Edexcel (B) Biology A-level

5.7 - Photosynthesis

Flashcards

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 with high enzyme and substrate concentration.

Where do the light-dependent & 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?

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

ATP synthase catalyses ADP + Pi → ATP

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.

What happens in photolysis of water?

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Light energy splits molecules of water

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

What happens to the products of the photolysis of water?

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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?

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$NADP + 2H^+ + 2e^- \rightarrow$ reduced NADP.

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 2 x 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?

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GALP acts as raw material when 1C leaves the cycle to produce monosaccharides, amino acids & other biological molecules.

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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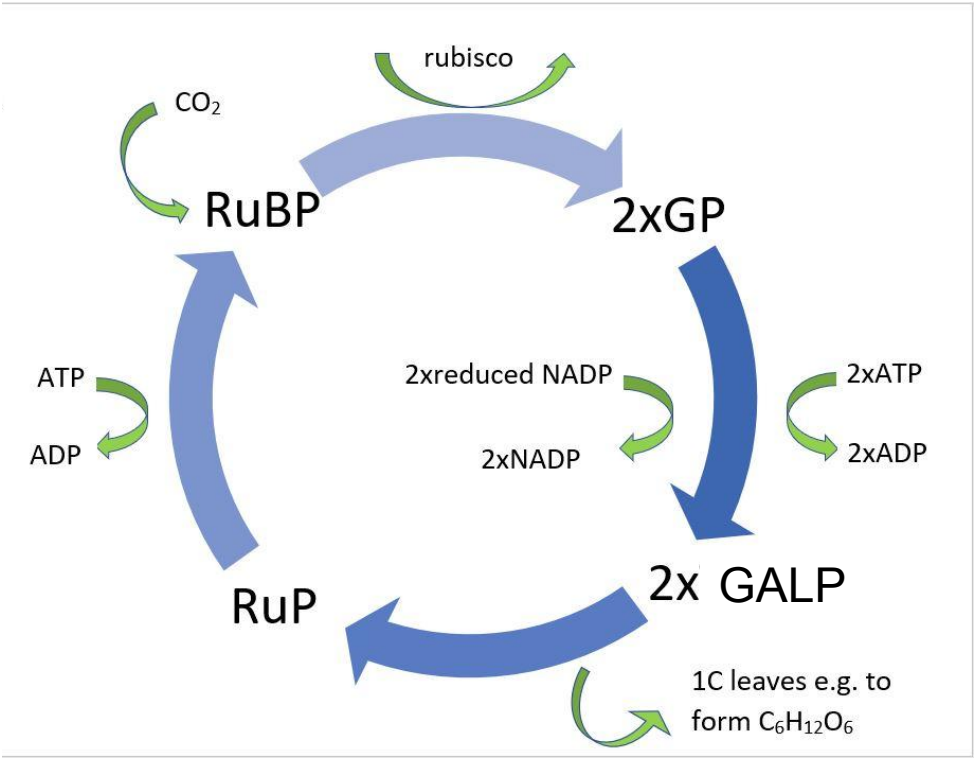

State the roles of ATP & (reduced) NADP in the light-independent reaction.

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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.

State the number of carbon atoms in RuBP, GP & GALP.

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RuBP: 5

GP: 3

GALP: 3

Define ‘limiting factor’.

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Factor that determines maximum rate of a reaction, even if other factors change to become more favourable.

Name 4 environmental factors that can limit the rate of photosynthesis.

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- Light intensity (light-dependent stage).
- CO_2 levels (light-independent stage).
- Temperature (enzyme-controlled steps).
- Mineral / magnesium levels (maintain normal functioning of chlorophyll).