1. **Pick up** Name Folder

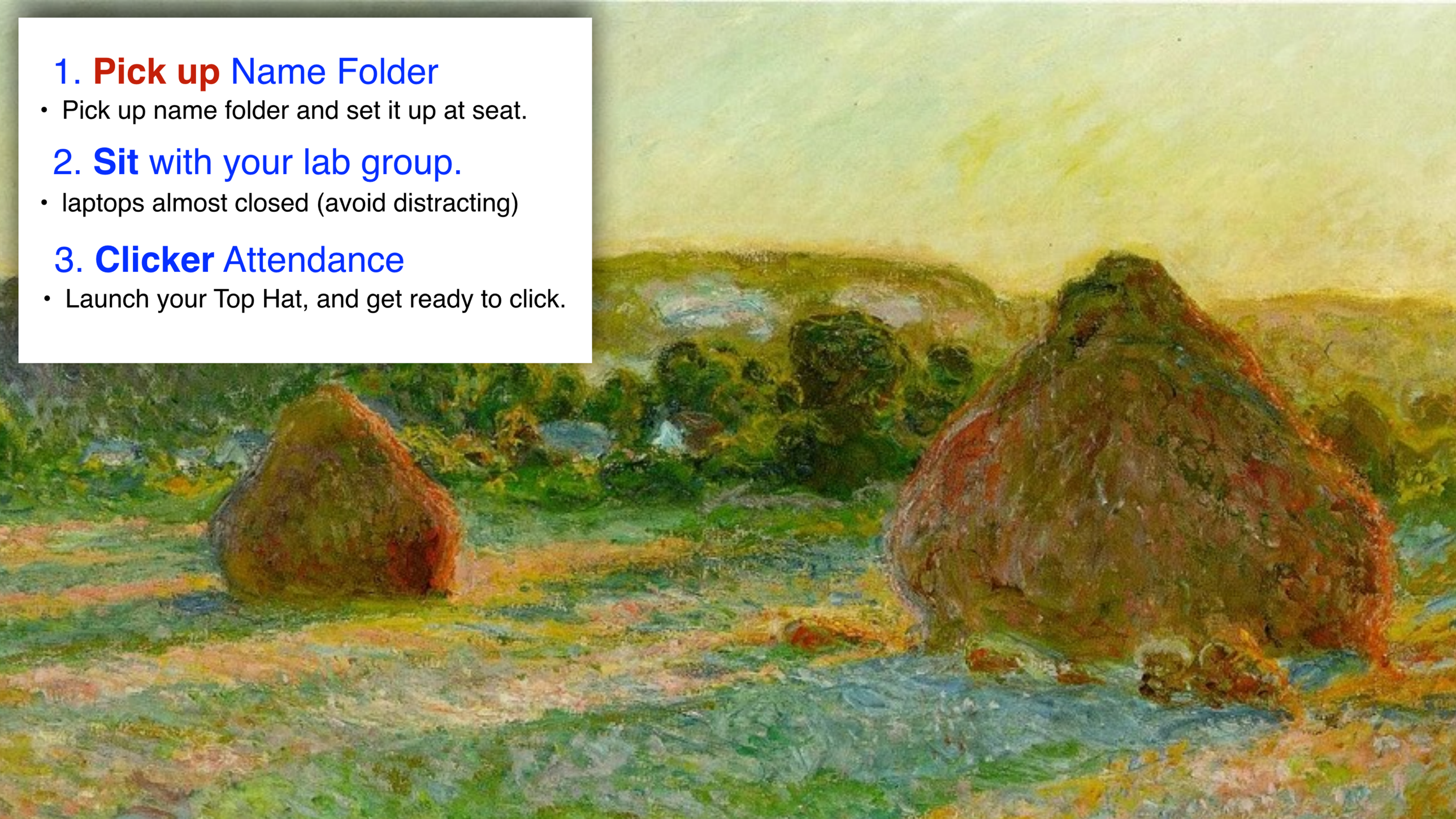
- Pick up name folder and set it up at seat.

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

- laptops almost closed (avoid distracting)

3. **Clicker** Attendance

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



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

Origin of Oxygen Gas

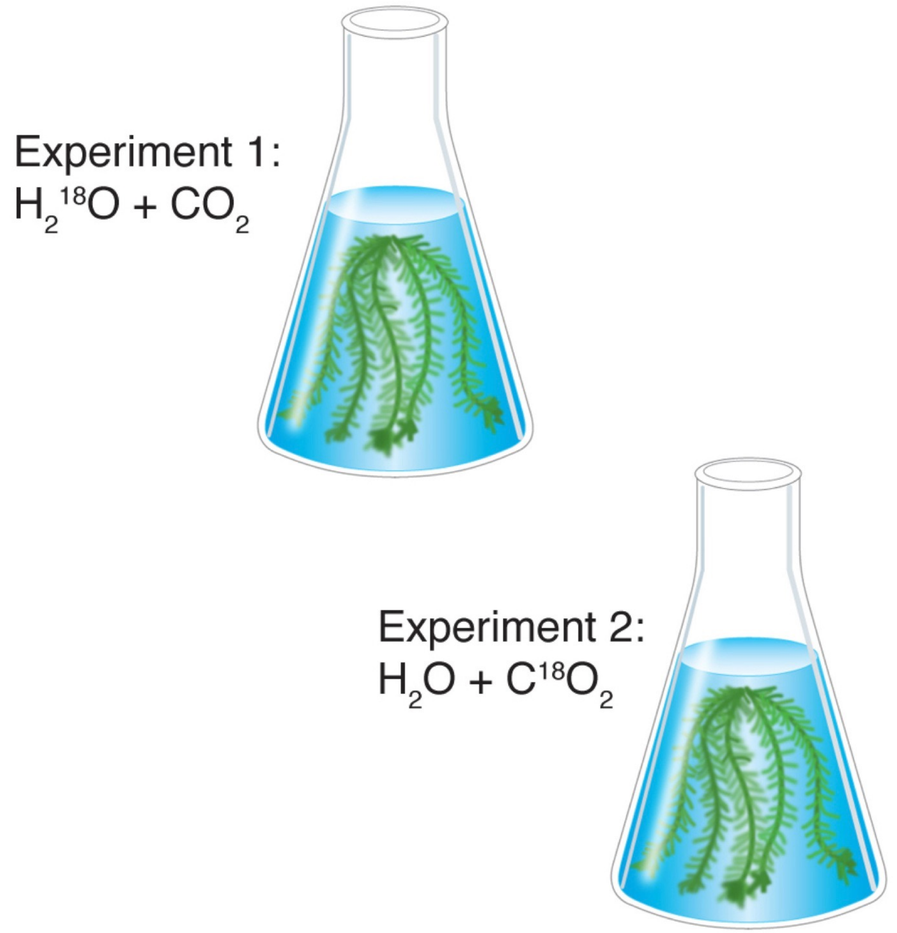
Which experiment will produce $^{18}O_2$?

a) experiment 1

b) experiment 2

c) both experiment 1 and experiment 2

d) neither



Which of the following statements is a **correct** distinction between autotrophs and heterotrophs?

a) Only heterotrophs require chemical compounds from the environment

b) Cellular respiration is unique to heterotrophs

c) Only heterotrophs have mitochondria

d) Autotrophs, but not heterotrophs, can nourish themselves beginning with CO_2

e) Only heterotrophs require oxygen

Question: Wavelengths of light absorbed by thylakoid pigments are mainly in what range ?

A. Green, which is why plants are green
B. The entire spectrum of white light
C. The range absorbed by carotenoids
D. Blue violet & red orange
E. The infrared

Photosynthesis and Biomass

The biomass (dry weight) of a tree comes primarily from

a) soil.

b) water.

c) air.

d) organic fertilizer (manure, detritus).

e) light.

Question: Which process is most *directly* driven by light energy?

A. creation of a pH gradient by pumping protons
B. carbon fixation in the stroma
C. reduction of $NADP^+$ molecules
D. removal of electrons from chlorophyll molecules
E. ATP synthesis

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


Laptops closed (unless TopHat)

Announcements

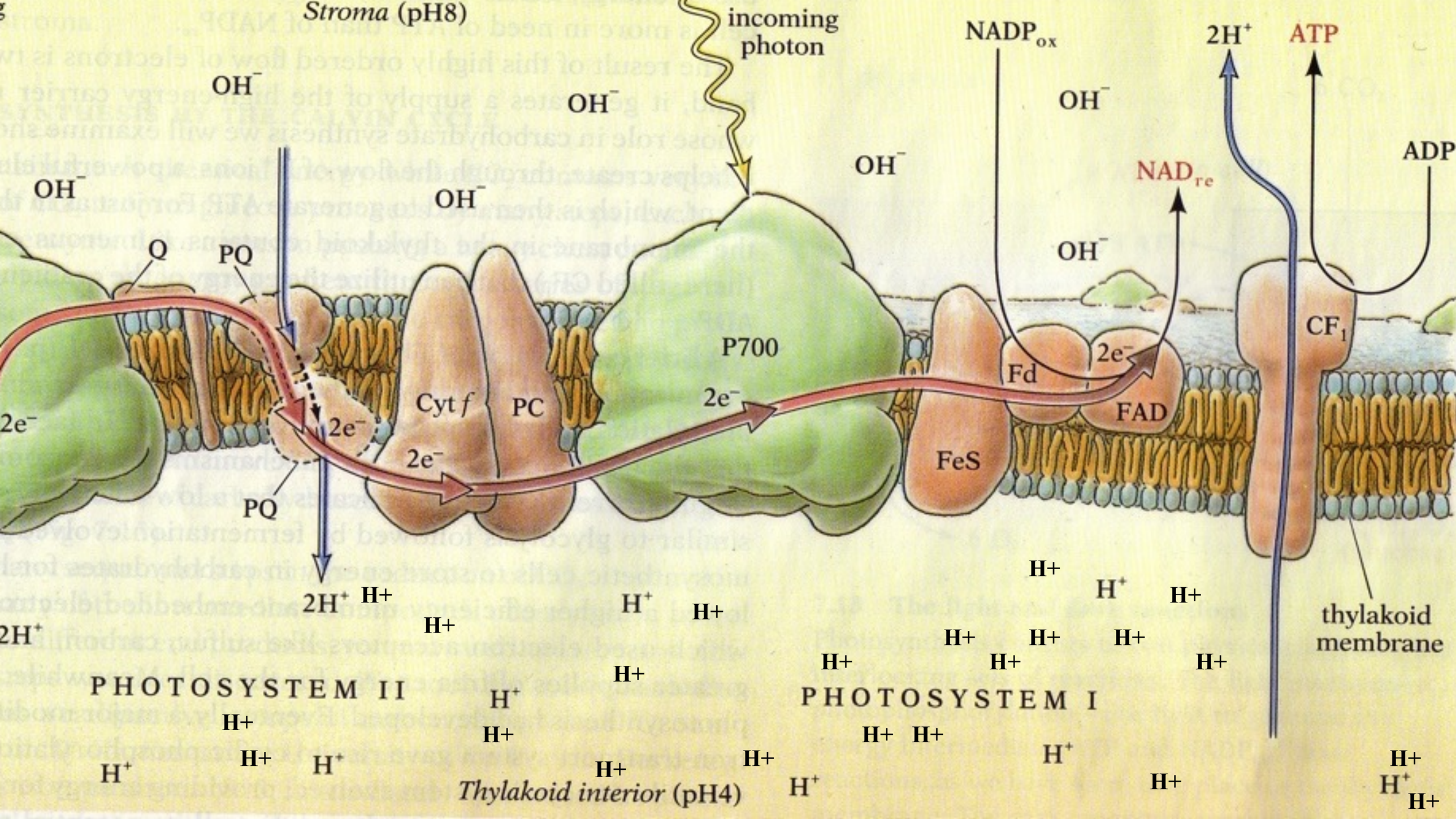
1. **8 red photons make how much ATP?**: 24 people completed the homework question for today, good job, some were brief others far more impressive...verbal final like this.
2. **DRAFT2 is next, so what part are you writing?**
3. **Write to scientist for sample CF DNA with your mutation yet?**
4. **Advice: Today is “comfort food”, is not an ICB reading with trifecta etc, it’s an old fashioned traditional lecture so take new notes to add to those from the reading.**

