

CAIE Biology A-level

Topic 13 - Photosynthesis

Definitions and Concepts

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Absorption spectrum - A graph which plots absorption of radiation against wavelength or frequency of light.

Action spectrum - A graph which plots biological activity of a system against the wavelength of light.

ATP synthase - An enzyme found embedded in cellular membranes that phosphorylates ADP to form ATP as protons flow through it.

Cabomba - An aquatic plant.

Calvin cycle - See 'Light-independent reaction'.

Carotenes - A group of photosynthetic carotenoid pigments which absorb blue, violet and ultraviolet wavelengths of light, and reflect orange and red wavelengths of light.

Chlorophyll - A photosynthetic pigment located in the thylakoids of chloroplasts that absorbs light energy. There are two main types, chlorophyll a and chlorophyll b.

Chlorophyll a - The main photosynthetic pigment. It absorbs orange-red and violet-blue wavelengths of light, and reflects green-yellow light.

Chlorophyll b - An accessory photosynthetic pigment which can absorb a higher frequency of blue light than chlorophyll a.

Chloroplast - An organelle found in plants and algae that is the site of photosynthesis.

Chromatography - The process of separating different substances from a mixture.

Cyclic photophosphorylation - The formation of ATP involving photosystem I only. Photoactivation of chlorophyll takes place.

C4 metabolism - A pathway in some plants which can bypass photorespiration. Carbon dioxide is incorporated into malate or aspartate in mesophyll cells then transported via plasmodesmata into the bundle sheath cells, where decarboxylation regenerates carbon dioxide.

DCPIP - An artificial hydrogen acceptor that changes colour from blue to colourless when reduced.

Electron carriers - Protein molecules that accept and release electrons e.g. NADP.

Elodea - An aquatic plant.

Glycerate 3-phosphate (GP) - A three-carbon molecule that is reduced by reduced NADP in the light-independent stage of photosynthesis to form two molecules of TP. This requires ATP.

Grana - Stacks of thylakoids connected by intergranal lamellae.



Hill reaction - During the light-dependent reaction of photosynthesis, the transfer of electrons due to photoionisation can be observed using a redox indicator.

Lamellae - Membranous channels that connect adjacent grana in a chloroplast.

Light-dependent reaction - The first stage of photosynthesis that uses light energy to produce ATP, reduced NADP and oxygen. It takes place in the thylakoids of the chloroplast.

Light-harvesting system - A collection of protein and chlorophyll molecules found in the thylakoid membranes of chloroplasts that absorbs light energy of varying wavelengths and transfers it to the reaction centre. It is also known as an antennae complex.

Light-independent reaction - The second stage of photosynthesis, also known as the Calvin cycle, in which the products of the light-dependent stage and carbon dioxide are used to build organic molecules. It does not require light energy and takes place in the stroma.

Limiting factor - A variable that limits the rate of a particular reaction.

Methylene blue - An artificial hydrogen acceptor that changes colour from blue to colourless when reduced.

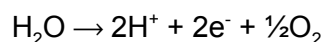
NADP - A coenzyme that becomes reduced when it takes up hydrogen atoms during the light-dependent stage of photosynthesis, forming reduced NADP.

Non-cyclic photophosphorylation - The formation of ATP and reduced NADP involving both photosystems I and II. Photoactivation of chlorophyll takes place.

Non-photochemical quenching - Excess energy from the excitation of chlorophyll is dissipated.

Photoactivation - The initiation of a process by the absorption of photons of light energy.

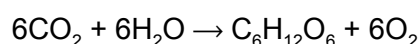
Photolysis - The splitting of a molecule of water in the presence of light that occurs during the light-dependent stage of photosynthesis. This produces protons, electrons and oxygen:



Photophosphorylation - The harnessing of light energy in photosynthesis to phosphorylate ADP, forming ATP.

Photorespiration - The enzyme rubisco has both carboxylase and oxygenase activity, so some of the substrate undergoes oxidation rather than carboxylation.

Photosynthesis - A complex metabolic pathway that synthesises organic molecules in the presence of light. It consists of three main stages: capturing of light energy, light-dependent reaction, light-independent reaction. Overall:



Photosynthetic pigments - Molecules present in chloroplasts that absorb certain wavelengths of light e.g. chlorophyll a, chlorophyll b, xanthophylls and carotenoids.

Photosystem - A protein complex consisting of a light-harvesting system and reaction centre, that is involved in the absorption of light and transfer of electrons in photosynthesis.

Reaction centre - The region of a photosystem where energy is funneled and photosynthetic reactions take place. It contains two chlorophyll a molecules.

Redox indicator - A substance which changes colour when it gains or loses electrons.

Retardation factor (R_f) value - Indicates the solubility of a substance in a particular solvent. A high R_f value represents high solubility. Calculated using the equation:

$$R_f = \frac{\text{Distance travelled by component}}{\text{Distance travelled by solvent}}$$

Ribulose biphosphate (RuBP) - A five-carbon compound that reacts with carbon dioxide in the light-independent stage of photosynthesis, forming two molecules of GP.

Rubisco - An enzyme that catalyses the reaction of RuBP and carbon dioxide in the light-independent stage of photosynthesis.

Stroma - The fluid interior of chloroplasts that contains the enzymes required for the light-independent reaction.

Thin-layer chromatography (TLC) - A technique used to separate photosynthetic pigments by their rate of movement when carried by a solvent, across an inert surface. Differences in rate arise due to varying solubilities in the mobile phase and interactions with the stationary phase.

Thylakoids - A series of flattened membrane-bound compartments in chloroplasts. They are stacked to form grana and contain the chlorophyll and other molecules needed for the light-dependent reaction.

Triose phosphate (TP) - A three-carbon compound formed in the light-independent stage of photosynthesis. It may serve as a starting material for the formation of organic molecules or be used to regenerate RuBP.

Xanthophylls - A group of yellow-coloured carotenoid pigments which probably aid non-photochemical quenching.

