Enzymes

5.1.2 Enzymes

Enzymes are proteins that are involved in all metabolic reactions, where they function as biological catalysts

-Metabolic reactions are all chemical reactions that occur in the body

5.1.1 Catalyst

A catalyst is a substance that increases the rate of a chemical reaction and is not changed by the reaction

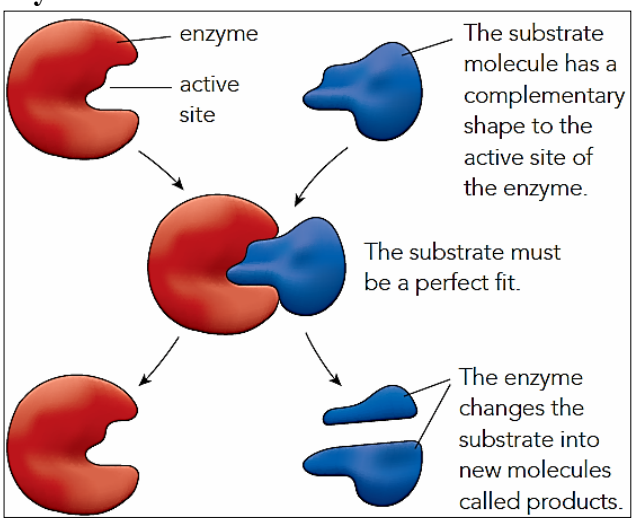
5.1.3 Importance of enzymes in living organisms

-to speed up reactions that are necessary to sustain life e.g speed up respiration to release energy that is needed for growth

Characteristics of enzymes

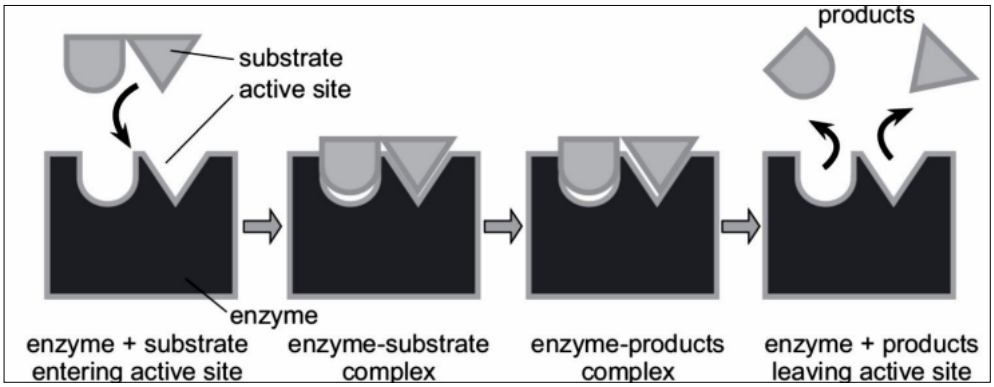
-enzymes are biological catalysts
-protein in nature
-work in small quantities
-not involved in chemical reactions
-can be reused
-work at certain degree of temperature
-can be destroyed by excess heat
-work at certain range of pH
-are specific in their action i.e. an enzyme will only work on one substrate e.g. amylase only acts on starch and pepsin only acts on protein

5.1.6 Enzyme action



-Enzymes have an active site
-The shape of the active site is complementary to that of the substrate
-Substrate binds to the active site
-This leads to the formation of the product
-The product no longer fits in the active site and leaves the active site
-Enzyme remains free to catalyse another reaction

