

# WJEC (Eduqas) Biology A-level

## Topic 1.2 - Photosynthesis

### Flashcards

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# What is a chloroplast?



# What is a chloroplast?

An organelle found in plants and green algae that is the site of photosynthesis.



Describe the structure of a chloroplast.



# Describe the structure of a chloroplast.

- Double membrane (chloroplast envelope)
- **Grana** - stacks of flattened disks (**thylakoids**) that contain photosystems I and II, electron transport chain, ATP synthase
- Grana connected by **intergranal lamellae**
- **Stroma** - fluid-filled matrix containing enzymes



Where are chloroplasts located in an angiosperm leaf?



Where are chloroplasts located in a leaf?

Mainly found in the palisade layer.



# How are chloroplasts adapted for photosynthesis?





# How are chloroplasts adapted for photosynthesis?

- Thylakoids give a **large surface area** for light-independent reactions
- Photosynthetic pigments arranged into photosystems to **maximise light absorption**
- Stroma directly surrounds grana - products of photosynthesis diffuse directly into the stroma.
- Contain their own DNA (**cpDNA**) and **ribosomes**
- Inner chloroplast membrane **less permeable** than outer, enabling control over the movement of substances



# How are angiosperm leaves adapted for photosynthesis?



# How are angiosperm leaves adapted for photosynthesis?

- **Large surface area** to maximise light absorption
- **Thin** to reduce the diffusion distance for  $\text{CO}_2$
- Upper epidermis **transparent** allowing light to strike mesophyll layers
- Palisade cells **densely packed** and contain many chloroplasts
- **Air spaces** reduce the diffusion distance for  $\text{CO}_2$
- **Vein network** transports water and minerals to the leaf and takes sugars away
- **Stomata** allow  $\text{CO}_2$  to diffuse into the leaf



What is a transducer? Why are chloroplasts described as transducers?



# What is a transducer? Why are chloroplasts described as transducers?

- Something that converts one type of energy into another
- Chloroplasts transduce light energy into the chemical energy of ATP



# What is a photosynthetic pigment?



## What is a photosynthetic pigment?

A molecule present in chloroplasts (or photosynthetic bacteria) that absorbs light energy for photosynthesis. It absorbs specific wavelengths of light and reflects others.



Give some examples of photosynthetic pigments.





Give some examples of photosynthetic pigments.

- Chlorophylls a and b
- Beta carotene
- Xanthophylls



# What is the purpose of chromatography?



What is the purpose of chromatography?

To separate different products from a mixture.



State the equation used to calculate retention value ( $R_f$ ).



State the equation used to calculate retention value ( $R_f$ ).

$$\text{Retention value } (R_f) = \frac{\text{Distance travelled by component}}{\text{Distance travelled by solvent}}$$

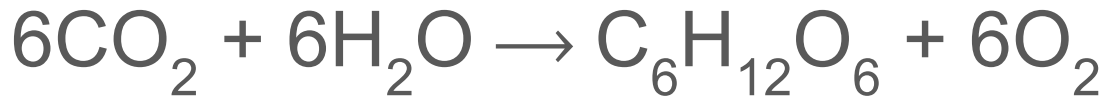


# What is photosynthesis?



# What is photosynthesis?

A complex metabolic pathway that synthesises organic molecules from carbon dioxide and water in the presence of light. Overall:



Name the two stages of photosynthesis.





Name the two stages of photosynthesis.

Light-dependent stage

Light-independent stage



# What is a Photosystem?



# What is a Photosystem?

- Protein complex consisting of an **antenna complex** and reaction centre
- Involved in the absorption of light and transfer of electrons in photosynthesis
- Two types: Photosystems I (PSI) and II (PSII).



# How do Photosystems I and II differ?



# How do Photosystems I and II differ?

They absorb different wavelengths of light.



Describe the process of light harvesting.



Describe the process of light harvesting in photosynthesis.

- **Antenna complex** absorbs light energy of varying wavelengths and transfers it quickly and efficiently to the reaction centre
- Energy absorbed by two chlorophyll a molecules which emit '**excited**' electrons



# What is an absorption spectrum?





# What is an absorption spectrum?

A pattern of bands that occurs when a substance absorbs the different wavelengths of light



# What is an action spectrum?



# What is an action spectrum?

A graph of the rate of photosynthesis against each wavelength of light absorbed by a pigment.



Describe the light-dependent stage of photosynthesis.



# Describe the light-dependent stage of photosynthesis.

- First stage of photosynthesis
- Takes place in the thylakoids of the chloroplast
- Uses light energy to produce ATP, reduced NADP and oxygen



State the sources of electrons for the electron transport chain.



State the two processes of ATP generation by the light-dependent reactions.

Cyclic and non-cyclic photophosphorylation.



Define cyclic photophosphorylation.





Define cyclic photophosphorylation.

