Edexcel IAL Biology A-level

5.1-5.8 - Photosynthesis

Flashcards

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Write a chemical equation for the overall reaction of photosynthesis

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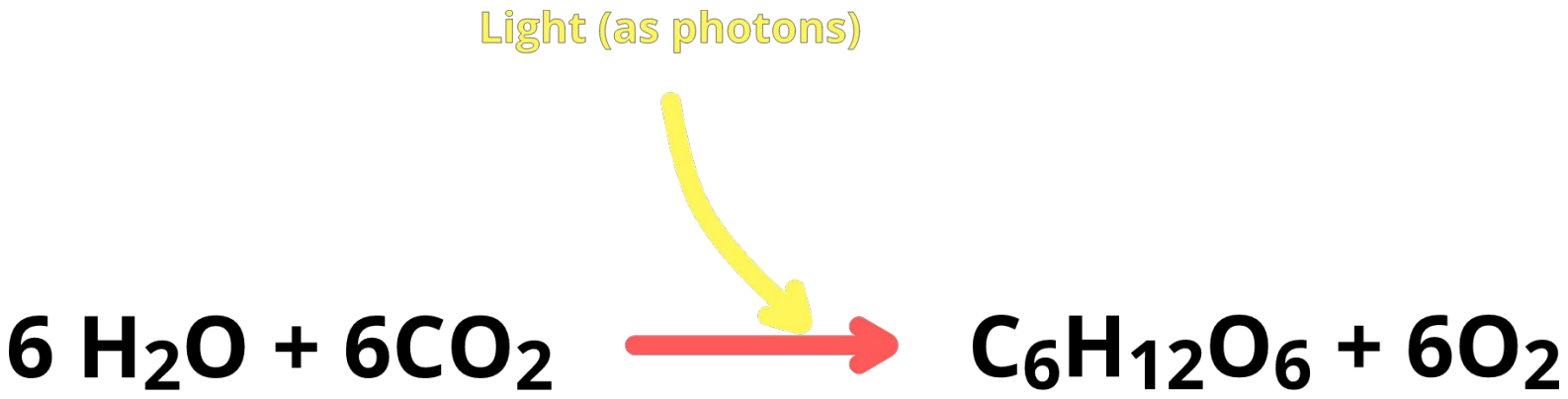
Write a chemical equation for the overall reaction of photosynthesis



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Outline the overall reaction of photosynthesis

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Outline the overall reaction of photosynthesis

- The production of fuel molecules (like glucose) by using high energy photons to split the strong bonds in water molecules and combining the hydrogen atoms with carbon dioxide. Oxygen is released as a by-product of the photolysis of water
- It is split into two main stages: the light-dependent reactions and the light-independent reactions

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What is a photosynthetic pigment?

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What is a photosynthetic pigment?

A molecule present in chloroplasts that absorbs certain wavelengths of light

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What is a Photosystem?

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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)

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How do Photosystems I and II differ?

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How do Photosystems I and II differ?

They absorb different wavelengths of light

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Describe the process of light harvesting

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Describe the process of light harvesting in photosynthesis.

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

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What type of reaction forms ATP?

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What type of reaction forms ATP?

An endergonic reaction which requires energy from processes like respiration

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Draw the reversible chemical equation for the breakdown and synthesis of ATP

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Draw the reversible chemical equation for the breakdown and synthesis of ATP

$$ATP \rightleftharpoons ADP + Pi$$

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Describe the structure of ATP

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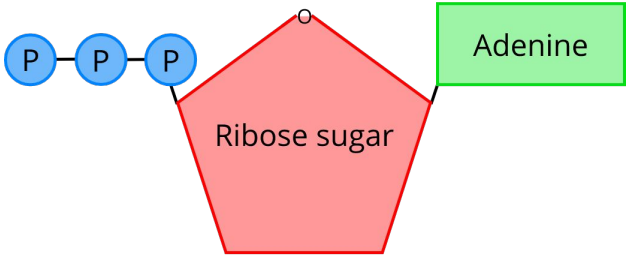
Describe the structure of ATP

ATP consists of adenosine (the nitrogenous base adenine bound to a ribose sugar) with 3 phosphate groups bonded to it covalently.



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Why is ATP called the ‘universal energy currency’?

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Why is ATP called the ‘universal energy currency’?

ATP is used as an energy source in all organisms

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Why is ATP only used as a short term energy store?

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Why is ATP only used as a short term energy store?

It is a very unstable molecule

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What is the photophosphorylation of ADP?

