Introduction to Botany. Lecture 8

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Outline

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1. Questions and answers
   - Quiz
2. Photosynthesis
   - Light stage: electron transport, synthesis of ATP and NADPH

Questions and answers

Quiz

Final question (1 point)

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

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

ATP stores chemical energy which then used for most of cell processes:

$$ATP \rightarrow ADP + P + energy$$

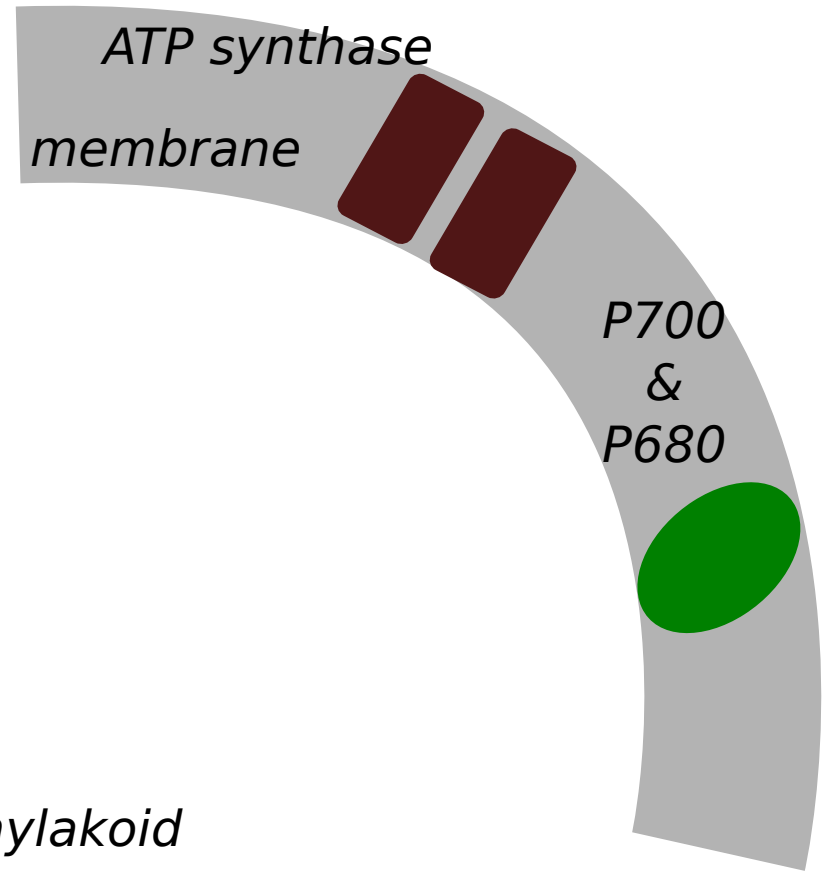
Photosynthesis

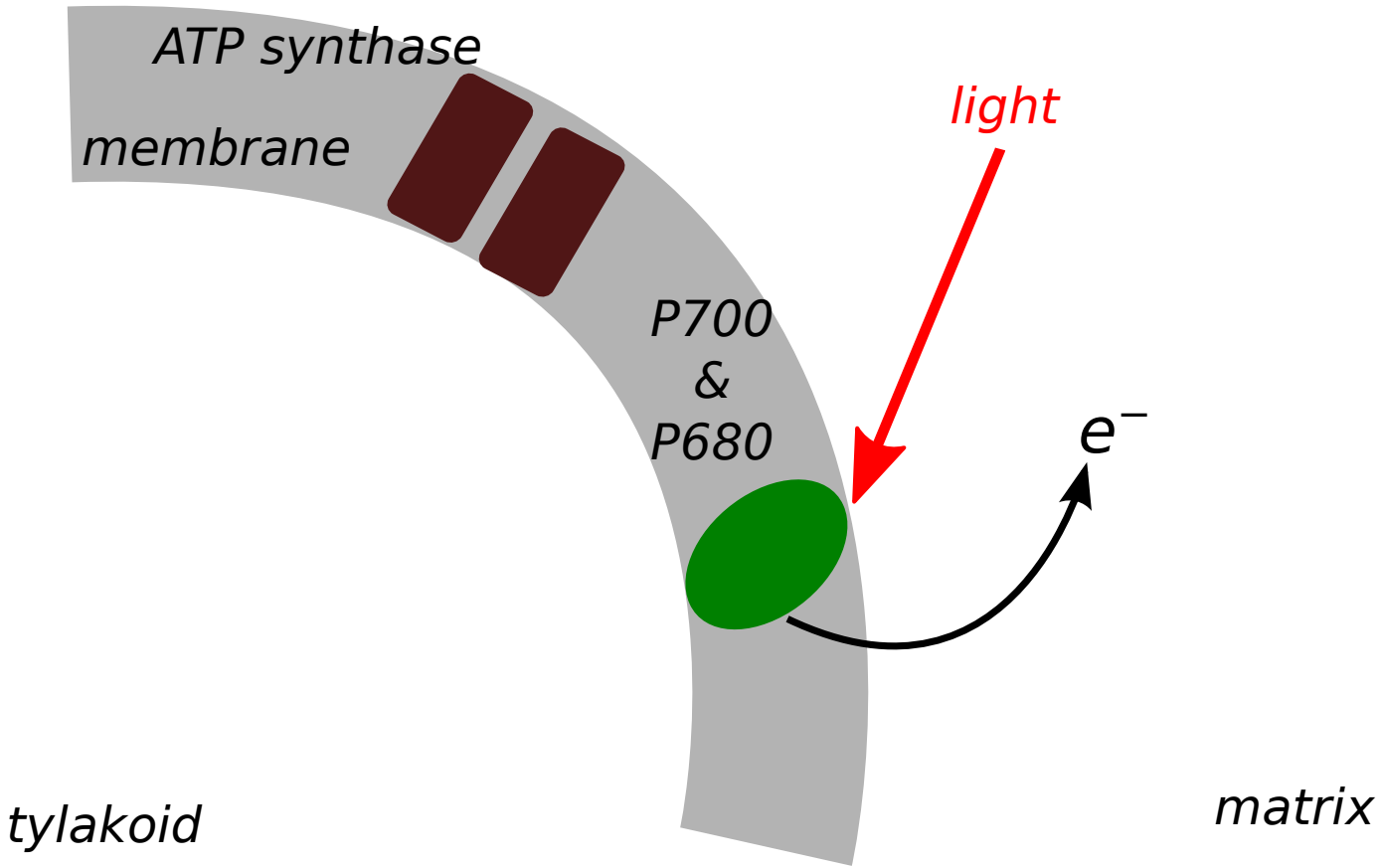
Light stage: electron transport, synthesis of ATP and NADPH

