Cellular and Molecular Biochemistry [FHS1104]

Enzymology

Section (B)

Lecture {9}

MBCHB/BDS
1ST YEAR SEM.-1
2026

Yasser Khater

Review:

- Define the following :{ Enzymology, enzymes, substrate, active site, activation energy .apoenzyme, Holoenzyme }
- Mention the Properties of Enzymes
- Explain the following
- 1.Lock and key model of enzyme-substrate binding
- 2. Induced-fit model of enzyme-substrate binding

{Lecture (9) Outline}

- Nomenclature of Enzymes
- Classification of Enzymes
- Factors Affecting Enzymes Activity

Nomeclature of enzymes:

1. The first discovered enzymes were named according to their source:

(for example: pepsin is found in the gastric juice of the stomach (Greek *pepsis* = digestion))

Nomeclature of enzymes:

2. Enzymes were named according to their

substrate: name of substrate + suffix -ase

(for example: urease is the enzyme that catalyzes the hydrolysis of urea, lipase is the enzyme that catalyzes the cleavage (hydrolysis) of lipids.

Classification of enzymes

{International Union of Biochemistry and Molecular Biology(IUBMB)}

Classification of enzymes:

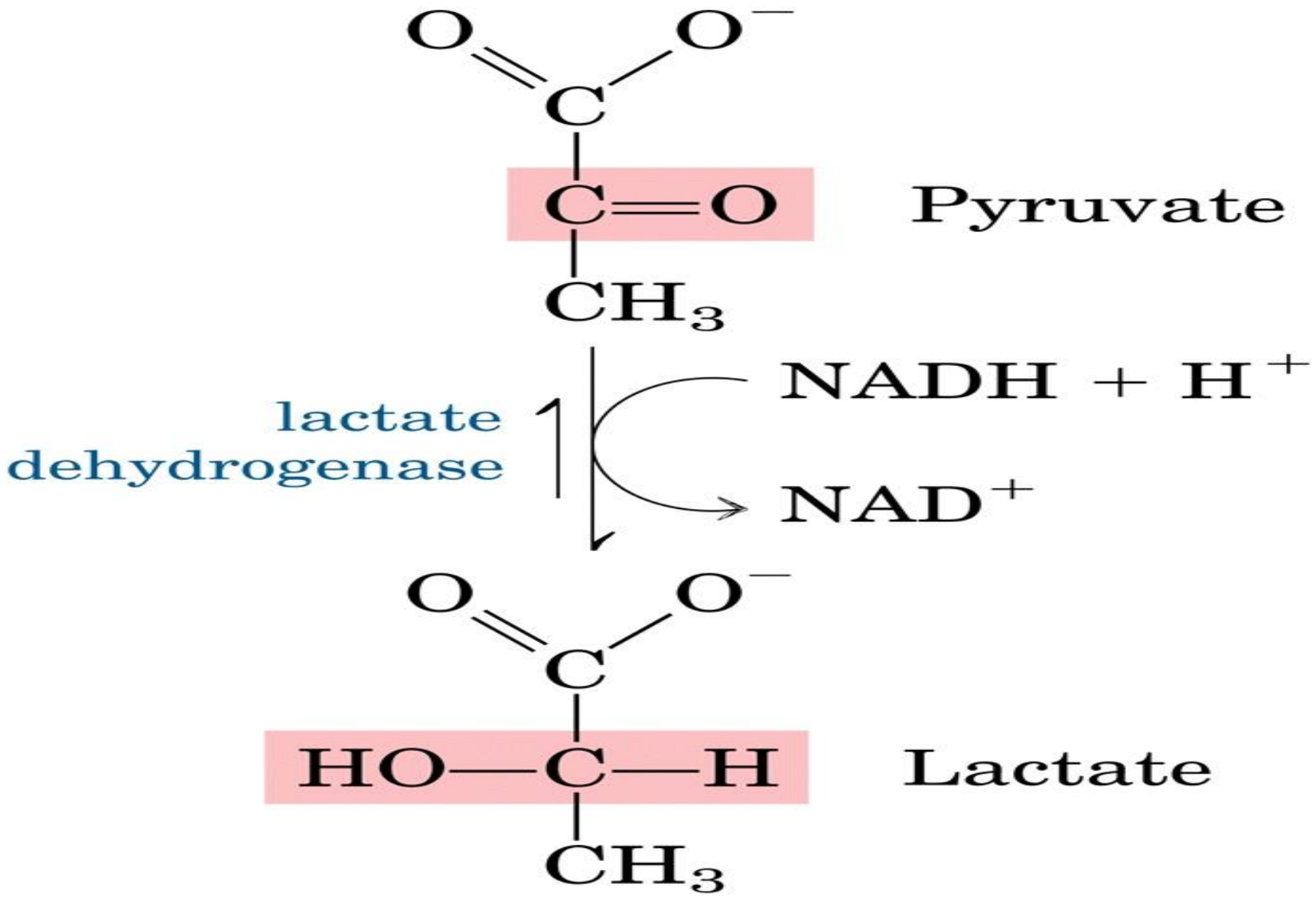
Enzymes be systematically classified according to the general type of reaction they catalyze → into seven major classes.

1. Oxidoreductases

catalyze oxidation-reduction reactions (remove of electrons, H+ from a substrate or addition of O2 into a substrate).

(for example : (lactate dehydrogenase LDH).

