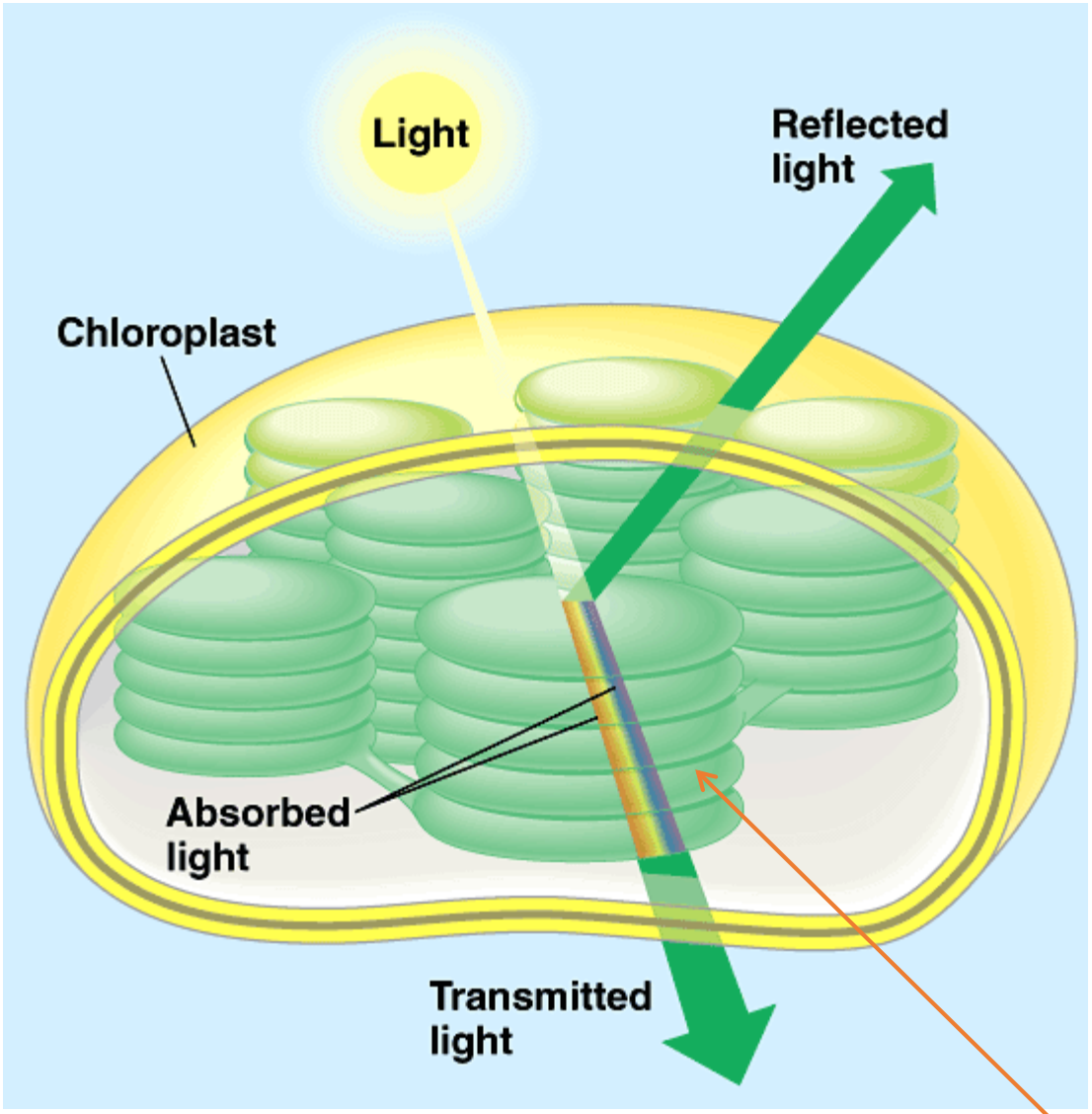
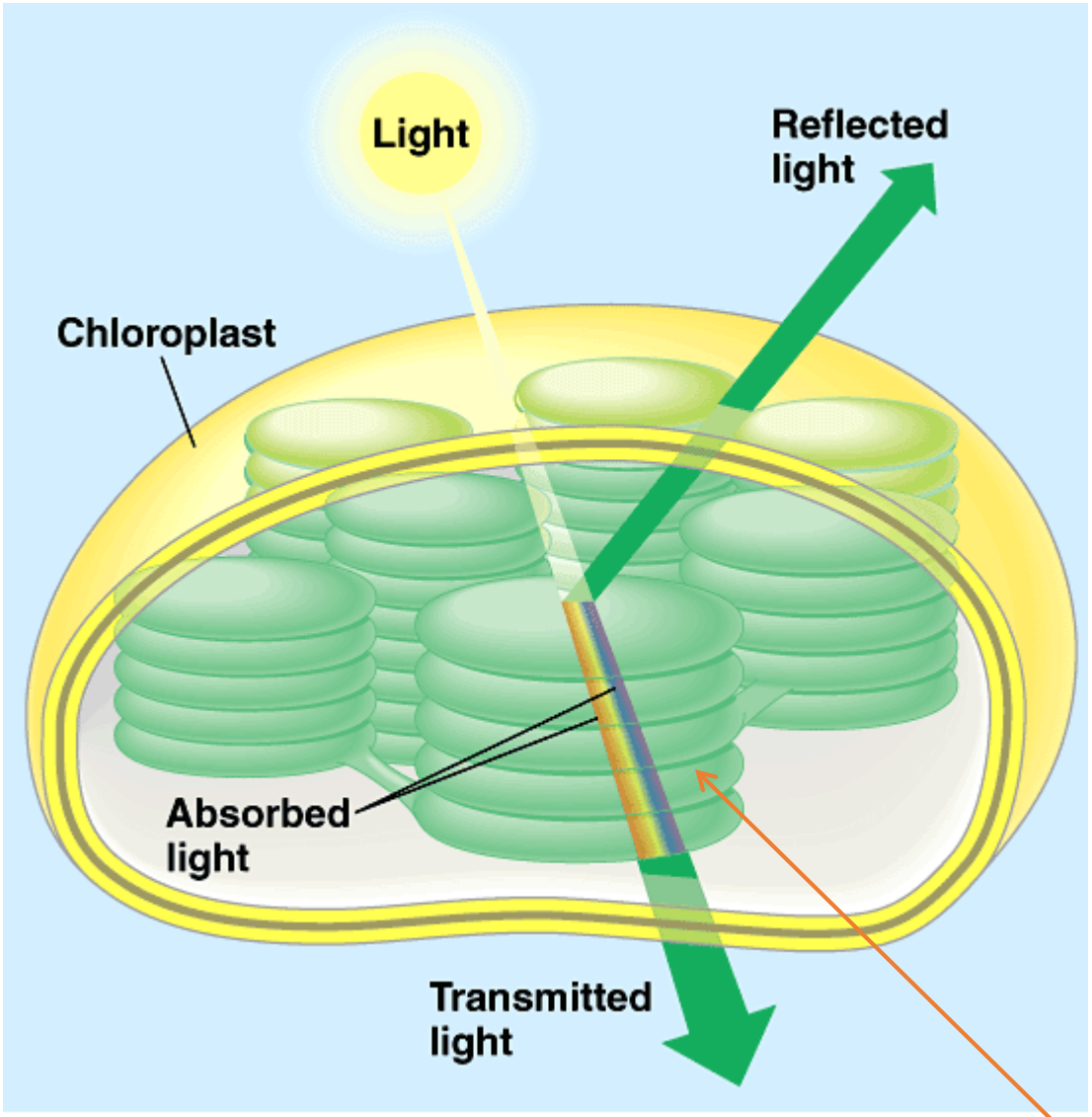
AP Biology Photosynthesis



The green pigment _____ absorbs _____ wavelengths.

Chlorophyll _____ the green wavelengths. This is why leaves appear _____.

The Pigment chlorophyll is located in the _____.

