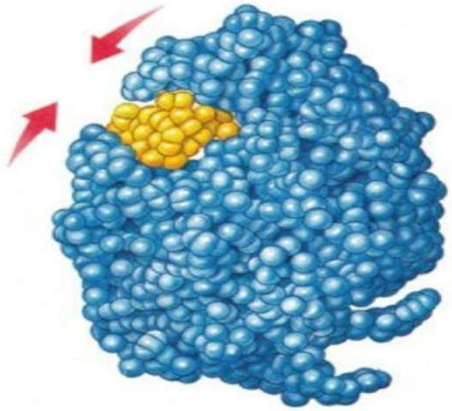

Lecture one Theory

Metabolism & Enzymes

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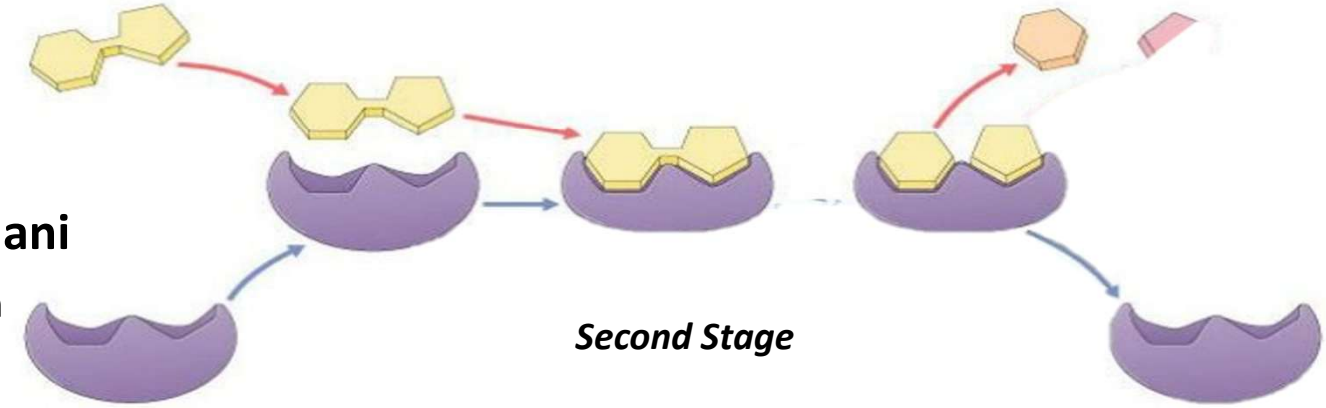
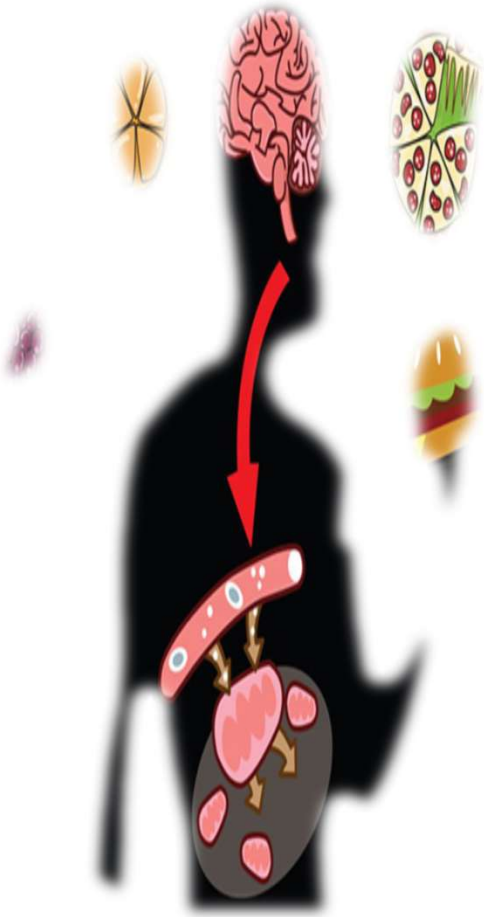