The formation of ATP involving Photosystem I only, where  $\text{NADP}^+$  is not reduced



# Outline cyclic photophosphorylation.



## Outline cyclic photophosphorylation.

- Involves Photosystem I only (no electrons supplied from PS II)
- Excited electrons enter the electron transport chain to produce ATP and then return to Photosystem I
- No reduction of NADP and no water required to replace lost electrons



# What is the purpose of cyclic photophosphorylation?



What is the purpose of cyclic photophosphorylation?

Produces additional ATP to meet surplus energy demands of the cell.



Define non-cyclic photophosphorylation.



Define non-cyclic photophosphorylation.

The formation of ATP and reduced NADP involving both Photosystems I and II.



# Outline non-cyclic photophosphorylation.





# Outline non-cyclic photophosphorylation.

- Involves Photosystem I and II
- Excited electrons enter the electron transport chain to produce ATP
- NADP acts as a final electron acceptor and is reduced
- Water is photolysed to compensate for electrons lost from Photosystem II



What is the purpose of non-cyclic photophosphorylation?



What is the purpose of non-cyclic photophosphorylation?

Produces ATP and reduced NADP for the Calvin cycle.



How does chemiosmosis produce ATP in the light-dependent stage?



# How does chemiosmosis produce ATP in the light-dependent stage?

- Protons flow down their concentration gradient from the thylakoid space into the stroma via **ATP synthase**
- ATP synthase phosphorylates ADP to form ATP as protons flow through it



# Describe photolysis.



## Describe photolysis.

The splitting of a molecule of water in the presence of light (energy from the sun) that occurs during the light-dependent stage of photosynthesis. This produces protons, electrons and oxygen:



# What happens to the products of photolysis?





# What happens to the products of photolysis?

- $\text{H}^+$  - used in proton pumping and to reduce NADP
- $\text{e}^-$  - replaces electrons lost from chlorophyll a in PSII
- $\text{O}_2$  - by-product, used for respiration or diffuses out of the leaf as waste gas



Explain how the electron transfer chain results in the production of reduced NADP.



Explain how the electron transfer chain results in the production of reduced NADP.

NADP acts as a final electron acceptor, and is subsequently reduced.



Describe the light-independent stage of photosynthesis.



# Describe the light-independent stage of photosynthesis.

- Second stage of photosynthesis
- Calvin Cycle produces glucose
- Does not require light energy and takes place in the stroma
- Uses carbon dioxide and the products of the light-dependent stage to build organic molecules



What is the light-independent stage  
also known as?



What is the light-independent stage also known as?

The Calvin cycle



Name the three main stages of the Calvin cycle.





Name the three main stages of the Calvin cycle.

1. Carbon fixation
2. Reduction
3. Regeneration



What happens during carbon fixation of the Calvin cycle?



# What happens during carbon fixation of the Calvin cycle?

- Reaction between  $\text{CO}_2$  and ribulose biphosphate (RuBP) catalysed by enzyme **RuBisCo**
- Forms unstable 6C intermediate that breaks down into two molecules of **glycerate 3-phosphate (G3P)**



# What happens during reduction of the Calvin cycle?



# What happens during reduction of the Calvin cycle?

- $2\times$  G3P are reduced to  $2\times$  **triose phosphate (TP)**
- Requires  $2\times$  reduced NADP and  $2\times$  ATP formed during the light-dependent reaction
- Forms  $2\times$  NADP and  $2\times$  ADP that enter the light-dependent reaction



What happens during regeneration of the Calvin cycle?



# What happens during regeneration of the Calvin cycle?

- After 1C leaves the cycle, the 5C compound ribulose monophosphate (**RuP**) forms
- Ribulose biphosphate (**RuBP**) is **regenerated** from RuP using  $1 \times$  ATP
- Forms  $1 \times$  ADP



How are nutrients produced as a result of photosynthesis?





# How are nutrients produced as a result of photosynthesis?

- Formation of amino acids from GP (requires nitrates and sulfates)
- TP molecules used to produce sugars e.g. glucose, fructose, sucrose



# What is a limiting factor?



# What is a limiting factor?

A variable that limits the rate of a particular reaction.



Name the factors that limit the rate of photosynthesis. What stage do they limit?



Name the factors that limit the rate of photosynthesis.  
What stage do they limit?

- **Light intensity** - light-dependent stage
- **Light wavelength** - absorption by chlorophyll
- **CO<sub>2</sub> concentration** - light-independent stage
- **Temperature** - enzyme-controlled reactions (Carbon fixation)
- **pH** - enzyme-controlled reactions

Describe the role of nitrogen in plant metabolism.



Describe the role of nitrogen in plant metabolism.

Synthesis of amino acids, nucleotides and chlorophyll.



# What does nitrogen deficiency in plants cause?





# What does nitrogen deficiency in plants cause?

- Stunted growth
- Chlorosis (yellowing of the leaves due to insufficient chlorophyll production)



Describe the role of magnesium in plant metabolism.



Describe the role of magnesium in plant metabolism.

Central component of chlorophyll.



# What does magnesium deficiency in plants cause?



What does magnesium deficiency in plants cause?

Chlorosis (yellowing of the leaves due to insufficient chlorophyll production)

