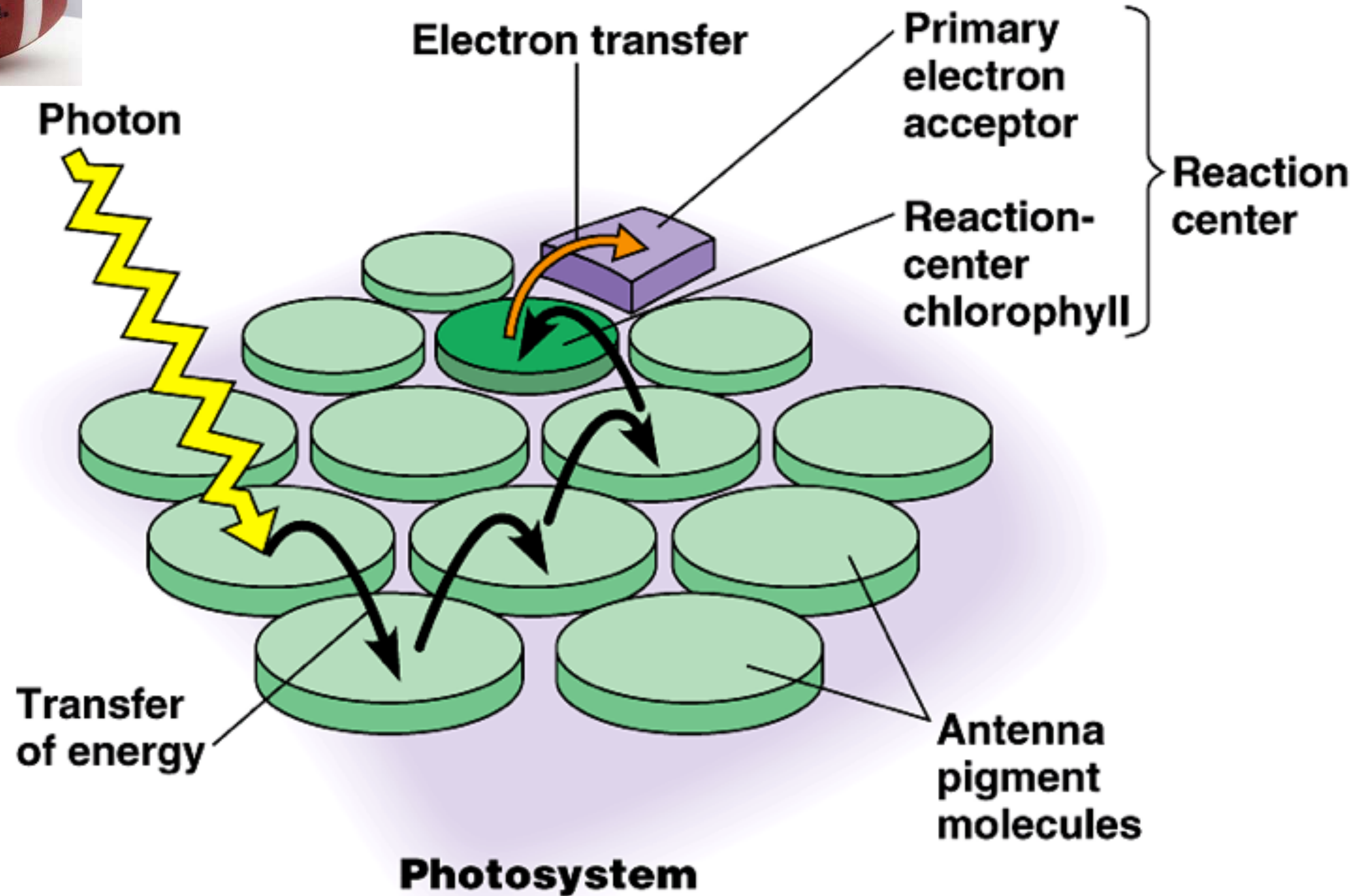
Laptops closed (unless TopHat)



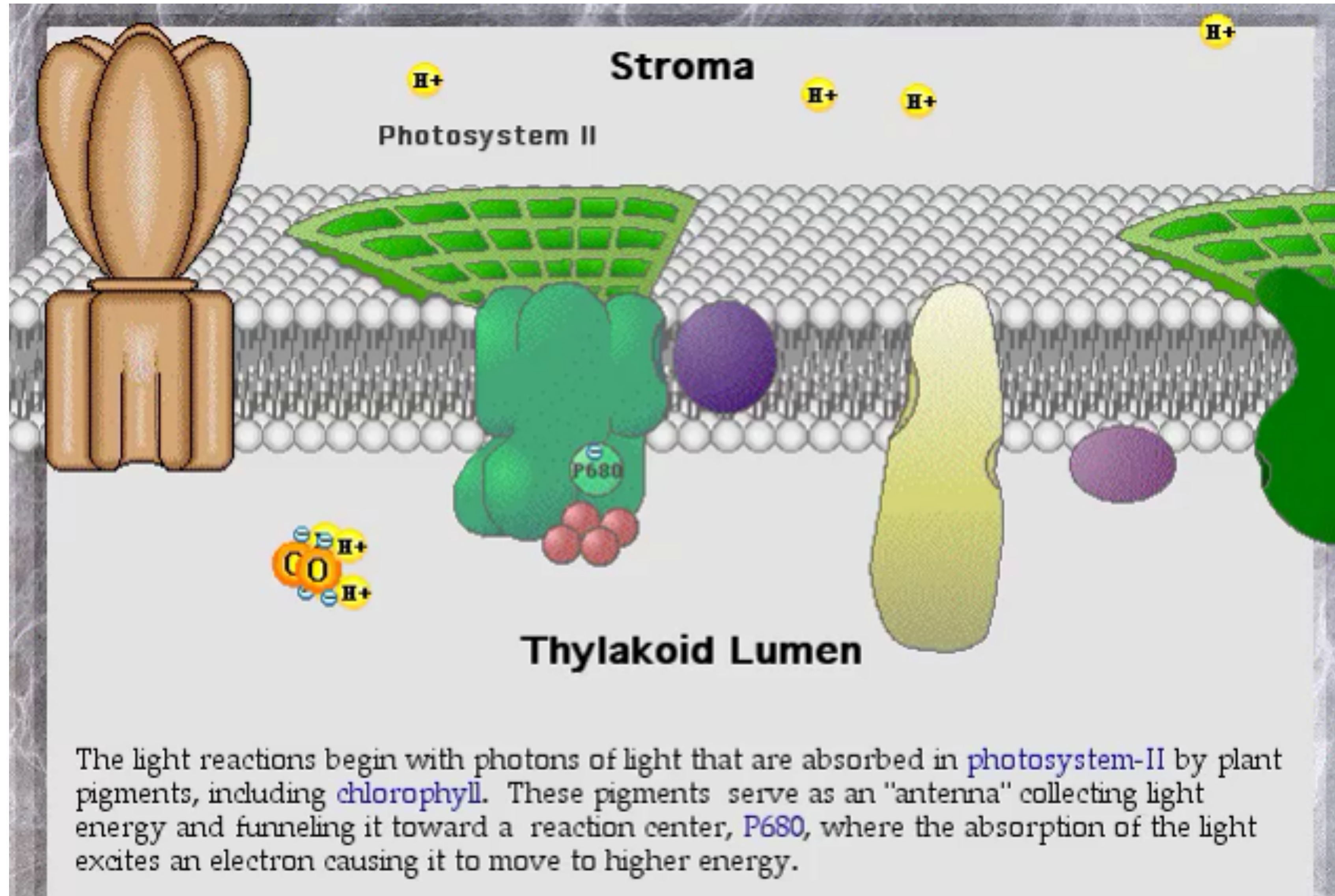
Announcements

1. Please provide CATME feedback and start work on Team Contract in Course Pack (page 83).
2. Homework questions, again asked: **So, 8 green photons make?**

Think about Jackson, when he threw green photons to carotenoids?



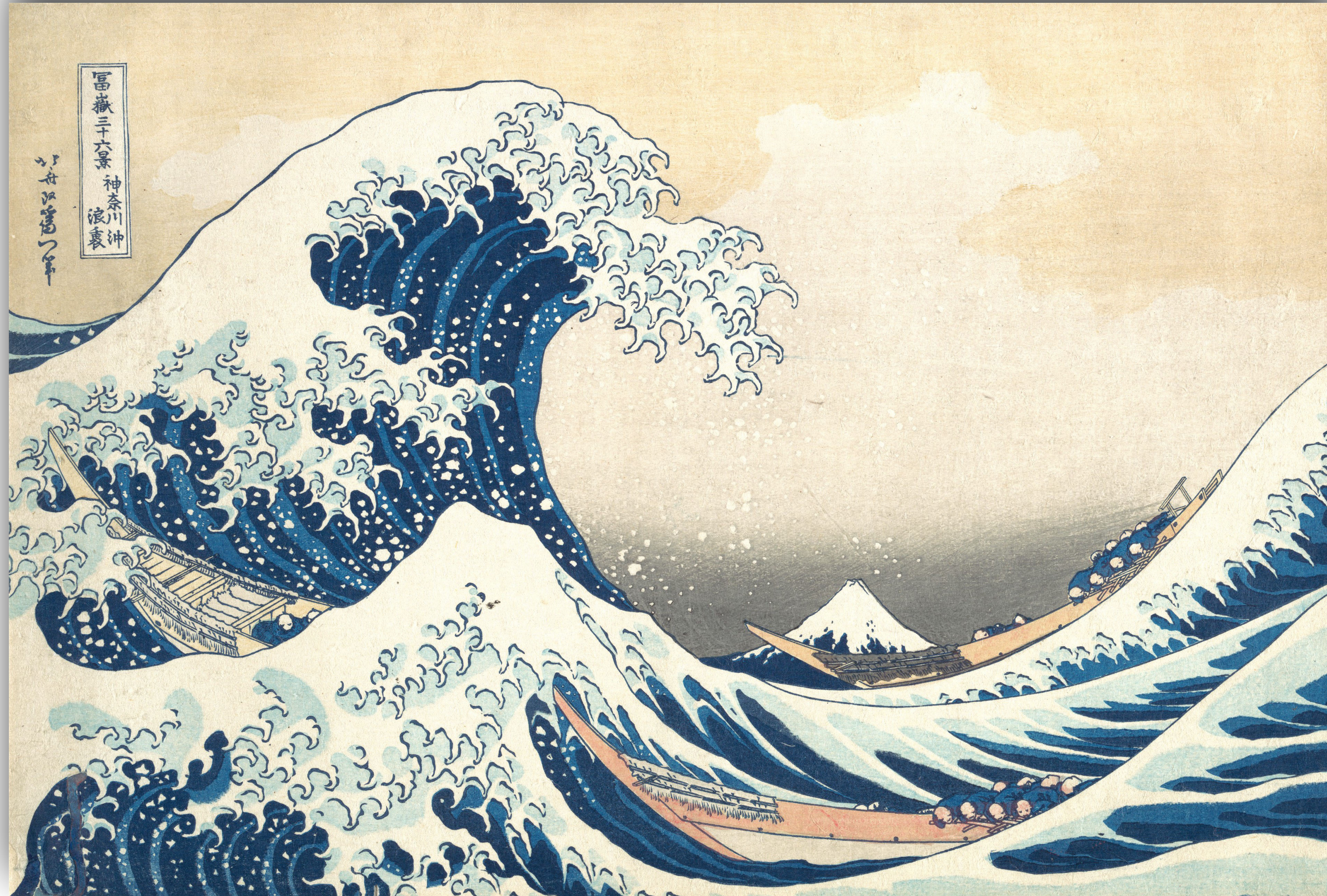
If 8 photons strike the two photosystems then what happens?



