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ENZYMES AND THEIR PROPERTIES

Annotation: The article provides information on the general characteristics, properties and structure of enzymes.

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Enzymes are biological catalysts of a protein nature. ―The term enzyme (lat. Fermentum - fermentation) was coined in the early seventeenth century by the Dutch scientist Van Gelmont and was used in alcohol brewing. Initially, the word enzyme was considered only in connection with the fermentation process, and it was concluded that its effect is associated with a living organism. An extracellular biocatalyst was coined by Kyune in 1878 as an enzyme (Greek enzyme meaning "inside yeast"). In 1897, after Büchner obtained a free yeast extract from a cell that breaks down glucose into ethyl alcohol and carbon dioxide, like living yeast, the distinction between enzyme and enzyme names disappeared. Nowadays, the words enzyme and enzyme are completely synonymous, and in the literature both terms are used almost equally, in the same sense.

Today, fermentology (enzymology) is an important part of biochemistry, the achievements of which are widely used in applied medicine, pharmacy, food industry and other sectors of the economy. It is known that the course of a chemical reaction is determined by the difference between the free energies of the initial and final products. If the starting material has a higher free energy than the product, ie Δ G is negative, then the reaction itself can take place (exergonic reaction). At the opposite values of free energy, an endergonic reaction is observed, there is a lack of energy capacity for its passage, and it is associated with another exergonic reaction. In this case, the overall energy balance of the reaction is positive. But the energy potential of an exergonic reaction does not mean the speed of that reaction. For example, the combustion of gasoline in the presence of oxygen is a sharp exergonic reaction, but the oxidation of gasoline hydrocarbons in the presence of oxygen at room temperature is almost imperceptible.

Enzymes accelerate chemical reactions by reducing the activation energy. According to the concept of catalysis, molecules must go through a configuration period called the "activated state" before they can react. In this case, the molecules have more energy than under normal conditions. This energy is called the activation energy and is the main factor determining the rate of a chemical reaction. The higher the activation energy of a reaction, the slower its rate, and conversely, the lower the activation energy, the faster the reaction. Activation energy is necessary to overcome the forces (energy barrier) that prevent molecules from approaching and reacting. This means that the reaction involves molecules that have more energy than the energy barrier of that reaction. The greater the number of activated molecules, the faster the reaction rate. Energy (heat, light) must be used to activate the molecules, for example, to burn gasoline. The function of catalysts is to reduce the activation energy. The catalyst performs this reaction in another direction with a lower activation energy. According to the modern understanding of the mechanism of action of the enzyme, in a catalytic reaction, the enzyme (E) forms a substrate complex with the substrate (S), which is primarily affected by the enzyme (E). This complex is then broken down into reaction products (M) and the enzyme is released freely:

$$E + S \leftrightarrow E + M$$

This does not mean that the decrease in activation energy accelerated the reaction to such an extent. A decrease in the activation reaction can significantly increase the reaction rate. Each enzyme, like any catalyst, has a limit to its rate of reaction.

This means that the enzyme does not change the free energy of the starting material and the reaction product.

Similarities and differences between enzymes and non-enzyme catalysts.

Enzymes and non-enzyme catalysts have the following similarities, subject to the general laws of catalysis:

1. Enzymes catalyze reactions that have only energy potential.

2. They never change the direction of the reaction.

3. Enzymes accelerate the reaction without changing the state of equilibrium.

4. They are not consumed in the reaction process. Therefore, the enzyme in the cell continues to function until it undergoes any degradation.

However, the enzyme differs from the non-biological catalyst in some respects. The differences are due to the fact that enzymes are complex protein molecules and their structure is unique.

1. The rate of enzymatic catalysis is much higher than for non-biological catalysts. This is because enzymes significantly reduce the activation energy of the reaction compared to conventional catalysts. For example, the activation energy of hydrogen peroxide in the decomposition reaction is 75.3 kJ / mol, and as a result of its very slow decomposition, the oxygen released in the form of bubbles is not noticeable at all. When an inorganic catalyst - iron or platinum - is added to the reaction, the activation energy is reduced by 54.1 kJ / mol, and the reaction is accelerated 1000 times, and the oxygen released in the form of bubbles is visible. The enzyme catalase, which breaks down hydrogen peroxide, accelerates the decomposition reaction of peroxide a billion times by reducing the activation energy by 4 times. Oxygen bubbles released as a result of the high rate of the reaction appear to be "boiling".

A single enzyme molecule can catalyze thousands to millions of molecules of a substance in one minute at normal body temperature (37 ° C). Inorganic catalysts do not have catalysis at this rate.

2. Enzymes have a high degree of specificity, ie their catalytic effect is limited to a certain type of chemical reaction. Some enzymes affect only one stereoisomer of the substance, platinum is used as a catalyst in various reactions, the high specificity of enzymes allows to direct the metabolism in a constant flow.

3. Enzymes catalyze chemical reactions under "soft" conditions, ie at normal pressure, low temperature (around 37 ° C) and ambient pH. With these properties, they differ from catalysts that act under conditions of high pressure, ambient pH and temperature. Due to the protein nature of enzymes, they are relatively sensitive to changes in temperature and pH.

4. Enzyme activity can be controlled, this property is not specific to inorganic catalysts. Enzymes allow the body to change the rate of metabolism depending on environmental conditions, that is, to adapt to the influence of various factors.

5. The rate of enzymatic reaction is directly proportional to the amount of enzyme, and in inorganic catalysts there is no such proportion. This means that when the amount of enzymes decreases, the rate of metabolism in the body decreases, and, conversely, the amount of additional enzymes increases the ability of the body's cells to adapt to the conditions.

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