



About Science Prof Online PowerPoint Resources

- Science Prof Online (SPO) is a free science education website that provides fully-developed Virtual Science Classrooms, science-related PowerPoints, articles and images. The site is designed to be a helpful resource for students, educators, and anyone interested in learning about science.
- The SPO Virtual Classrooms offer many educational resources, including practice test questions, review questions, lecture PowerPoints, video tutorials, sample assignments and course syllabi. New materials are continually being developed, so check back frequently, or follow us on Facebook (Science Prof Online) or Twitter (ScienceProfSPO) for updates.
- Many SPO PowerPoints are available in a variety of formats, such as fully editable PowerPoint files, as well as uneditable versions in smaller file sizes, such as PowerPoint Shows and Portable Document Format (.pdf), for ease of printing.
- Images used on this resource, and on the SPO website are, wherever possible, credited and linked to their source. Any words underlined and appearing in blue are links that can be clicked on for more information. PowerPoints must be viewed in *slide show mode* to use the hyperlinks directly.
- Several helpful links to fun and interactive learning tools are included throughout the PPT and on the Smart Links slide, near the end of each presentation. You must be in *slide show mode* to utilize hyperlinks and animations.
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"Photosynthesis"

a song by
They Might Be Giants

LYRICS

Photosynthesis
Photosynthesis
Photosynthesis

Photosynthesis does not involve a camera
Or a synthesizer
Although that's interesting too
Photosynthesis is how plants take in light
From the sun and turn it into energy
It's actually a thing on which most life depends
Here on the planet Earth

Photosynthesis X3

With plants

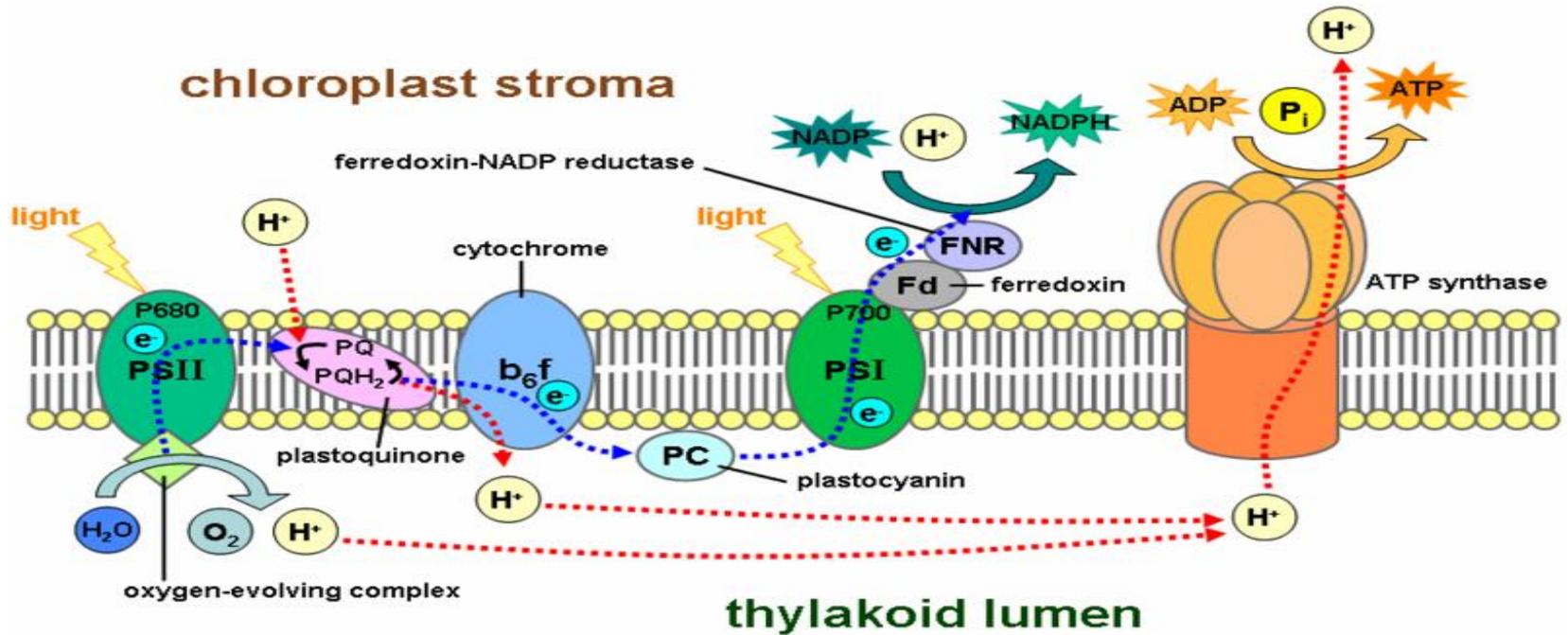
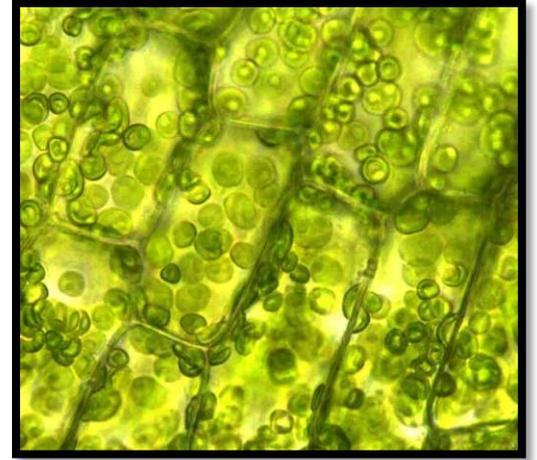
Chlorophyll cells take in carbon dioxide
Now that's the air that we breathe out
Combines it with water and exposes it to sunlight
And that's how plants can make their own food
Photosynthesis is why plants need light
And photosynthesis is why humans need plants
Because through photosynthesis plants make oxygen
And humans need oxygen to breathe

