Enzymes (1)

Foundation block….

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Quiz your self

Color index: red=important note
orange=further explanation

What are enzymes ?

Enzymes are biological catalysts that speed up the rate of a reaction without being changed in the reaction

All enzymes are **protein** in nature

But all proteins are **not enzymes**

Substance upon which the enzymes act are called **substrates**

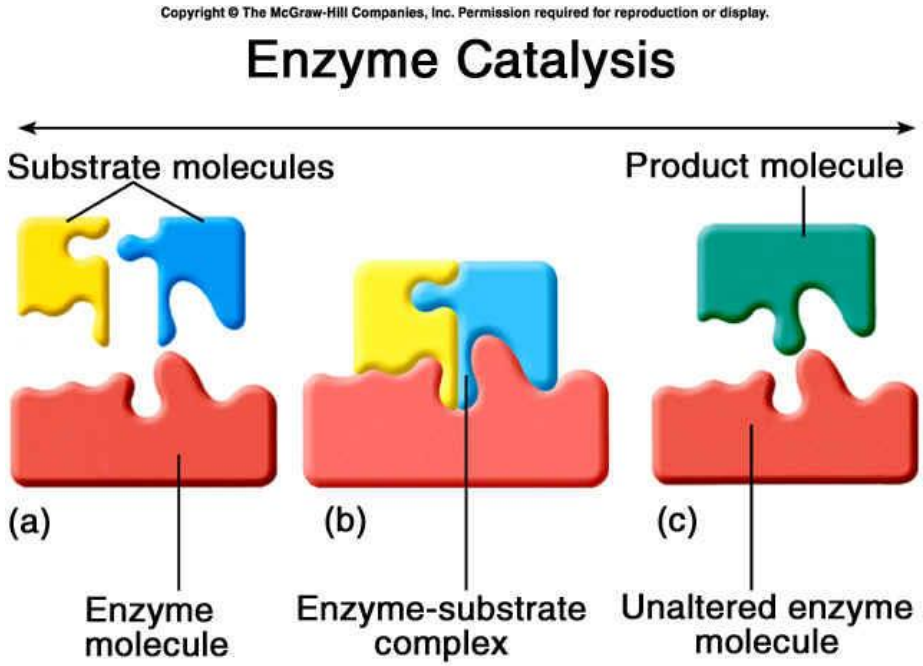
Enzyme converts substrates into **product(s)**

N.B:

Catalysts : increase the speed of the reaction

Some of the enzymes are RNA(riboenzymes)