Announcements

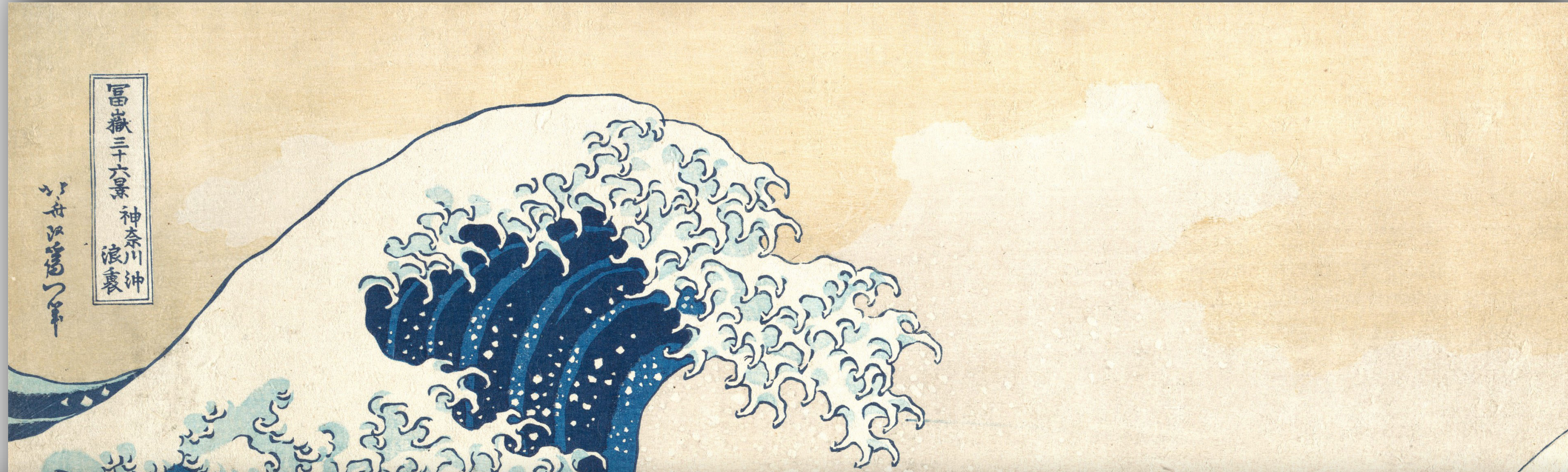
1. Please provide CATME feedback and start work on Team Contract in Course Pack (page 83).
2. Homework added question asks :8 **green photons make?**:
3. **DRAFT2** is next, so what part are you writing?
4. Write to scientist for CF DNA with your mutation yet?
5. Today is more “comfort food”, an old fashion lecture, is not an ICB reading with many trifectas etc, **so take new notes** to add to those from the reading.
6. **Students** asking “wait (how much) should I be studying?”

LB145 is two courses



Katsushika Hokusai, The Great Wave off Kanagawa (Kanagawa oki nami ura), from the series Thirty-six Views of Mount Fuji (Fugaku sanjurokkei), (c. 1830–32), Metropolitan Museum of Art, New York, polychrome woodblock print, (25.7 x 37.9 cm). Photo: The Metropolitan Museum of Art.

LB145 is 5 credits

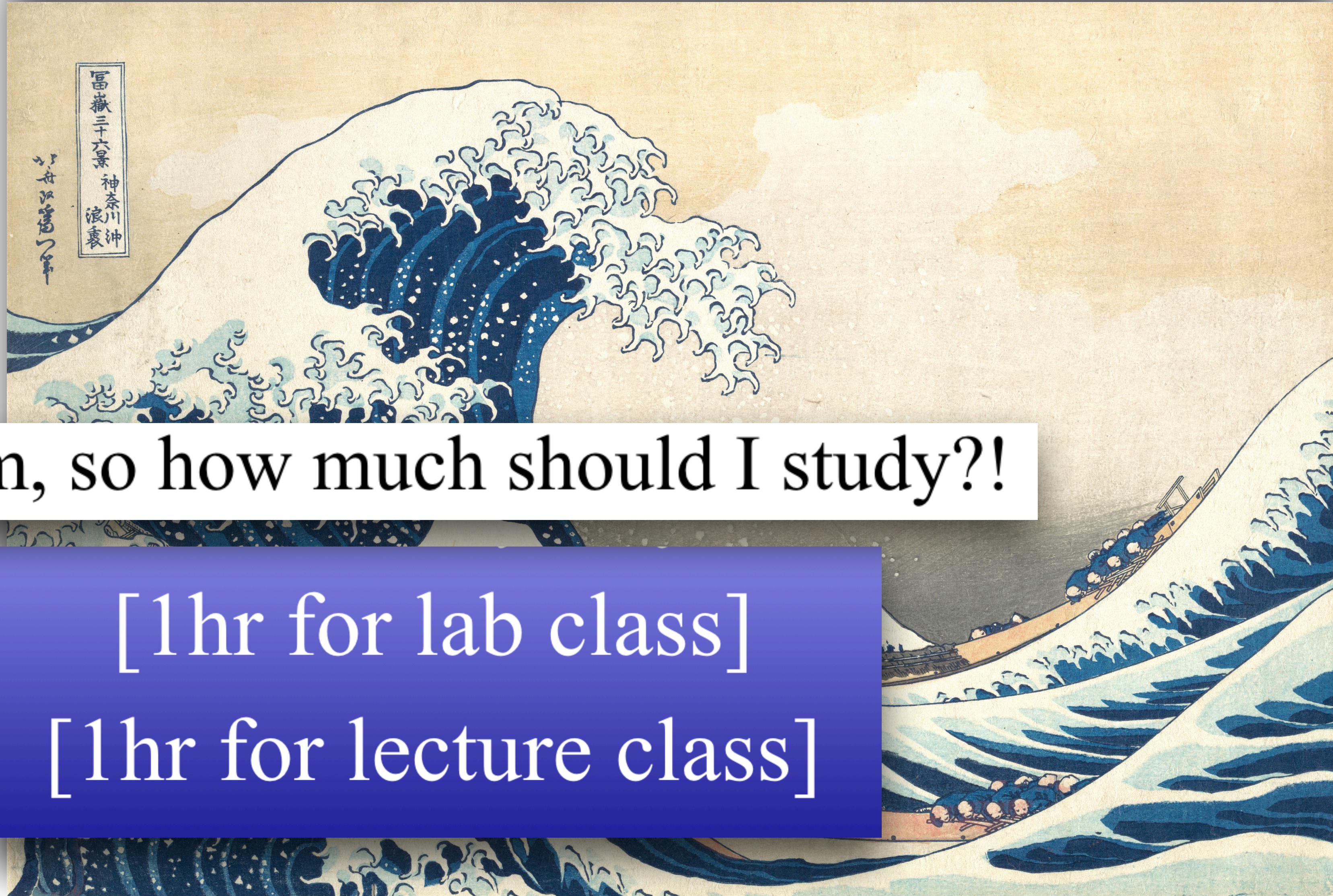


LB145 is a 5-credit course comprised of two classes you must take together. The Carnegie Institute established 2-3hrs per week of outside study per credit hour for all courses offered at all top universities. This is the standard all AAU elite Big Ten universities adhere to and MSU is extremely proud of both its membership in the Big Ten as well as its AAU elite status.



Katsushika Hokusai, The Great Wave off Kanagawa (Kanagawa oki nami ura), from the series Thirty-six Views of Mount Fuji (Fugaku sanjurokkei), (c. 1830–32), Metropolitan Museum of Art, New York, polychrome woodblock print, (25.7 x 37.9 cm). Photo: [The Metropolitan Museum of Art](#).

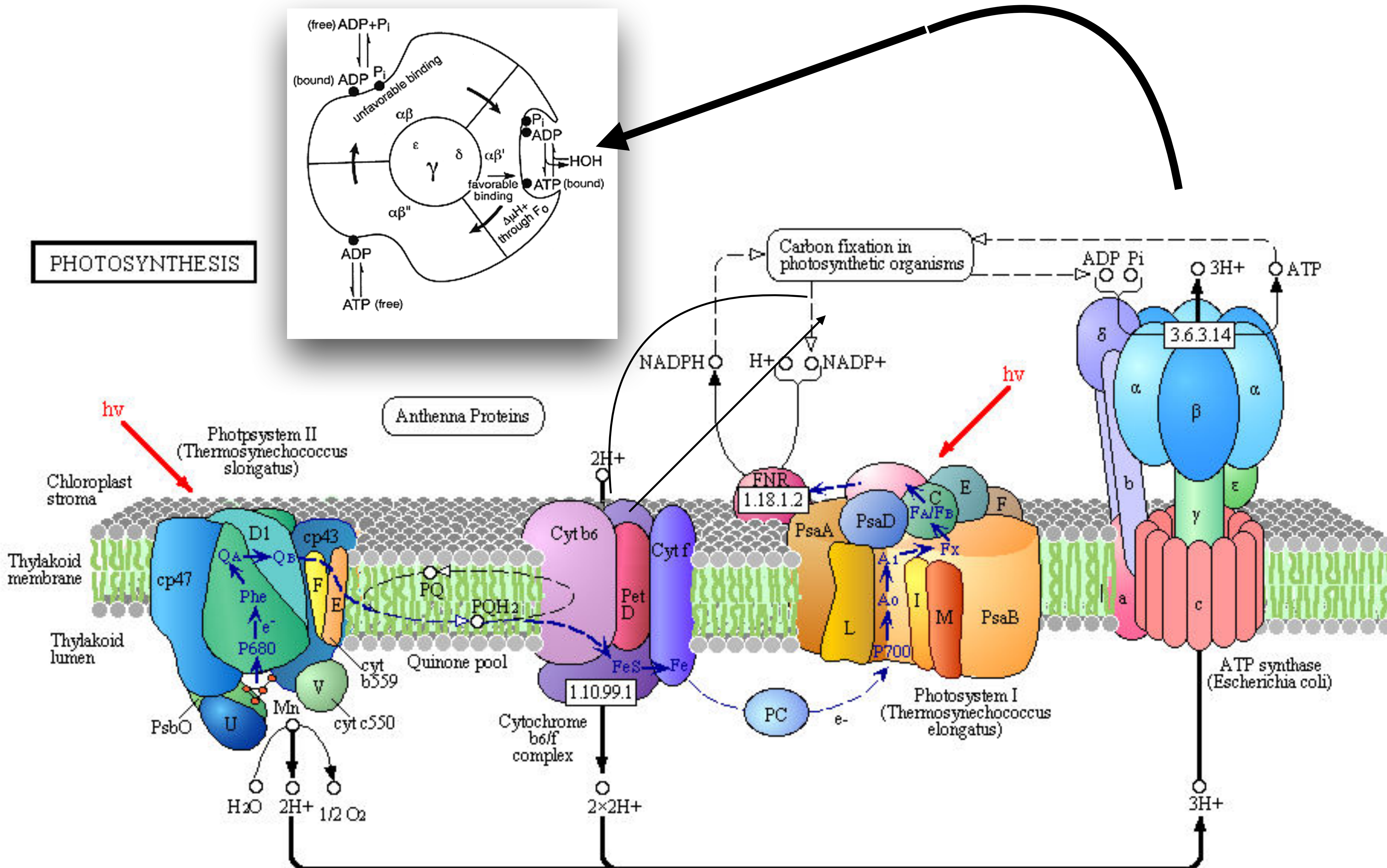
LB145 is two courses



Umm, so how much should I study?!

[1hr for lab class]
[1hr for lecture class]

Images of "Xmas future"



(Preparing for) **Wednesday's lecture:**

Budgeting homework time (60 min): Photosynthesis (OSB) section 8.3 is 1573 words in length, and does not have many figures. This should take 13 minutes if you just read it. But the video is 12 minutes and when done properly, when you pause to review figures and take careful notes, this assignment should take you more like 60 minutes.

1. _____ **For Wednesday's lecture**, read section 8.3 "Using Light Energy to Make Organic Molecules" (**1573 words**) in the chapter Photosynthesis (OSB) and take handwritten notes.
2. _____ (flipped classroom) Watch the **12min lecture by Mr. Andersen** provided where he gives quickly reviews Photosynthesis. Add to your notes any interesting points he makes that helped you better understand the parts of the cell and what they do.
3. _____ (Tip): While reading, focus mostly and take notes regarding **Figures 1, and 2**. We will discuss these in class.
4. _____ **Advanced**: Take a sneak peek at "Chapter 11: Photosynthesis", section 11.1, in particular study Figures 11.4.

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~~***~~ Evo Life (cont)

Ch. 8 section 8.3 Photosynthesis (OSB) (Fig 1+2 focus)

→ Using light energy to make organic molecules

L.O.s

- Describe the Calvin Cycle
- Define carbon fixation
- Explain how PHS works in the energy cycle of all living organisms

After sun photons become NADPH + ATP long term storage is needed next. (live millionths of seconds) → CHO/wood. CO₂ made into

Anatomy CO₂ → stomata → inside leaf → mesophyll cells → stroma of chloroplast.

names: "light-independent rxns of PHS" = "Calvin Cycle" = "Calvin-Benson cycle" = "dark rxns" = "PCR" = "Photosynthetic Carbon Reduction".