1. Oxidoreductases



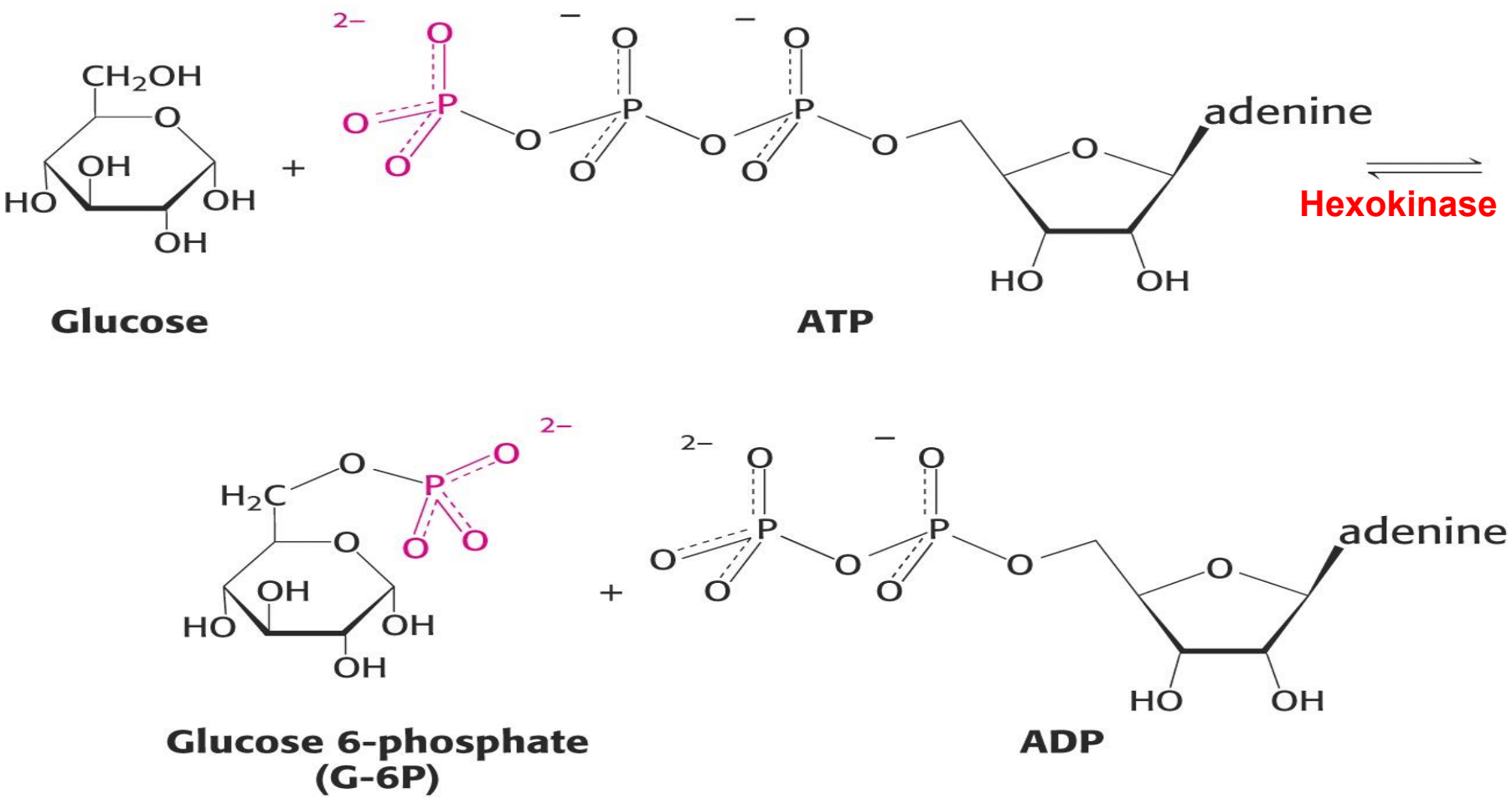
2. Transferases

- These enzymes transfer functional groups between donors and acceptors

" e.g. Glucokinase

Glucose + ATP ⟶ Glucose 6-phosphate

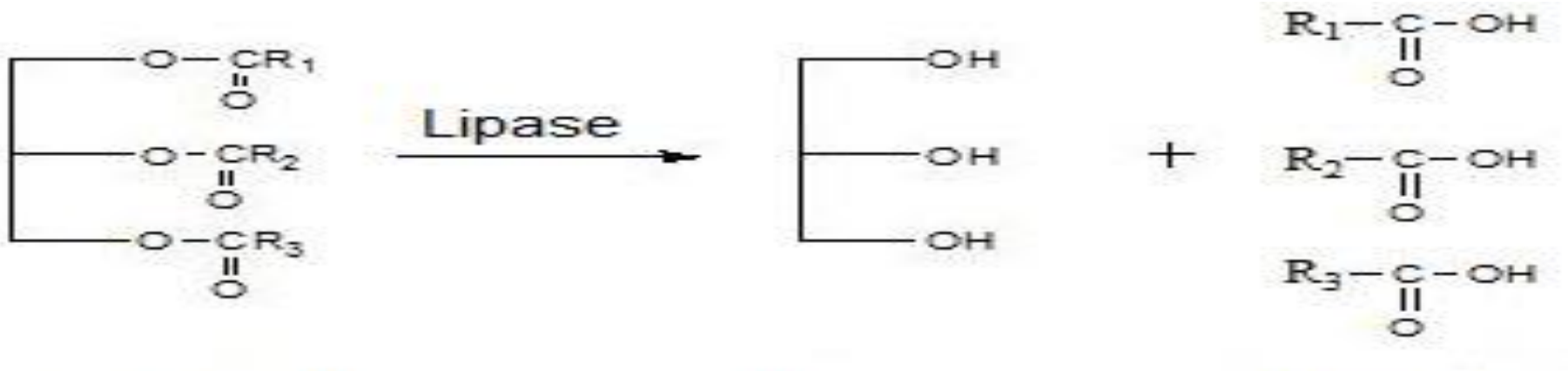
2. Transferases



3. Hydrolases

These enzymes catalyze the hydrolytic cleavage bonds of compounds by addition of water .

Examples: Lipase (All digestive enzymes are hydrolases).