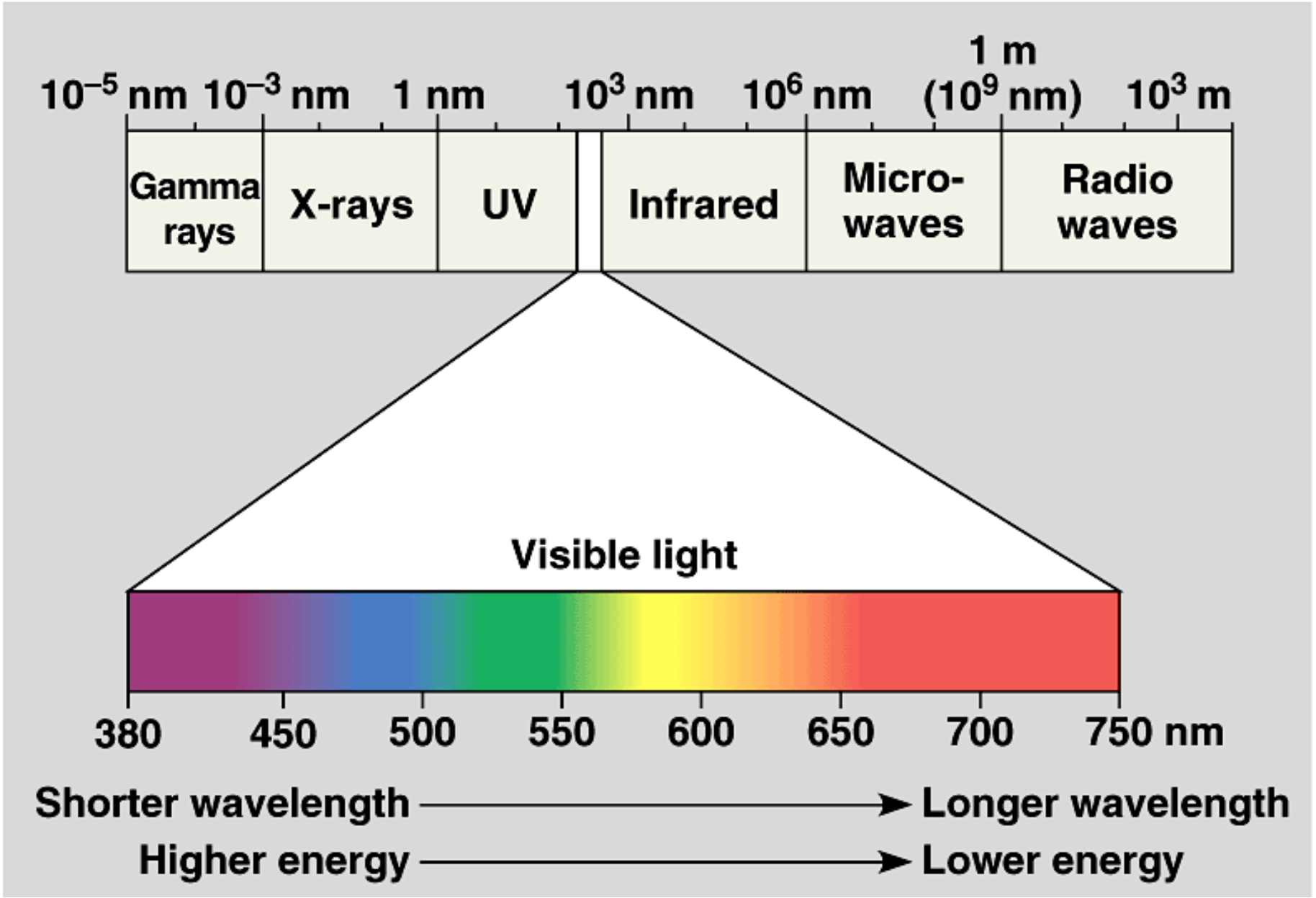


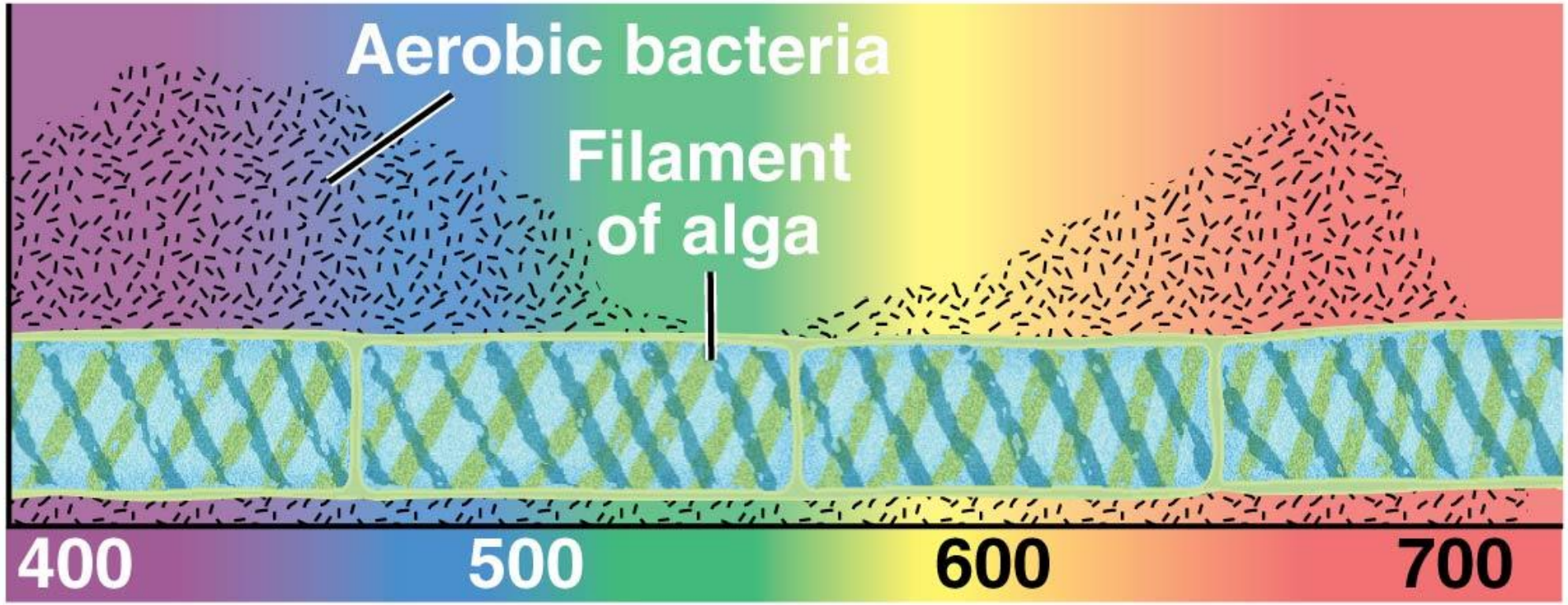
The green pigment *Chlorophyll* absorbs *violet, blue, and red* wavelengths.

Chlorophyll *reflects/transmits* the green wavelengths. This is why leaves appear _green_.

The Pigment chlorophyll is located in the *thylakoid membrane*.

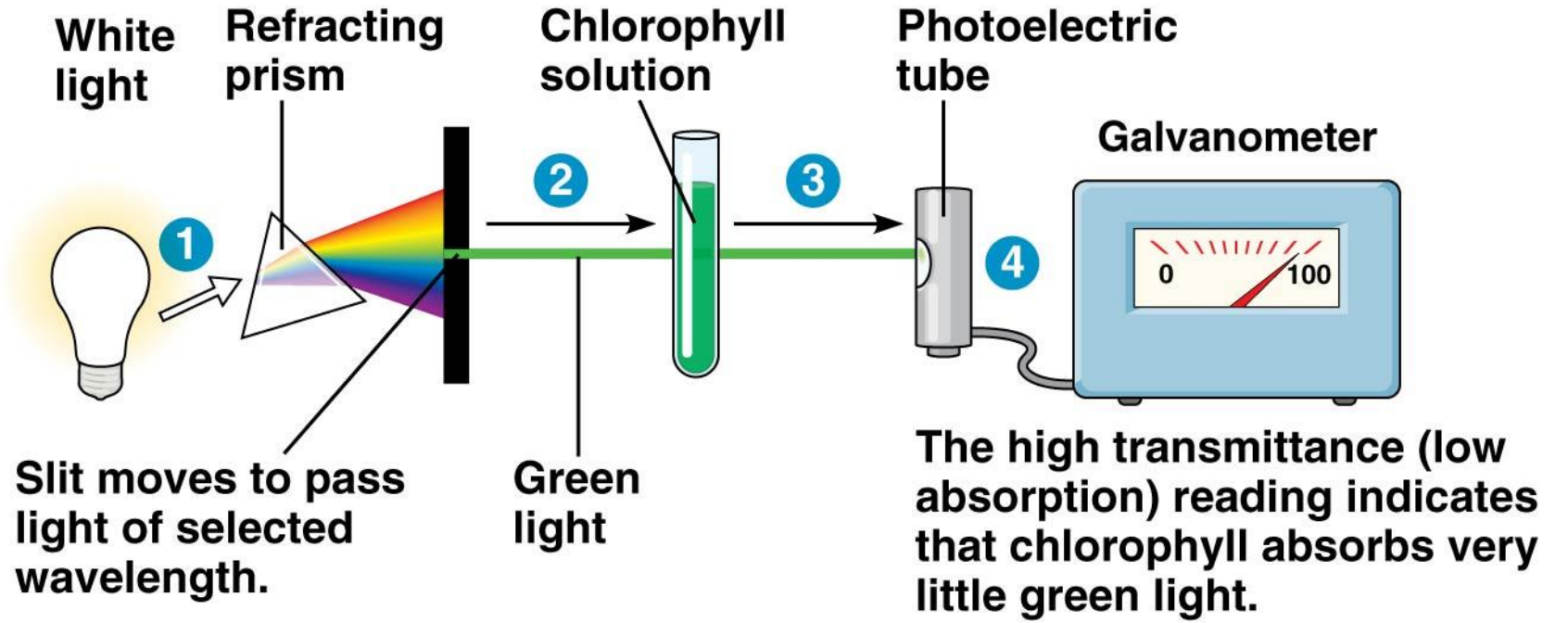
Photosynthesis and the Electromagnetic Spectrum

