

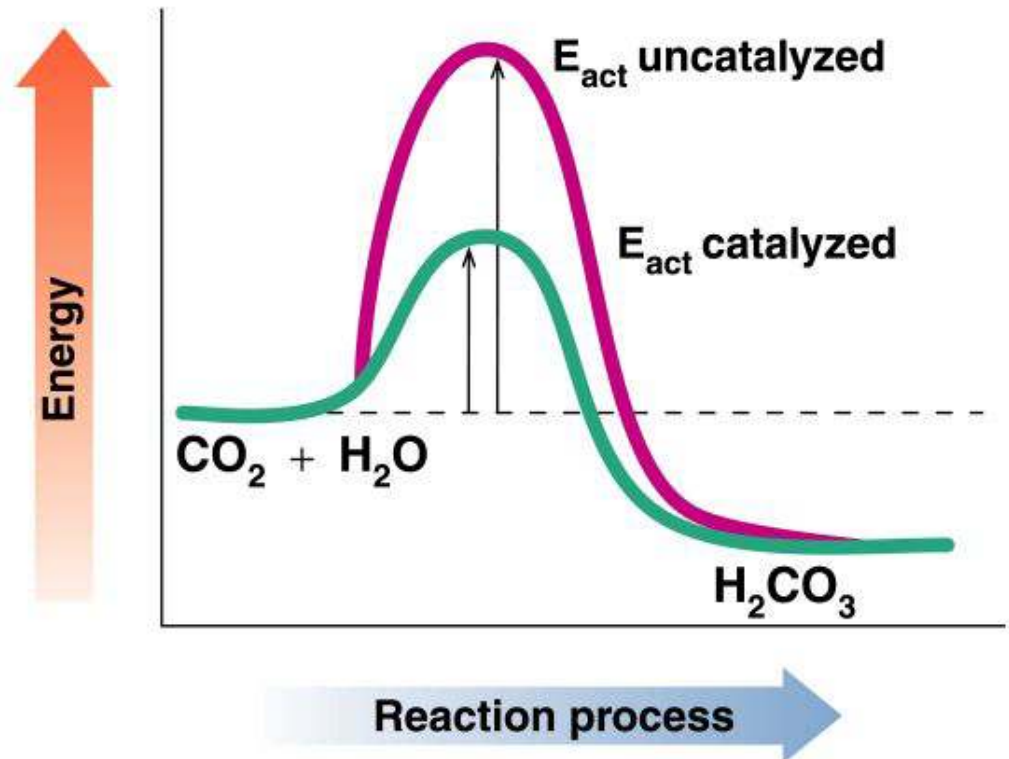
**Enzyme**

# Definition of enzyme

- Enzymes are biological catalysts.
- A Catalyst is defined as "a substance that increases the rate of a chemical reaction without being itself changed in the process."

# Enzymes as Biological Catalysts

- **Enzymes** are proteins that increase the rate of reaction by lowering the energy of activation
- They catalyze nearly all the chemical reactions taking place in the cells of the body
- Enzymes have unique three-dimensional shapes that fit the shapes of reactants (**substrates**)



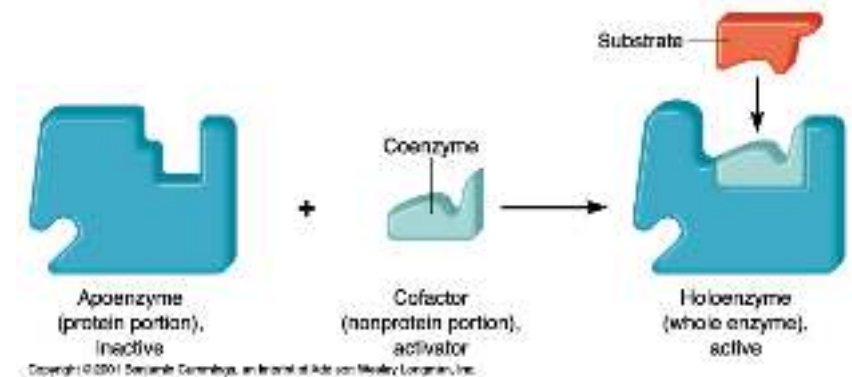
## 2. Properties of enzymes (important!)

