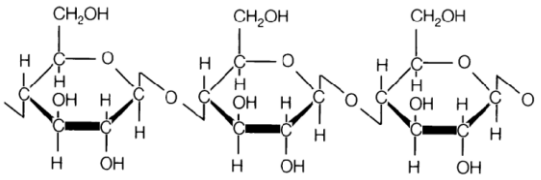
Polysaccharides

- Macromolecules present in the acid insoluble fraction.
- Long chains of sugars, not sweet and are insoluble in water.
- Thread made up of different monosaccharides.

Homopolymer/Homopolysaccharide-

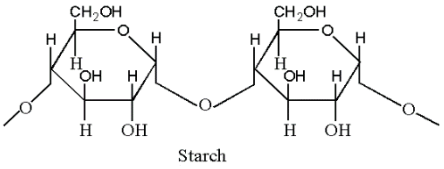
- Made up of single monosaccharide.
- Complex polymer are made up of Homopolymer.

❖ **Cellulose**



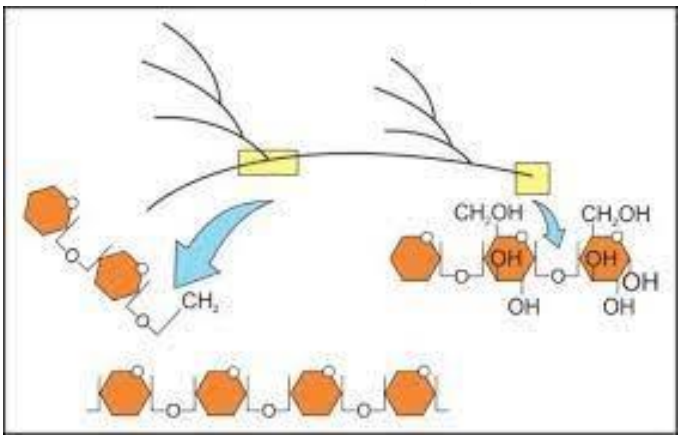
- Made up of glucose.
- Found in cell wall of most algae, certain protists, fungi and plants.
- Paper & Cotton Fibre made up of cellulose.

❖ **Starch**



- Homopolymer of Glucose.
- Storage of energy in plant tissues.
- Forms helical secondary structures.
- Can hold iodine (I2) molecules in the helical portion hence gives blue/black colour.

❖ **Glycogen**



- Storehouse of energy found in animals only (in liver cells and muscles).
- Its chain made up of two ends, right end- reducing end and left end- non-reducing end.
- Animal starch.
- It gives red/brown colour on reaction with iodine.

❖ **Inulin**

- Polymer of fructose.
- It's not digested or absorbed in the stomach.
- It stays in the bowel and helps certain beneficial bacteria to grow.
- Act as Dietary fibres- Found in fruits, vegetables, and herbs.
- Plants that synthesis and store inulin as energy are unable to store other forms of carbohydrates like starch, etc.

Heteropolymer/heteropolysaccharides- Made up of more than two monosaccharide. e.g., Chitin, pectin, peptidoglycans (murein), hyaluronic acid.

❖ **Chitin**

- Second most abundant natural polymer.
- Found in exoskeleton of arthropods (e.g., prawns, crabs, etc.) and in cell wall of fungi.
- It has building blocks of amino sugars and chemically modified sugar

❖ **Acetylglucosamine**

- Acetyl Amino sugar synthesized from glucose
- Units interlinked by glycosidic bond

❖ **Glucosamine**

- Compound found in cartilage
- Amino sugar synthesized from glucose and glutamine

❖ **Agar**

- Galactose-based polysaccharide derived from red algae.
- Used in tissue culture.

❖ **Hyaluronic acid**

- Helps in lubrication of joints between bones Used in tissue culture.