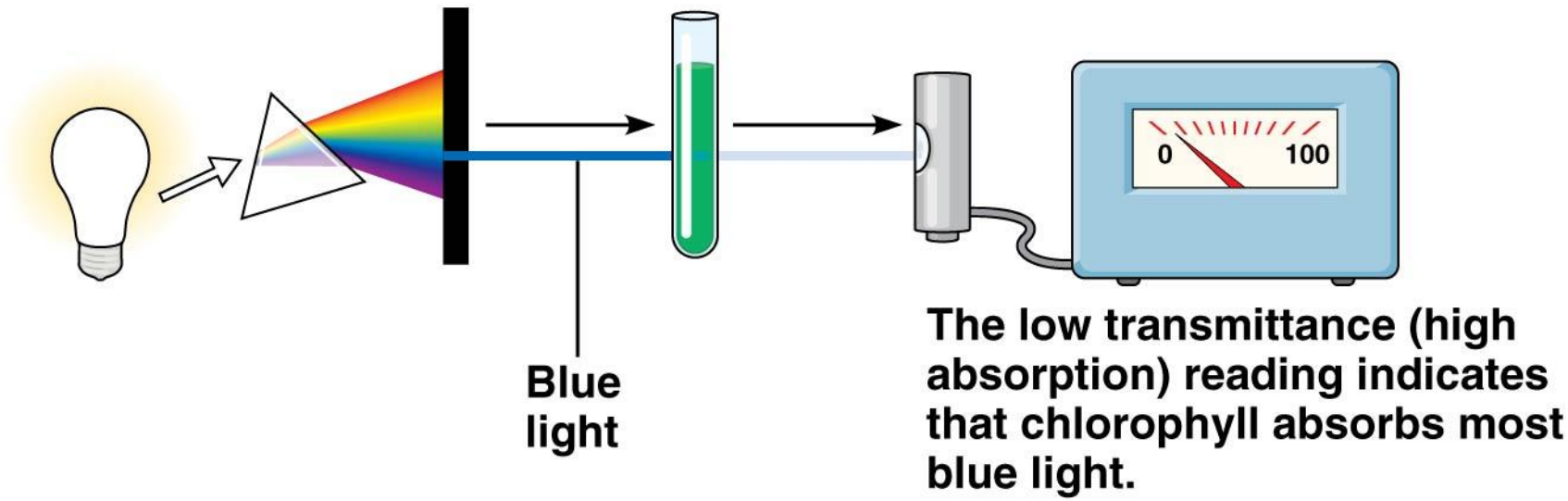


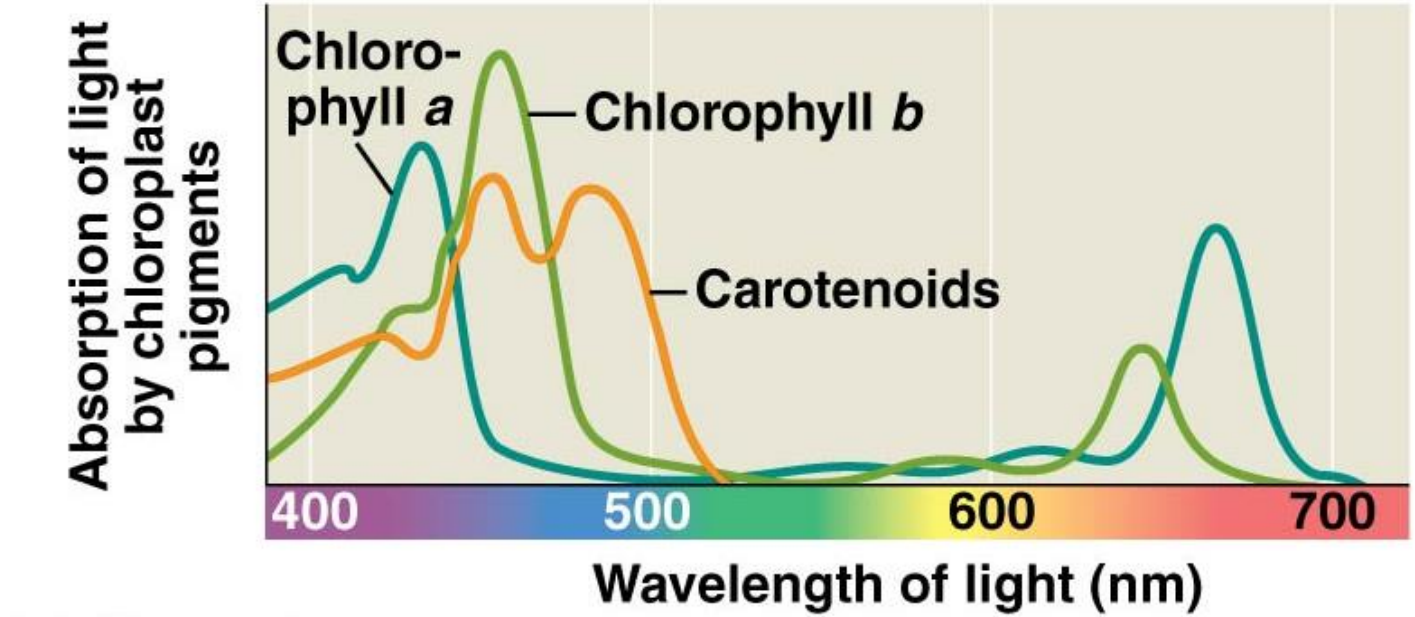


(c) Engelmann's experiment

Technique

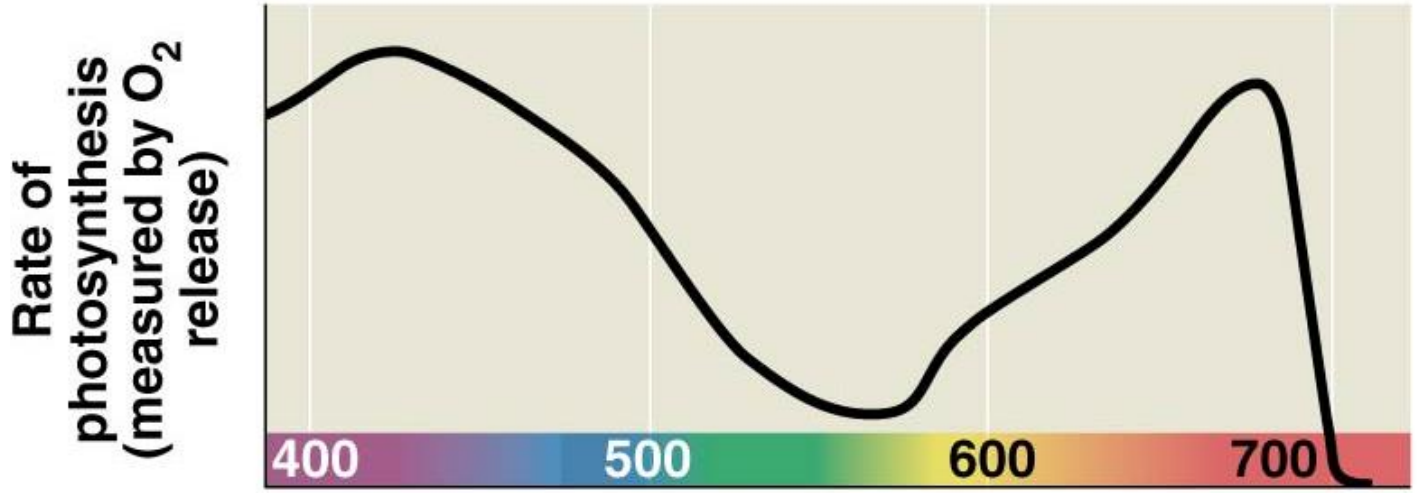




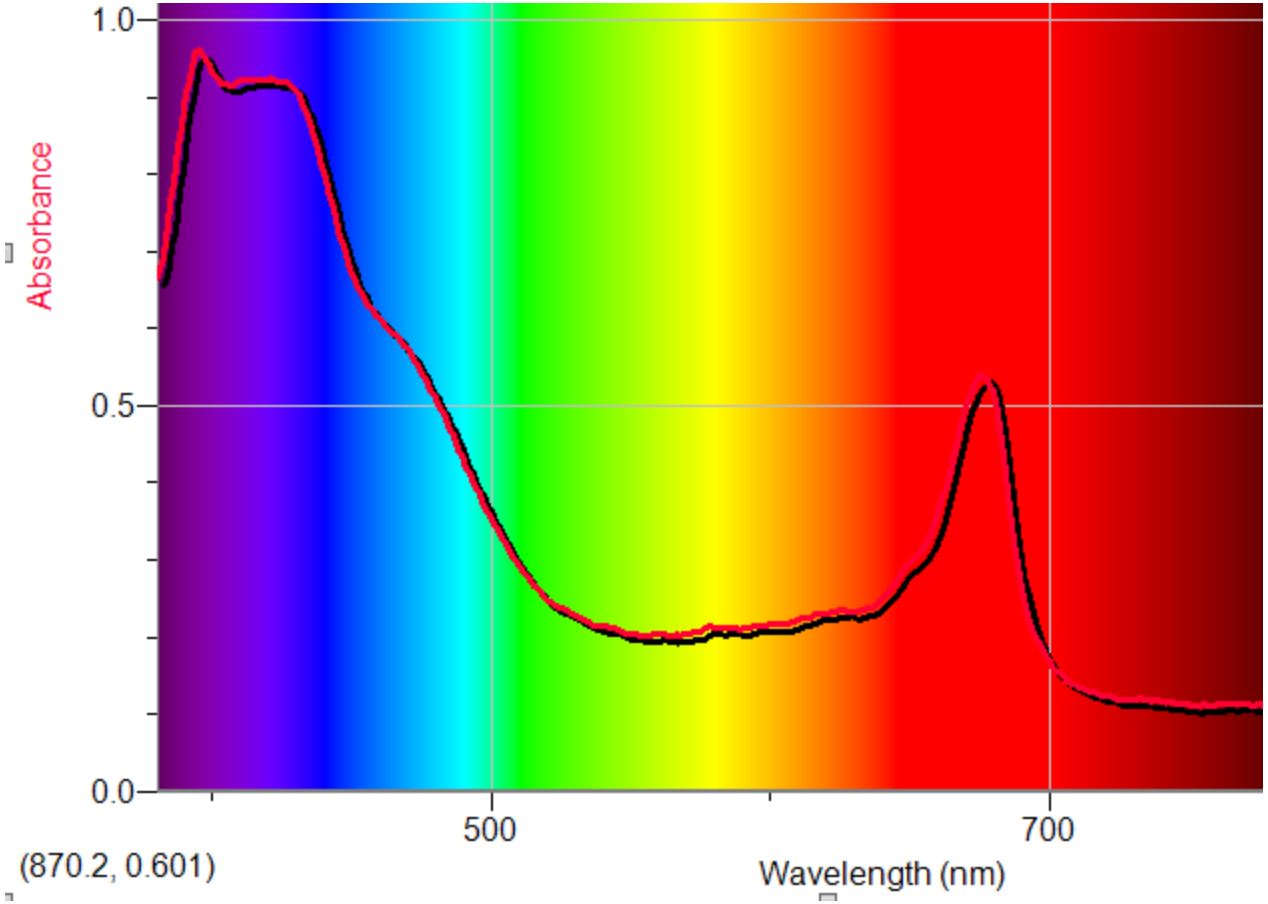


(a) Absorption spectra

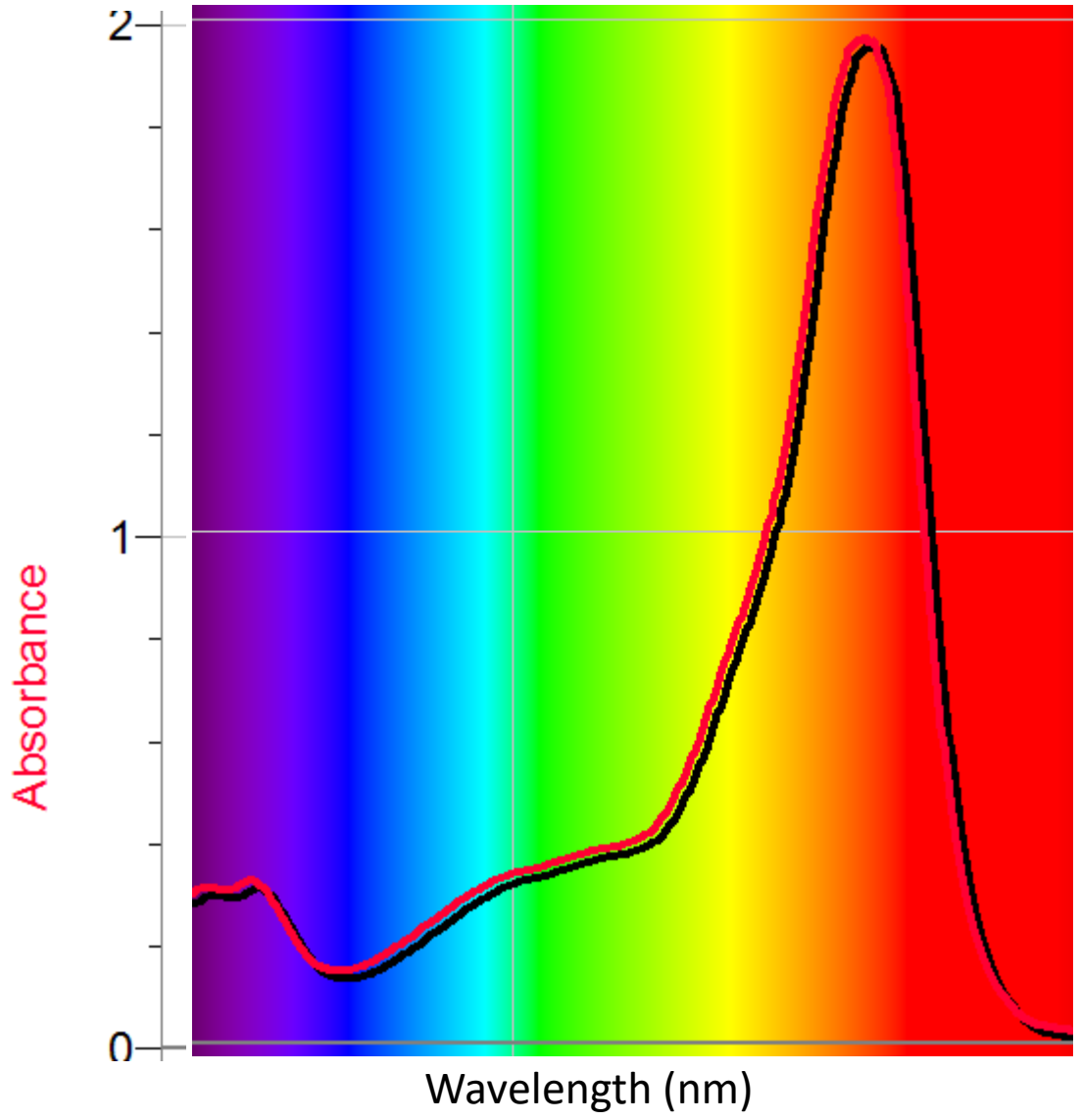
In order to do work in photosynthesis, the light must be absorbed by a pigment