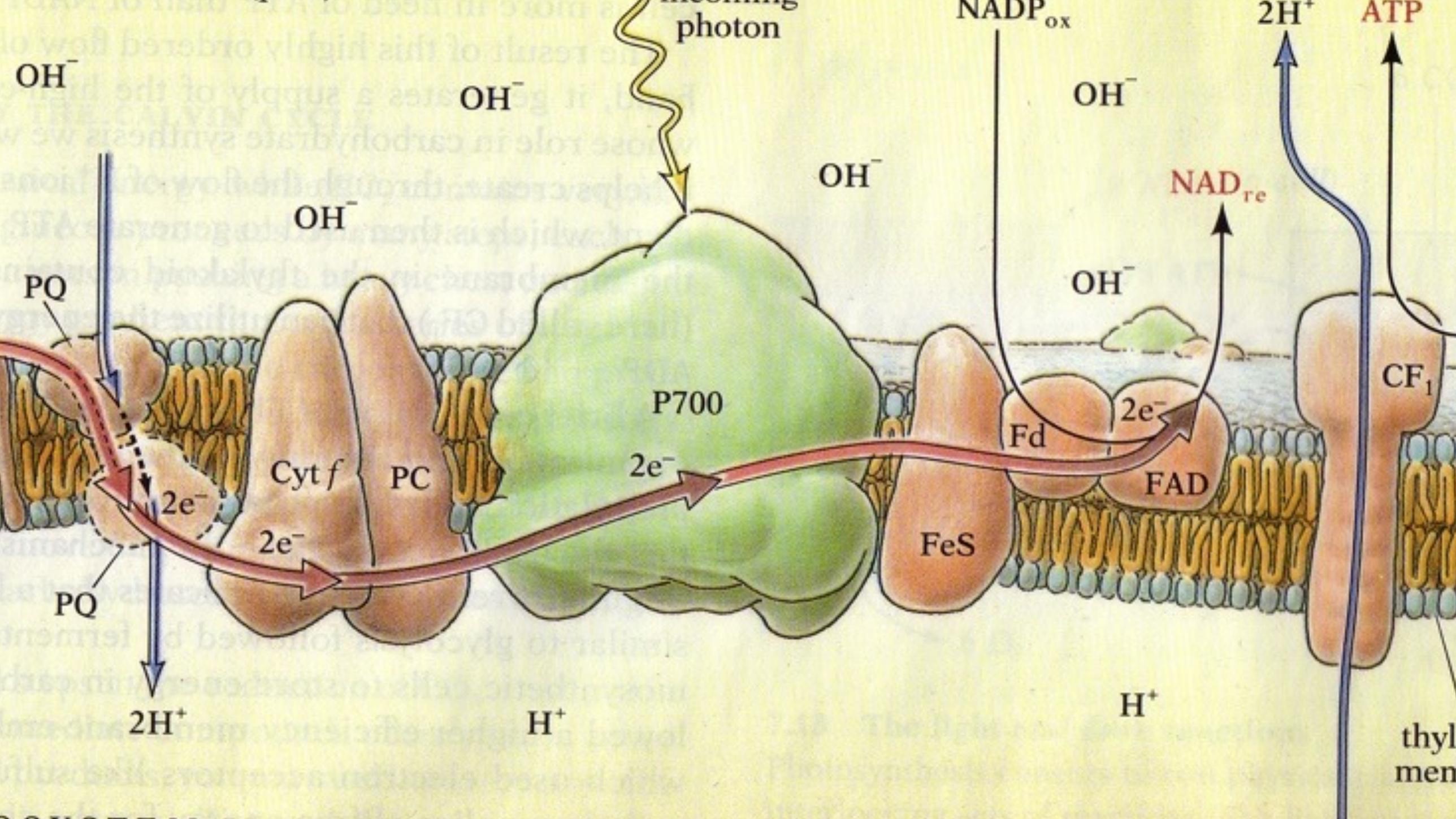

The verbal final

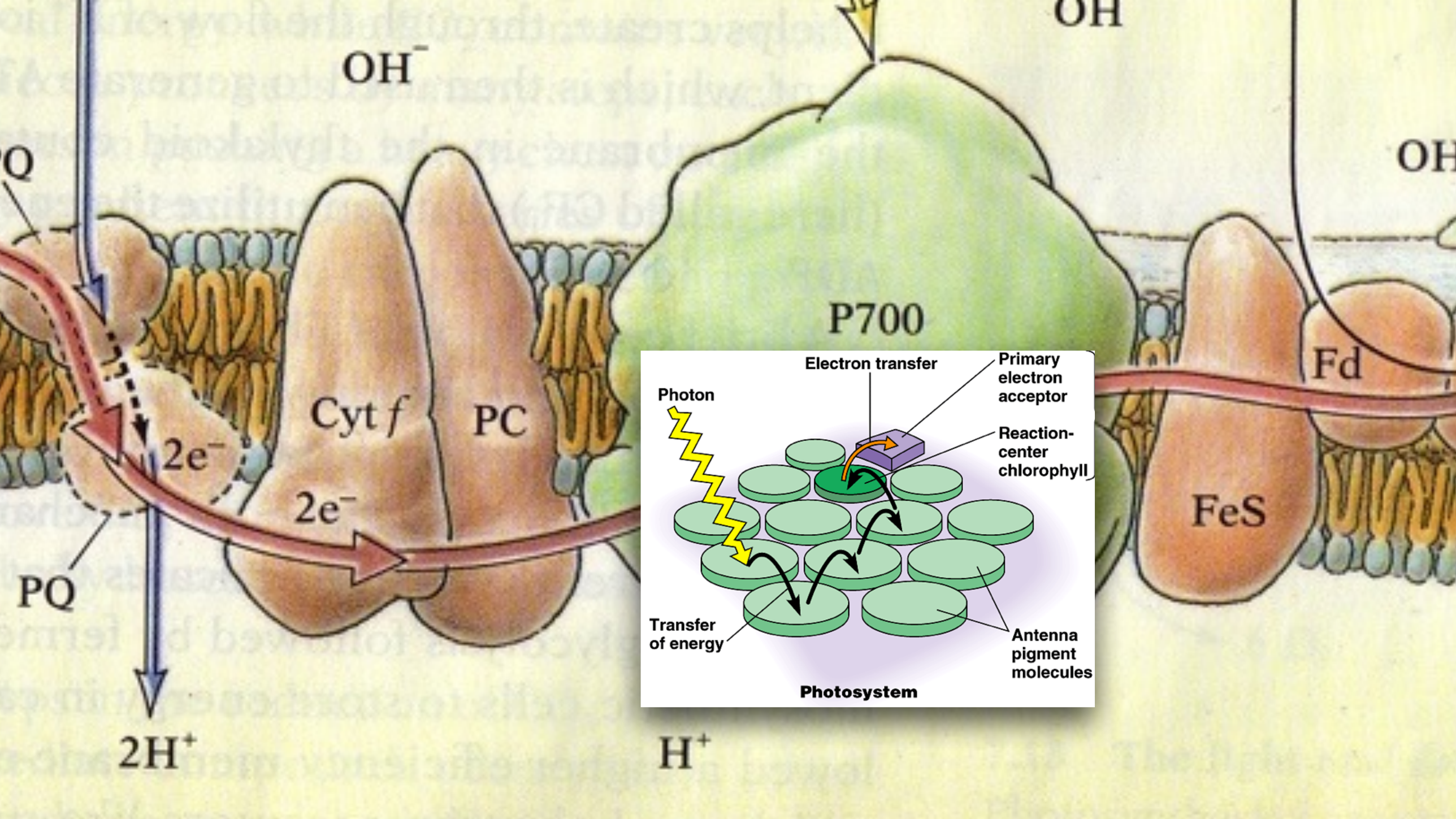
8 photons

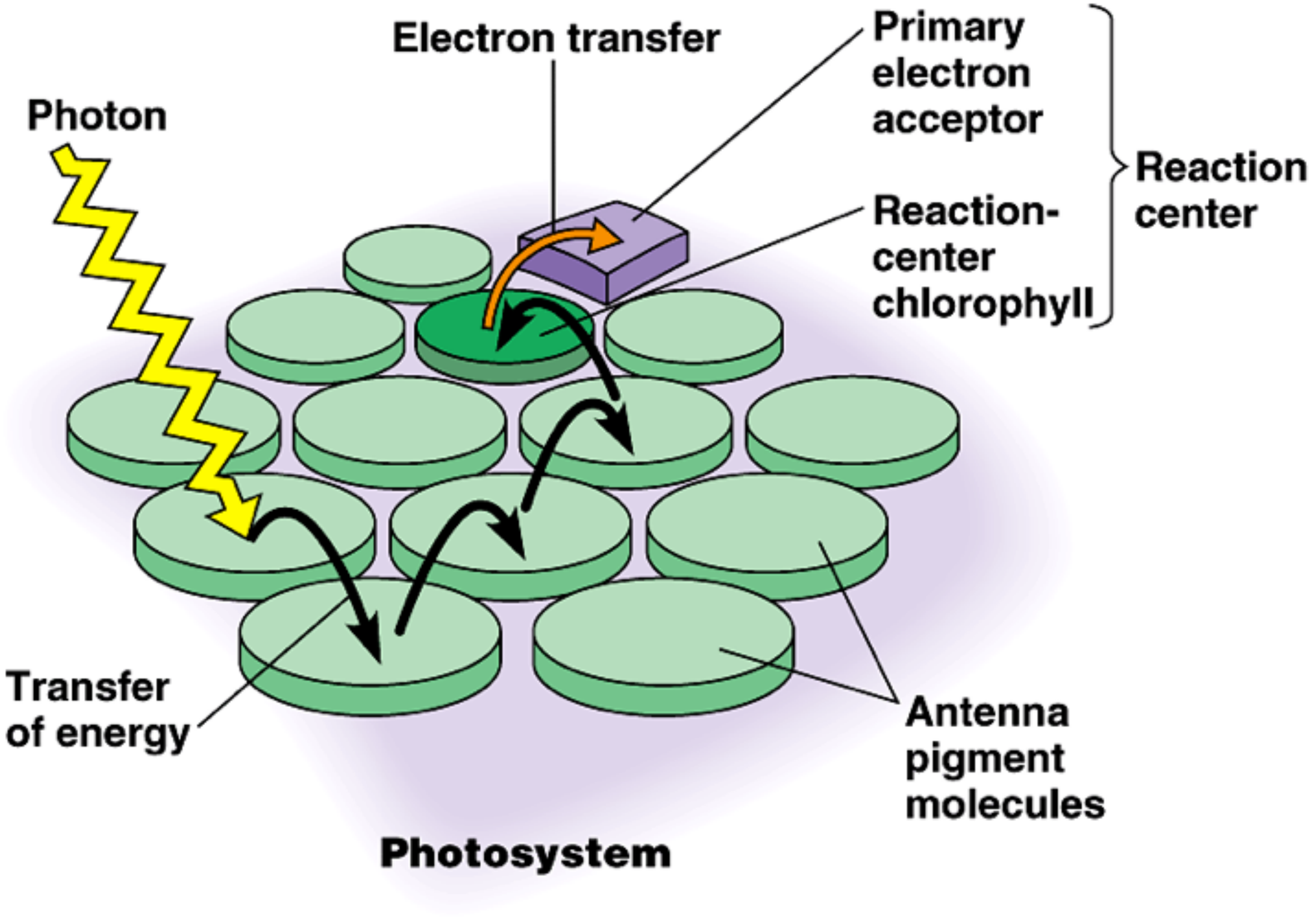
What's your prediction: 8 red photons can make how much ATP?

Responses


Stroma (pH8)
incoming photon
NADP$_{ox}$
2H$^+$
ATP
ADP
NAD$_{re}$
OH$^-$
Q
PQ
Cyt *f*
PC
P700
Fd
FAD
FeS
CF$_1$
2e$^-$
thylakoid membrane
PHOTOSYSTEM II
PHOTOSYSTEM I
H+
Thylakoid interior (pH4)


photon
$NADP_{ox}$
$2H^+$
ATP
OH^-
OH^-
OH^-
OH^-
OH^-
OH^-
NAD_{re}
PQ
P700
$2e^-$
Fd
$2e^-$
FAD
Cyt *f*
PC
$2e^-$
$2e^-$
FeS
CF_1
PQ
$2H^+$
H^+
H^+
thyl
mem


OH⁻
OH
Q
P700
Cyt f
PC
2e⁻
2e⁻
PQ
Fd
FeS
2H⁺
H⁺
Electron transfer
Primary electron acceptor
Photon
Reaction-center chlorophyll
Transfer of energy
Antenna pigment molecules
Photosystem



