Enzymes and Coenzymes 1+2

- Color Index:

- Important.
- Extra Information.
- **Doctors slides.**

436 Biochemistry team

Objectives:

- Understand how enzymes are able to speed up the rate of biochemical reactions in the body.
- Identify classes of enzymes based on the type of reactions they catalyze.
- Comprehend the basic terms of coenzymes, isoenzymes
- Understand enzyme activity and specificity
- Understand factors affecting enzyme activity.
- Understand the enzyme kinetics, types of inhibition and regulation of enzyme activity.
- Discuss the clinical role enzymes in the diagnosis of diseases.

What are enzymes?

- Enzymes are biological catalysts that speed up the rate of a reaction without being changed in the reaction.
- Enzymes are non-consumable molecules.
- All enzymes are protein in nature, but all proteins are not enzymes.
- Some enzymes have both active and regulatory sites.
- Substances upon which the enzymes act are called substrates.
- Enzymes bind to their specific substrates to convert them to product(s).

Properties of enzymes

Active site

- It's the region of enzyme that **binds** with the substrate and where catalysis occurs.
- Consist of residues that form temporary bonds with the substrate **(binding site)** and residues that catalyze a reaction of that substrate **(catalytic site).**
- All enzymes have one or more active sites.
- Once the substrate is bound, catalysis takes place

Specificity

- Enzymes bind to their **specific** substrates in the active site to convert them to product(s).
- **highly specific**, Interact with only one or a few of the substrates.
- Catalyze only **one type** of reaction.

Regulation

- Enzymes can be activated or inhibited so that **the rate of product formation** responds to the **need of the cell**

Objective: Understand enzyme activity and specificity

Ways of Enzyme-substrate Binding

طريقة الارتباط بالانزيم.

1. Induct fit binding

After the binding of substrate the enzyme changes its shape to fit more perfectly with substrate "not fully complementary"

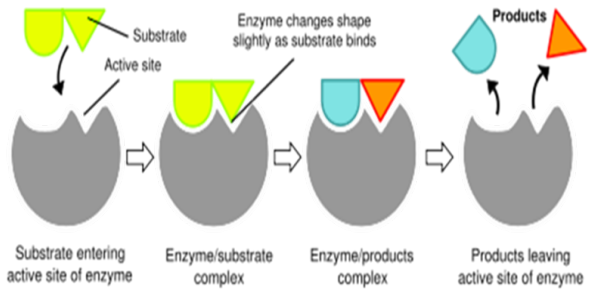
زي القفاز ياخذ شكل اليد بعد ماينلبس.

2. Lock and key binding

The enzyme has an active site that fits **the exact** dimensions of the substrate

Active site is **complementary** to the substrate

1



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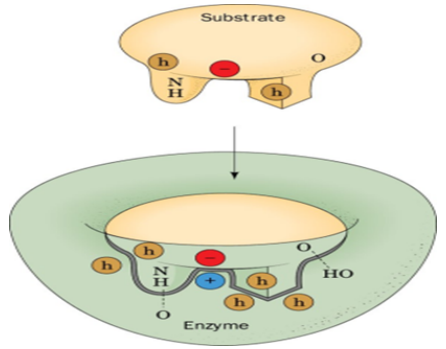


Objective: Identify classes of enzymes based on the type of reactions they catalyze.

Classification of enzymes

They are classified into 6 types, according to the type of chemical reaction catalyzed.

Omar Tried Hard Learning International Languages

Classification	Type of reaction catalyzed
1.**oxidoreduct**ases	Oxidation- reduction reaction
2.**transfer**ases	Transfer of functional group
3.**hydrol**ases	Hydrolysis reaction
4.**ly**ases	Group elimination to form double bonds
5.**isomer**ases	isomerization
6.**liga**ses	Bond formation coupled with ATP hydrolysis

ملاحظة: لازم نحفظهم بالترتيب!

enzyme Nomenclature (naming):

It is based on the rules given by IUBMB (international union of biochemistry and molecular biology

Class.Subclass.Sub-subclass.Enzyme number

Example:
EC: 3.4.17.1 (carboxypeptidase A)

EC: Enzyme Commission (classification)

ملاحظة: الأرقام ليست للحفظ

Some enzymes require **non-protein** groups to become active:
Apoenzyme (inactive) + (Cofactor/coenzyme) *non-protein part* = Holoenzyme (active)

Objective: Comprehend the basic terms of coenzymes, isoenzymes

Holoenzymes

The inactive form of enzyme without its non-protein part

Holoenzymes (Active) = Apoenzyme (Inactive) + Non-protein part

Non-protein part → Cofactors
Non-protein part → Coenzyme

If the non-protein part is a metal ion such as Cu2+, Fe3+, Zn2+, etc.
They also help an enzyme to catalyze a reaction.

If the non-protein part is a **small organic molecules**, known such as NAD^+

1.Prosthetic Group

Coenzymes that are **permanently** associated with an enzyme e.g. FAD

2. Co-substrate

Coenzymes that only **temporarily** associate with an enzyme e.g. NAD

Ribozymes, Isoenzymes and zymogens

Ribozymes

are RNAs (Ribonucleic acid) with enzyme activity.

Isoenzymes

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

Why do they exist?
To cover the excessive body's demand of this chemical reaction in some situations..

Zymogens

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

They are activated when needed.

