Factors Affecting Enzyme Activity

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Factors Affecting Enzyme Activity

Eman Farghly Hassan Shrief
Department of Biochemistry and Nutrition, Ain Shams University, Women Faculty for Arts, Science and Education.

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Abstract

Enzyme activity affected by a variety of factors, such as temperature, pH, and concentration. Substrate concentration: Increasing substrate concentration also increases the rate of reaction to a certain point, Effect of Water and effect of Inhibitors and activator.

Introduction

Enzymes are catalysts or chemical agents that speed up chemical reactions without being consumed. Most enzymes are proteins that function to reduce energy of activation in chemical reactions. They work on reactants called substrate; the enzyme attaches to the substrate and then the enzyme converts the substrate into a product, while the enzyme remains unaffected. Enzyme activity affected by several factors that will be discussed below.

1. Temperature Effect

As the temperature increases the rate of chemical reaction will increase, but just up to a certain point, then it will sharply drop.

The optimal temperature it occurs when the rate of the reaction is at its highest, each enzyme has a certain temperature at which it is more active, ranges between 37 to 40C°.

The protein nature of the enzymes makes them extremely sensitive; so after the optimal temperature the rate starts to drop that is because the protein starts to denature so it loses its shape and don't function well.

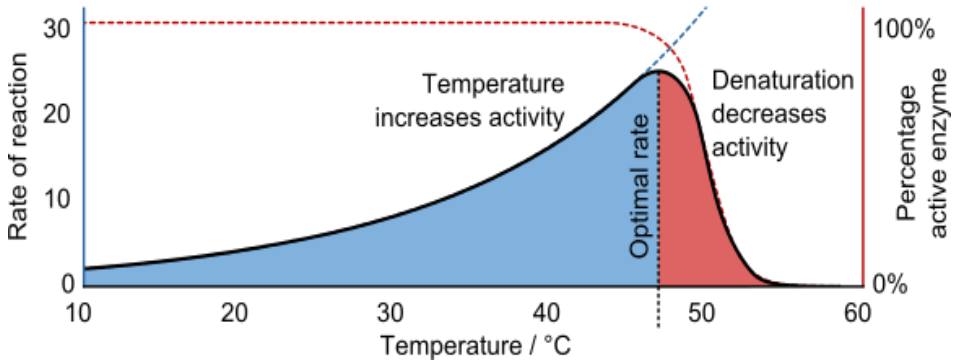

Figure 1.1 Temperature influence on rate of reaction.

The enzyme activity gradually lowers as the temperature rises more than the optimal temperature until it reaches a certain temperature at which the enzyme activity stops completely due to the change of its natural composition.

On the other hand, if the temperature lowers below the optimal temperature, the enzyme activity lowers until the enzyme reaches a minimum temperature at which the enzyme activity is the least. The enzyme activity stops completely at 0C°, but if the temperature rises again, and then the enzyme reactivate once more. **[1, 2]**

2. PH Effect

Enzymes are protein substances that contain acidic carboxylic groups (COOH–) and basic amino groups (NH2). So, the enzymes are affected by changing the pH value.

Each enzyme has a pH value that **it works at with maximum efficiency** called the optimal pH. If the pH is lower or higher than the optimal pH, the enzyme activity decreases until it stops working. For example, pepsin works at a low pH, i.e., it is highly acidic, while amylase works at a high pH, i.e., it is basic. Most enzymes work at neutral pH 7.4. **[2]**

