

# Introduction to Botany

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Lecture 9

## 1 Questions and answers

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- Enzymatic stage: fixation of carbon dioxide
- As a whole

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# Questions and answers

## Quiz

# Final question (2 point)

Explain the role of hydrogen carrier (NADP<sup>+</sup>)

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- In the light stage of photosynthesis, with the help of Photosystem I ( $\text{P}_{700}$ ) it takes hydrogen (protons from water and electrons from chlorophyll) and removes them from the space outside of membrane
- Hydrogen used in enzymatic reactions
- Accumulated  $\text{OH}^-$  helps with the gradient and therefore with the electrical current through ATPase

# Photosynthesis

## Enzymatic stage: fixation of carbon dioxide

# Participants of enzymatic stage

- A Carbon dioxide ( $\text{CO}_2$ )
- B Hydrogen carrier with hydrogen (NADPH)
- C Source of energy (ATP)
- D Ribulose biphosphate (RuBP, five-C-hydrocarbonate, "C<sub>5</sub>")
- E *Rubisco* and other enzymes

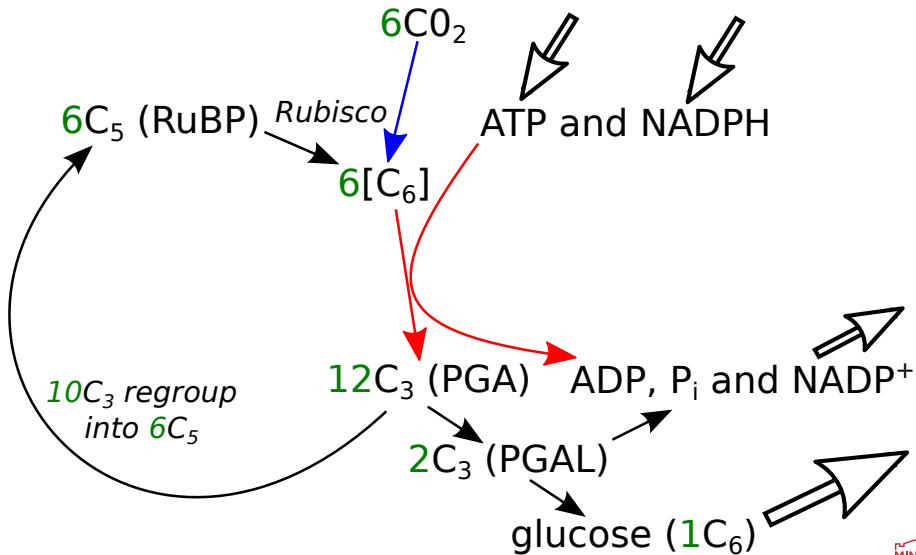
**Place:** in the matrix (stroma) of chloroplast



# Main events of enzymatic stage

- A  $\text{CO}_2 + \text{C}_5$  (RuBP, ribulose biphosphate)  $\xrightarrow{\text{Rubisco}}$   $\text{C}_6$
- B  $\text{C}_6 \longrightarrow 2\text{C}_3$  (PGA, phosphoglyceric acid)
- C  $\text{C}_3 + \text{NADPH} + \text{ATP} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_6$  (or other organic molecules) +  $\text{C}_5 + \text{NADP}^+ + \text{ADP} + \text{P}_i$  (inorganic phosphate)
  - Organic molecules are synthesized from  $\text{C}_3$  (PGA) through energy-rich **PGAL** (phosphoglyceric aldehyde)

# Enzymatic stage: scheme



# Results of enzymatic stage

At the start	At the end
CO <sub>2</sub>	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> (or other organic molecules)
NADPH	NADP <sup>+</sup> (H goes to C <sub>6</sub> H <sub>12</sub> O <sub>6</sub> )
ATP	ADP and P <sub>i</sub> (inorganic phosphate)
C <sub>5</sub>	C <sub>5</sub>
Rubisco	Rubisco

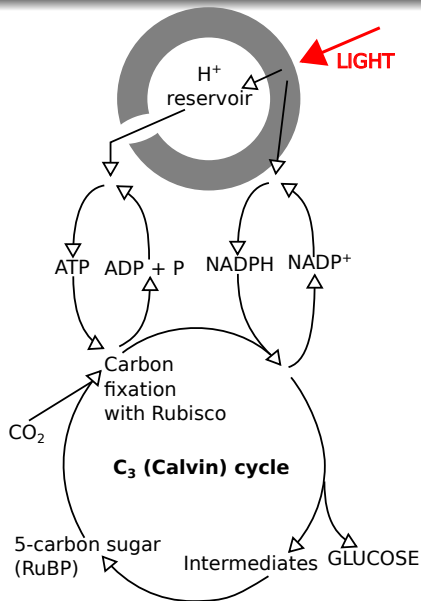
The other names for enzymatic stage are “Calvin cycle” and “C<sub>3</sub> cycle”

# Photosynthesis

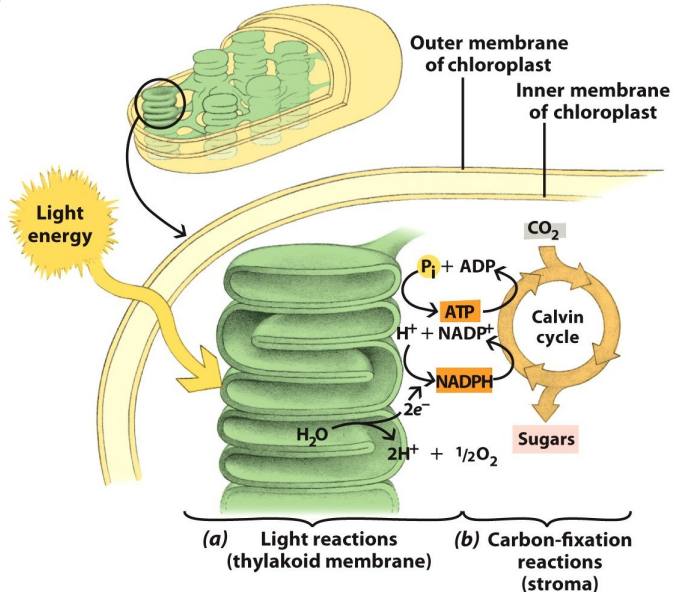
## As a whole



# Overview of photosynthesis



# Photosynthesis in the cell



## Photosynthesis movie



# Final question (2 points)

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Explain the role of NADPH in the enzymatic stage.

# Summary

- **Photosynthesis** is a sum of light-dependent (photo-) and light-independent (auto-) reactions
- **Light stage** of photosynthesis results in accumulation of energy and hydrogen, and release of oxygen
- **Enzymatic stage** of photosynthesis results in assimilation of the  $\text{CO}_2$  and synthesis of organic molecules

# 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)