When Light Is Absorbed, Electrons Enter an Excited State

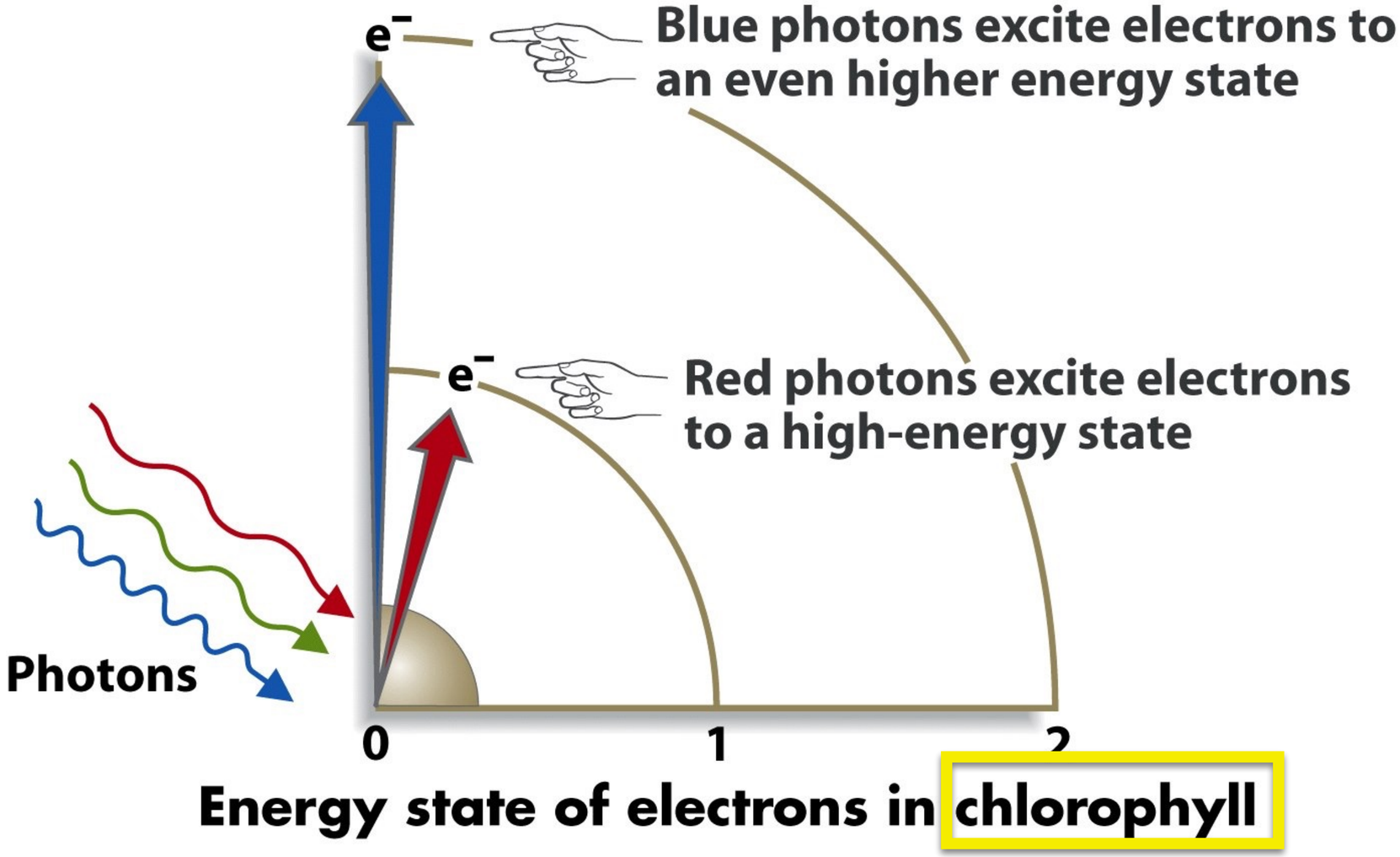
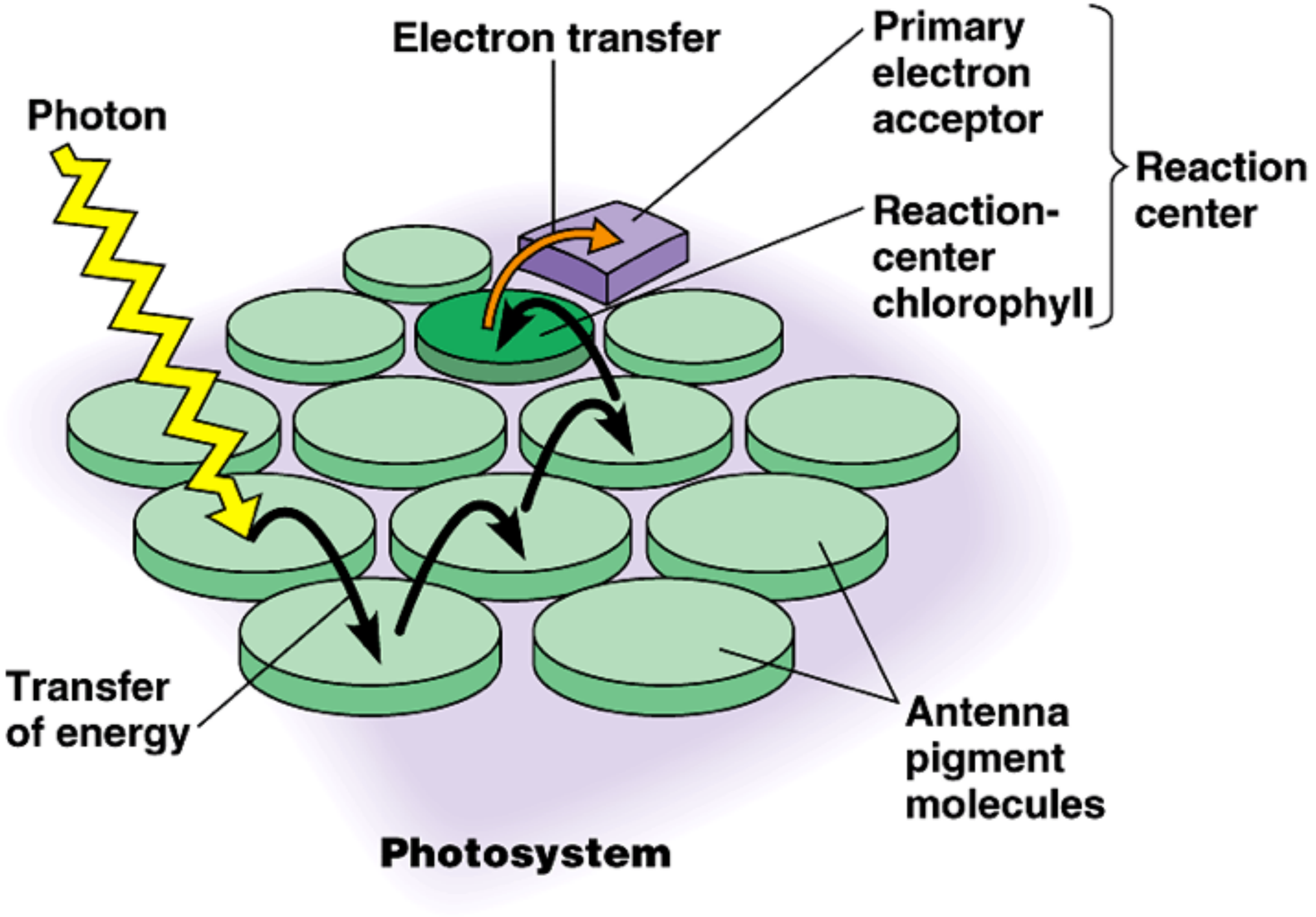


Figure 10-9 Biological Science, 2/e



Time to capture photons (photosystem football)

8.2 The Light-Dependent Reactions of Photosynthesis

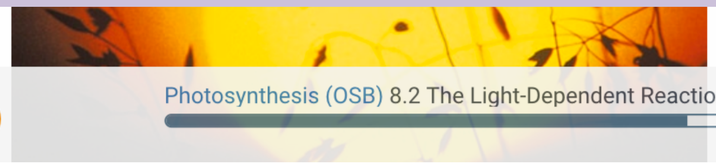
How do chloroplasts function? (a deep dive into one organelle)

Summa

- Ex
- De
- Describe how and where photosynthesis takes place within a plant

Biology Learning Objective

- Build knowledge of the processes used by chloroplasts when functioning (photosynthesis).
- How do photons that depart the sun and strike the earth get converted to chemical energy (ATP, CHO) that is the source of all life.



Week 4

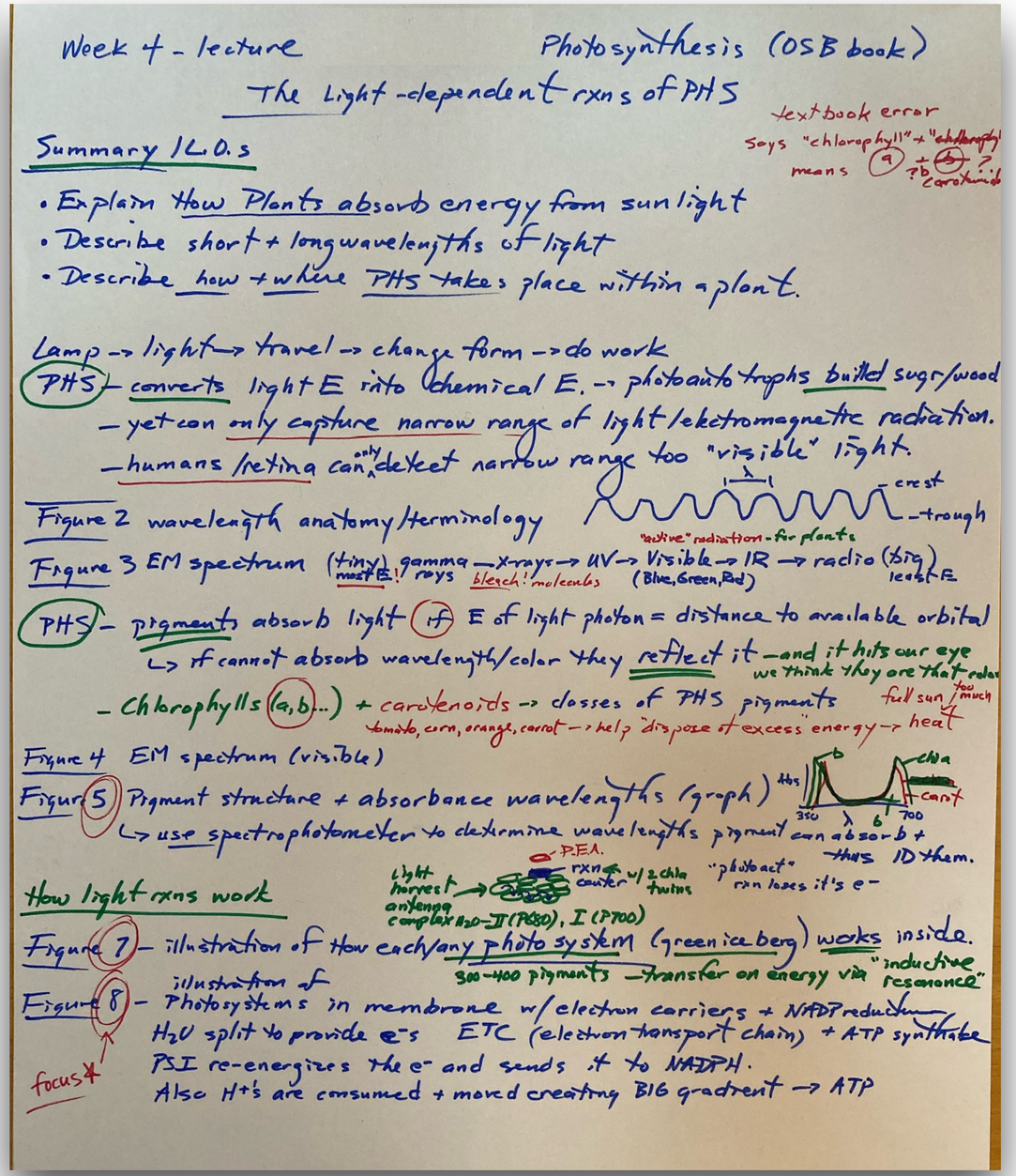
(Preparing for) **Monday's lecture:**

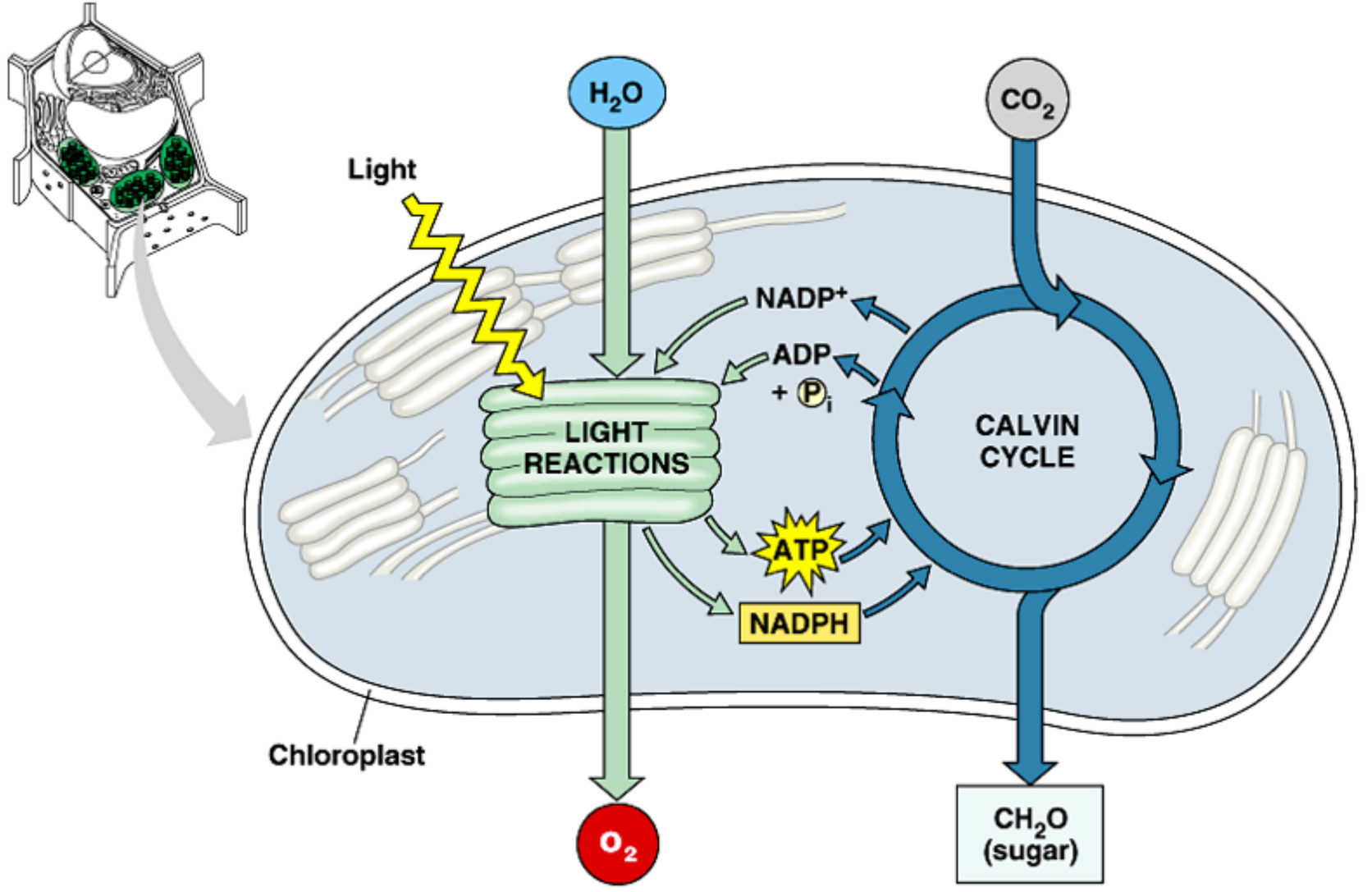
Budgeting homework time (60 min): Photosynthesis (OSB) section 8.2 is 2603 words in length, but has quite a few figures. This should take 13 minutes if you just read it. But when done properly, when you pause to review figures and take careful notes, this assignment should take you more like 60 minutes.