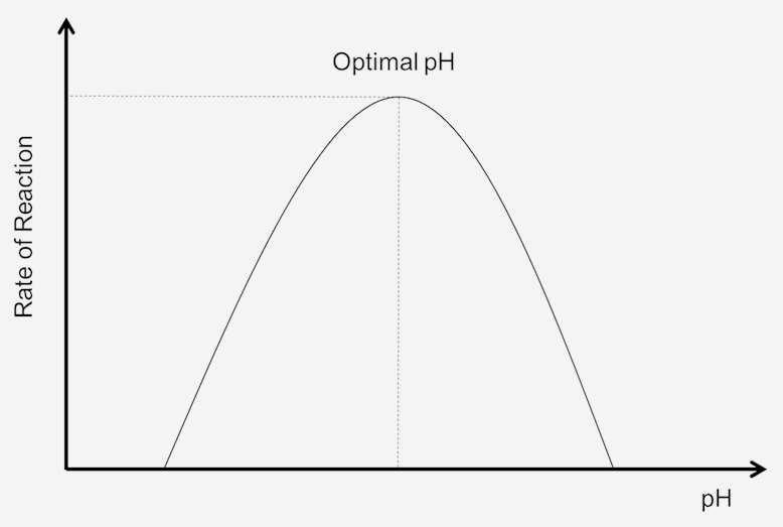

Figure 2.1. pH influence on rate of reaction.

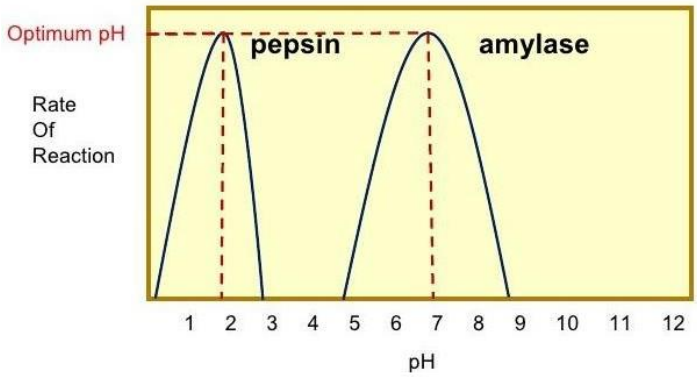

Figure 2.2. Low pH is commonly found in stomach enzymes e.g. Pepsin
High pH e.g. amylase

3. Concentration Effect

a. Substrate concentration

Increasing substrate concentration also increases the rate of reaction to a certain point. Once all of the enzymes have bound, any substrate increase will have no effect on the rate of reaction, as the available enzymes will be saturated and working at their maximum rate.

b. Enzyme concentration

Increasing enzyme concentration will elevate the chemical reaction rate, as long as there is substrate available for binding. Once all of the substrate is bound, the reaction will no longer speed up, because there will be nothing for additional enzymes to bind to.**[3]**