Mr Andersen → 15min movie.

Figure 1 - Light rxns + Calvin all together (illustration)

Phase Stage 1: Calvin - Fixation, reduction, and regeneration.

Carbon Fixation - 3 RuBP (5c) + 3 CO₂ (3c) → 6C(6) → 6 3-PGAs (3c)

rubisco enzyme
ribulose 1,5 bisphosphate carboxylase

Figure 2 - Calvin Cycle diagram

Phase Stage 2: Reduction - the energy/electrons temporarily stored in ATP + NADPH is transferred (in two steps) to 3-PGA → 6, 3-BisPGA → 6 3P (reduced) G3P (enzyme) dehydrogenase (enzyme) more e⁻s now!

Phase Stage 3: Regeneration - 1 G3P departs → sucrose + starch CHO/wood. 5 G3Ps (3 each) → 3 RuBPs (5 each) 3ATP → ADP

PG kinase (enzyme)

→ Calvin cycle hmi / BioInteractive simulation ← Cool! (longish)

Evolution connection Respiration breaks down CHO → ATP
Photorespiration CO₂ ↑ ↓ CO₂ → Rubisco O₂

→ Over time shift occurred from bacterial anoxygenic PHS (PSI cycling only) into modern oxygenic PHS (makes O₂ both PSI+II) fix

→ To conserve water, plants in the desert, cactus, at night, CAM night fix CO₂, C4 - bundle sheath cells, do collect CO₂ at night, stomata open

8.3 Using Light Energy to Make Organic Molecules

Summary: By the end of this section, you will be able to:

- Describe the Calvin cycle
- Define carbon fixation
- Explain how photosynthesis works in the energy cycle of all living organisms

After the energy from the sun is converted into chemical energy and temporarily stored in ATP and NADPH molecules, the cell has the fuel molecules for long-term energy storage. The products of the light-dependent reactions, ATP and NADPH, have lifespans in the range of milliseconds. The products of the light-independent reactions (carbohydrates and other forms of reduced carbon) can survive for hundreds of millions of years. All organic molecules will have a backbone of carbon atoms. Where does the carbon come from? It comes from carbon dioxide, the gas that is a waste product of respiration in plants and animals.

The Calvin Cycle

In plants, carbon dioxide (CO_2) enters the leaves through stomata, where it diffuses over short distances through intercellular spaces until it reaches the mesophyll cells. Once in the mesophyll cells, CO_2 diffuses into the stroma of the chloroplast—the site of light-independent reactions of photosynthesis. These reactions actually have several names associated with them. Another term, the **Calvin cycle**, is named for the man who discovered it, and because these reactions function as a cycle. Others call it the Calvin-Benson cycle to include the name of another scientist involved in its discovery. The most outdated name is dark reactions, because light is not directly required (**Figure 1**). However, the term dark reaction can be misleading because it implies incorrectly that the reaction only occurs at night or is independent of light, which is why most scientists and instructors no longer use it.

Link to Learning:

Video: The process of photosynthesis by which plants and algae can convert carbon dioxide into useable sugar.



8.1 Overview of Photosynthesis

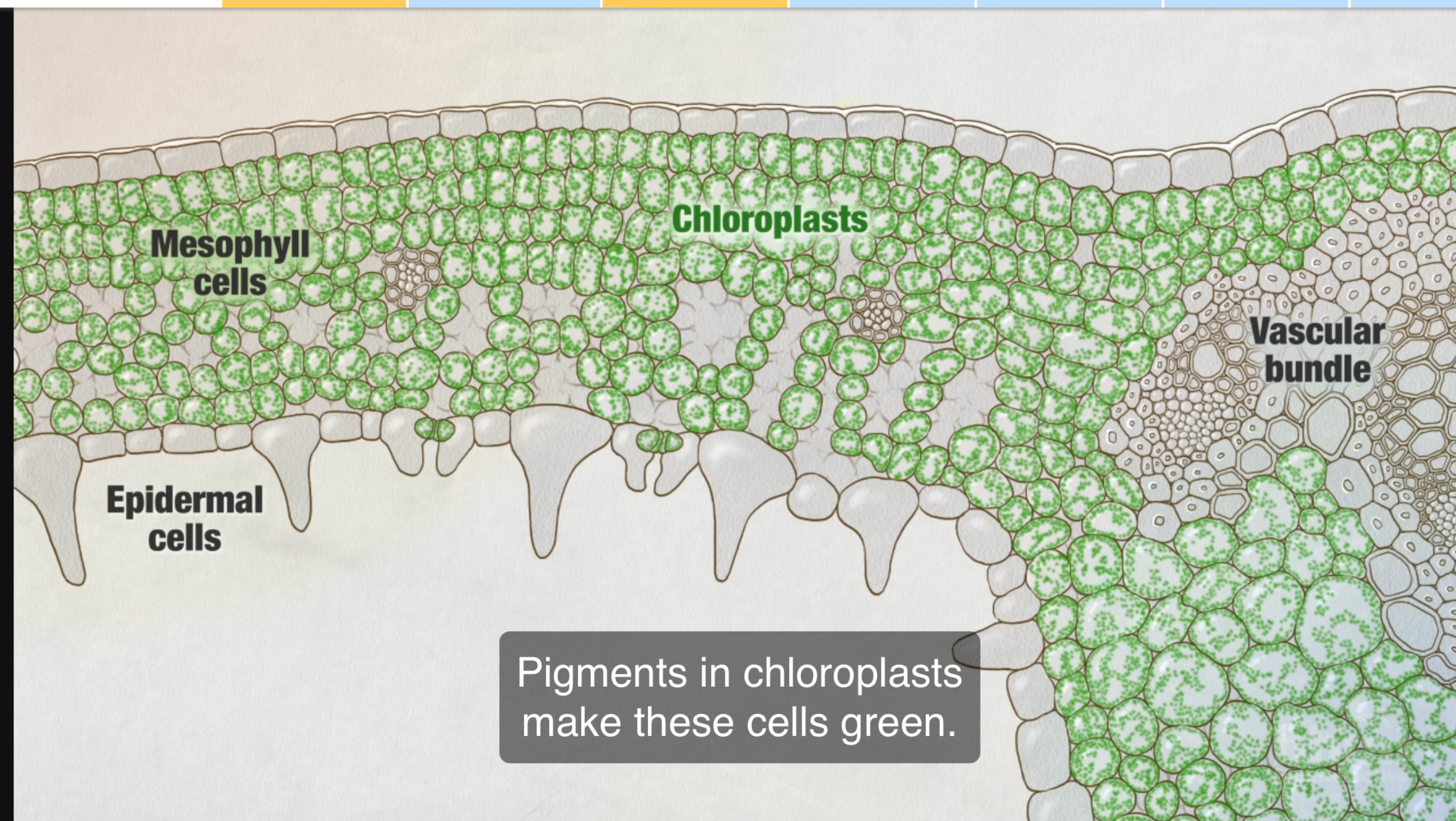
Quiz Me 8.1 > Overview of Photosynthesis

8.2 The Light-Dependent Reactions of Photosynthesis

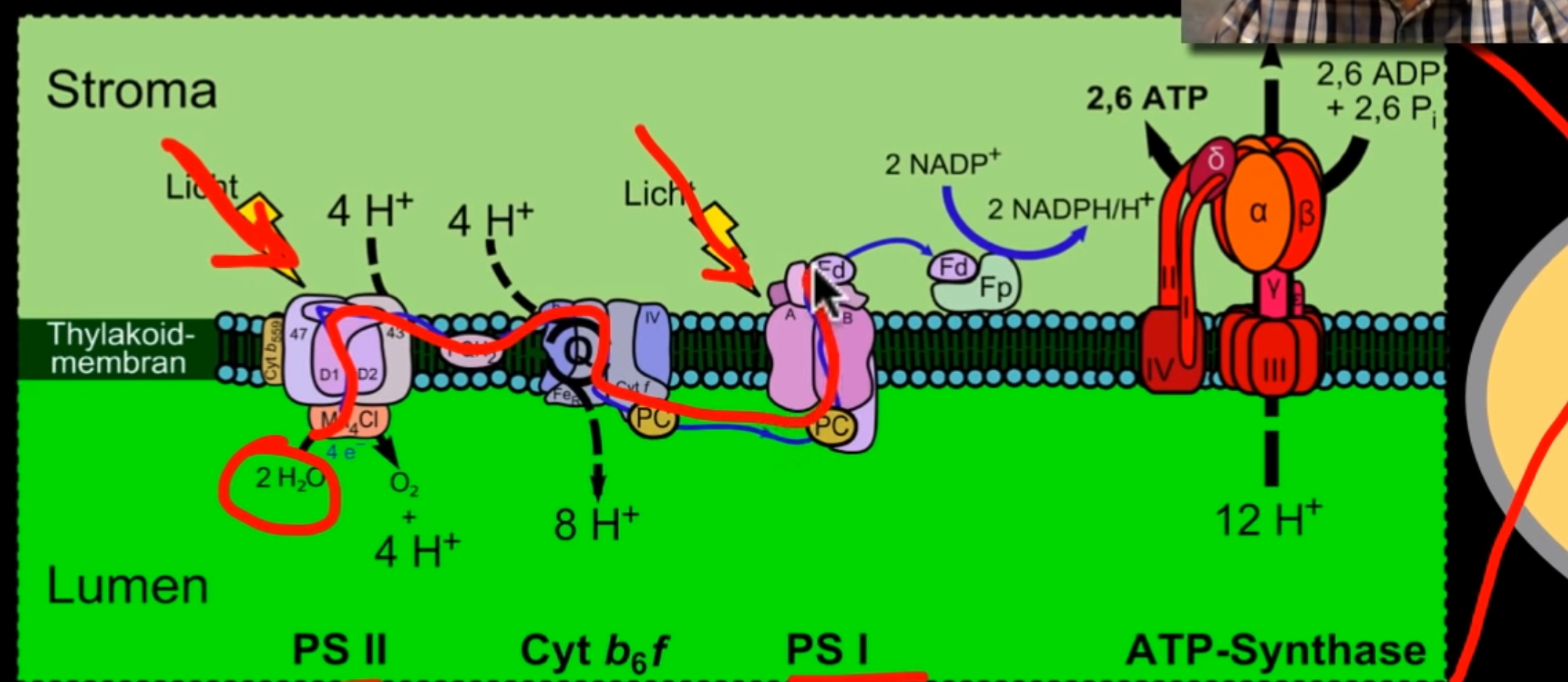
Quiz Me 8.2 > The Light-Dependent Reactions of Photosynthesis

