Enzyme

- Enzyme are biological catalysts that speed up the rate of the biochemical reaction.
- Most of the enzyme are protein in nature.

→ Properties of Enzymes

- Biological catalyst
- Speeds up rate of reaction
- Enzymes are protein
- Enzymes are specific to a substrate of reaction
- Enzymes are reversible & can catalyzed a reaction going both ways.
- Enzymes are denatured by change in temperature or pH.

→ Nomenclature of Enzyme

i) Enzyme acted on the substrate.

- The molecules upon which enzyme acts is known as substrate.

- then naming the enzyme by adding the suffix - ase in the name of substrate.

suffix

eg ⇒ Substrate — -ase

Maltose → Maltase

lactose → lactase

Lipid → Lipase

i) we add -ase in suffix at the name of process

suffix

eg ⇒ Process — -ase

DNA polymerization → DNA polymerase

→ International union of Biochemistry (IUB)

- IUB established in 1955.
- They formed 'Enzyme commission'

→ During future enzymes, how we will gave names & classify it.

→ classification of enzymes (six types/divided)

1) → Oxidoreductases
   - those enzymes involved in oxidat^n-Reduct^n
   eg ⇒ Glucose-6-Phosphate dehydrogenase
2) → Transferases
   - Group enzymes involved in group transfer
   eg ⇒ Hexokinase, Transketolase
3) → Hydrolyses → involved in hydrolysis
   eg ⇒ Maltase, lactase.
4) → Lyases → involve in the process of addn or removal of group from the substrate
   eg ⇒ Aldolase, fumerase
5) → Isomerases → enzymes involved to interconversion of isomer.
   eg ⇒ phosphotriose Psomerase.
6) → Ligases → enzyme involved in joining of two molecules using ATP.
   eg ⇒ DNA ligase, succinate thiokinase.

Enzyme kinetics :

- Enzyme kinetics is the study of the chemical reactions that are catalysed by enzyme.
- The target molecules means substrate binds to enzyme active site & transformed into product through a series of step known as enzymatic mechanism.

→ Factors affecting rate of reaction :

i) The collision or kinetic theory :

- collision theory states that the two molecules approaches within a bond forming distance of one another for reaction. So, the molecules need to sufficient kinetic energy to remove the barrier towards each other & form the product by reaching transition state.

↓

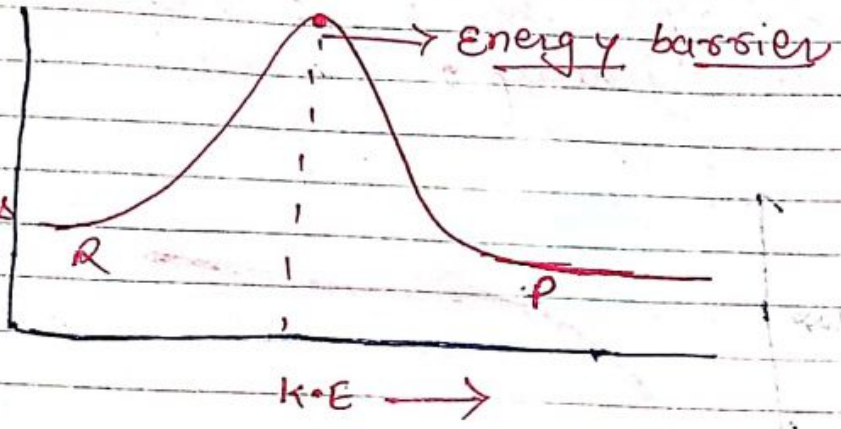
[old bond break new bond form]

eg⇒ $AB + C \rightleftharpoons [A\cdots B\cdots C] \rightarrow A\text{-}C + B$

ii) Activation Energy :

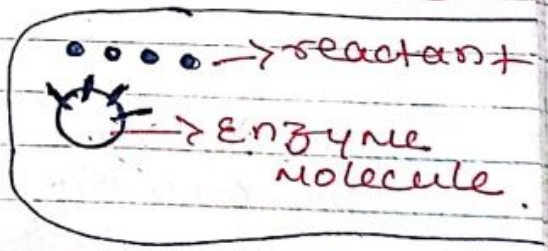
- The energy require to activate or remove the energy barrier b/w between the substrate to reach at transition state is known as Activation energy.