- **Catalytic efficiency – high efficiency,  $10^3$  to  $10^{17}$  faster than the corresponding uncatalyzed reactions**
- **Specificity - high specificity, interacting with one or a few specific substrates and catalyzing only one type of chemical reaction.**
- **Mild reaction conditions-  $37^\circ\text{C}$ , physiological pH, ambient atmospheric pressure**

# 3. Chemical composition of enzymes

(1) Simple protein

(2) Conjugated protein



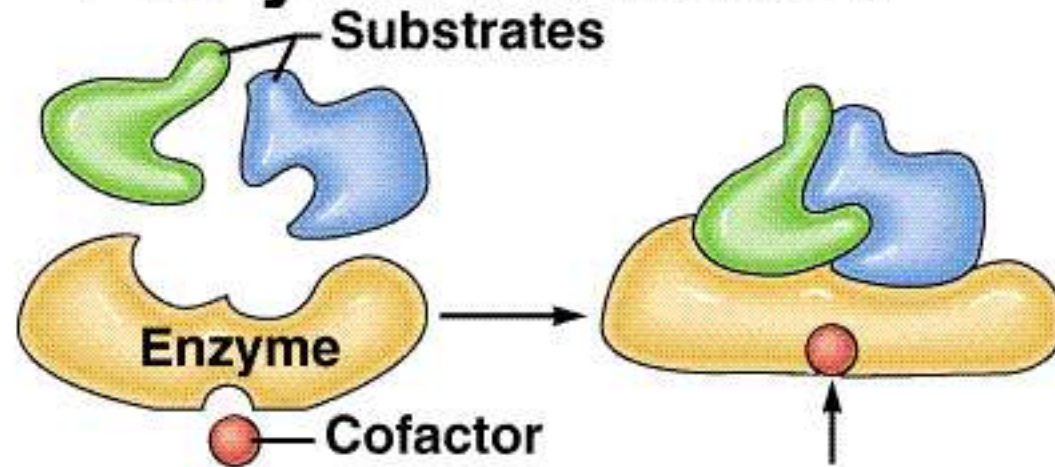
Holoenzyme = Apoenzyme + Cofactor

Cofactor

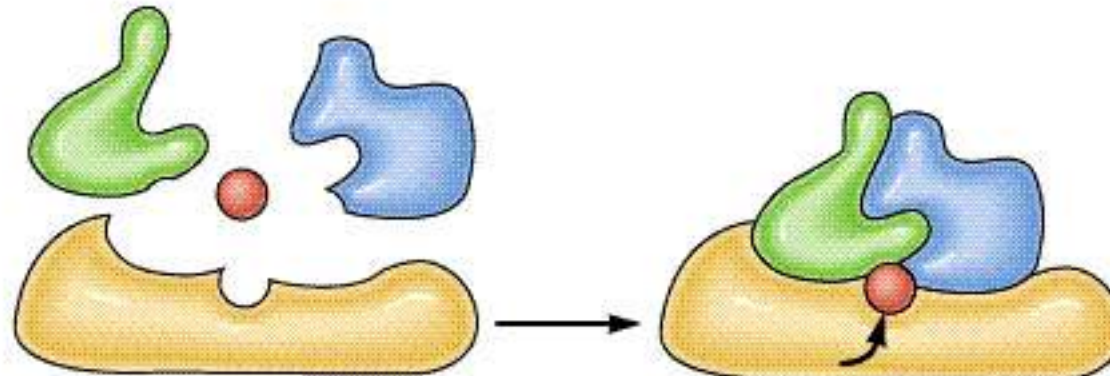
Coenzyme : loosely bound to enzyme (non-covalently bound).

Prosthetic group : very tightly or even covalently bound to enzyme (covalently bound)

# Roles of Cofactors in Enzyme Function



Cofactor changes conformation of active site.



Cofactor participates in temporary bonding between active site and substrates.

## 4. Classification of enzymes

### (1). By their composition

1). Monomeric enzyme

2). Oligomeric enzyme

3). Multienzyme complex: such as  
Fatty acid synthase

## (2) Nomenclature

- Recommended name

- Enzymes are usually named according to the reaction they carry out.

- To generate the name of an enzyme, the suffix *-ase* is added to the name of its substrate (e.g., **lactase** is the enzyme that cleaves lactose) or the type of reaction (e.g., **DNA polymerase** forms DNA polymers).