Enzyme action: with reference to enzyme-substrate complex



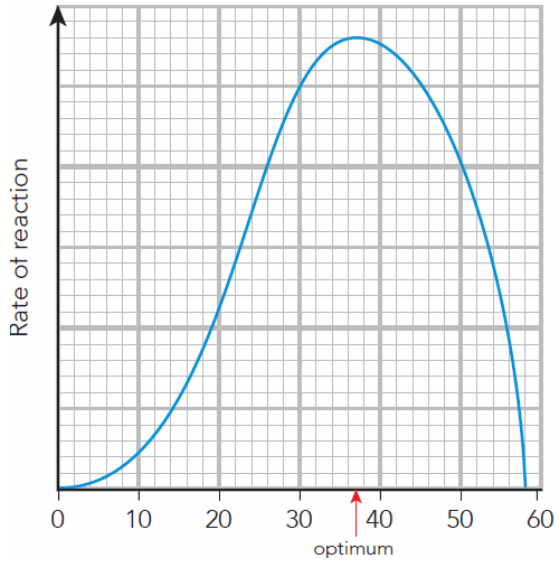
-the substrate binds onto the active site of the enzyme
-forming an enzyme substrate complex
-enzyme lowers the energy needed for the reaction to occur
-forming a product
-product no longer fits onto the active site
-enzyme is free to enter into another reaction

5.1.7 The specificity of enzymes
-The shape of the active site is complementary to the shape of substrate
-Therefore the substrate can fit into the active site
-forming an enzyme substrate complex
-This allows a reaction to occur

5.1.5 Enzyme activity
-To investigate enzyme activity:

1. Test for the presence of the product e.g. using starch and amylase and carry out Benedict test
2. Test for the disappearance of substrate e.g. using starch and amylase and carry out an iodine test

Effect of temperature on enzyme activity



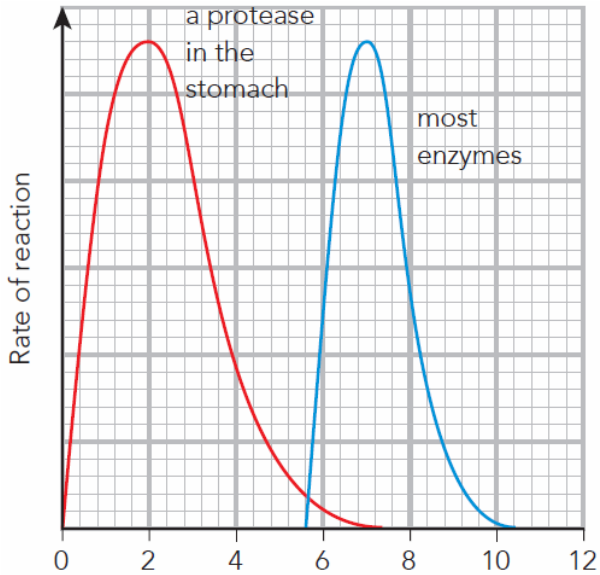
Description

-At low temperature the rate of reaction is low
-As temperature increases the rate of reaction increases
-Enzyme activity doubles with every 10 ˚C temperature increase
- At optimum temperature the enzyme activity is the highest
-As temperature increases beyond optimum temperature the enzyme activity drops sharply
-At extremely high temperature (60 ˚C) rate of reaction drops to 0 and the enzyme is completely denatured

Explanation

-At low temperatures enzyme and substrate have little kinetic energy, hence the frequency of collision is low
-As temperature increases, the kinetic energy of enzyme and substrate molecule increases
-The frequency of collision between the enzyme and the substrate molecules increases
-Effective collisions are more frequent
-More enzyme substrate complexes are formed and more product is formed
-At optimum temperature there is the highest frequency of collisions between enzyme and substrate molecules
-Beyond optimum temperature the kinetic energy of enzyme makes the enzyme vibrate more
-Enzyme starts to lose shape (denature)
- It cannot form an enzyme–substrate complex and is not converted to product
-At 60 ˚C enzyme is completely denatured
-The shape of the active site is completely lost

Effect of pH on enzyme activity



Description

-The optimum pH for each enzyme differs
-Enzyme activity is highest at optimum pH
-As pH decreases or increases from optimum enzyme activity sharply decreases
-At extremes of pH enzyme is completely denatured and the rate of reaction drops to zero

Explanation

-If pH is too high or too low the bonds of the enzymes are broken
-The shape of the active site is completely changed
-The substrate can no longer fit onto the active site