8.3 Using Light Energy to Make Organic Molecules

Quiz Me 8.3 > Using Light Energy to Make Organic Molecules

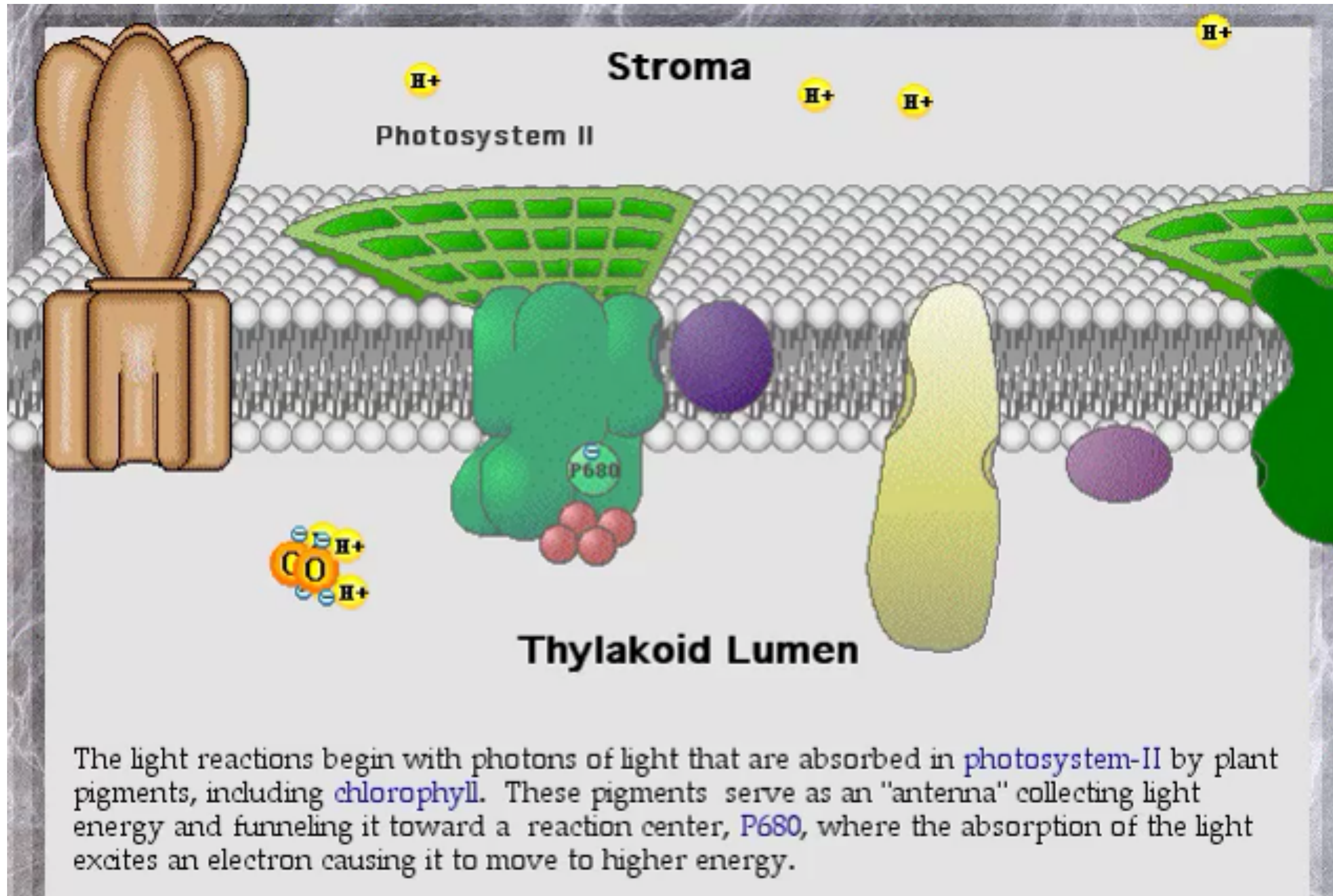


Pigments in chloroplasts make these cells green.



through an electron transport chain. So that electron is going through proteins, carrier

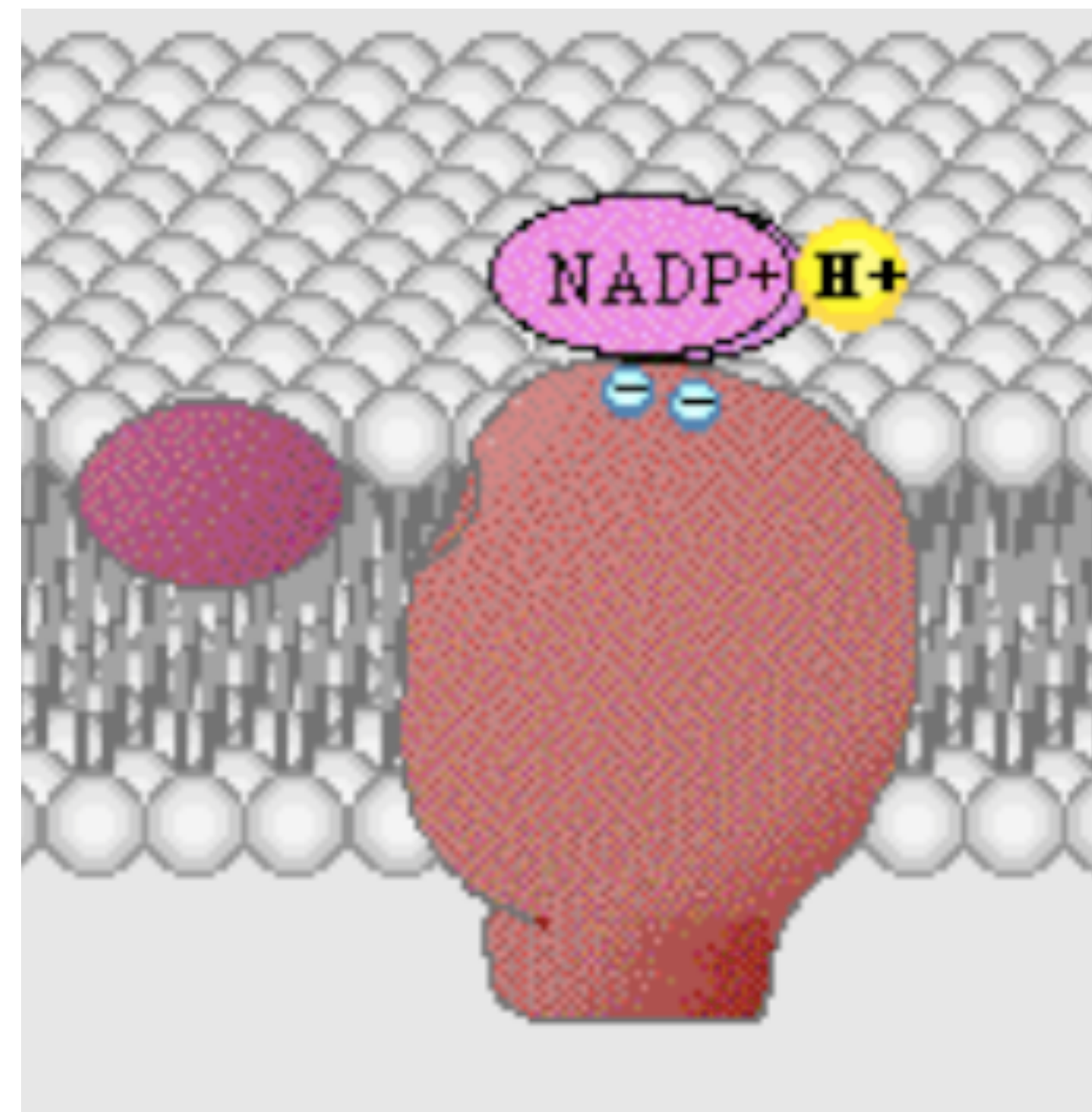
Emailed to expect a quiz on this and be prepared to act out in class



“4-minute Pop Quiz”: **Reward** for those who prepared.
(4 questions, 60 seconds each)

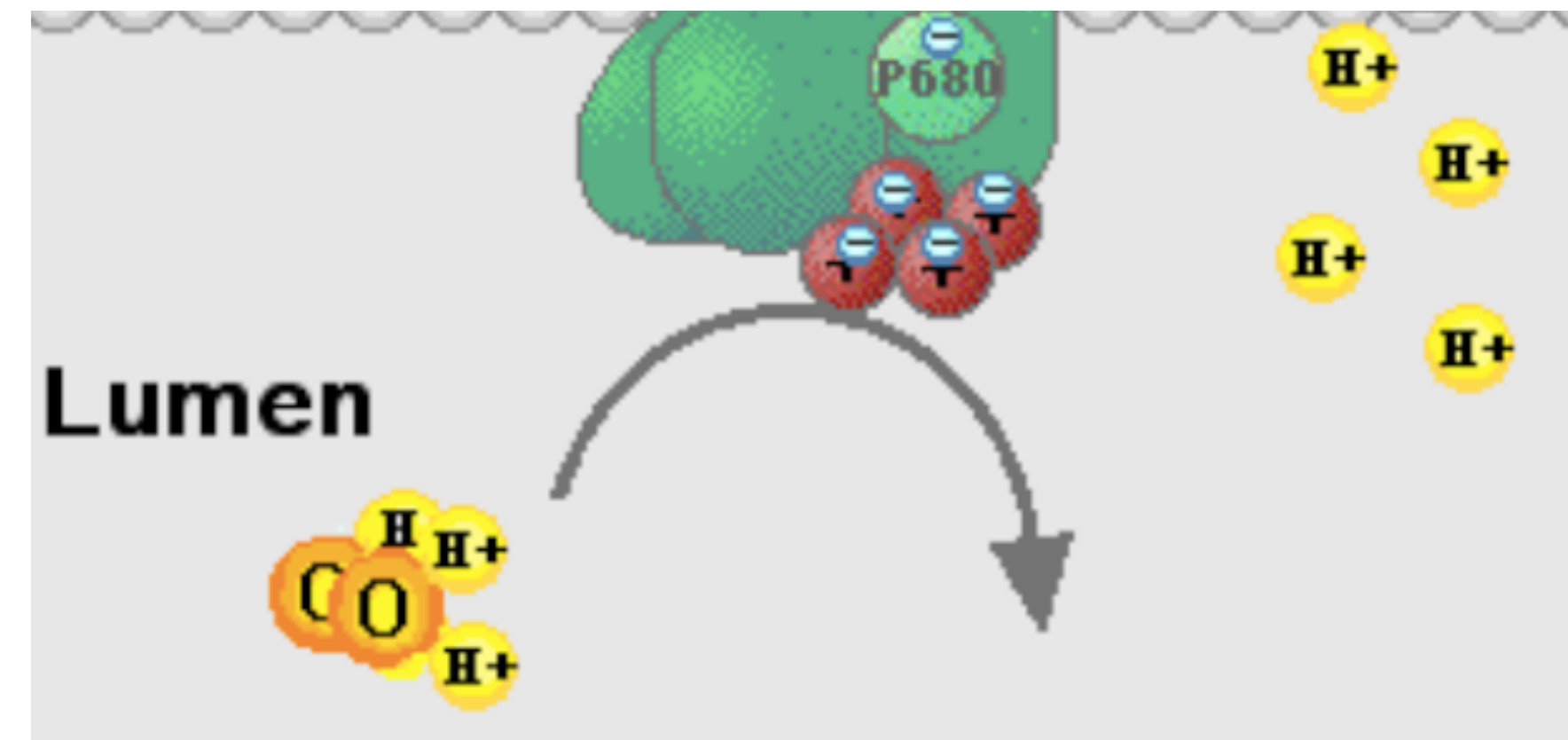
What is the name of this red enzyme that brings electrons, NADP^+ and H^+ together?

- A. Taq polymerase
- B. Plastoquinone
- C. Cytochrome
- D. NADPH synthase
- E. None of the above



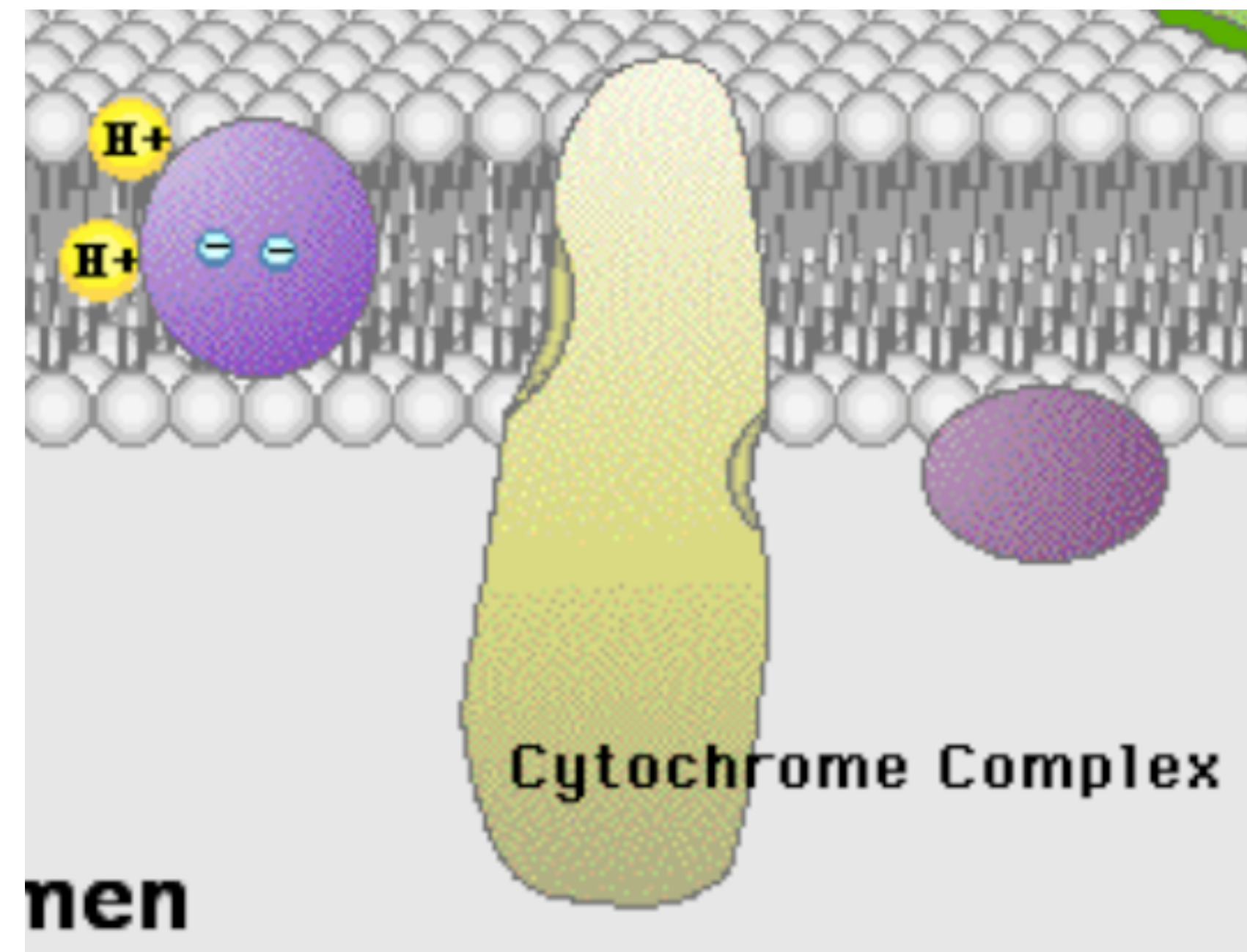
What role do H₂O molecules play in Photosynthesis light reactions?