- Systematic name (International classification)

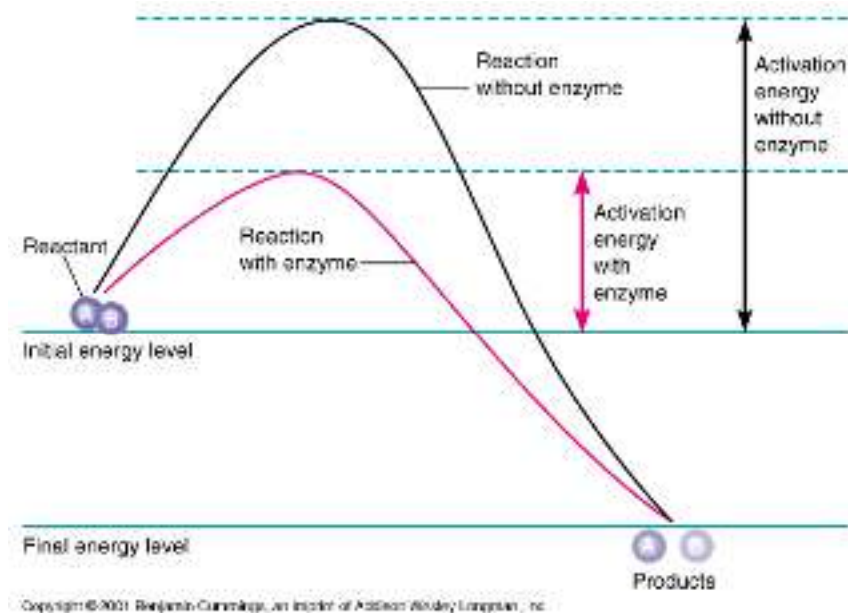
- By the reactions they catalyze (Six classes)



## 5. How enzymes work (important!)

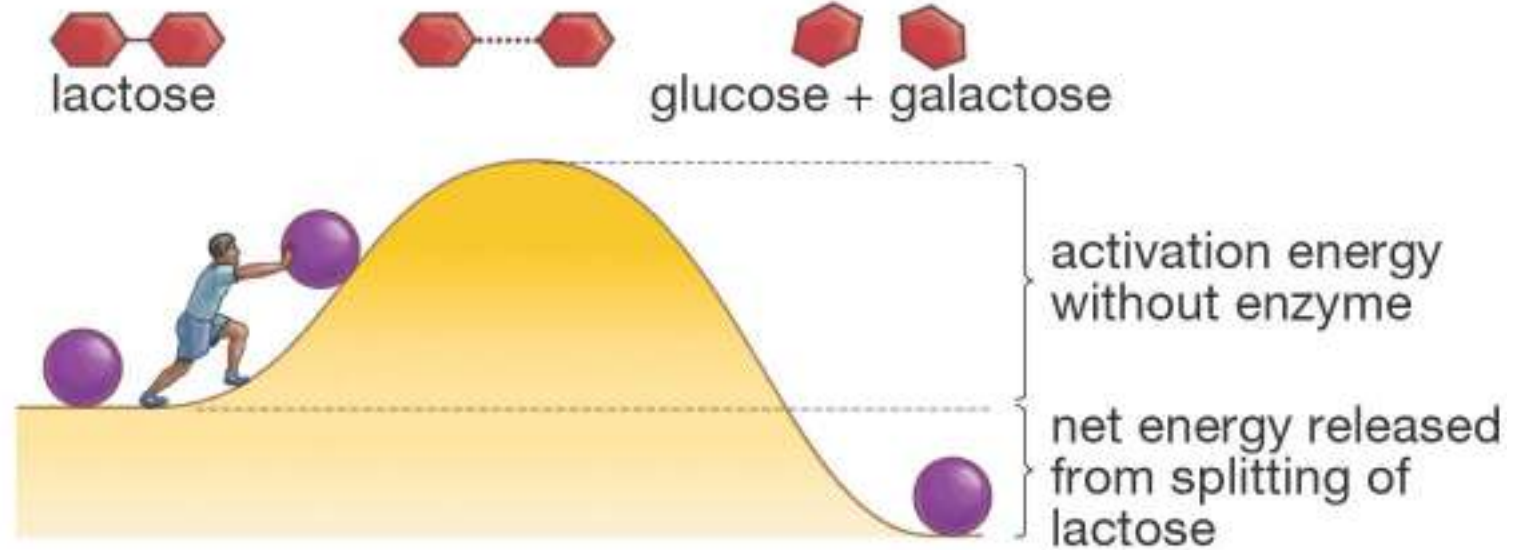
### 1) Enzymes lower a reaction's activation energy

- All chemical reactions have an energy barrier, called the **activation energy**, separating the reactants and the products.
- **activation energy**: amount of energy needed to disrupt stable molecule so that reaction can take place.