Enzymes act on Substrate by chemical reaction Gives products

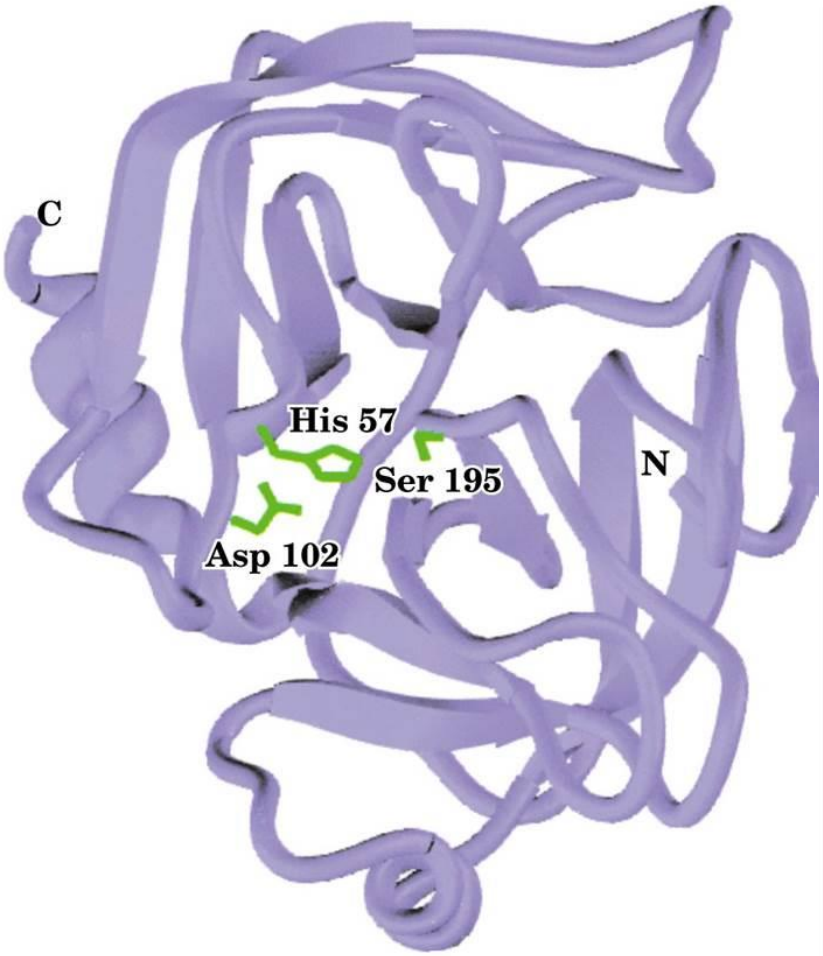


Enzyme substrate complex
it gives two products
the products leave the enzyme
and the enzyme stay as it is .

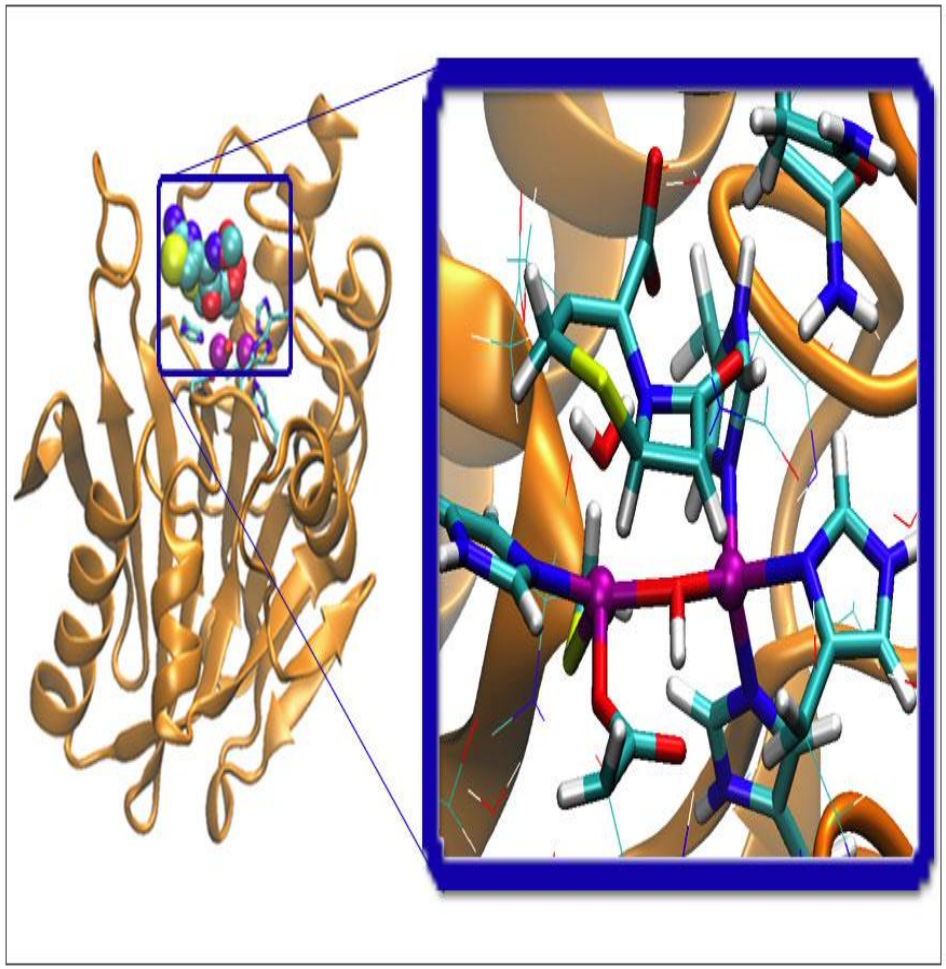
Properties of Enzymes

Active site	Specificity	Regulation
• The region of enzyme that binds with the substrate and where catalysis occurs • All enzymes have one or more active sites • N.B : area where the substrate come and bind to the enzyme	• Enzymes bind to their specific substrates in the active site to convert them to product(s) • Enzyme it very specific in what kind of work will do and what kind of substrate will bind to • Enzymes are highly specific • Interact with only one or a few of the substrates • Catalyze only one type of reaction	• Enzymes can be activated or inhibited so that the rate of product formation responds to the need of the cell • Increase the activity of the enzyme or inhibit