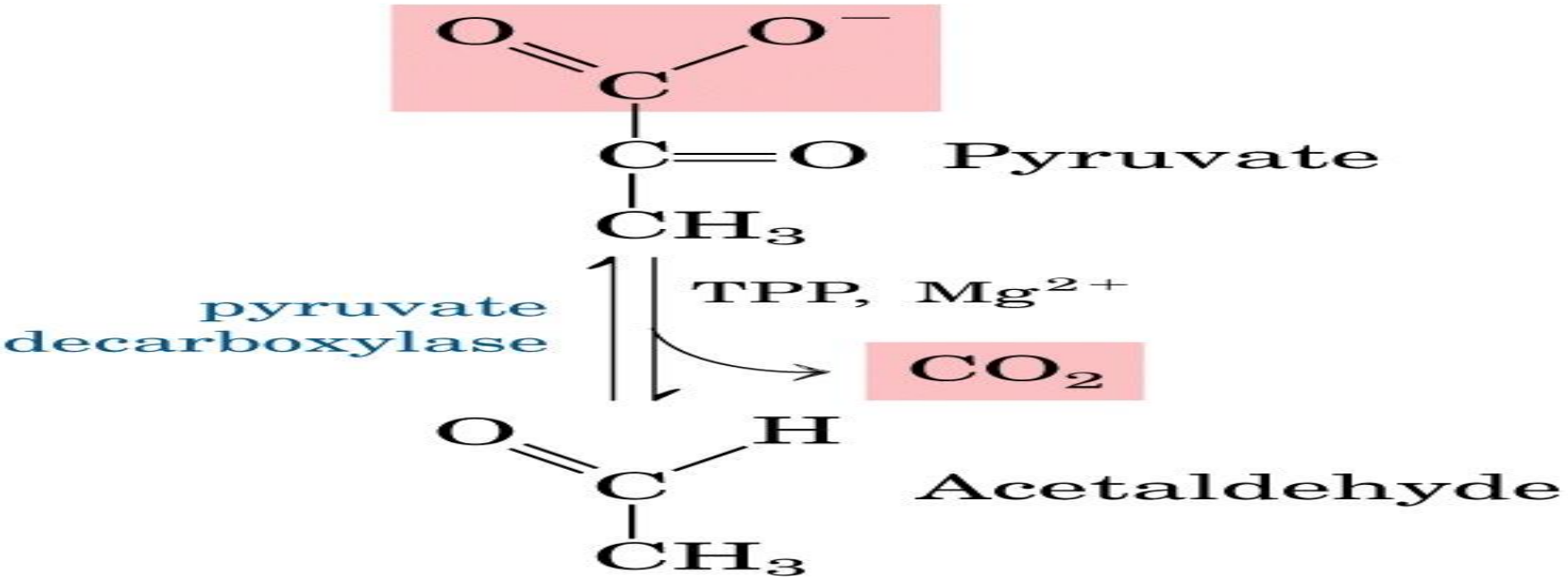
Hydrolysis of triglycerides

4. Lyases (synthases)

Lyases add or remove the small molecule (H2O , NH3 or CO2) to/from substrate molecule (nonhydrolytic cleavage).

Pyruvate Decarboxylases remove CO2 from pyruvate

Cleavage of C-C, C-O , C- N bonds by eliminating atom

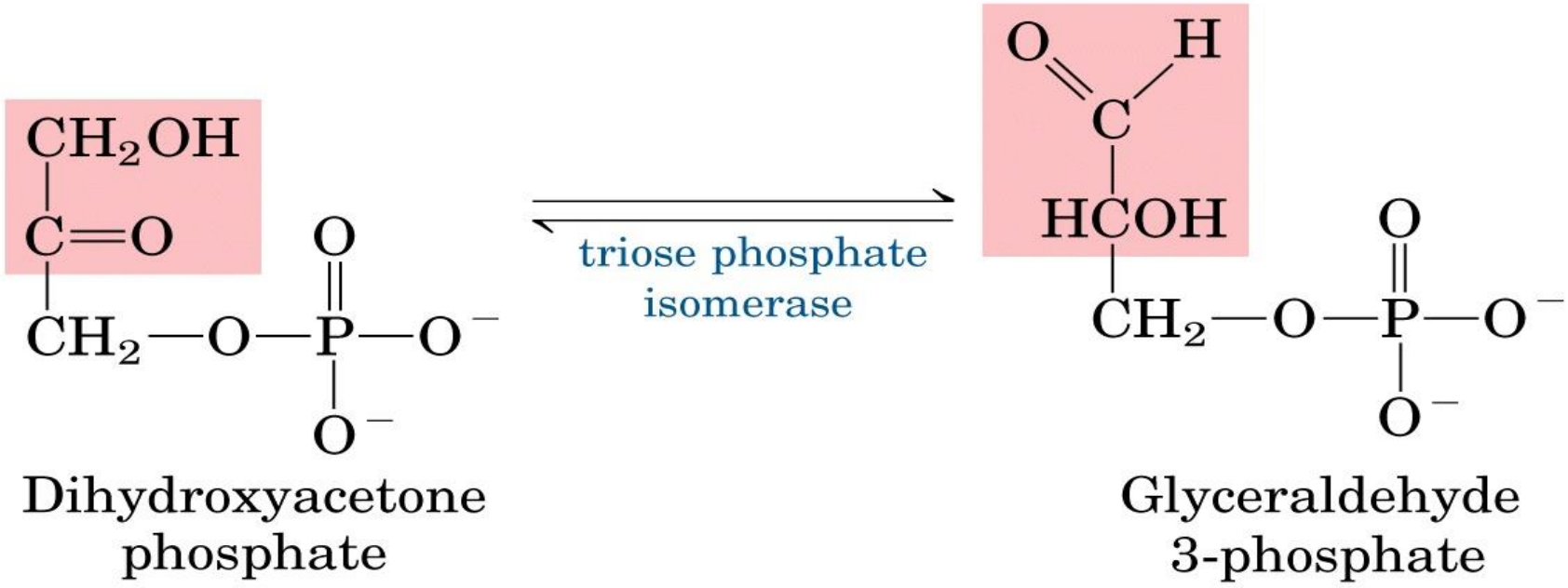


5. Isomerases

These enzymes catalyze several types of

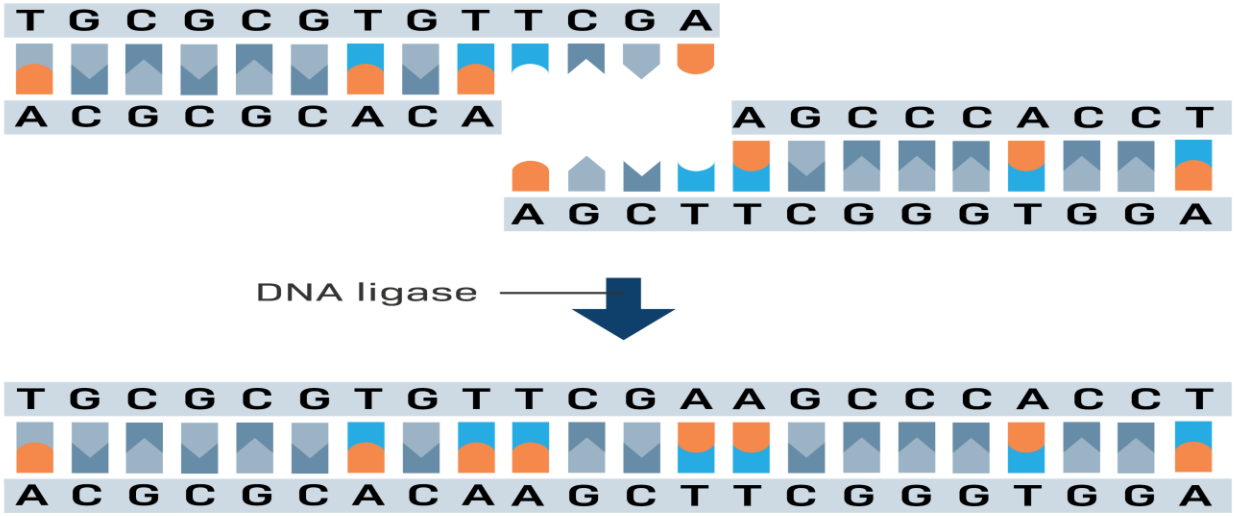
Isomerizations reactions.