- A. Keeping pH neutral
- B. Providing electrons
- C. Providing protons
- D. Preventing dryness
- E. Serving as a base



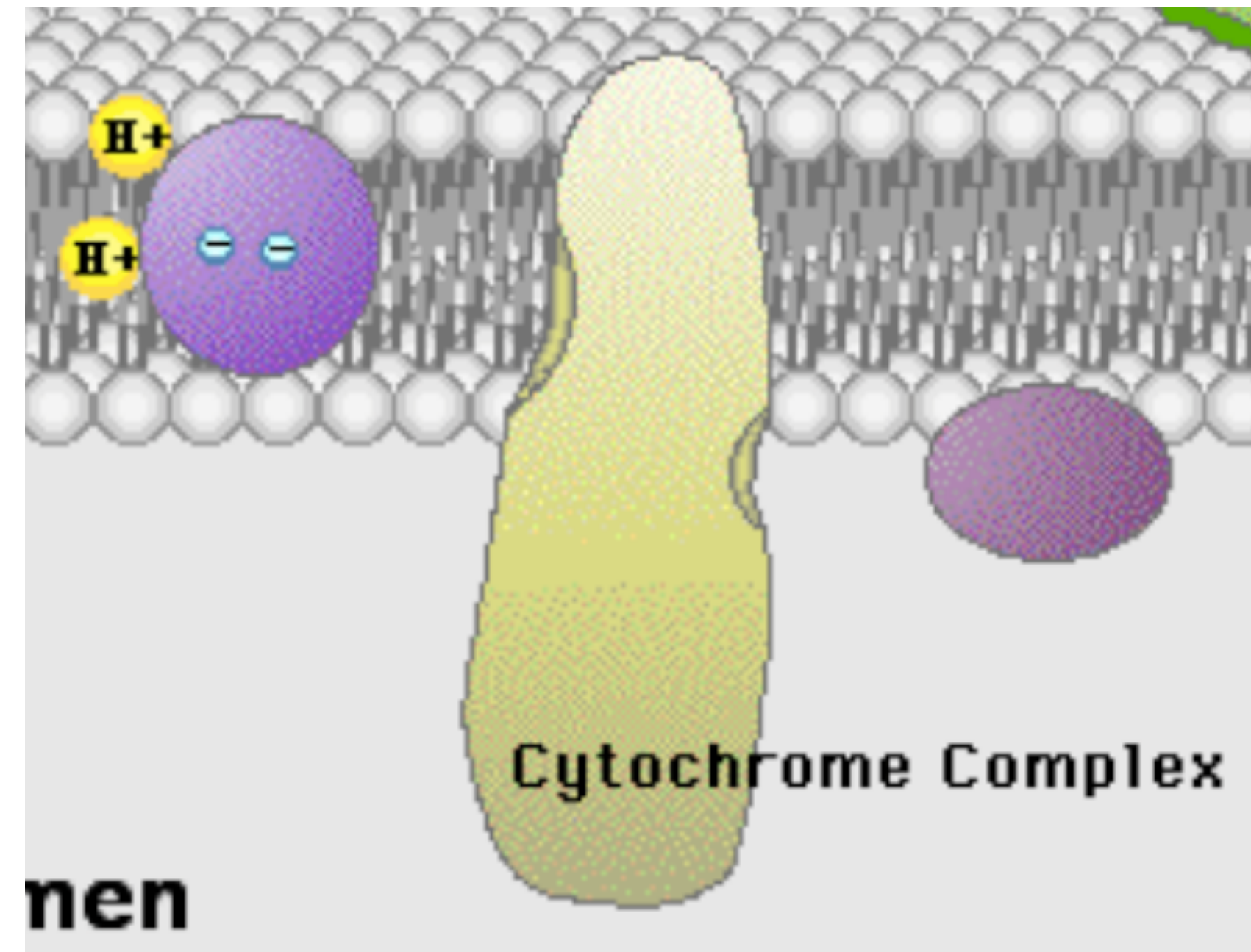
What is the name of the purple carrier with electrons and protons below?

- A. Photosystem
- B. Plastoquinone
- C. Cytochrome
- D. NADP⁺ reductase
- E. ATP synthase



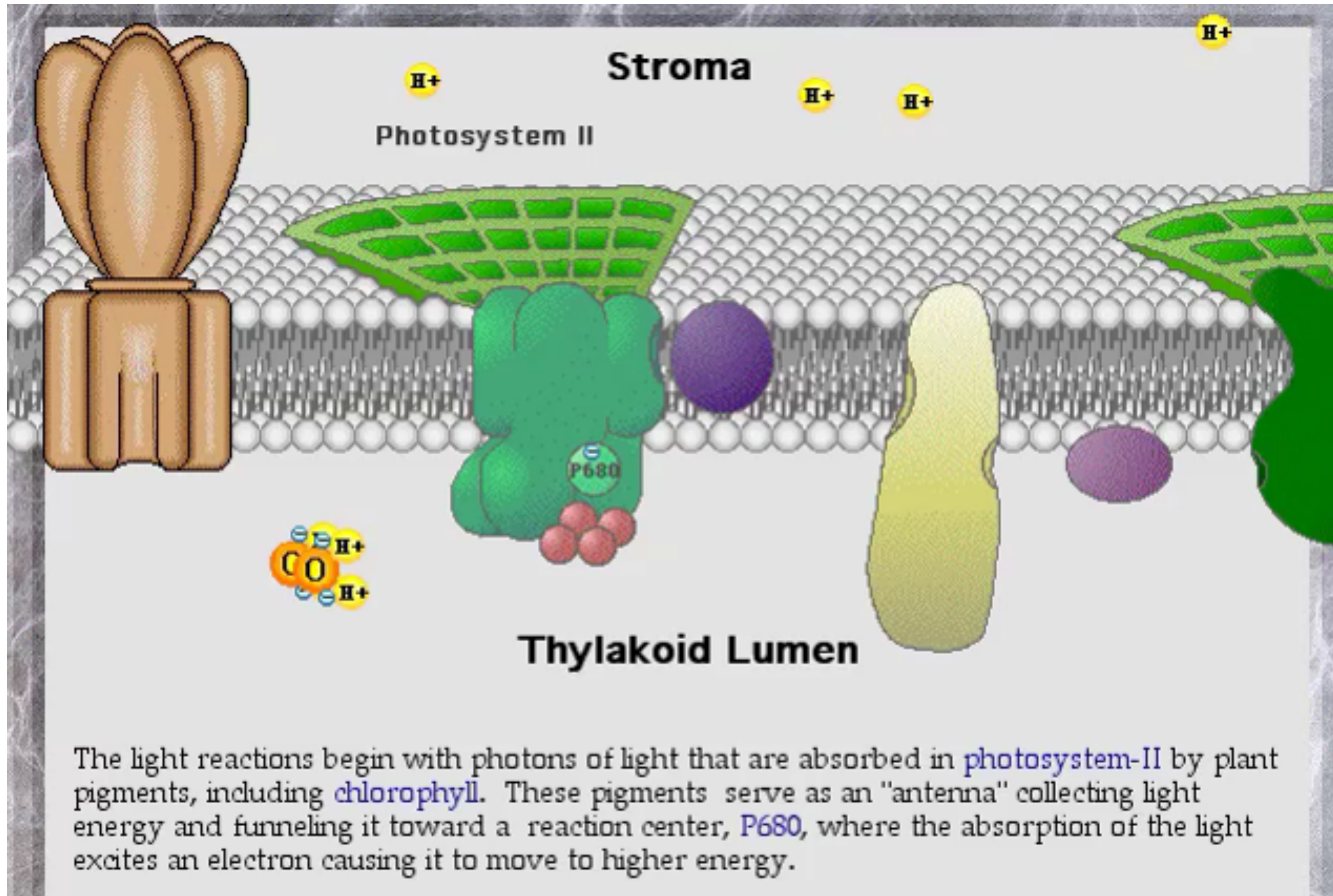
What is the function of the purple carrier with electrons and protons below?

- A. carry electrons
- B. pump protons
- C. catch photons
- D. make ATP
- E. make NADPH

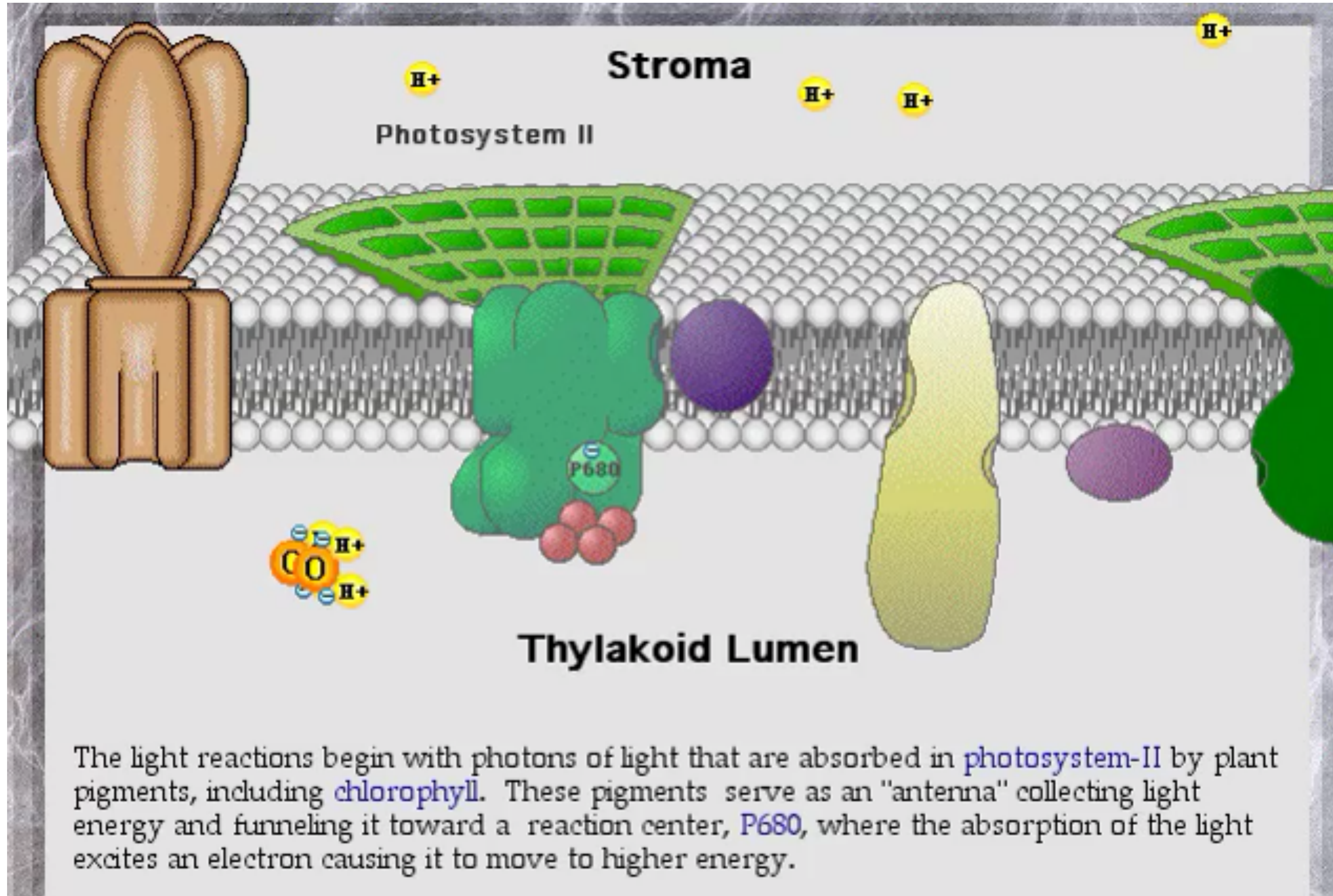


“4-minute Pop Quiz”: **Reward** for those who prepared.
(NOW OVER)