Photosynthesis x3



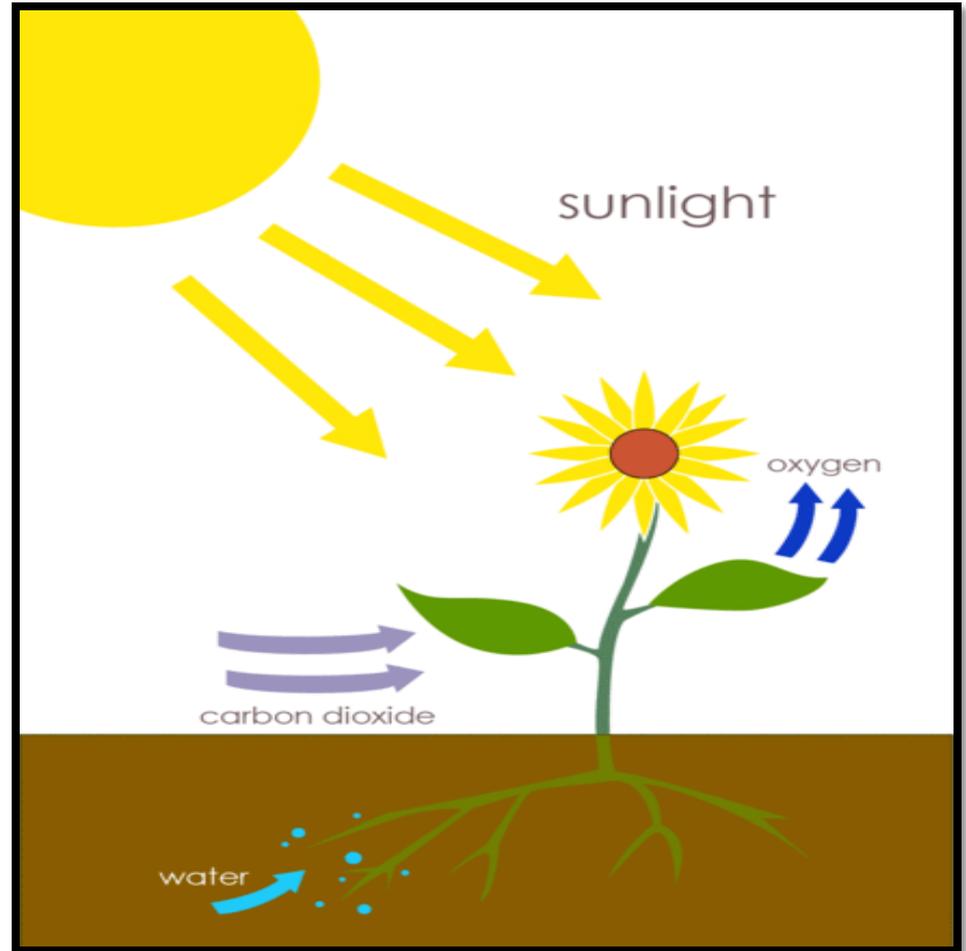
Watch the
"Photosynthesis"
music video!

Photosynthesis: Light Dependent Reactions



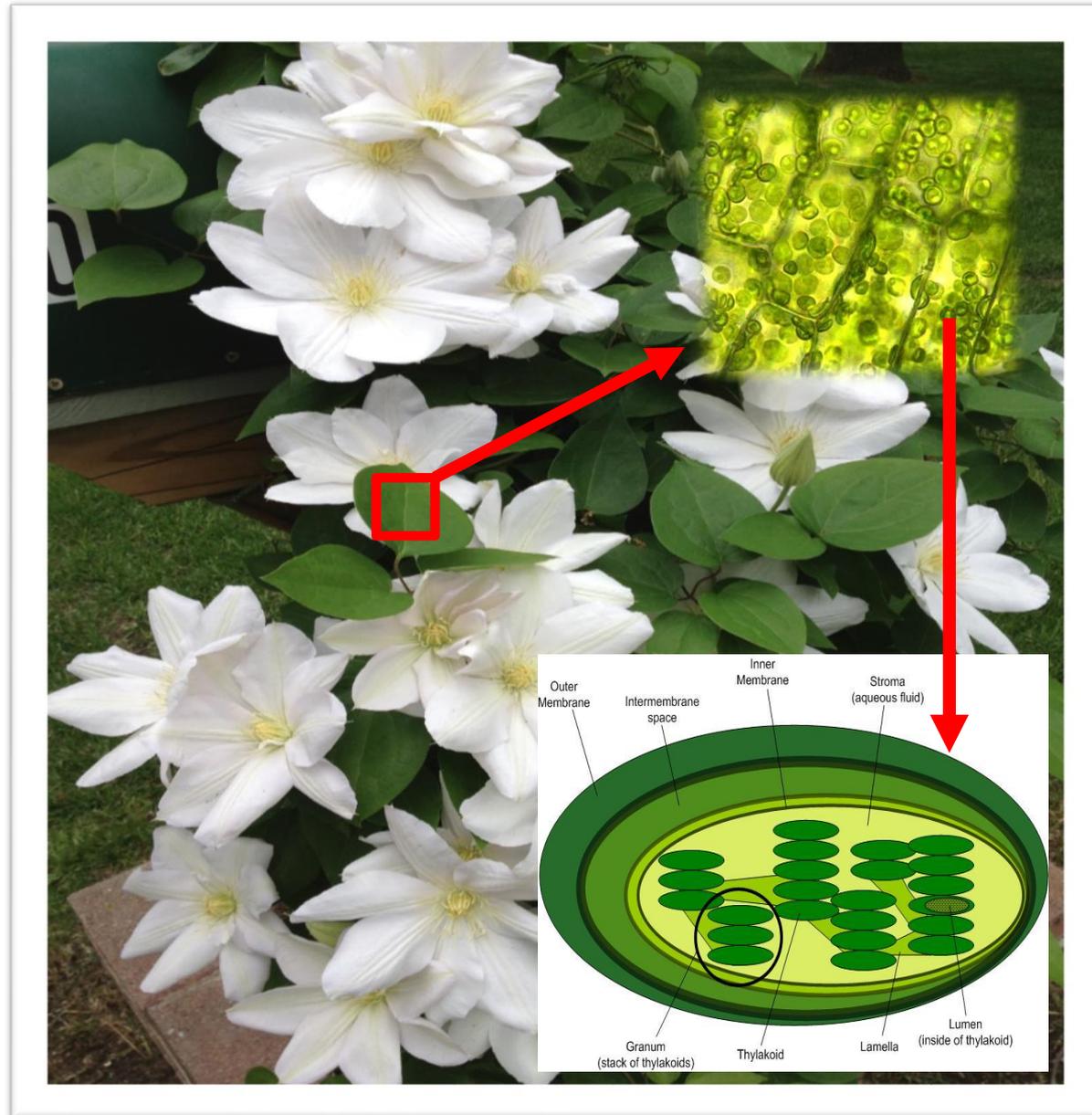
Photosynthesis

- The food chain begins with **autotrophs**, organisms that can make their own food.
- Most of autotrophs capture **light** energy from the sun and use it, along with CO_2 and H_2O , to drive the synthesis of **glucose**.
- **Q:** What is glucose?
- The **oxygen** we breathe is a waste product of photosynthesis.