These include aldose-ketose interconversions



6.Ligases (synthetases)

These enzymes catalyze synthetic(join) reactions where two molecules are joined to form one molecule and this synthesis requires energy from "high-energy“ phosphate bond of ATP. E.g. DNA ligase.

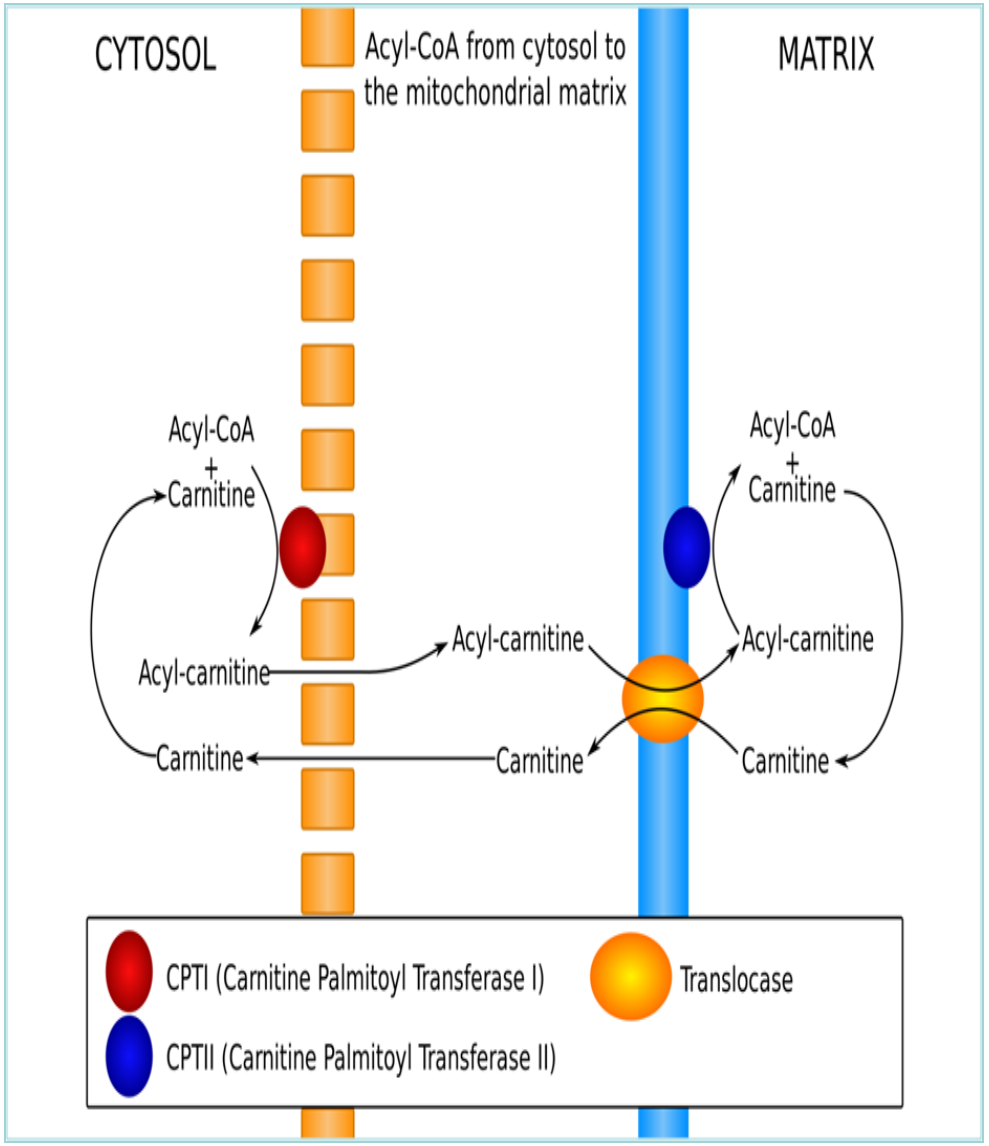


7. Translocase (Added in 2018)

Enzyme that catalyze movement of ions & molecules across membrane.

Examples:

Carnitine acyl Translocase



Systemic naming of enzymes:

3. In 1961 International Union of Biochemistry and molecular biology(IUBMB).

All enzymes are entered in the „Enzyme Commission“ under a four-digit number = EC number.

The first digit indicates membership of one of the 7 major classes. The next two indicate subclasses and sub-subclasses.The last digit indicates where enzyme belongs in the sub-subclass.

Systemic Naming of enzymes:

For example, E.C. 2.7.1.1.”

Enzyme Nomenclature

E.C 2.7.1.1

2 denotes class name (transferase)

7 subclass (phosphotransferase)

1 a phosphotransferase with a hydroxyl group as acceptor;

1 D-glucose as the phosphoryl group acceptor.

Factors Affecting enzymes activity:

1. Temperature.
2. pH.
3. Substrate Concentration {S}.
4. Enzyme Concentration {E}.

1.Temperature:

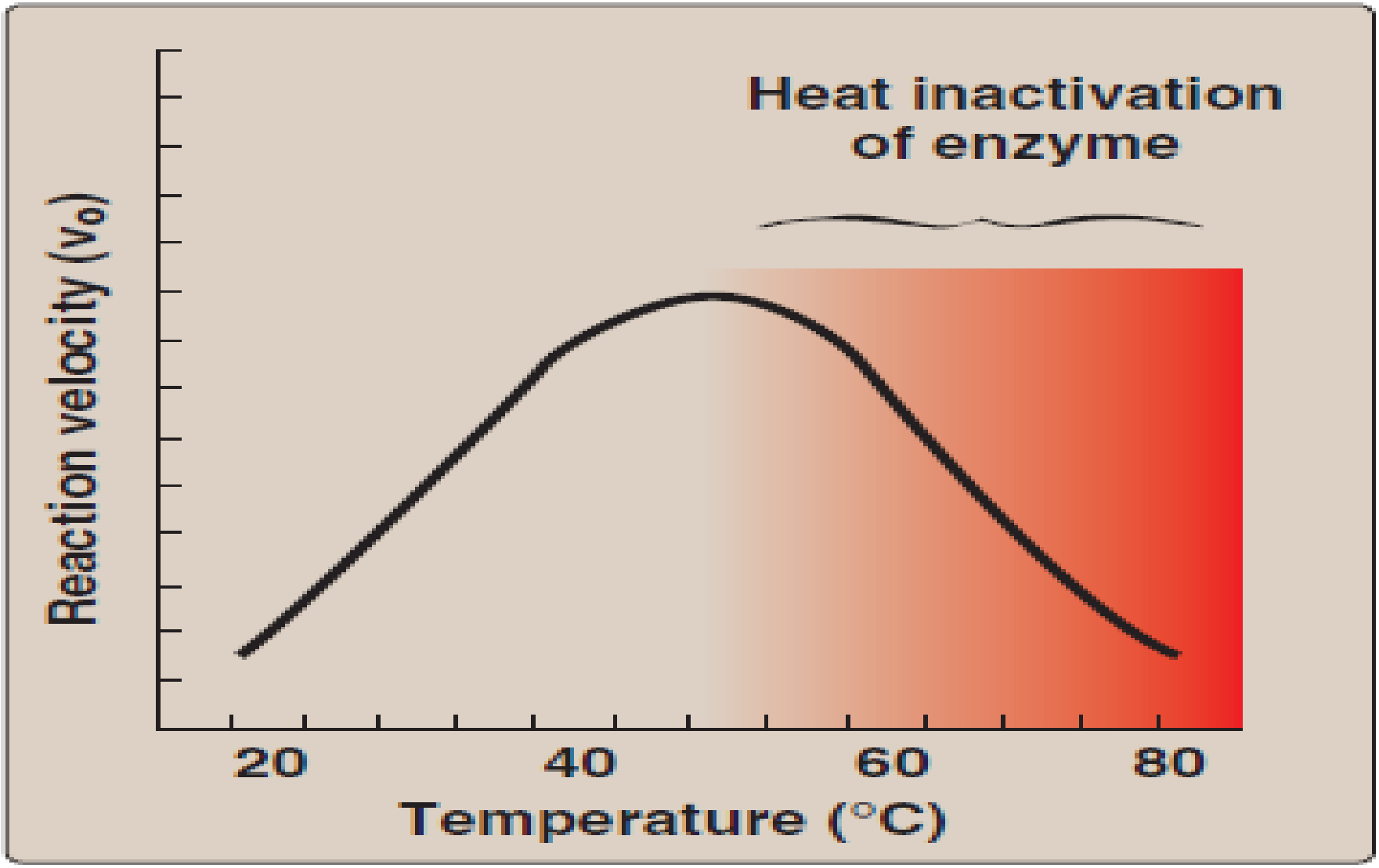
- The reaction velocity increase with temperature , this increase is due to the increase number of molecules having sufficient energy to pass over the energy barrier(activation energy), and formed the products of reactions .
- Phase 1 :- Raising the temp by 10°C doubles the rate up to the optimum temp .

1. Temperature:

Phase 2 :-

as temp. raised above optimum temp , denaturation of enzyme occur (why) , because enzymes are protein in nature and will be converted from tertiary structure to primary structure , due to breaking of hydrogen bonds and another bonds.

1. Temperature:



Source: Lippincott's Biochemistry 5th Edition

1. Temperature:

- The optimum temperature for most human enzymes is between 35 and 40°C.



- Enzymes from thermophilic bacteria found in hot springs, may still be active at 100 °c.