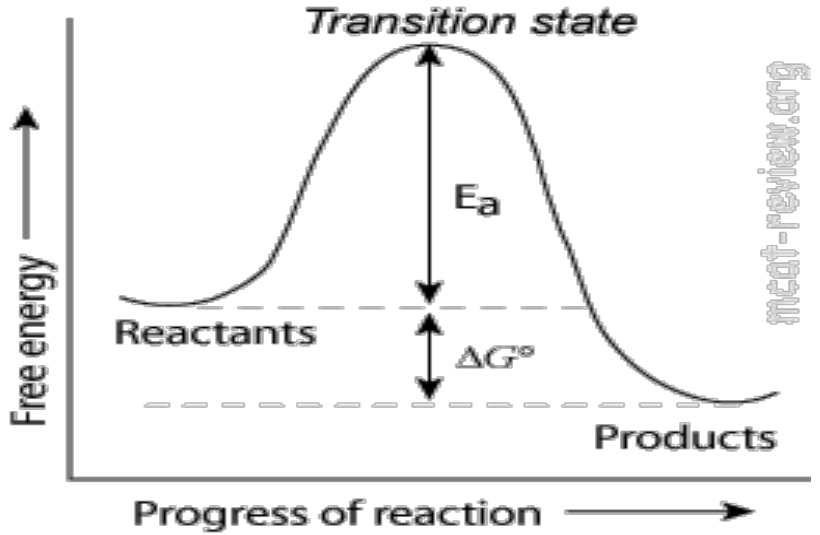
- RNA or antibodies could act as enzymes.
- Inhibitors are structurally similar to enzymes → to control the action.

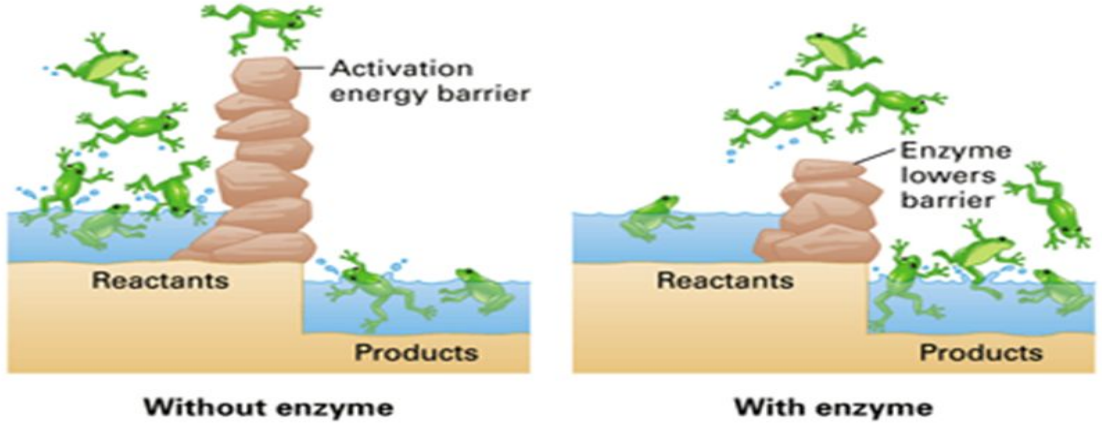
Understanding Activation Energy

- In every chemical reaction, the reactants pass through a transition state that has greater energy than that of the reactants or products alone (the highest point as shown in the figure, it's also called high-energy intermediate)
- activation energy (Ea): The difference in energy between the reactants and the transition state.
- If the activation energy is available then the reaction can proceed forming products

For molecules to react, they must contain sufficient energy to overcome the energy barrier of the transition state. In the absence of of enzyme, only a small amount of molecules may posses enough energy to achieve the transition state between reactants and products.
So, the lower activation energy, the more molecules have sufficient energy to pass through the transition state, and therefore, the faster the rate of the reaction.

- Enzyme induction → increases enzyme activity.
- Enzyme inhibition → decreases enzyme activity.



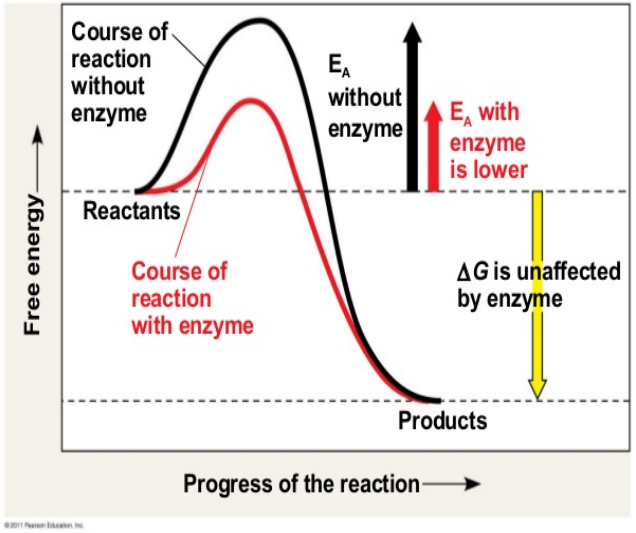


The activation energy barrier is like a wall between two parts of a pond. If an enzyme lowers the wall, more frogs have enough energy to reach the other side

How do enzymes work?

Objective: Understand how enzymes speed up the rate of biochemical reactions in the body

Figure 8.13



- An enzyme reduces the activation energy required for a reaction
- It provides 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)
- (it remains the same) and it does not change the equilibrium of the reaction. It does however accelerate the rate by which equilibrium is reached.