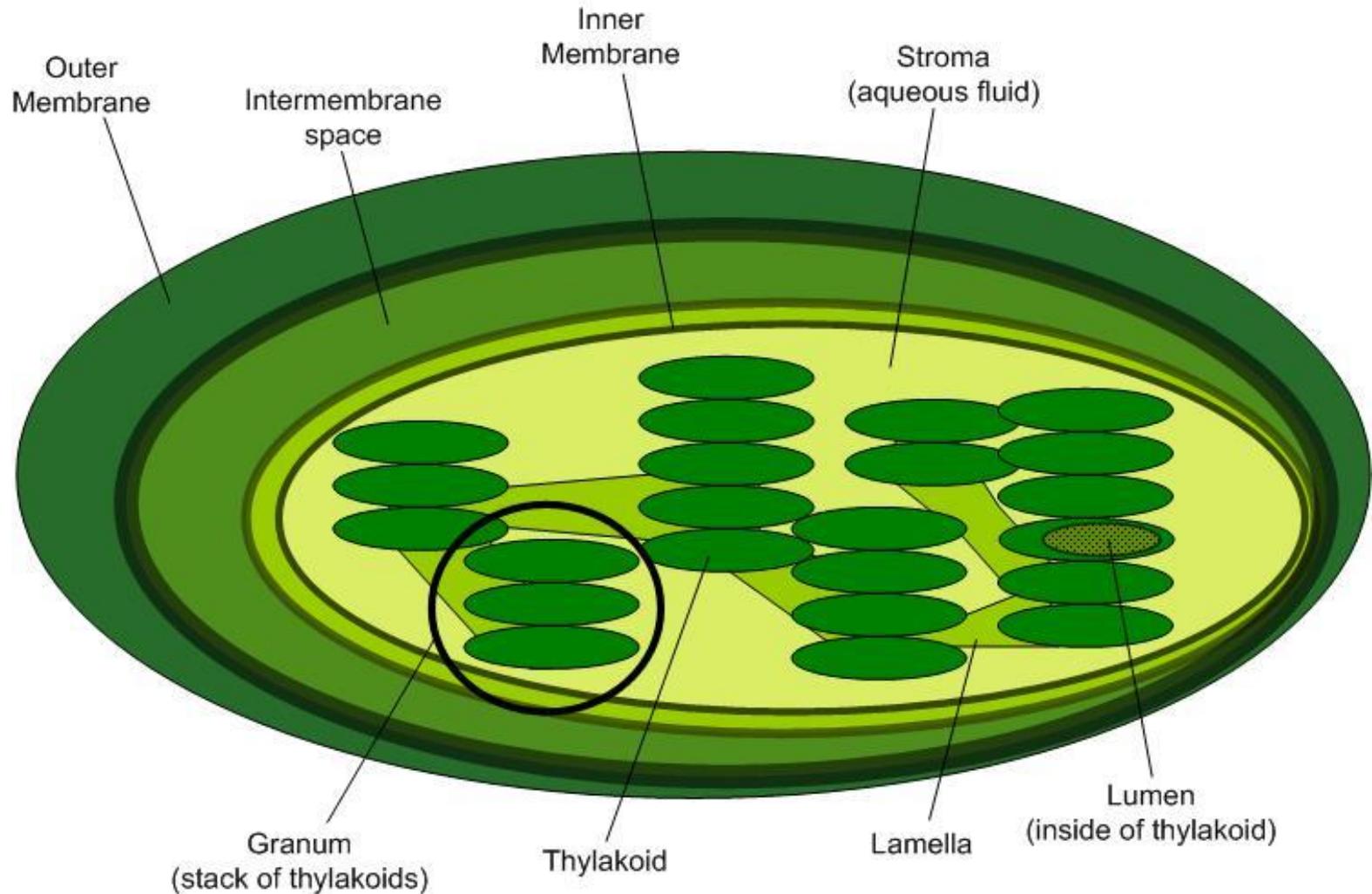


WHERE does photosynthesis happen?

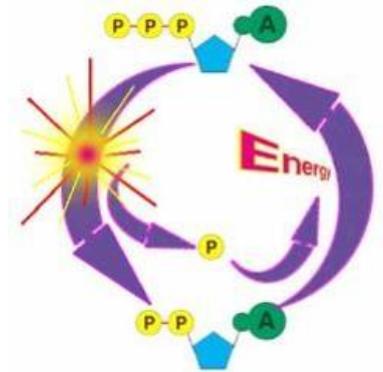
- Eukaryotic autotrophs, like plants, have **chlorophyll** (green photosynthetic pigment) in organelles called **chloroplasts**.
- All green parts of a plant, including stems, have chloroplasts, but leaves are where most of the photosynthesis happens.
- Leaves are like the "solar panels" of a plant.
- Lets look at the different parts of a chloroplast ➤



WHERE does photosynthesis happen?



HOW does photosynthesis happen?



Photosynthesis can be divided into two main stages:

- **Stage 1 - Light dependent reactions:**

The chloroplast traps **light energy** and, with the help of water, converts the light energy into **chemical energy**.

ATP & NADPH are like tiny rechargeable batteries in the cell.

Light energy can be put into these "battery" molecules to provide mobile energy to do cellular work.

Adenosine diphosphate (ADP) + Pi & energy > **Adenosine Triphosphate (ATP)**

Nicotinamide adenine dinucleotide phosphate (NADP⁺) + electron & hydrogen ion > **NADPH**



- **Stage 2 - Light independent reactions:**

The energy captured in NADPH & ATP is used, with CO₂, to make glucose (food).

HOW does photosynthesis happen?