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What is the photophosphorylation of ADP?

The use of photons to provide the energy to carry out the unfavourable addition of a phosphate group onto ADP to form ATP

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Describe the light-dependent stage of photosynthesis

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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

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State the sources of electrons for the electron transport chain

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State the sources of electrons for the electron transport chain

Cyclic and non-cyclic photophosphorylation

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Define cyclic photophosphorylation

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Define cyclic photophosphorylation

The formation of ATP involving Photosystem I only

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Outline cyclic photophosphorylation

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Outline cyclic photophosphorylation.

- Involves Photosystem I only
- 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

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What is the purpose of cyclic photophosphorylation?

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What is the purpose of cyclic photophosphorylation?

Produces additional ATP to meet surplus energy demands of the cell

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Define non-cyclic photophosphorylation

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Define non-cyclic photophosphorylation.

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

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Outline non-cyclic photophosphorylation

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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

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What is the purpose of non-cyclic photophosphorylation?

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What is the purpose of non-cyclic photophosphorylation?

Produces ATP and reduced NADP for the Calvin cycle

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

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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

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Describe photolysis

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Describe photolysis

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

$$H_2O \longrightarrow 2H^+ + 2e^- + \tfrac{1}{2}O_2$$

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What happens to the products of photolysis?

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What happens to the products of photolysis?

- H^+ - used in proton pumping and to reduce NADP
- e^- - replaces electrons lost from chlorophyll a in PSII
- O_2 - by-product, used for respiration or diffuses out of the leaf as waste gas

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

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

NADP acts as a final electron acceptor and is subsequently reduced

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Describe the light-independent stage of photosynthesis

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Describe the light-independent stage of photosynthesis

- Second stage of photosynthesis
- 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

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What is the light-independent stage also known as?

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What is the light-independent stage also known as?

The Calvin cycle

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Name the three main stages of the Calvin cycle

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Name the three main stages of the Calvin cycle

1. Carbon fixation
2. Reduction
3. Regeneration

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What happens during carbon fixation of the Calvin cycle?

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What happens during carbon fixation of the Calvin cycle?

- Reaction between CO_2 and ribulose bisphosphate (RuBP) catalysed by enzyme **RuBisCo**
- Forms unstable 6C intermediate that breaks down into two molecules of **glycerate 3-phosphate** (GP)

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What happens during reduction of the Calvin cycle?

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What happens during reduction of the Calvin cycle?

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

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What happens during regeneration of the Calvin cycle?

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What happens during regeneration of the Calvin cycle?

- After 1C leaves the cycle, the 5C compound **RuP** forms
- **RuBP** is **regenerated** from RuP using 1× ATP
- Forms 1× ADP

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How are nutrients produced as a result of photosynthesis?

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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

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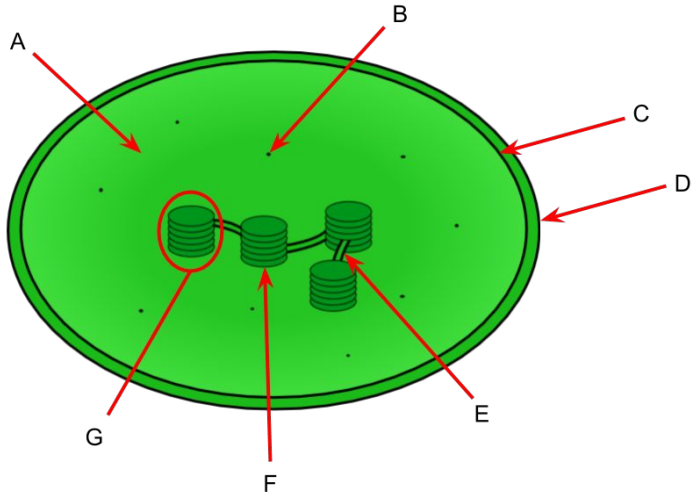
Label this diagram of a chloroplast