Second Stage

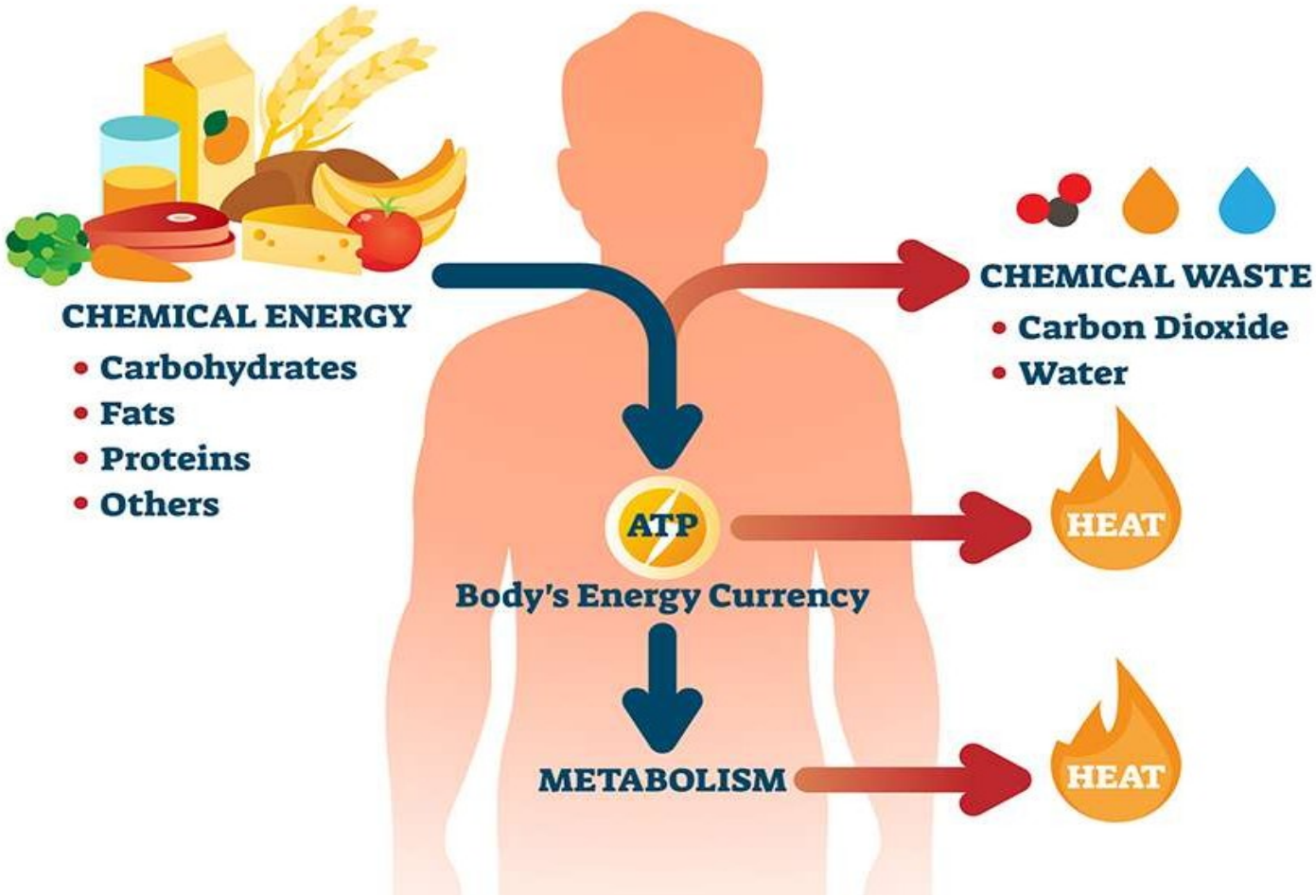

٢٤
فَلْيَنظُرِ ٱلْإِنسَٰنُ إِلَىٰ طَعَامِهِۦٓ
LET PEOPLE THEN CONSIDER
THEIR FOOD

What is Metabolism?



the chemical reactions in the body's cells that change food into energy. Our bodies need this energy to do everything from moving to thinking to growing.

Metabolism


CHEMICAL ENERGY
• Carbohydrates
• Fats
• Proteins
• Others
CHEMICAL WASTE
• Carbon Dioxide
• Water
ATP
Body's Energy Currency
HEAT
METABOLISM
HEAT

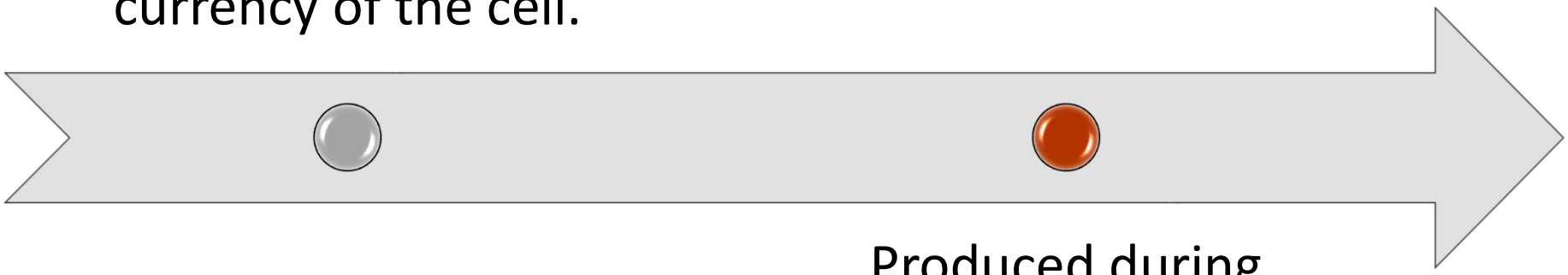
Types of Metabolism

Anabolism (building up processes, energy-consuming).

Catabolism (breaking down processes, energy-releasing).

Energy and ATP

ATP is the main energy currency of the cell.



Produced during catabolism and consumed during anabolism

NOT:-Metabolic reactions occur in sequences known as pathways.
Examples: Glycolysis, Krebs Cycle, Electron Transport Chain.

