Quaternary: Containing more than 1 A.A chain.

29/10 ENZYMES

- Enzymes are mostly proteins (with exception of ribosomes) which are made up of RNA.
- All are globular proteins
- Catalysts
- Catalyzed reaction is reversible
- Efficient
- Highly specific.

Enzymes are biological catalyst which enhance the rate of biochemical reaction from 10^6 to 10^{16} time when compared to uncatalyzed reaction.

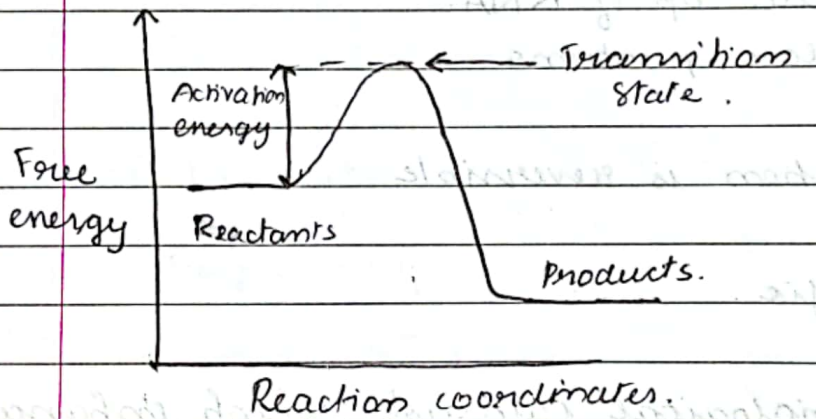
CHARACTERISTICS OF ENZYMES

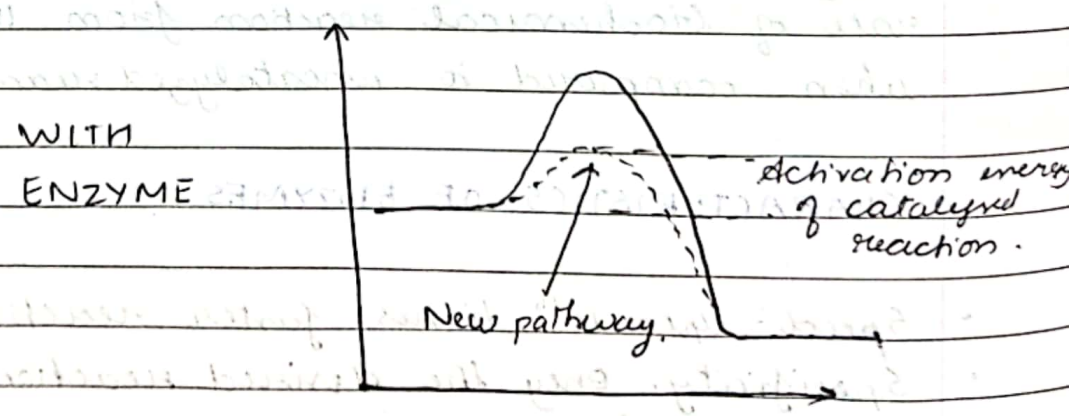
- Speed: Upto 10^{16} times faster reaction rate.
- Specificity. Only the desired reaction occurs. Hence high quality products, fewer by-products & purification process becomes much easier.
- Permit reaction ~~to~~ under mild conditions.

- Enzyme carries out its activity without being consumed in the reaction. Hence a small amount of ~~sub~~ enzyme can act on large amount of substrate
- Enzymes can be classified based on the chemical reaction it catalyzes: eg oxidoreductase, isomerase, hydrolases etc

CHEMICAL REACTIONS

- Chemical reactions need an initial input energy ie Activation energy
- During this part of the reaction the molecules are said to be in a transition state.





ENZYME STRUCTURE

- Enzymes are proteins
- They have a globular shape.
- A complex 3-D structure.

THE ACTIVE SITE

- One part of an enzyme, the active site, is particularly important
- The shape and the chemical environment inside the active site permits a chemical reaction to proceed more easily.

COFACTORS

- An additional non-protein molecule that is needed by some enzymes to help the reaction.
- Tightly bound co-factors are called prosthetic groups
- Cofactors that are bound and released easily are called coenzymes.
- Many vitamins are called coenzymes.