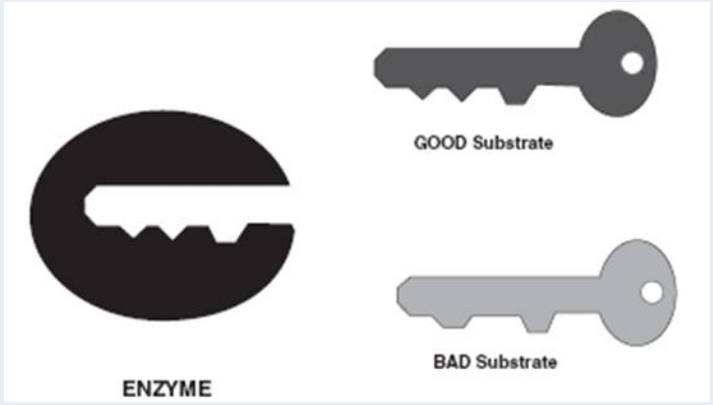
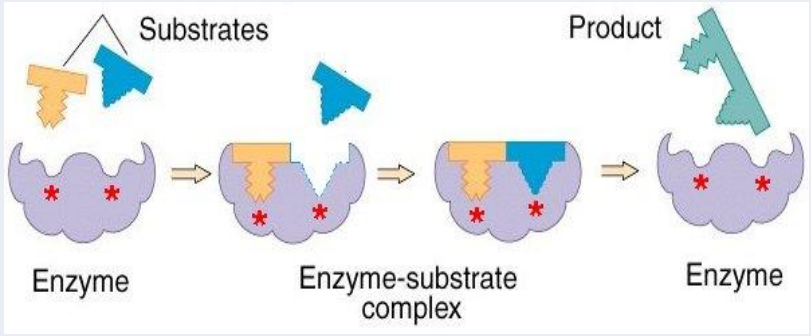
Structure of trypsin enzyme



An enzyme with its active site



»Enzyme-substrate binding "MODLSE

Lock and key binding	Induced fit binding
The substrate is exactly Complementary to active site of the enzyme so the enzyme don't need to change it's shape during reaction .	The substrate is not exactly complementary to active site of the enzyme but it's Similar to active site of the enzyme so the enzyme will be change its shape to fit the substrate during process called **enzyme / substrate complex** at the end of reaction enzyme will back again into original shape and release product
	

Classification of Enzymes

Classified into six types according to the reaction catalyzed

Note : we should know the names of the classification

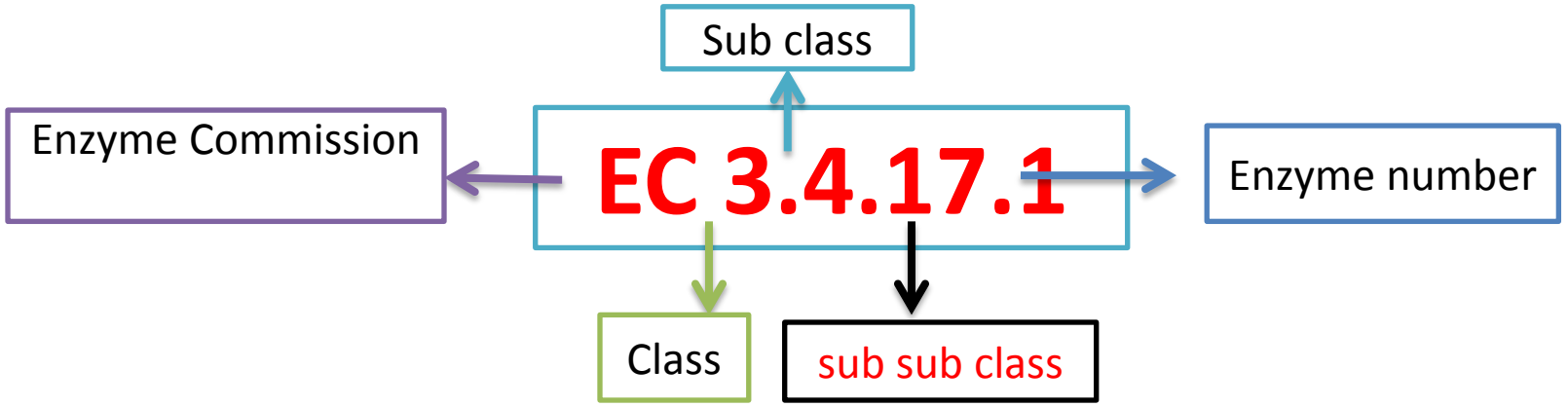
Classification	Type of Reaction Catalyzed
1. Oxidoreductases	Oxidation–reduction reactions
2. Transferases	Transfer of functional groups
3. Hydrolases	Hydrolysis reactions
4. Lyases	Group elimination to form double bonds
5. Isomerases	Isomerization
6. Ligases	Bond formation coupled with ATP hydrolysis

