PHOTOSYNTHESIS

LIGHT DEPENDENT REACTION

- Light energy is absorbed by photosynthetic pigments (e.g. chlorophyll) in photosystem II (PSII). The photosystems are found in the thylakoid membranes of the chloroplasts.
- Electrons in the chlorophyll are excited to a higher energy level = the electrons move to photosystem I (PSI) via electron carriers (proteins that transfer electrons).
- The energy the electrons lose as they move to PSI is used to transport H+ from the stroma into the thylakoid = a proton gradient forms.
- H+ move back into the stroma down their concentration gradient via ATP synthase. The energy from this movement drives the formation of **ATP** from ADP and P.
- PSI absorbs light energy and electrons in the chlorophyll are excited even further.
- Electrons are transferred to NADP (along with H+) to form **NADPH.**

NOTE: when electrons move from PSII along the electron transport chain to PSI they need to be replaced. Light energy splits water into H+, **oxygen** and **electrons** (so the electrons are replaced); this is called photolysis.

The light dependent reaction involves 2 types of photophosphorylation to produce ATP from ADP. **Non-cyclic photophosphorylation** = the main type, both photosystems are used (see notes above). **ATP**, **NADPH** and **oxygen** are produced (oxygen produced from the photolysis of water). ATP and NADPH are the useful products as these are needed for the next part of photosynthesis.
Cyclic photophosphorylation can also happen at the same time as non-cyclic. This type only uses PSI and produces small amounts of ATP only.

LIGHT INDEPENDENT REACTION (Calvin cycle) - ATP and NADPH from light dependent reaction used

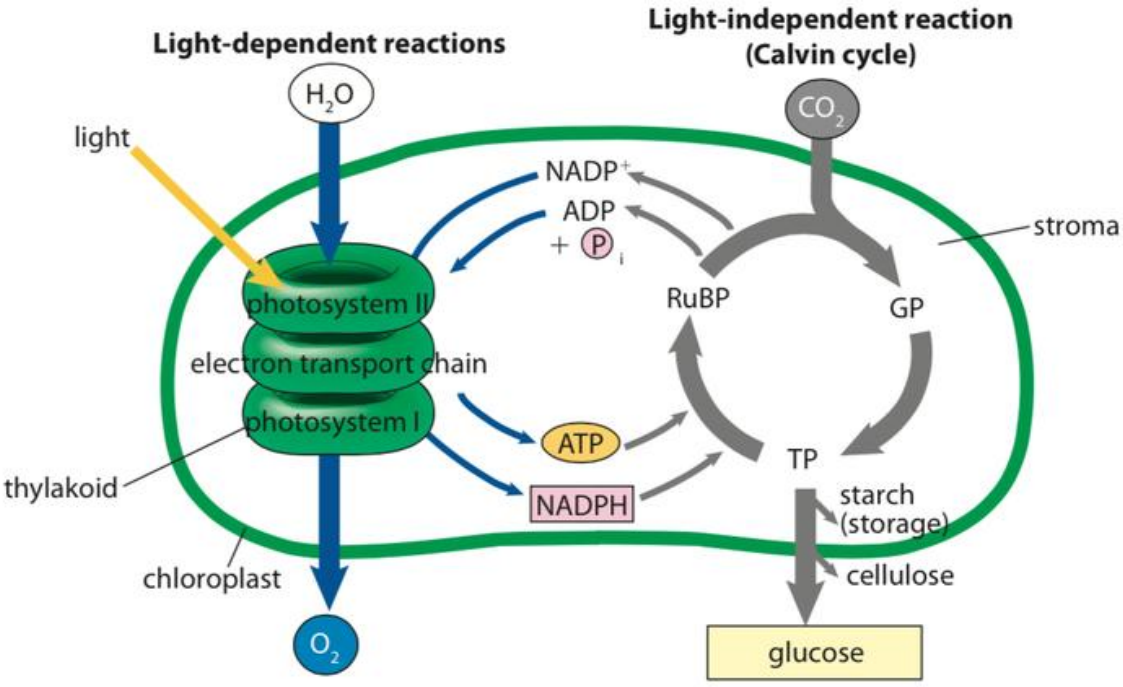
CO_2 + RuBP → 2 x GP (RuBisCO enzyme needed)

2 x GP → 2 x TP (**ATP** provides energy for this stage and **NADPH** provides H+ for this)

TP → glucose (and other organic substances) ⅙ TP made is used for this only

TP → regenerates RuBP ⅚ TP made are used for this **ATP** needed

The Calvin cycle happens in the stroma. It needs to turn 6 times to make 1 glucose molecule. 3 cycles makes 6 TPs but only 1 out of 6 is used to make glucose. TP is a 3 carbon molecule so you need 2 TPs to make a 6 carbon sugar like glucose.


Light-dependent reactions
Light-independent reaction
(Calvin cycle)
H_2O
CO_2
light
$NADP^+$
ADP
+ P_i
stroma
photosystem II
RuBP
GP
electron transport chain
photosystem I
ATP
TP
thylakoid
NADPH
starch
(storage)
cellulose
chloroplast
O_2
glucose