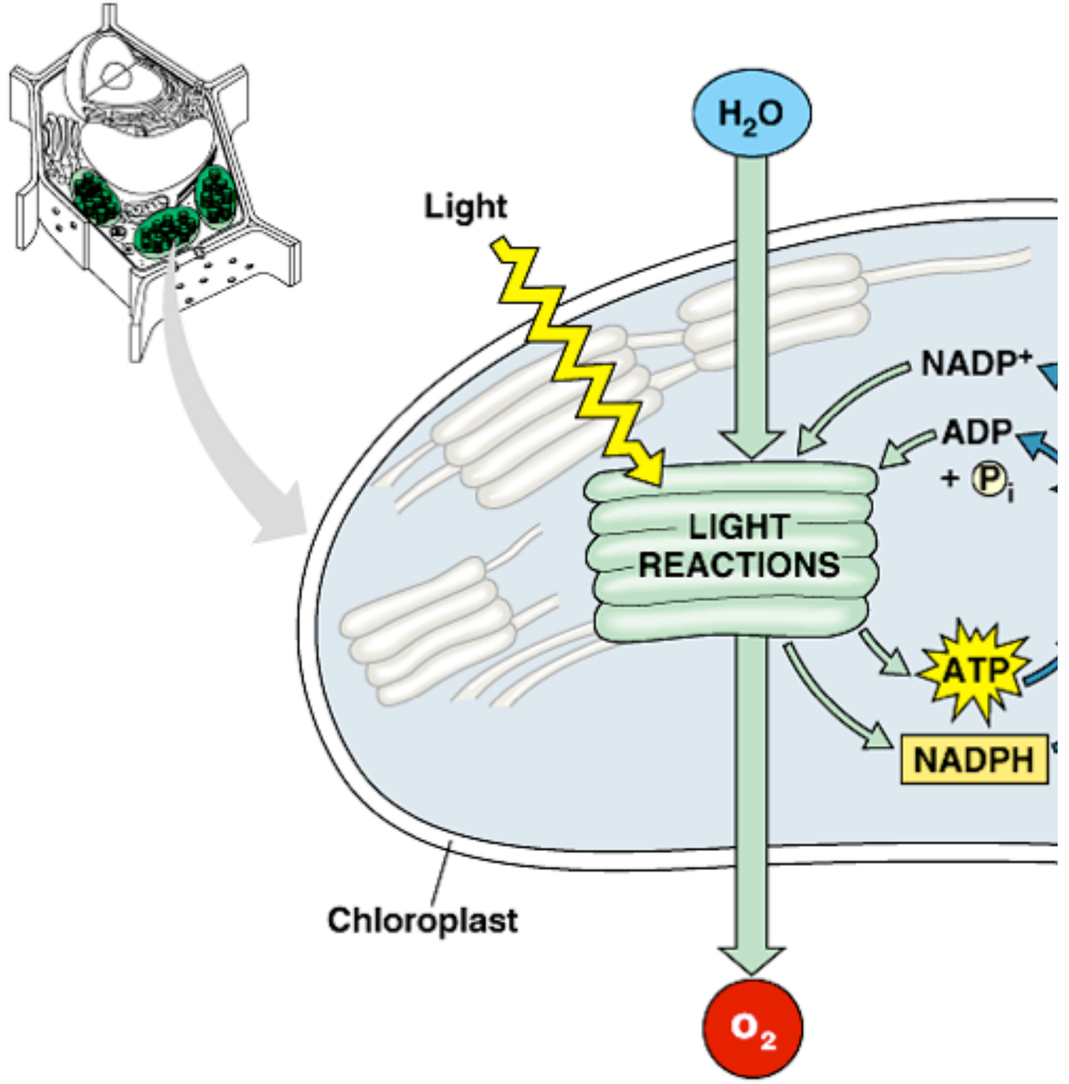
1. _____ **For Monday's lecture,** in the chapter Photosynthesis (OSB) read section 8.2 "The Light-Dependent Reactions of Photosynthesis" and as you read it on your computer be sure to take handwritten notes in your lecture notebook.

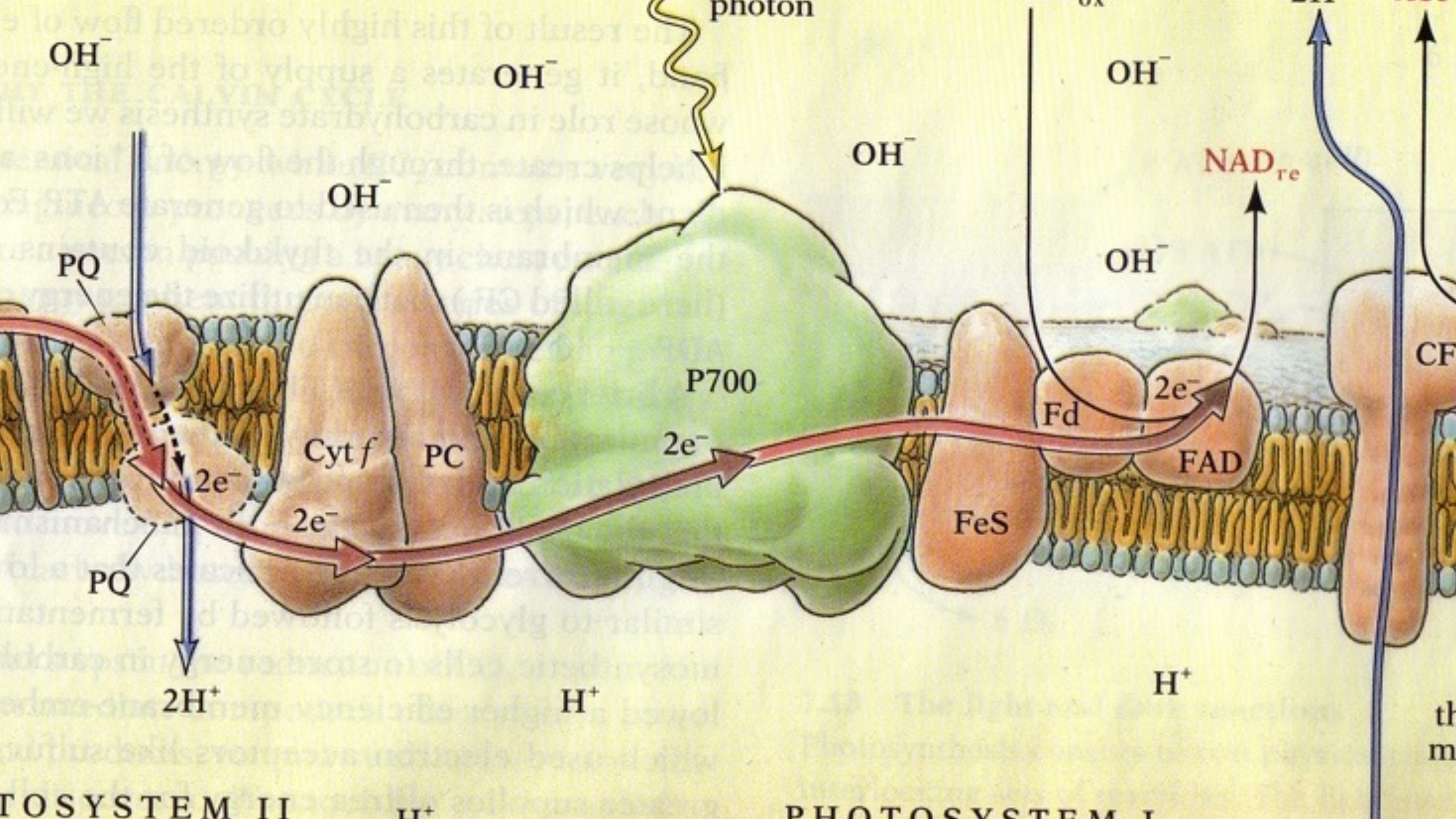
2. _____ (Tip): While you are reading focus mostly and take notes regarding **Figures 5, 7, and 8.** We will discuss these in class.

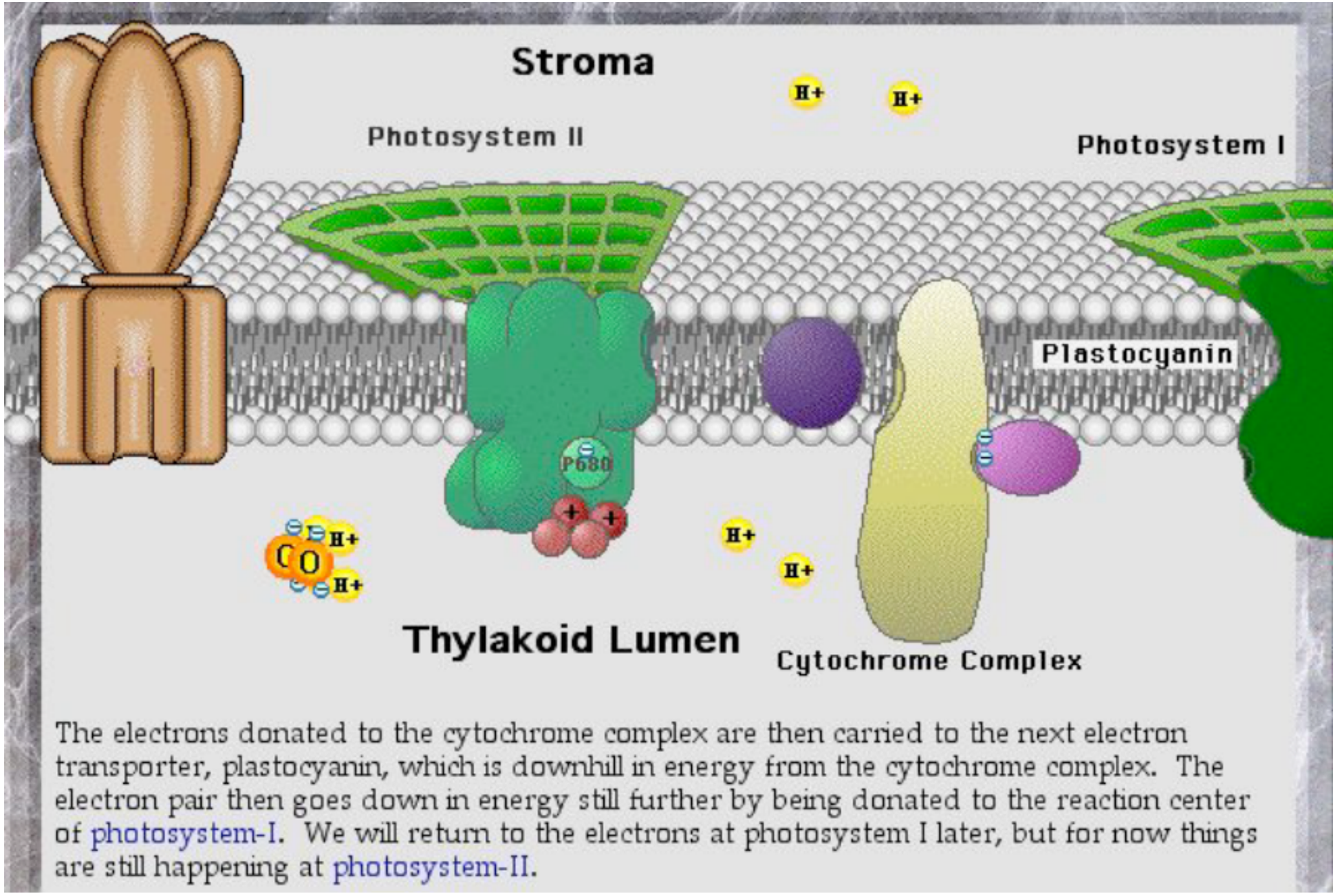
3. _____ **Advanced**: Take a peek at section 8.3, in particular study Figure 1. Take a sneak peek at "Chapter 11: Photosynthesis", section 11.1, study Figures 11.2 and 11.3.





