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# Enzymes

*By*

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# Definition

- ❖ Enzymes are **biological catalyst** produced by **living tissues**.
- ❖ Enzymes are a linear chain of **amino acids** that generate the three-dimensional structure
- ❖ All enzymes are **Proteins** except **Ribozymes**.
- ❖ **Ribozymes** are a group of **RNA molecules** with **catalytic activity**.
- ❖ Enzymes **accelerate** chemical reactions.



\*Some enzymes need to be **CLEAVED** to be active

\*A **zymogen** or **proenzyme** is the **inactive form** of the enzyme.

\*it is activated by **proteolytic cleavage**.

- prefix **“pro”**
- suffix **“ogen”**



The enzyme is  
**INACTIVE**

Chymotrypsinogen

*Inactive*

Proteolytic cleavage

Chymotrypsin

*Active*

Trypsinogen

*Inactive*

Proteolytic cleavage

Trypsin

*Active*

Prothrombin

*Inactive*

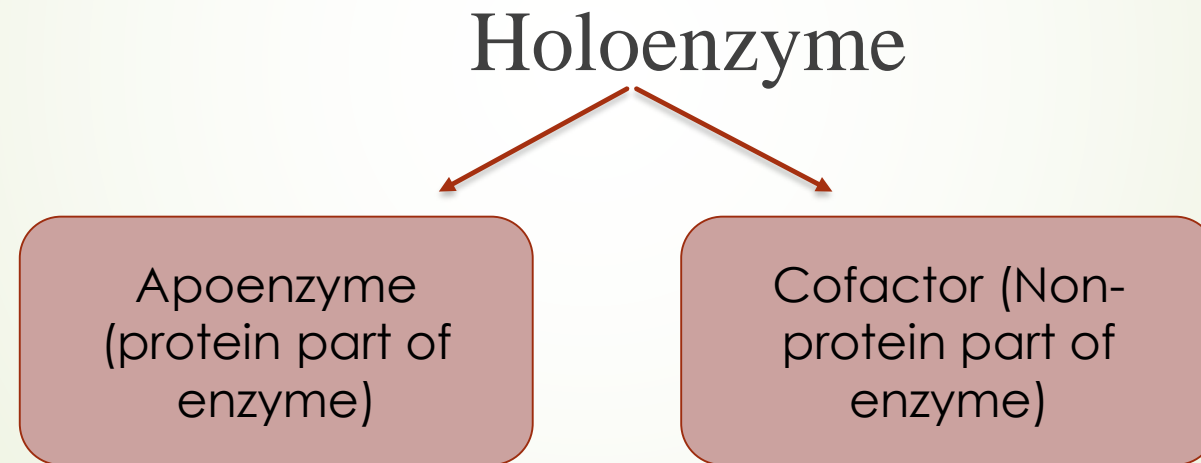
Proteolytic cleavage

Thrombin

*Active*

# Some enzymes need an **additional (Prosthetic group)** to be active

- ➔ **Holoenzyme** is the enzyme **with** its cofactor (catalytically *active*).



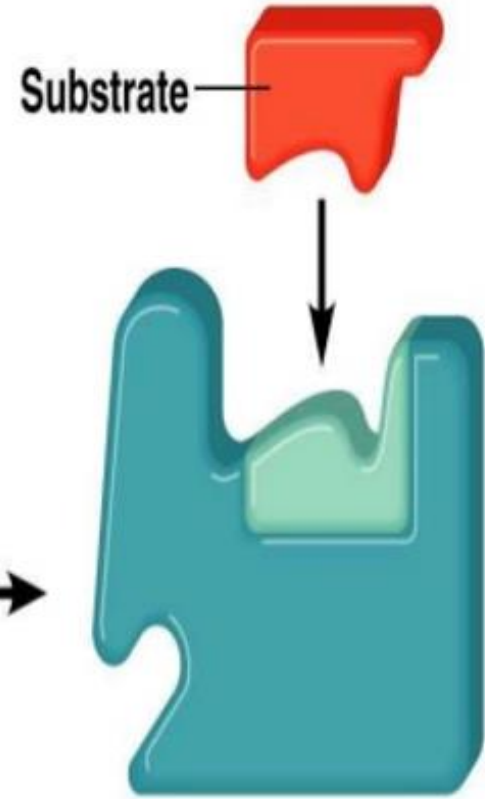


**Apoenzyme**  
(protein portion),  
inactive

+



**Cofactor**  
(nonprotein portion),  
activator



**Holoenzyme**  
(whole enzyme),  
active

❖ Cofactors are **additional, non-protein** components that are **required** for the **optimum activity** of some enzymes.