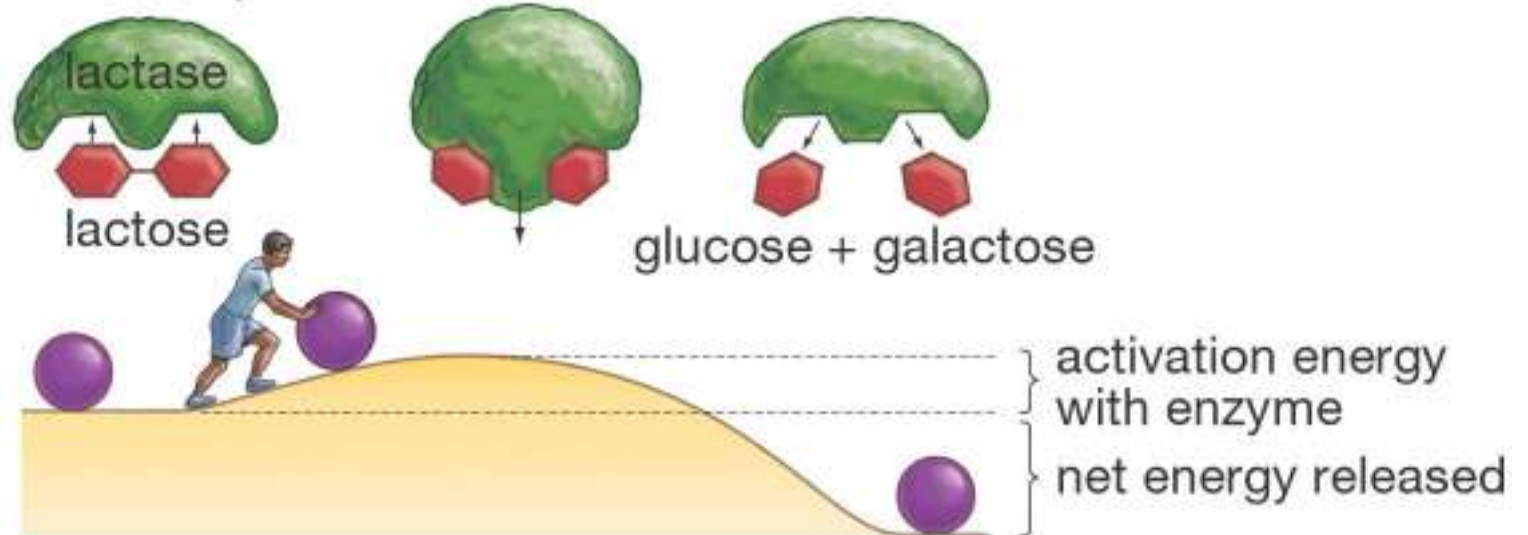


# Enzymes Lower a Reaction's Activation Energy

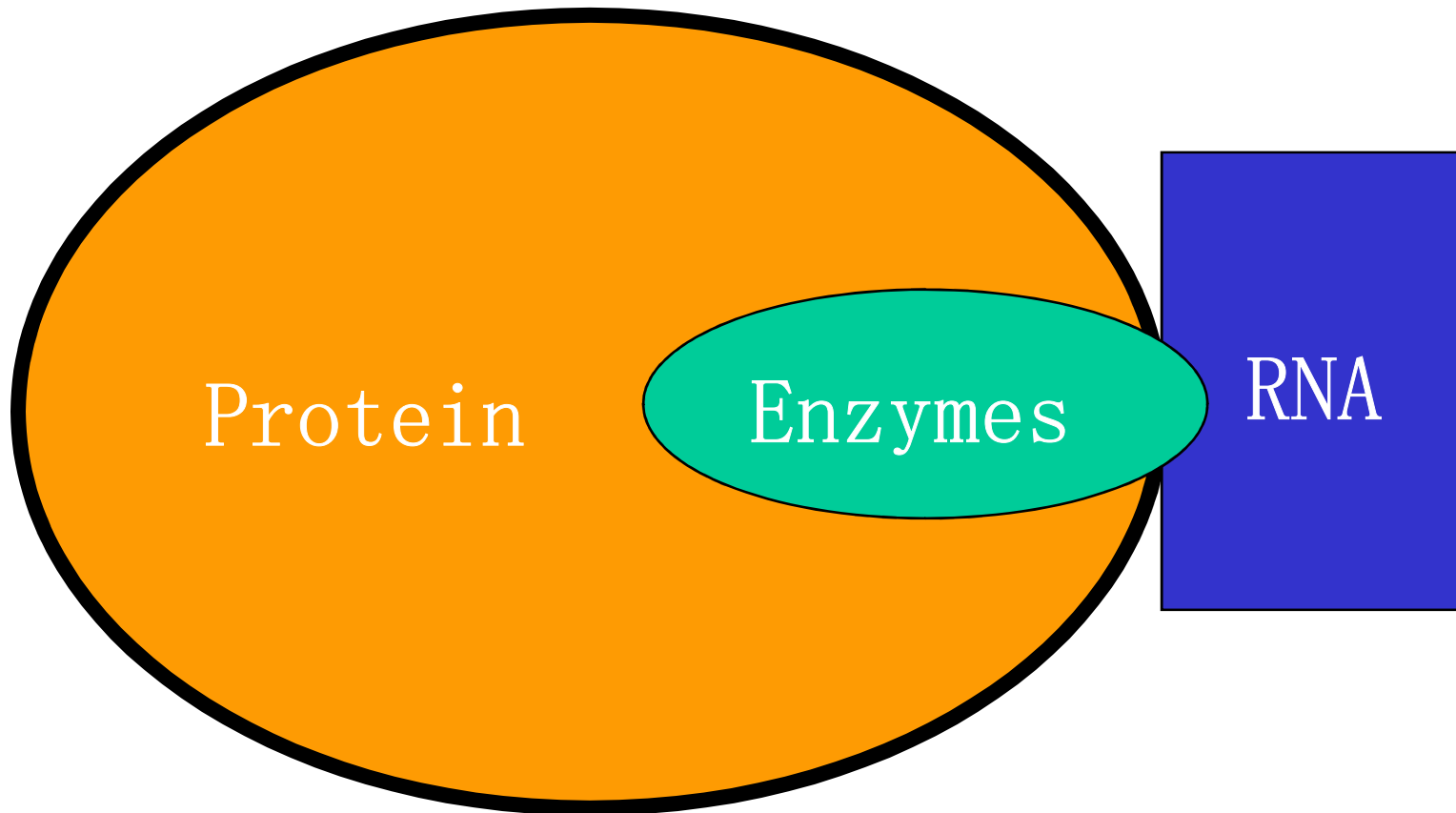