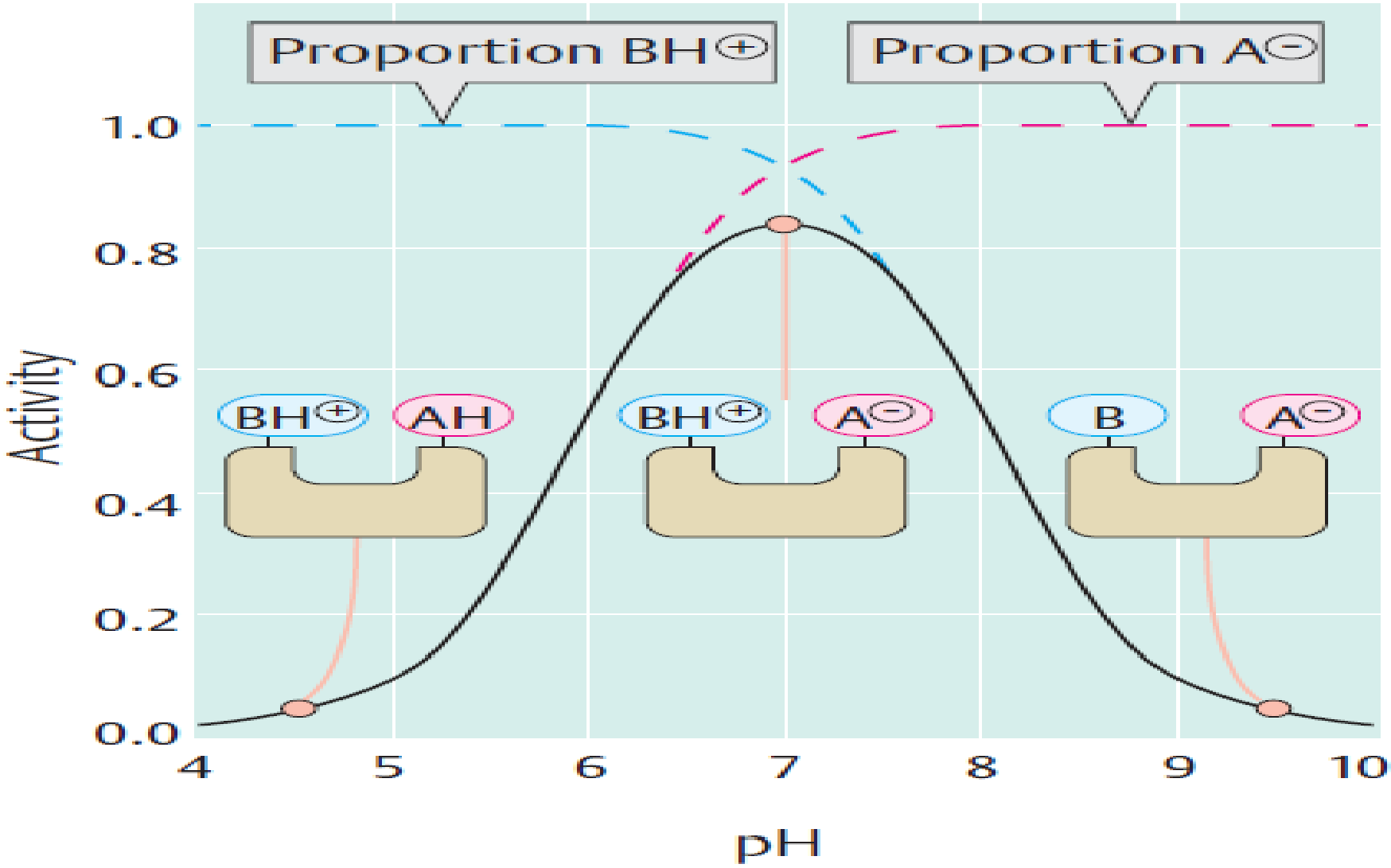


(e.g. Tag polymerase enzyme)

2. pH:

- Enzyme and substrate have specific chemical groups in either an ionized or un-ionized state in order to interact. For example, catalytic activity may require that an amino group of the enzyme be in the protonated form ($–NH3^{+}$). At alkaline pH, this group is deprotonated, and the rate of the reaction, declines.

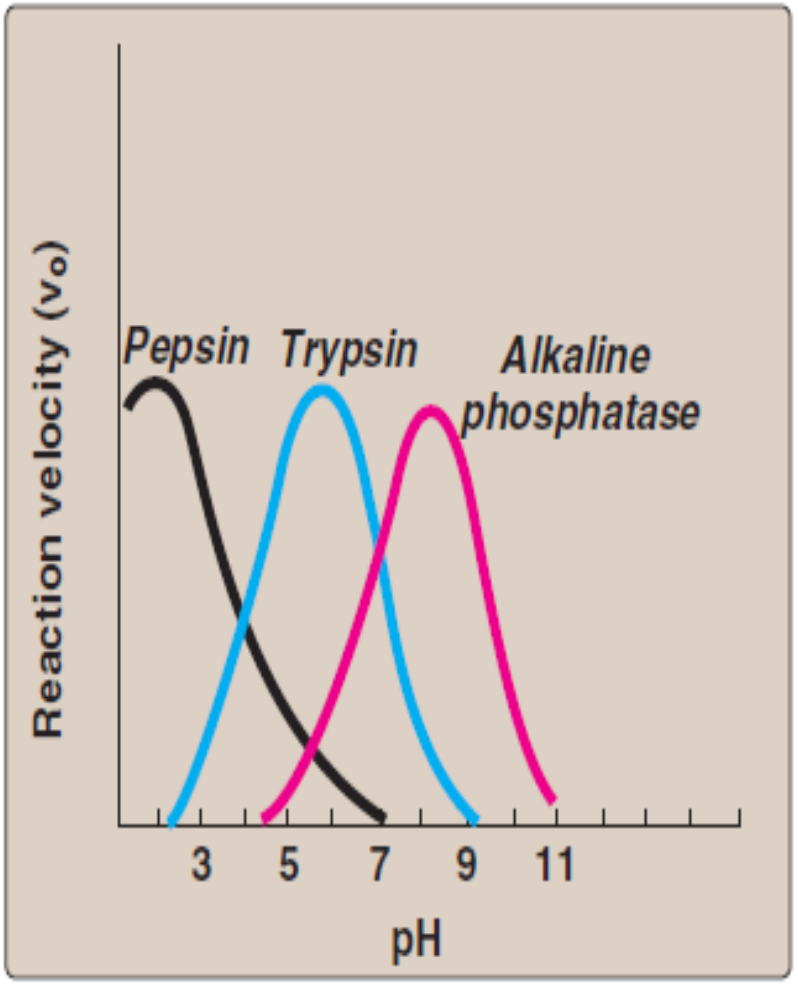
2: pH



Source: Color Atlas Of Biochemistry 2d ed

2: pH The optimum pH varies for different enzymes.

- The optimum pH : The pH at which maximal enzyme activity is achieved.
- Extremes of pH can also lead to enzyme denaturation.



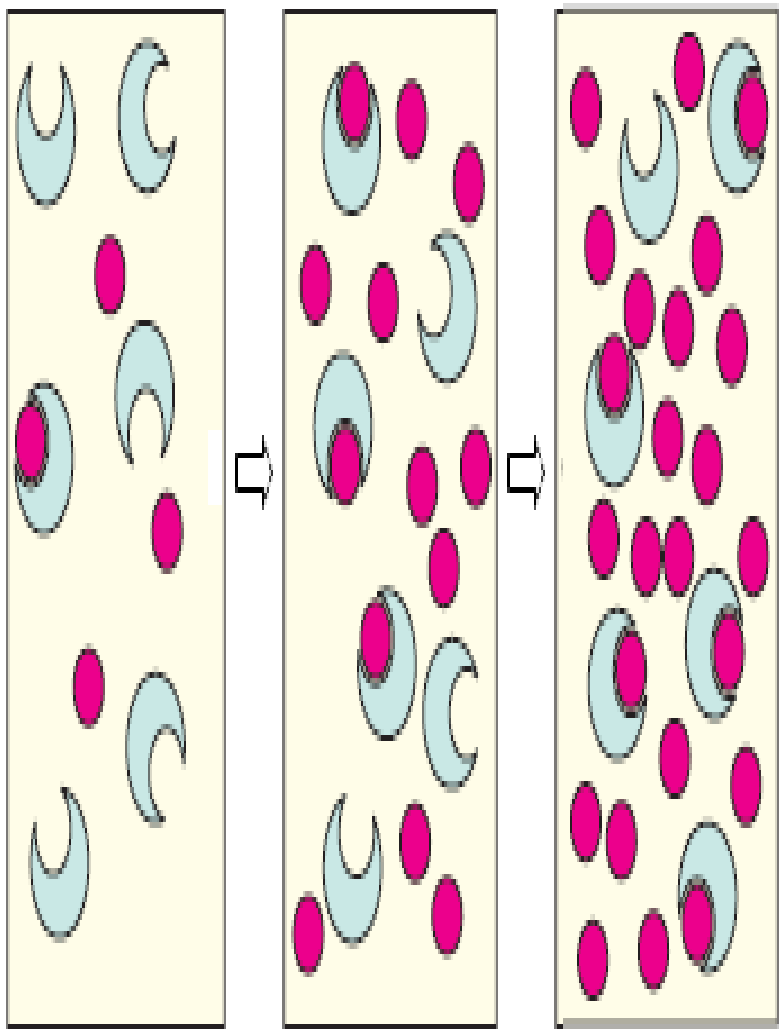
Source: Lippincott's Biochemistry 5th Edition