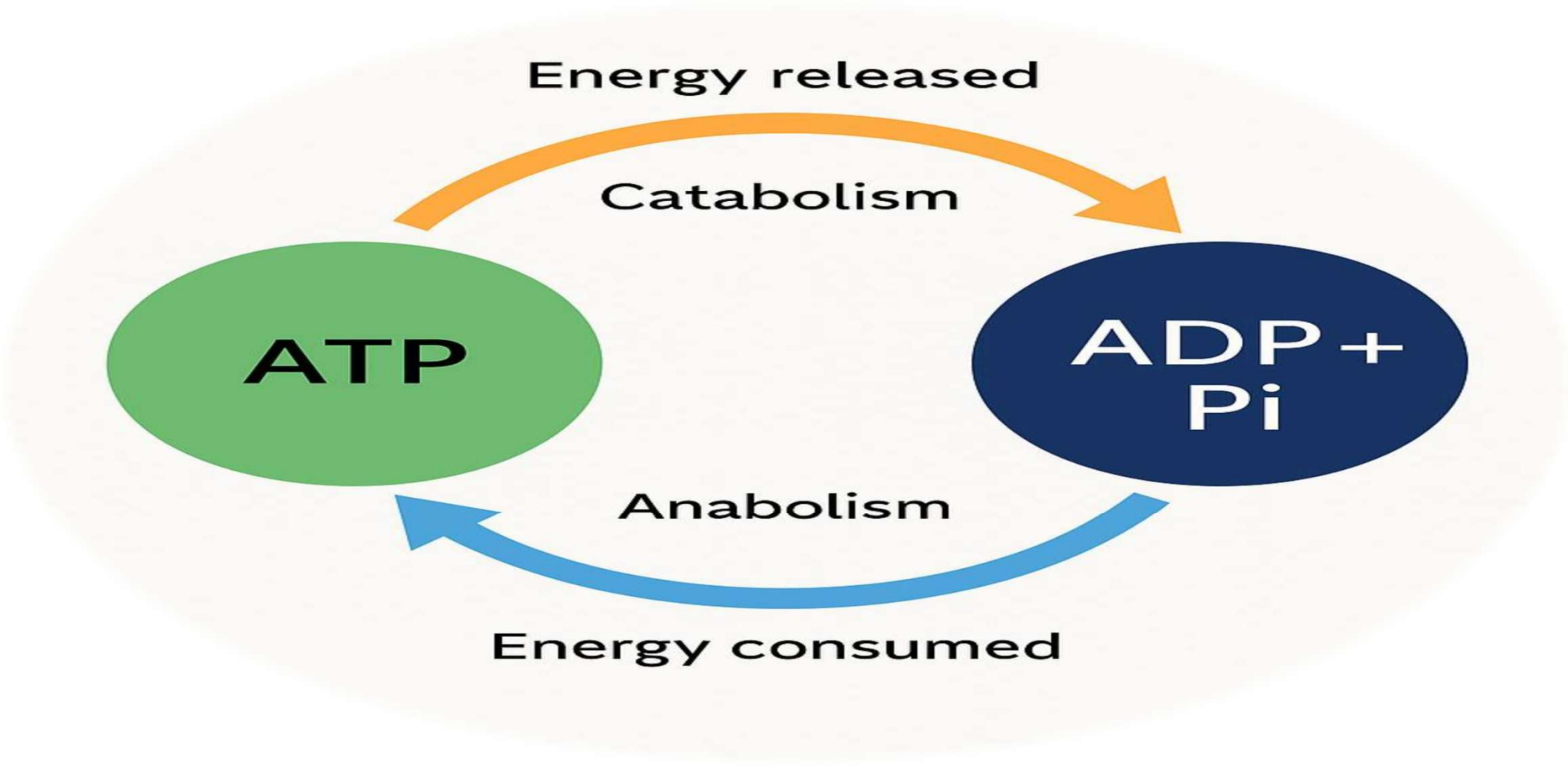


Figure 1. ATP Cycle showing energy release and consumption during metabolism

Regulation of Metabolism

Metabolic regulation is the process that controls **metabolic pathways** — both **anabolic (biosynthetic)** and **catabolic (degradative)** — in living organisms.
It ensures continuous **energy generation** required for vital **cellular functions**.

Mechanisms of Control

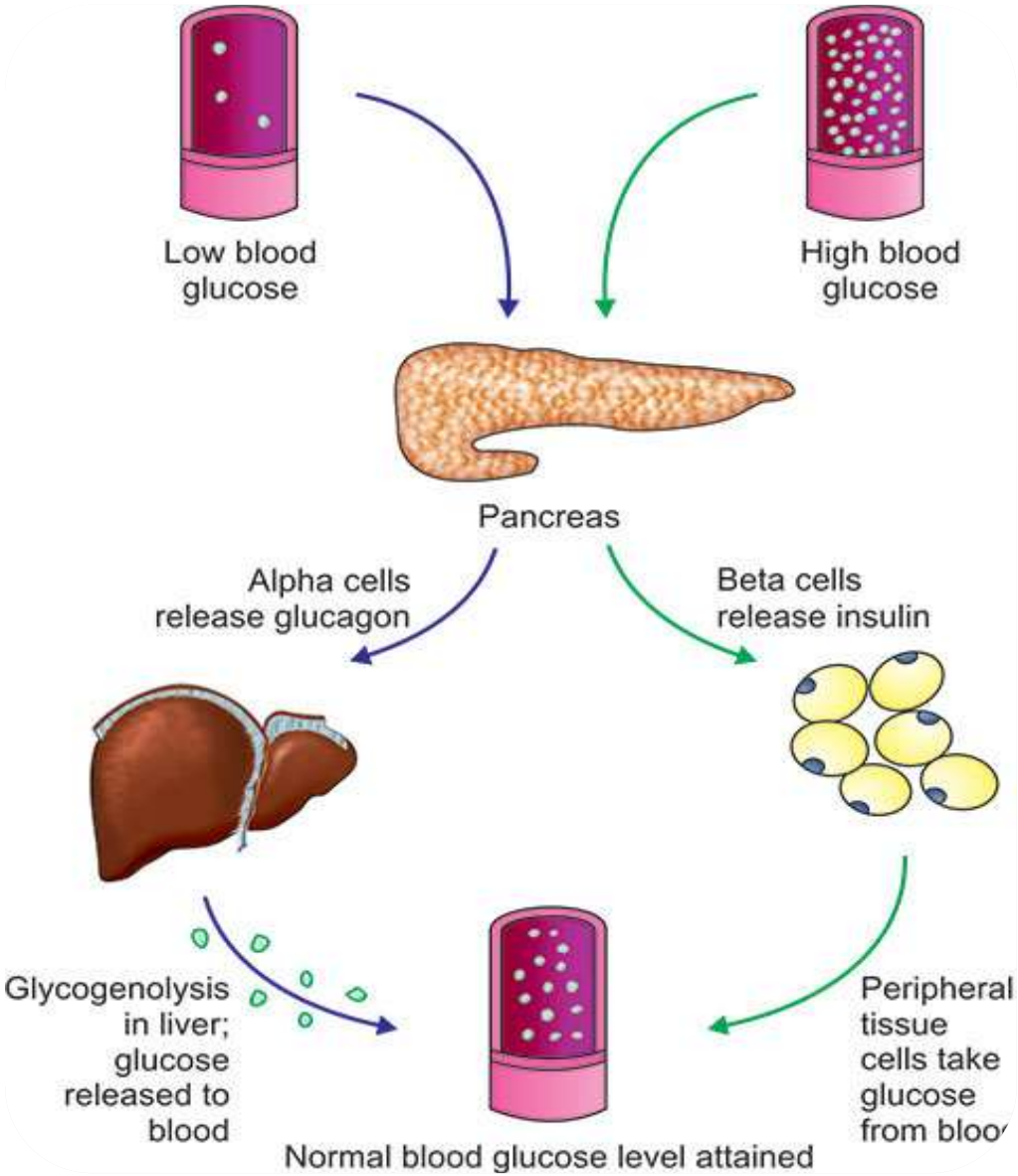
- Enzymes: Activation or inhibition of key metabolic enzymes.
- **Hormones: Such as insulin and glucagon, coordinating metabolism**.
- **Feedback mechanisms:** End products inhibit their own synthesis (negative feedback)..

Maintains the **balance** between **energy production** and **energy consumption**, preserving **cellular homeostasis** and **metabolic efficiency**

- **Example**

•High blood glucose → Insulin → Glycogenesis (Anabolic)

•Low blood glucose → Glucagon → Glycogenolysis (Catabolic)



WHAT ENZYME ?

enzymes are biological catalysts which bring about chemical reaction in the living cell.

. produced by the living organism in small amounts.

