Coenzymes

A **Coenzyme'** (cofactor) is a low molecular weight non-protein structure attached to the protein chain of an enzyme. Coenzymes play an important role in the transfer of hydrogen atoms, electrons, or groups of atoms during an enzyme-catalyzed reaction. According to the method of binding to the protein part of the enzyme, we distinguish:

- dissociable coenzymes
- prosthetic groups

Dissociable coenzymes

They are kept in contact with the enzyme by a non-covalent interaction. They can easily separate from the original enzyme molecule and bind to another. These include, for example, NAD^+ or $NADP^+$.

Prosthetic groups

They are structures firmly bound to the enzyme mainly **covalent bonds**. The character of this bond makes the prosthetic group a stable part of the enzyme. Examples include FMN, FAD and lipoic acid.

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Functions of coenzymes
1. Formation of complex 1
2. Regeneration of substrate + transfer of x to coenzyme
3. Formation of complex 2
4. Regeneration of coenzyme + formation of product

File:Functions of prosthetic groups.JPG

Functionality of prosthetic groups

Action of coenzymes

It is conditioned by two reactions. In the course of these two reactions, on the one hand, reaction catalysis takes place, on the other hand, simultaneous regeneration of the coenzyme. As mentioned above, we distinguish two types of coenzymes.

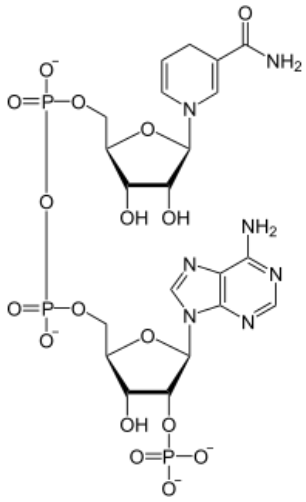
The two types of coenzymes differ in the way they are regenerated.

Catalysis and regeneration of dissociable coenzymes

First, dissociable coenzyme K, bound to apoenzyme E1, accepts the transferred group X from the substrate S1. Next, the K−X complex binds to the second apoenzyme E2 and transfers the transferred X group in this form to the S2 product. At the same time, coenzyme K is regenerated

Catalysis and regeneration of prosthetic groups

The course of the reaction with prosthetic groups is different due to their strong binding to the apoenzyme. The main difference is that only one apoenzyme participates in the catalysis of both reactions.



Structure of NADPH

Functions of coenzymes

Coenzymes are important for the functions of enzymes that catalyze oxidation-reduction events (oxidoreductases), or enzymes catalyzing the transfer of groups (transferases).

Coenzymes of oxidoreductases

🔎 *For more information see Redox Enzymes.*

These coenzymes are involved in the transfer of a hydrogen atom or electrons.

Coenzyme	Note
NAD^+	transfer of reducing equivalents (hydride ions: 2 e^-, 1 H^+) from catabolic events to the respiratory chain
NADPH	reducing agent of biosynthetic processes, is formed mainly in the pentose cycle
FMN	transfer of reducing equivalents (2 e^-, 2 H^+) using nitrogen atoms
FAD	transfer of reducing equivalents (2 e^-, 2 H^+) using nitrogen atoms
Coenzyme Q (ubiquinone)	part of the mitochondrial respiratory chain
Lipoic acid	bound by an amide bond to the side chain of lysine (referred to as liponamide), contains an intramolecular disulfide bond that has an oxidoreductive effect and changes to a dithiol upon reduction
Hem	only transfers electrons, e.g. mitochondrial cytochromes of the respiratory chain, cytochrome P450
Glutathione	antioxidant in erythrocytes, contains a redox-active intramolecular disulfide bond - similar to lipoic acid
[[Vitamin C|Template:L-ascorbic acid]]	coenzyme of monoxygenases and dioxygenases, participation in the hydroxylation of proline and lysine residues in the synthesis of collagen, synthesis of catecholamines and bile acids
Tetrahydrobiopterin (BH_4, THB)	coenzyme involved in the hydroxylation of tyrosineu, phenylalanineu, tryptophanu, etc.

Transferase coenzymes

These coenzymes allow the transfer of groups.

Coenzyme	Note
Nucleoside triphosphates: ATP, GTP, UTP, CTP	they mostly carry the rest of phosphoric acid, part of kinases
Coenzyme A	contains a -SH group, to which a carboxylic acid residue can be attached via a thioester bond, e.g. acetyl coenzyme A
Tetrahydrofolate (THF)	transfers one-carbon residues (methyl, formyl, methylene)
Pyridoxal Phosphate (PLP)	coenzyme important for metabolism AMK (transamination, decarboxylation)
Phosphoadenosine phosphosulfate (PAPS)	carries sulfate
S-adenosylmethionine (SAM)	transfers methyl e.g. during conversion of noradrenaline to adrenaline or during creatine synthesis, DNA methylation
Cobalamins	coenzymes of methyltransferases – e.g. methylation of homocysteine to methionine

Coenzymes of carboxylation and decarboxylation reactions

Coenzyme	Note
Pyridoxal Phosphate (PLP)	coenzyme important for metabolism AMK (transamination, decarboxylation)
Lipoic acid	bound by an amide bond to the lysine side chain of the respective apoenzyme → liponamide, which participates in the oxidative decarboxylation of 2-oxoacids
Thiamine diphosphate (TPP)	coenzyme of oxidative decarboxylation of 2-oxoacids and transketolases
Biotin	coenzyme of all carboxylases, reacts with bicarbonate (HCO_3^-) to form carboxybiotin, which transfers CO_2 to other molecules and thus creates carboxyl groups in them (COOH) – an example can be the synthesis of malonyl-CoA from acetyl-CoA or oxaloacetate from pyruvate

Links

Related Articles

- Enzymes
- Vitamins
- Enzyme Cofactors

References

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