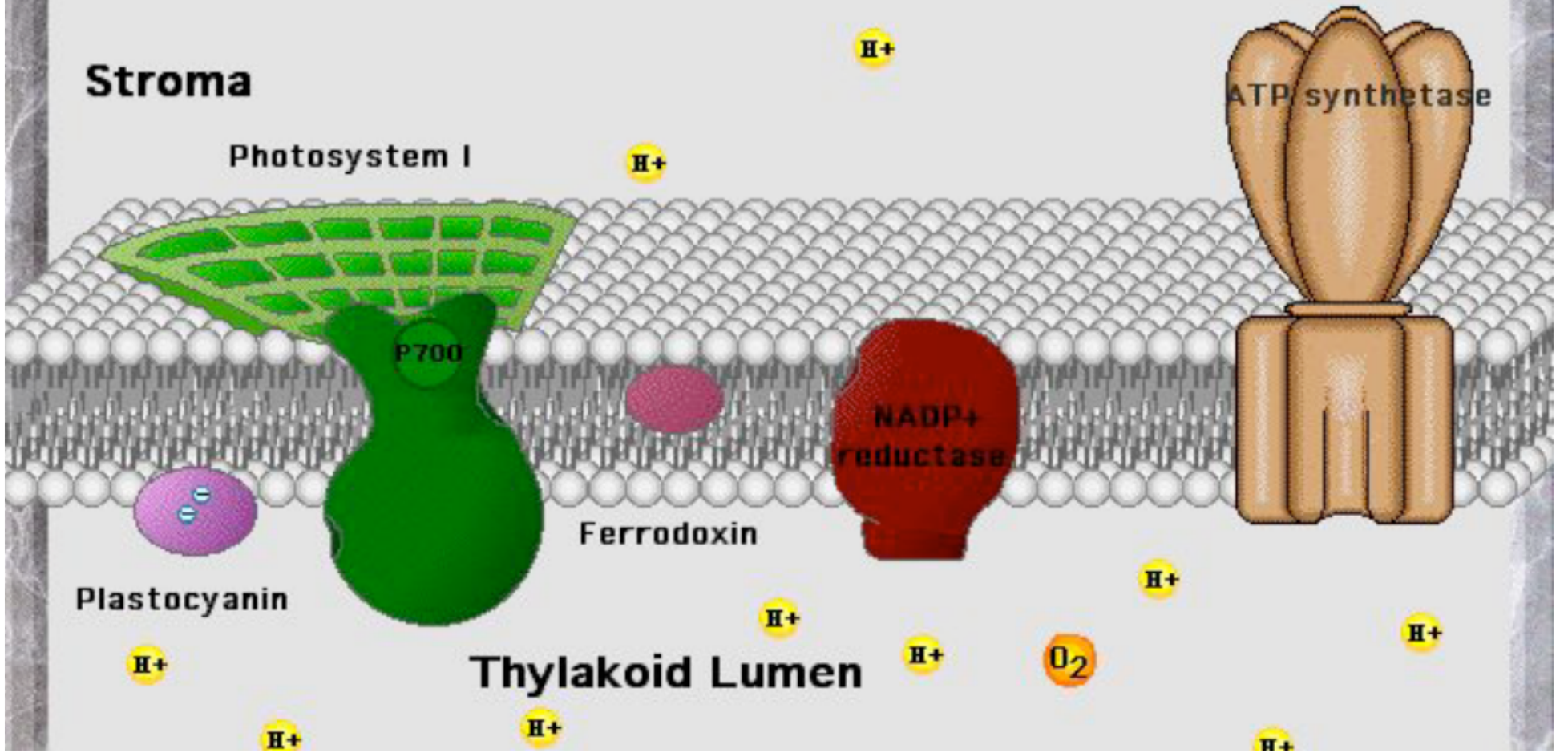



photon
OH⁻
OH⁻
OH⁻
OH⁻
OH⁻
OH⁻
NAD re
PQ
PQ
2e⁻
2e⁻
Cyt f
PC
P700
2e⁻
Fd
2e⁻
FAD
FeS
CF
2H⁺
H⁺
H⁺
th
m
TOSYSTEM II
PHOTOSYSTEM I

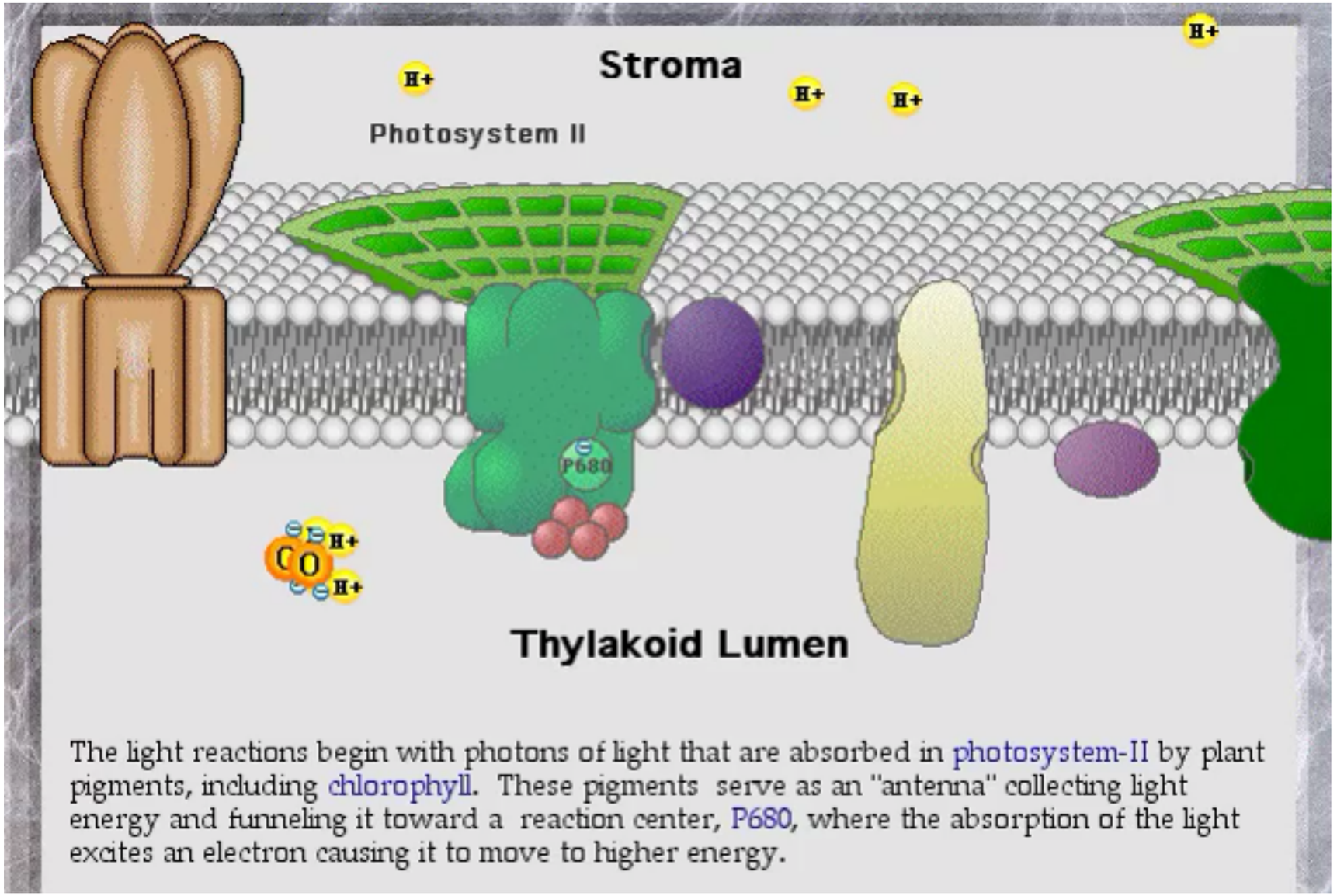


The electrons donated to the cytochrome complex are then carried to the next electron transporter, plastocyanin, which is downhill in energy from the cytochrome complex. The electron pair then goes down in energy still further by being donated to the reaction center of photosystem-I. We will return to the electrons at photosystem I later, but for now things are still happening at photosystem-II.

At this point, four electrons (originally from water) have been donated to photosystem-I (P700) via photosystem-II. Photosystem I absorbs additional light energy to excite the electrons again and send them on their way down another leg of the electron transport chain, ultimately reducing NADP to NADPH. That is, the four electrons stripped from the two water molecules are eventually donated to two molecules of oxidized coenzyme, NADP, to produce reduced, high energy coenzyme, NADPH.

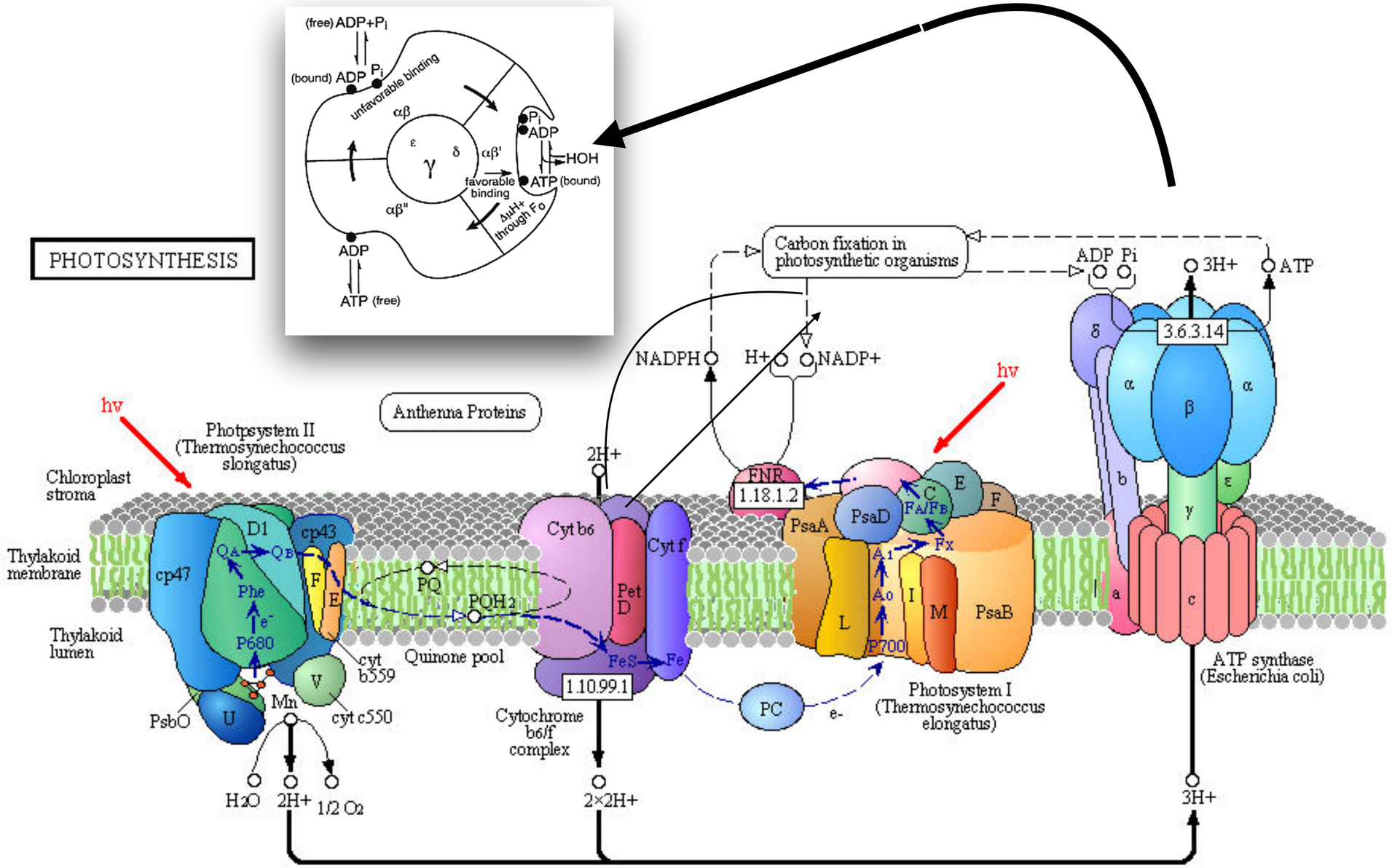


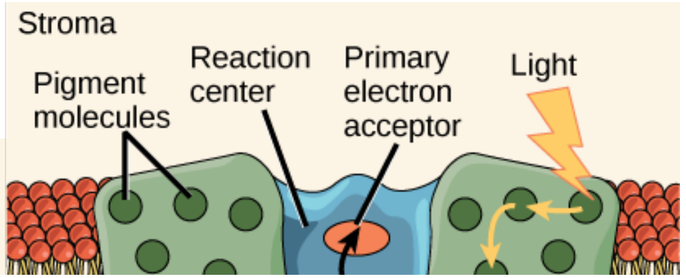
Next time expect a **quiz** on this and be prepared to **act out in class**

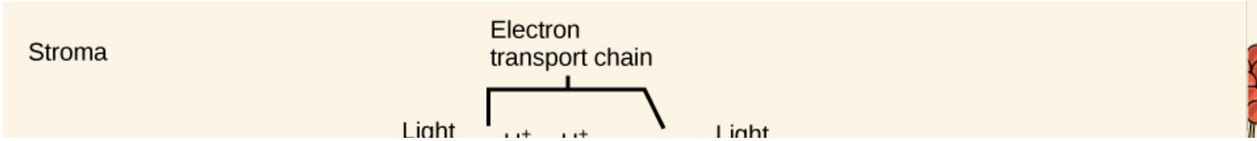


The light reactions begin with photons of light that are absorbed in photosystem-II by plant pigments, including chlorophyll. These pigments serve as an "antenna" collecting light energy and funneling it toward a reaction center, P680, where the absorption of the light excites an electron causing it to move to higher energy.

