D.PHARM • SECOND YEAR

Biochemistry & Clinical Pathology

CHAPTER 6

Enzymes



ENGLISH CHAPTER NOTES

DIPLOMA IN PHARMACY

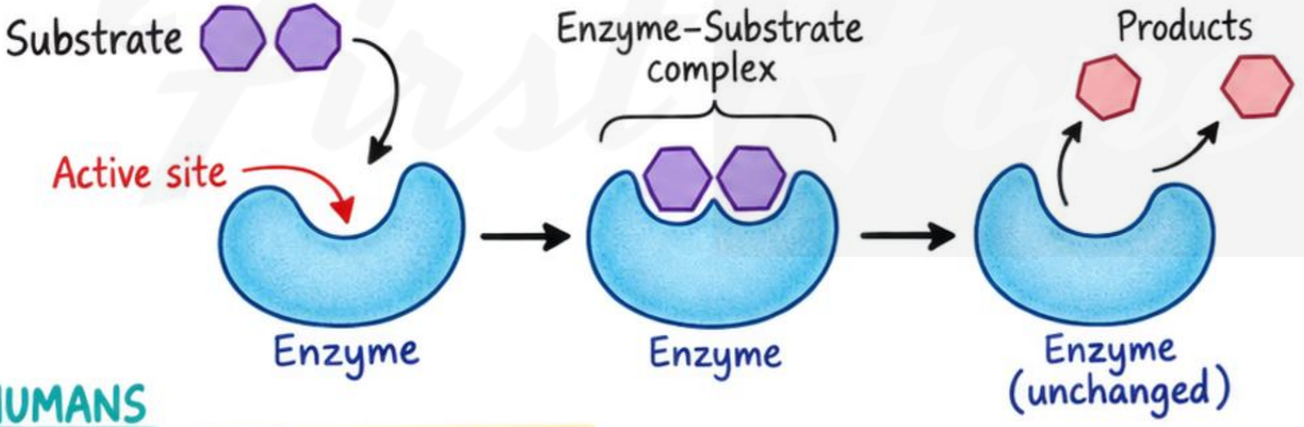
ENZYMES: DEFINITION & FEATURES

DEFINITION

Enzymes are biological catalysts that speed up biochemical reactions by lowering activation energy. Most enzymes are proteins; a few catalytic RNAs are called ribozymes.

KEY FEATURES

- highly specific for a substrate and reaction
- not consumed or permanently changed
- reusable for many reaction cycles
- work efficiently under mild physiological conditions
- activity can be activated, inhibited or regulated
- essential for metabolism and life processes



REMEMBER

An enzyme increases reaction rate but is regenerated at the end.

MILD CONDITIONS IN HUMANS

Temperature: about 37°C
Blood pH: about 7.4

Each enzyme still has its own optimum temperature and pH.

BASIC ACTION

Enzyme + Substrate → Enzyme–Substrate complex → Enzyme + Product

EXAMPLE

Amylase catalyses hydrolysis of starch into smaller sugars such as maltose.

GENERAL PROPERTIES OF ENZYMES

1. SPECIFICITY

An enzyme usually recognises a particular substrate and catalyses one type of reaction.

