Difference Between Holoenzyme and Apoenzyme

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Key Difference - Holoenzyme vs Apoenzyme

Enzymes are biological catalysts which increase the rate of chemical reactions in the body. They are proteins made up of amino acid sequences. Enzymes are involved in the chemical reactions without being consumed. They are specific for substrates and chemical reactions. The function of the enzyme is supported by different non-proteinaceous small molecules. They are known as cofactors. They aid enzymes in their catalytic action. These cofactors can be metal ions or coenzymes; they can also be either inorganic or organic molecules. Many enzymes require a cofactor to become active and initiate the catalytic function. Based on the binding with cofactor, enzymes how two forms named apoenzyme and holoenzyme. The key difference between apoenzyme and holoenzyme is that **apoenzyme is the protein component of the enzyme which is inactive and not bound to the cofactor** while **holoenzyme is the protein component of the enzyme and bound cofactor which creates the active form of the enzyme.**

What is Holoenzyme?

Enzymes are proteins that catalyze biochemical reactions in the cells. Most enzymes require a small non protein molecule to initiate catalytic functions. These molecules are known as cofactors. Cofactors are mainly inorganic or organic molecules. Cofactors are categorized into two main types named metal ions and coenzymes. The binding of the cofactor is essential for the activation of the enzyme and initiation of the chemical reaction. When the protein component of the enzyme is bound to the cofactor, the complete molecule is known as a holoenzyme. Holoenzyme is catalytically active. Hence, it actively binds with the substrates and increases the rate of the reaction. Coenzymes loosely bind with the enzymes while prosthetic groups bind tightly with the apoenzymes. Some cofactors bind to the active site of the enzyme. Upon binding, it changes the conformation of the enzyme and enhances the binding of substrates to the active site of the enzyme.

DNA polymerase and RNA polymerase are two holoenzymes. DNA polymerase requires magnesium ions to become active and initiate DNA polymerization. RNA polymerase needs sigma factor for its catalytic function.

What is Apoenzyme?

Apoenzyme is the enzyme before binding with the cofactor. In other words, apoenzyme is the protein part of the enzyme which lacks the cofactor. Apoenzyme is catalytically inactive and incomplete. It forms an active enzyme system upon combining with a coenzyme and determines the specificity of this system for a substrate. There are many cofactors that bind with apoenzymes to make holoenzymes. Common coenzymes are NAD+, FAD, Coenzyme A, B vitamins and vitamin C. Common metal ions that bind with apoenzymes are iron, copper, calcium, zinc, magnesium, etc. Cofactors bind tightly or loosely with the apoenzyme to convert apoenzyme into holoenzyme. Once the cofactor is removed from the holoenzyme, it is converted again into apoenzyme, which is inactive and incomplete.

The presence of the cofactor at the active site of the apoenzyme is essential because they provide groups or sites that the protein part of the enzyme does not possess to catalyze the reaction.

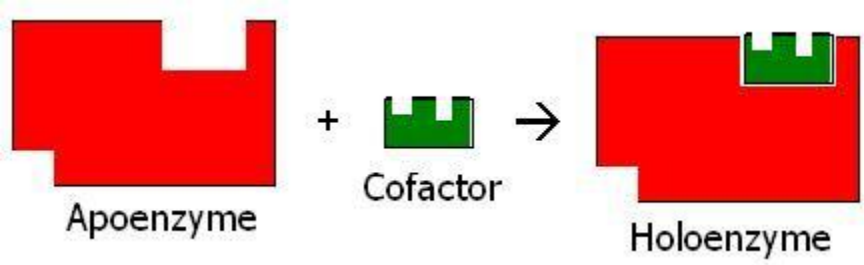

Figure 01: Apoenzyme and Holoenzyme

What is the difference between Holoenzyme and Apoenzyme?

Holoenzyme vs Apoenzyme	
Holoenzyme is an active enzyme consisting of an apoenzyme bound to its cofactor.	Apoenzyme is the protein component which lacks its cofactor.
Cofactor	
Holoenzyme is bound to its cofactor.	Apoenzyme is the enzyme component without the cofactor.
Activity	
Holoenzyme is catalytically active.	Apoenzyme is catalytically inactive.

Completeness	
Holoenzyme is complete and can initiate the reaction.	Apoenzyme is incomplete and cannot initiate the reaction.
Examples	
DNA polymerase, RNA polymerase are examples of holoenzym.	Aspartate transcarbamoylase is an example for apoenzyme.

Summary - Holoenzyme vs Apoenzyme

Enzymes are biological catalysts of the cells. They lower the energy needed for reaction occurrence. Enzymes increase the rate of reaction by actively inducing the substrate converting to products. They specifically catalyze the reactions without entering into the reactions. Enzymes are composed of protein molecules. The protein portion of the enzyme is known as apoenzyme. Apoenzyme needs binding with non proteinacious small molecules called cofactors to become active. When apoenzyme binds with cofactor, the complex is known as holoenzyme. Holoenzyme is catalytically active to initiate the chemical reaction. The substrate binds with the holoenzyme, not with the apoenzyme. This is the difference between holoenzyme and apoenzyme.

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