2.5. ENZYMES

An enzyme is a globular protein that works as a catalyst - speeds up chemical reactions without getting altered themself.

Substrates:

The substances that enzymes convert into products are known as substrates.

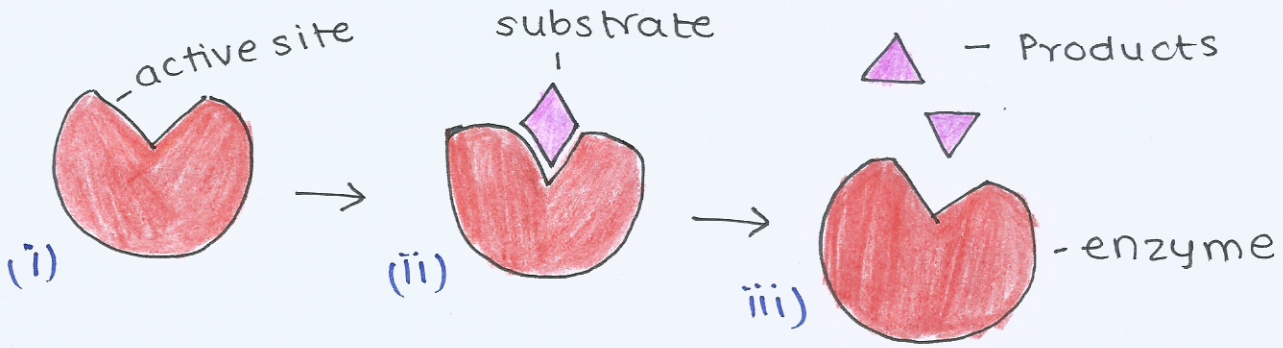
Enzyme - catalyzed reaction - general equation

substrate $\xrightarrow{\text{enzyme}}$ product

Active site

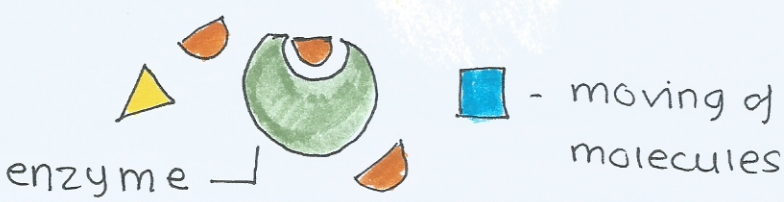
- The region on the surface of the protein which binds to the substrate molecule.
- The shape and chemical properties of the active site & the substrate match each other.

This allows the substrate to bind & not the other substances.



ENZYME ACTIVITY

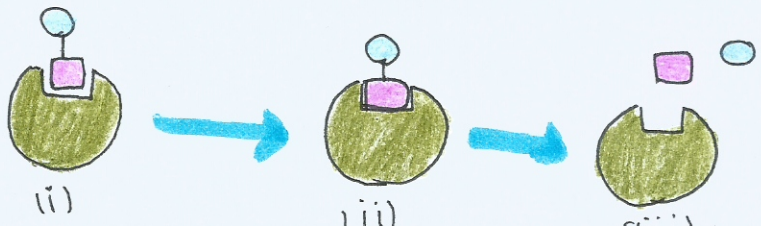
Enzyme catalysis involves the substrate molecules to move around and collide with the active site.



i) The substrate binds to the active site of the enzyme.

ii) When the are attatched to the active sites they change into different chemical substances (products of the reaction)

iii) The products leave the binding site and it becomes vacant again.



(i) enzyme + substrate

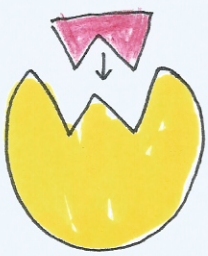
(ii) enzyme-substrate complex

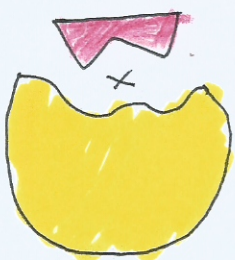
(iii) enzyme + product

- In most reactions, the substances are dissolved in water around the enzyme.
- Water molecules are always in motion and the direction of movement keeps changing.
- collisions between substrate and enzymes occur because of their movement.

DENATURING

- Enzymes can be irreversibly altered by certain conditions.
- Denaturing can happen because of temperature or pH which causes a change in the structure of the enzyme.