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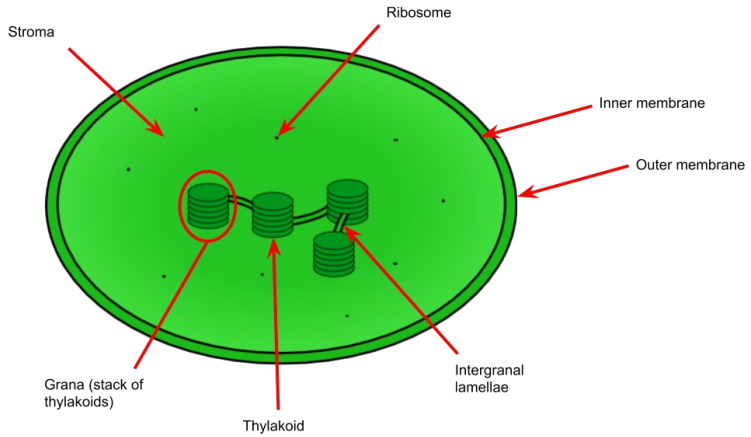
Label this diagram of a chloroplast

A	Stroma	E	Intergranal lamellae
B	Ribosome	F	Thylakoid
C	Inner membrane	G	Grana
D	Outer membrane		



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How are chloroplasts adapted to carry out photosynthesis?

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How are chloroplasts adapted to carry out photosynthesis?

- They contain many photosynthetic pigments to absorb many photons
- They contain many important enzymes used in photosynthesis such as **RuBisCO** and **ATP synthase**
- Thylakoids stacked into grana to increase the surface area of the thylakoid membrane
- 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

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What is an absorption spectrum?

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What is an absorption spectrum?

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

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What is an action spectrum?

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What is an action spectrum?

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

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What is the purpose of chromatography?

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What is the purpose of chromatography?

To separate different products from a mixture

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How can pigments in chloroplasts be separated by chromatography?

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How can pigments in chloroplasts be separated by chromatography?

Different pigments in chloroplasts have different properties and so will move different amounts through the chromatography medium, allowing separate pigments to be distinguished

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

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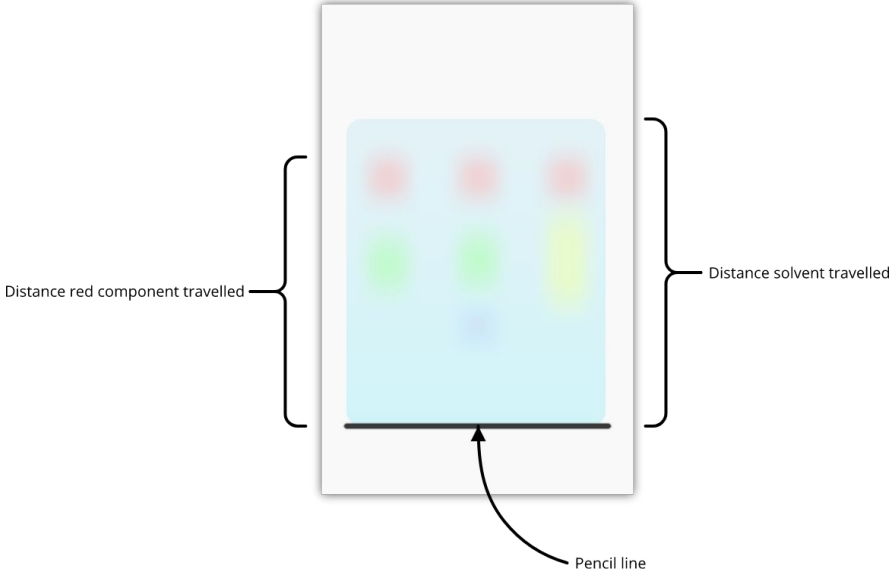
State the equation used to calculate retention value (R_f).

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



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What factors affect the rate of photosynthesis?

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What factors affect the rate of photosynthesis?

- Temperature
- Light intensity
- Carbon dioxide concentration

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What is a limiting factor?

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What is a limiting factor?

A variable that limits the rate of a particular reaction

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Explain how temperature affects the rate of photosynthesis

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Explain how temperature affects the rate of photosynthesis

- Higher temperatures provide more KE for enzymes involved in photosynthesis so the rate increases as temperature rises
- The optimum temperature is usually 25°C
- If the temperature becomes too high (around 45°C) enzymes become denatured and the rate of photosynthesis decreases

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Draw a graph to show the effect of increasing temperature on the rate of photosynthesis

