

# Introduction to Botany

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Lecture 7

## 1 Questions and answers

- Quiz

## 2 Photosynthesis

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

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## 2 Photosynthesis

- History
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# Questions and answers

## Quiz

## Quiz question (2 points)

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

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...

# 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

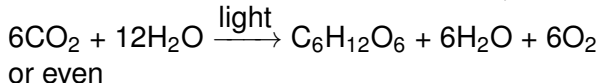
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# Four equations of photosynthesis

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

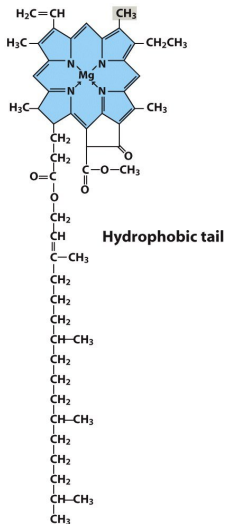
- A Chlorophyll (photosystems II and I)
- B Light
- C Water
- D ATP synthase (ATPase)
- E Protons ( $H^+$ )
- F Hydrogen carrier ( $NADP^+$ )

**Where:** around thylakoid membrane

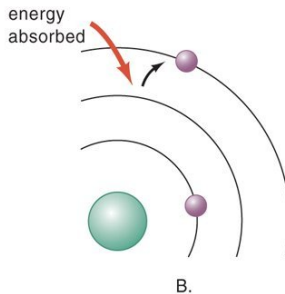
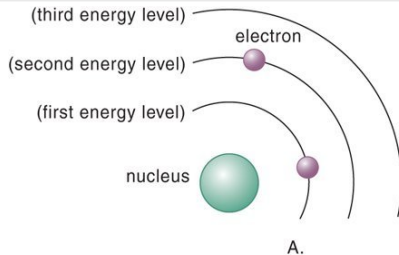
# Logic of the light stage

- 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

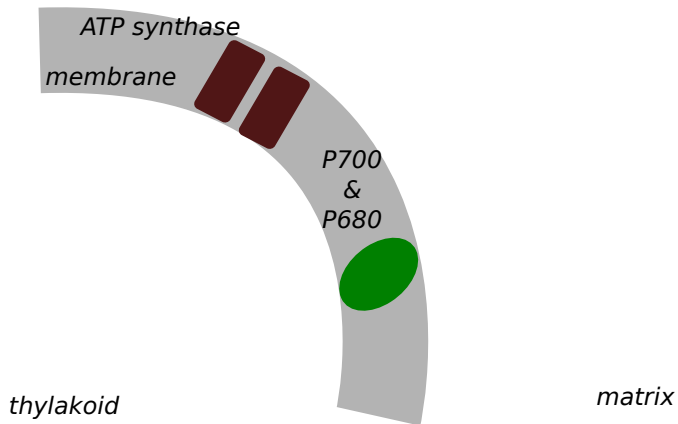


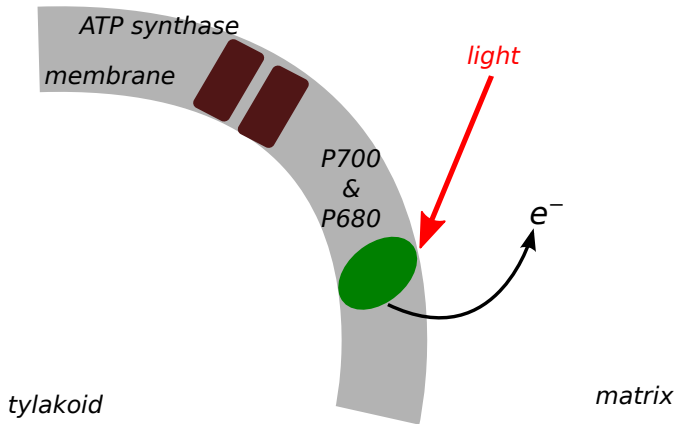
# How chlorophyll works: excitation of the electron





## *Scheme of light stage*





# 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](http://ashipunov.info/shipunov/school/biol_154)