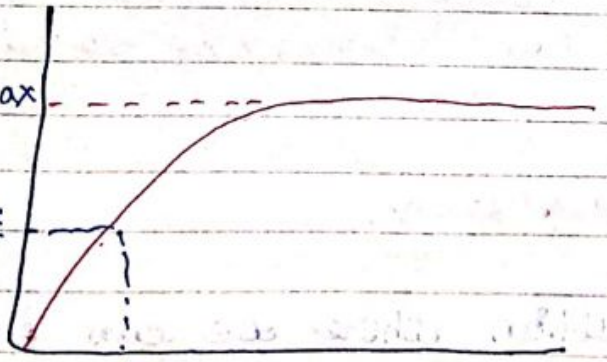
• In a reaction there is an optimum number of atoms that collide colloids to form the product & the energy of this optimum ation is known as activation energy.



→ conc. of the substrate affect enzyme activity :

• The conc. of substrate is increase, the substrate molecule combined with active sites of enzyme molecule & no more active sites available, On this stage it reaches to no further inc. in the rate of reaction

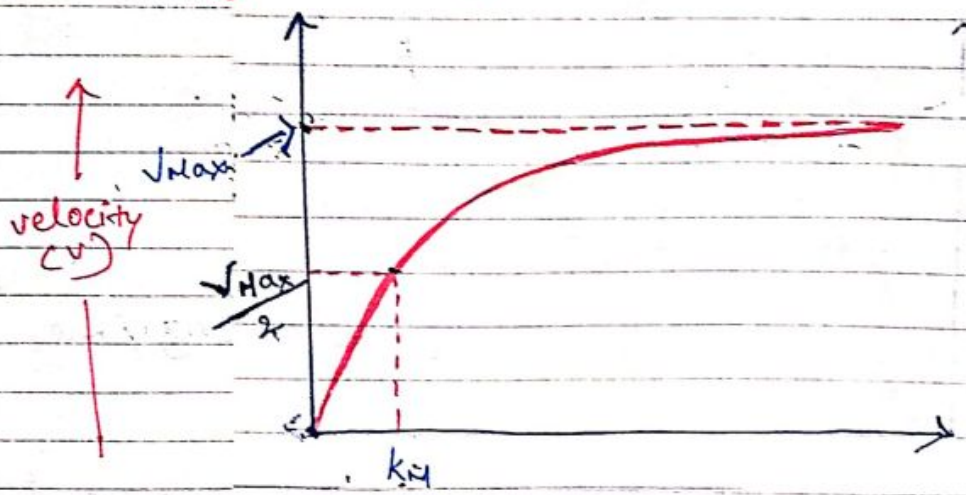




ENZYME KINETICS

Michaelis – Menten Equation :

- Michaelis – Menten eqn gives the Mathematical relationship between initial velocity reaction (V_i) & substrate conc. [S] shown graphically,



The equation $V_i = \frac{V_{MAX}[S]}{K_M + [S]}$

K_M ⇒ Michaeli's const. it is the substrate constant when velocity of rxn is half of maximum velocity.

V_{MAX} ⇒ Maximum velocity.

- There are 3 condition where we can evaluate Michaeli's – Menten equation.

i) when [S] is much less than K_M:

$$V_i = \frac{V_{MAX} \cdot [S]}{K_M + [S]}$$

$$V_i = \frac{V_{MAX} \cdot [S]}{K_M} \quad [\because \text{neglect } [S]]$$

$$V_i = \left(\frac{V_{MAX}}{K_M}\right) \cdot [S]$$

Hence, initial velocity (V_i) $\propto$ [S].
→ substrate.

ii) when substrate is much greater than K_M:

$$V_i = \frac{V_{MAX} \cdot [S]}{[S]} \quad [\because \text{neglect } K_M]$$

$$\boxed{V_i = V_{MAX}}$$

iii) when [S] is equal to K_M.

$$V_i = \frac{V_{MAX} \times [S]}{[S] + [S]}$$

$$V_i = \frac{V_{MAX} \cdot [S]}{2[S]}$$

$$\boxed{V_i = \frac{V_{MAX}}{2}}$$

Lineweaver – Burke plot

- When V_{MAX} is ploted against S in Mechaeli's Menten eqn it is difficult to fix the point of V_{MAX} (Max. velocity)

- This difficulty is overcome by reciprocal of ~~V & [S]~~ V & [S] then plot. The resulting curve is linear & is called Lineweaver–burke plot. Then K_M & V_{MAX} can be easily obtained from the plot.

$$V_i = \frac{V_{MAX} \times [S]}{K_M + [S]}$$ [From Mechaeli's Menten eqn]

$$\frac{1}{V_i} = \frac{K_M + [S]}{V_{MAX} \times [S]}$$ [reciprocal it]

$$\frac{1}{V_i} = \frac{K_M}{V_{MAX} \times [S]} + \frac{[S]}{V_{MAX} \times [S]}$$

$$\frac{1}{V_i} = \frac{K_M}{V_{MAX} \times [S]} + \frac{1}{V_{MAX}}$$

- This is an eqn for straight line

$$y = ax + b$$

$$\boxed{y = \frac{1}{V_i}}, \quad \boxed{x = \frac{1}{[S]}}, \quad \boxed{a = \frac{K_M}{V_{MAX}}}, \quad \boxed{b = \frac{1}{V_{MAX}}}$$

y-axis, x-axis.