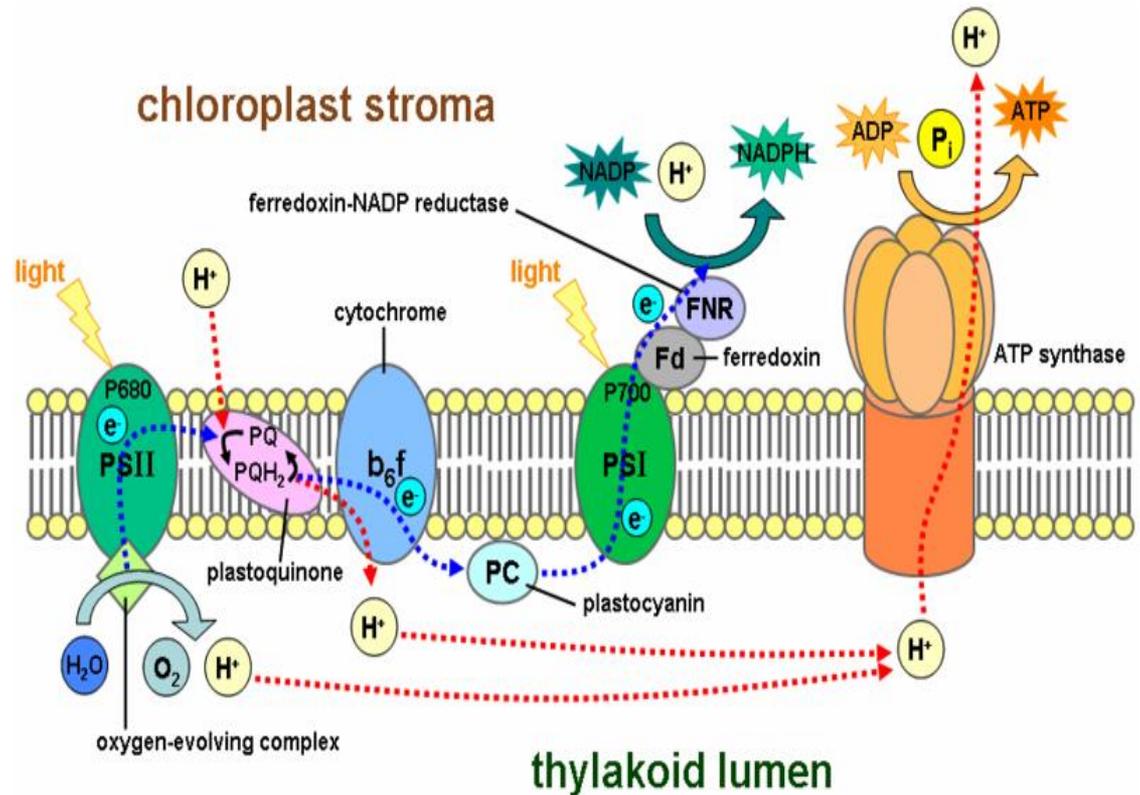
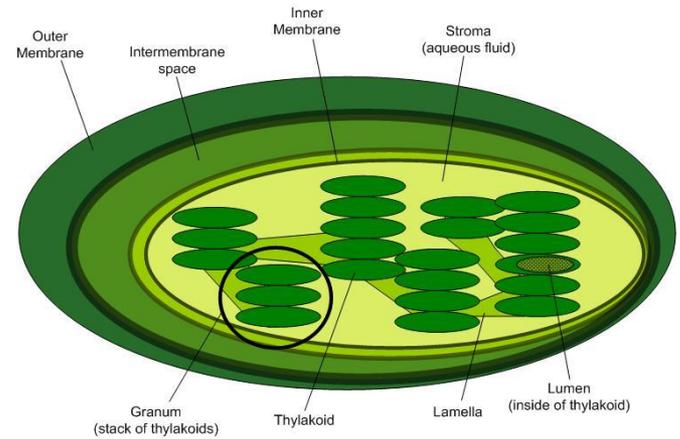
Thylakoid membrane contains **electron transport chains** > groups of proteins that run the light-dependent reactions.

Four major players in the thylakoid membrane:

- Photosystem II (PS2)
- Cytochrome
- Photosystem I (PS1)
- the enzyme ATP synthase

They work together to make the charged up "batteries".

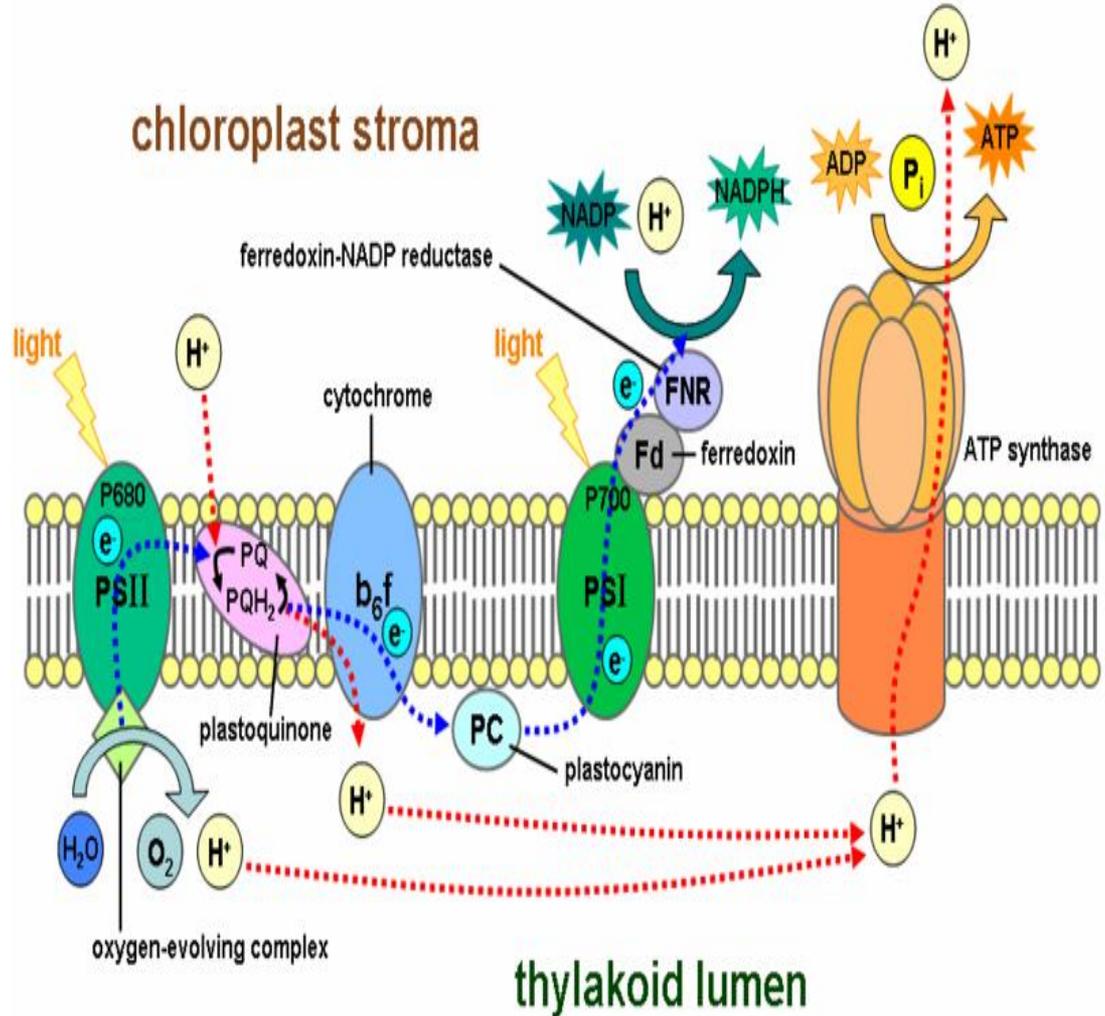
Q: What are the names of the rechargeable batteries?



HOW does photosynthesis happen?