Enzyme nomenclature (Naming)

We can names enzymes by follow role of IUBMB

IUBMB = International Union of Biochemistry and Molecular Biology

Enzyme number :

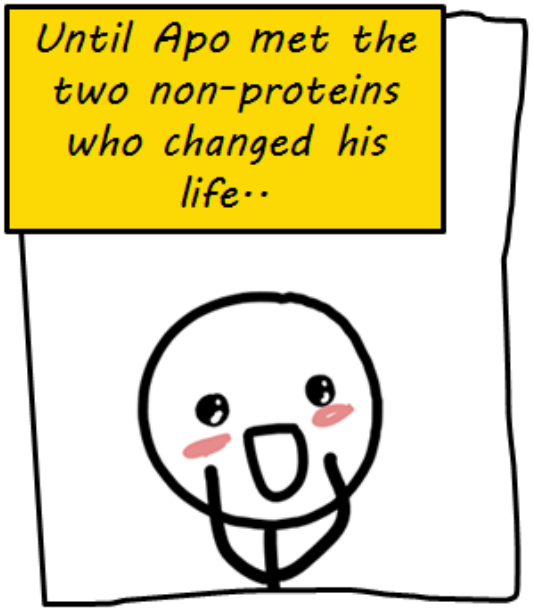


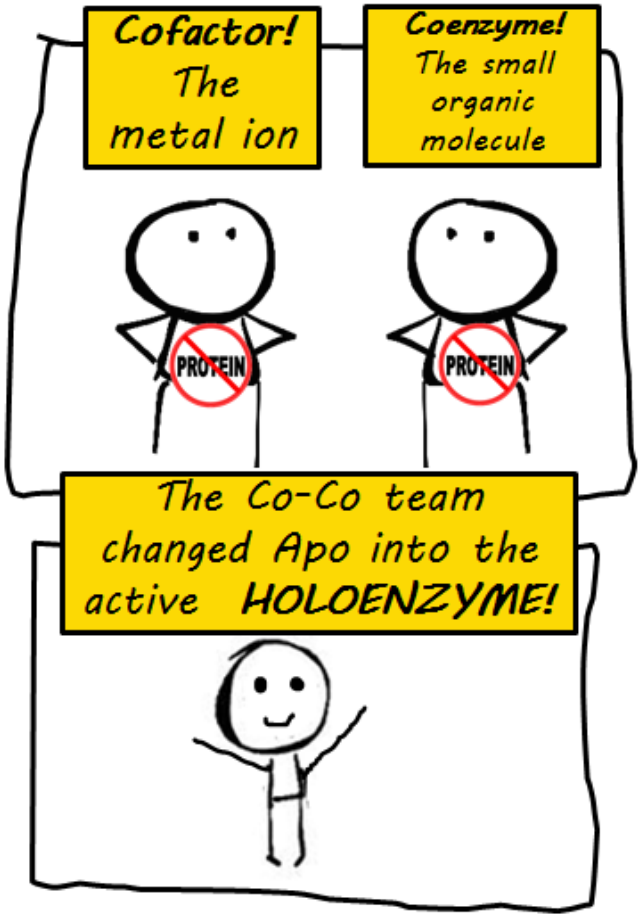
(carboxypeptidase A) common name :

Note : number 3 refers to hydrolase enzyme

The Story of HOLOENZYME

By: Lina Alj.