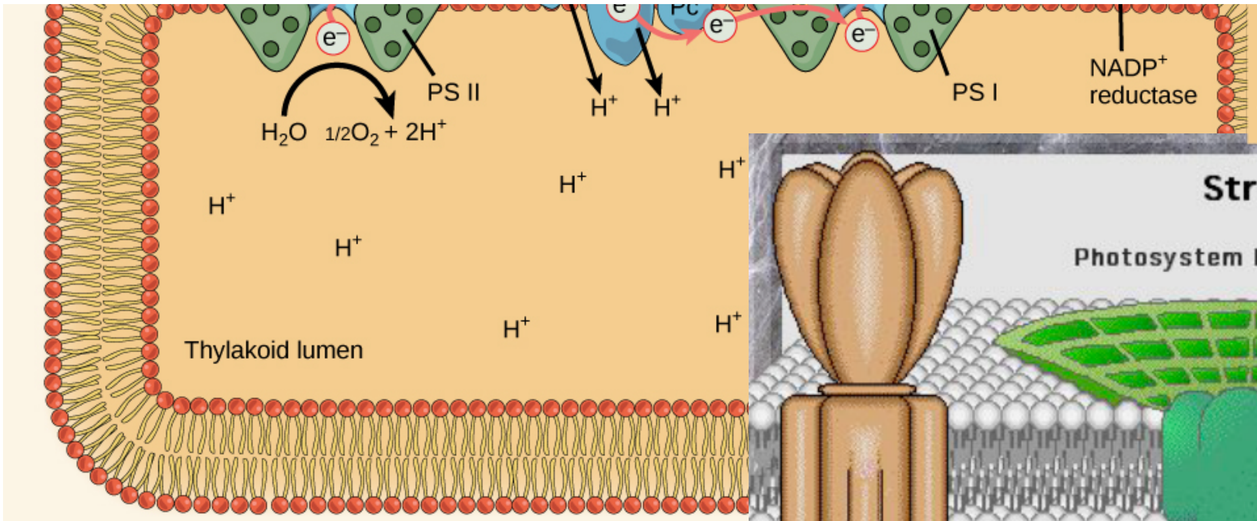
Images of “Xmas future”

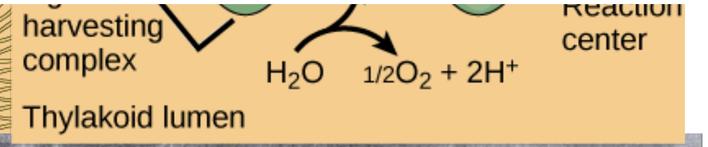


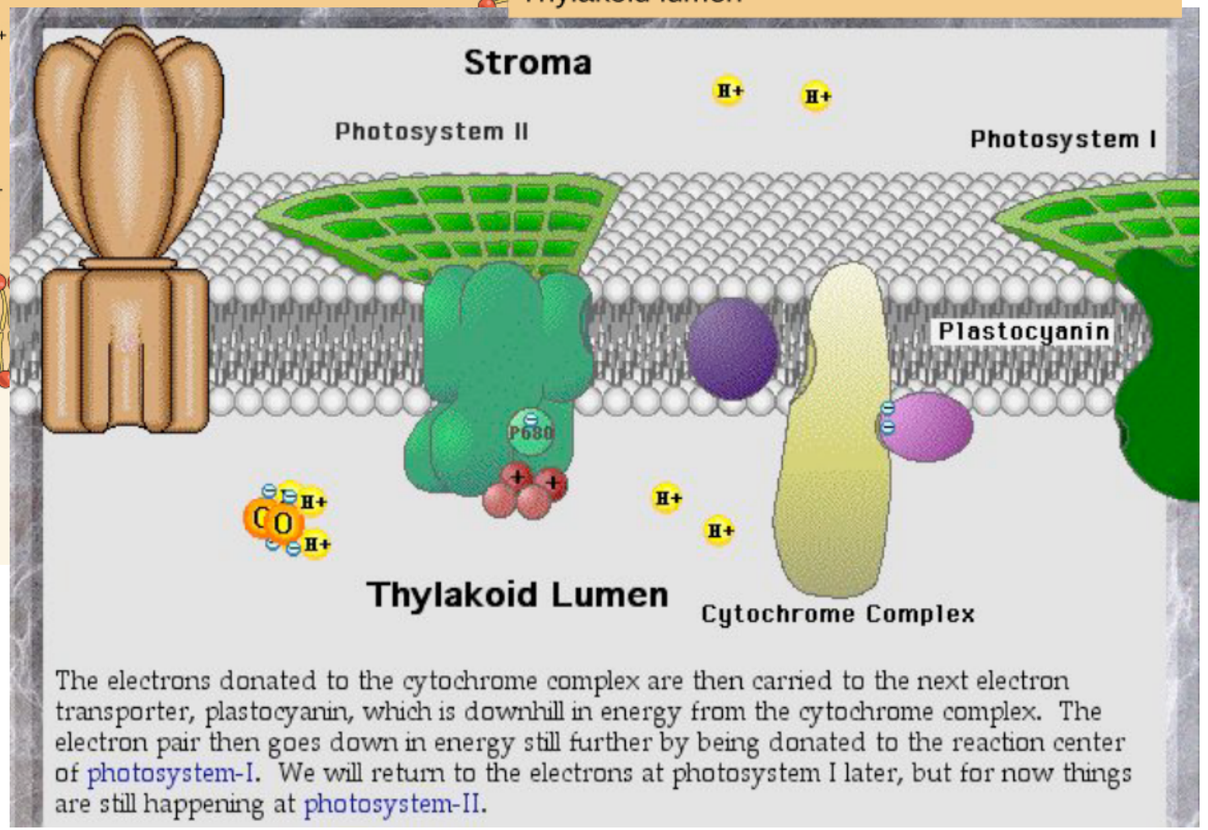




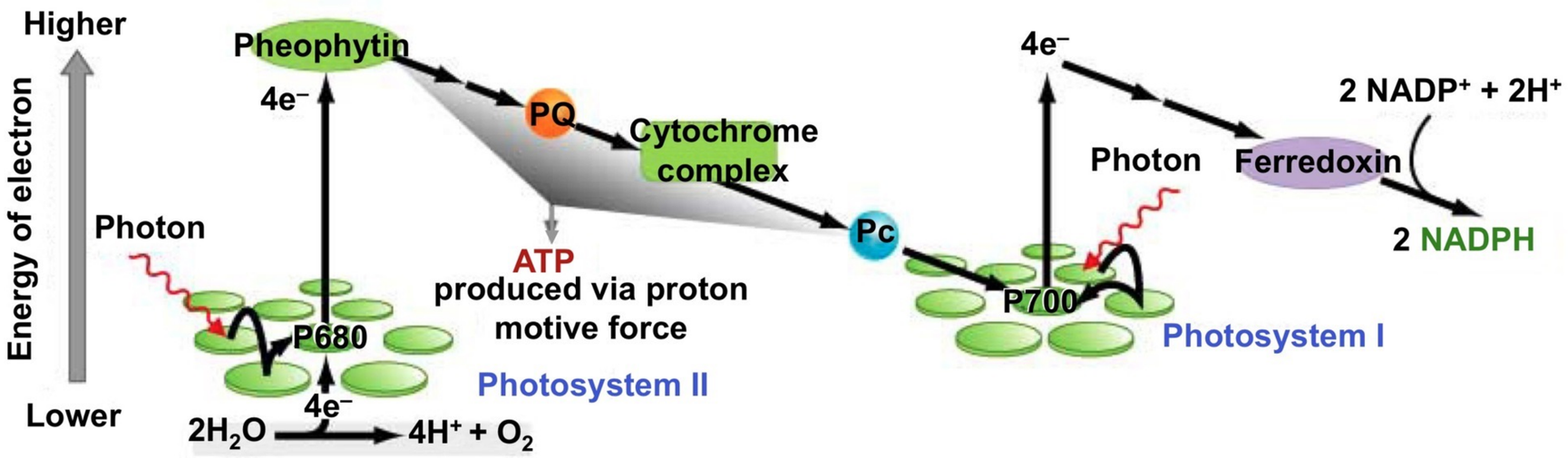
- *We will anoint the PHS animation on course website as our working model and the "correct" one.*





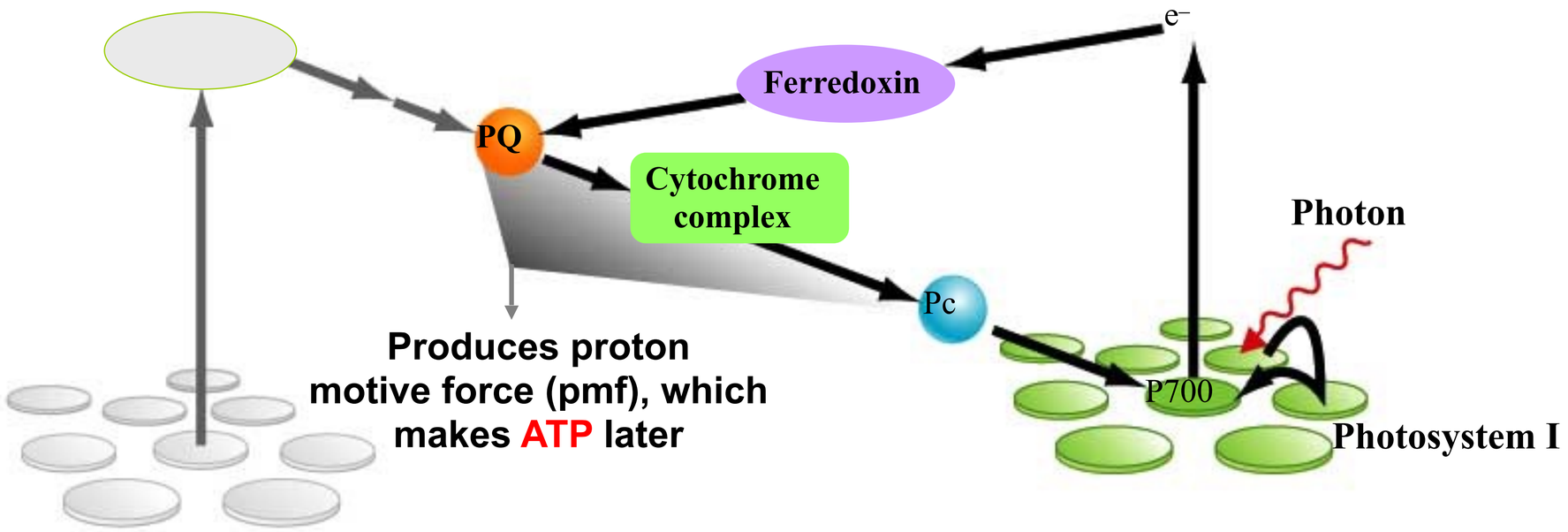


In the linear scheme of Photosythesis, electrons flow from water to NADPH.

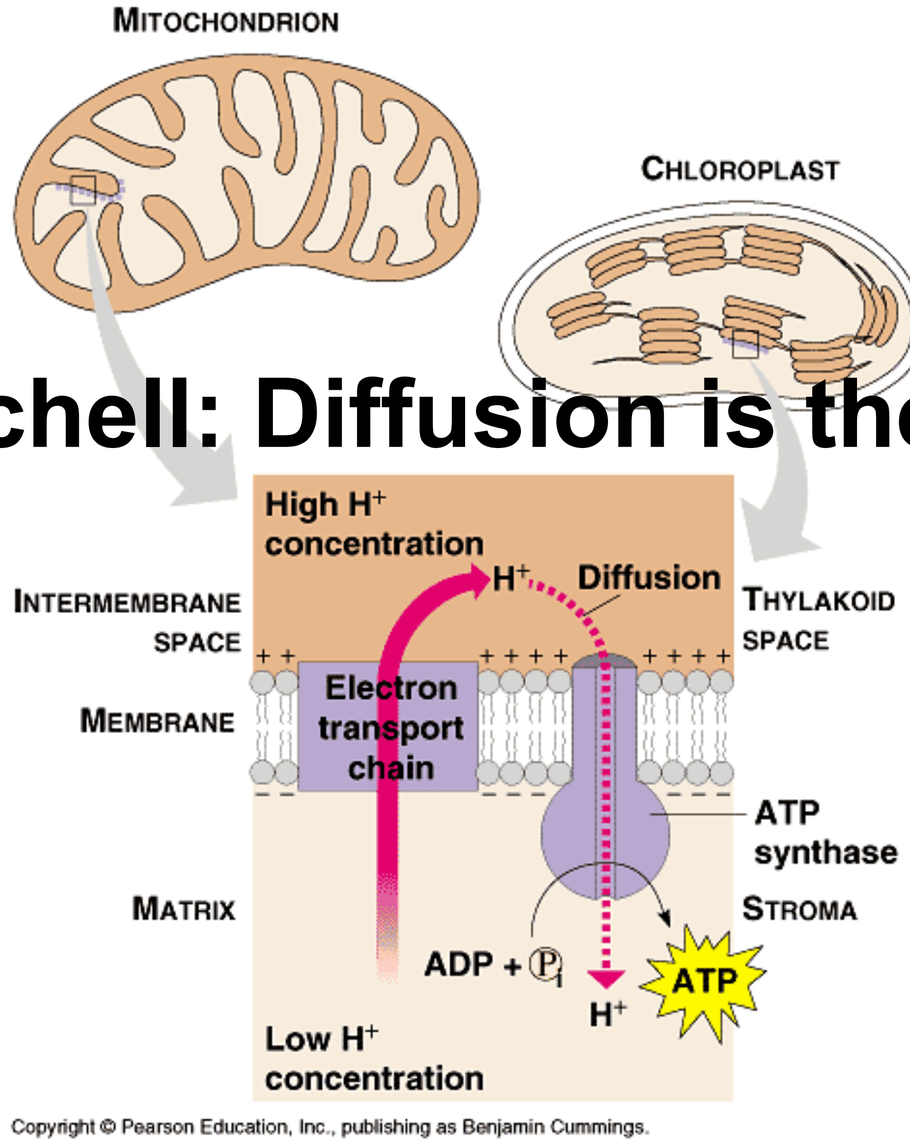


Cyclic Photosynthesis

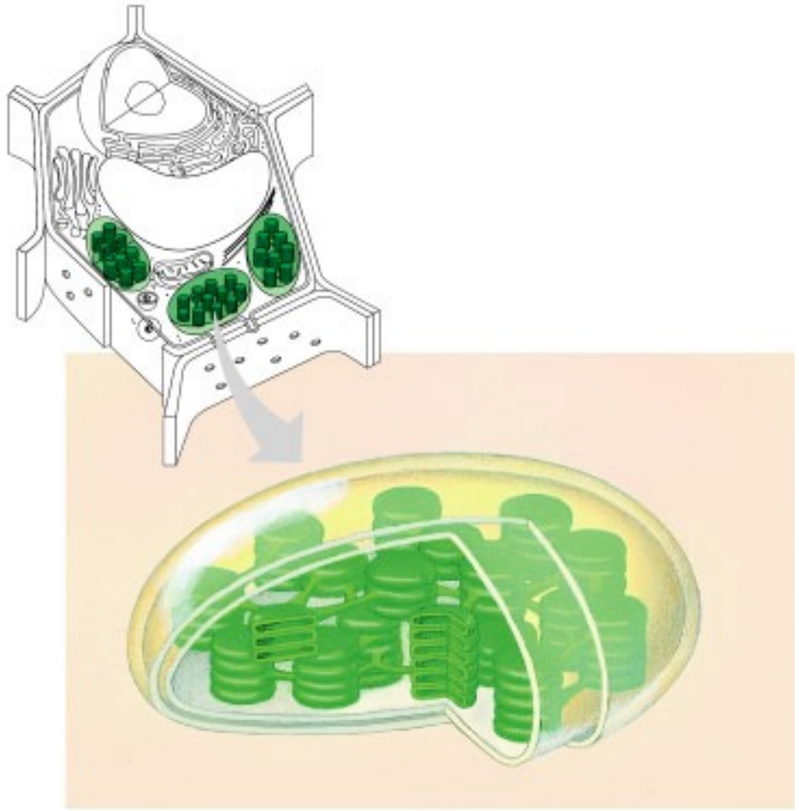
In cyclic electron transport, photosystem I transfers electrons to plastoquinone (PQ)

