How is ATP produced and used in living organisms?

What is ATP?

Adenosine Triphosphate (ATP) is a molecule present in all living organisms. It is constructed from an Adenine nucleotide base, attached to a ribose sugar and three phosphate molecules. It is used as a source of energy in cells for a multitude of different processes, and is created in a phosphorylation reaction between Adenosine Diphosphate (ADP) and an inorganic phosphate (Pi) which is catalysed by the enzyme ATP synthase. Energy to synthesis ATP comes from an energy releasing reaction. The energy stored is in the form of a phosphate bond between two of the phosphate groups, which is released through a hydrolysis reaction catalysed by the enzyme ATP hydrolase. ATP is constantly recycled to ADP + Pi and back again, in different parts of the cells, whenever energy in needed.

Production and use via photosynthesis

The production of ATP on a global scale starts with plants, which convert light energy from the sun into chemical potential energy in the form of ATP. This occurs through two different reactions, the light dependent and light independent reaction. In the light-dependent reaction, ADP is combined with Pi to form ATP in the thylakoid membranes of the chloroplasts. This happens as light energy is absorbed by chlorophyll, exciting the electrons and raising their energy level. Energy from the excited electrons then makes ATP, through transporting H^+ ions (protons) into the thylakoid, causing it to have a higher concentration of protons than the stroma. When the protons then move back along their concentration gradient via the enzyme ATP synthase, ATP is produced. In this stage of photosynthesis NADPH is also produced and photolysis of water occurs.

The light independent reaction also occurs in photosynthesis, which is where ATP is used by the plant in order to provide long term storage of energy, as well as all the other organic substances the plant needs. CO_2 is combines with ribulose bisphosphate (RuBP) in a reaction catalysed by rubisco, forming two GP molecules. These then form two TP molecules, which is a process that requires the energy from two molecules of ATP to occur. One more molecule of ATP is required to recycle most of the TP back to RuBP, with only a small amount of carbon being utilised. Six turns of the Calvin cycle are required to make one hexose sugar, which is used in respiration to produce ATP for energy for the cell.

Production and use via respiration

The production of ATP in respiration occurs in two different ways – aerobic respiration and anaerobic respiration. Aerobic respiration occurs in four stages: glycolysis, the link reaction, the Krebs cycle and finally oxidative phosphorylation. The products of the first three stages are utilised in the final stage to produce lots of ATP. In glycolysis, which occurs in the cytoplasm as glucose molecules are too big to enter the mitochondria and occurs without oxygen, ATP is initially used,