(b) Action spectrum

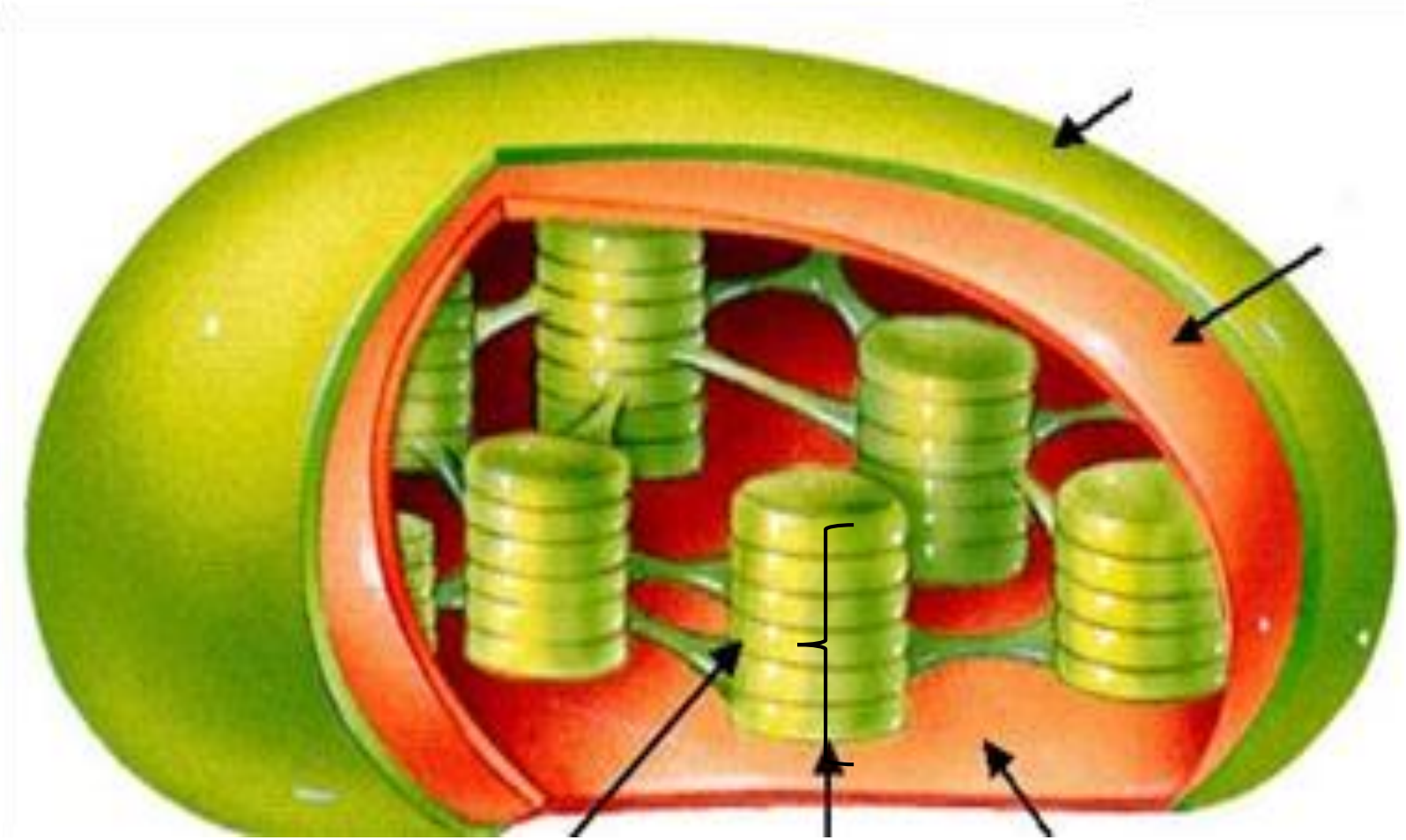


1. Which wavelengths are most strongly absorbed by this pigment (justify your answer)?
2. What color would this pigment appear (justify your answer)?
3. What is the identity of the pigment?

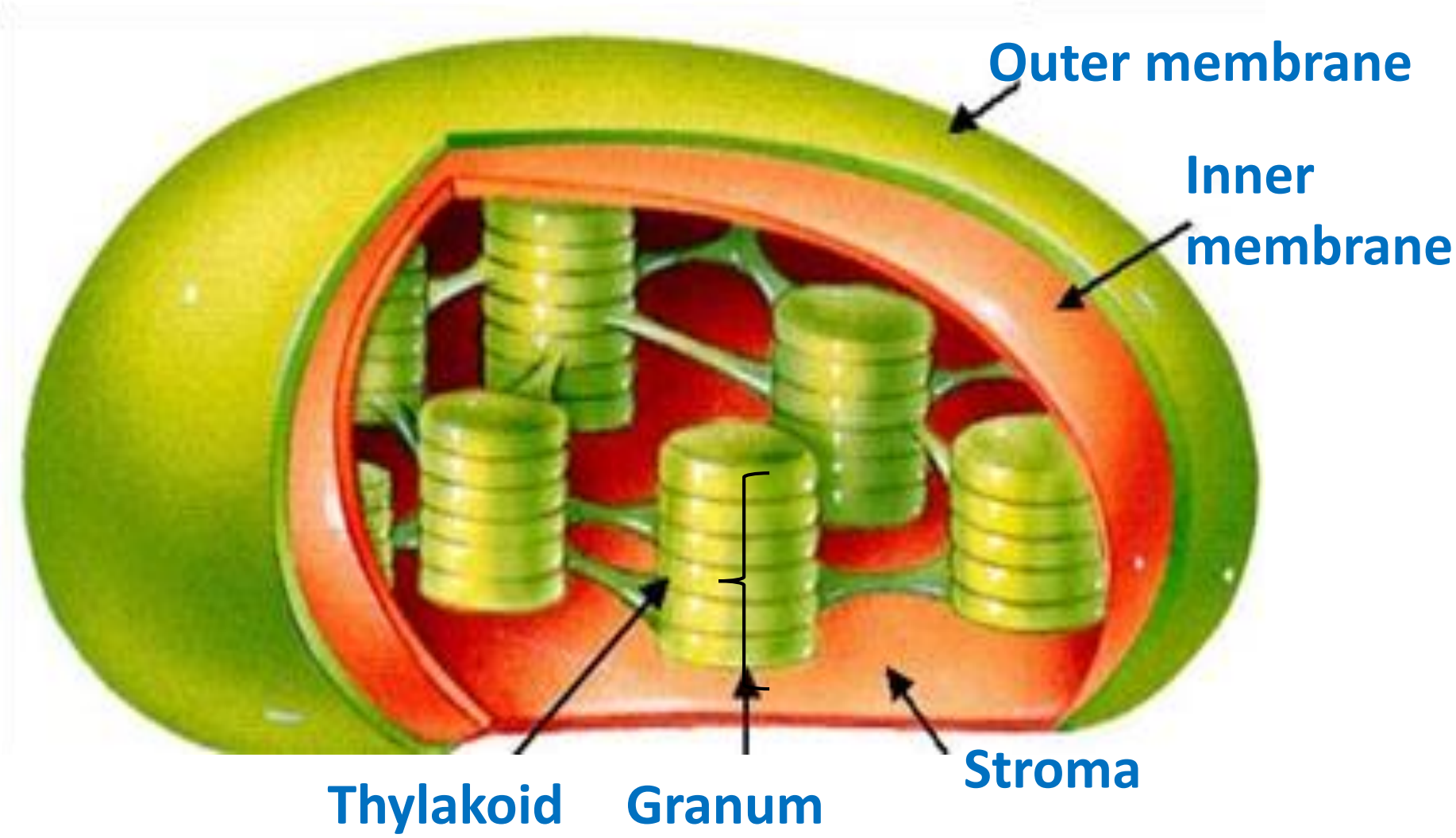


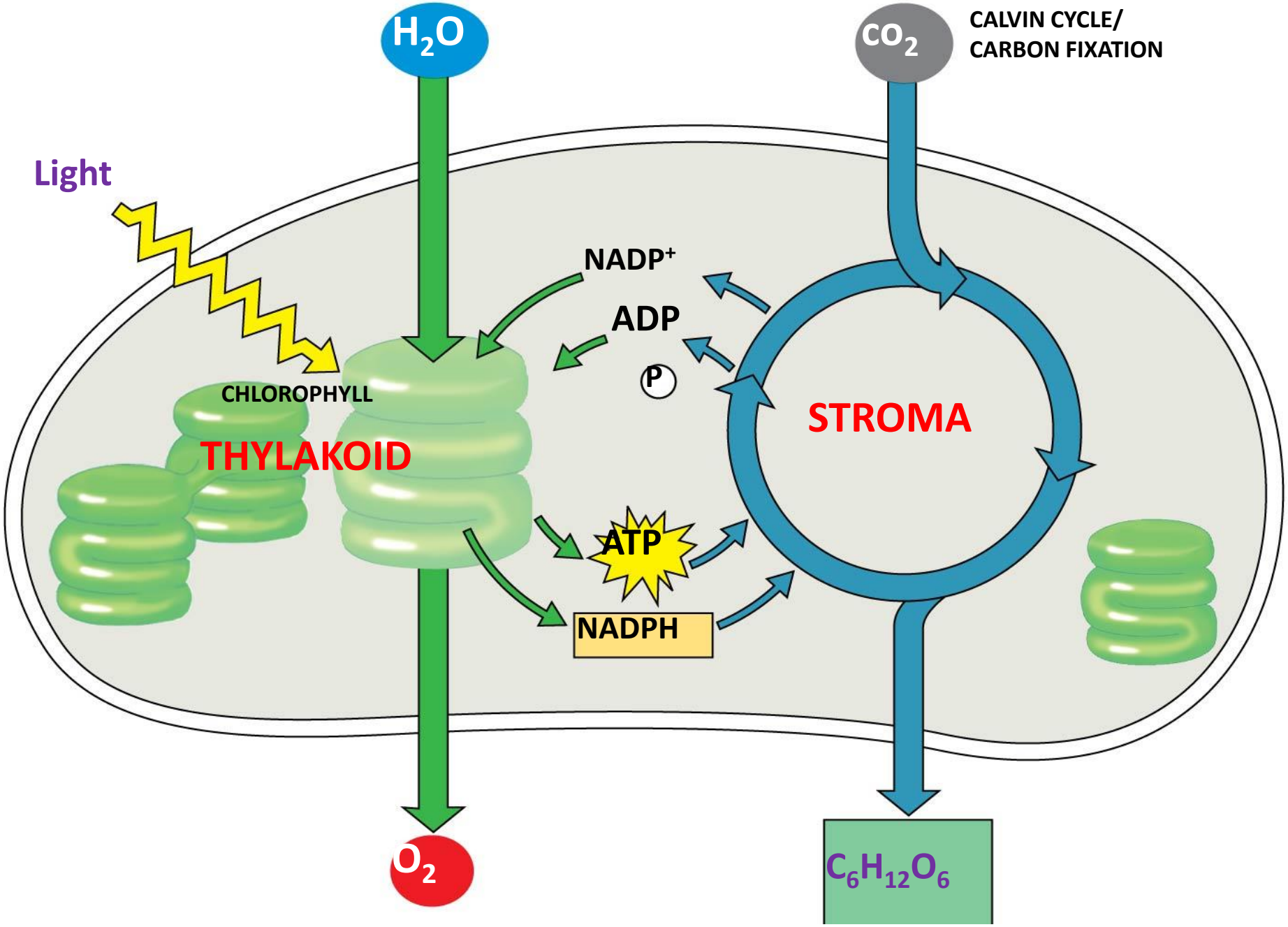
1. Which wavelengths is this pigment absorbing?
2. Make a claim with justification for the color of this pigment.
3. If this were a photosynthetic active pigment, which wavelength(s) would result in the highest rate of photosynthesis?

Chloroplast Structure



Chloroplast Structure




H_2O
CO_2
CALVIN CYCLE/
CARBON FIXATION
Light
$NADP^+$
ADP
P
CHLOROPHYLL
THYLAKOID
STROMA
ATP
NADPH
O_2
$C_6H_{12}O_6$

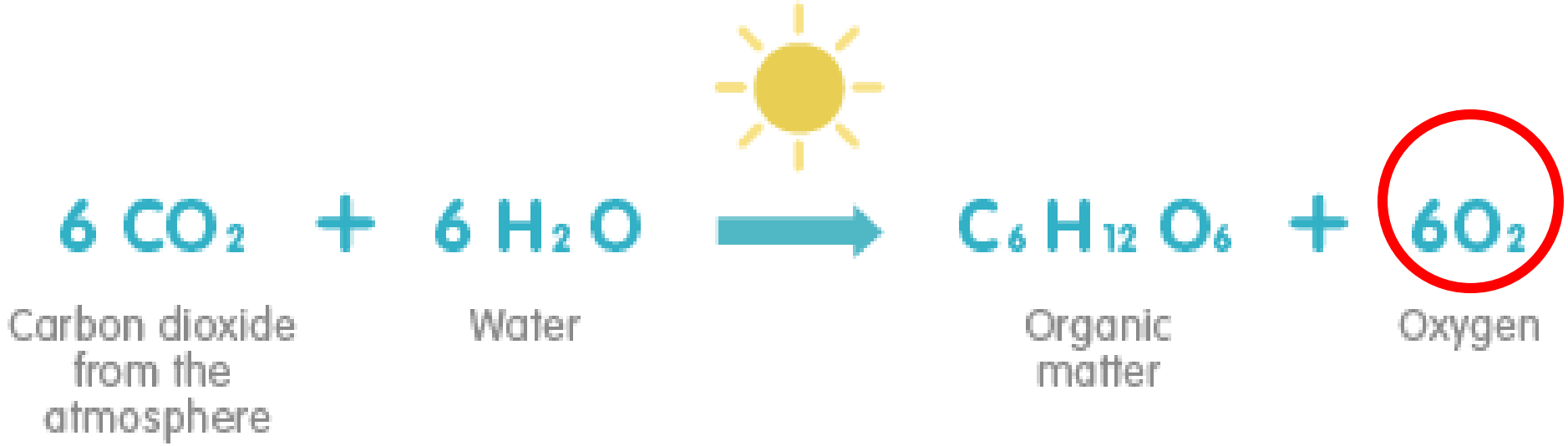
1. Which organelle is shown?
2. What process is diagrammed?
3. Where do the light reactions occur?
4. Where does the Calvin cycle occur?