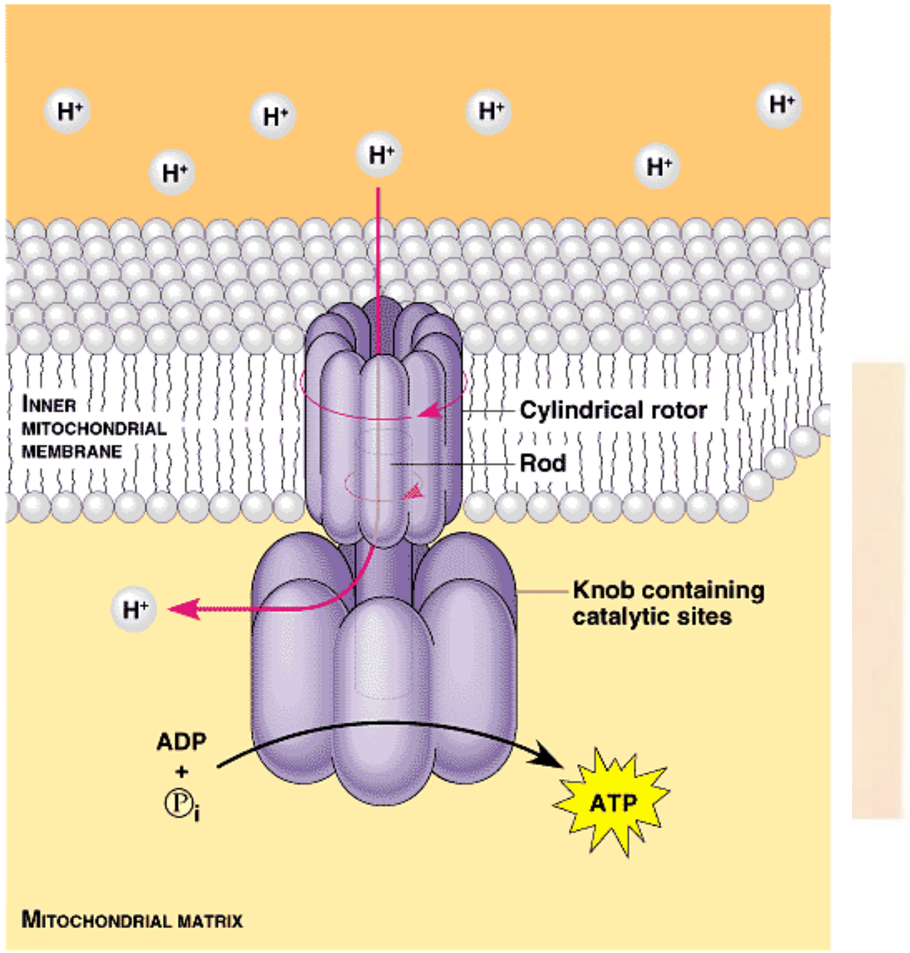


Peter Mitchell: Diffusion is the answer!

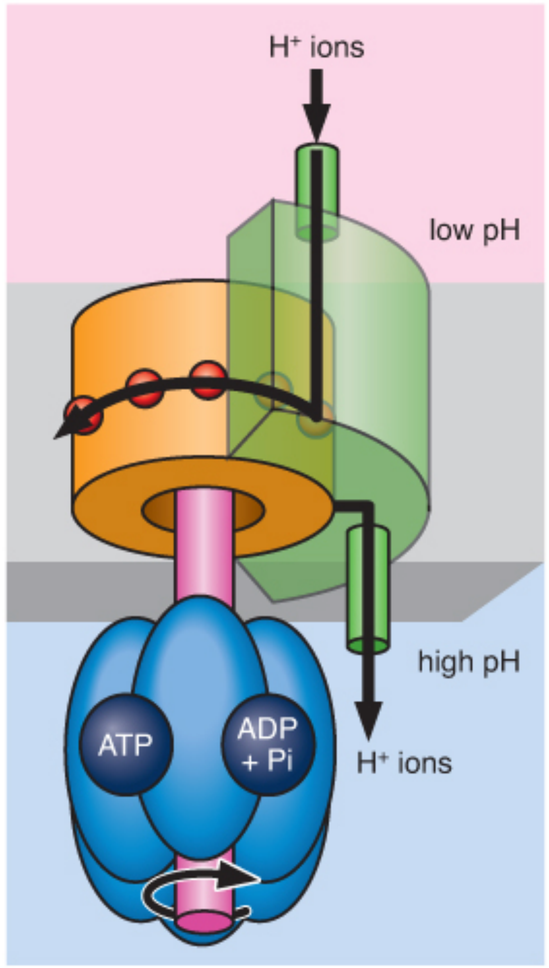


Paul Boyer: I think it actually twists!

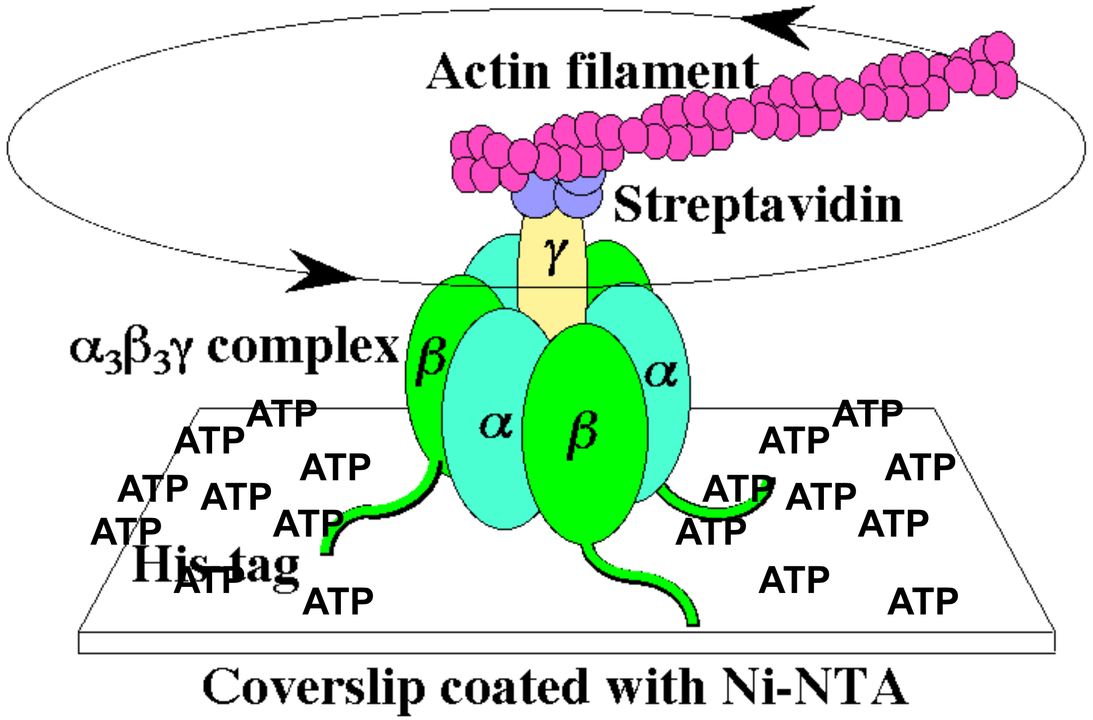




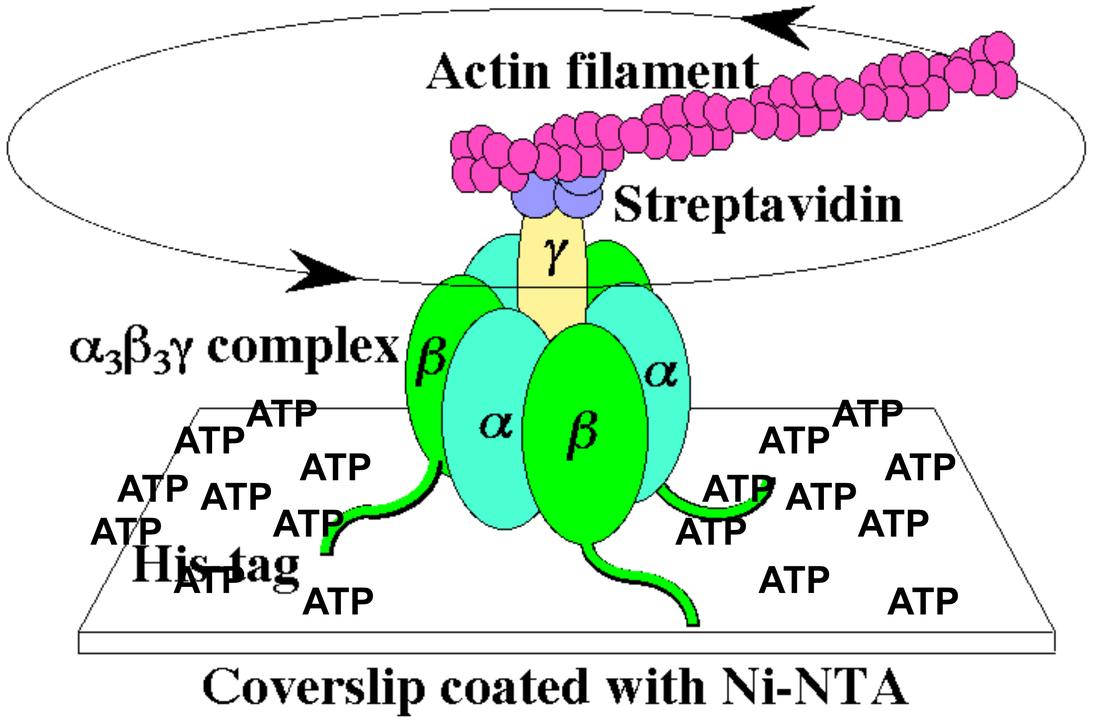
Paul Boyer:
I think it is *Rotational Catalysis*

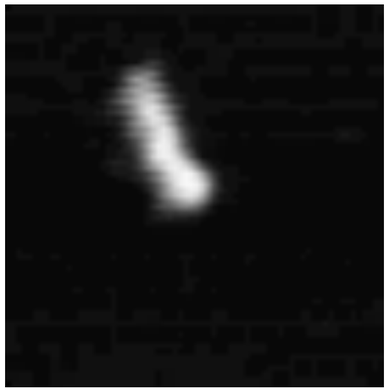


Masasuke Yoshida “check this out.”

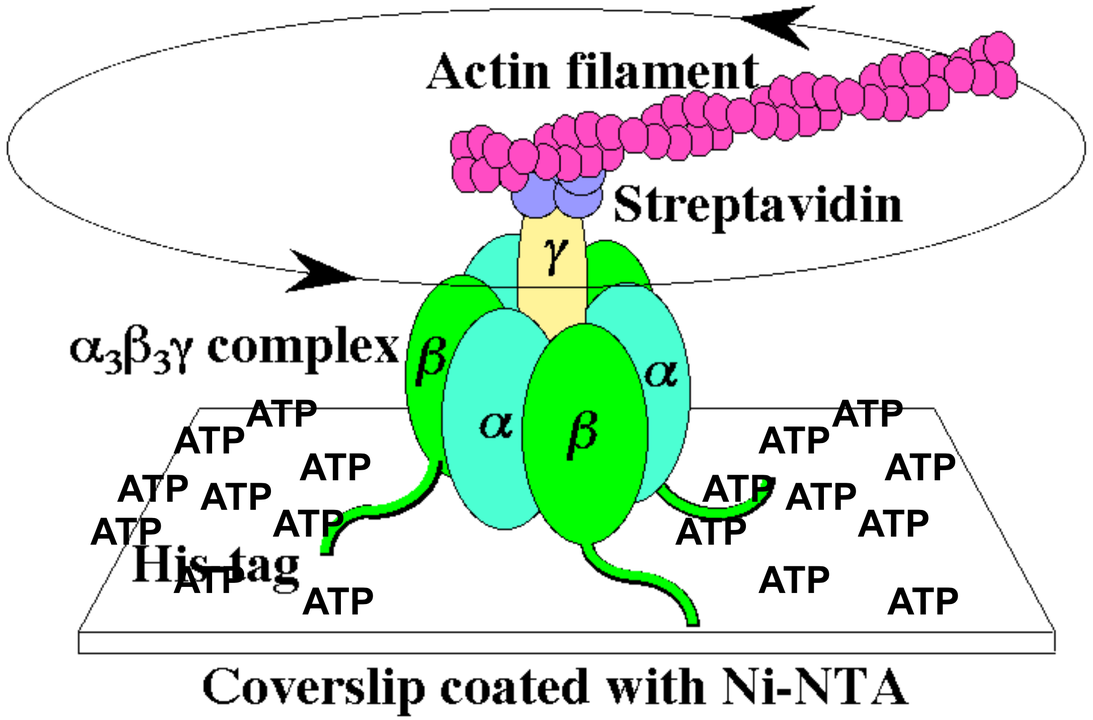


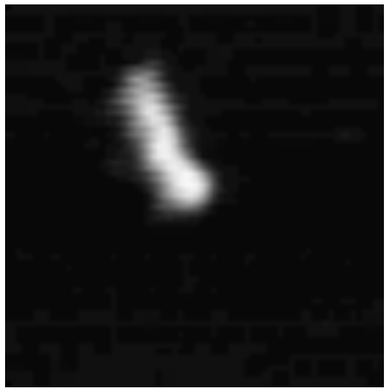
Masasuke Yoshida “check this out.”