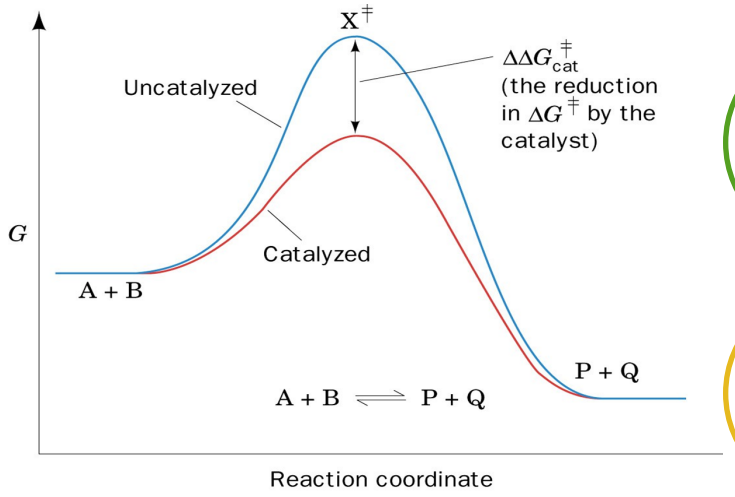
The difference between Activation energy (EA) and free energy (ΔG)
- Activation energy is reduced.
- Free energy remains the same.

Notes :

Enzymes operate by lowering the amount of energy needed to get a reaction going (the activation energy). When this energy is lowered, the nature of the bonds is changed, so they are more easily broken.

Therefore, the lower activation energy required, the faster rate of the reaction.

عندما يعمل الأنزايم فإن الترانسيشن ستايت راح تقل طاقتها وعليه:
1 - طاقة التنشيط ستقل (لأنها الفرق بين طاقة المتفاعلات وطاقة الترانسيشن ستايت، وطاقة الترانسيشن ستايت قلّت!)
2 - لن يحدث أي تغيير في دلتا جي (لأنها الفرق بين طاقة المتفاعلات وطاقة النواتج ولم يحدث أي تغيير فيهم)



The effect of a catalyst on the transition state diagram of a reaction.

Enzyme velocity

Velocity is the **rate of a reaction** catalyzed by an enzyme.

Enzyme activity

*It is expressed as **µmoles** *mmoles* (*girls slides*)* of product formed in **min/mg enzyme.**

Factors that affect enzyme activity:

Objective: Understand factors affecting enzyme activity.

Temperature | PH | [E] and [S]

1. Effect of temperature

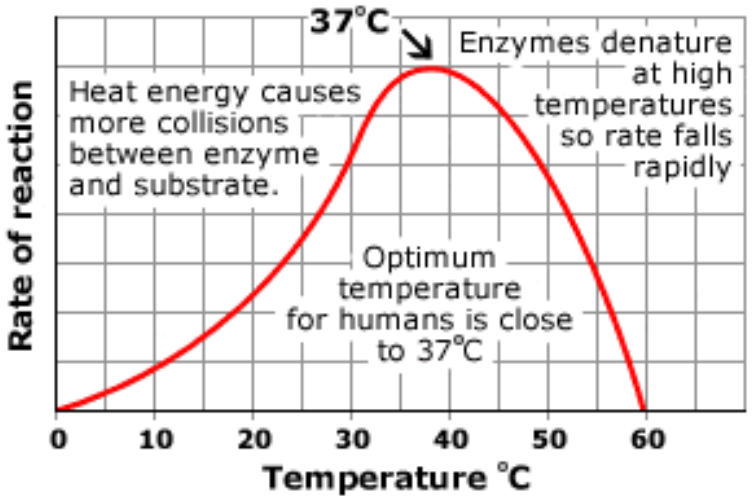
Every enzyme has an optimal temp for catalyzing a reaction

(In humans: most enzyme have an optimal temperature of 37 C.)

The rate of an enzyme reaction **initially** increases (in velocity) with rise in temperature until it reaches a specific temperature that is considered

too high for the enzyme to work because it denatures the enzyme, After about 40c.

(الشيء اذا زاد عن حده ينقلب ضده)



 # Remember

Denaturation is a process in which proteins or nucleic acids lose the quaternary structure, tertiary structure and secondary structure which is present in their native state, by application of some external stress.

In Summary

Every enzyme has an optimal temperature for catalyzing a reaction

In humans, most enzymes have an optimal temperature of 37c

At high temperatures, enzymes are denatured and become inactive.

2.Effect of pH

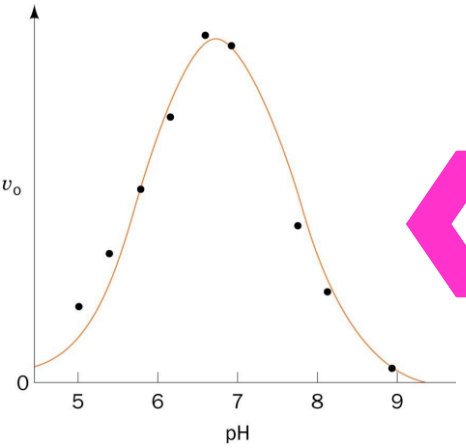
Every enzyme has an optimal pH for catalyzing a reaction.