For the light reactions:

5. Which reactant enters?
6. Which product leaves?
7. What happens to the hydrogen atoms?
8. What is light energy transformed into?

For the Calvin cycle:

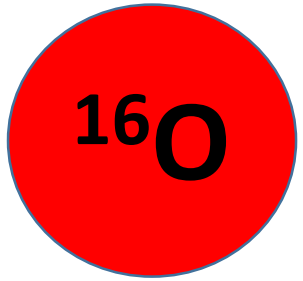
9. Which reactant enters?
10. Which product leaves?
11. Where does the ATP and NADPH come from?
12. What is ATP and NADPH used for?



Does the oxygen gas we breath come from the splitting of CO_2 or H_2O?

Answered by a classic experiment by C.B. van Niel of Stanford University (1930s)

Particle	Symbol	Location	Charge	Relative Mass (amu)
electron	e^-	Electron cloud	–	1/1840 approx 0
proton	p^+	nucleus	+	1
neutron	n^0	nucleus	**0**	1

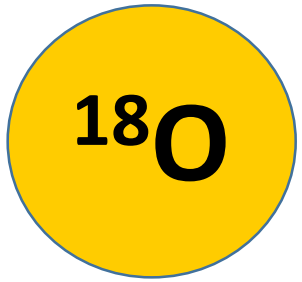


^{16}O

Protons: 8

Neutrons: 8

Electrons: 8



^{18}O

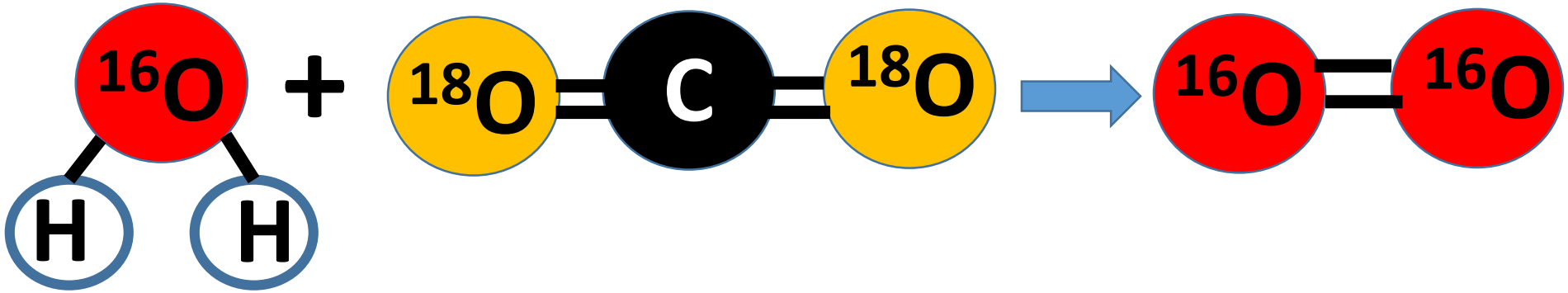
Protons: 8

Neutrons: 10

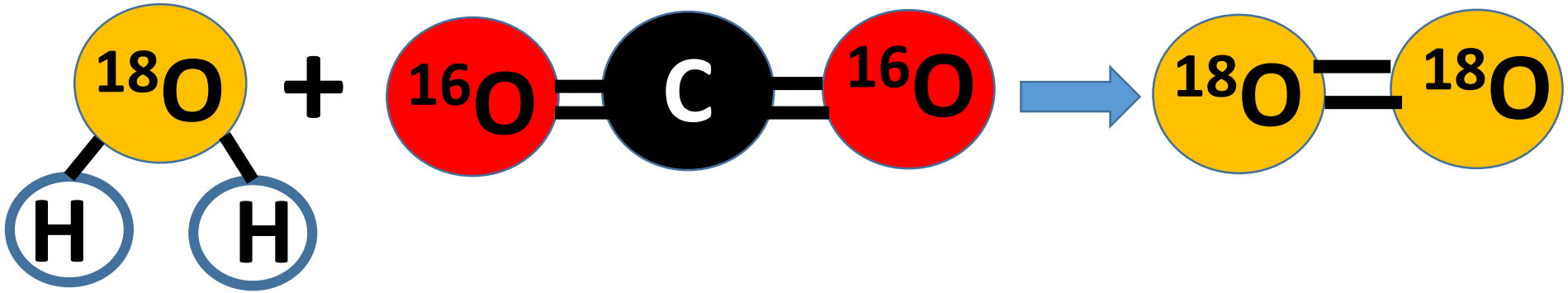
Electrons: 8

1. Describe two ways that ^{16}O and ^{18}O are similar.
2. State one way that the two differ.
3. Calculate the mass of each (in amu):

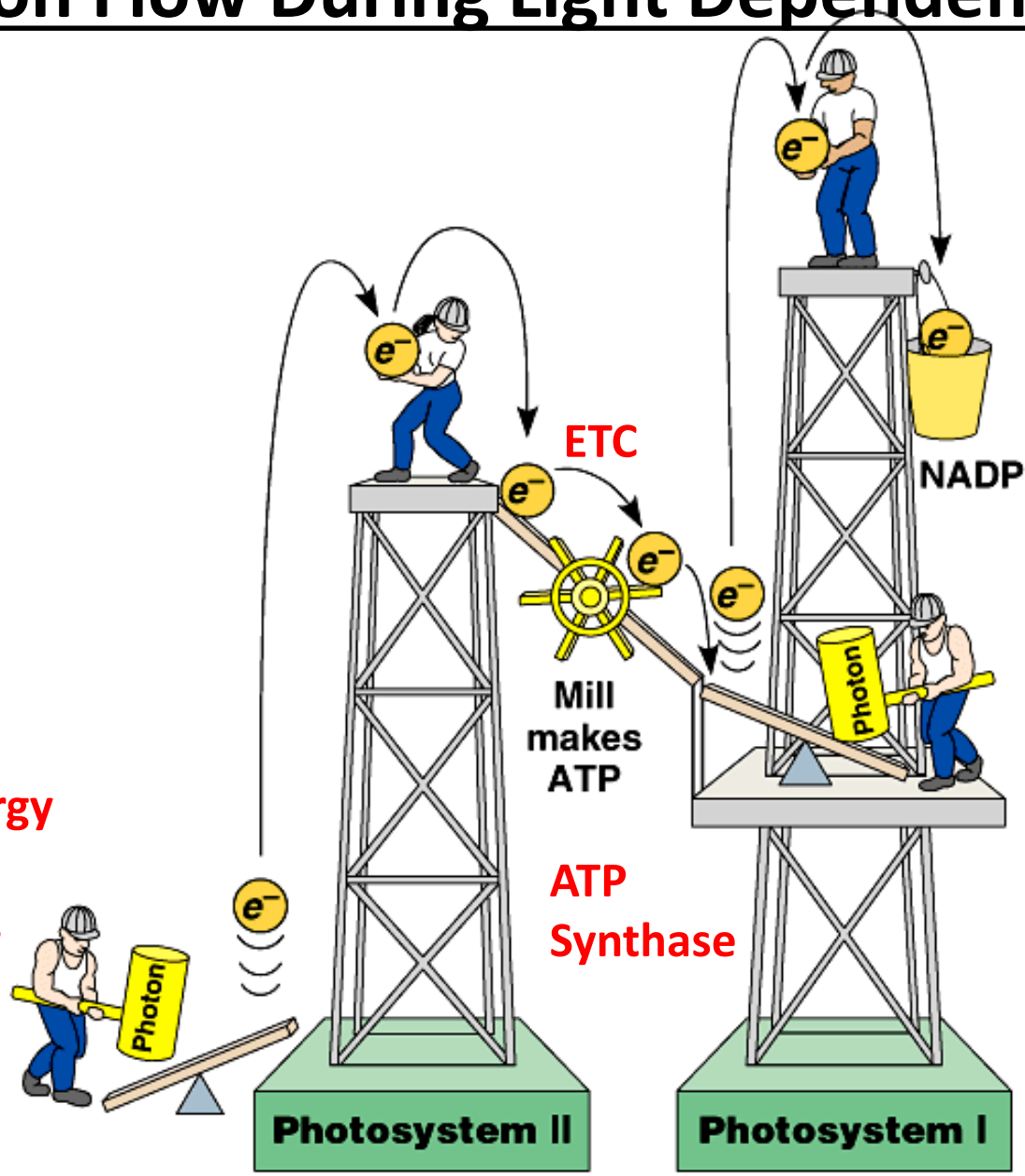
Photosynthesis: Trail #1



Photosynthesis: Trail #2



Electron Flow During Light Dependent Reaction



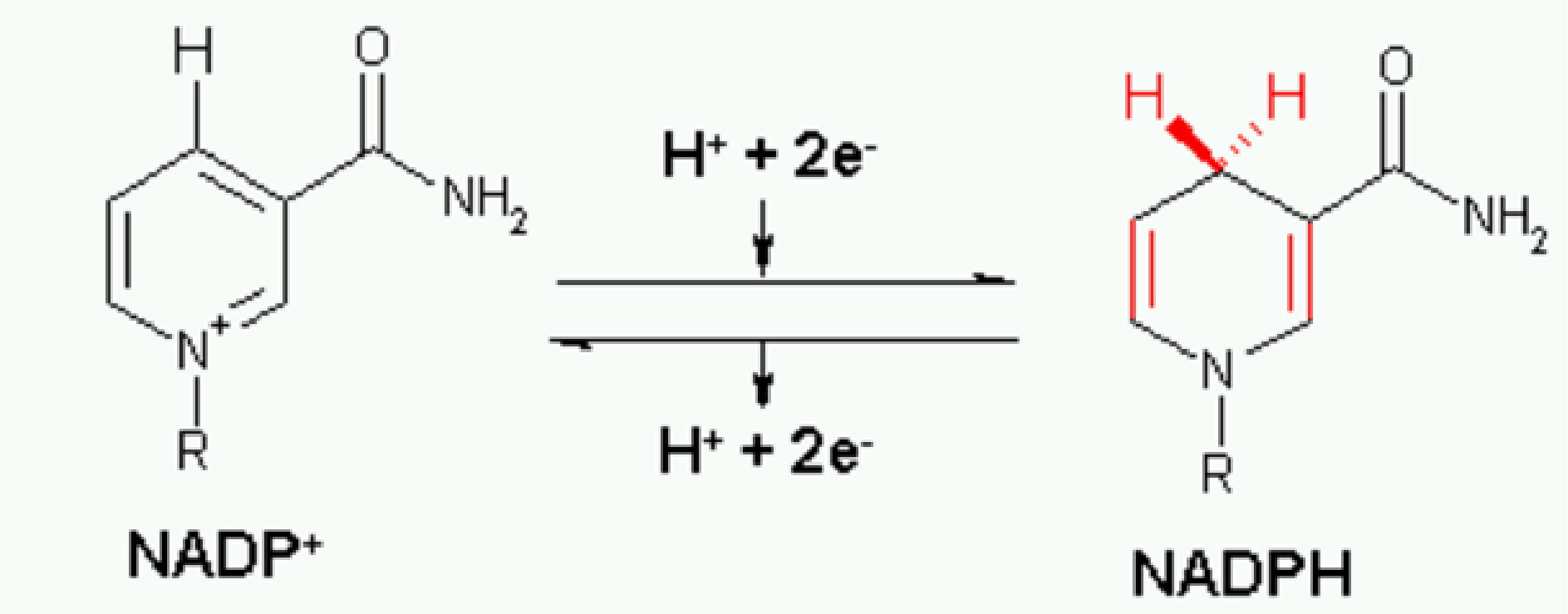
Light energy boosts an electron's potential energy