The coenzyme has two types:

Prosthetic Groups

- **P**ermanently associated with an enzyme
- e.g. FAD

Cosubstrates

- Temporarily associates with an enzyme
- e.g. NAD

RNA

RIBOZYMES

Ribozymes are RNAs with enzyme activity

ISOENZYMES

Isoenzymes are enzymes that catalyze the same chemical reaction but they have slightly different structures

ZYMOGENS

Zymogens are inactive enzyme precursors that require a biochemical change to become active e.g. cleavage of a peptide blocking the active site

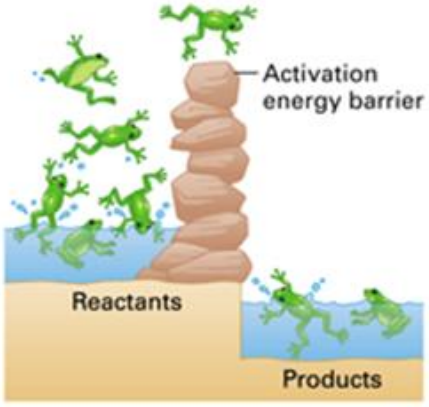
Notice that*: Both **Zymogens and **Holoenzymes** require something to become active, BUT there's a difference between them..

Holoenzymes need non-proteins to become active

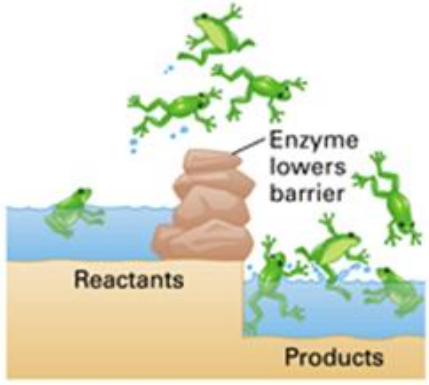
Zymogens require a biochemical change to become active.

- Enzymes decrease activation energy of a reaction
- They provide an alternative transition state of lower energy called the enzyme-substrate complex and thus speeds up the reaction

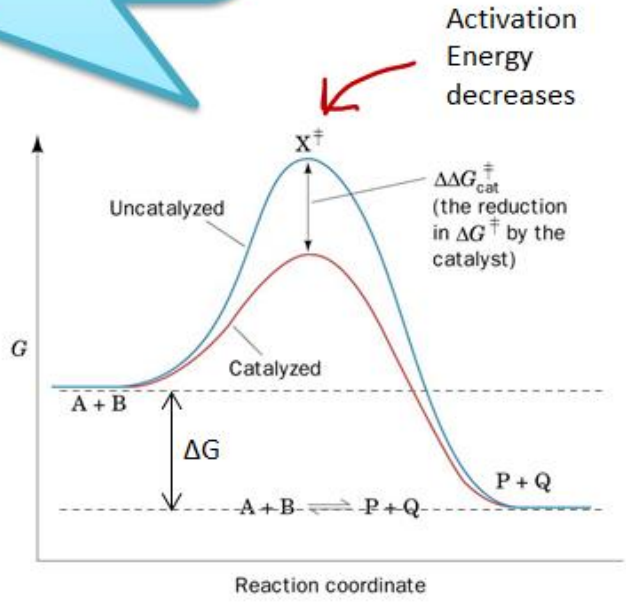
Enzymes decrease the activation energy but they do not alter the change in the free energy (ΔG)



Without enzyme



With enzyme



ENZYME..

..VELOCITY

Enzyme velocity is the rate of a reaction catalyzed by an enzyme
i.e. the speed rate of changing substrates into products

..ACTIVATION

Enzyme activity is expressed as:
mmoles of product formed/min/mg enzyme

Factors that affect enzyme activity:

pH

[E] and [S]