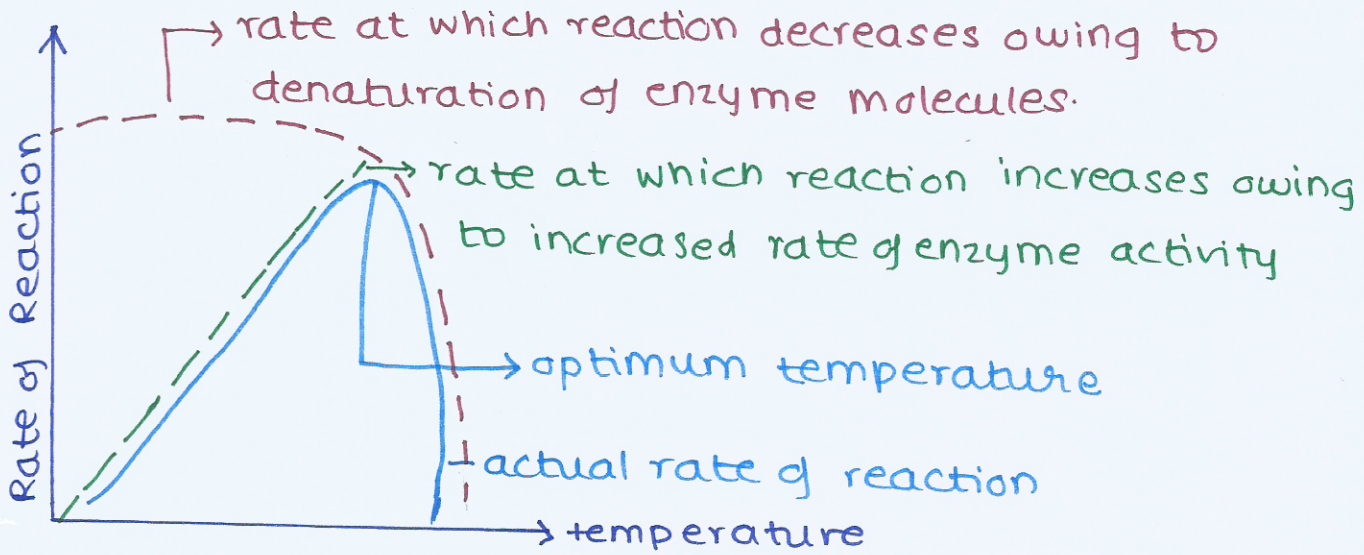




Denatured enzyme will have an incompatible active site.

FACTORS AFFECTING RATE OF ENZYME ACTIVITY

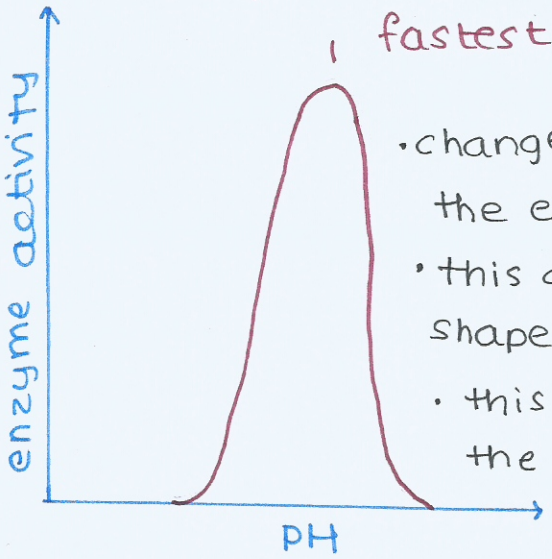
Temperature



- Low temperatures do not have enough thermal energy which will activate the enzyme-catalyzed reaction to start.
- Increasing the temperature will increase the enzyme activity till it reaches an optimal temperature.
- At the optimal temperature, the enzyme activity is at its peak.
- Eventually increasing the temperature will cause the enzymes to denature (disrupts the hydrogen bonds)
- This will result the enzyme to lose its shape and will show loss of activity.