ATP Synthase

High-energy electron donated to electron-carrier

Chlorophyll

High-energy electron carrier NADPH is a form of potential energy



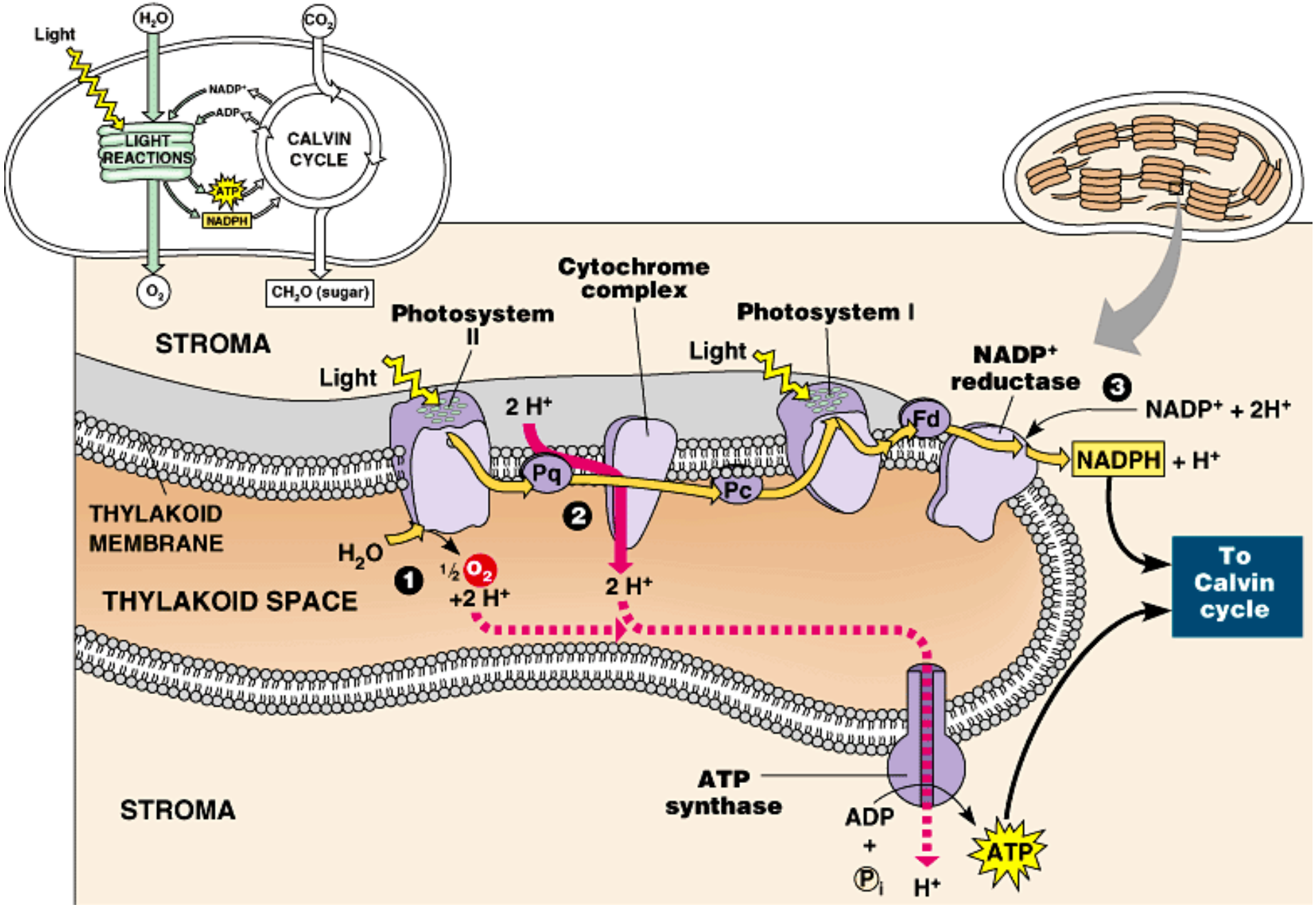
The electrons and Hydrogen come from the splitting of water

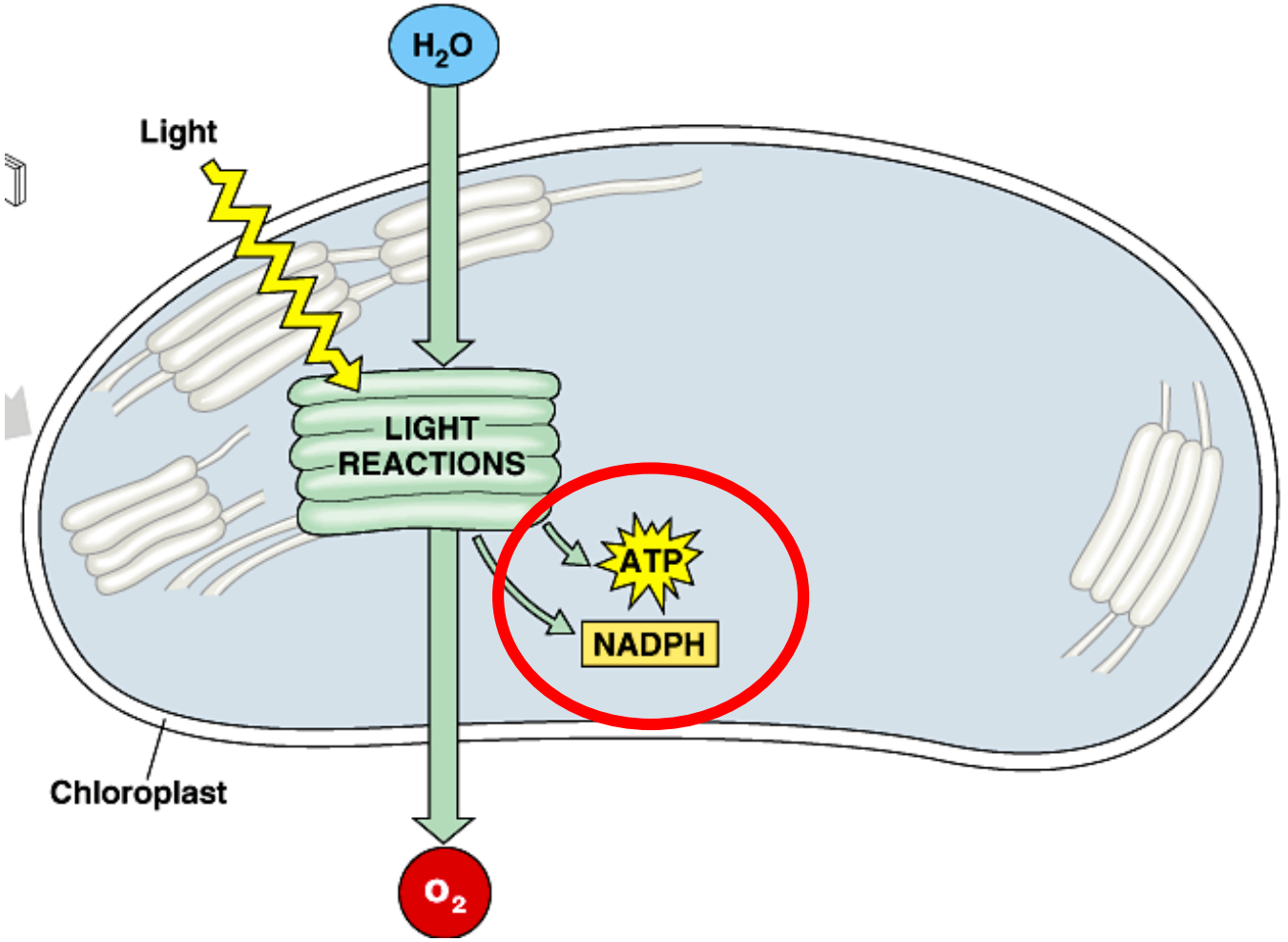
GER = Gain Electrons Reduced

Photosynthesis: Light-dependent reaction animation

http://highered.mheducation.com/olc/dl/120072/bio13.swf

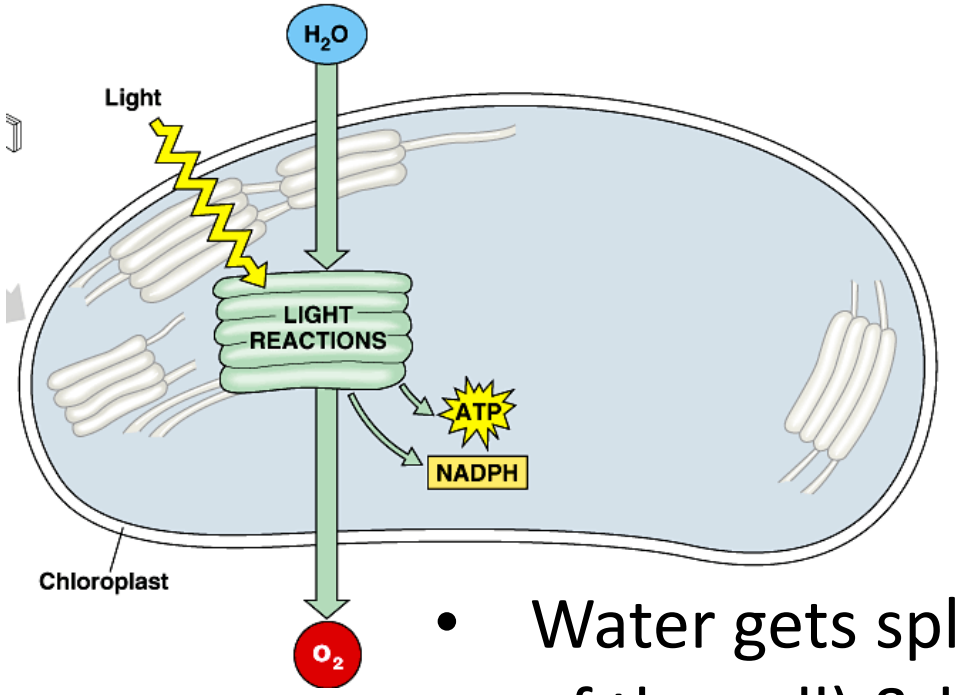
Play: Photosynthesis: Light-Dependent Reaction





- Light energy → chemical potential energy
- Will be used to build glucose (anabolic)

