Energy transfers inside living organisms

The transfer of energy is essential in all living organisms as energy is vital for cells to live, grow and replicate. One significant transfer of energy is photosynthesis which converts light energy from the sun into stored chemical energy in the form of glucose and ATP. In the light-dependent reaction light energy is absorbed by chlorophyll in the grana of chloroplasts which excites two electrons from the photo system. Water is split into protons, electrons and oxygen using the light energy in photolysis. These two electrons then travel along the electron carrier chain and pull protons from the stroma to the intermembranal space, creating a steep proton concentration gradient. Protons then facilitatedly diffuse back into the stroma down a proton concentration gradient via a proton channel protein associated with ATP synthase. The movement of protons turns ATP synthase smashing ADP and Pi together, forming ATP and trapping 30.6KJ of energy. Thus the light energy is now stored as ATP ready to be hydrolysed to supply energy to the cells for processes like mitosis. In the light-independent reaction one molecule of glucose is produced from six complete Calvin Cycles. Reference

Energy from photosynthesis is ~~then stored~~ as biomass which is passed along the food chain from producer to primary consumer to secondary consumer and so on. A significant proportion of this energy is lost through respiration so the amount of biomass passed on through each trophic level decreases. Furthermore, photosynthesis is not one hundred percent efficient as some light energy passes straight through the leaf, without hitting the chloroplasts or is a different wavelength than those absorbed by the chlorophyll or accessory pigments, such as carotenoids, and so is not absorbed by the chloroplast. This energy transfer through the food chain is vital for the ecosystem to survive as if one trophic level is affected, the whole food chain will be affected and the ecosystem may not function correctly.

The glucose formed in photosynthesis can then be used as a substrate in aerobic respiration which forms ATP from glucose. The glucose is split into two molecules of pyruvate during glycolysis which has a net gain of two ATP as four ATP are produced and two are required to start the process as glucose is quite a stable molecule. Glycolysis is followed by the link reaction and Kreb's cycle which leads to oxidative phosphorylation which produces the most ATP and occurs on the cristae. Reduced NAD and reduced FAD are oxidized by cytochrome oxidase, and the electrons travel along the ETC, pulling protons from the matrix into the intermembranal space, creating a steep proton concentration gradient. The protons then move back into the matrix via facilitated diffusion through a proton channel protein. This turns ATP synthase which produces ATP, thus aerobic respiration converts one form of stored chemical energy; glucose, into another form of stored chemical energy; ATP so energy has been transferred. Reference

Adenosine triphosphate is a phosphorylated RNA nucleotide comprised of an adenine nitrogenous base joined to a ribose sugar joined to three phosphate groups. When ATP is hydrolysed, the bond between the second and third phosphate groups breaks, releasing 30.6KJ of energy and forming adenosine diphosphate and a phosphate group. The end phosphate group is replaced by a hydroxide ion as this is more stable. ATP is the universal energy currency for all living organisms so the transfer of energy during the hydrolysis of ATP is essential to provide the energy for vital processes such as mitosis.

Once formed, ATP is then used for various processes in the organism such as muscle contraction in humans. Once the action potential reaches the neuromuscular junction, the

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action potential is sent down the t tubules and calcium ions are released from the sarcolemma. The calcium ions bind to troponin which causes tropomyosin to uncover the myosin binding sites on the actin. ATP is then hydrolysed to ADP and Pi which causes the myosin head to lift and bind to the myosin binding sites on the actin- known as a power stroke. ✓ ME ATP then binds to myosin head, causing the cross bridge to break and the myosin head recocks, allowing the muscle to relax. The energy transfer in the hydrolysis and condensation of ATP is essential for contraction and relaxation of muscles, a process which is vital for mechanisms in the body like breathing through the contraction and relaxation of the diaphragm and intercostal muscles.

✓ Relevance