7. REUSABILITY

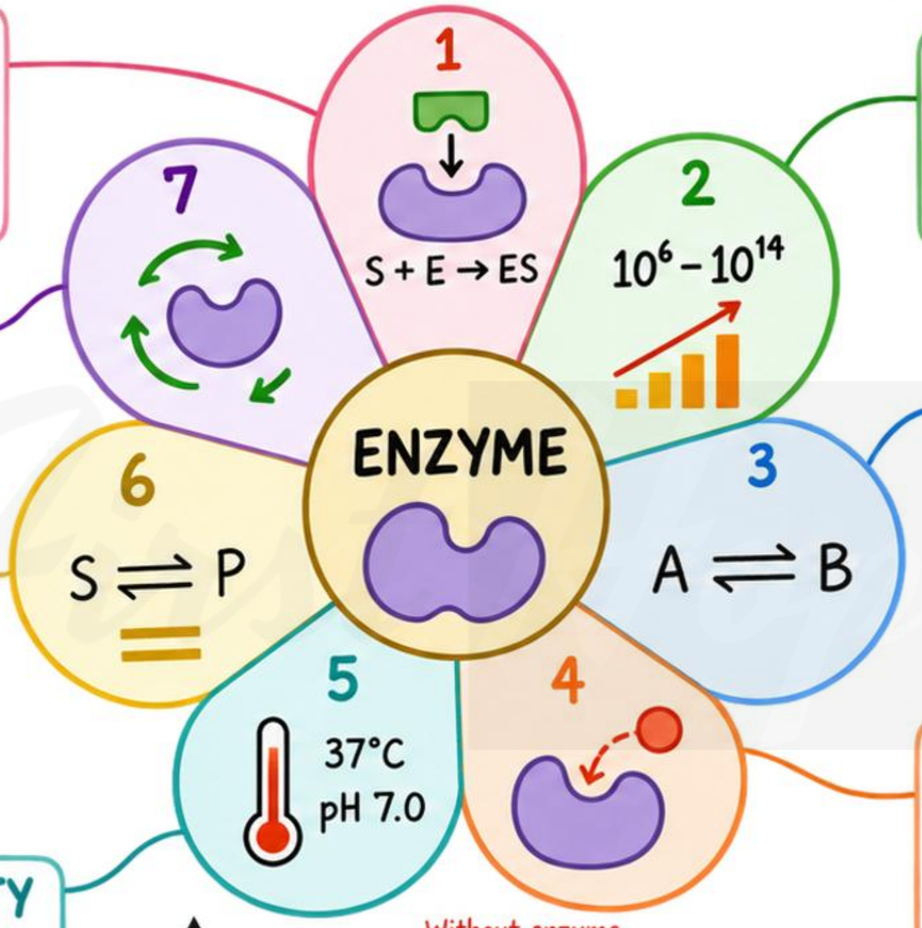
Enzymes are regenerated after a reaction and can act again.

6. NO CHANGE IN EQUILIBRIUM

Enzymes lower activation energy and help equilibrium occur faster. They do not change the equilibrium position or overall free-energy change.

5. TEMPERATURE & pH SENSITIVITY

Every enzyme has an optimum range. Extreme heat or unsuitable pH reduces activity and may denature it.



2. HIGH CATALYTIC POWER

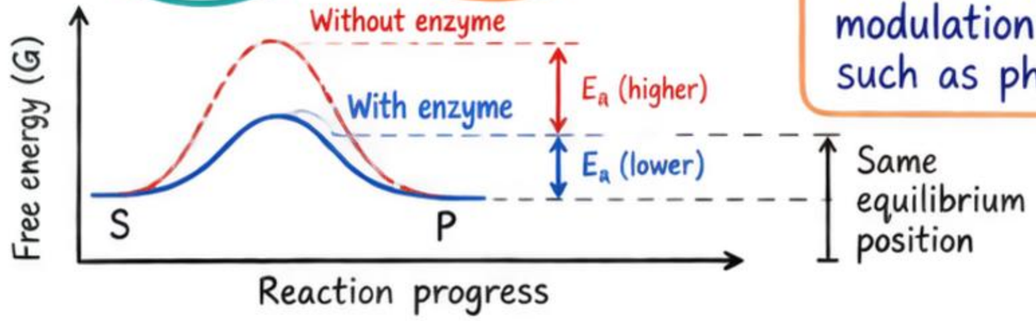
Enzymes may increase reaction rate by about 10^6 to 10^{14} times.

3. REVERSIBILITY

Many enzymes catalyse forward and reverse reactions; direction depends on substrate and product conditions.

4. REGULATION

Activity may be controlled by feedback inhibition, allosteric modulation or covalent modification such as phosphorylation.



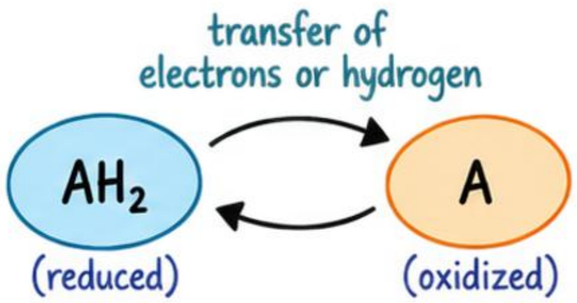
ENZYME CLASSES I–III

IUBMB CLASSIFICATION

Enzymes are classified by the reaction they catalyse. An EC number has four parts: EC x.x.x.x. The first number shows the main class.