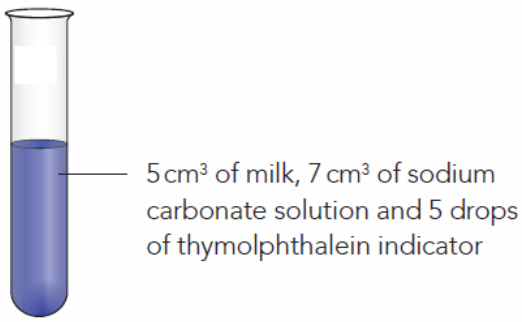
Investigating the effect of temperature on the activity of lipase

-Lipase is an enzyme that catalyses the breakdown of lipids (fats and oils).

$$\text{lipid} \xrightarrow{lipase} fattyacidsandglycerol$$

-Fatty acids are acids, so they decrease the pH.
-You will use an indicator called thymolphthalein to detect their presence.
-Thymolphthalein is blue in alkaline conditions and loses its colour when the pH becomes less alkaline

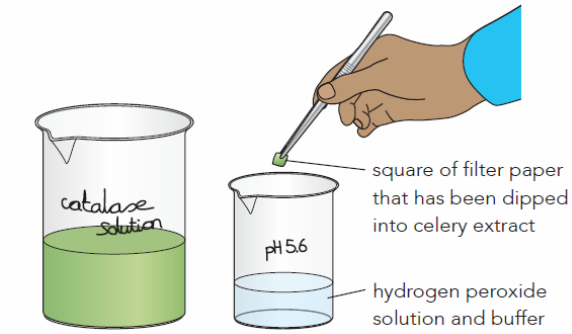
Method



1. Label two test-tubes 15 ˚C and 35 ˚C.
2. Measure 7 ml of sodium carbonate solution into each test-tube.
3. Add 7ml of milk into each test tube
4. Add 5 drops of thymolphthalein indicator to each test-tube. This will make the liquid go blue. Stir the contents using the glass rod.
5. Pour 1m1 lipase into two separate test tubes labelled 15 ˚C and 35 ˚C.
6. Put the four test-tubes in a water-bath at 15 ˚C and 35 ˚C respectively.
7. Leave the test-tubes for 2 minutes, so that the contents come to the same temperature as the water-bath (acclimatise).
8. After 2 minutes add the lipase to the test tube labelled 15 ˚C
9. Record the time taken for the blue colour to disappear. Measure the time to the nearest second.
10. Repeat steps 8 to 9 with the 35 ˚C test tube
11. Repeat the whole procedure two times more

Investigating the effect of pH on the activity of catalase

-You are going to find out how changing the pH affects the rate at which catalase breaks down hydrogen peroxide to water and oxygen.
-You will change the pH using buffer solution
-A buffer solution is a liquid that has a particular pH. It keeps this pH the same, even if chemical reactions take place.
-You will use catalase from celery or any other plant such as a potato, or some leaves.
-You can mash up the celery in water, so that the catalase forms a solution in the water. It's best if this is done once for the whole class.



Method

1. Cut up some celery and put it into a blender. Add water and blend.
2. Filter the mixture of celery and water to obtain the filtrate
3. Label 3 beakers pH 3 , 7 and 11
4. Measure 5ml of hydrogen peroxide solution into each labelled beaker.
5. Measure 10ml of the appropriate buffer solution into each beaker.
6. Use forceps to pick up one of the little squares of filter paper. Dip the paper into the liquid containing catalase
7. Using the forceps, push the paper to the bottom of the hydrogen peroxide solution in pH 3.
8. Using a stopwatch time how long it takes for the paper to rise to the top of the liquid.

9. Record this in your results table.
10. Repeat Steps 6 to 9 twice more, using the hydrogen peroxide solution in pH 3.
11. Now repeat Steps 6 to 10 for pH 7 and 11.

pH	Time taken for paper to rise to top / s			
	1st try	2nd try	3rd try	Mean