Enzymes

- Proteinaceous substances that catalyses (increase rate of reaction) chemical reactions.
- The nucleic acids that behave like enzymes are called **ribozymes.**
- Enzyme like protein have secondary & tertiary structure.
- **Active Site-** Tertiary Enzyme has pockets or **crevice** into which substrate fit to form ES complex.
- Enzyme catalyst damage at high temp (above 40^0 C) as they are made up of protein (denatured on heating)
- Inorganic catalyst differ from enzyme and are functional at high temp and high pressure.
- Enzyme extracted from Thermophilic (Organisms lives in hot vent & sulphur spring) are Thermally stable (at high temp upto 80^o-90^o C)
- Rate (velocity- in specified direction) of physical/chemical process is amount of product formed per unit time.

$$\text{rate} = \frac{\delta P}{\delta t}$$

- A general rule of thumb- Rate doubles or decreases by half for every 10°C change in either direction of **OPTIMUM TEMP**

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} \xrightleftharpoons{\text{Carbonic anhydrase}} \underset{\text{carbonic acid}}{H_2CO_3}$$

- Rates of catalysed reaction are very high for example:
  - In absence of enzyme 200 molecules of H_2CO_3 are formed in an hour.
  - In presence of enzyme Carbonic Anhydrase 600,000 molecules of H_2CO_3 are formed every second, reaction rate increases 10 million times.
- Metabolic Pathway- A multistep chemical reaction where each step is catalysed by same or different enzyme.

$$\text{Glucose} \rightarrow 2\ \text{Pyruvic acid}$$
$$C_6H_{12}O_6 + O_2 \rightarrow 2C_3H_4O_3 + 2H_2O$$

Metabolic pathway of glucose with one or two additional reaction give rise to different end products::

(i) Aerobic respiration (in Skeletal Muscles) – pyruvic acid converted to CO_2 and H_2O

(ii) Anaerobic respiration (in Skeletal Muscles) – pyruvic acid converted to Lactic Acid

(iii) Fermentation (in Yeast) – pyruvic acid converted to Ethanol.

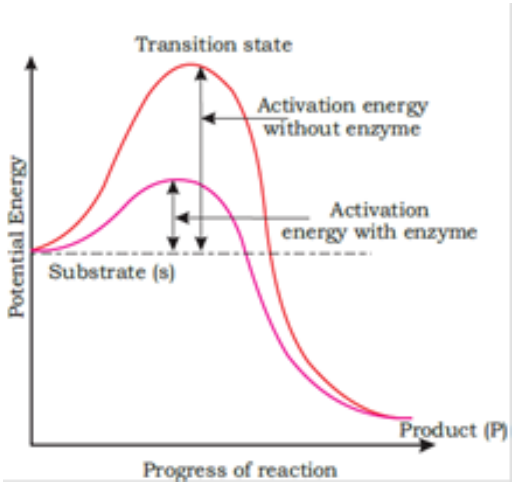
- Substrate- Chemical that convert into Product.

S →P

- Transient state- ES & EP
- All the intermediate structure formed are unstable.
- If Product is at lower level than substrate the reaction is Exothermic.
- **Activation energy**- External energy required to start a chemical reaction.

Or

The difference in average energy content of Substrate from that of Transition State

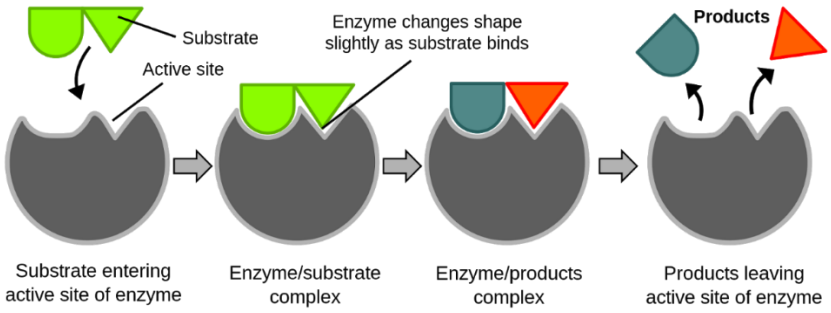


Nature of Enzyme Action

1. Substrate binds to the active site of the enzyme.
2. The binding alter the shape & it fitting more tightly .
3. The active site breaks the chemical bonds of the substrate forming enzyme- product complex.
4. The enzyme releases products & free enzyme bind to another molecule cycle goes on.