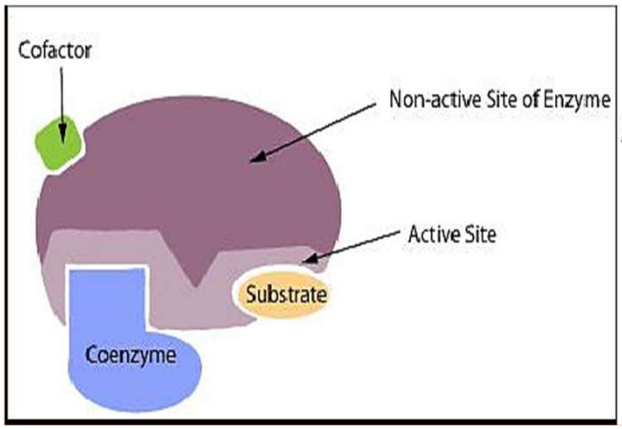
Sources of enzymes:

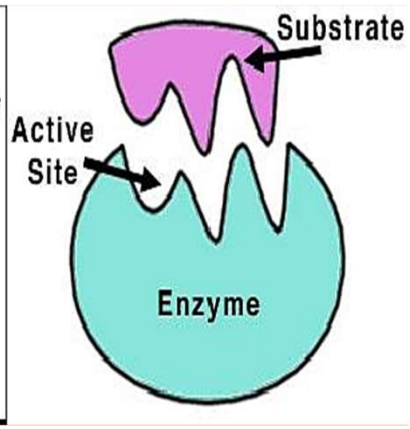
Endoenzymes: enzymes that function within the cells, most of enzymes are these types. Ex: metabolic oxidase.

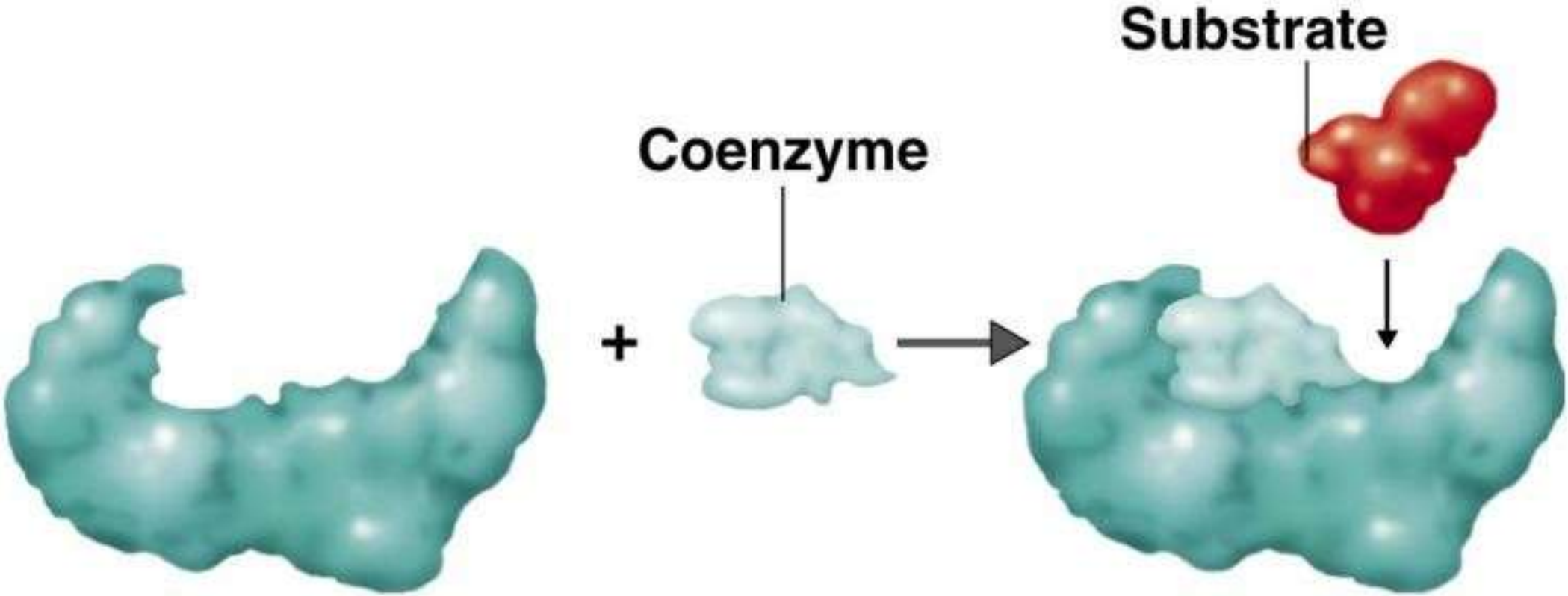
Exoenzymes: enzymes that are liberated by cells and catalyze reactions outside the cell. Ex: digestive enzymes (amylase, lipase, protease).

Chemical composition of enzymes:

- **Enzyme consist of only protein.** Ex: pepsin, trypsin (amino acids binding peptide bonds).
- **Enzyme consist of** : protein (enzyme) + Co - Enzyme = **Holoenzyme (apoenzyme)**
- **Enzyme consist of**: Protein (enzyme) + prosthetic group (Co – factor) **= Holoenzyme**







Apoenzyme (protein portion), inactive

Cofactor (nonprotein portion), activator

Holoenzyme (whole enzyme), active

Coenzymes : are typically organic molecules, used by enzymes to help catalyse reactions, contain functionalities not found in proteins,