(a) Without enzyme



(b) With enzyme



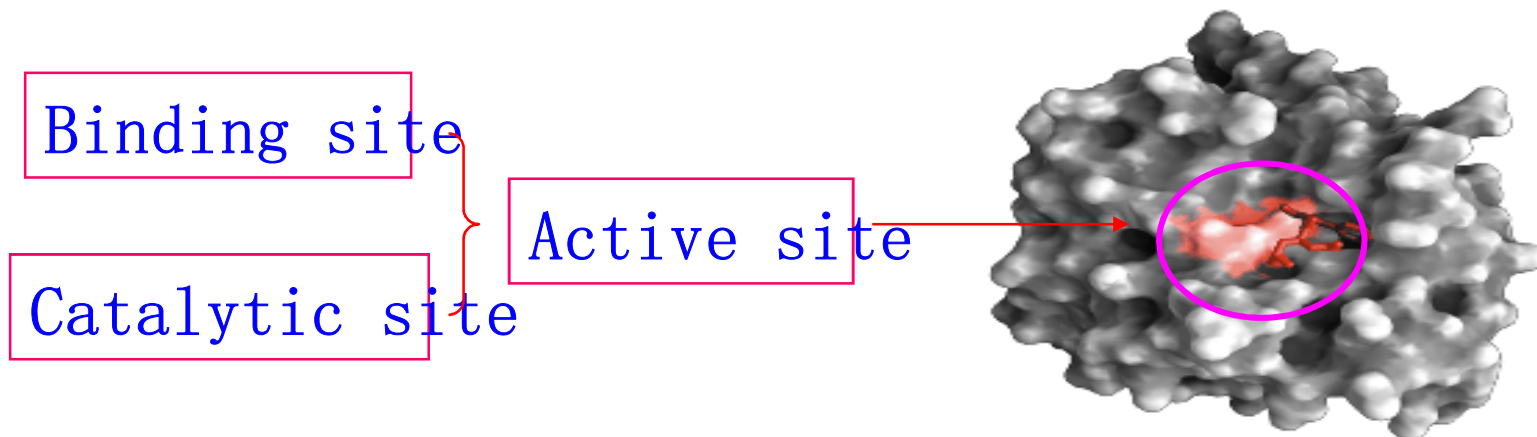
What is the difference between an enzyme and a protein?