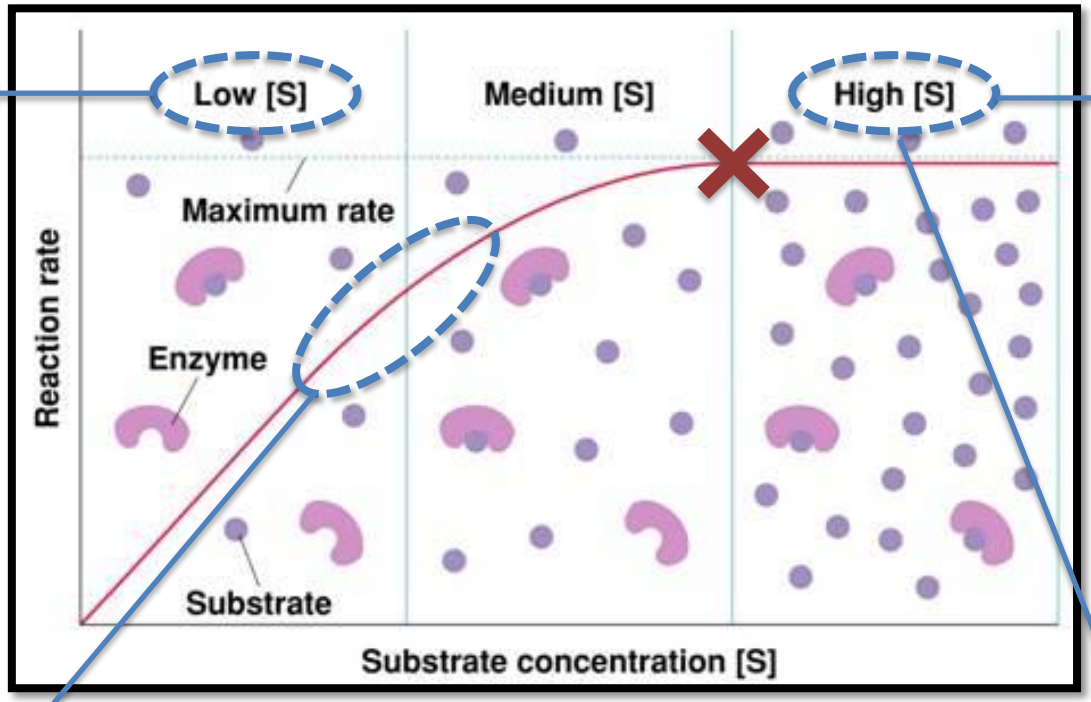
- Rising temperature increases the speed of an enzyme reaction, BUT if the temperature became extremely high it will denature the enzymes which makes them inactive
- Every enzyme has an optimal temp. for catalyzing a reaction
- In humans most enzyme have an optimal temp. of 37oC

- Effect of pH on the ionizable groups in the active site of enzyme or in the substrate affect catalysis
- Every enzyme has an optimal pH for catalyzing a reaction
- Most enzymes have highest activity between pH 6 and pH 8
- Pepsin has highest activity at pH 2

- The reaction velocity increases initially with increasing substrate concentration [S]
- Further addition of substrate has no effect on enzyme velocity (v) if it reached the v-max
- The rate of an enzyme reaction is directly proportional to the conc. of enzyme if the substrate concentration [S] is higher than enzyme

Factors That Effect Enzyme Activity

(effect of enzyme and substrate concentration)



Low substrate concentration:

Reaction rate is proportional to [S]

Further addition of substrate:

No effect on enzyme velocity (point of saturation reached)

↑ [S] = ↑ Reaction velocity

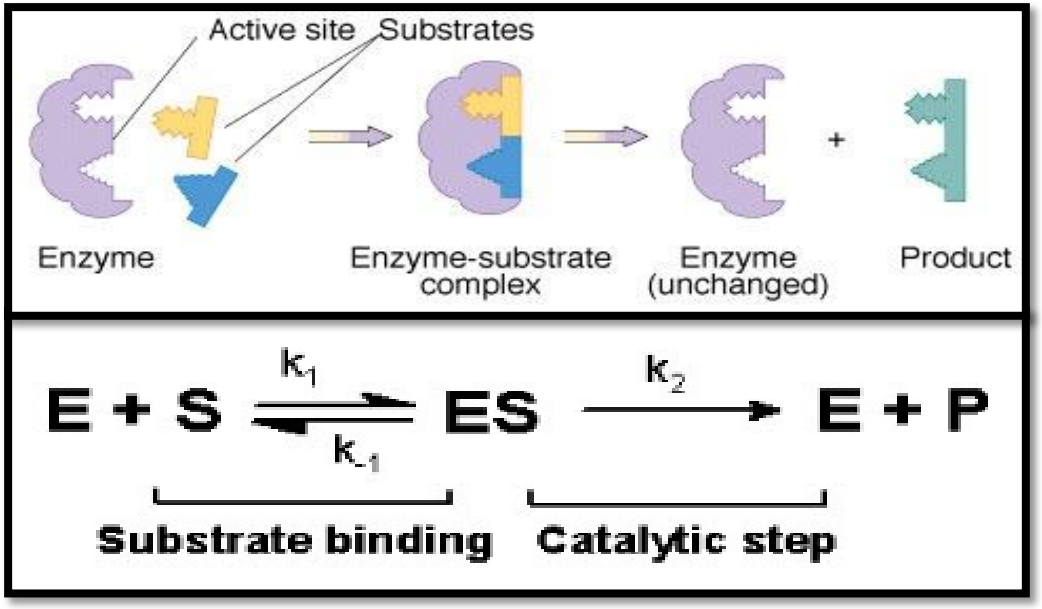
[S] higher than [E]:

Reaction rate is directly proportional to [E]

[E] Enzyme concentration
[S] Substrate concentration
✕ Point of saturation

Enzyme Kinetics

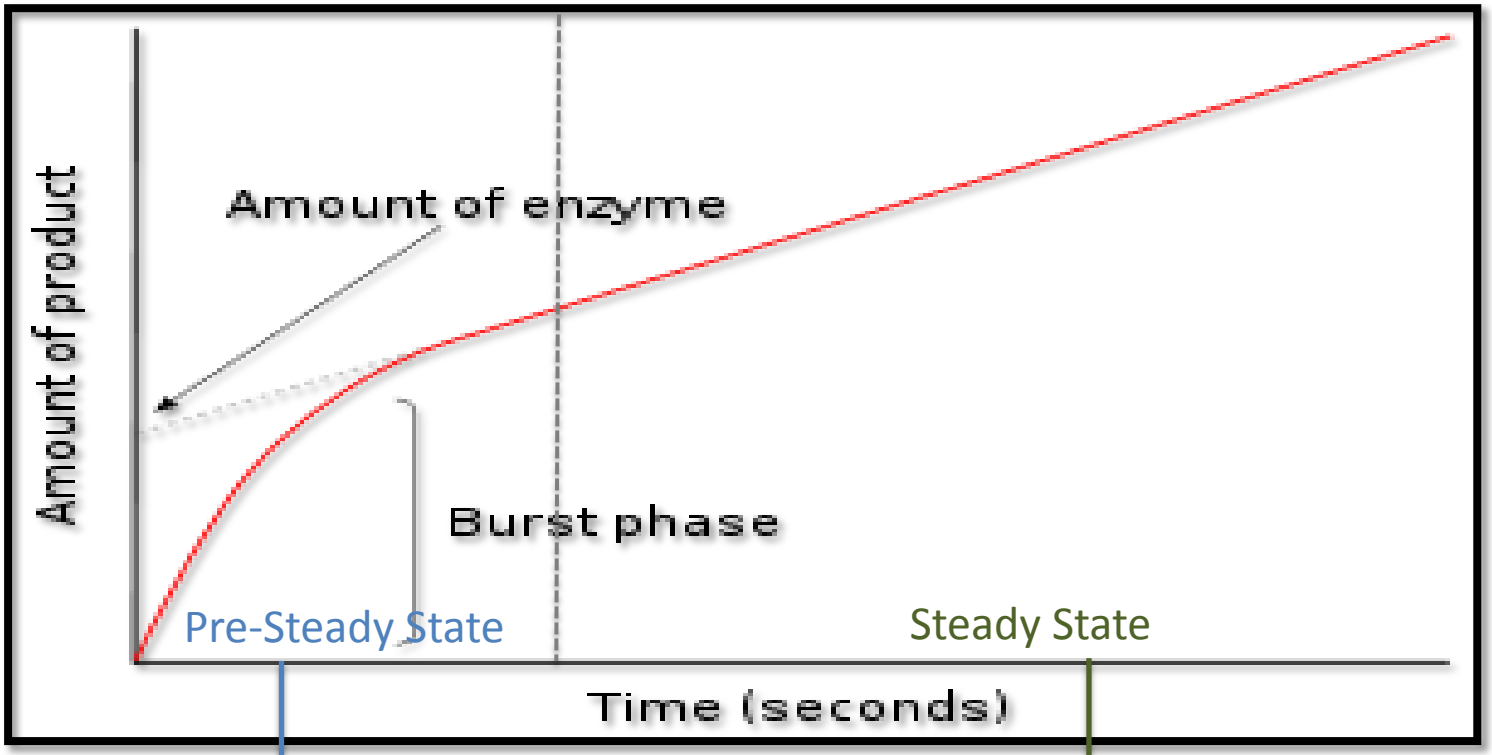
- 1913: Michaelis and Menton first proposed the model of 'Enzyme Kinetics'.
- Briggs and Haldane modified it later.



- The equation describes the relationship of:

Initial rate of enzyme reaction → to → [S]

Initial Rate of Enzyme Reaction



The initial short period of time (hundred microseconds, when enzyme mixes with high concentration of substrate) during which intermediates leading to formation of products start to build up.