Four main events occur in these thylakoid membrane protein complexes:

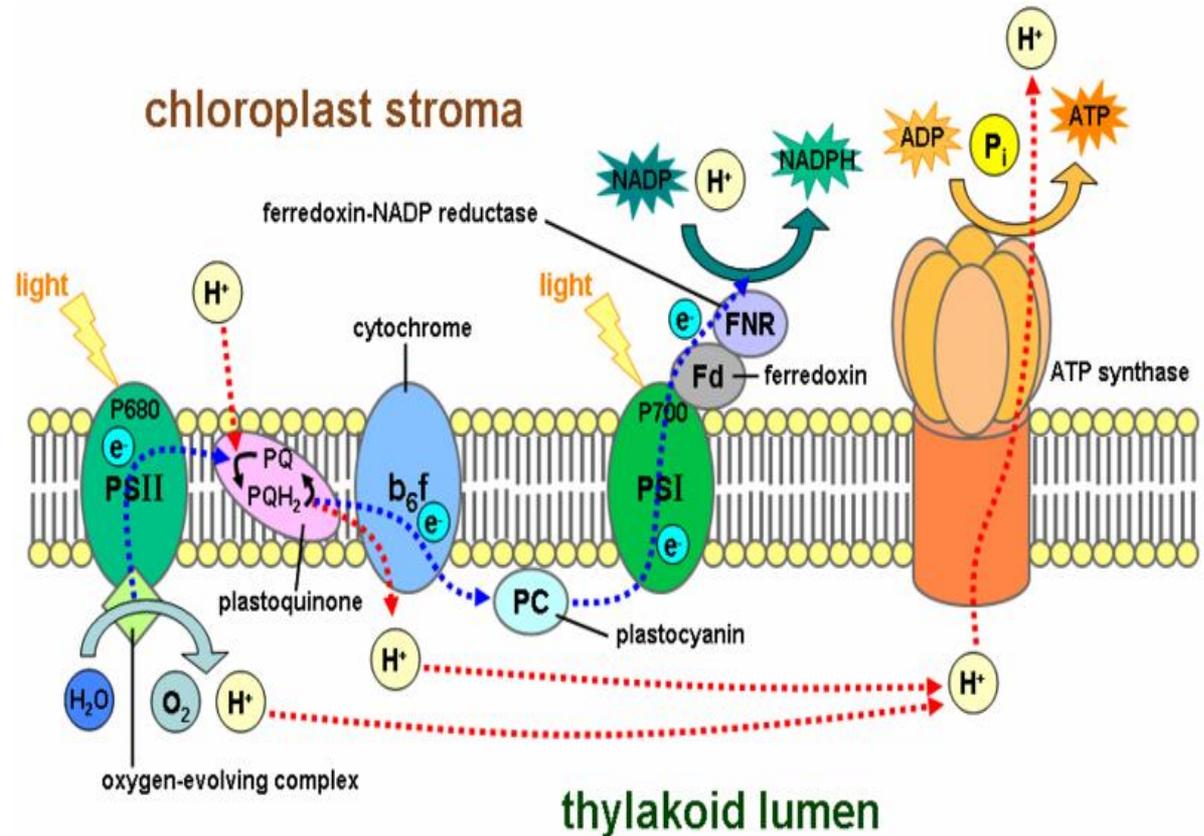
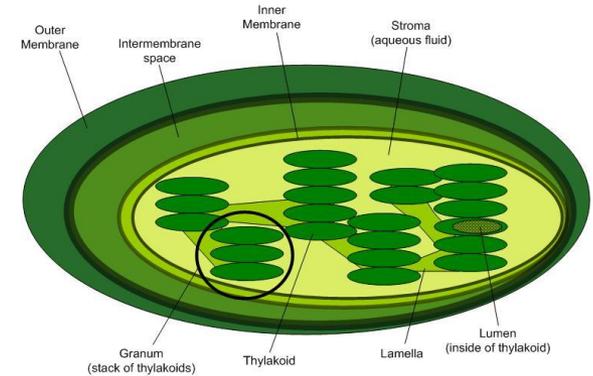
1. Electron transport
2. Making NADPH
3. Creation of a hydrogen ion (H^+) gradient
4. Making ATP



HOW does photosynthesis happen?

1. Electron transport

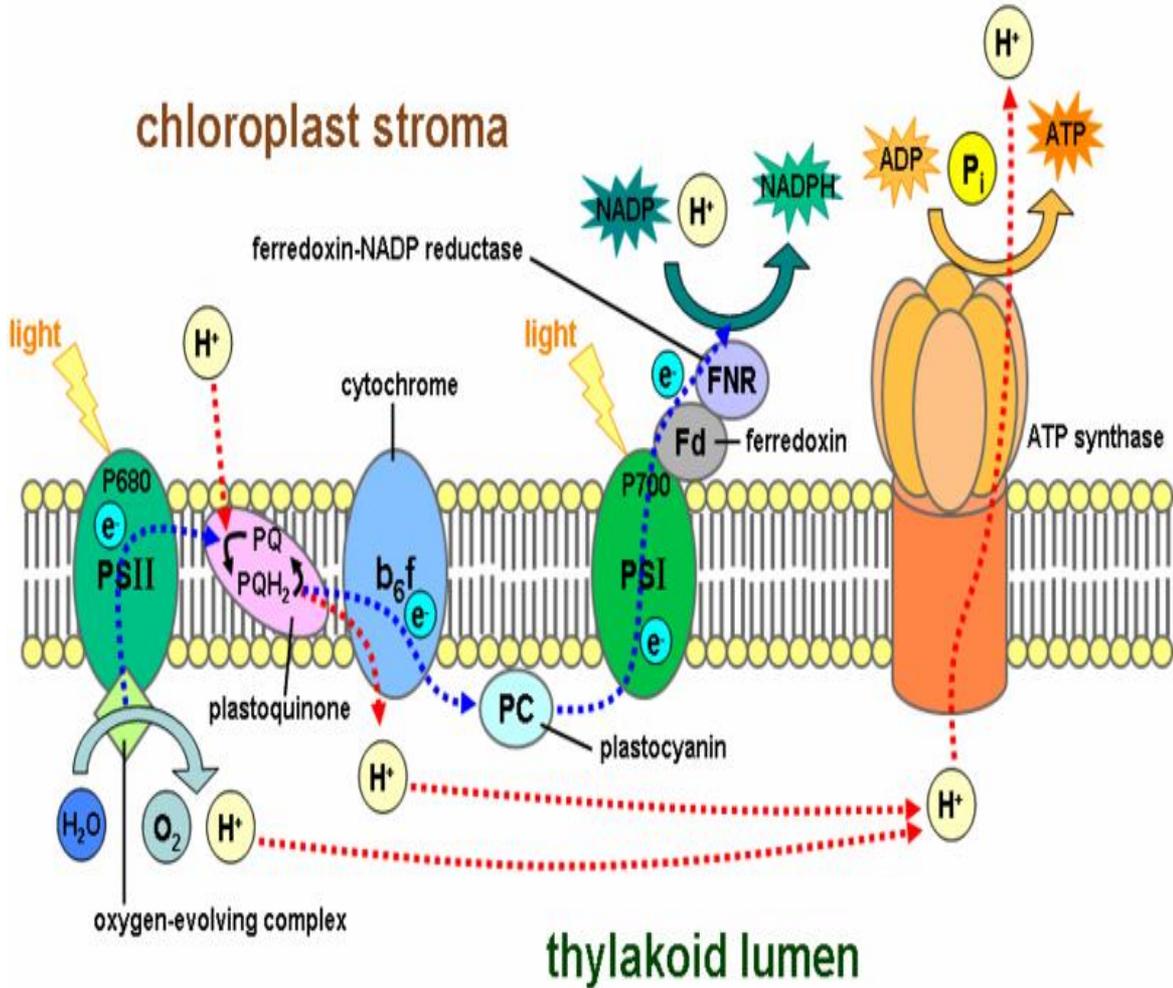
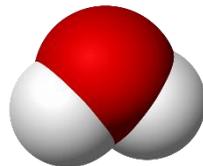
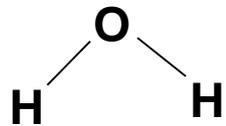
- When light hits the chlorophyll in PS2, two excited electrons are released.
- These electrons are then passed from one protein to the next, like a game of "hot potato".