- Most enzymes have highest activity between **pH 6** and **pH 8**
- **Pepsin** (digestive enzyme in the stomach) has **highest activity** at **pH 2**

The ionizable groups which on the side chain of amino acid

Effect of pH

- on the **ionizable groups** in the active site of enzyme → Affects catalysis
- in the **substrate** → Affects catalysis



(the bell-shaped curve) Effect of pH on the initial rate of the reaction catalyzed by most enzymes

3. Effect of [E] and [S]

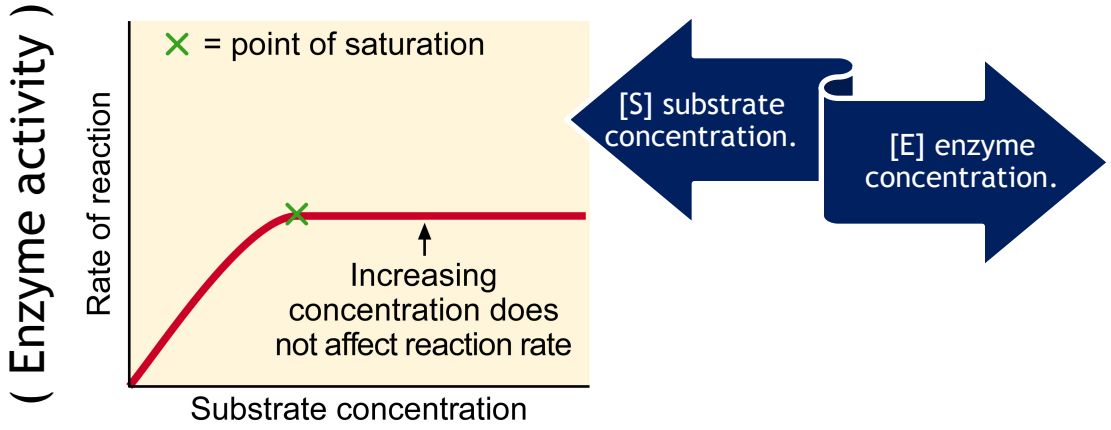
Higher than

***If [S] > enzyme → the rate of enzyme reaction will be directly proportional to the concentration of enzyme.**

The reaction velocity increases initially with increasing [S]

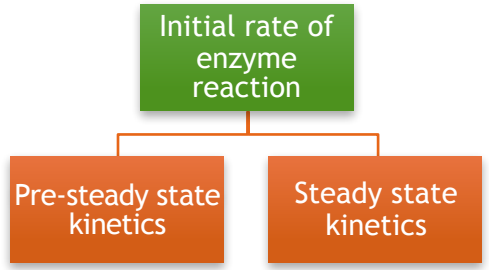
Until excess substrate causes the reaction velocity to be constant *Further addition of substrate has no effect on enzyme velocity (v)* (because enzyme is saturated).

***At low [S] → the reaction rate is proportional to [S]**




Enzyme Kinetics

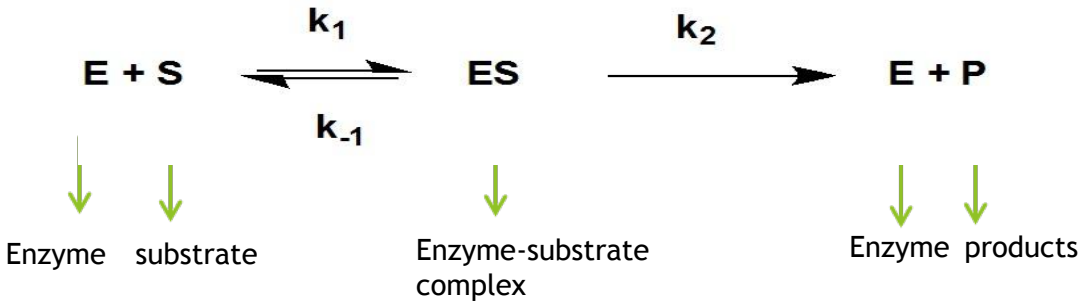
Objective: Understand the enzyme kinetics



YouTube

- The model of **enzyme kinetics** was first proposed by Michaelis and Menten in 1913 and later modified by Briggs and Haldane.
- **The equation of** Michaelis Menten **describes the relationship of: Initial rate of enzyme reaction to [S]**

Rate concentration



Notes:

Michaelis–Menten kinetics is one of the best-known models of **enzyme kinetics**.

What does the equation describe? the rate of enzymatic reactions.

How? by relating reaction rate v to [S] the concentration of a substrate.

1. Pre-steady state:

Enzyme + high concentration of substrate → an **initial short** period of time (a few hundred microseconds) during which intermediates of products gradually build up. NO PRODUCT DURING THIS PHASE.

2. Steady state reaction: occurs after initial state: when the **reaction rate** and the **concentration of intermediates** change slowly with time.