The formation of the Enzyme Substrate (ES) complex is essential for catalysis.

E + S → ES → EP →E + P



Factors influencing Enzyme Activity

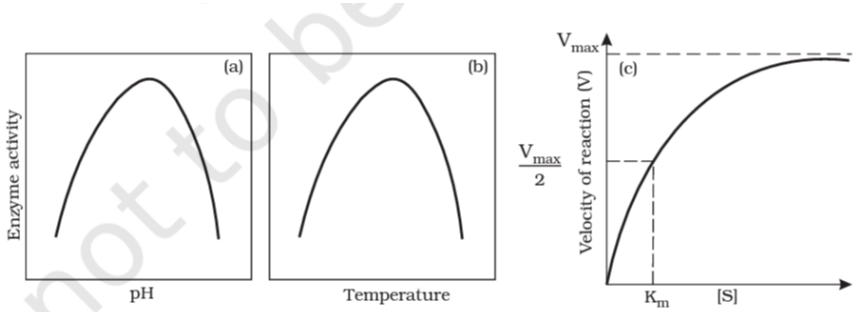
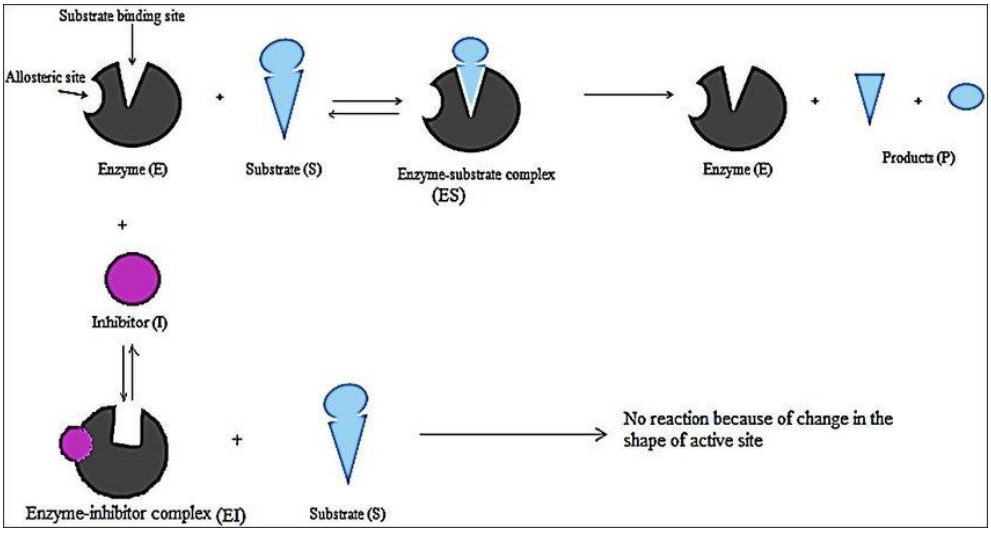


Figure 9.5 Effect of change in : (a) pH (b) Temperature and (c) Concentration of substrate on enzyme activity

1. **Temperature**- An enzyme is active within a narrow range of temperature.
   Optimum Temp- Temp at which enzyme activity is maximum. Its activity decrease above and below this temperature.
2. **pH** – Every enzymes has an optimum pH at which it is maximum active.
   Ex: pepsin works at pH 2, Catalase at pH 9 and most of the intracellular enzymes work at neutral pH.
3. **Concentration of Substrate–** Increase in substrate concentration increases the rate of reaction till reaction reaches Vmax.
   After reaching maximum velocity rate of reaction do not increase further by increasing concentration of enzyme as there are only few enzymes to bind with substrate.

