Edexcel (A) Biology A-level

5.5 to 5.9 - Photosynthesis

Flashcards

Outline the overall reaction of photosynthesis.

Outline the overall reaction of photosynthesis.

In light-dependent stage, light energy breaks strong covalent bonds in water. Oxygen is released into the atmosphere.

In light-independent stage (Calvin cycle), fixation with carbon dioxide enables hydrogen to be stored as glucose, a respiratory fuel.

Where do the light-dependent and light-independent reactions occur in plants?

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light-dependent: in the thylakoids of chloroplasts.

light-independent: stroma of chloroplasts.

Name the processes in the light-dependent reaction.

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- photoionisation
- electron transfer chain
- chemiosmosis

non-cyclic only:

- reduction of NADP
- photolysis of water

Explain the role of light in photoionisation.

Explain the role of light in photoionisation.

Chlorophyll molecules absorb energy from photons of light.

This ‘excites’ 2 electrons (raises them to a higher energy level), causing them to be released from the chlorophyll.

What happens in the electron transfer chain (ETC)?

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Electrons released from chlorophyll move down a series of carrier proteins embedded in the thylakoid membrane & undergo a series of redox reactions, which releases energy.

How is a proton concentration gradient established during chemiosmosis?

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Some **energy released from the ETC** is **coupled** to the **active transport** of **H^+ ions** (protons) from the **stroma into the thylakoid space**.

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

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

H^+ ions (protons) move down their **concentration gradient** from **thylakoid space into stroma** via transmembrane channel protein **ATP synthase.**

ATP synthase catalyses ADP + Pi → ATP (requires energy).

Describe non-cyclic photophosphorylation.

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Uses Photosystems Ⅰ & Ⅱ. Excited electrons enter ETC to produce ATP. NADP acts as final electron acceptor & is reduced. Water is photolysed to release electrons to replace those lost from PS Ⅱ.

Describe cyclic photophosphorylation.

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Uses only Photosystem Ⅰ. Excited electrons enter ETC to produce ATP then return directly to photosystem. (so no reduction of NADP & no water needed to replace lost electrons).

State the purpose of cyclic and non-cyclic photophosphorylation.

State the purpose of cyclic and non-cyclic photophosphorylation.

cyclic: produces additional ATP to meet surplus energy demands of cell.

non-cyclic: produces ATP and reduced NADP for Calvin cycle to produce biological compounds.

How does ATP provide energy for metabolic reactions?

How does ATP provide energy for metabolic reactions?

Hydrolysis of high-energy bond between ADP & Pi releases small amount of energy that can be directly coupled to a reaction with little energy wasted as heat.

What happens in photolysis of water?

What happens in photolysis of water?

Light energy splits molecules of water.

$$2H_2O \rightarrow 4H^+ + 4e^- + O_2$$

What happens to the products of the photolysis of water?

What happens to the products of the photolysis of water?

H^+ ions: move out of thylakoid space via ATP synthase & are used to reduce the coenzyme NADP.

e^-: replace electrons lost from chlorophyll.

O_2: used for respiration or diffuses out of leaf as waste gas.

How and where is reduced NADP produced in the light-dependent reaction?

How and where is reduced NADP produced in the light-dependent reaction?

$NADP + H^+ + 2e^- \rightarrow NADPH$

Catalysed by dehydrogenase enzymes.

Stroma of chloroplasts.

Where do the H^+ ions and electrons used to reduce NADP come from?

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H^+ ions: photolysis of water.

Electrons: NADP acts as the final electron acceptor of the electron transfer chain.

Name the 3 main stages in the Calvin cycle.

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1. Carbon fixation
2. Reduction
3. Regeneration

What happens during carbon fixation?

What happens during carbon fixation?

Reaction between CO_2 & ribulose bisphosphate (RuBP) catalysed by ribulose bisphosphate carboxylase (RUBISCO).

Forms unstable 6C intermediate that breaks down into 2x glycerate 3-phosphate (GP).

What happens during reduction (in the Calvin cycle)?

What happens during reduction (in the Calvin cycle)?

