Oxidoreductive enzymes

Most of the energy in an animal organism comes from oxidoreduction processes. The oxidation products of the reaction have a lower energy content than the initial reactants and the energy is released as heat or transformed into other types of usable energy, e.g. chemical bond energy. Numerous oxidations are associated with the formation of "macroergic" phosphate esters of anhydride nature (ATP, ADP), which are of particular importance in energy conservation and transfer. They are formed from the energy released in the cell during oxidation reactions. Oxidoreductions can occur anaerobically, e.g. in glycolysis, or aerobically, e.g. in the oxidation of substrates of the citrate (Krebs) cycle or by β-oxidation of fatty acids in mitochondria.

Sugars, lipids and proteins are sources of energy in the body, but oxidation does not usually occur directly with molecular oxygen or in aerobic oxidoreductions (with the exception of oxygens).

During oxidoreduction processes in mitochondria, electrons are transferred from substrates to oxygen by a series of carriers that form a precisely interconnected system of enzymes. This chain of oxidoreduction processes (cellular respiration) occurs in two stages:

1. Transfer of hydrogen atoms by the action of dehydrogenases containing pyridine and flavin nucleotides as coenzymes.
2. Electron transfer mainly via cytochromes (in mitochondria). The last step is important, where the autooxidizable cytochrome oxidase reacts directly with molecular oxygen to form water molecules.

The oxidoreduction sequence of reactions takes place in the inner mitochondrial membrane in the so-called respiratory chain, which is very schematically expressed as a two-electron transfer, since electrons are removed from organic substrate molecules in pairs by dehydrogenase coenzymes during biological oxidations. However, at the level of cytochromes the transfer is one-electron and at the level of cytochrome oxidase during the reduction of the O2 molecule it is four-electron.

During the two-electron transfer from the substrates (most often) of the citrate cycle to molecular oxygen, ATP molecules are simultaneously formed - so-called aerobic (oxidative) phosphorylation.

However, the electron acceptor is not necessarily oxygen. Some dehydrogenases also transfer electrons to other acceptors, e.g. pyruvate (lactate dehydrogenase) or in vitro to arteficial acceptors such as methylene blue (flavin dehydrogenase). This involves anaerobic oxidoreductions.

In addition to dehydrogenases and cytochromes, oxidoreductases include (among others) peroxidase (EC 1.11.1.7) and catalase (EC 1.11.1.6), which decompose H2O2 so that peroxidase catalyses the oxidation of a suitable substrate.

$$AH_2 + H_2O_2 \rightarrow 2\ H_2O + A,$$

whereas catalase releases molecular oxygen in the reaction

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$