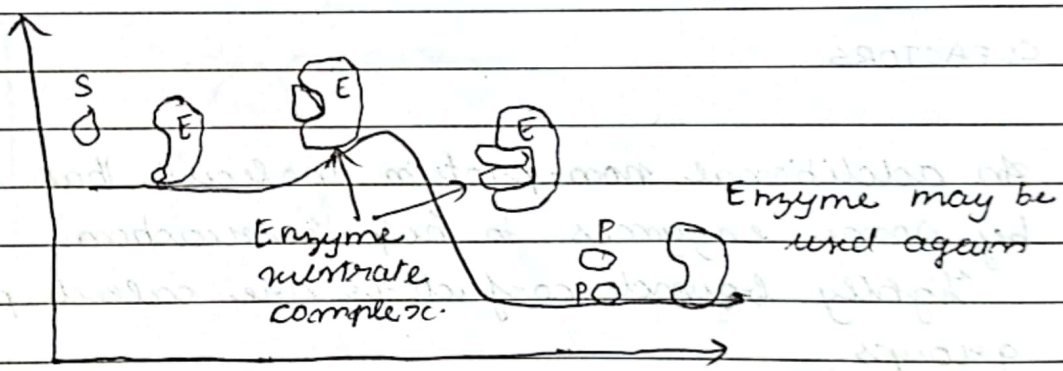
THE CATALYTIC SITE OF ENZYME

- Usually the size of the enzyme is bigger than that of the substrate
- Enzyme binds to substrate at least in three different regions called as catalytic sites.
- Different models were proposed regarding how enzyme binds to substrate.

A. The 'Lock & Key' or Template Model.
- The model was proposed by Emil Fischer
- The enzyme is considered to be rigid.
- The catalytic site is presumed to be pre-shaped to fit the substrate.

B. The "Induced Fit" Model.
- The model was proposed by Koshland
- The enzyme is considered to be flexible.
- The substrate induces a conformational change in the enzyme.

THE LOCK AND KEY HYPOTHESIS.



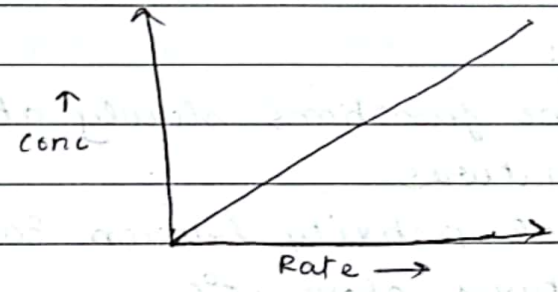
WHAT HAPPENS IN AN ENZYME CATALYZED REACTION?

1. [E] binds to [S] to form [ES] complex (rate k_1)
2. [ES] can release substrate (rate k_2) or convert [S] to [P] (rate k_3)
3. In steady state, the production and consumption of the transition state proceed at the same rate. So the concentration of transition state keeps a constant.
4. At equilibrium [S] and [P] remain constant.

FACTORS AFFECTING ENZYMES ACTION

1. Concentration of Enzyme.
2. Substrate concentration.
3. Temperature.
4. pH.
5. Effect of product concentration.
6. Effect of activators.
7. Effect of light and radiation.

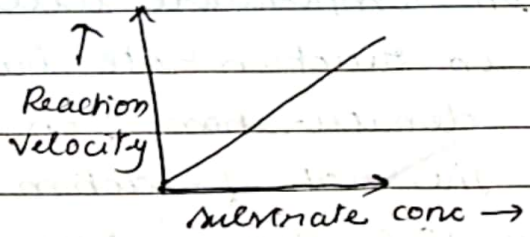
- **Concentration of enzyme:**



- **The substrate:**

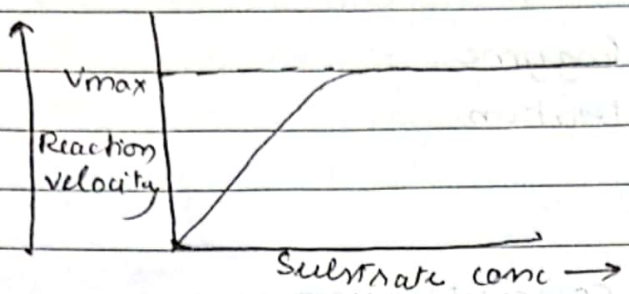
They are the reactants activated by the enzyme
The Enzymes are specific to their substrates.
The specificity is determined by the active site

Substrate conc: Non-enzymic reactions.



