AQA Biology A-level

5.1 - Photosynthesis

Flashcards

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

Explain the role of light in photoionisation.

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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.

Name the 2 main stages involved in ATP production in the light-dependent reaction.

Name the 2 main stages involved in ATP production in the light-dependent reaction.

1. electron transfer chain
2. chemiosmosis

What happens in the electron transfer chain (ETC)?

What happens in the electron transfer chain (ETC)?

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 the **thylakoid space into the stroma** via the channel protein **ATP synthase.**

ATP synthase catalyses ADP + Pi → ATP.

Explain the role of light in photolysis.

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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?

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?

- $NADP + 2H^+ + 2e^- \rightarrow$ 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 **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 triose phosphate (TP)
- 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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1C leaves the cycle (i.e. some of the TP is converted into useful organic 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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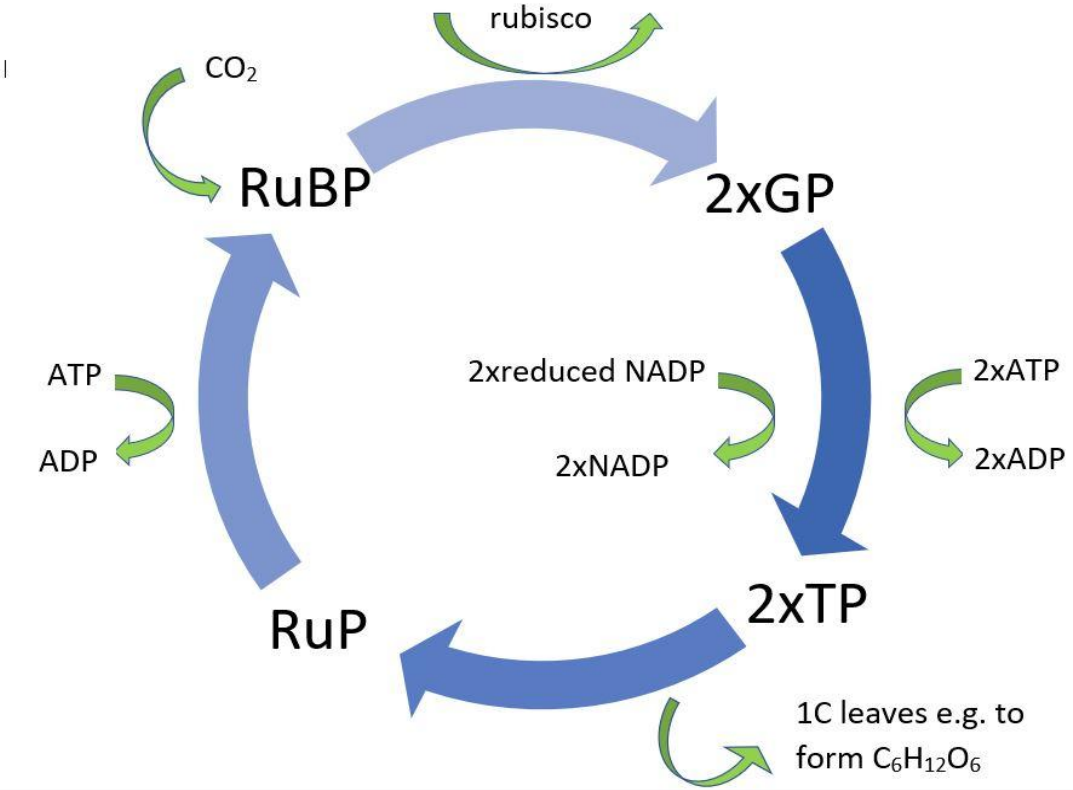

State the roles of ATP & (reduced) NADP in the light-independent reaction.

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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 & TP.

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RuBP: 5

GP: 3

TP: 3

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.

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).

Outline some common agricultural practices used to overcome the effect of limiting factors in photosynthesis.

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- Artificial light, especially at night.
- Artificial heating.
- Addition of CO_2 to greenhouse atmosphere.

Why do farmers try to overcome the effect of limiting factors?

Why do farmers try to overcome the effect of limiting factors?

- To increase yield.
- Additional cost must be balanced with yield to ensure maximum profit.

Suggest how a student could investigate the effect of a named variable on the rate of photosynthesis.

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dependent variable: rate of O_2 production/ CO_2 consumption

1. Use a potometer
2. Place balls of calcium alginate containing green algae in hydrogencarbonate indicator (colour change orange → magenta as CO_2 is consumed & pH increases).

State the purpose and principle of paper chromatography.

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Molecules in a mixture are separated based on their **relative attraction** to the mobile phase (**running solvent**) vs the stationary phase (**chromatography paper**).

Outline a method for extracting photosynthetic pigments.

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Use a pestle and mortar to grind a leaf with an extraction solvent e.g. propanone.

Outline how paper chromatography can be used to separate photosynthetic pigments.

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1. Use a capillary tube to spot pigment extract onto pencil ‘start line’ (origin) 1 cm above bottom of paper.
2. Place chromatography paper in solvent. (origin should be above solvent level).
3. Allow solvent to run until it almost touches the other end of the paper. Pigments move different distances.

What are Rf values? How can they be calculated?

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- Ratios that allow comparison of how far molecules have moved in chromatograms.
- Rf value = distance between origin and centre of pigment spot / distance between origin and solvent front.