HOW does photosynthesis happen?

Why is water required for photosynthesis?

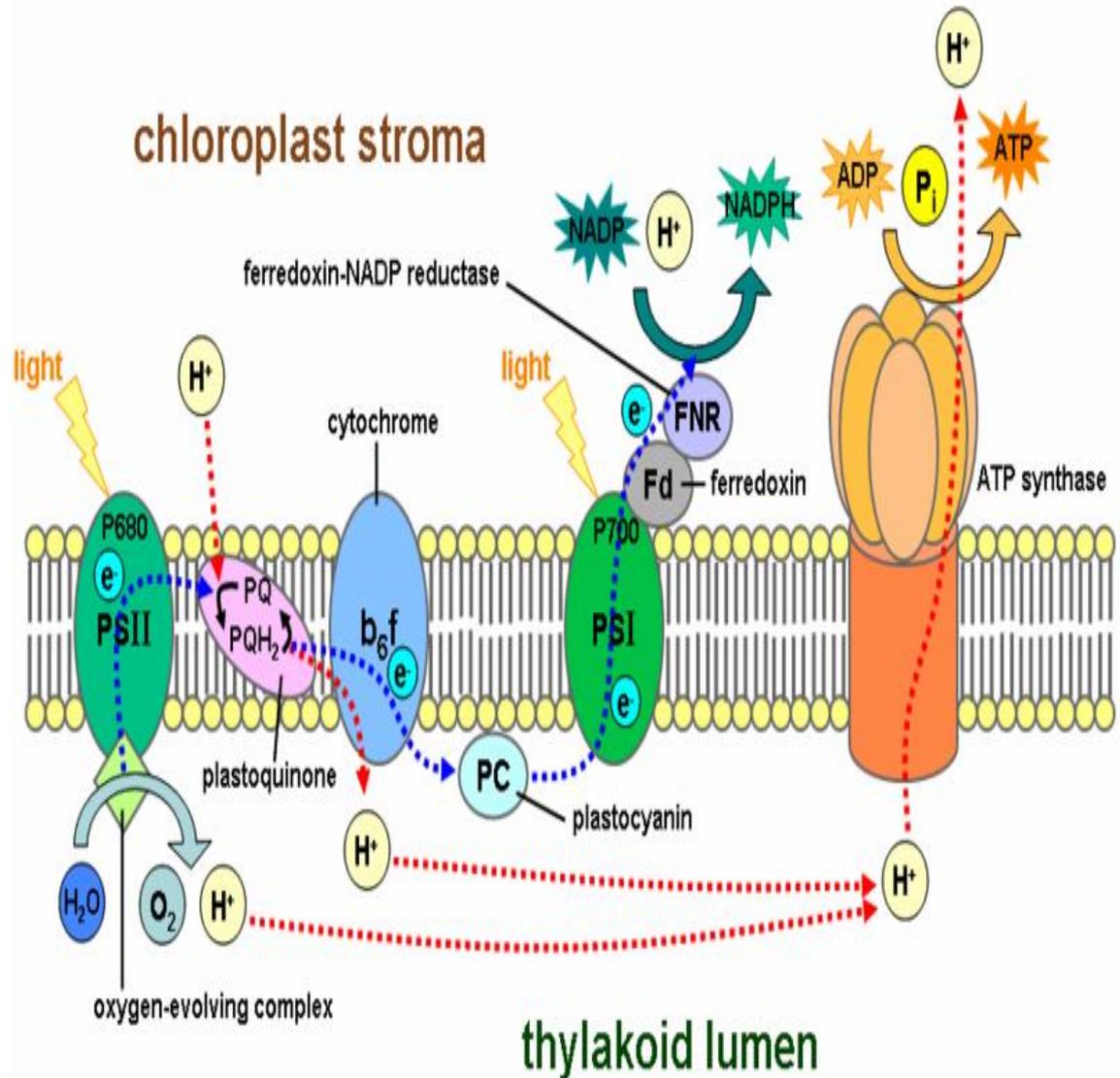
- The electrons that are leaving the PS2 need to be replaced, so a water molecule (H_2O) is split.
- Two electrons from the split water molecule go into PS2, the two hydrogen ions (H^+) are released into the thylakoid lumen.
- For each two water molecules that are split, molecular oxygen (O_2) is released as a waste product.



HOW does photosynthesis happen?