- So, $\frac{1}{v_i}$ is plotted as a function of $\frac{1}{[S]}$ gives a straight line whose intercept is $\frac{1}{V_{max}}$ & slope is $\frac{K_M}{V_{max}}$.

- Now in eqn $y = ax + b$

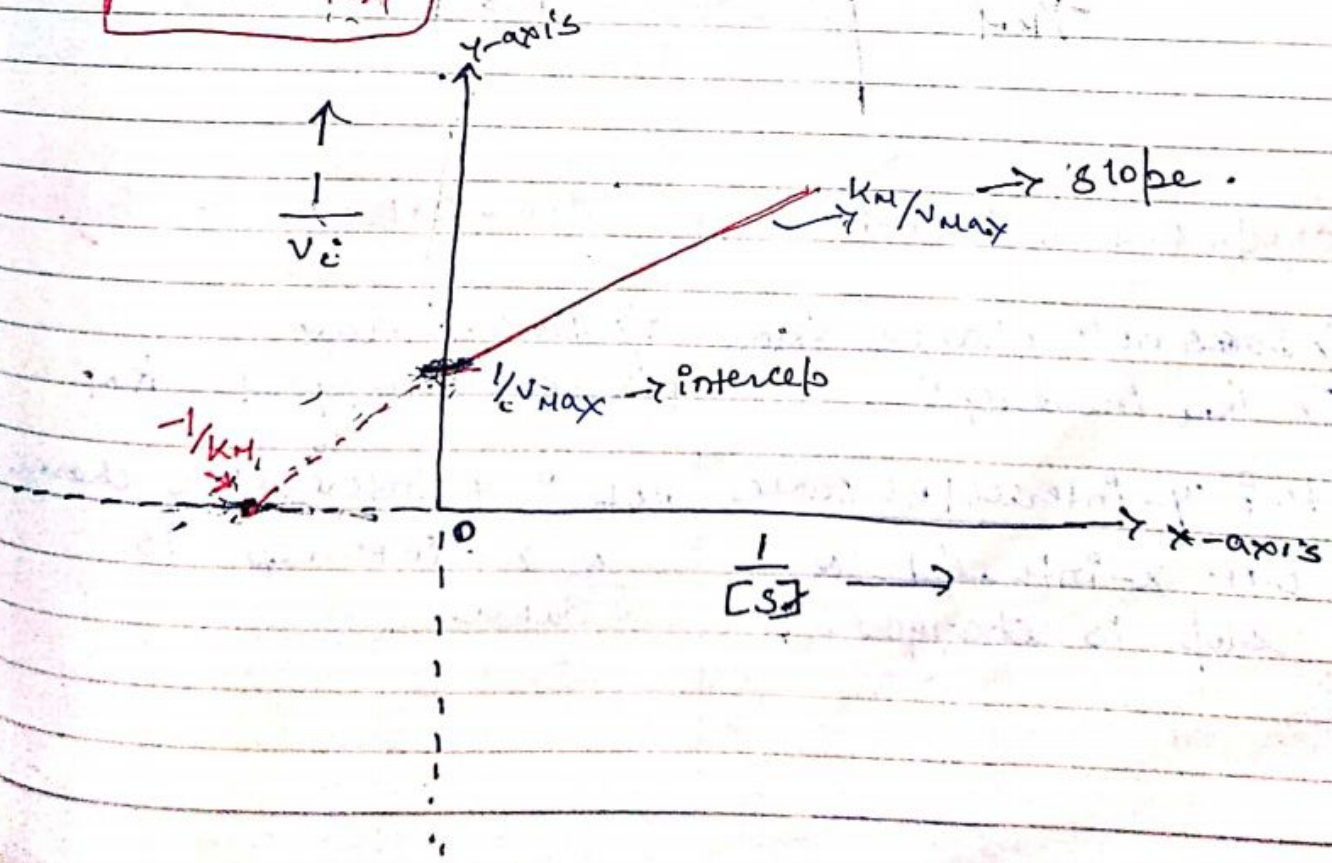
put, $y = 0$

$0 = ax + b$

$-ax = b$.