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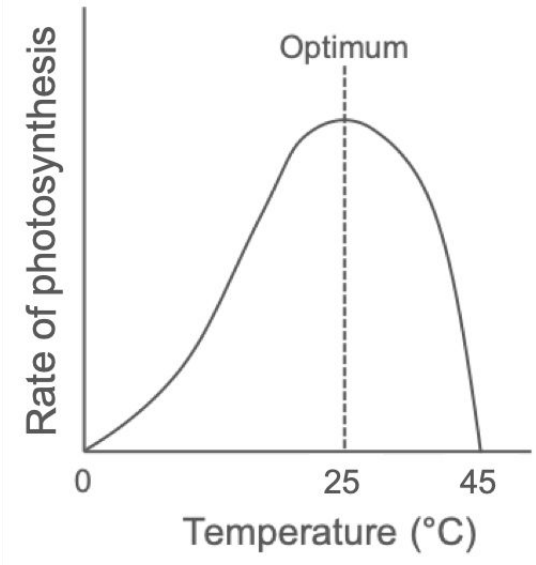
Draw a graph to show the effect of increasing temperature on the rate of photosynthesis



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Explain how light intensity affects the rate of photosynthesis

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Explain how light intensity affects the rate of photosynthesis

Rate of photosynthesis is directly proportional to light intensity ∴ as light intensity increases, the rate of photosynthesis increases.

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Why does the rate of photosynthesis eventually plateau even if light intensity continues to increase?

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Why does the rate of photosynthesis eventually plateau even if light intensity continues to increase?

Another factor (temperature or CO_2 concentration) becomes limiting.

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Draw a graph to show the effect of light intensity on the rate of photosynthesis

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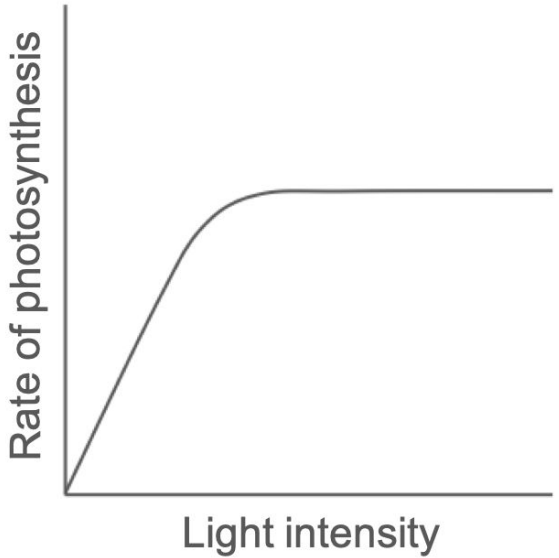
Draw a graph to show the effect of light intensity on the rate of photosynthesis



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Explain how carbon dioxide concentration affects the rate of photosynthesis

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Explain how carbon dioxide concentration affects the rate of photosynthesis

As carbon dioxide concentration increases, the rate of photosynthesis increases

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Why does the rate of photosynthesis eventually plateau even if CO_2 concentration continues to increase?

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Why does the rate of photosynthesis eventually plateau even if CO_2 concentration continues to increase?

Another factor (temperature or light intensity) becomes limiting

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Draw a graph to show the effect of carbon dioxide concentration on the rate of photosynthesis

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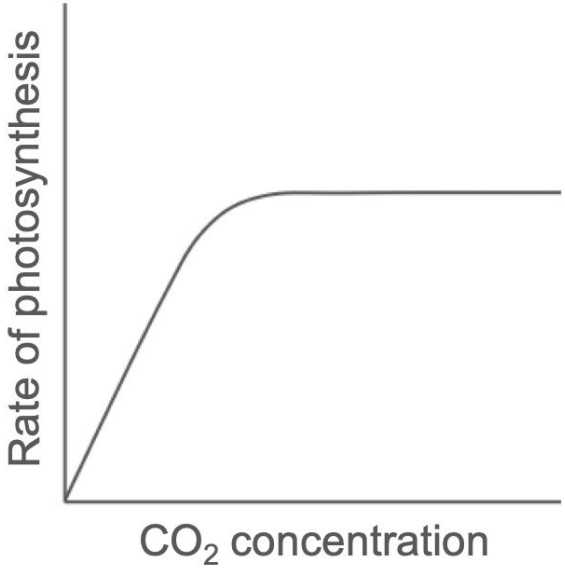
Draw a graph to show the effect of carbon dioxide concentration on the rate of photosynthesis



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When does temperature become a limiting factor?

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When does temperature become a limiting factor?

When temperature drops too low on cold winter days

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When does light intensity become a limiting factor?

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When does light intensity become a limiting factor?

At night

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When does carbon dioxide concentration become a limiting factor?

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When does carbon dioxide concentration become a limiting factor?

- Atmospheric CO_2 concentrations generally remain constant
- $\therefore$ CO_2 only becomes limiting when light intensity and temperature are not limiting factors

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