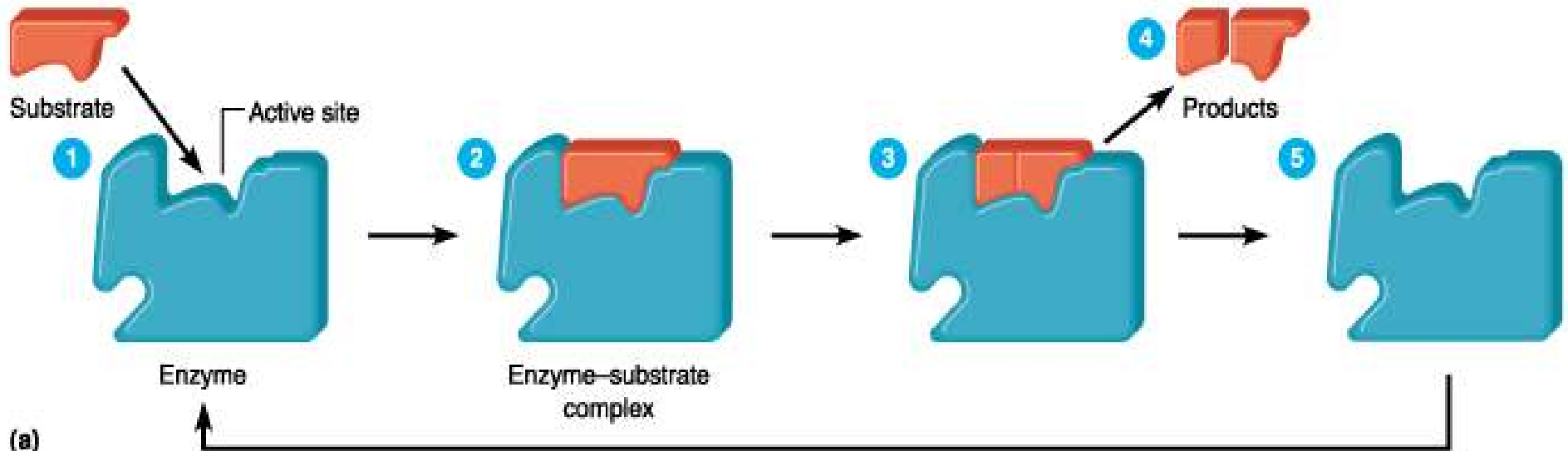
- All enzymes are proteins except some RNAs
- not all proteins are enzymes

## 2) The active site of the enzyme

- Enzymes bind substrates to their active site and stabilize the transition state of the reaction.
- The **active site** of the enzyme is the place where the substrate binds and at which catalysis occurs.
- The active site binds the substrate, forming an enzyme-substrate(ES) complex.



# Enzymatic reaction steps



Copyright © 2001 Benjamin Cummings, an imprint of Addison Wesley Longman, Inc.

1. Substrate approaches active site
2. Enzyme-substrate complex forms
3. Substrate transformed into products
4. Products released
5. Enzyme recycled

## 6. Enzyme activity

- Enzymes are never expressed in terms of their concentration (as mg or  $\mu\text{g}$  etc.), but are expressed only as activities.
- **Enzyme activity** = moles of substrate converted to product per unit time.
  - The **rate** of appearance of product or the rate of disappearance of substrate
  - Test the absorbance: spectrophotometer

# 7. Factors affecting enzyme activity

- Concentration of substrate
- Concentration of enzyme
- Temperature
- pH
- Activators
- Inhibitors

# Enzymes in clinical diagnosis

- An enzyme test is a **blood** test or **urine** test that measures levels of certain enzymes to assess how well the body's systems are functioning and whether there has been any tissue damage. (why?)



- Common enzymes used for clinical diagnosis include:
  - alanine aminotransferase(ALT,also called glutamate pyruvate transaminase,GPT)
  - alkaline phosphatase
  - amylase
  - aspartate aminotransferase
  - creatine kinase
  - lactate dehydrogenase