2 x GP are reduced to 2 x glyceraldehyde phosphate (GALP).

Requires 2 x reduced NADP & 2 x ATP.

Forms 2 x NADP & 2 x ADP.

How does the light-independent reaction result in the production of useful organic substances?

How does the light-independent reaction result in the production of useful organic substances?

GALP acts as raw material. 1C leaves cycle to produce monosaccharides.

Simple sugars act as respiratory substrate to produce ATP for synthesis of polysaccharides, amino acids, lipids, nucleic acids.

What happens during regeneration (in the Calvin cycle)?

What happens during regeneration (in the Calvin cycle)?

After 1C leaves the cycle, the 5C compound RuP forms.

RuBP is regenerated from RuP using 1x ATP

forms 1x ADP.

Outline the sequence of events in the light-independent reaction (Calvin cycle).

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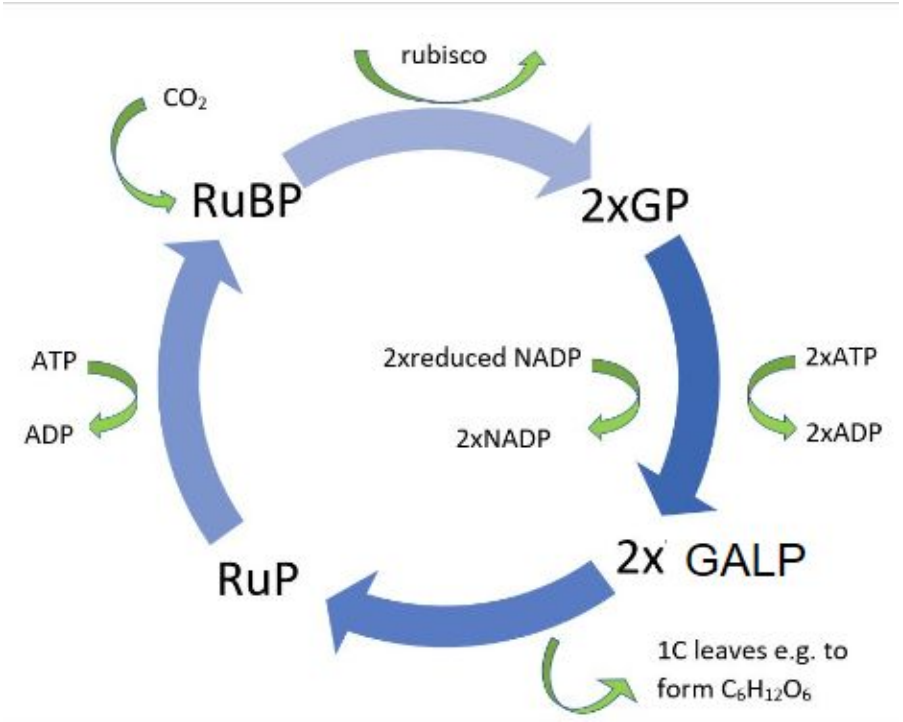

State the roles of ATP & (reduced) NADP in the light-independent reaction.

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ATP: reduction of GP to TP & provides phosphate group to convert RuP into RuBP.

(reduced) **NADP**: coenzyme transports electrons needed for reduction of GP to TP.

Describe the structure of a chloroplast.

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- Usually disc-shaped
- Double membrane (envelope)
- **Thylakoids:** flattened discs stack to form **grana**
- **Intergranal lamellae:** tubular extensions attach thylakoids in adjacent grana
- **Stroma:** fluid-filled matrix

How does the structure of the chloroplast maximise the rate of the light-dependent reaction?

How does the structure of the chloroplast maximise the rate of the light-dependent reaction?

- ATP synthase channels within granal membrane.
- Large surface area of thylakoid membrane for ETC.
- Photosystems position chlorophyll to enable maximum absorption of light.

How does the structure of the chloroplast maximise the rate of the light-independent reaction?

How does the structure of the chloroplast maximise the rate of the light-independent reaction?

- Own DNA & ribosomes for synthesis of enzymes e.g. rubisco.
- Concentration of enzymes & substrates in stroma is high.