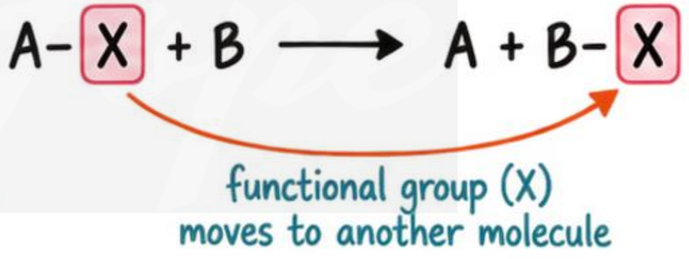
EC 1 OXIDOREDUCTASES

- Catalyse oxidation–reduction reactions by transferring electrons or hydrogen.
- General idea: $AH_2 + B \rightleftharpoons A + BH_2$
- Examples: dehydrogenases, oxidases, reductases.



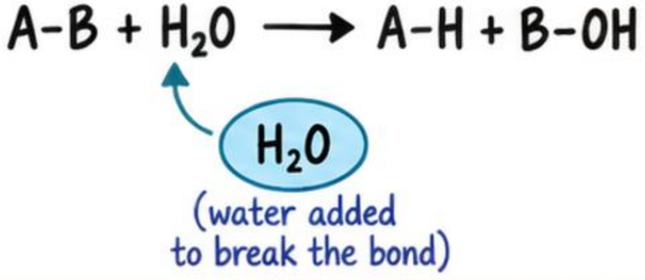
EC 2 TRANSFERASES

- Transfer a functional group from one molecule to another.
- General idea: $A\text{-}X + B \longrightarrow A + B\text{-}X$
- Transferred groups may include phosphate, amino or methyl groups.
- Examples: kinases and transaminases.



EC 3 HYDROLASES

- Break chemical bonds by addition of water.
- General idea: $A\text{-}B + H_2O \longrightarrow A\text{-}H + B\text{-}OH$
- Examples: amylase, lipase, proteases and phosphatases.



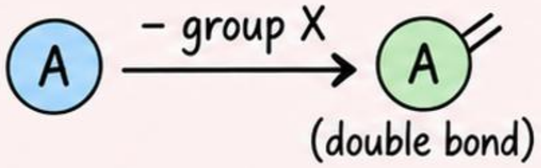
QUICK MEMORY

1 redox
•
2 transfer
•
3 hydrolysis

ENZYME CLASSES IV–VII

1 EC 4 – LYASES

Remove groups to form double bonds, or add groups to double bonds, without hydrolysis or oxidation.



Examples: decarboxylase, aldolase, fumarase.

2 EC 5 – ISOMERASES

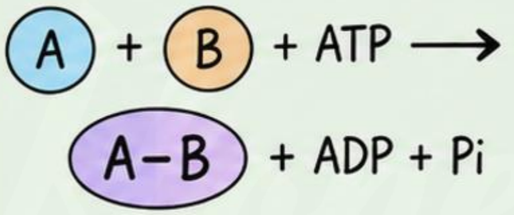
Rearrange atoms within one molecule to form an isomer.



Examples: isomerases, racemases and mutases.

3 EC 6 – LIGASES / SYNTHETASES

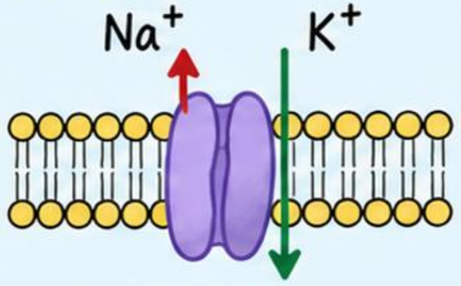
Join two molecules, usually using energy from ATP.



Examples: DNA ligase and glutamine synthetase.

4 EC 7 – TRANSLOCASES

Catalyse movement of ions or molecules across membranes or their separation within membranes.



Example: Na^+/K^+-transporting ATPase.

CURRENT FACT IUBMB now recognises seven main EC classes; translocases were added as EC 7.

CLINICAL GROUPING BY FUNCTION

- **Digestive:** amylase, lipase
- **Coagulation:** thrombin
- **Metabolic:** G6PD
- **Diagnostic markers:** ALT, AST, CK-MB

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