Photosynthesis: The Light-Dependent Reactions

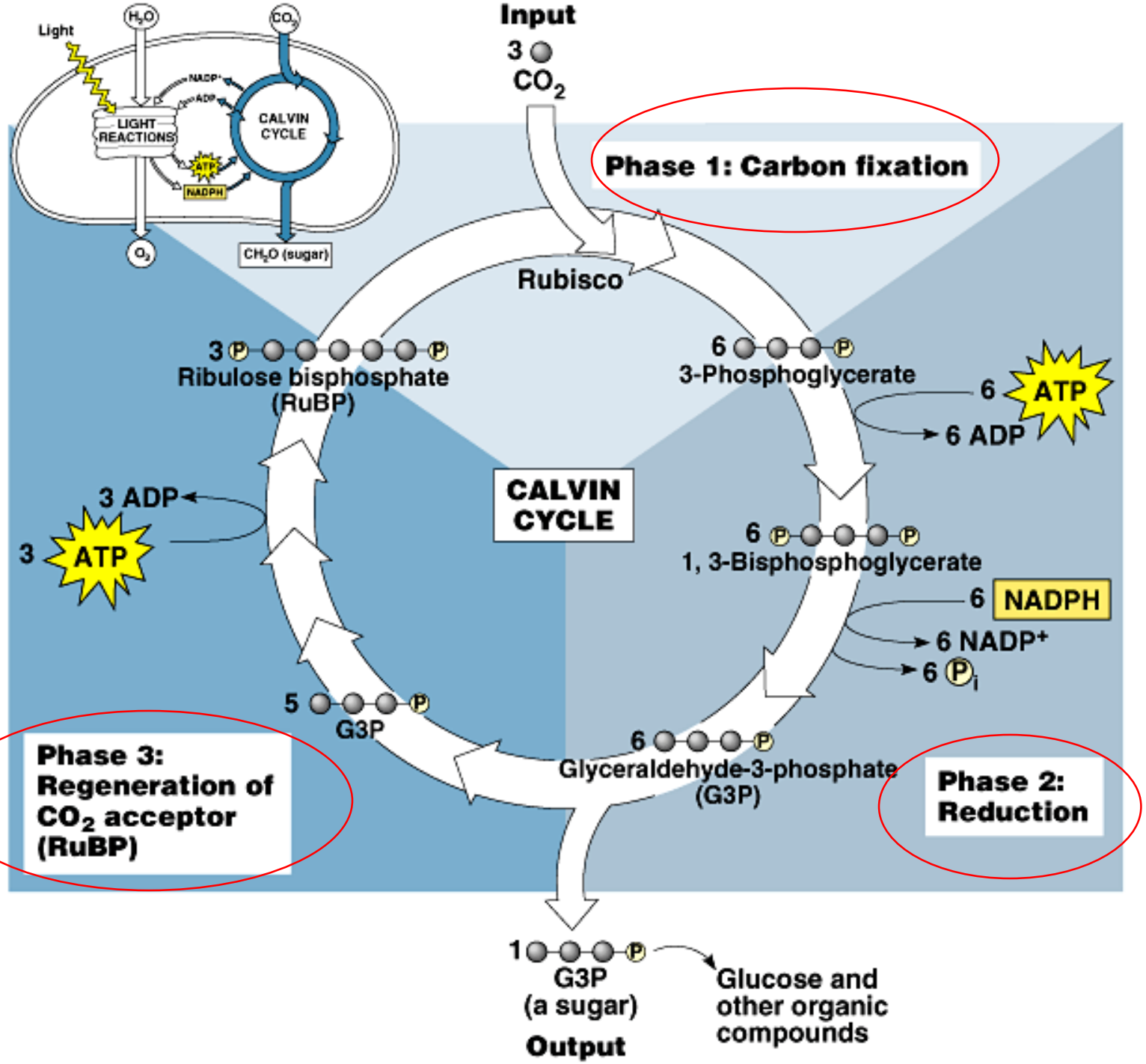


- Requires light
- Occur in the thylakoid membrane (within the chloroplast)
- Water gets split: to oxygen gas (diffuses out of the cell) & hydrogen ions and high-energy electrons, which reduce $NADP^+$ to NADPH & will be added to CO_2 to build glucose
- ATP synthase uses a $[H^+]$ gradient to convert ADP to ATP

Summary of energy input to build 1 glucose

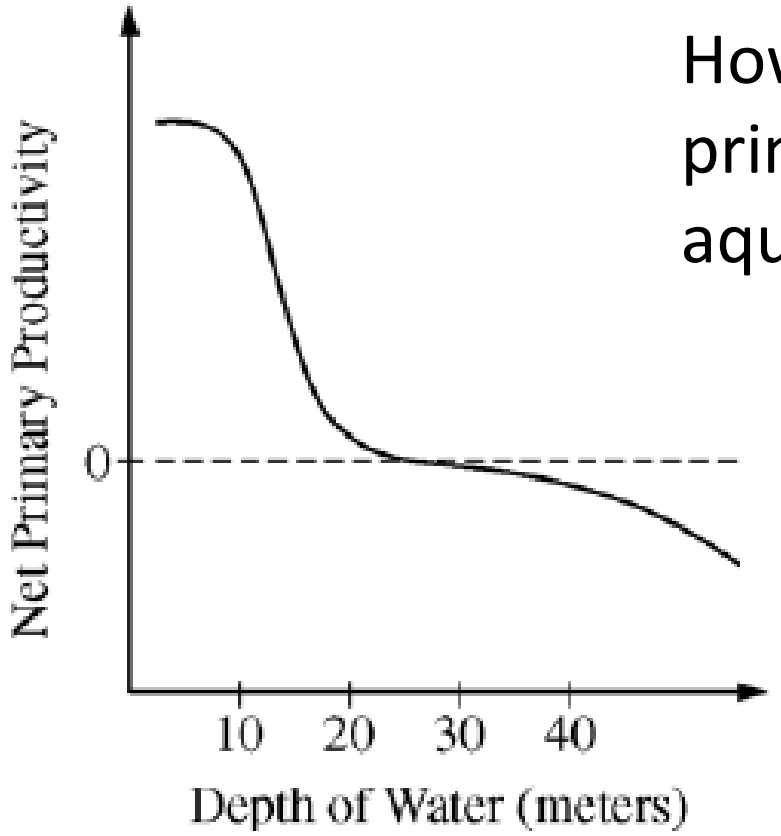
12 NADPH (provides the 12 Hydrogen ions …and high-energy electrons…remember these came from the splitting of H_2O molecules)

18 ATP provide the energy to attach CO_2, hydrogen ions and high-energy electrons together to build (anabolic reaction) $C_6H_{12}O_6$


Light
H_2O
CO_2
NADP+
ADP
LIGHT REACTIONS
CALVIN CYCLE
ATP
NADPH
O_2
CH_2O (sugar)
Input
3 CO_2
Phase 1: Carbon fixation
Rubisco
3 Ribulose bisphosphate (RuBP)
6 3-Phosphoglycerate
6 ATP
6 ADP
CALVIN CYCLE
3 ADP
3 ATP
6 1, 3-Bisphosphoglycerate
6 NADPH
6 NADP+
6 P_i
5 G3P
6 Glyceraldehyde-3-phosphate (G3P)
Phase 3: Regeneration of CO_2 acceptor (RuBP)
Phase 2: Reduction
1 G3P (a sugar)
Output
Glucose and other organic compounds

Calving Cycle Animation

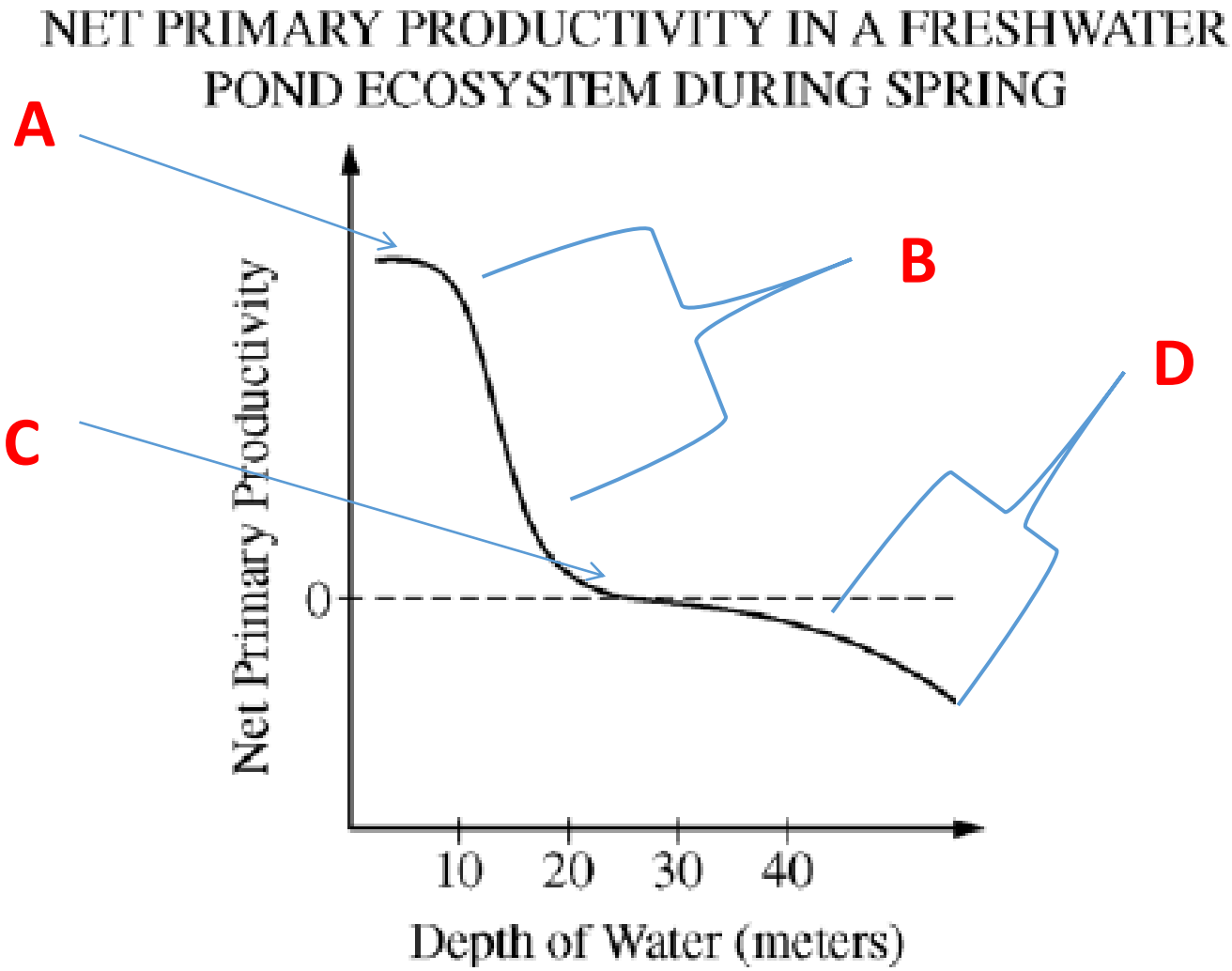
https://highered.mheducation.com/sites/9834092339/student_view0/chapter39/calvin_cycle.html