## Cofactors

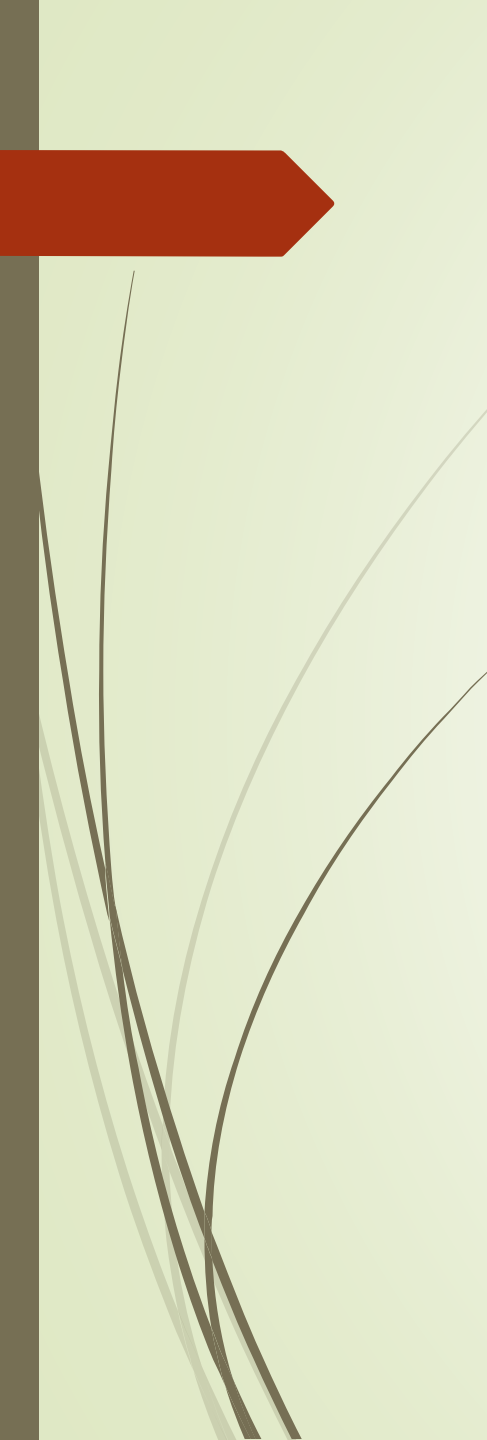
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graph TD; Cofactors[Cofactors] --- Line1[ ]; Line1 --- Line2[ ]; Line2 --> Organic[Organic compounds (Coenzymes)]; Line2 --> Inorganic[Inorganic ions (Activators)];
```

### Organic compounds (Coenzymes)

Examples include;  
vitamins such as **B<sub>6</sub>, B<sub>12</sub>,  
biotin, NAD<sup>+</sup> ... etc.**

### Inorganic ions (Activators)

Examples include;  
**Mg<sup>2+</sup>, Zn<sup>2+</sup>, K<sup>+</sup> ... etc.**

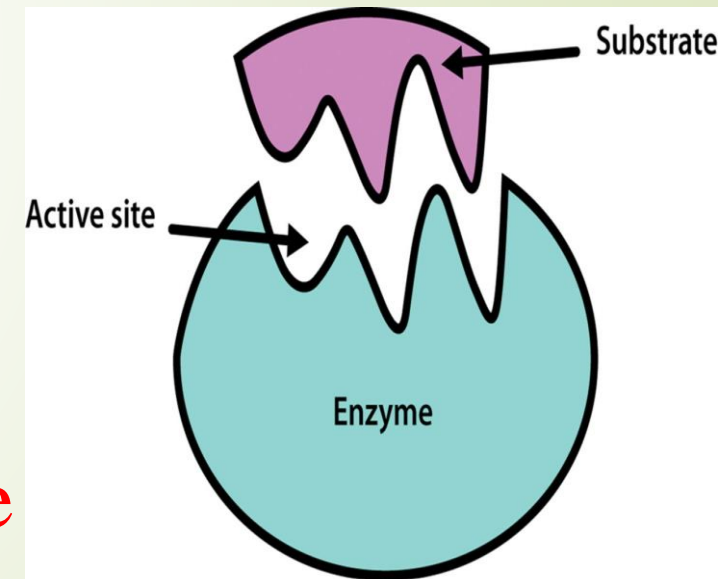


Vitamin	Co-enzyme
B1 (Thiamine)	Thiamin pyrophosphate(TPP)
B2 (Riboflavin)	FAD
B3 (Niacin)	NAD <sup>+</sup> / NADP <sup>+</sup>
B5 Pantothenic acid	Coenzyme A (COA)
B6 (pyridoxine)	Pyridoxal phosphate (PLP)