pH

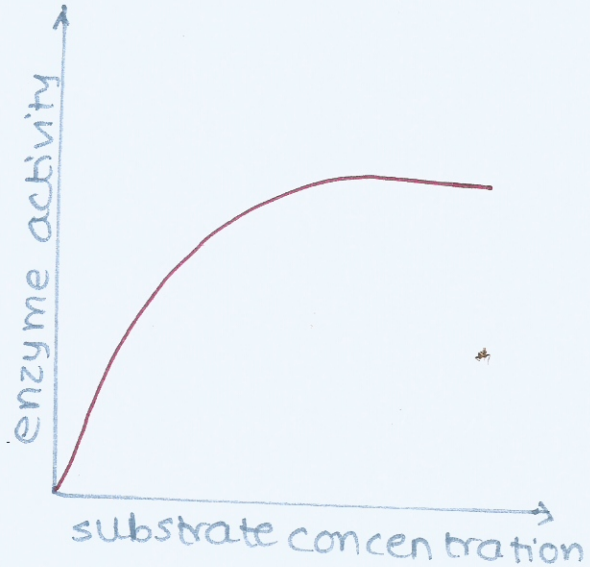
optimum pH at which enzyme activity is fastest (pH 7 for most enzymes)



- change in the pH alters the charge of the enzyme
- this changes the solubility and the overall shape of the protein
- this results to the diminished ability of the enzyme to bind the substrate.

- After reaching the optimum pH, the rate of enzyme activity diminishes.

Substrate concentration



- Increasing substrate concentration will increase the rate of enzyme activity.
- This happen as the chance of a substrate colliding with its active site increases.
- After reaching a certain point the environment will be saturated with substrates.

- when the environment is saturated, all the enzymes are bound and reacting.

IMMOBILIZED ENZYMES

Theory of Vitalism:

Substances in animals and plants can only be made under the influence of a "vital spirit".

- Immobilized enzymes are widely used in industries
- Enzymes are attached to other substances or aggregations so that the movement of the enzyme is restricted.

Advantages of immobilization

- The enzyme can be separated from the products of the reaction.
  (Stops the reaction and prevents contamination of products)
- The enzyme can be retrieved from the reaction mixture and it can be recycled.
  (Enzymes are expensive so recycling is cost-efficient)
- It increases the stability of enzymes to changes in temperature and pH.
- Substrates can be exposed to higher enzyme concentrations than with dissolved enzymes, speeding up the reaction rate.

Immobilized enzymes in industrial practices

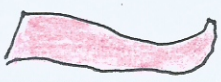
Biofuels

medicine

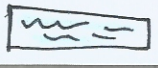
Biotechnology

Food production

Textiles



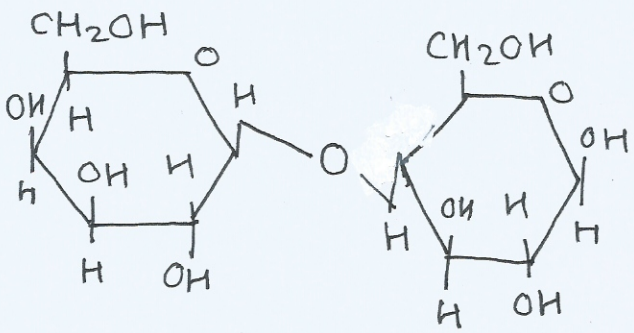
Paper



LACTOSE

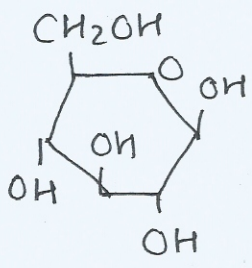
Lactose is a disaccharide of glucose and galactose.
It is broken down by an enzyme called lactase.

Incidents of lactose intolerance are high in Asian, African and Aboriginal populations. It is low in european populations.

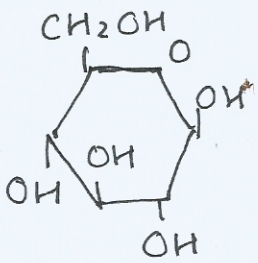


Lactose

Lactase



Galactose



Glucose

LACTOSE FREE MILK

Lactose free milk is produced by treating the milk with enzyme (lactase).

ADVANTAGES OF LACTOSE FREE DAIRY PRODUCTS

- source of diary for lactose intolerant people.
- increases sweetness in the absence of artificial sweeteners.
- reduces crystallisation of ice-cream (more soluble)
- reduces production time for cheese and yogurts as bacteria ferment monosaccharides more readily.