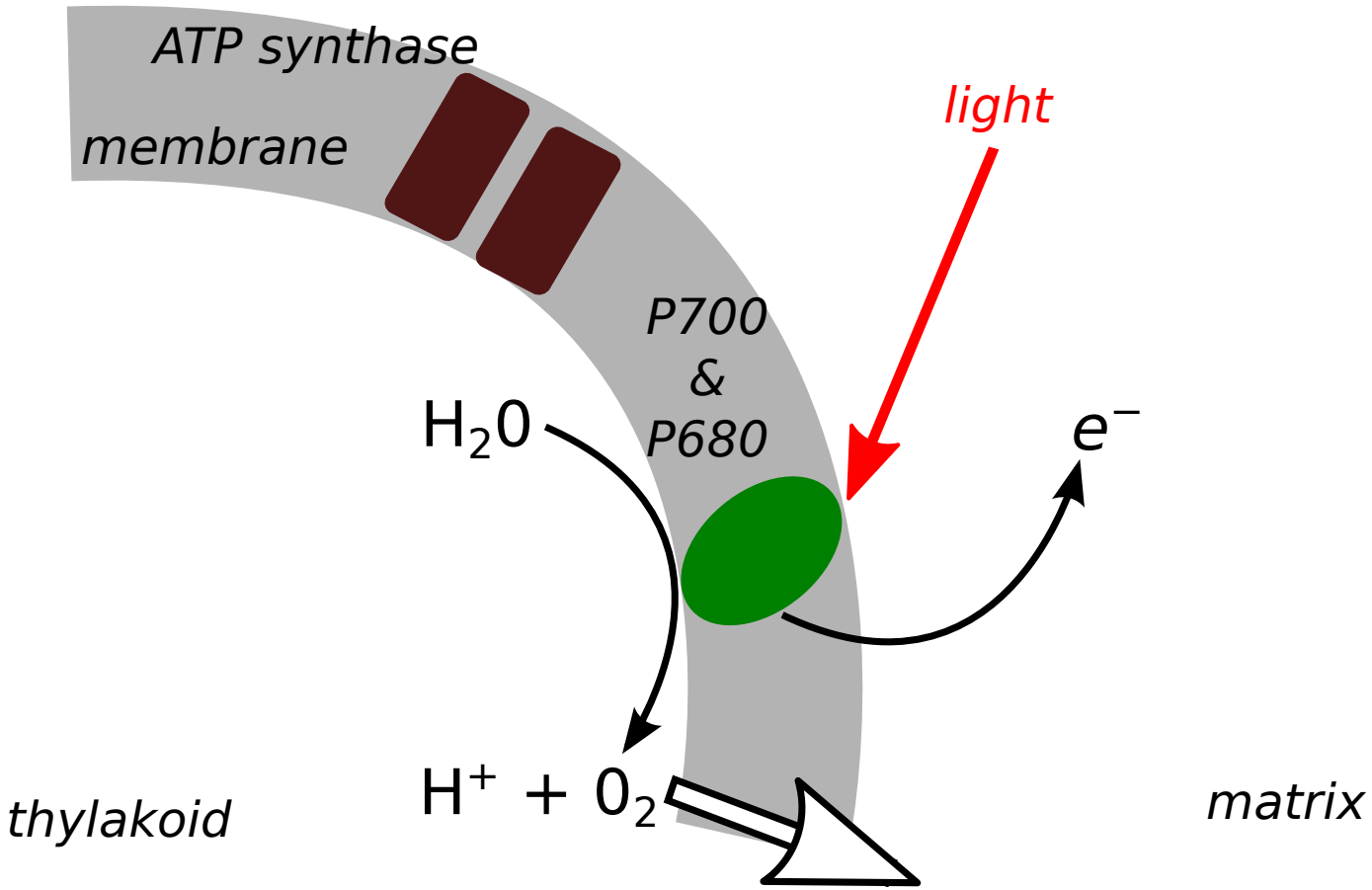
Participants of light stage

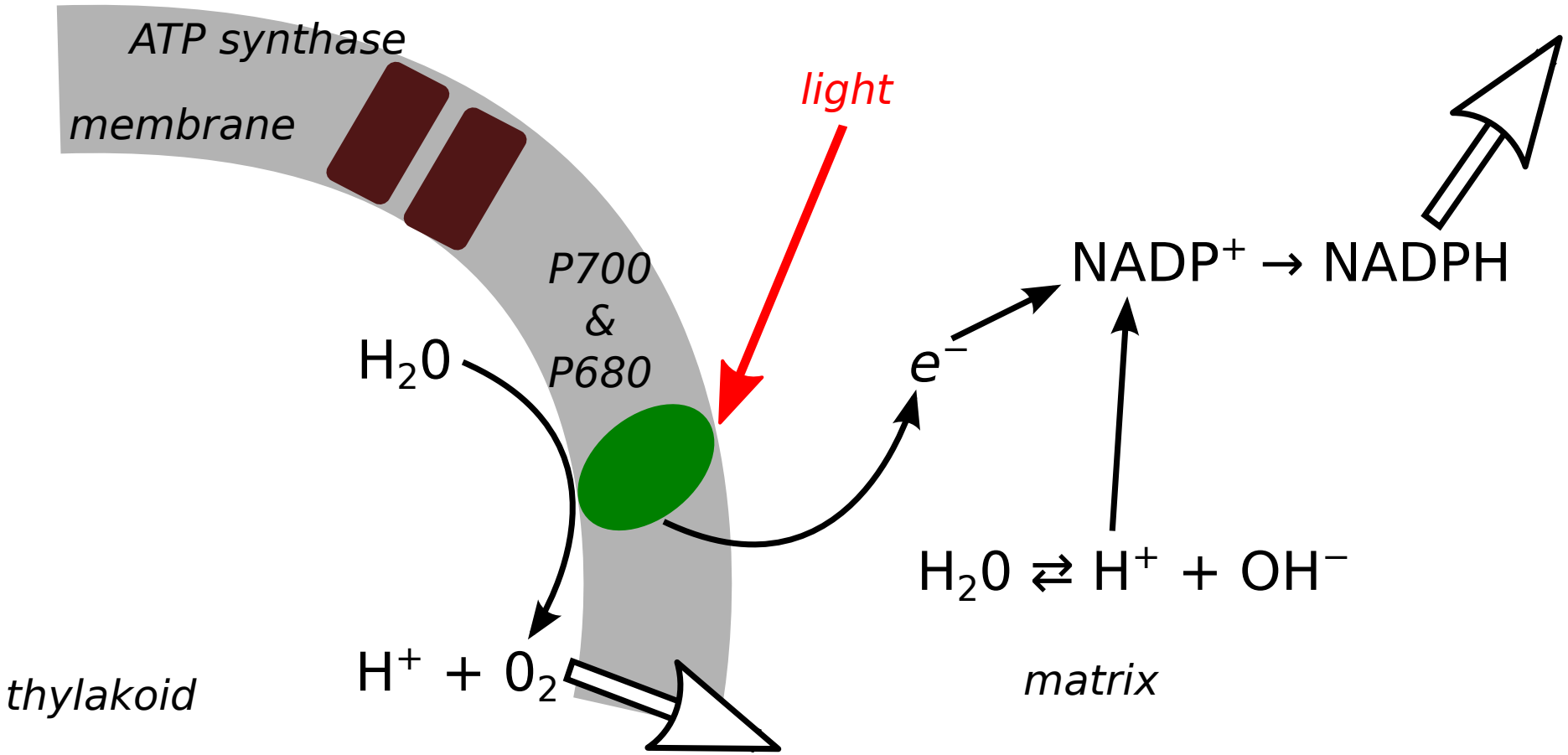
A. Chlorophyll (photosystems II and I)
B. Light
C. Water
D. ATP synthase (ATPase)
E. Protons (H^+)
F. Hydrogen carrier ($NADP^+$)