مهم*

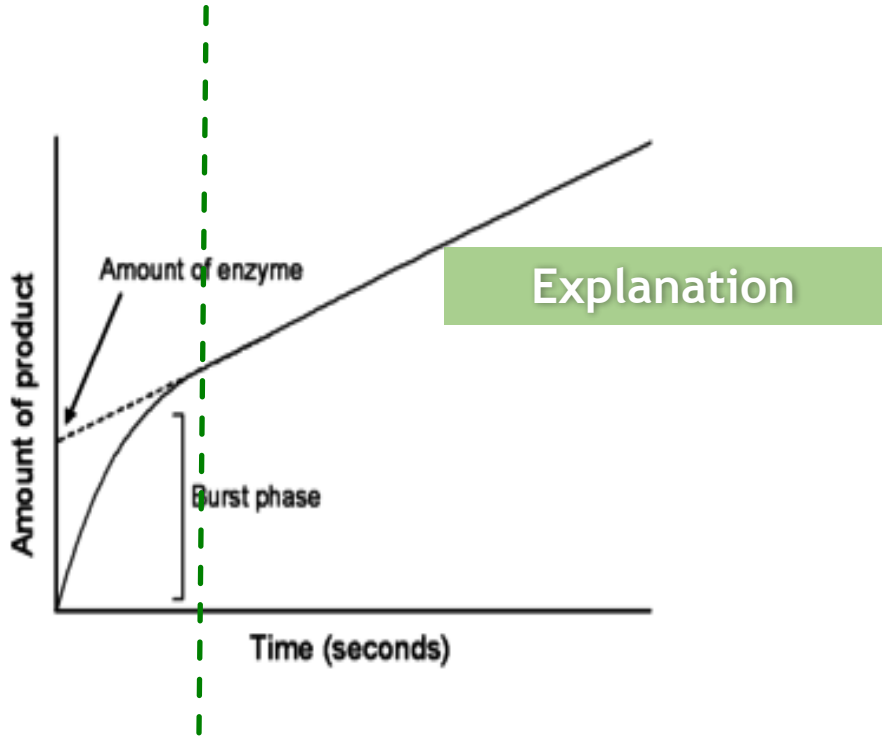
An intermediate changes into steady state when the rate of its synthesis becomes equal to its rate of degradation.

The rate of formation of ES = the breakdown of ES to (E+S) & (E+P)

*يعني سرعة تكون ES تساوي انحلاله وتفككه.

Notes:

- Pre-steady-state kinetics is concerned with the formation and consumption of enzyme-substrate intermediates until their steady-state concentrations are reached.
- reactive intermediate: a short-lived, high-energy, highly reactive molecule. When generated in a chemical reaction, it will quickly convert into a more stable molecule.



Explanation

Pre-steady state kinetics

- مرحلة إرتباط الإنزايم بالسبستريت عشان يتكوّن لي ال ES
وهو ليس بروكت إنما "انزايم مرتبط مع سبستريت"
(Enzyme-substrate complex)

- هذه الخطوة تعتبر قصيرة جداً لأن كمية السبستريتس اكبر بكثير من كمية الانزايم فبالتالي تصبح نسبة ارتباط هذه السبستريتز بالانزايم قليلة.

Steady state kinetics

بعد ما تكوّن عندي
ES (Enzyme-substrate complex)
سيصبح تركيزه يزداد بشكل ثابت مع الوقت (نلاحظ إن الميل في الصورة يزداد بثبات)

Michaelis Menten Equation

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

Note: initial velocity is also described as "rate of a reaction."

$$v_o = \frac{V_{max}[S]}{K_M + [S]}.$$

[S] = Substrate concentration

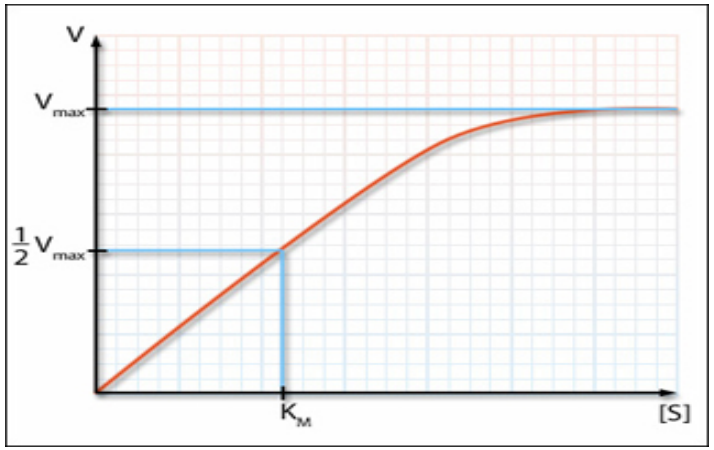
K_m = Michaelis constant

The constant K_m is a measure of how efficiently an enzyme converts a substrate into product.

V_{max} = Maximum velocity achieved by the system when the enzymes will be saturated & full up with substrate, and won't able to react anymore quickly..

K_m: a **substrate concentration** where the initial **rate** is **half** of the maximum rate (½ **V_{max}**)
Meaning: It is the [S] required to saturate **half** of all of the active sites of an enzyme

Initial velocity v_o of a Simple Michaelis – Menten reaction versus the substrate concentration [S]



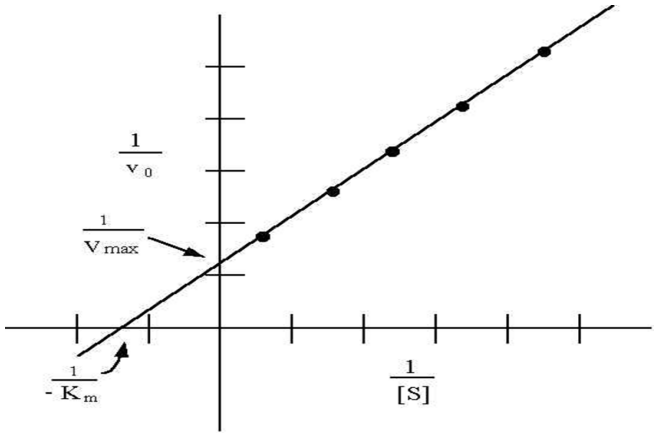
The K_m value of a substrate depends on its affinity with the enzyme

High K_m → low affinity with enzyme
(Therefore higher concentration of substrate is needed to saturate the enzyme)

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

Note: The meaning of affinity is "natural liking."