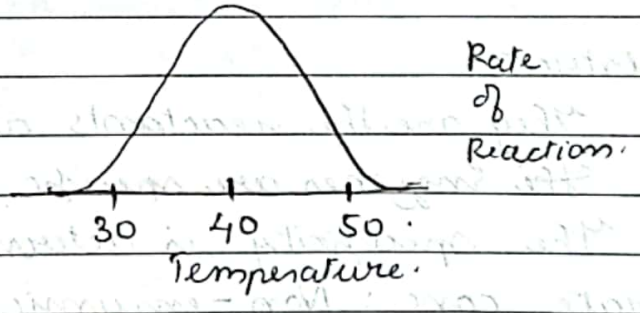
Increase in velocity α substrate conc.

- Substrate conc : Enzymic reactions.



- Faster reaction but it reaches a saturation point when all ~~en~~ enzyme molecules are occupied.
- If you ~~alter~~ alter the concentration of the enzyme then V_{max} will change too.

- Temperature:
  - Enzyme functions slowly at sub-freezing temperatures
  - Optional-activity between 30-40°C.
  - Denatures above 45°C.



  - Increase in temperature will lead to an increase in reaction rate, but it also can lead to denaturation of enzyme.
  - Usually the rate of reaction will double for every 10°C rise in temperature, thus speeding up the process.

- The effect of temperature
  - For most enzymes the optimum temperature is about 30°c.
  - Many are a lot lower, cold water fish die at 30°c because their enzymes denature.
  - A few bacteria have enzymes that can withstand temperatures up to 100°c.
  - Most enzymes are however fully denatured at 70°c.
  - The optimum temperature for an enzyme controlled reaction will be a balance between the Q10 and denaturation

- pH:
  - Extremes generally inactivates enzymes.
  - pH optimum
  - Maximum pH activity of most enzymes between pH 4.5 and 8.0.
  - Narrow pH range.
  - Exceptions.
    - Pepsin: Optimum pH is 1.8.
    - Trypsin: Optimum pH is 9.8.

- The effect of pH.
  - Extreme pH levels will produce denaturation.
  - The structure of enzyme is changed.
  - The active ~~state~~ site is distorted and the substrate molecule will no longer fit in it
  - At pH values slightly different from the enzyme's optimum value, small changes in

the charges of the enzyme and its substrate molecules will occur.

- This change in ionisation will affect the binding of the substrate with the active state

Inhibitors.

- Inhibitors are chemical that reduce the rate of enzymic reactions
- They are usually specific and they work at low concentrations
- They block the enzyme but they do not usually destroy it
- Many drugs and poisons are inhibitors of enzymes in the nervous system.

- The effect of enzyme inhibition.
  - Irreversible inhibitors: Combine with the functional groups of the amino acids in the active site, irreversibly.
  - Reversible inhibitors: These can be washed out of the solution of enzyme by dialysis.

- Effect of Product Concentration.
  - The accumulation of products generally decreases the enzyme velocity.
  - For certain enzymes, the product combine with the site of enzyme and form a loose complex, and thus inhibit enzyme activity (Feed back mechanism)

- **Effect of activators.**

Some of the enzymes requires certain inorganic metallic cations like Mg^{2+}, Mn^{2+}, Ca^{2+}, Co^{2+}, Co^{2+}, Na^{2+}, K^{+} etc. for their optimum activity.

- Metal activated enzymes: Enzyme is tightly held by the enzyme. Eg ATPase (Mg^{2+} & Ca^{2+})
- Metalloenzymes: Enzymes hold the metals tightly. Eg: Alcohol dehydrogenase, carbon anhydrase.

- **Effect of light and radiation.**

Exposure of enzymes to ultraviolet, gamma & and/or X-rays may inactivate certain enzymes due to the formation of peroxides.

SOURCES OF ENZYMES

- Biologically active enzymes are extracted from any living organisms.
- Selection of source of enzymes influences:
  - Type of extraction & purification process
  - Stability of the enzyme and,
  - Cost of the enzymes.