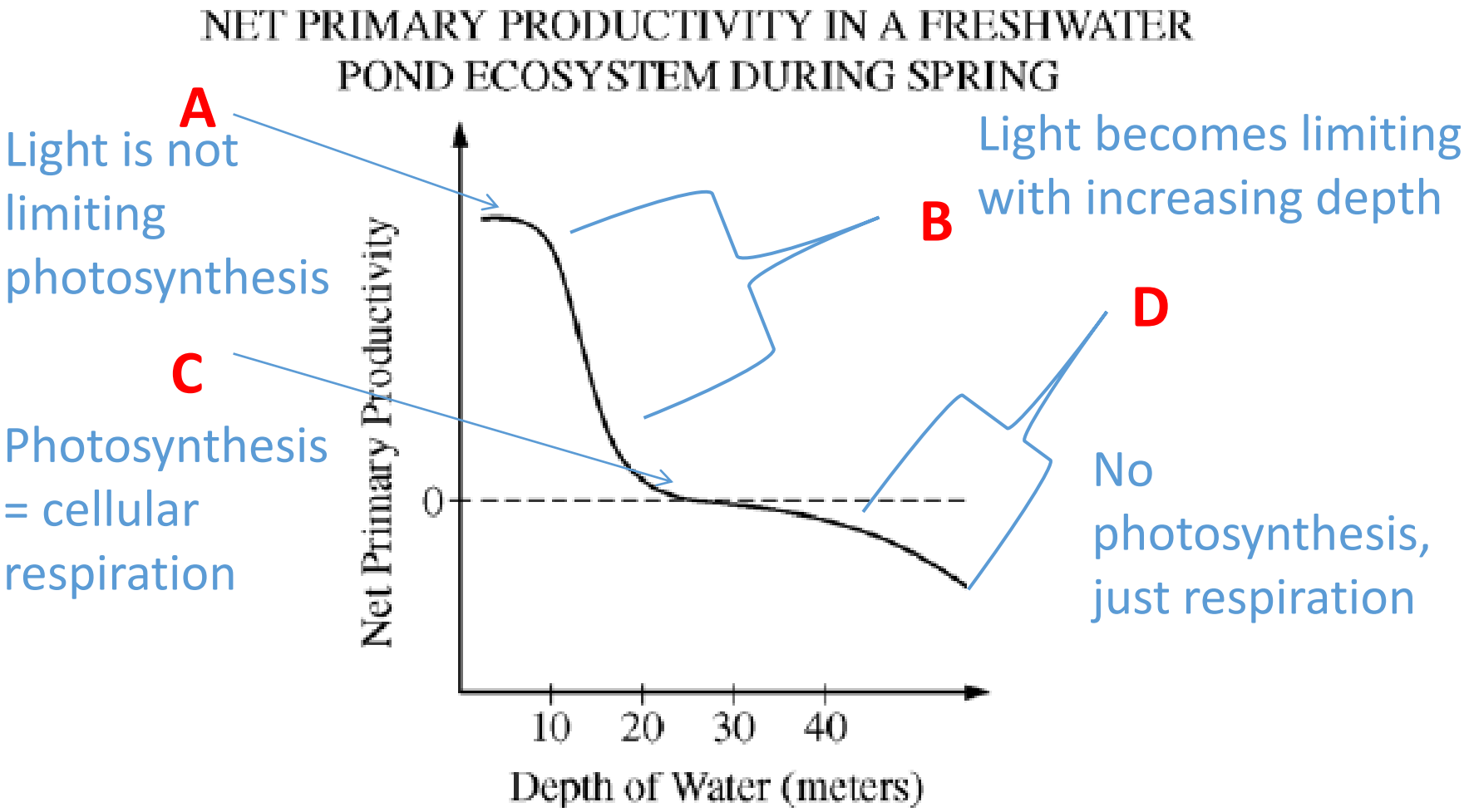
How could you measure/quantify primary productivity in this aquatic community?

- Weight mass of aquatic plants over time, record increase in biomass
- Quantify O_2 production
- Quantify CO_2 removal

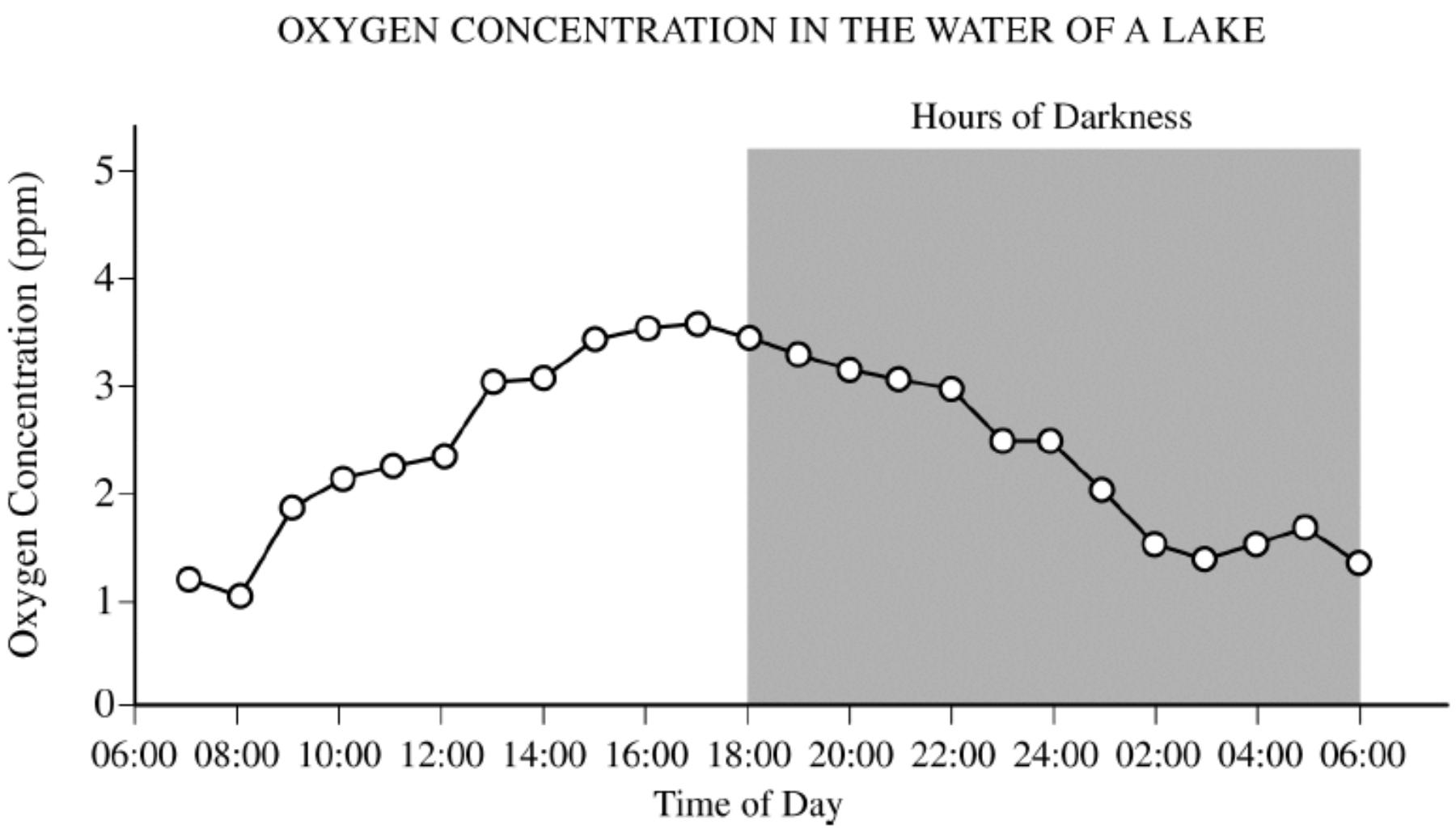
$$6CO_2 \text{ Carbon dioxide} + 6H_2O \text{ Water} \xrightarrow[\text{Enzymes}]{\text{Light}} C_6H_{12}O_6 \text{ Sugar} + 6O_2 \text{ Oxygen}$$



1. Describe how the rate of photosynthesis and cellular respiration compares along depths A – D
2. Describe and explain the relationship between water depth and primary productivity:

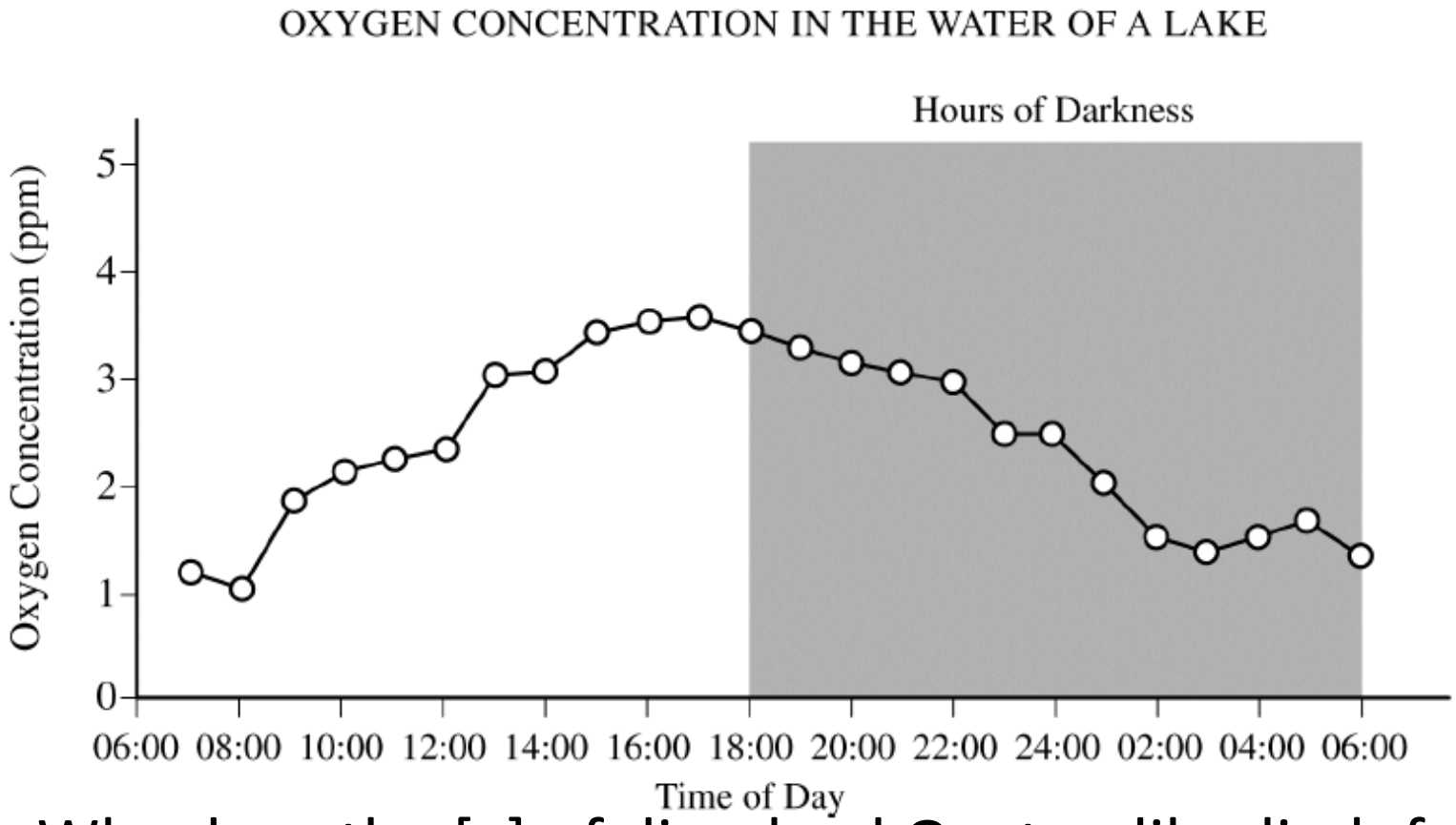


Light is required for photosynthesis. The amount of light available decreases with increasing water depth; therefore the amount of photosynthesis decreases with depth.



1. Why does the [ ] of dissolved O_2 steadily climb from 8:00 to 16:00?

2. Why does the [ ] of dissolved O_2 fall during the night?



1. Why does the [ ] of dissolved O_2 steadily climb from 8:00 to 16:00? Photosynthesis requires light and releases O_2 outpaces respiration during the day
2. Why does the [ ] of dissolved O_2 fall during the night? Photosynthesis stops (with no light), cellular respiration consumes O_2