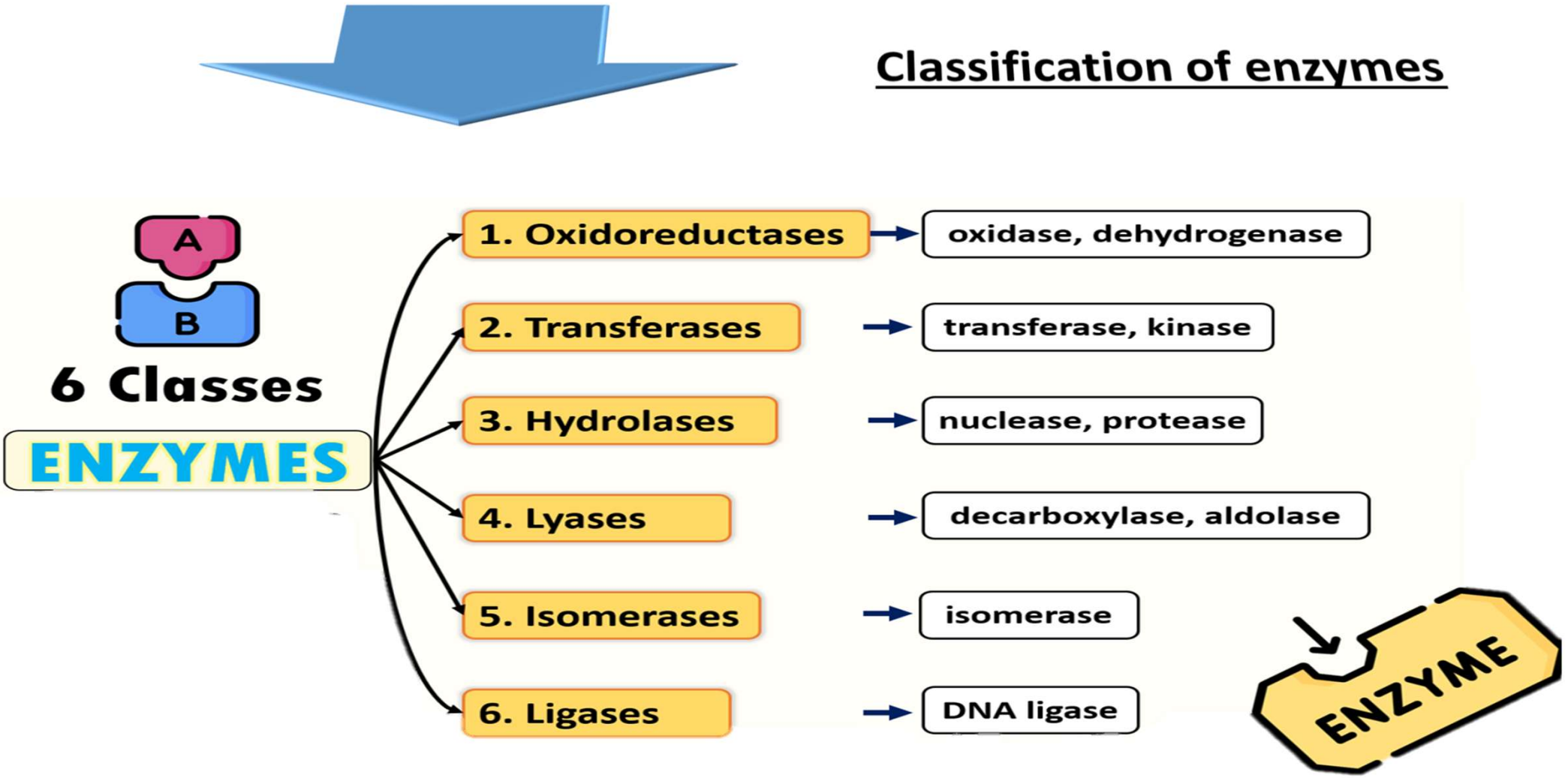
cofactors : are catalytically essential molecules or ions that are covalently bound to the enzyme

Holoenzyme : enzyme consist of Apoenzyme + prosthetic group

Apoenzyme : term refers to the protein part of enzyme.

Active site of enzyme: the point in the enzyme which interaction with substrate, co-enzyme, inhibitor take place.

Classification of enzymes

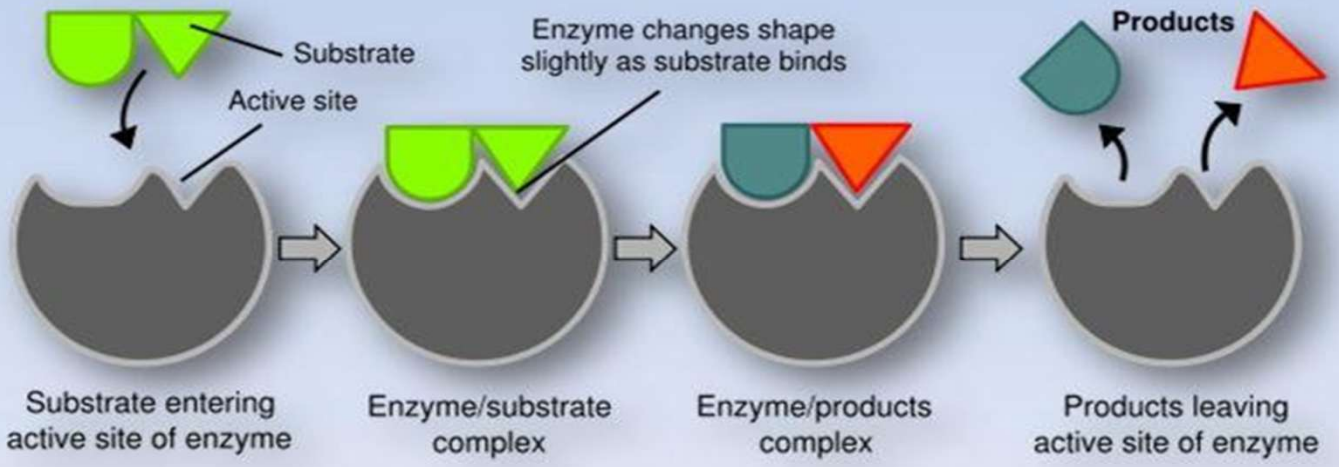


Mechanism of Enzyme Action

- The whole process begins with the *binding of the substrate to the active site* of the enzyme. The *active site* is the specific region of the enzyme which combines with the substrate.