3. Substrate concentration:

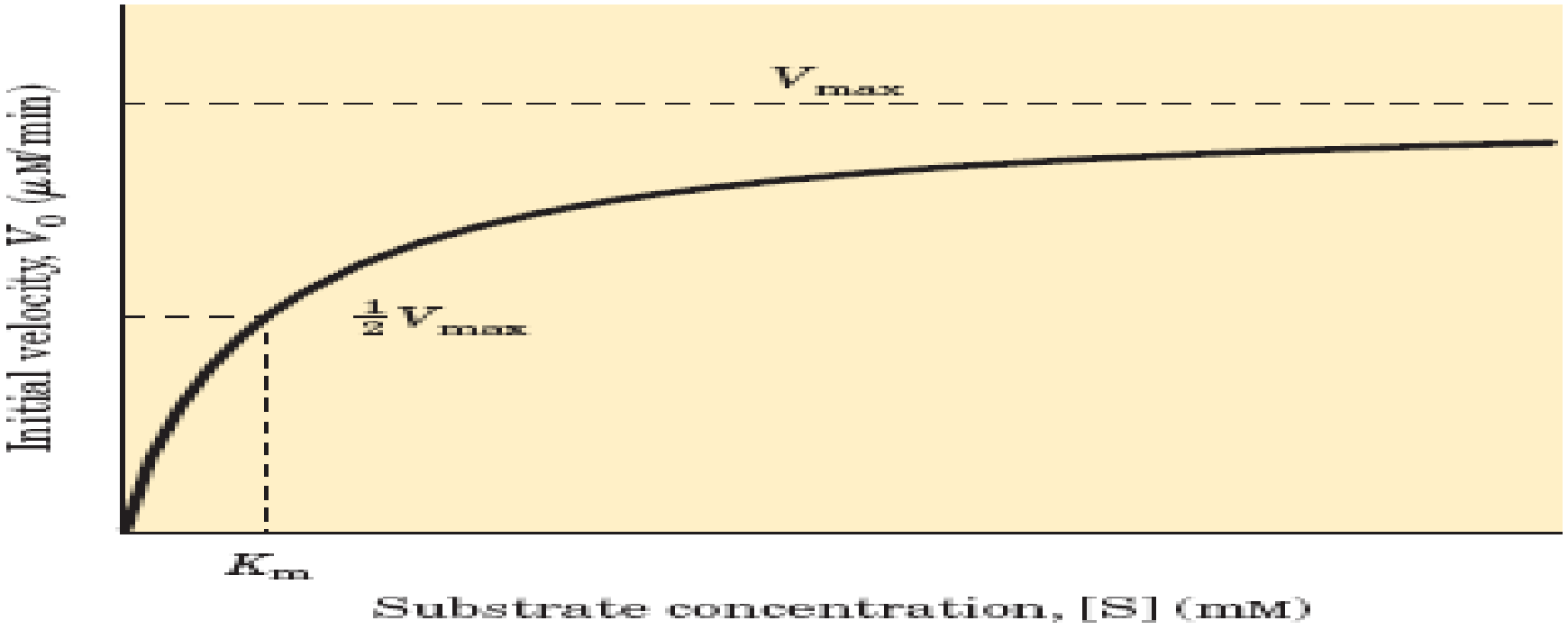
- The rate or velocity of a reaction (v) is the number of substrate molecules converted to product per unit time.
- Velocity is usually expressed as µmol of product formed per minute.
- At high substrate concentrations all available binding sites on the enzyme are saturated . So there is will be no increase in velocity of reaction with the increase in substrate concentration.

3: Substrate Concentration

- The rate of an enzyme-catalyzed reaction increases with substrate concentration until a **maximal velocity (Vmax)** is reached.
- All/Most available binding sites on the enzyme molecules present are being **saturated** with substrates.



Substrate concentration



V_0 : Initial velocity of a reaction

V_{max} : Maximum velocity of a reaction

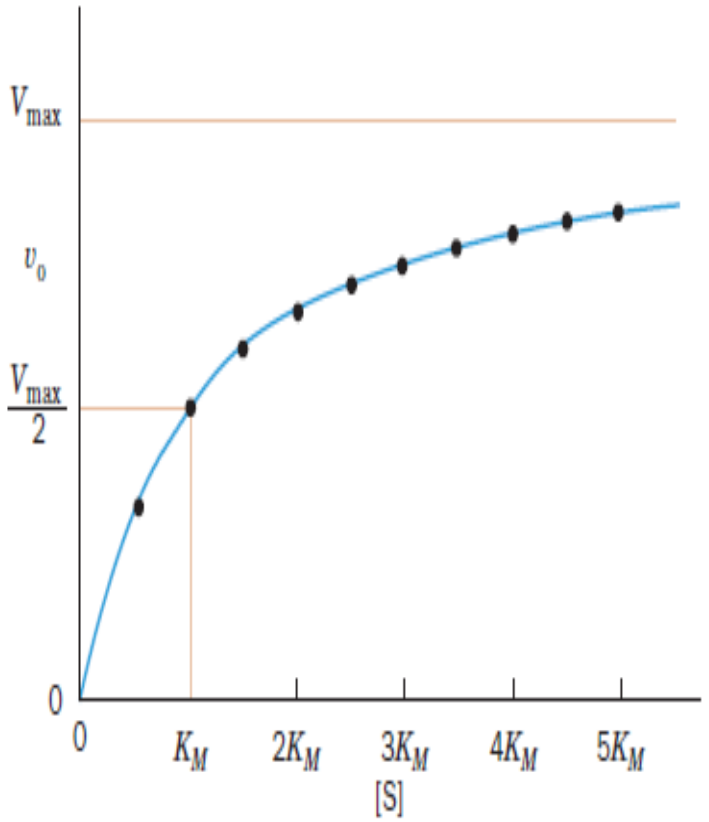
Km : Substrate concentration at Vmax 1/2

3: Substrate Concentration

Km (Michaelis constant):

Reflects the affinity of enzyme for substrate.

Km (numerically) is the [substrate concentration] at which the reaction velocity is equal to ½Vmax.

