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LECTURE

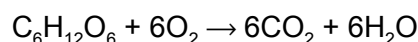
Definitions and Concepts for AQA Biology A-level

Topic 5 - Energy Transfers in and Between Organisms

Acetyl coenzyme A: A two-carbon molecule formed in the link reaction when acetate reacts with coenzyme A. It is oxidised in the Krebs cycle.

Adenosine triphosphate (ATP): Universal energy carrier found in all living cells.

Aerobic respiration: A form of cellular respiration that takes place in the presence of oxygen and produces carbon dioxide, water and ATP. It involves four main stages: glycolysis, link reaction, Krebs cycle, and oxidative phosphorylation. Overall:



Ammonification: The production of ammonia when saprobiontic microorganisms feed on organic nitrogen-containing compounds. Ammonium ions are formed and added to the soil.

Anaerobic respiration: A form of cellular respiration that takes place in the absence of oxygen. In animals, lactate is produced. In plants and microorganisms, ethanol and carbon dioxide are produced. Less ATP is formed than in aerobic respiration.

Artificial fertilisers: Man-made compounds generally containing nitrogen, phosphorus and potassium that are used to increase the mineral content of soils.

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

Biomass: The total mass of organic material, measured in a specific area over a set time period. This can be calculated in terms of dry mass or mass of carbon per given area.

Calorimetry: A technique used to estimate the chemical energy store in dry biomass.

Carnivores: Animals that prey on and eat other animals. They can be secondary or tertiary consumers.

Chemiosmotic theory: The synthesis of ATP through the movement of protons down their concentration gradient across a semipermeable membrane, catalysed by ATP synthase.

Chlorophyll: A photosynthetic pigment located in the thylakoids of chloroplasts that absorbs light energy and becomes ionised.

Coenzymes: Molecules that help enzymes carry out their function e.g. NAD, FAD, NADP.

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Consumers: Organisms that feed on other organisms to obtain energy.

Denitrification: The conversion of nitrate ions to nitrogen gas by denitrifying bacteria.

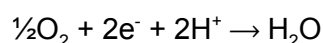
Denitrifying bacteria: Anaerobic microorganisms found in waterlogged soils responsible for the reduction of nitrate ions to nitrogen gas.

Ecosystem: The community of organisms (biotic) and non-living (abiotic) components of an area and their interactions.

Efficiency of energy transfer: The efficiency of energy transfer between trophic levels is calculated using:

$$\text{percentage efficiency} = \frac{\text{energy available after transfer}}{\text{energy available before transfer}} \times 100$$

Electron acceptor: Oxygen acts as the final electron acceptor in the electron transfer chain:



Electron transfer chain: A series of electron carrier proteins that transfer electrons in a chain of oxidation-reduction reactions.

Eutrophication: When a body of water becomes excessively rich with nutrients (often from fertilisers).

FAD: A carrier molecule that becomes reduced when it takes up protons and electrons during the Krebs cycle, forming reduced FAD.

Food chain: Describes the feeding relationships between organisms and the resultant stages of biomass transfer. It takes the form:

producer → primary consumer → secondary consumer → tertiary consumer

Food web: The interconnection of many different food chains in a habitat.

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

Glycolysis: The first stage of aerobic and anaerobic respiration that takes place in the cytosol of the cell and breaks down glucose into two molecules of pyruvate. Two molecules of ATP and two molecules of reduced NAD are also formed.

Gross primary production (GPP): The total amount of chemical energy stored in plant biomass in a set area or volume.

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Herbivores: Animals that eat plants, also known as primary consumers.

Krebs cycle: A series of oxidation-reduction reactions in the matrix of the mitochondria in which acetyl coenzyme A is oxidised generating reduced NAD, reduced FAD, ATP and carbon dioxide.

Leaching: The loss of nutrients from the soil due to rainwater.

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

Light-independent reaction: The third stage of photosynthesis, also known as the Calvin cycle, in which the products of the light-dependent stage and carbon dioxide are used to form a simple sugar. This stage does not require light energy and takes place in the stroma of the chloroplast.

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

Link reaction: The second stage of aerobic respiration that takes place in the mitochondrial matrix and converts pyruvate into acetyl coenzyme A and carbon dioxide. Reduced NAD is also formed. Overall:



Mycorrhizae: Mutualistic associations between some species of fungi and the roots of many plants that retain water and minerals around the roots.