2. Making NADPH

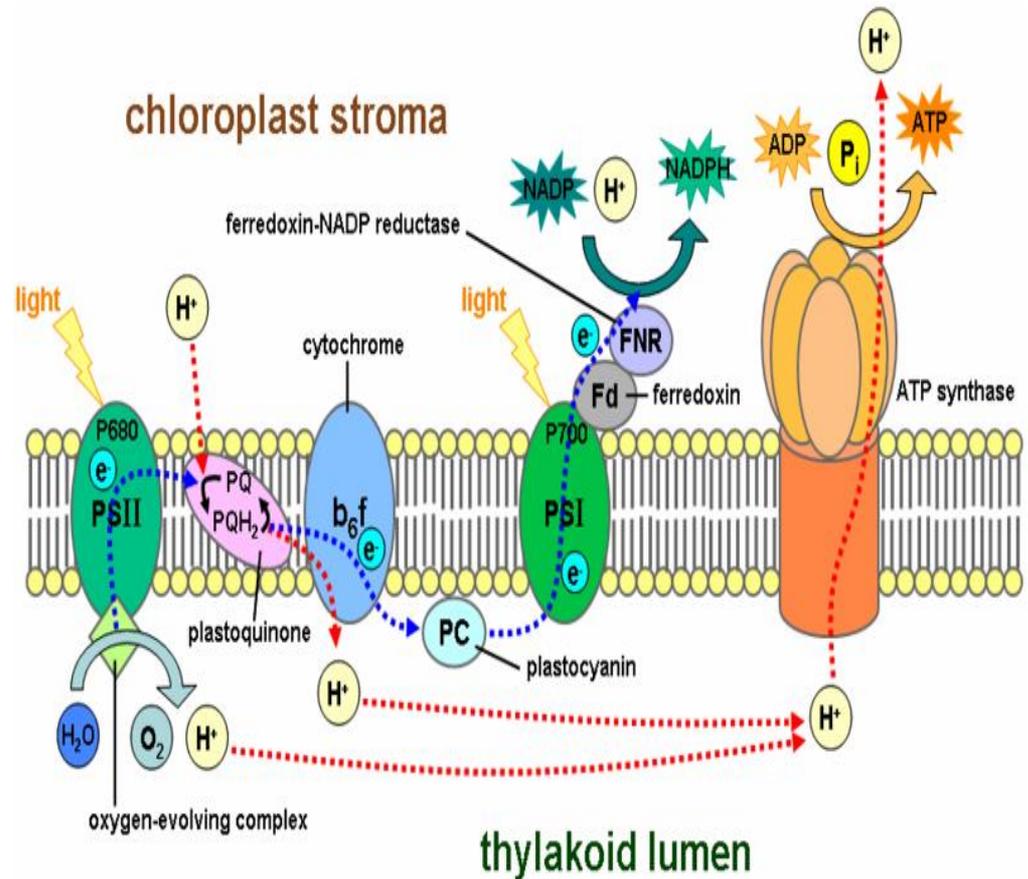
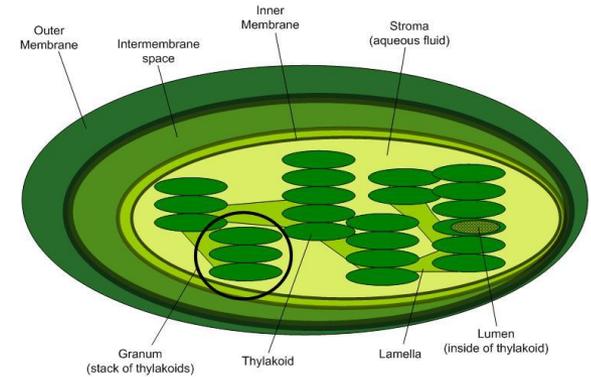
- When the electrons get to the last protein in the chain (PS1).
- Light excites electrons here too.
- The excited electrons are they are accepted by the rechargeable battery NADP^+ , charging it up and adding a H^+ , to make **NADPH**.



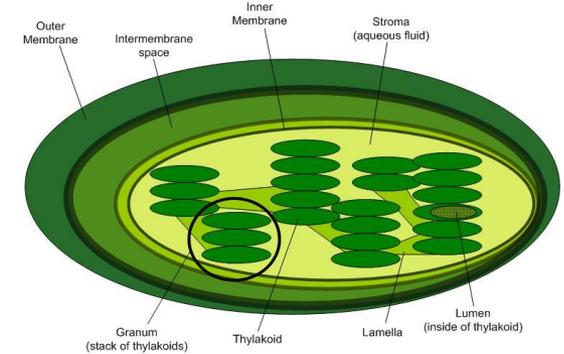
HOW does photosynthesis happen?

3. Creation of a proton gradient

- Remember, when the water molecule was split, it released hydrogen ions (H^+) into the lumen.
- When electrons pass through the cytochrome protein, more H^+ are pumped from the stroma into the lumen (one for each electron).
- The buildup of these hydrogen ions on one side of the membrane creates a gradient where the lumen side of the membrane is more + than the stroma side.
- This difference in charge is potential energy that can be used to do work.

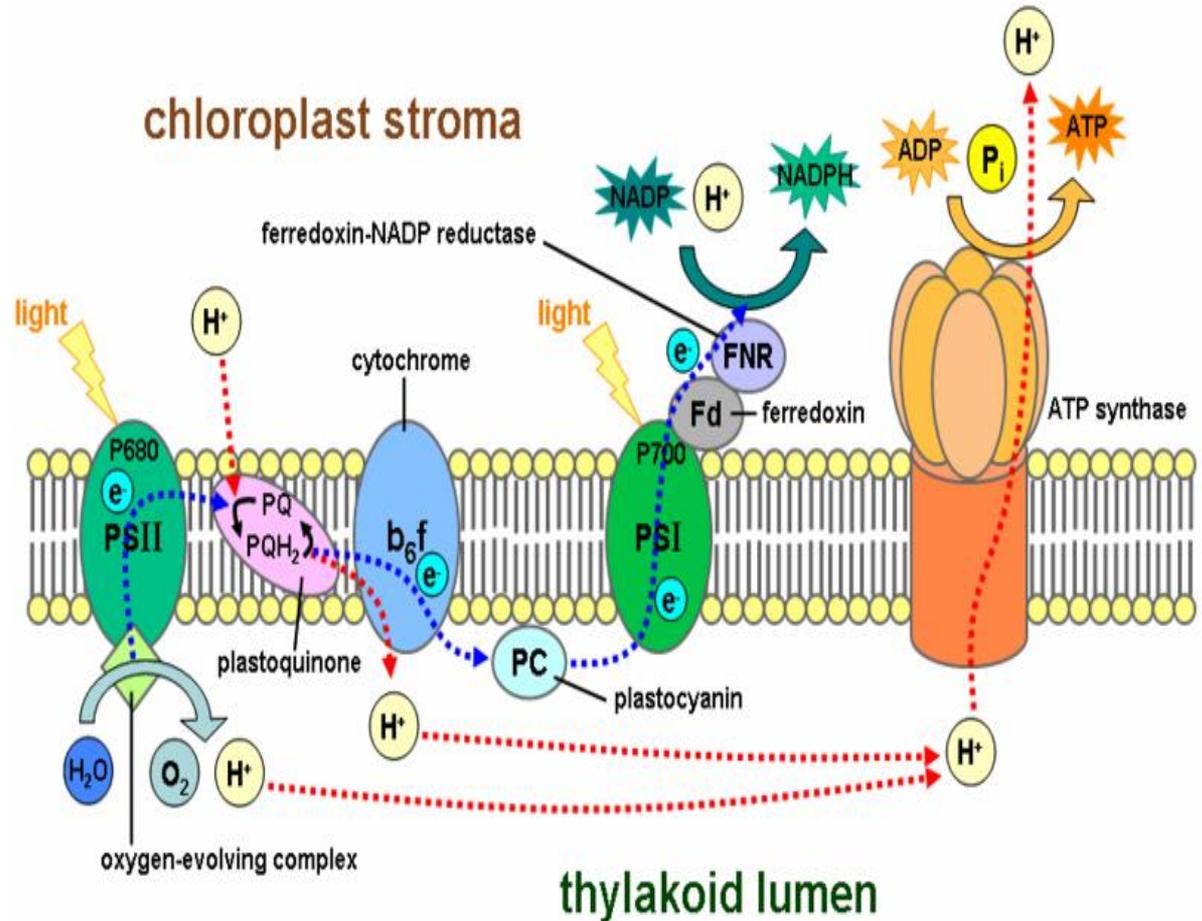


HOW does photosynthesis happen?