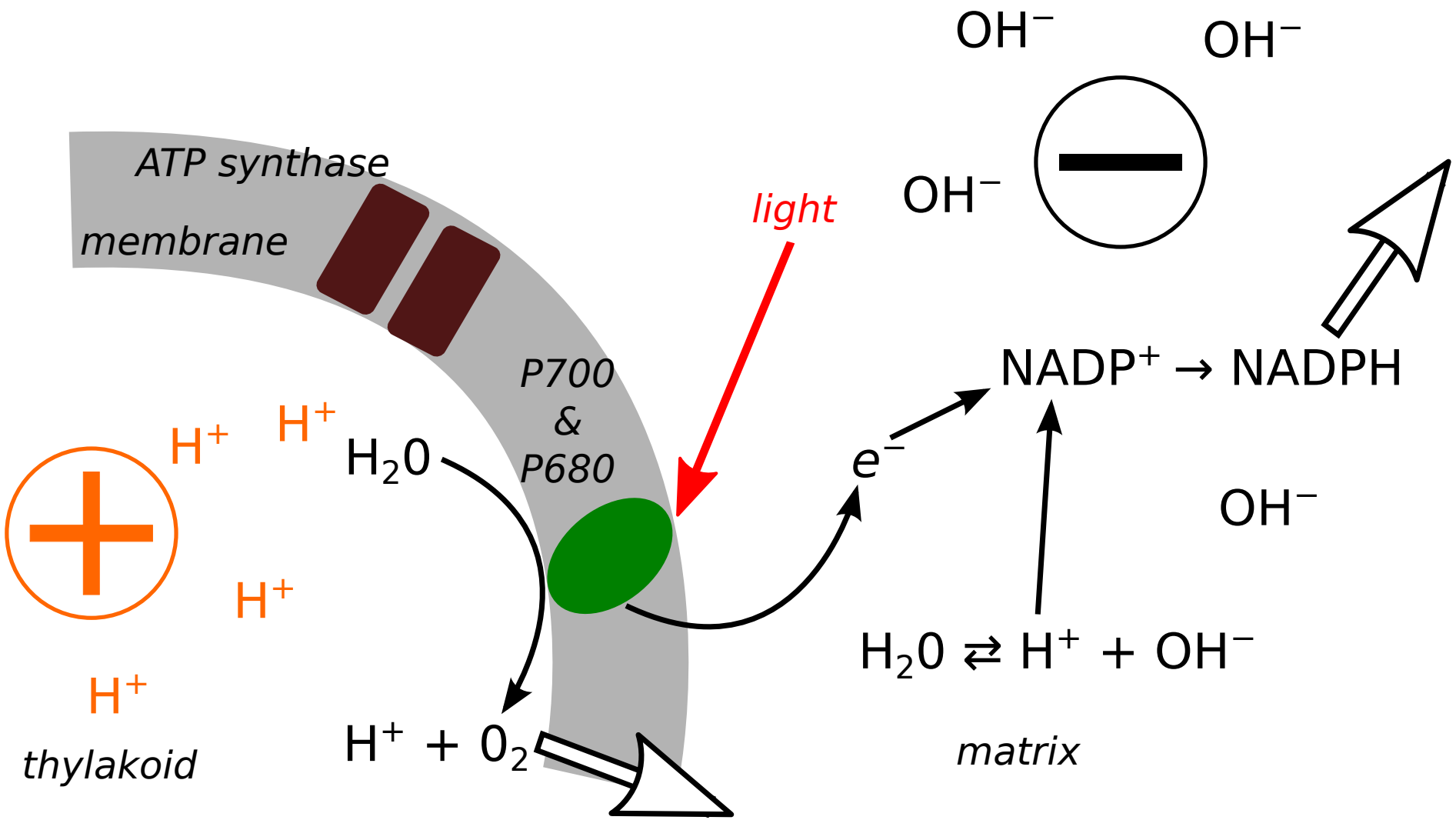
Where: around thylakoid membrane

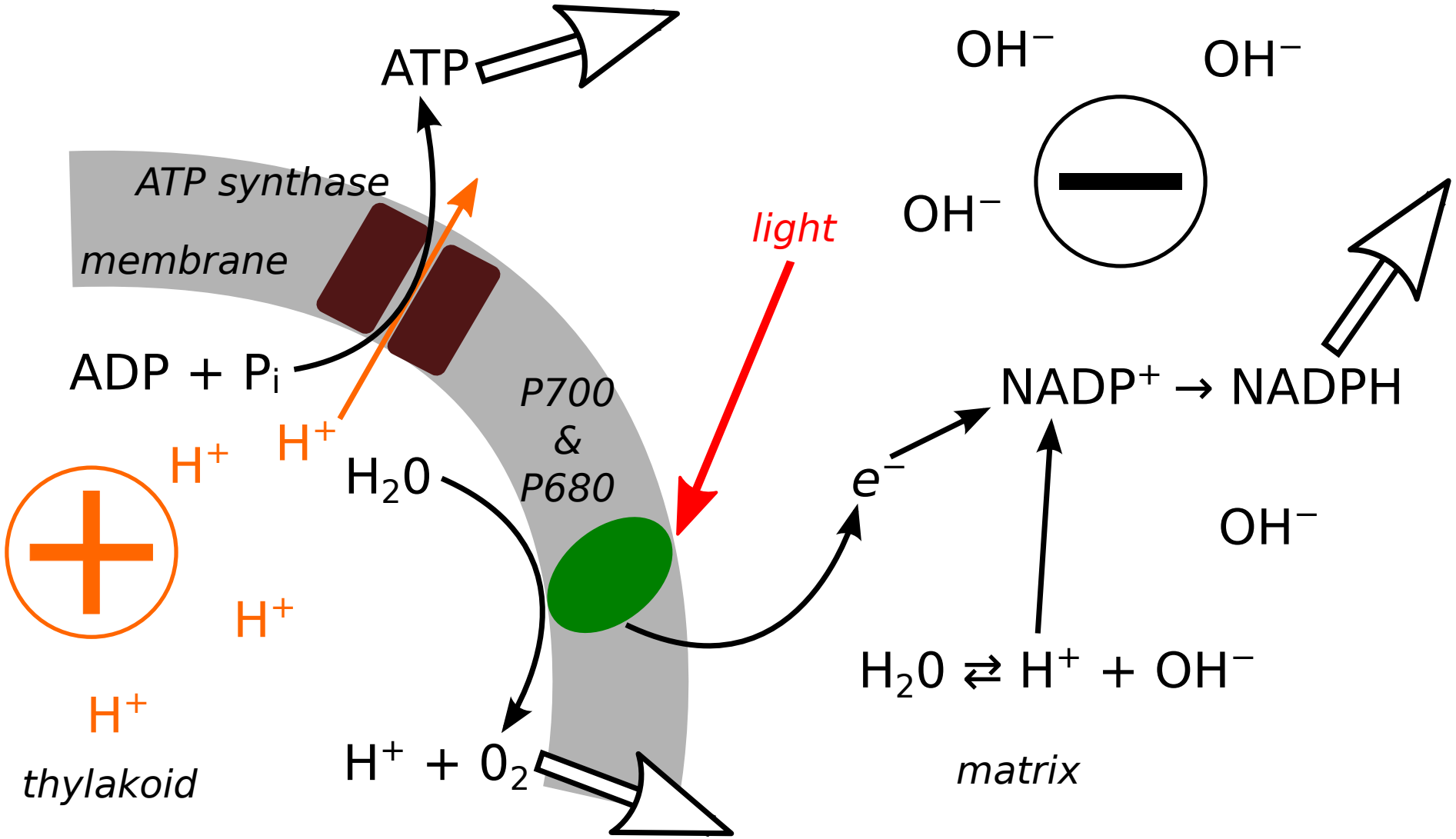

ATP synthase
membrane
P700
&
P680
thylakoid
matrix


ATP synthase
membrane
light
P700
&
P680
e^-
tylakoid
matrix


ATP synthase
membrane
light
P700
&
P680
H_2O
e^-
$H^+ + O_2$
thylakoid
matrix


ATP synthase
membrane
light
P700
&
P680
H_20
e^-
$NADP^+ \rightarrow NADPH$
$H_20 \rightleftarrows H^+ + OH^-$
$H^+ + 0_2$
thylakoid
matrix


ATP synthase
membrane
light
P700
&
P680
OH^-
OH^-
OH^-
$NADP^+ \rightarrow NADPH$
H^+
H^+
H^+
H^+
H_20
e^-
OH^-
$H_20 \rightleftarrows H^+ + OH^-$
$H^+ + 0_2$
thylakoid
matrix


ATP
ATP synthase
membrane
ADP + Pi
H+
H+
H+
H+
H+
thylakoid
H20
P700
&
P680
light
e−
H+ + 02
OH−
OH−
OH−
NADP+ → NADPH
OH−
H20 ⇄ H+ + OH−
matrix

Main events of light stage

A. Chlorophyll + Light $\longrightarrow$ Electron (e^-) + Chlorophyll$^+$

B. e^- + H^+ (from water) + Hydrogen carrier ($NADP^+$) $\longrightarrow$ NADPH (moves away)

C. $H_2O \longrightarrow H^+$ (accumulates inside) + e^- + O_2

D. H^+ (inside) + OH^- (from water, located outside) $\Longrightarrow$ gradient $\Longrightarrow$ proton pump $\Longrightarrow$ H_2O
TOGETHER WITH
ADP + P_i (inorganic phosphate) $\longrightarrow$ **ATP**

Photosystems

- Photosystem II (P_{680}, contains chlorophylls and carotene):
  A. decomposes water;
  B. forwards electron to Photosystem I;
  C. makes proton gradient
- Photosystem I (P_{700}, contains only chlorophylls) makes NADPH

Photosystems movie

Results of the light stage

At the start	At the end
H_2O	H_2O (result of pump) and $\mathbf{O_2}$
Chlorophylls	Chlorophylls
ADP and P_i (inorganic phosphate)	ATP
$NADP^+$	NADPH

Final question (2 points)

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Explain the role of $NADP^+$

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