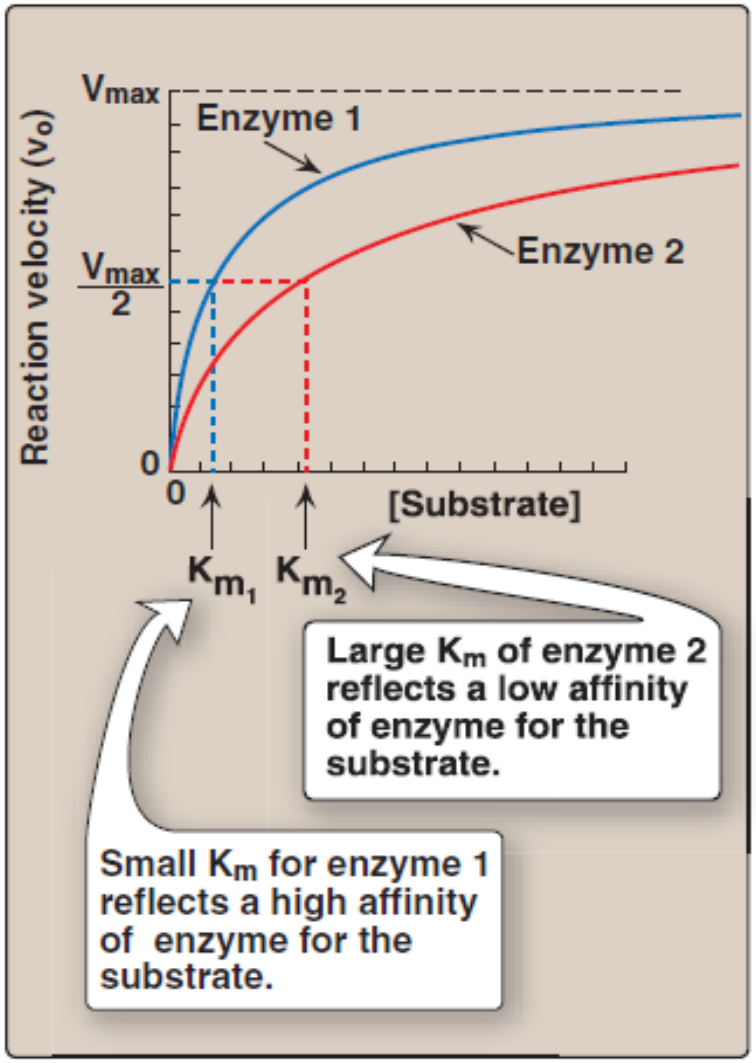


Source: Biochemistry - Voet and Voet 4th edition

Importance of the Km

Km (Michaelis constant):

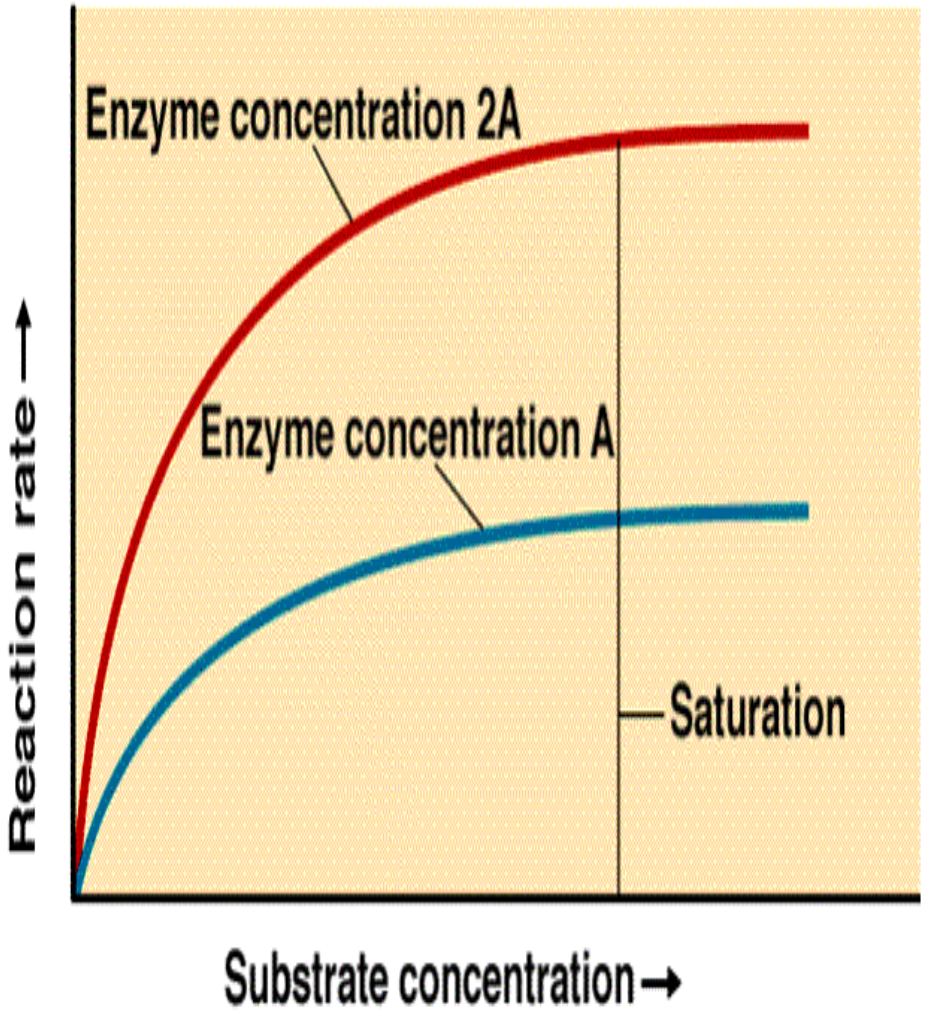
- **Small Km:**
  - **High affinity of the enzyme for substrate (low concentration of substrate is needed to half-saturate the enzyme.**
- **Large Km:**
  - **Low affinity of enzyme for substrate (high concentration of substrate is needed to half-saturate the enzyme).**



Source: Lippincott's Biochemistry 5th Edition

4: Enzyme Concentration

- **The rate of the reaction is directly proportional to the enzyme concentration at all substrate concentrations.**



Source: Luciano Human Physiology 7th edition

References:

1-lipincotts biochemistry 8th edition 2022

2. Harpers 25th , 27th and 32nd edition 2023

3- Lehninger principles biochemistry 8th edition 2021

4- Medical biochemistry 6th edition 2023

5- Mark Basic Medical biochemistry 6th edition 2023

6- Stryer biochemistry.


Thank You