$x = \frac{-b}{a}$ $\Rightarrow$ $x = \frac{-1}{V_{max}} \times \frac{V_{max}}{K_M}$.

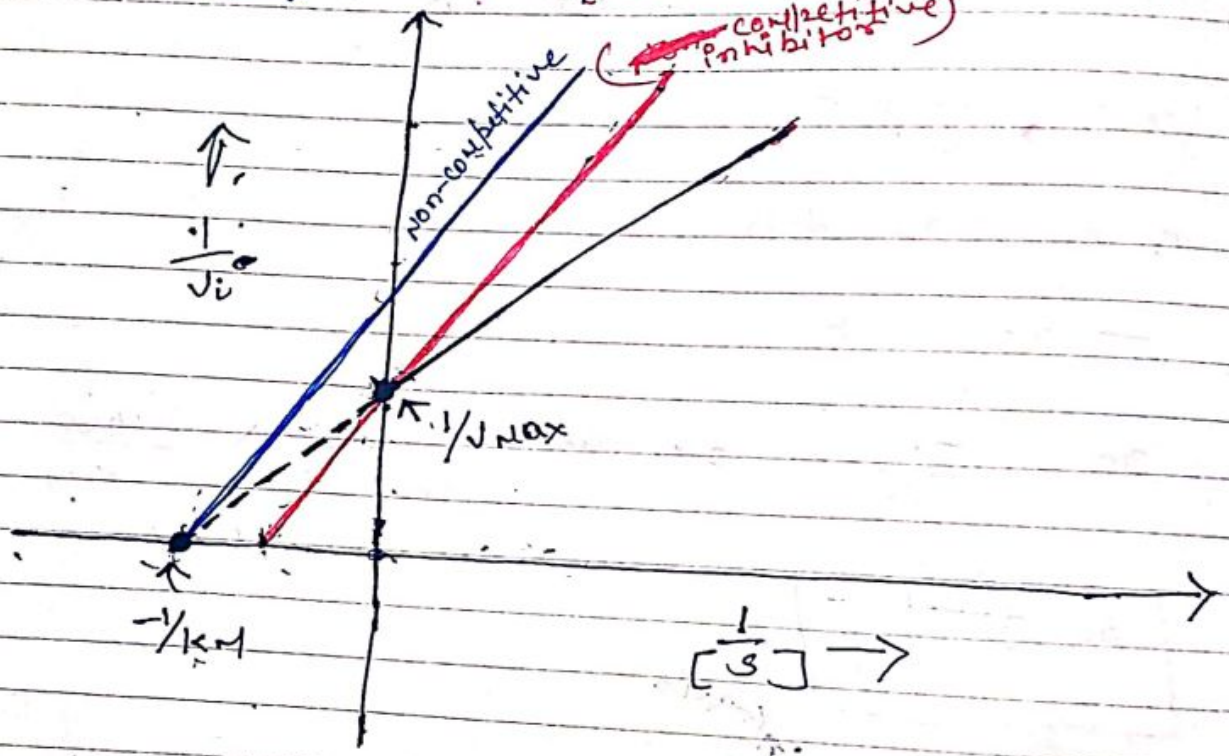
$$x = \frac{-1}{K_M}$$



• The line weaver-burk plot particularly useful for calculating inhibitor.

→ Enzyme inhibition

① → competitive inhibitor
② → Non-competitive inhibitor.



competitive inhibitor	Non-competitive inhibitor
i) Does not change V_{max}	i) Dec. V_{max}.
ii) K_M increases	ii) Doesn't affect K_M
Note: y-intercept is same but x-intercept & slop is changes.	Note: y-intercept is change & x-intercept is same

→ Competitive inhibitor : (irreversible inhibitor)

- In lineweaver burk plot the V_{MAX} (MAX. velocity) doesn't change but the K_M (Michaelis menten const.) is increase.
- The V_{MAX} at y-intercept is same but the K_M at x-intercept is change.

eg :) Di-iso/pro/pyl fluoro/phos/phate inhibits Acetylcholinesterase.

→ Non-competitive inhibitor : (reversible inhibitor)

- In line weaver burk plot the V_{MAX}. is decreases but doesn't change in. K_M.
- The V_{MAX} at y-intercept is change but the K_M at x-intercept is same.

eg :) Monoamine oxidase.