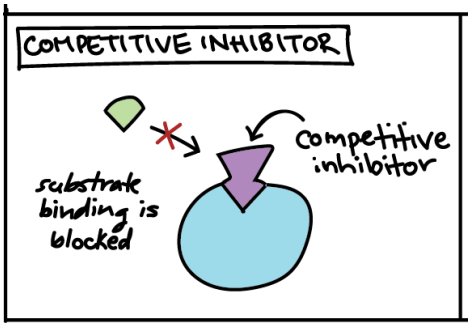
Inhibitor- Chemical that binds to enzyme and shut off the reaction.



Competitive Inhibitor- Chemical substance that resembles the shape of substrate and competes with substrate in binding.

Ex: Inhibition of succinic dehydrogenase by malonate which closely resembles the substrate succinate in structure.

Such competitive inhibitors are often used in the control of bacterial pathogens.



Enzymes are classified into 6 classes (each with 4-13 subclasses) based on reaction:

1. **Oxidoreductases/Dehydrogenases**–
   S reduced + S' oxidised ⟶ S oxidised + S' reduced
2. **Transferases**

$S - G + S' \longrightarrow S + S' - G$

3. **Hydrolases** catalyses the hydrolysis of peptide, ester, glycosidic bonds etc

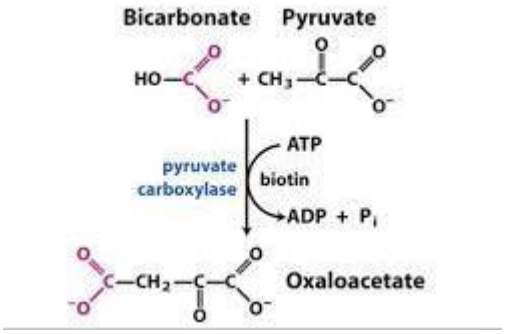
$A - B + H_2O \longrightarrow A - OH + B\ --\ H$

4. **Lyases** remove the groups from substrate.

$A - B \longrightarrow A + B$

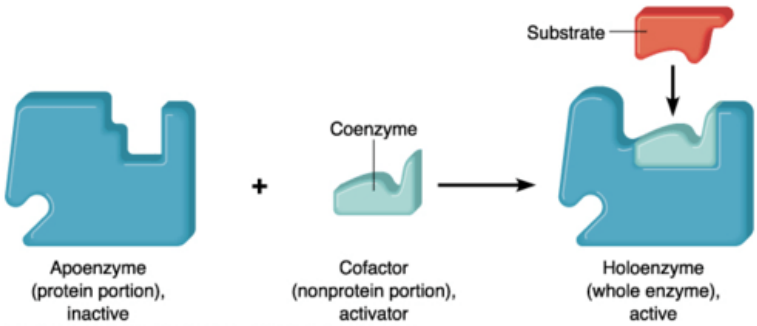
5. **Isomerases**-inter conversion of optical, geometrical or positional isomers.

6. **Ligases** – catalyses the linking together of two compounds.



Co-factors- The non-protein constituent of an enzyme which make the enzyme more catalytically active.

Apoenzyme -The protein portions of enzyme.



Kinds of co-factors-

1. **Prosthetic Group-** Organic compound tightly bound to apoenzyme.
   Ex- Haem is prosthetic group in enzyme peroxidase and catalase (enzyme that catalyses breakdown of Hydrogen peroxide (H_2O_2- Toxic for human) to water and oxygen).
2. **Co-enzyme**- Organic group bound to apoenzyme for a short period (Transient) during catalysis.
   It contains essential chemicals like vitamins. Ex: NAD & NADP contains Vitamin Niacin (B3)
3. **Metal Ion-** Forms one or more coordinate bond with side chain of enzyme at active site and with substrate also.
   Ex: Zinc- cofactor for Proteolytic enzyme (hydrolysis of peptide bond) carboxypeptidase.