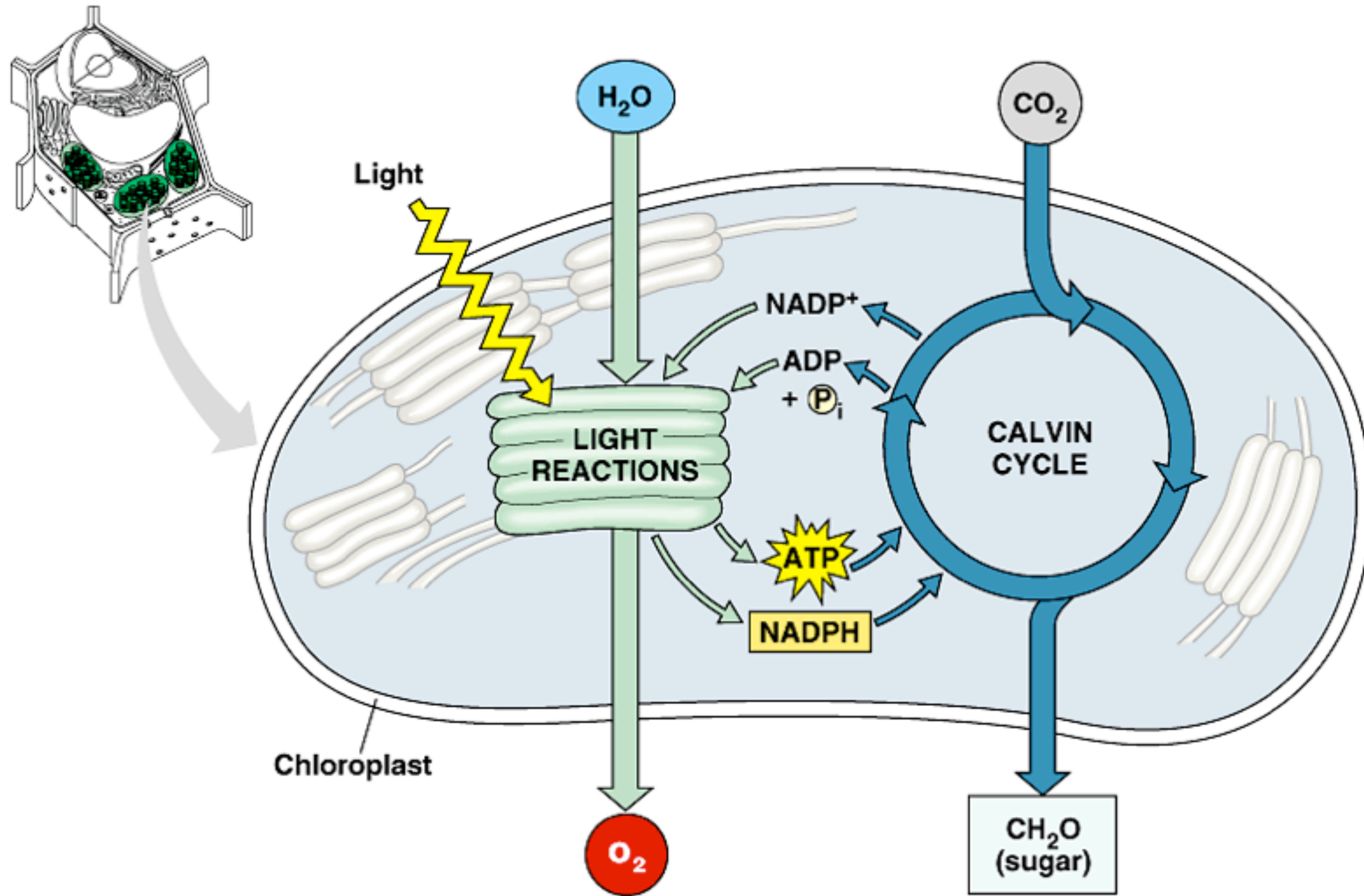
Emailed to expect a quiz on this and be prepared to act out in class



Biology Theater!



A crystal ball:
A view of the future *for you?*



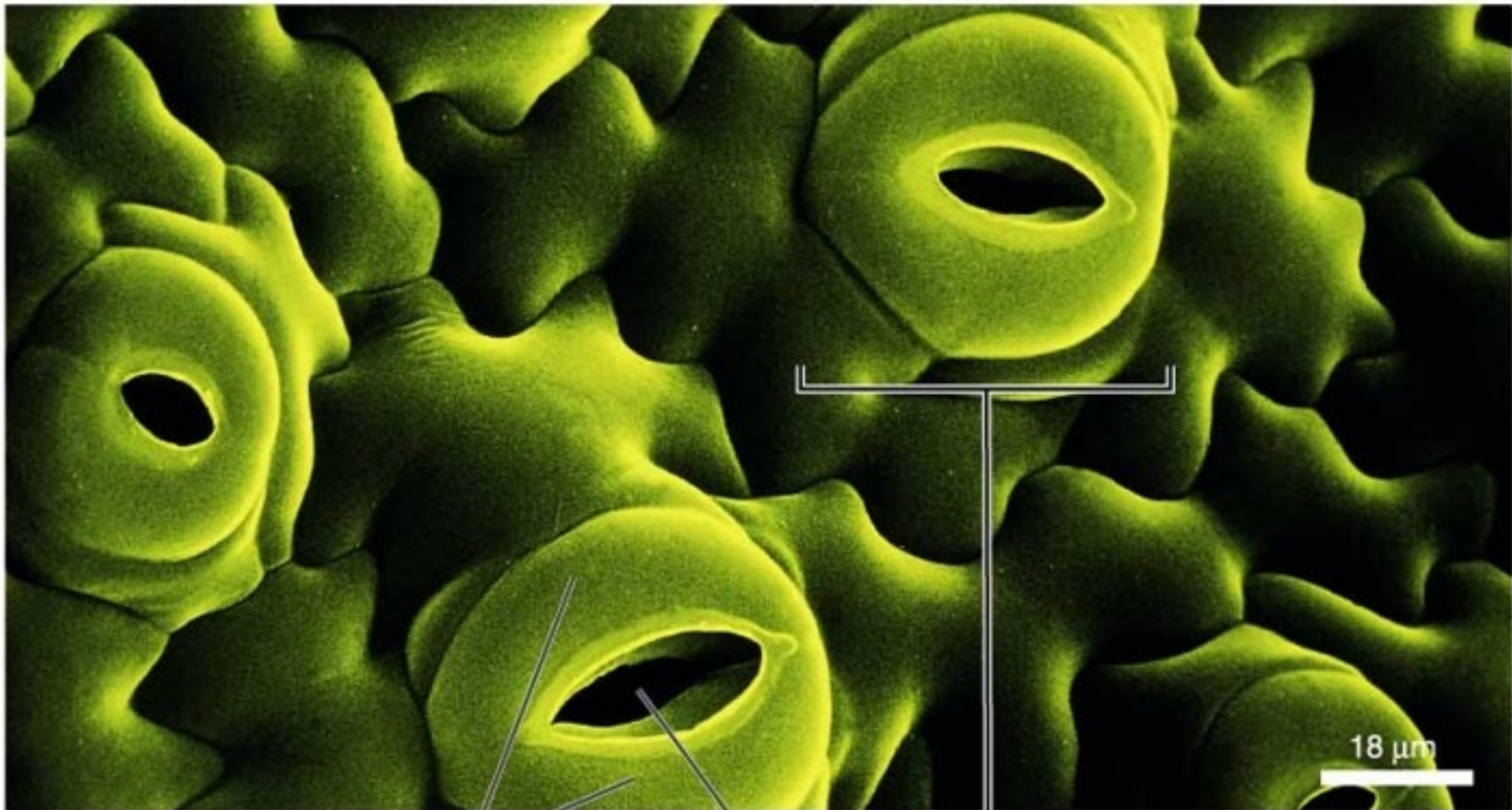
Where do plants get their 'food'...

C02

C02

C02

Thin Air...