Lineweaver-Burk plot (double-reciprocal plot)



- obtained by taking **reciprocals** of the **Michaelis Menten equation**
- It is plotted to:

*calculate the **Km and Vmax values**
*determine the **mechanism of action** of enzyme **inhibitors**

#للرّبط

High Km:
مثل لما يكون الشخص صاحب مستوى عالي بمنصب أو غيره ومشغول طول الوقت هنا يصير إحتكاكه مع أصدقائه أقل (Affinity)
فلذلك يحتاج إنه يقوّي علاقته أكثر فيحتاج سبستريتس أكثر عشان يتشبّع.

Low Km:
هنا العكس اللي يكون منصبه بسيط فبكذا عنده وقت أكثر وإحتكاكه مع أصدقائه عالي فبيحتاج عدد أقل من السبستريتس عشان يتشبّع الإنزايم

نشكر رانيا العيسى على التنسيه

Summary

Reacts with to form

Enzyme → Substrate → Products

- Enzymes are biological catalysts that speed up the rate of a reaction without being changed in the reaction
- All enzymes are protein in nature
- Apoenzyme (inactive) + nonprotein part = Holoenzyme (active)

Initial rate of enzyme reaction:

Pre-steady state kinetics

initial short period of time which intermediates gradually build up

Steady state kinetics

the reaction rate and the concentration of intermediates change slowly with time

Michaelis Menten Equation:

$$V_o = \frac{V_{max}\,[S]}{K_m + [S]}$$

High Km

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

Low Km

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

Factors that affect enzyme activity

- Temperature
- pH
- [E] and [S]

3 Properties of Enzymes:

Active site

region of binding and catalyzing

Specificity

Enzymes bind to their specific substrates in the active site.

Regulation

Enzymes control the rate of product formation responds to the need of the cell

Holoenzymes

- Cofactor: Metal ions
- Coenzyme: Organic molecules

MCQs + Videos

- Test

- https://youtu.be/j00Ep0Byu0Y
- https://youtu.be/7u2MkbsE_dw
- https://youtu.be/X_YXTWU2maY

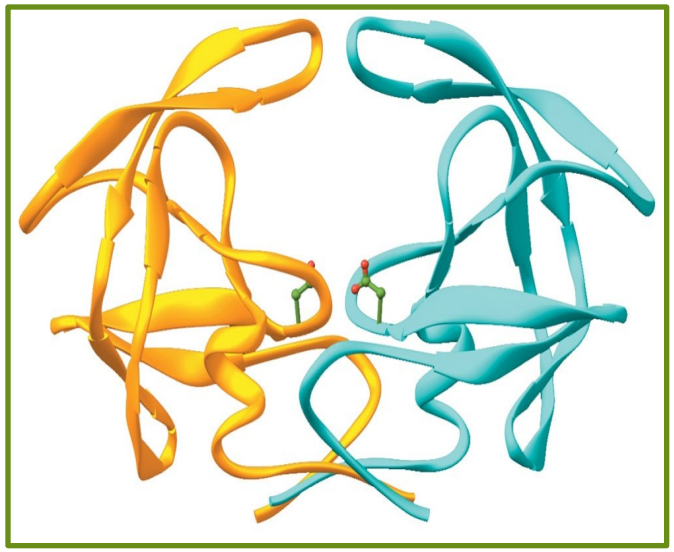
Enzyme inhibition

Objective: Understand types of inhibition

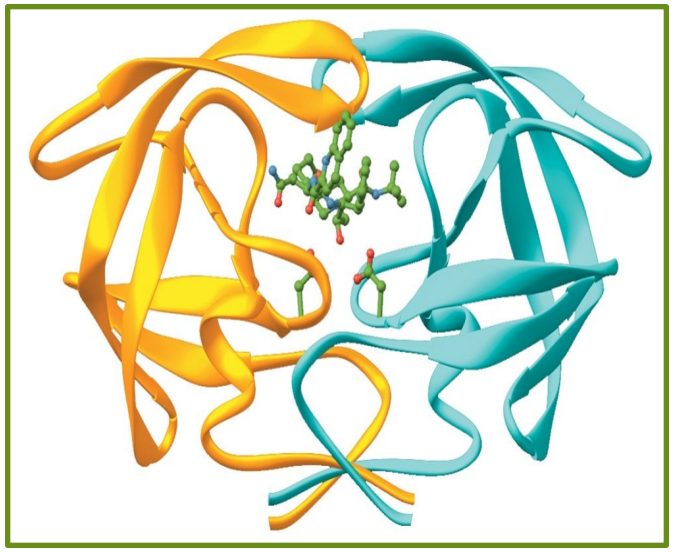
To inhibit means to stop the enzyme activity

- Inhibition is a process in which the enzyme activity is regulated or controlled or stopped.
- Ki (inhibitor constant) is a measure of the affinity of the inhibitor for the enzyme. Also, known as dissociation constant.

An enzyme **without** inhibitor



An enzyme **with** inhibitor



Note:

-affinity is the tendency of a molecule to associate with another.
-if enzymes worked randomly, our whole system will be damaged.

