

Introduction to Botany. Lecture 7

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1 Questions and answers

- Quiz

2 Photosynthesis

- History
- Light stage: electron transport, synthesis of ATP and NADPH



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Questions and answers

Quiz



Final question (1 point)

Why did Engelmann decide that photosynthetic pigment has a green color?



Final question (1 point)

Why did Engelmann decide that photosynthetic pigment has a green color?

- Because he saw that *oxygen-loving bacteria are concentrating only in places where red and blue light present*. It means that pigment of question accepts blue and red so it is green.
- In other words:
There are many pigments in plants. Which of them is responsible for photosynthesis?
Photosynthesis makes oxygen AND bacteria like oxygen AND bacteria concentrate around blue and red spots → photosynthesis is going on these blue and red spots → photosynthetic pigment accepts blue and red (but not green) → photosynthetic pigment IS green.



Photosynthesis

History



Blackman

- In 1905, Frederick Blackman discovered that if light intensity is low, increase of temperature has a little effect on the rate of photosynthesis. But if temperature is low, light works!
 - A If light and temperature were *independent*, this could not happen
 - B If temperature and light were *components of the chain*, than light was first and temperature second
- Consequently, photosynthesis has two stages:
 - A Light stage which relates more with light intensity
 - B “Dark” (now called *enzymatic*) stage which relates more with temperature



Light and enzymatic (“dark”) reactions

- Light reactions depend on the light and water, they produce oxygen and energy (in form of ATP)
- Enzymatic reactions depend on carbon dioxide and water, they take energy from light reactions and result in production of carbohydrates



Light and enzymatic (“dark”) reactions

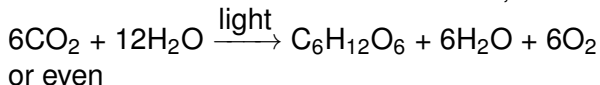
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Four equations of photosynthesis

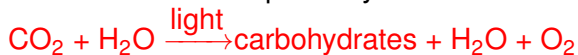
A $6\text{CO}_2 + 6\text{H}_2\text{O} \xrightarrow{\text{light}} \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ is *not a formula*, but merely a general description of a process

B Water molecules arise from both sides, and the better formula is



C carbon dioxide + hydrogen donor $\xrightarrow{\text{light}}$ carbohydrate + water + oxidized hydrogen donor

D And the best one is probably



Photosynthesis

Light stage: electron transport,
synthesis of ATP and NADPH



Participants of light stage

- A Chlorophyll (photosystems II and I)
- B Light
- C Water
- D ATP synthase (ATPase)
- E Protons (H^+)
- F Hydrogen carrier ($NADP^+$)

Where: around thylakoid membrane

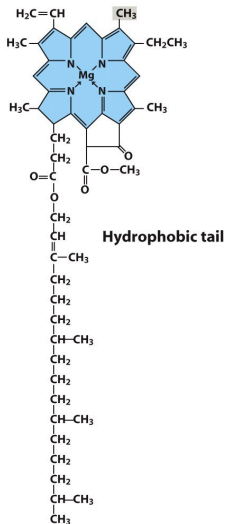


Logic of the light stage

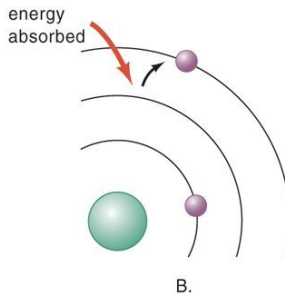
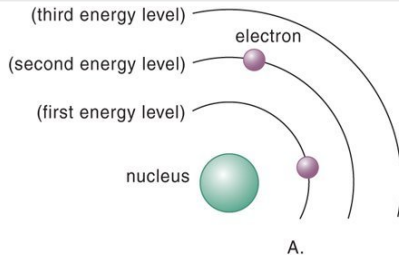
- A To assemble carbon dioxide into sugar, we need ATP
- B To make ATP, we need *electrical current* through the proton pump
- C To make this current, we need the *difference in charge* (voltage difference) between thylakoid and matrix (stroma) compartments
- D To make this difference, we need to *segregate ions*: positively charged (like H^+) will go from outside and stay inside, negatively charged (like e^- and OH^-) will go from inside and stay outside
- E To segregate ions, we need the energy and the energy booster. These are sun rays and chlorophyll



Why chlorophyll is good for the membrane

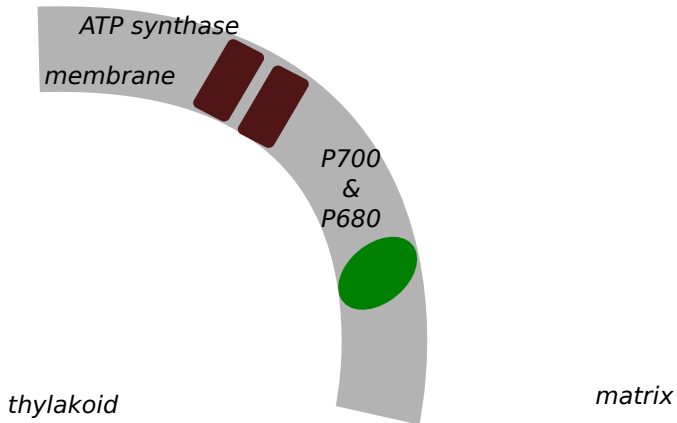


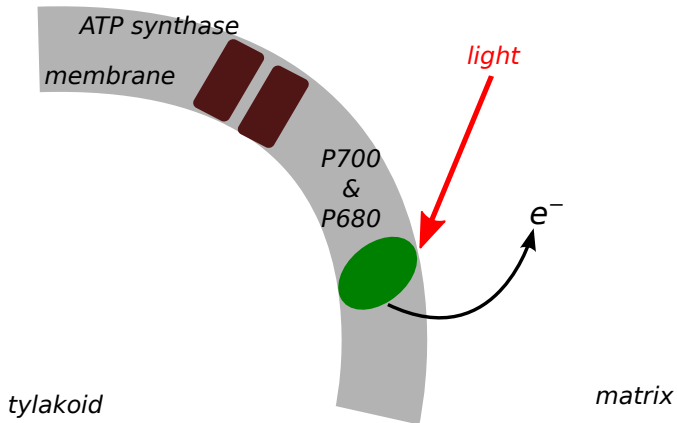
How chlorophyll works: excitation of the electron



Scheme of light stage







Final question (2 points)



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Why is ATP important for us (plants, animals, microbes) all?



Summary

- **Photosynthesis** is a sum of light-dependent and light-independent reactions
- **Light stage** of photosynthesis results in accumulation of energy and hydrogen, and release of oxygen



For Further Reading



A. Shipunov.

Introduction to Botany [Electronic resource].

Mode of access:

http://ashipunov.info/shipunov/school/biol_154