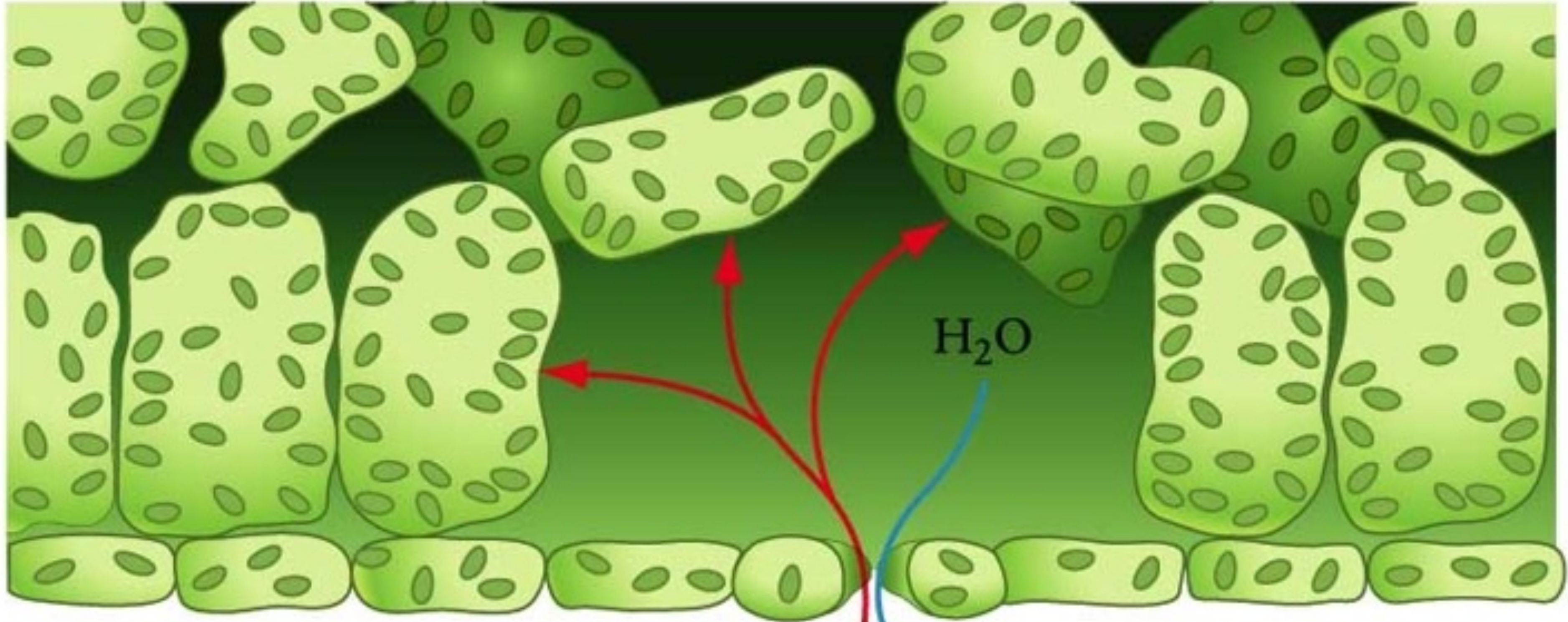


Guard cells

Pore

Stoma

18 μm

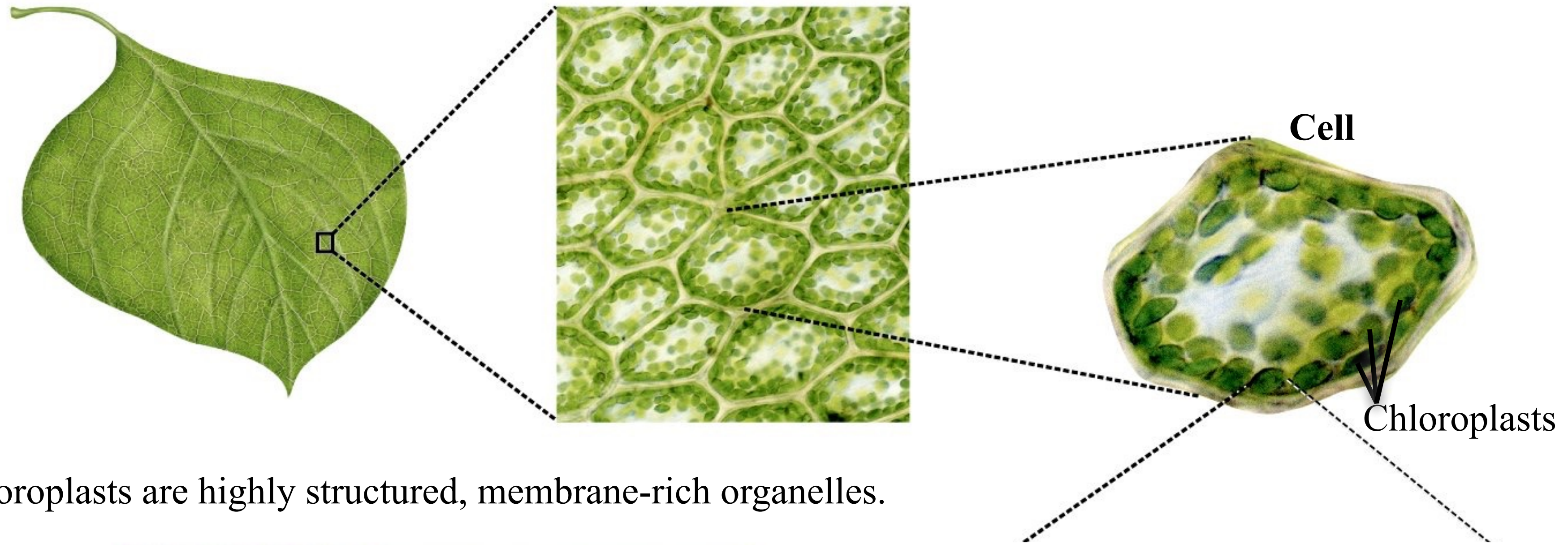


Leaf cross-section

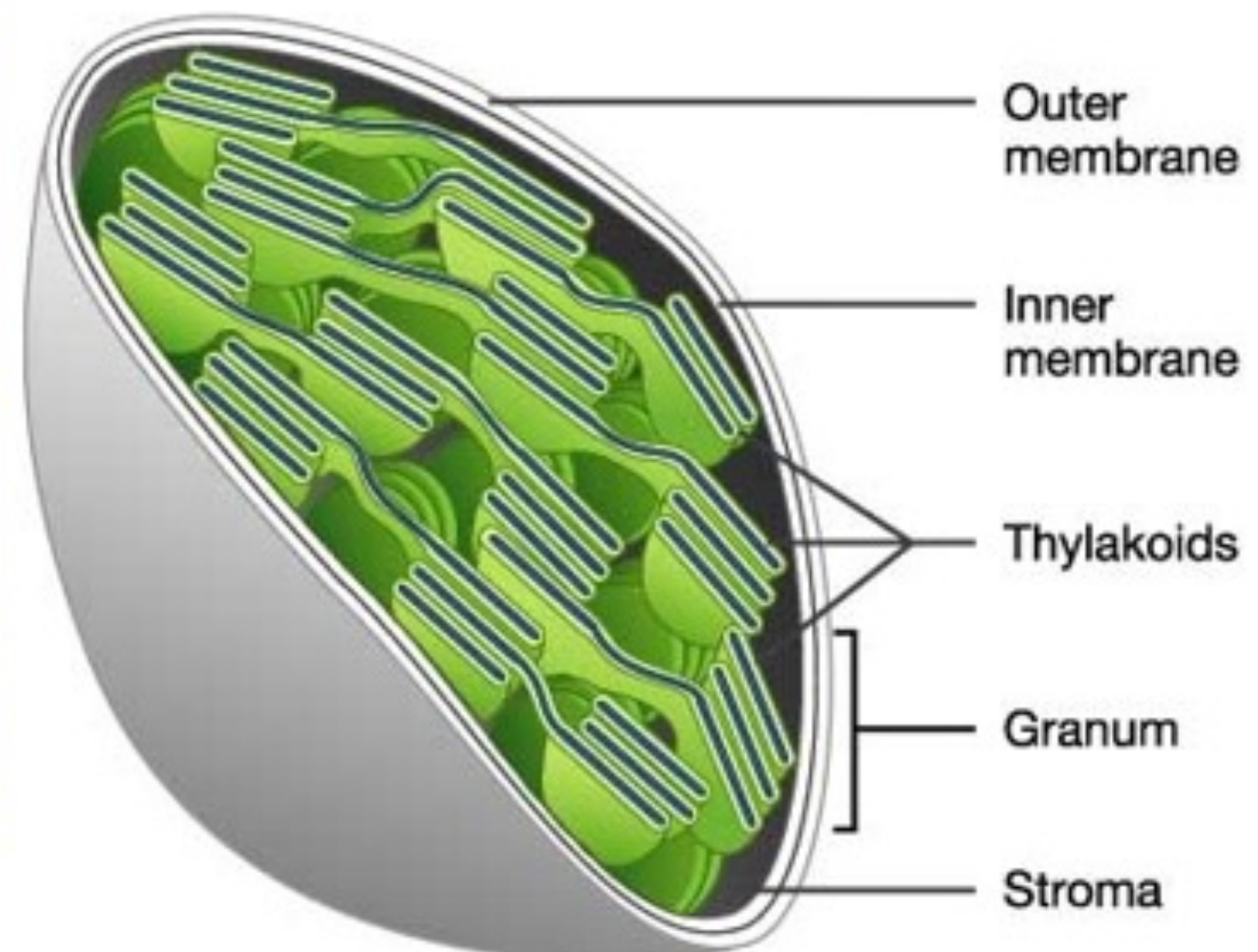
CO_2

H_2O

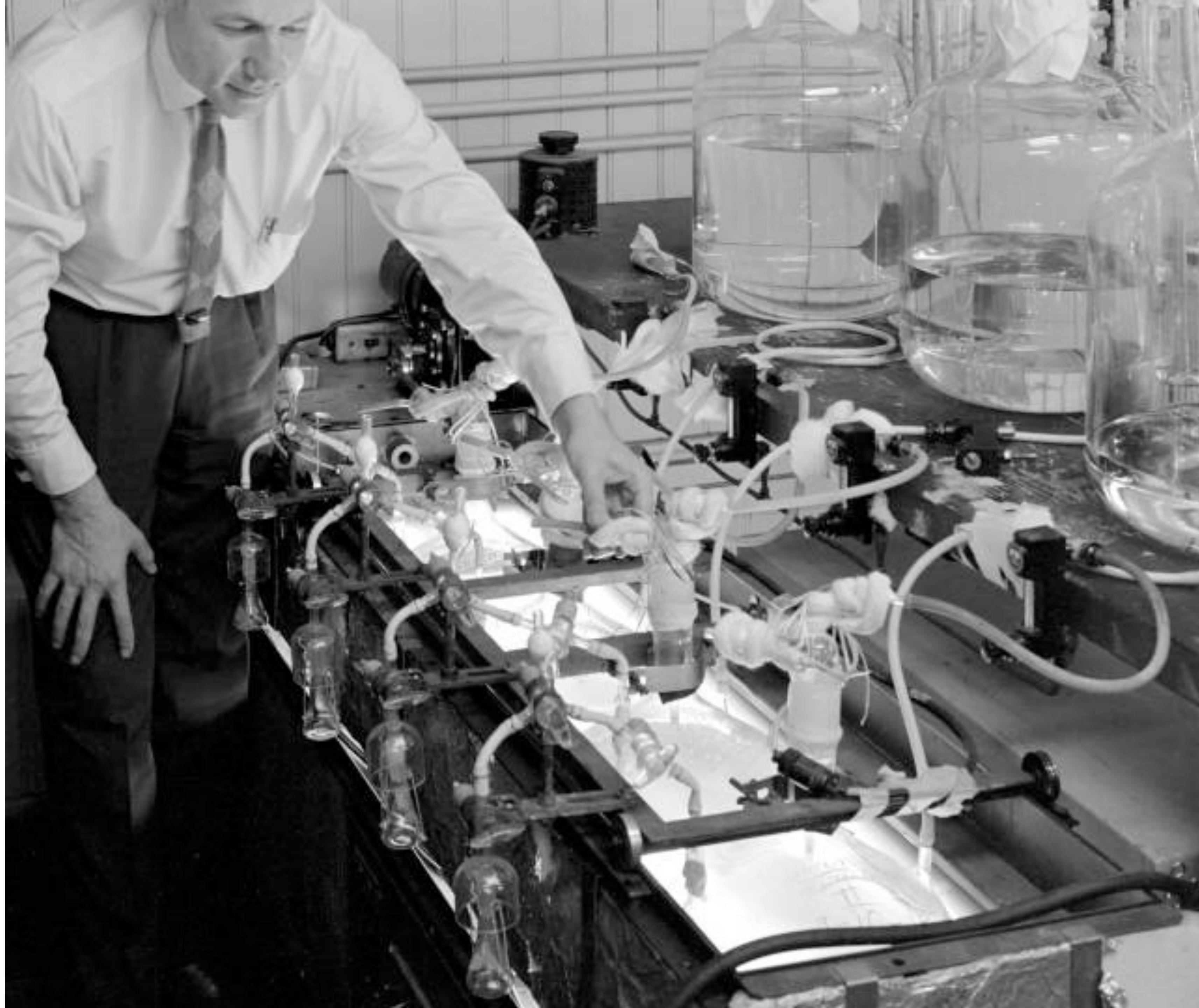
Leaves contain millions of chloroplasts.