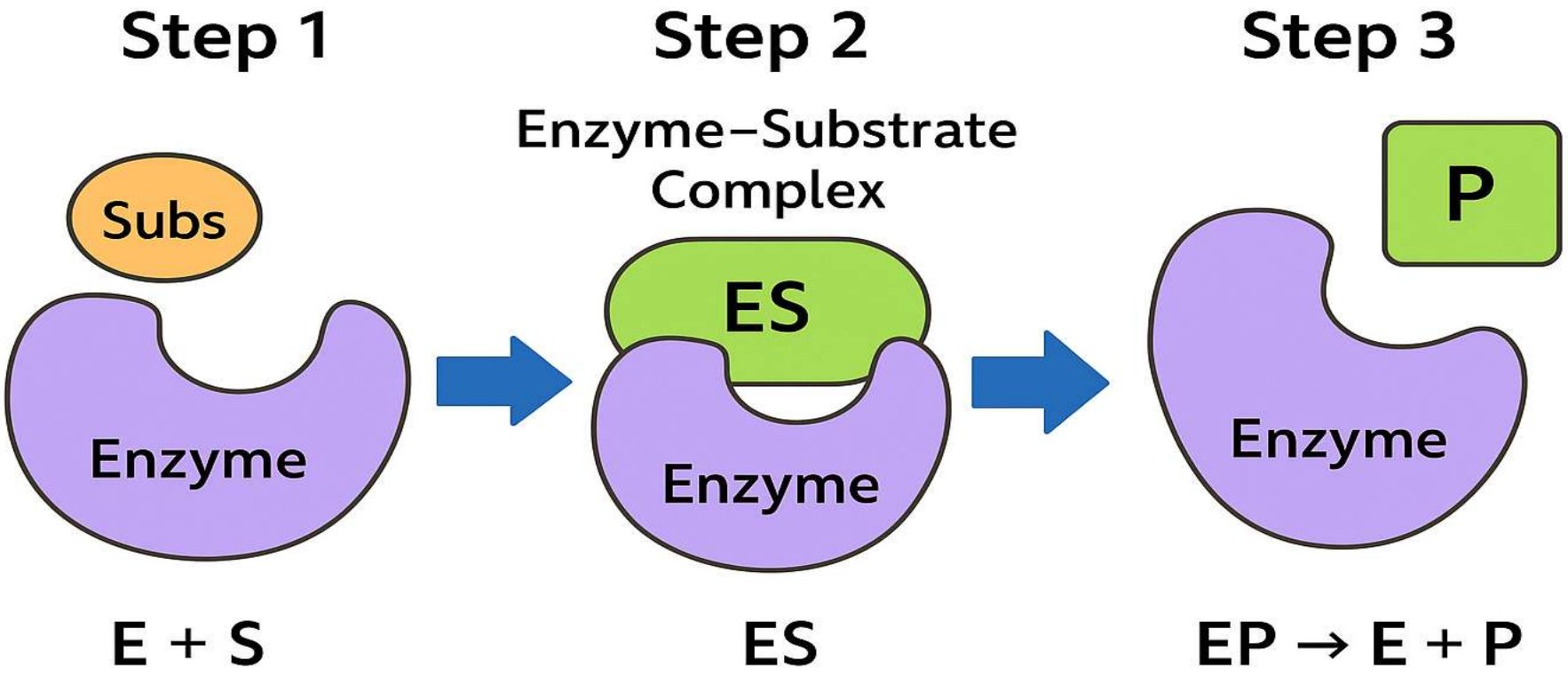
- changes in the distribution of electrons in the chemical bonds of the substrate
- reactions that lead to the formation of products

- The products are released and the enzyme is ready to catalyze another reaction.



http://en.wikipedia.org/wiki/Enzyme

Mechanism of Enzyme Action



Factors Affecting Enzyme Activity

Temperature, pH, substrate concentration, and presence of inhibitors.

Enzyme activity increases with temperature up to an optimum point.

Enzyme inhibition

Inhibitors : a chemical substance, can react in place of substrate with the enzyme but is not transformed into product(s). the process called enzyme inhibition.

- **The Inhibitors** : poisons, like cyanide, antibiotics, anti-metabolites and some drugs.

Classification of inhibitors:

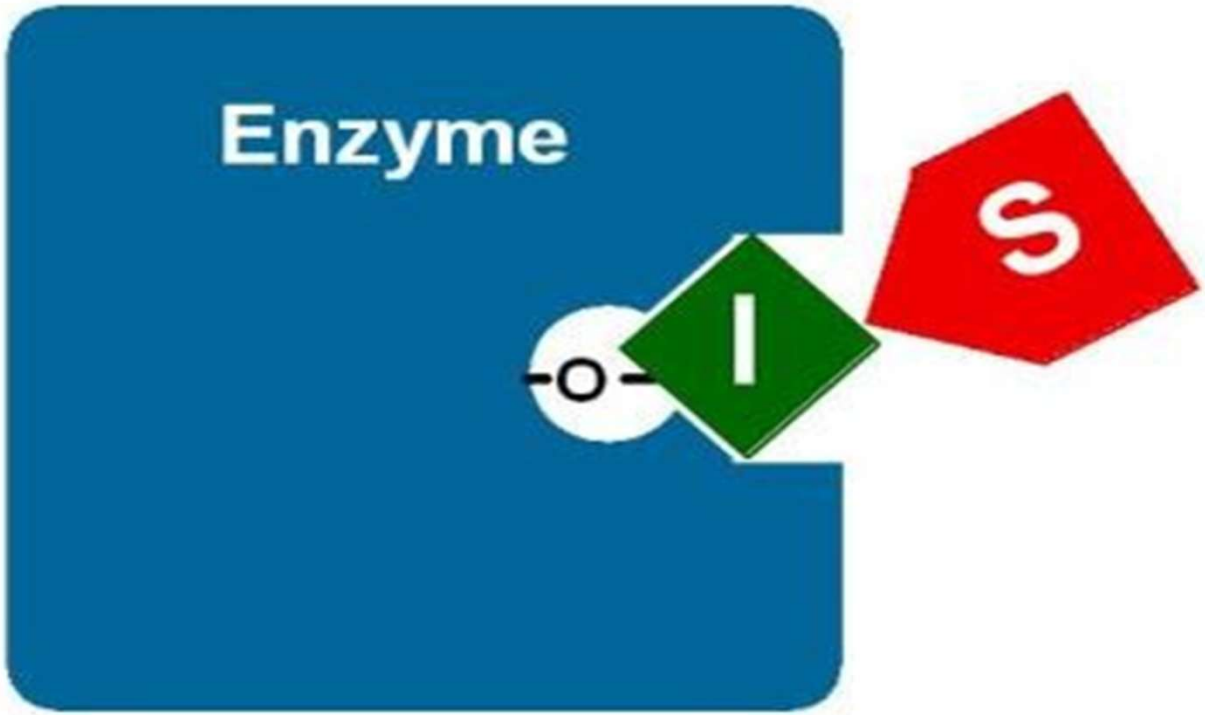
Inhibitors can be divided into two types: **(i) Irreversible** **(ii) Reversible**

Irreversible inhibitors:

1-The inhibitor occupying the **active sites** by forming covalent bonds or they may physically block the **active sites.**

2-The inhibitor destroying the globular structure.

