OCR (A) Biology A-level

5.2.1- Photosynthesis

Flashcards

How are photosynthesis and respiration related?

How are photosynthesis and respiration related?

CO_2 & H_2O are the raw materials for photosynthesis and the products of respiration.

O_2 & glucose are the raw materials for respiration and the products of photosynthesis.

Describe the structure of a chloroplast.

Describe the structure of a chloroplast.

- 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 & substrate concentration & own loop of DNA.

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

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

Light-dependent: in the thylakoids of chloroplasts.

Light-independent: stroma of chloroplasts.

What is the role of photosynthetic pigments? Name the 2 main groups.

What is the role of photosynthetic pigments? Name the 2 main groups.

Embedded within thylakoid membrane. Absorb different wavelengths of light to maximise rate of photosynthesis.

- Primary pigment: chlorophyll (made of chlorophyll a & chlorophyll b) found in photosystems.
- Accessory pigments: carotenoids (carotene & xanthophylls) found in light-harvesting systems.

Name the processes in the light-dependent reaction.

Name the processes in the light-dependent reaction.

- 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)?

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 does chemiosmosis produce ATP in the light-dependent stage?

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

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

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

ATP synthase catalyses ADP + Pi → ATP

Describe non-cyclic photophosphorylation.

Describe non-cyclic photophosphorylation.

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.

Purpose is to produce ATP & reduced NADP for Calvin cycle to produce biological compounds.

Describe cyclic photophosphorylation.

Describe cyclic photophosphorylation.

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).

Purpose is to produce additional ATP to meet surplus energy demands of cell.

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 + $2H^+$ (from photolysis of water) + $2e^-$ (from acting as final electron acceptor in ETC) → reduced NADP.

Catalysed by dehydrogenase enzymes.

Stroma of chloroplasts.

Name the 3 main stages in the light-independent reaction.

Name the 3 main stages in the light-independent reaction.

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 light-independent reaction?

What happens during reduction in the light-independent reaction?

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

Outline the roles of TP from the light-independent reaction.

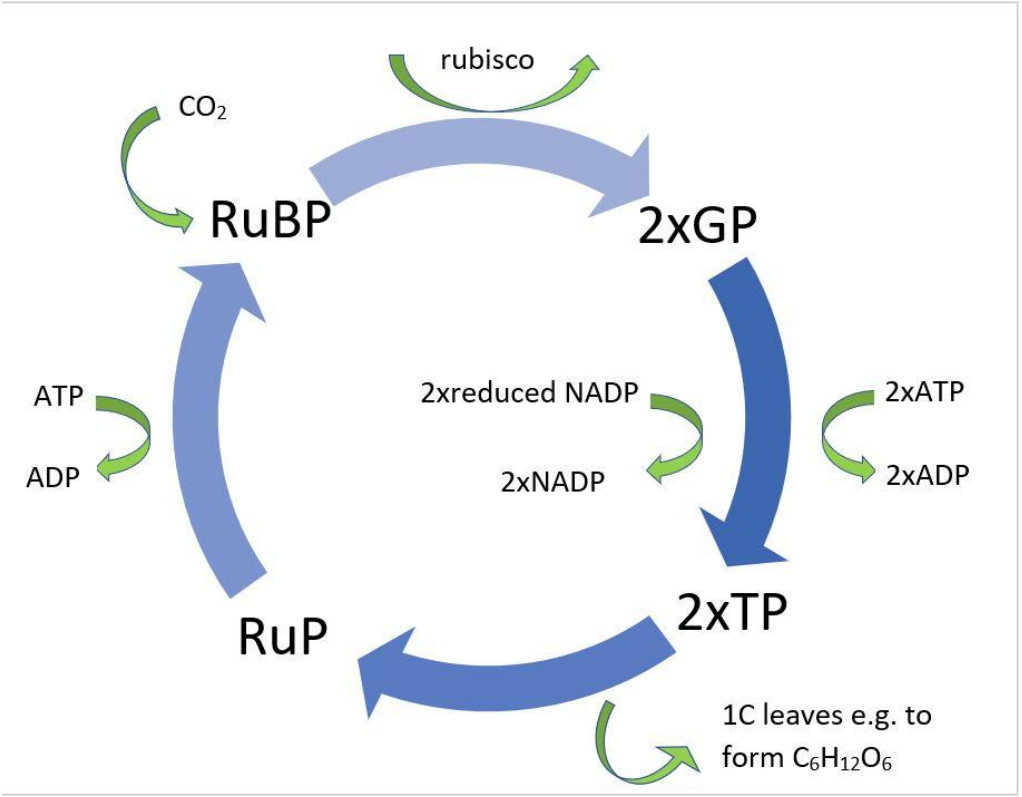
Outline the roles of TP from the light-independent reaction.

Raw material: 1C leaves the cycle to produce monosaccharides, amino acids & other biological molecules.

Involved in regeneration of RuBP: After 1C leaves cycle, the 5C compound RuP forms. RuP is converted into RuBP using 1x ATP. Forms 1x ADP.

Outline the sequence of events in the light-independent reaction.

Outline the sequence of events in the light-independent reaction.



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

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

RuBP: 5

GP: 3

GALP: 3

Define ‘limiting factor’.

Define ‘limiting factor’.

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.

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

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

How does light intensity affect the rate of photosynthesis?

How does light intensity affect the rate of photosynthesis?

Low light intensity = slower light- dependent reaction = less ATP & NADPH produced to convert GP to TP in light-independent reaction.

- GP level rises
- TP level falls = RuBP level falls

Describe the implications of water stress.

Describe the implications of water stress.

1. Abscisic acid binds to complementary receptors on guard cell membrane, causing Ca^{2+} ion channels on tonoplast to open. Ca^{2+} ions diffuse from vacuole into cytosol.
2. Positive feedback triggers other ion channels to open. Other ions e.g. K^{+} diffuse out of guard cell.
3. Water potential of guard cell becomes more positive. Water diffuses out via osmosis.
4. Guard cells become flaccid so stomata close.

State the purpose and principle of thin layer chromatography (TLC).

State the purpose and principle of paper chromatography.

Molecules in a mixture are separated based on their **relative attraction** to the mobile phase (**running solvent**) vs the stationary phase (**TLC plate,** usually coated in a silicate).

Outline a method for extracting photosynthetic pigments.

Outline a method for extracting photosynthetic pigments.

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

Outline how TLC can be used to separate photosynthetic pigments.

Outline how TLC can be used to separate photosynthetic pigments.

1. Use a capillary tube to spot pigment extract onto pencil ‘start line’ (origin) 1 cm above bottom of plate.
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.