NAD: A carrier molecule that becomes reduced when it takes up protons and electrons during aerobic respiration, forming reduced NAD.

NADP: A carrier molecule that becomes reduced when it takes up protons and electrons during the light-dependent stage of photosynthesis, forming reduced NADP.

Natural fertilisers: Dead and decaying organic matter used to increase the mineral content of soils.

Net primary productivity (NPP): The chemical energy store that remains when energy losses due to respiration are subtracted from the total energy store. This is used in plant growth or reproduction and is also available to other trophic levels.

$$\text{net primary production (NPP)} = \text{gross primary production (GPP)} - \text{respiratory losses (R)}$$

Net production of consumers (N): Calculated by subtracting the chemical energy lost due to respiration (R) and as a result of excretion and egestion (F) from the chemical energy

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stored in ingested food (I).

$$N = I - (F + R)$$

Nitrification: The conversion of ammonium ions to nitrate ions by nitrifying bacteria. This takes place in two stages: ammonium ions are oxidised to nitrite ions; nitrite ions are oxidised to nitrate ions.

Nitrifying bacteria: Aerobic microorganisms found in the soil responsible for the oxidation of ammonium ions to nitrate ions.

Nitrogen cycle: The cycle through which nitrogen moves between living organisms and the environment, involving ammonification, nitrification, nitrogen fixation and denitrification.

Nitrogen fixation: The conversion of atmospheric nitrogen gas into nitrogen-containing compounds by nitrogen-fixing bacteria in the soil or root nodules of legumes.

Nitrogen-fixing bacteria: Microorganisms responsible for the conversion of atmospheric nitrogen gas into nitrogen-containing compounds. They can be free-living or mutualistic.

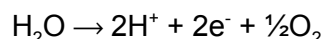
Oxidation: The loss of electrons, gain of oxygen or loss of hydrogen in a substance.

Oxidative phosphorylation: The synthesis of ATP from reduced coenzymes and oxygen in the electron transfer chain of aerobic respiration.

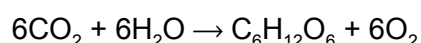
Phosphorus cycle: The cycle through which phosphorus (in the form of phosphate ions) moves between living organisms and the environment. This involves absorption by plants, feeding, digestion and excretion by animals, sedimentation and erosion of rocks and the decay of guano, bones and shells.

Photoionisation: The process by which a molecule of chlorophyll is ionised. A chlorophyll molecule absorbs light energy causing a pair of electrons within it to become excited, raised to a higher energy level, and leave the molecule.

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:



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



Primary productivity: The rate of primary production; the energy fixed by photosynthesis in a given area in a given period of time ($\text{kJ ha}^{-1} \text{ year}^{-1}$).

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Producers: Photosynthetic organisms at the start of the food chain that manufacture biomass (using light energy, carbon dioxide, water and mineral ions) for all living things.

Pyruvate: A three-carbon molecule produced in glycolysis. In aerobic respiration, pyruvate is oxidised to acetate in the link reaction. In anaerobic respiration it is converted to lactate (animals) or ethanol and carbon dioxide (plants and microorganisms).

Reduction: The gain of electrons, loss of oxygen or gain of hydrogen in a substance.

Ribulose biphosphate (RuBP): A five-carbon compound which reacts with carbon dioxide in the light-independent stage of photosynthesis to form two molecules of glycerate 3-phosphate (GP).

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

Saprobionts: Microorganisms that break down dead plant and animal material into simpler organic matter to obtain nutrients. Also known as saprophytes.

Secondary productivity: The rate of secondary production; the rate at which animals convert the chemical energy in plants they eat into their own biomass in a given area in a given period of time ($\text{kJ ha}^{-1} \text{ year}^{-1}$).

Substrate-level phosphorylation: The synthesis of ATP by the transfer of a phosphate group from a phosphorylated intermediate to ADP.

Triose phosphate (TP): A three-carbon compound formed in the light-independent stage of photosynthesis that may be converted into useful organic substances or used to regenerate ribulose biphosphate (RuBP).

Trophic level: The position of an organism in a food chain.