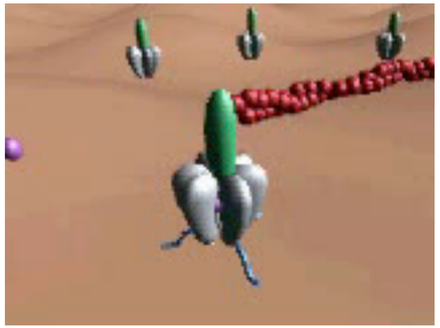




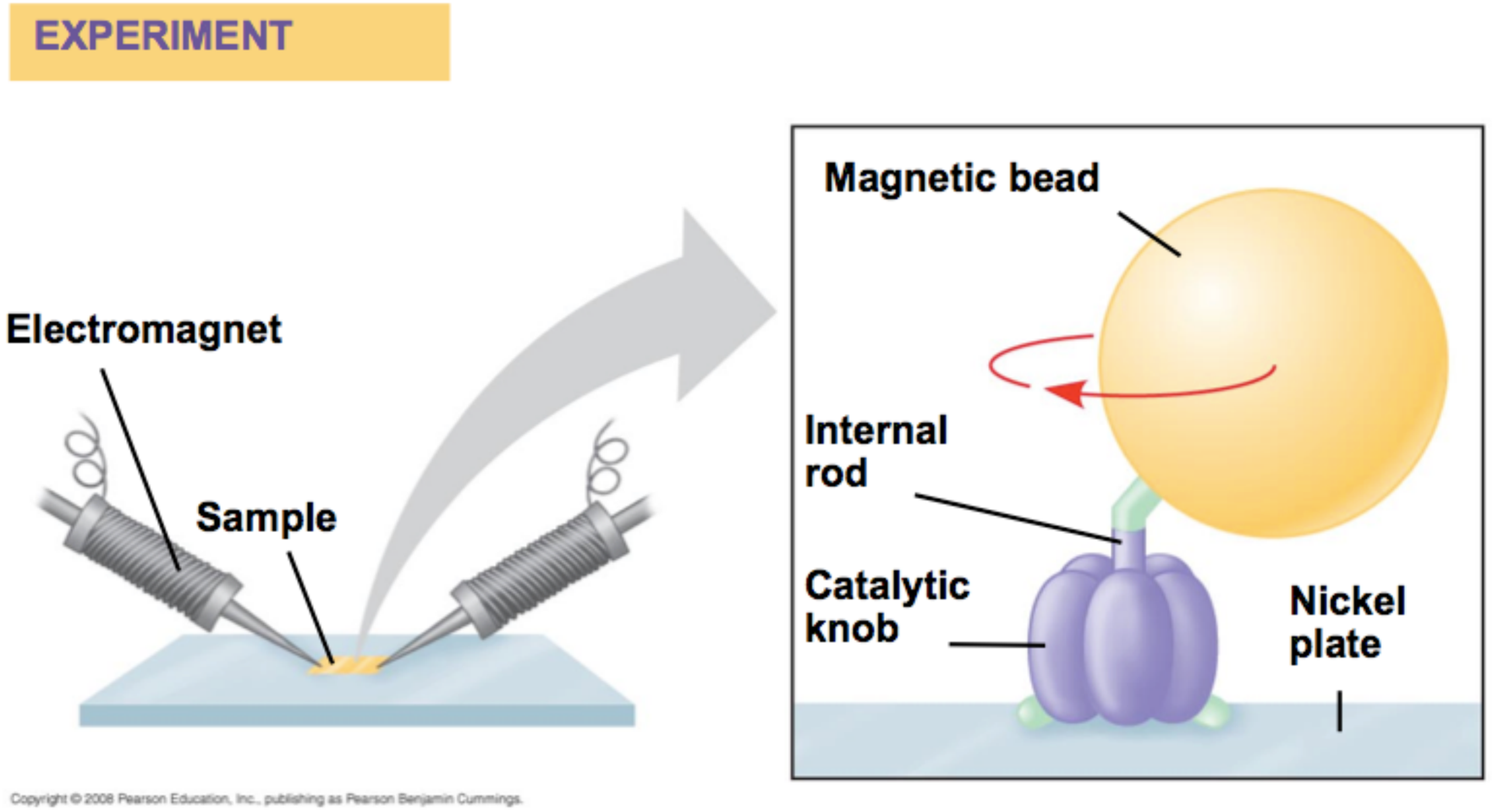
Masasuke Yoshida “check this out.”





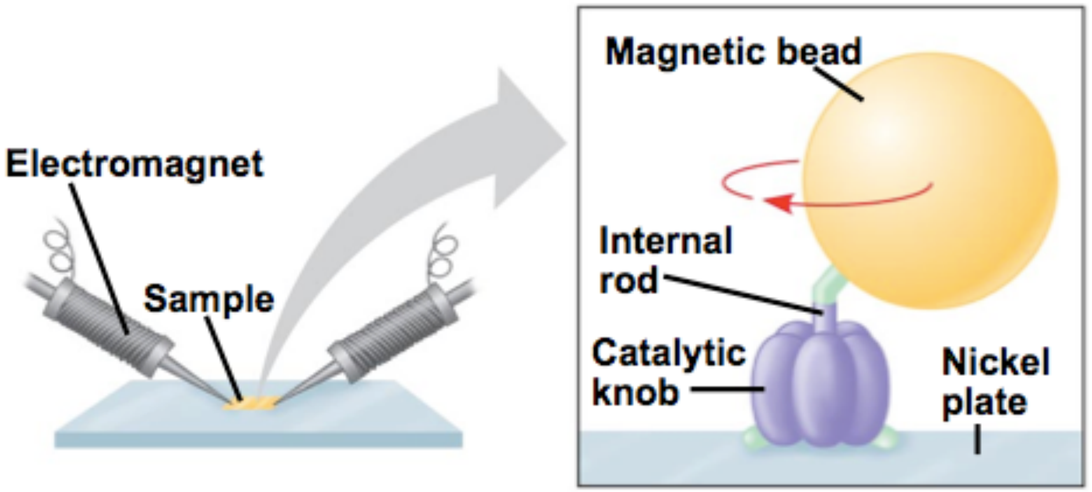


Hiroyasu Itoh –designed this approach (Nature 2004)

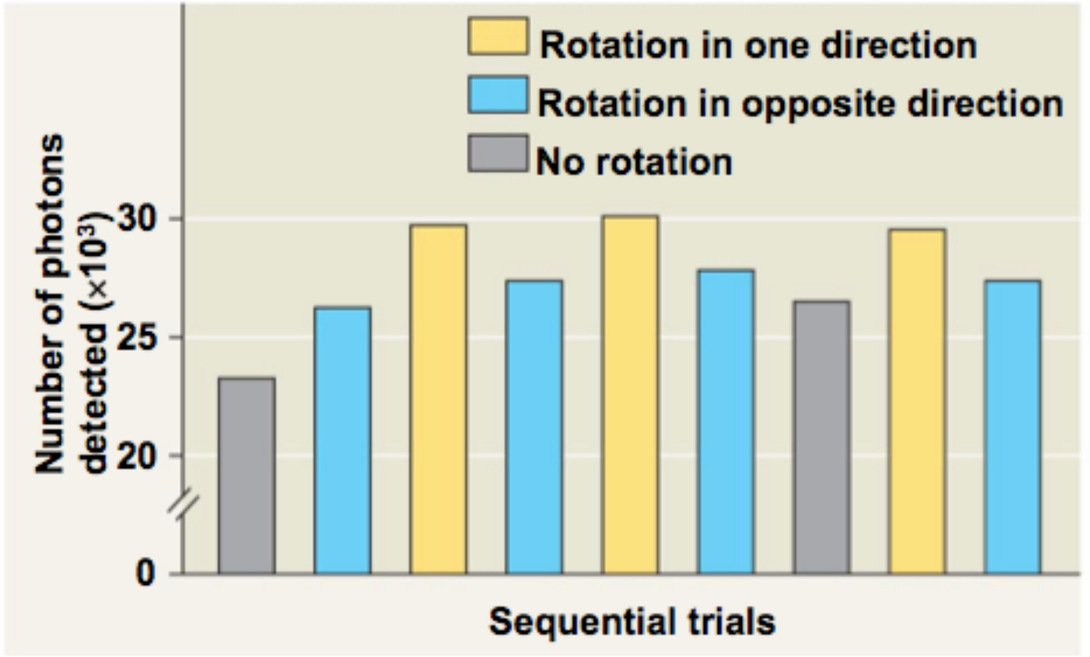


"Reporter enzyme" emits light when detects new ATP

EXPERIMENT



RESULTS



- *Analyze the data*. Given that the gray bars represent the basal/background level of ATP in the experiment, explain what you believe would be (i) **predictions** v. (ii) **observations**

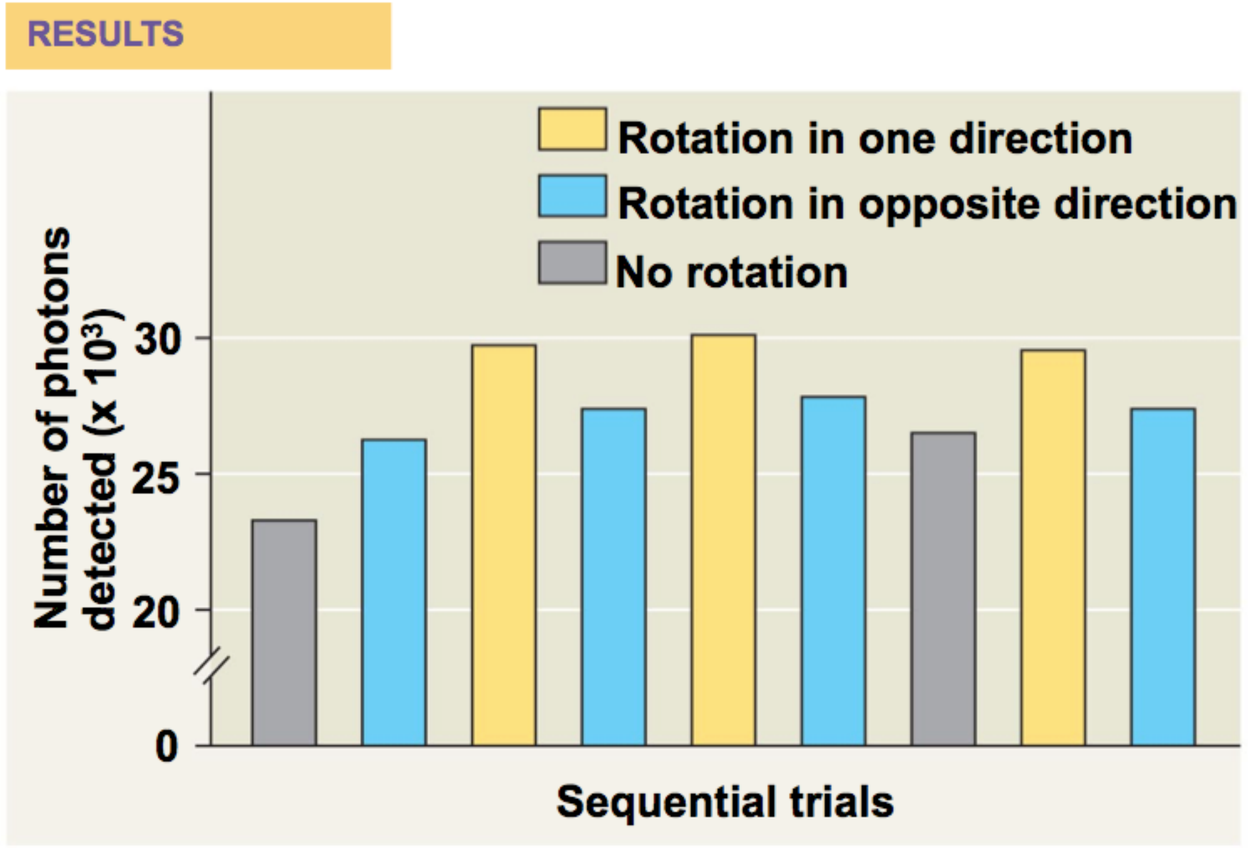


Figure 1 Itoh et al, Nature 2004