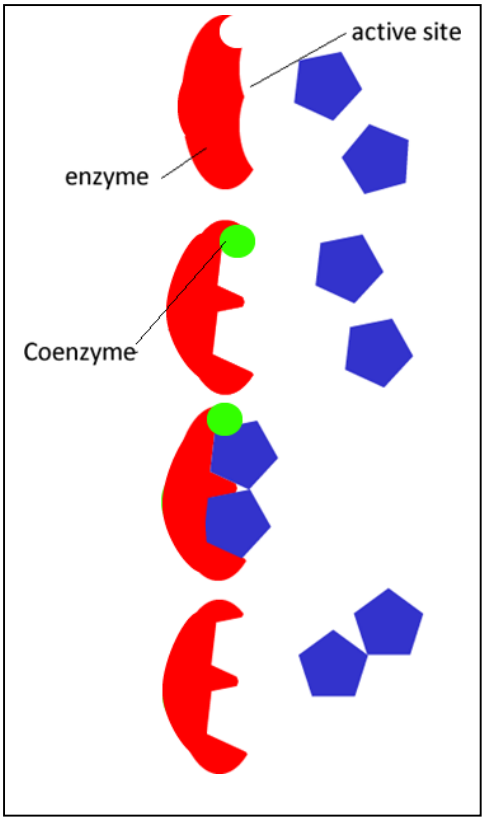
Lesson 2-digestion- part 2 – enzymes
Click to revise enzymes



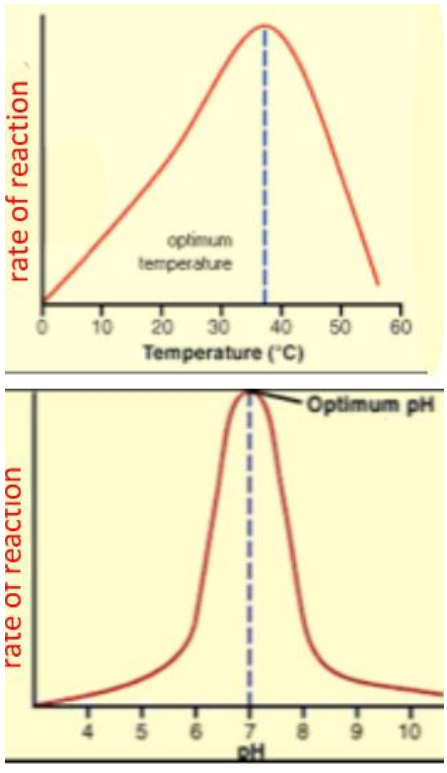
Most of the chemical reactions in the body are controlled by organic catalysts called enzymes. Enzymes are proteins that act as catalysts to speed up chemical reactions in the body. Enzymes are specific to one particular reaction and act on one particular optical isomer of a compound. Just like inorganic catalysts they offer an alternate reaction pathway with a lower activation energy.

An enzyme's catalytic activity depends on its 3-D shape which is determined by its primary structure which ultimately determines the secondary and tertiary structure of the protein. A specific section of the surface of the enzyme protein, known as the ***active site***, binds the substrates in a lock and key fashion.
The lock-key model has being further modified to take into account that the active site is flexible and can change shape, somewhat, to facilitate the substrate. This is known as the ***induced fit model***.

Some enzymes need a co-factor to function properly. Cofactors can be metal ions, such as Ca^{2+} or organic molecules known as coenzymes, most of which are derived from vitamins. Coenzymes bind with some enzymes and modify their active site in order to better facilitate the binding of the substrates. Coenzymes can even bind to the active site, where they act as carriers of electrons or small groups of atoms, such as CH_3 groups. Coenzymes, however, are not considered substrates. An enzyme that is activated by a coenzyme is inactive until the coenzyme binds to the enzyme. Unlike enzymes, coenzymes can change as a result of the chemical reaction taking place, however, a secondary reaction follows that changes the coenzyme back to its original form.

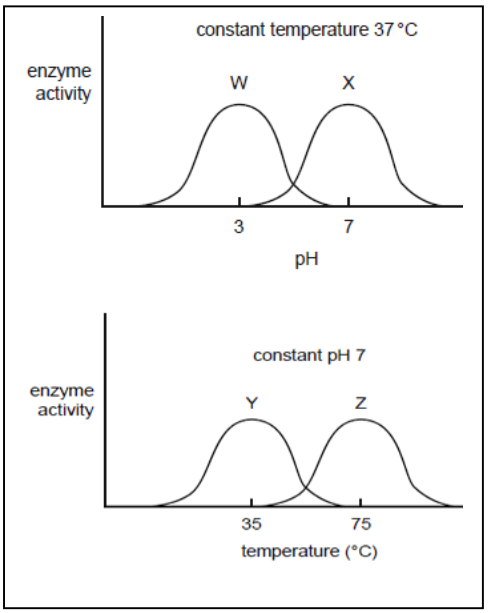
Being proteins an enzyme's activity is influenced by pH and temperature. Temperature and pH both influence the tertiary structure of the protein and have an impact on the structure of the active site.