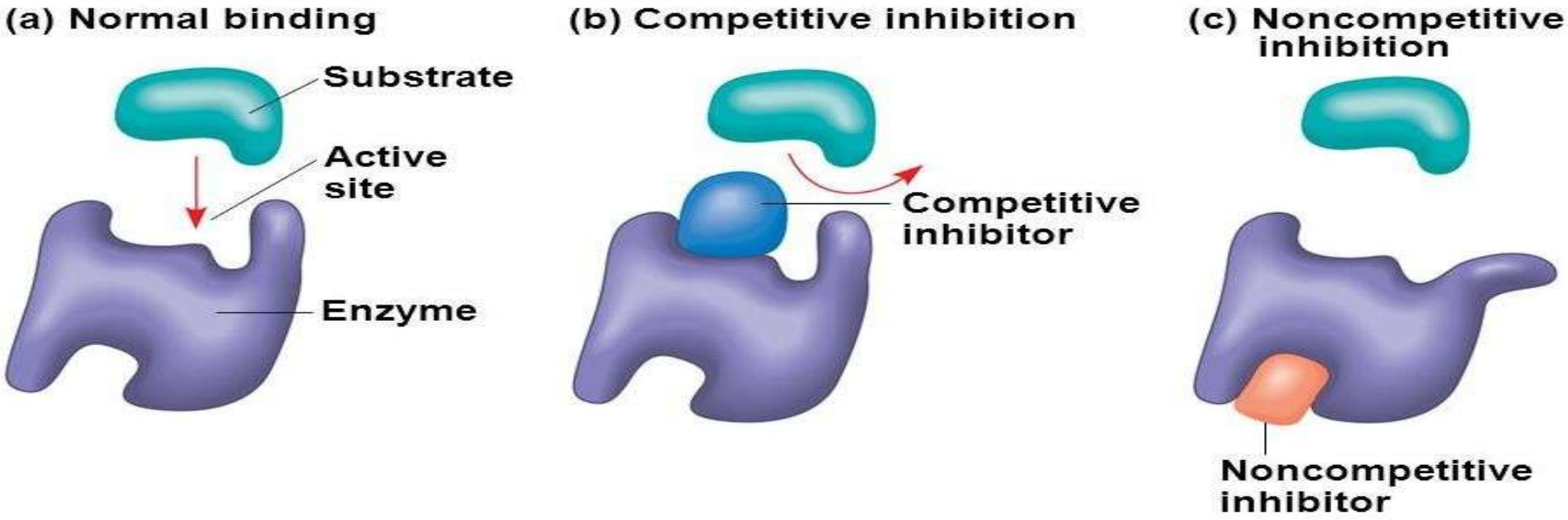
Irreversible Inhibition



In irreversible inhibition, the inhibitor binds to the enzyme irreversibly through formation of a covalent bond with the enzyme , permanently inactivating the enzyme

Reversible Inhibitors:

- Reversible inhibitors attach to enzymes with non-covalent interactions such as hydrogen bonds, hydrophobic interactions and ionic bonds. Inhibitors form weak linkages with the enzyme.



Clinical Importance of Enzymes

Used in diagnosis of diseases through enzyme assays.

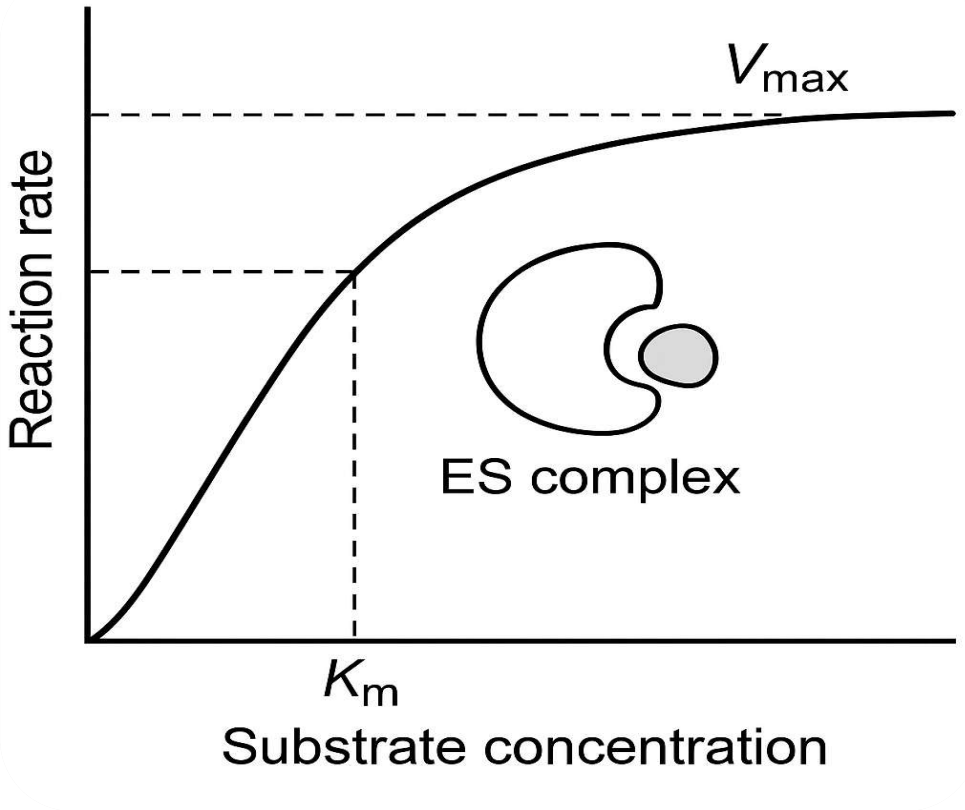
Examples: ALT and AST for liver function; CK for muscle damage.

Enzymes	Increase in disease
Aspartate transaminase	myocardial infarction (GOT) (previously)(AST)
Alanine transaminase (GPT)(Previously) (ALT)	liver disease especially with liver cell damage
Amylase	Acute pancreatitis
Acid phosphatase(ACP)	Prostatic carcinoma
Alkaline phosphatase(ALP)	Liver disease, bone disease (rickets)
Lactate Dehydrogenase(LDH)	myocardial infarction, liver disease, Blood disease
Creatine Kinase(CK)	myocardial infarction , skeletal muscle disease (Muscle dystrophy)
Glutamyl transferase (GT)	liver disease, biliary obstruction

Michaelis–Menten Theory

Explains the relationship between enzyme rate and substrate concentration.

Enzyme binds to substrate forming ES complex.



Reaction Steps

1. Binding of Substrate to Enzyme (Formation of ES Complex)
$E + S \rightleftarrows ES$

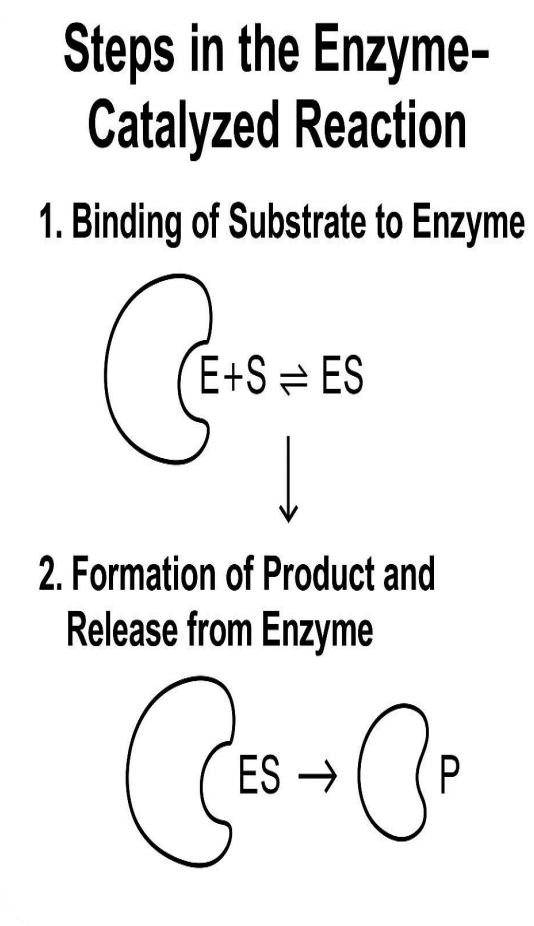
The enzyme (E) binds to the substrate (S) at its active site.