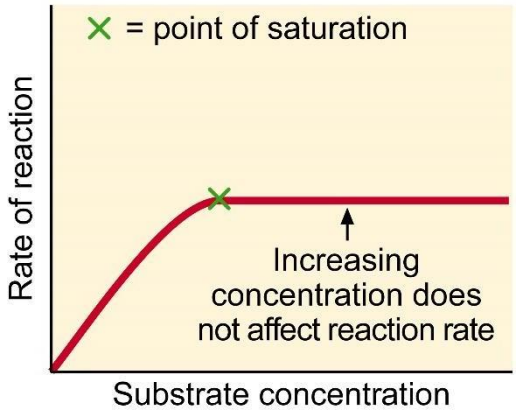

Figure 1.3. there is no use of excess substrate once it all bind with the enzyme

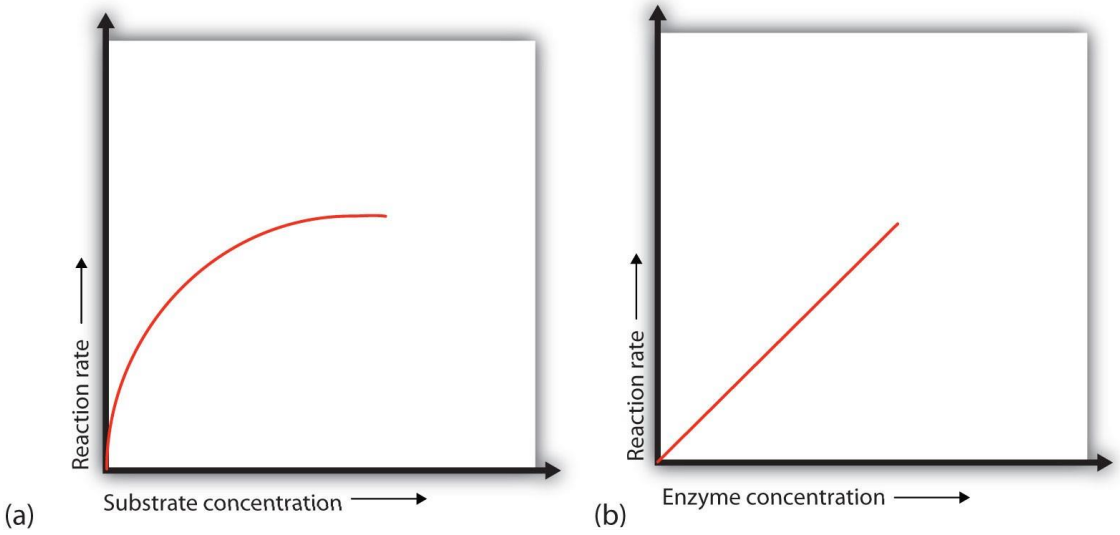

Figure 3.2 the difference between the enzyme and substrate concentration upon the chemical reaction rate

4. Water effect

To some extent, enzymes need to b hydrated in order to develop activity e.g. Hydration of Lysozyme was determined by IR and NMR spectroscopy. first the charged polar groups of the side chains hydrate, followed by the uncharged ones.

In preservation of food, it is mandatory to inhibit enzymatic activity completely if the storage temperature is below the phase transition temperature. **[4]**

5. Activators Effect

Activators they enhance the activity of an enzyme.

Some of the enzymes require certain **inorganic metallic cations**, like Mg2+, Mn2+, Zn2+, Ca2+, Co2+, Cu2+, Na+, K+ etc., for their optimum activity.

Compounds which are active as prosthetic groups or which provide stabilization of the enzyme's conformation or of the enzyme-substrate complex

Rarely, anions are also needed for enzyme activity, e.g. a chloride ion (CI–) for amylase. **[1, 3, 4]**

6. Inhibitors effect

Enzyme activity is inhibited in various ways. Two of them are:

a. Competitive inhibition

Occurs when molecules very similar to the substrate molecules bind to the active site and prevent binding of the actual substrate.

Penicillin, for example, is a competitive inhibitor that blocks the active site of an enzyme that many bacteria use to construct their cell walls.

b. Noncompetitive inhibition

1. Occurs when an inhibitor binds to the enzyme at a location other than the active site.

2. In some cases of noncompetitive inhibition, the inhibitor is thought to bind to the enzyme in a way to block the normal active site.

3. In other instances, the binding of the inhibitor is believed to change the shape of the enzyme molecule, thereby deforming its active site and preventing it from reacting with its substrate. This type of noncompetitive inhibition called allosteric inhibition; the place where the inhibitor binds to the enzyme is called the allosteric site. Frequently, an end product of a metabolic pathway serves as an allosteric inhibitor on an earlier enzyme of the pathway. This inhibition of an enzyme by a product of its pathway is a form of **negative feedback**.

Allosteric (control)

In enzymology, inhibition or activation of an enzyme by a small regulatory molecule that interacts at a site (allosteric site) other than the active site (at which catalytic activity occurs)