Depending on the enzyme, it will have an optimum pH and optimum temperature at which it will have its highest impact on the rate of a reaction, as shown on the right.



Denaturing or sever disruption of the tertiary structure happens at either end of the optimum pH.
At low temperatures the rate of the reaction is slow because very little kinetic energy in the system. At temperatures above the optimum temperature disruption of the tertiary structure takes which inactivates the enzyme.

1) Consider the two graphs on the right representing the activity of four enzymes in different conditions.
Which of the following statements are true. Explain



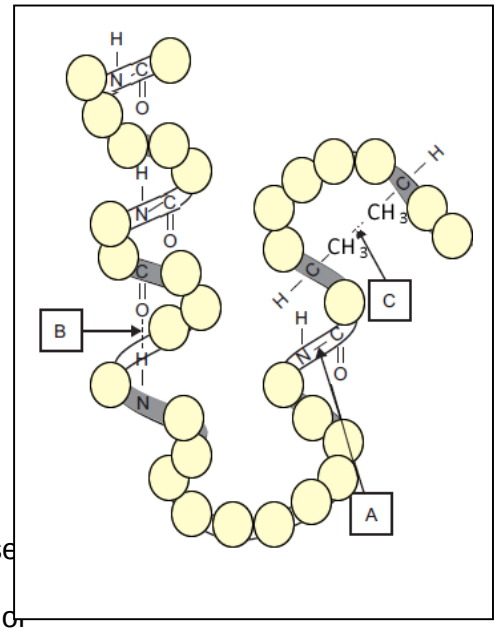
i. At pH 7, enzyme Z is denatured at temperatures below 20 °C. *False*
Low temperatures do not denature the enzyme. Reactant particles simply do not have enough kinetic energy to overcome the activation energy.

ii. Enzyme Z could be an enzyme that is active in the human body. *False*
Enzyme Z has an optimum temperatures of 75°C not 37°C.

iii. At pH 7 and a temperature of 37 °C, the active site of enzyme X binds well with its substrate.
True. At 37°C and at a pH of 7 enzyme X has the highest activity.

iv. At pH 12 and a temperature of 37 °C, enzyme X is denatured. *True.*
At such a high pH the activity drops off indicating a disruption to the active site.

2) Consider a small section of a protein's tertiary structure shown in the right.
This protein functions as an enzyme in the Human body.



a) Name the type of bonding labelled
A *Covalent*
B *H-bonding*
C *Dispersion*

b) At temperatures above 50°C describe which of the bonds mentioned in a) above will be disrupted.
B and C

c) Why do enzymes catalyse only one reaction?
The active site is very specific to the substrates involved in the reaction.

3) Consider the following statements relating to enzyme-catalysed reactions. Label each as True or False Explain why.

I The shapes of the substrate and the active site of the enzyme are complementary. *True*
The lock and key model and the induced fit model indicate that the interaction between active site and substrates are shape specific.

II When enzymes are denatured, the shape and structure of the active sites are **not** altered.
False
Denaturing disrupts the secondary and tertiary structures of the enzyme and hence disrupts the active site.

III The substrate forms bonds with the active site of the enzyme. *True.*

4) Consider the following statements and label them true or false with an explanation.

i. The optical isomers of an organic compound will be treated equally by the enzyme catalysing the reaction.
False. Enzymes are specific to a particular optical isomer. Click for a detailed explanation on optical isomers.

ii. An enzyme acts on a chemical reaction at equilibrium to speed up the rate of the forward reaction more than the backward reaction and therefore drive the overall reaction to completion
False. Enzymes are very specific catalysts that increase equally the rate of a forward and reverse reactions when a system is at equilibrium. This principle of catalysis follows from the fact that catalysts can't change the equilibrium of a reaction. Because a reaction at equilibrium occurs at the same rate in both directions, a catalyst that speeds up the forward but not the reverse reaction necessarily alters the equilibrium position of the reaction and this is not possible for catalysts to do.

iii. A reaction the uses an enzyme produces more product than a similar reaction that is not catalysed.
False _ an enzyme is a catalyst and all catalyst have no impact on the equilibrium position of a reaction and hence the yield.

iv. An enzyme is not able to change shape.
False. An enzyme is capable of changing shape slightly to accommodate the substrates on its active site. This is called the induced fit model.

v. All enzymes require a cofactor in order to function.
False