This process is reversible — the ES complex can dissociate back to free enzyme and substrate.

2. Formation of Product and Release from Enzyme
$ES \rightarrow E + P$

Within the ES complex, the substrate is converted into product (P).

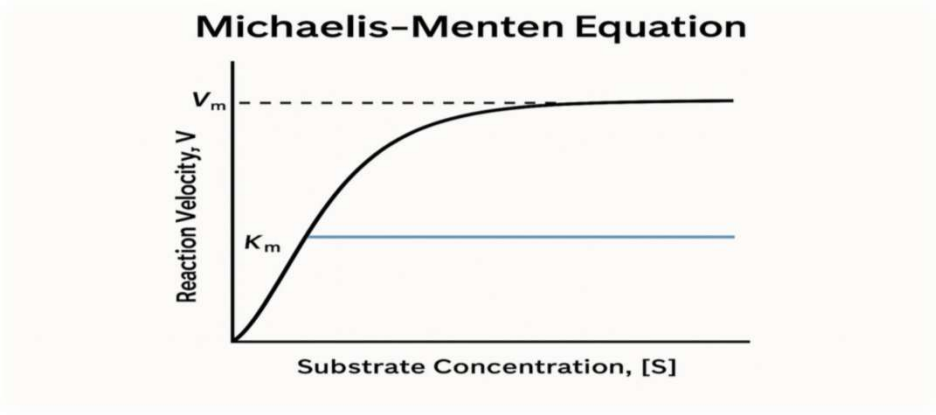
The product is released, and the enzyme is free to catalyze another reaction.



Michaelis–Menten Equation

$V = (V_{max}[S]) / (K_m + [S])$

V = reaction velocity, [S] = substrate concentration,
Km = Michaelis constant.



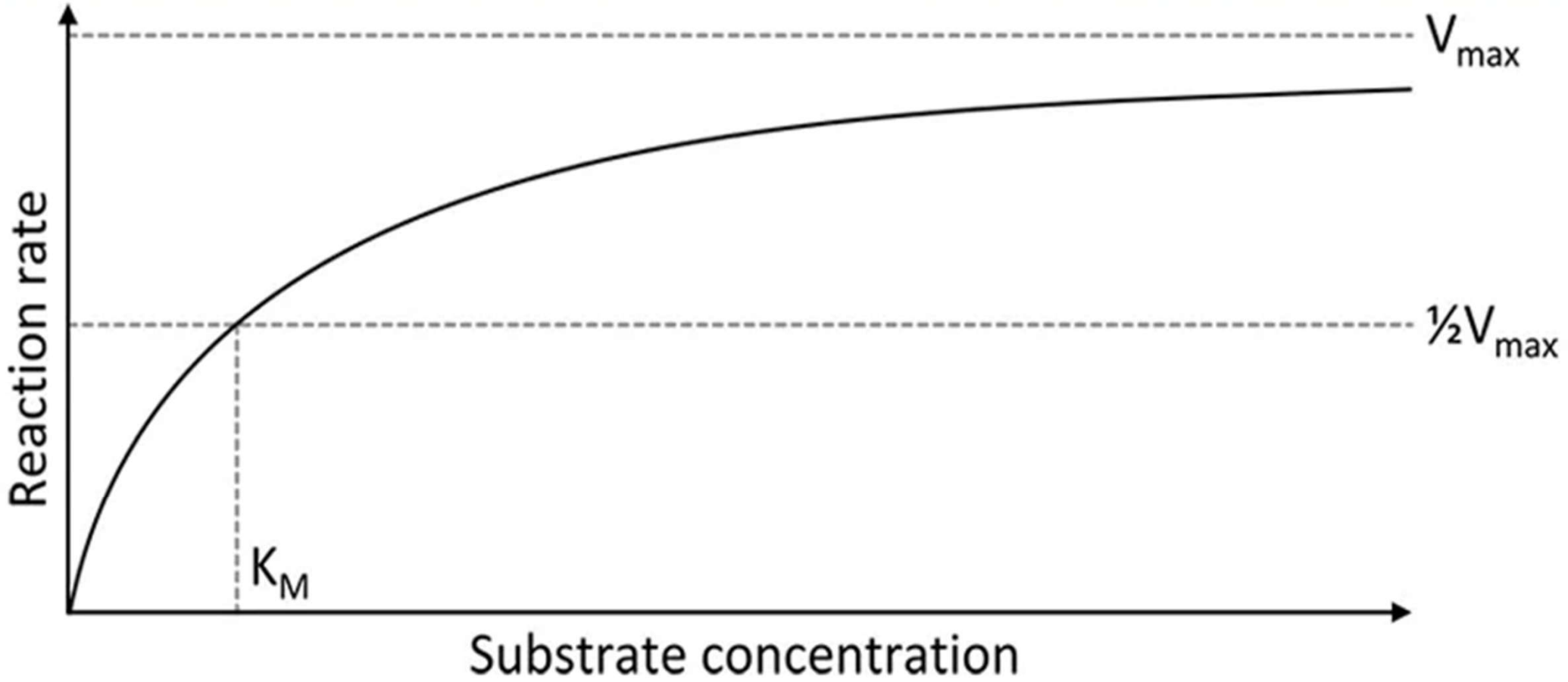
Parameters Explained

Vmax: maximum reaction rate when enzyme is saturated.

Km: substrate concentration at which reaction rate is half of Vmax.

Low Km = high enzyme affinity for substrate.

The Michaelis–Menten Model (Kinetics)



Clinical Relevance of Michaelis–Menten Theory

Helps in understanding enzyme efficiency and drug inhibition mechanisms.

Useful in pharmacology and metabolic studies.

Thank You
for Your Attention