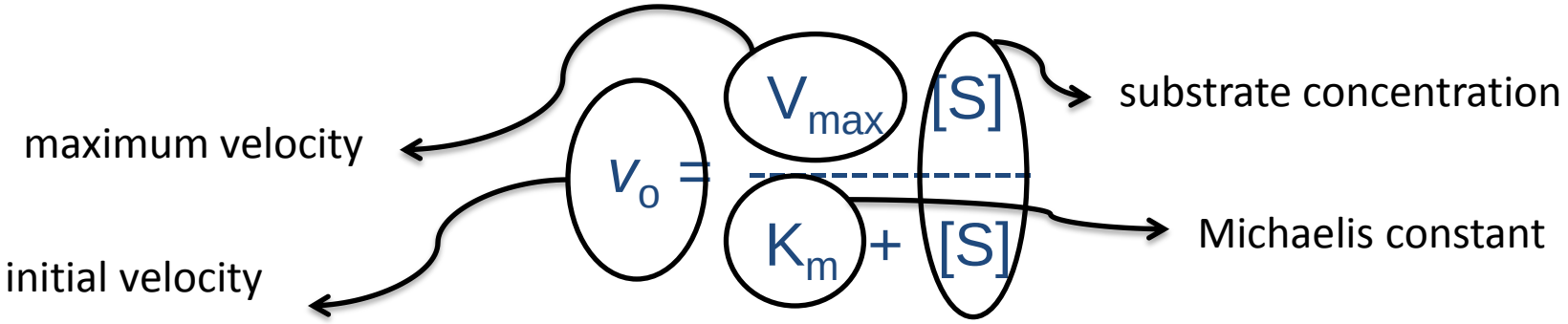
'no products during this phase'

Reaction rate and concentration of intermediates change slowly with time (after initial state)

Rate of synthesis = Rate of degradation

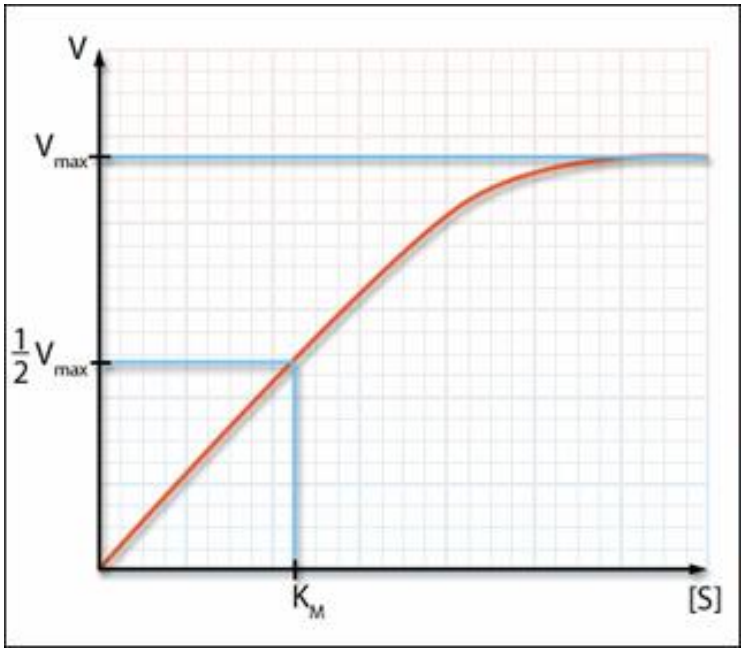
Michaelis Menten Equation

It measures the initial velocity (v_o) of an enzyme reaction



Initial velocity v_o of
a simple Michaelis–Menten

reaction versus the substrate
concentration[S]



K_m (Michaelis Constant)

It is the [S] required to saturate half of all of the active sites of an enzyme

K_m is the substrate concentration at which the initial rate is one-half of the maximum rate (½ V_{max})

The K_m value of a substrate depends on its affinity with the enzyme

High K_m means low affinity with enzyme (more substrate needed to saturate the enzyme)

Low K_m means high affinity with enzyme (less substrate needed to saturate the enzyme)

Lineweaver-Burk plot

It is plotted to calculate the Km and Vmax values and to determine the mechanism of action of enzyme inhibitors

Also called the double-reciprocal plot, obtained by taking reciprocals of the Michaelis Menten equation

Best of luck with your midterms <3 ….