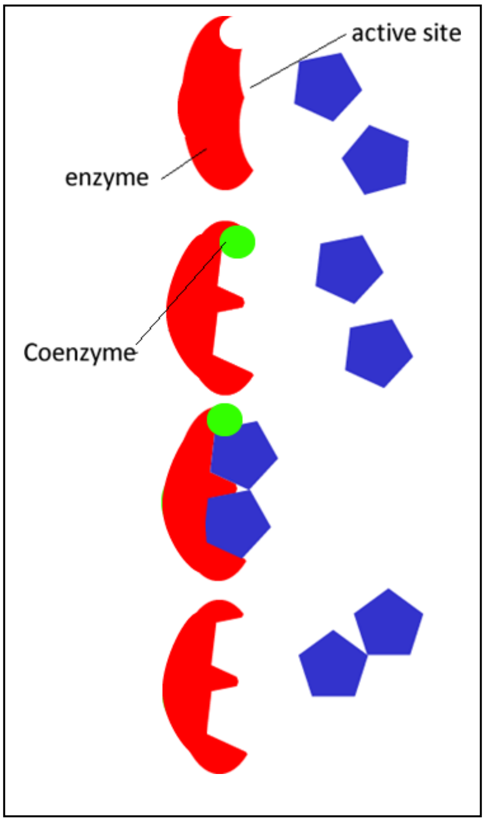
Lesson 2-digestion- part 2 – enzymes

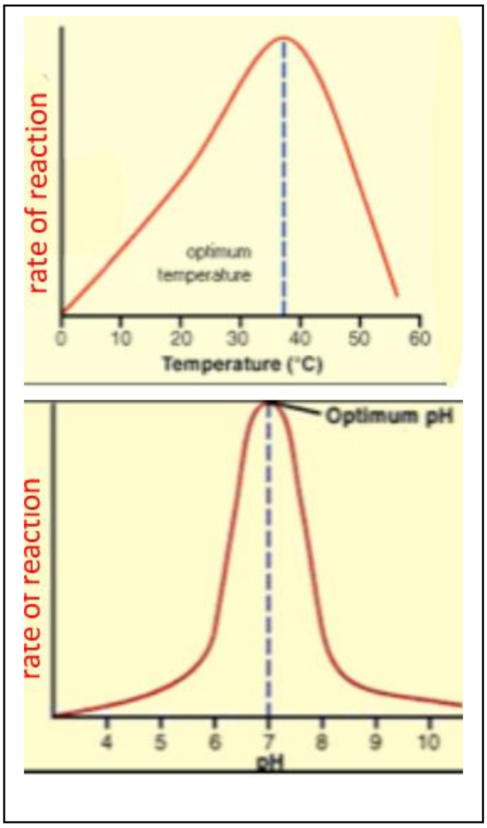
Click to revise enzymes




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.



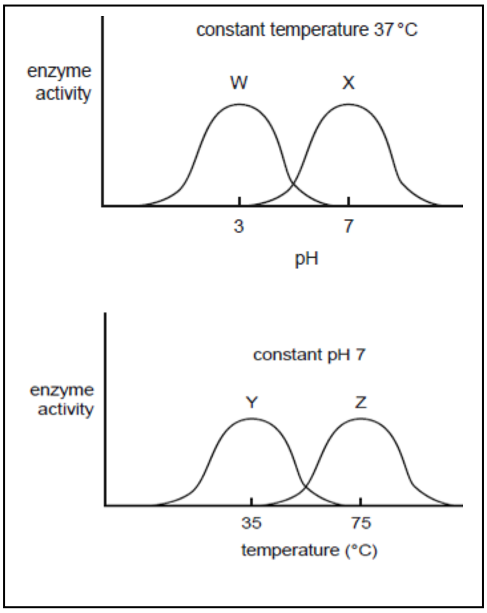

Being proteins an enzyme's activity is influenced by pH and temperature. Temperature and pH both influence the tertiary structure of the protein and have an impact on the structure of the active site.

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 severe disruption of the tertiary structure happens ateither 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.

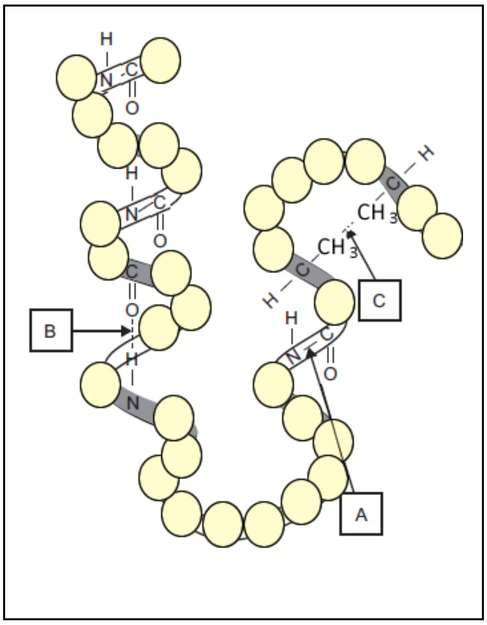
Enzymes are extremely specific and can distinguish between optical isomers. Like all, catalysts, enzymes increase the rate of the forward and reverse reactions but do not impact the equilibrium constant of the reaction.

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.
   **ii.** Enzyme Z could be an enzyme that is active in the human body.
   **iii.** At pH 7 and a temperature of 37 °C, the active site of enzyme X binds well with its substrate.
   **iv.** At pH 12 and a temperature of 37 °C, enzyme X is denatured.




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

   c) Why do enzymes catalyse only one reaction?




3) Consider the following statements relating to enzyme-catalysed reactions.
   I The shapes of the substrate and the active site of the enzyme are complementary.
   II When enzymes are denatured, the shape and structure of the active sites are **not** altered.
   III The substrate forms bonds with the active site of the enzyme.
   Which statements are true? Explain
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.
   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.
   iii. A reaction the uses an enzyme produces more product than a similar reaction that is not catalysed.
   iv. An enzyme is not able to change shape.
   v. All enzymes require a cofactor in order to function.