B7 (Biotin)	Biotin-carboxylases
B9 (Folic acid)	Tetrahydrofolic acid (THF)



## Catalytic Site

Each enzyme (E) have a special site known as active site where the substrate (S) binds to form enzyme- substrate (ES) complex, which undergoes catalytic proses to form enzyme-product (EP) complex, then (EP) dissociate into product and free enzyme.

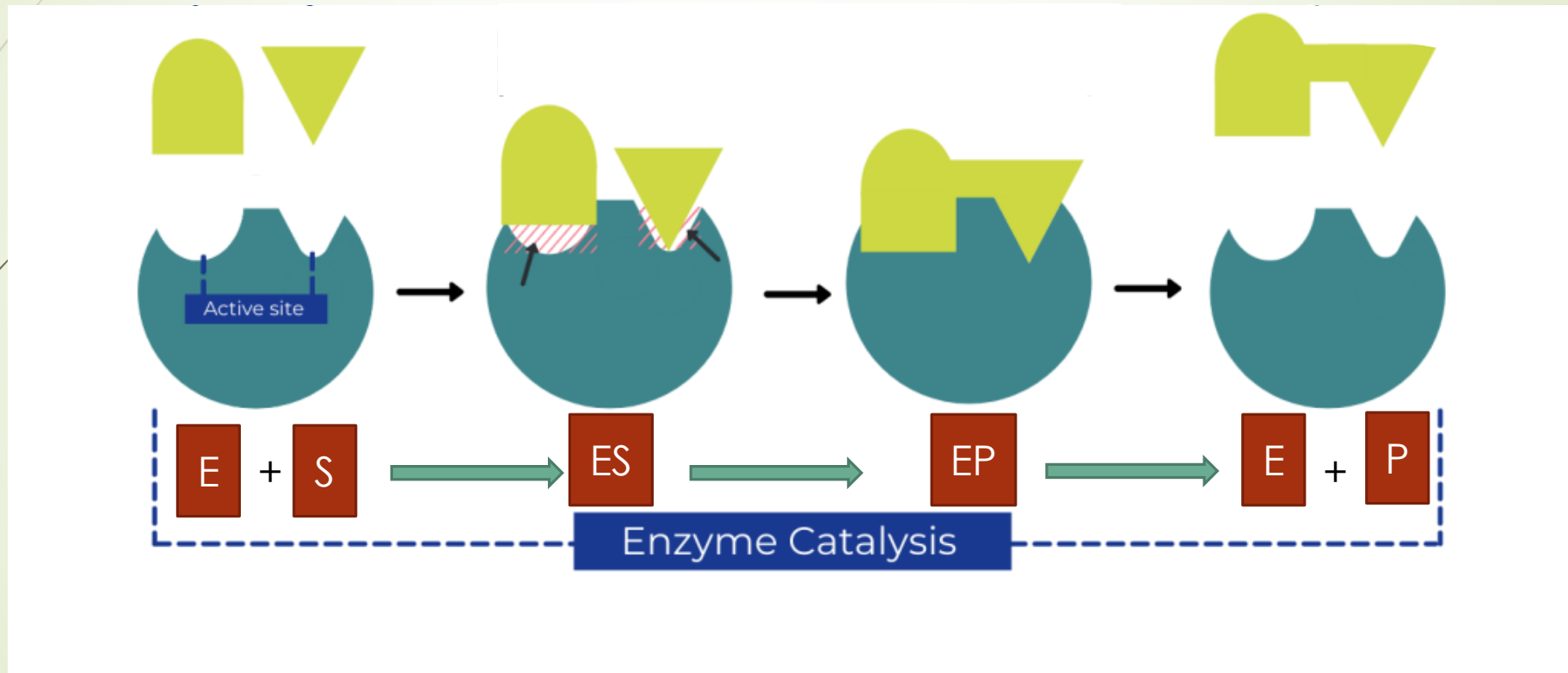


❖ The active site of an enzyme contains:

➤ **Binding residues** ..... **Binding the substrate**

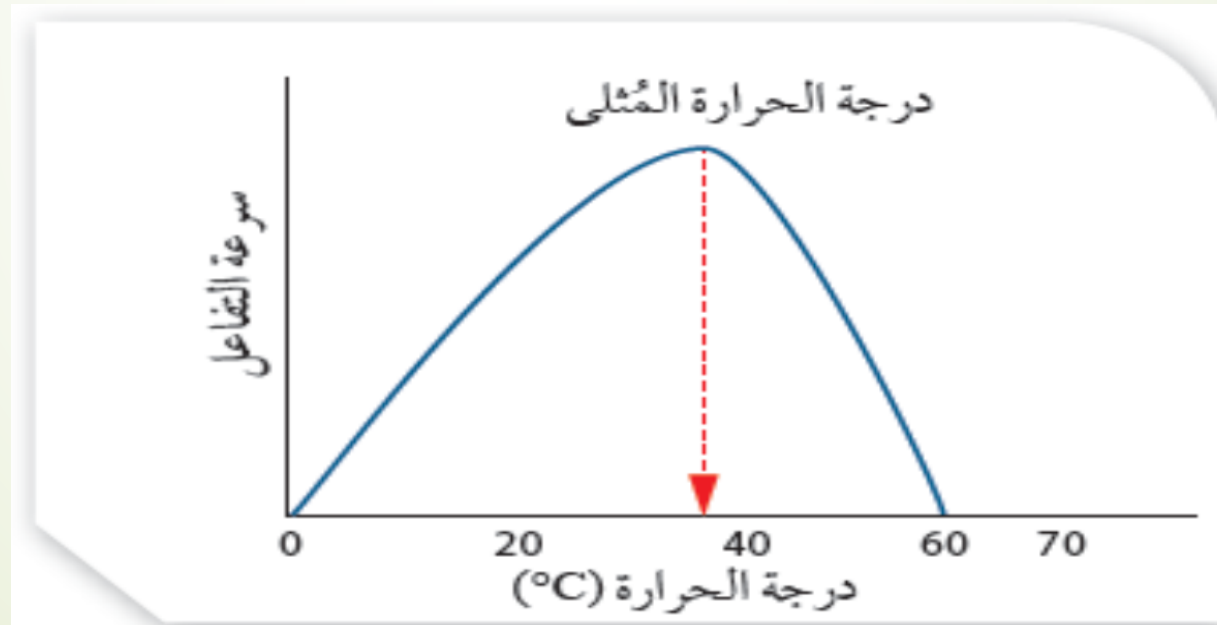
➤ **Catalytic residues** ..... **Converting substrate to product**

Enzyme + Substrate → Enzyme-Substrate complex → Enzyme-Product complex → Enzyme + Product



## Enzymes are heat sensitive

Since enzymes are protein in nature, it's influenced by heat. Enzyme normally exhibit optimum activity at body temperature ( $37^{\circ}\text{C}$ ). At higher temperature ( $>40^{\circ}\text{C}$ ), they losing their catalytic activity and become totally catalytically inactive at about ( $70^{\circ}\text{C}$ )



أثر درجة الحرارة في سرعة تفاعل يُحفَّزه إنزيم.

## Some important enzymes in our body

**Amylase:** Present in the pancreas and salivary glands, act on carbohydrate.

Starch , glycogen  glucose

**Lipase:** Secreted by the pancreas, it converts **fats** with the help of bile produced by the gallbladder into **F.A+ Glycerol**

**Lysozyme:** Produced by lacrimal and nasal secretions, saliva and in the skin, it accelerates the demolition of the cell wall of some germs.



**H.W.**



What are the special enzymes of the small intestine for digesting carbohydrates?



**THANK YOU!**