There are three types of enzyme inhibition:

Competitive

- Inhibitor has a similar structure to substrate
- It competes with substrate for binding to active site of enzyme.

Noncompetitive

- Inhibitor does not have similar structure to substrate
-No competition exists between inhibitor and substrate

Uncompetitive (this type of inhibition was only mentioned in boys slides).

COMPETITIVE INHIBITION

- The inhibitor is a structural analogue (similar) *to the substrate* that competes with the substrate for binding to the same active site of enzyme (competitive). Thus prevent the enzymatic reactions .
- Competitive inhibition is always reversible reaction.

Two reactions are possible:

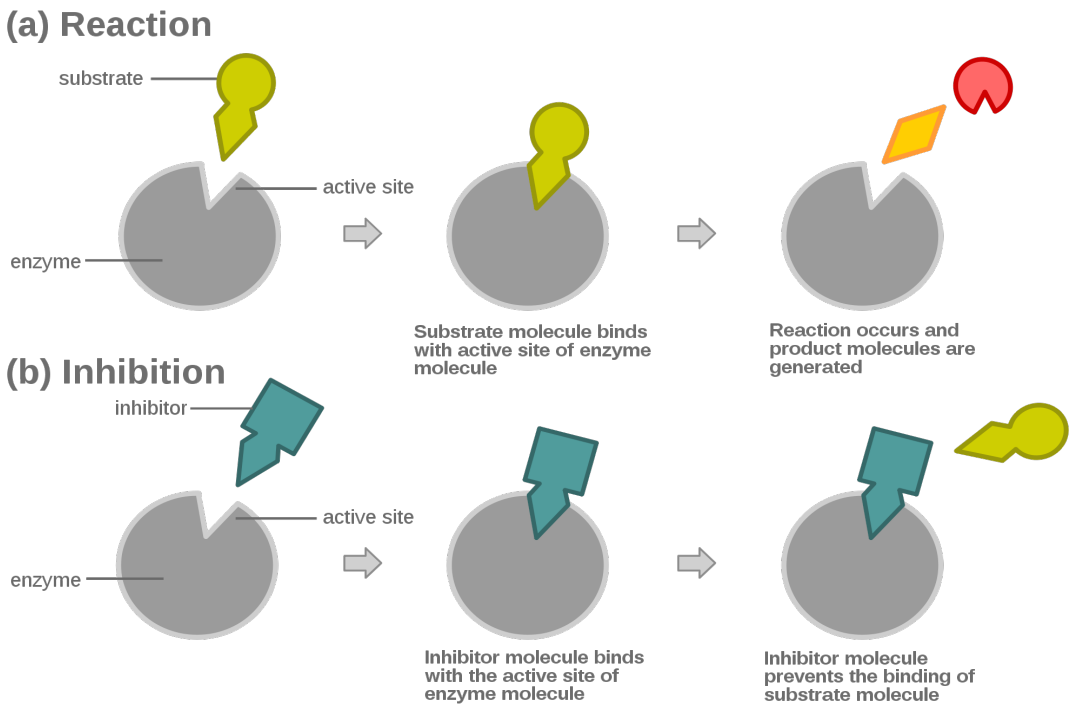
Enzyme + Substrate ⇿ ES complex →Product + Enzyme (active)

OR

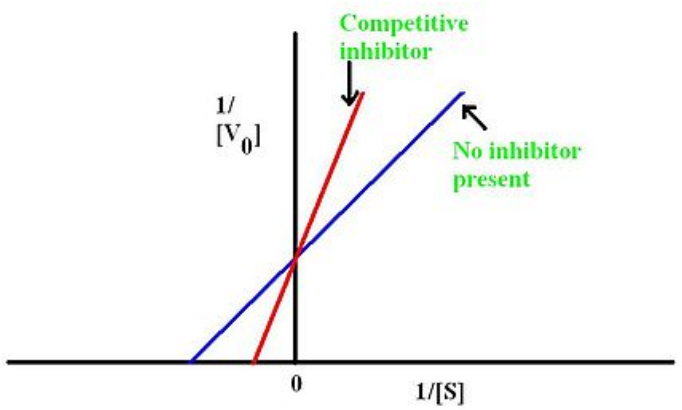
Enzyme + Inhibitor ⇿ EI (inactive)

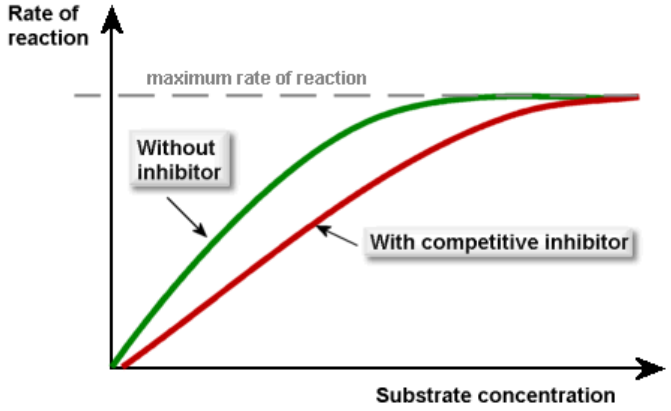
- **Vmax →** unchanged in the presence and the absence of inhibitor.
- **Km →** increased, because **Substrate** and **Inhibitor** compete for binding **at the same site.**

A higher concentration of substrate is required to achieve half-maximal velocity*



Which means : The competitive inhibition prevents the reaction by preventing the substrate from binding to the active site.