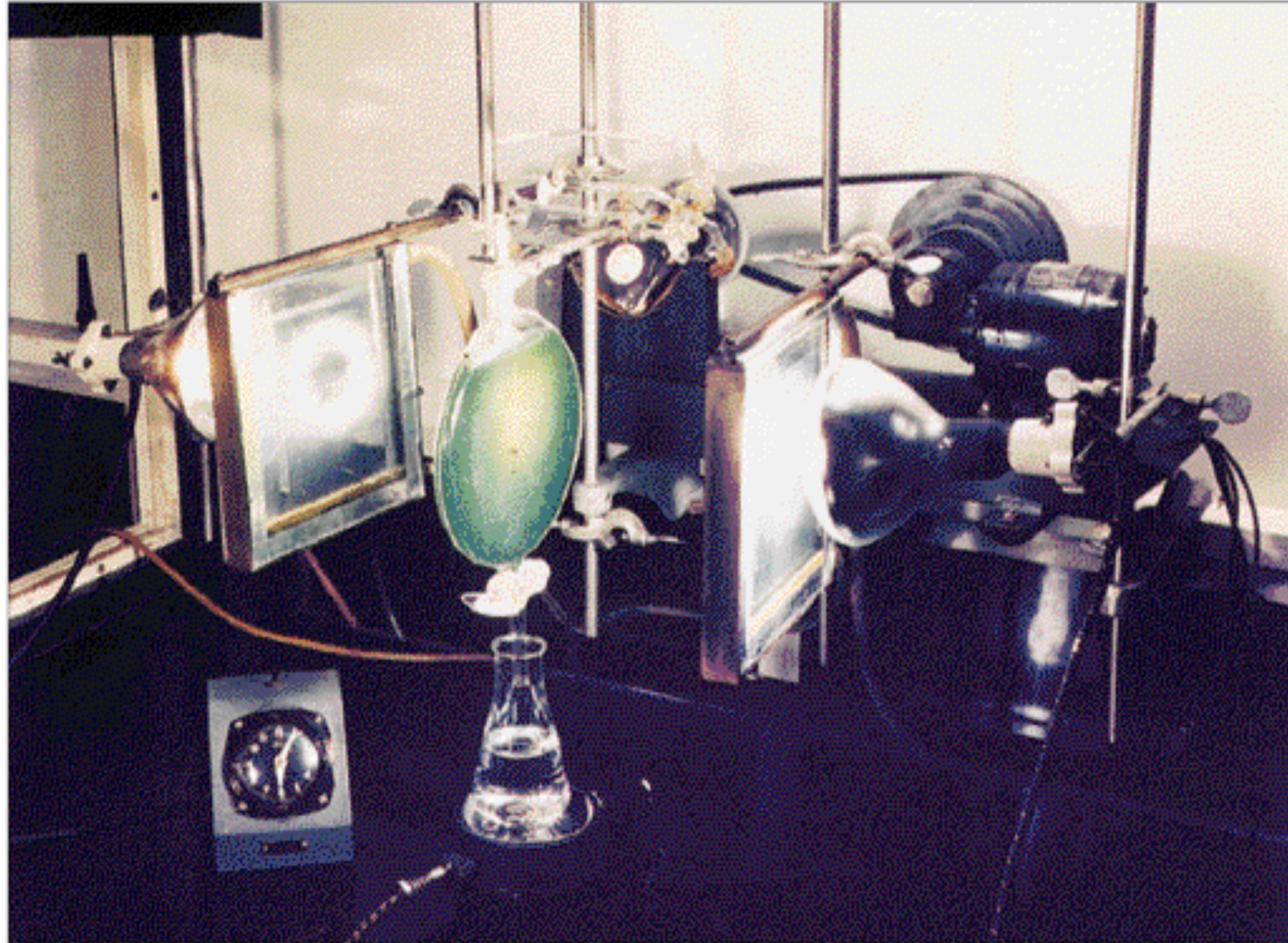


Chloroplasts are highly structured, membrane-rich organelles.



Who got the Nobel:
For discovering the steps of the
Calvin Cycle?





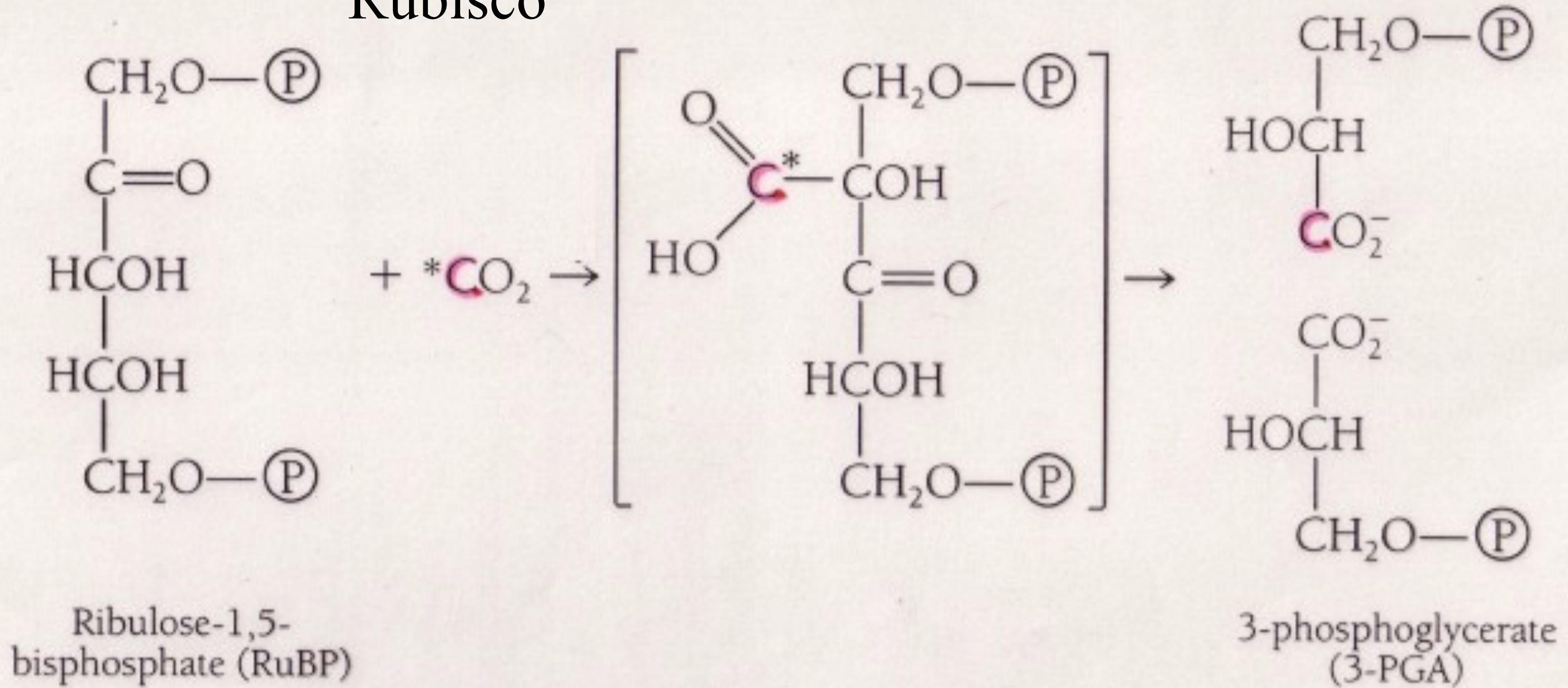
1. First **stable** product of Calvin Cycle

***C-C-C-P**

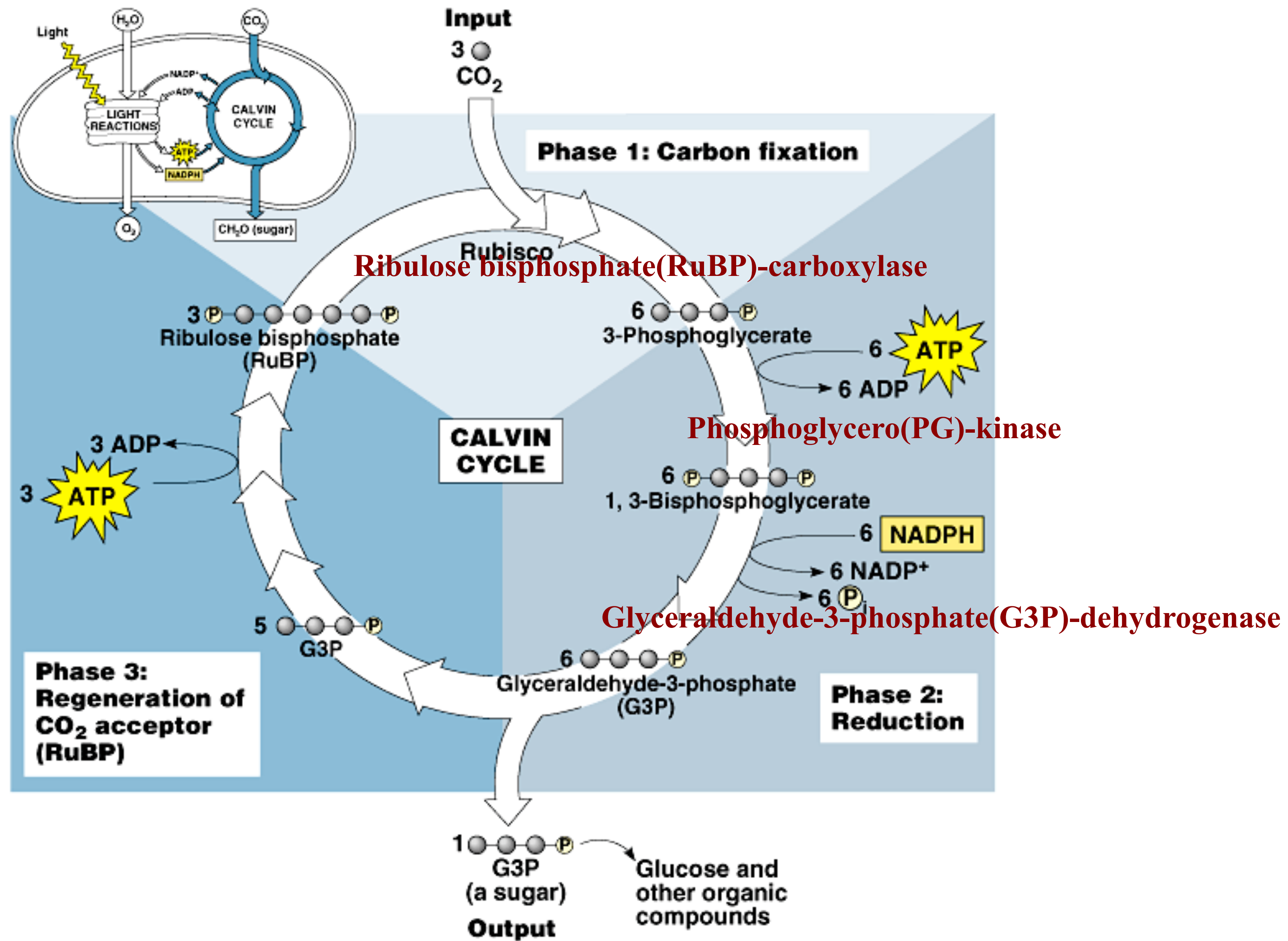
3-Phosphoglycerate (3-PGA)

Question: What size molecule was the radioactive **C**₋₁₄ likely attached to (fixed to)?

Rubisco

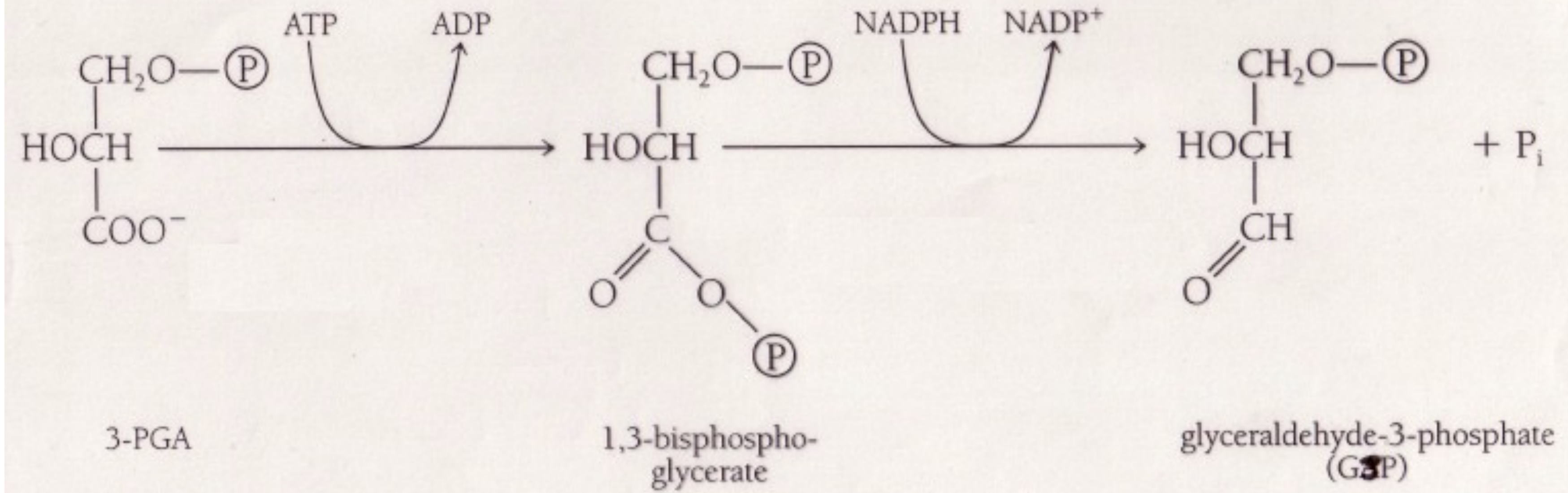


1. Fixation



PG kinase

G3P dehydrogenase



2. Reduction