4. Making ATP!

- Hydrogen ions (H^+) want to move back across the membrane to get rid of this difference in charge.
- They move across with the help of the enzyme **ATP synthase**.
- Each time a H^+ moves back to the stroma, this provides the energy to pop a phosphate onto ADP, making the rechargeable battery ATP.



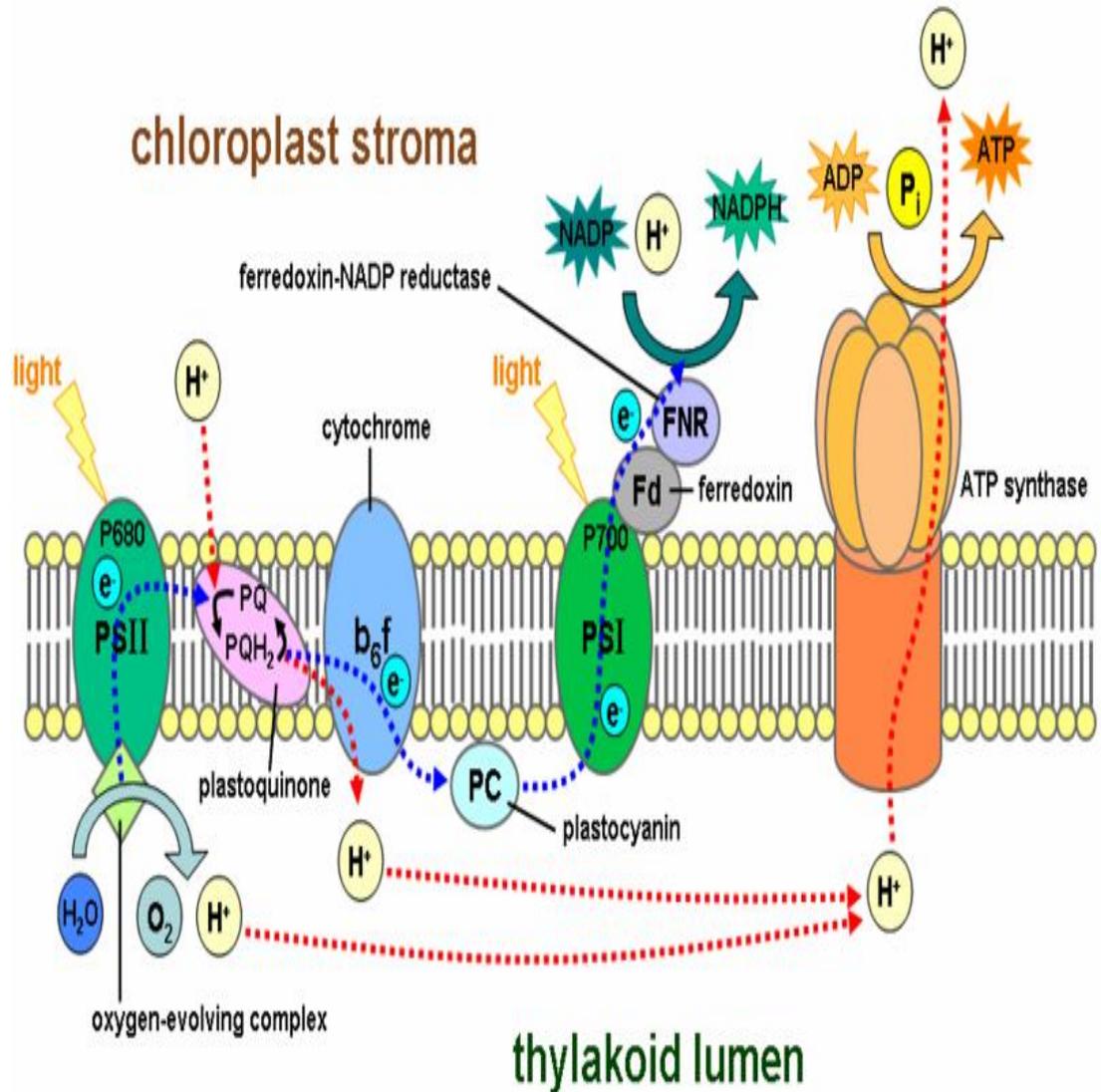
HOW does photosynthesis happen?

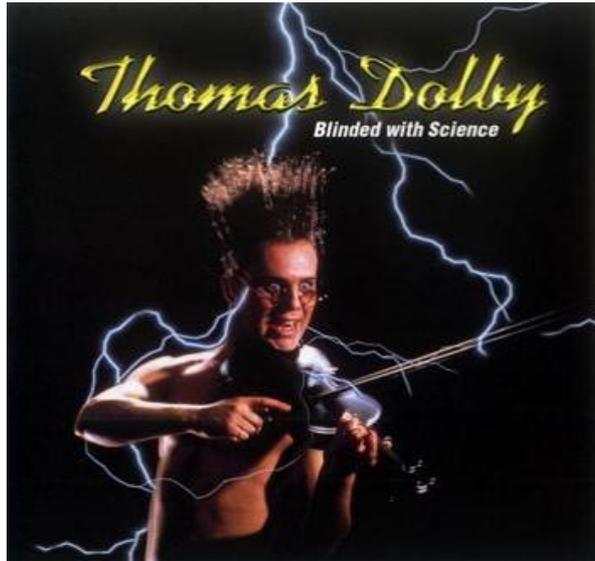
Take a look!

Photosynthesis: The Movie

from

The National Science
Foundation





Are you feeling blinded by science?

Do yourself a favor. Use the...

Virtual Cell Biology Classroom (VCBC)!

The VCBC is full of resources to help you succeed,
including:



- practice test questions
- review questions
- study guides and learning objectives
- PowerPoints on other topics

You can access the VCBC by going to the Science Prof Online website
www.ScienceProfOnline.com