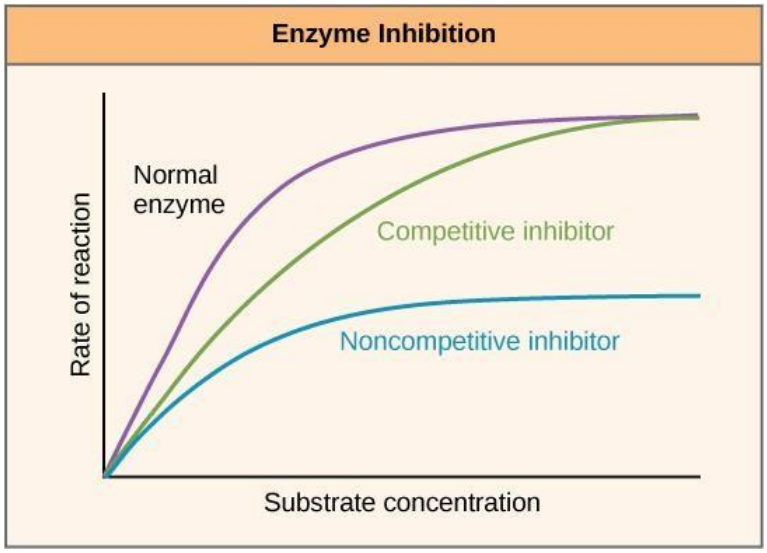

Figure 6.1. The competitive and non-competitive inhibitors effect on reaction rate.

Allosteric control can involve stimulation of enzyme action i.e. ;(activators) as well as inhibition. An activator molecule can be bound to an allosteric site and induce a reaction at the active site by changing its shape to fit a substrate that could not induce the change by itself. Common activators include hormones and the products of earlier enzymatic reactions. **[5]**

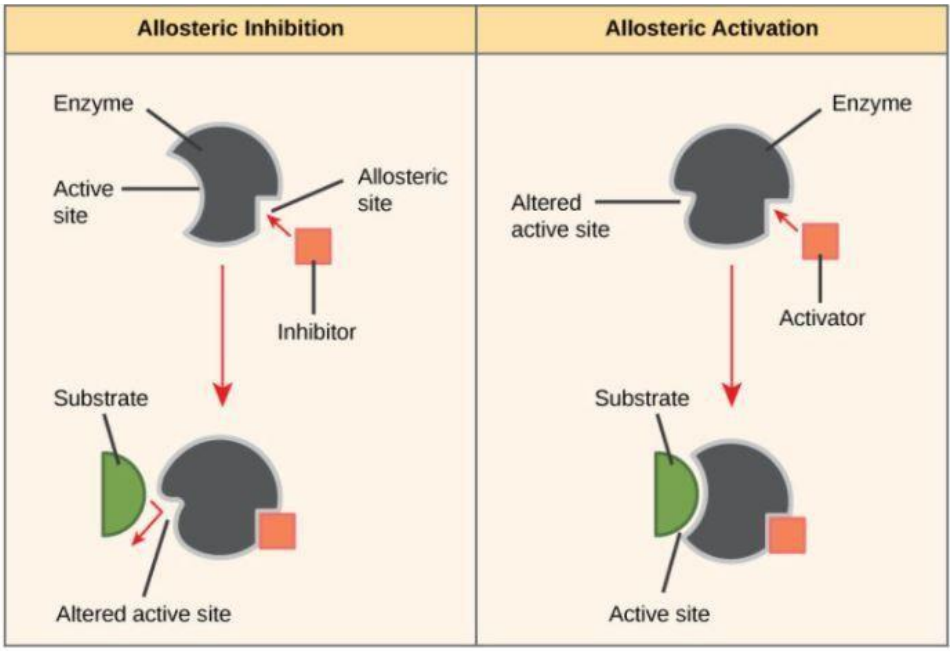

Figure 6.2. Allosteric control can involve stimulation of enzyme action i.e. ;(activators) as well as inhibition ,as illustated.

A comparison between Enzyme activators and inhibitors

	Enzyme activator	**Enzyme inhibitor**
Definition	Chemical species can bind with an enzyme to increase its activity.	Chemical species can bind with an enzyme to decrease its activity.
Effect on enzyme	Can increase enzyme activity.	Can decrease enzyme activity.
Examples	Include hexokinase-1 and glucokinase.	Include drugs, ribonuclease inhibitor.

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