NON-COMPETITIVE INHIBITION

- Inhibitor doesn't have a similar structure to the substrate.
- It binds somewhere other than the active site.
- Non-competitive inhibition could be irreversible or reversible.

Remember: *No competition exists between the inhibitor and the substrate*

- The inhibitor can bind to: a free enzyme or to an enzyme-substrate complex. In both cases the complex is catalytically inactive

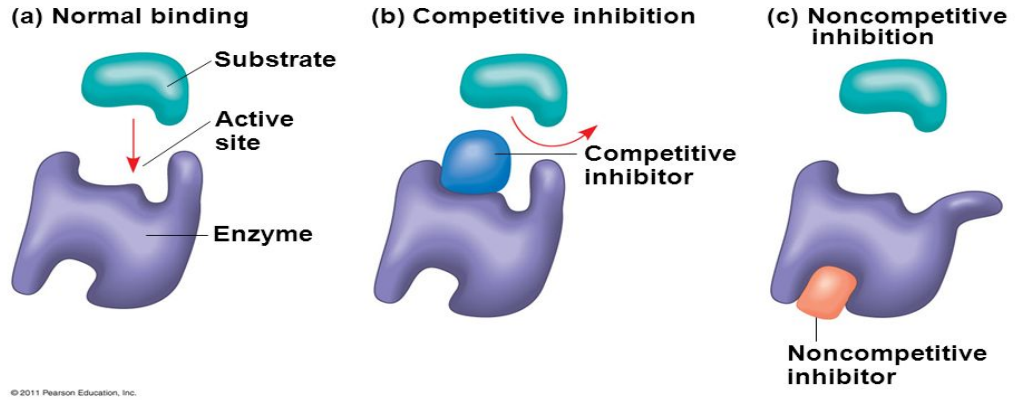
Two reactions are possible:
ES + I ⇿ ESI (inactive)
Or
E + I ⇿ EI (inactive)

- **Vmax →** decreased by the inhibitor.
- **Km →** unchanged because the affinity of Substrate for Enzyme is unchanged

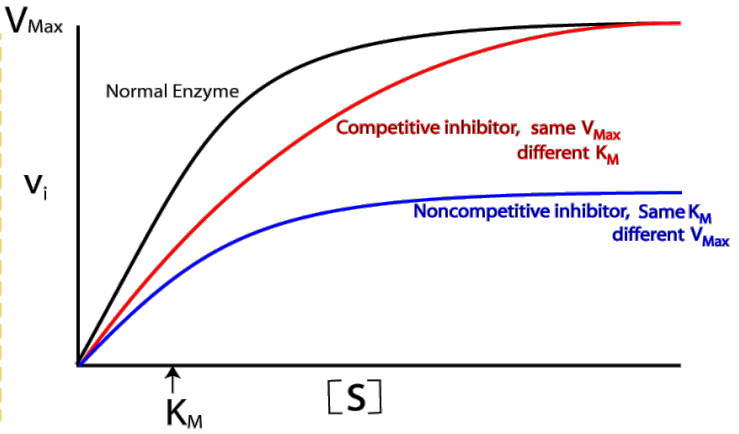
Further Explanation

اقتباس من TEAM435:
على عكس الـ competitive يعمل الـ inhibitor هنا دون منع الـ substrate من الارتباط بالانزيم , بمعنى أنه ممكن أن نجد الـ enzyme-substrate complex موجود بشكله الطبيعي ولكن غير فعال! وذلك لأن فعالية الـ inhibitor تكمن فقط في ارتباطه هو شخصياً وليس بالتدخل في ارتباط الـ substrate

Figure 8.17



اقتباس من TEAM435:
الـ Km (وهي قابلية الانزيم على جذب الـsubstrates لنفسه) لا تتغير, بينما الذي يتغير ويقل هو الـ Vmax (أقصى فعالية ممكن أن يصلها الانزيم), وهذا يؤكد أن الفعالية هي وحدها التي تتغير في الـ non-competitive inhibition



COMPETITIVE VS NON-COMPETITIVE

مُقتبس من تيم ٤٣٥

	Competitive	Non-competitive
structure	Similar to substrate	Different from substrate
Binding site	Active site of enzyme	Away from active site
Competition exists bet. S & I	Yes	No
K_m	increased	Unchanged
V_{max}	Unchanged	Decreased
Possible reactions	E + S ↔ ES complex → P (ACTIVE) or E + I ↔ EI (INACTIVE)	ES + I ↔ ESI (INACTIVE) or E + I ↔ EI (INACTIVE)
Reversibility	Always reversible	Sometimes reversible & sometimes irreversible

Regulation of enzyme activity

عمل الإنزيمات في أجسامنا دقيق جداً بحيث يحفظ لنا الإتزان الداخلي. فالزيادة في المتفاعلات تؤدي لتحفيز الإنزيم للعمل وتحولها لنواتج, وزيادة النواتج تثبط الإنزيم لوقف التصنع!

MED435

Objective: understand regulation of enzyme activity.

- Regulatory enzymes usually catalyze first or an early reaction in a metabolic pathway.
- They catalyze a rate-limiting reaction (slowest step) that controls the overall pathway.
- They may also catalyze a reaction unique to that pathway known as committed step.
- After the committed step reactants in the pathway become **committed** and will end up as the **final product** of the pathway.

Notes:

-The overall rate of a reaction is often determined by the slowest step, known as the rate-limiting step.

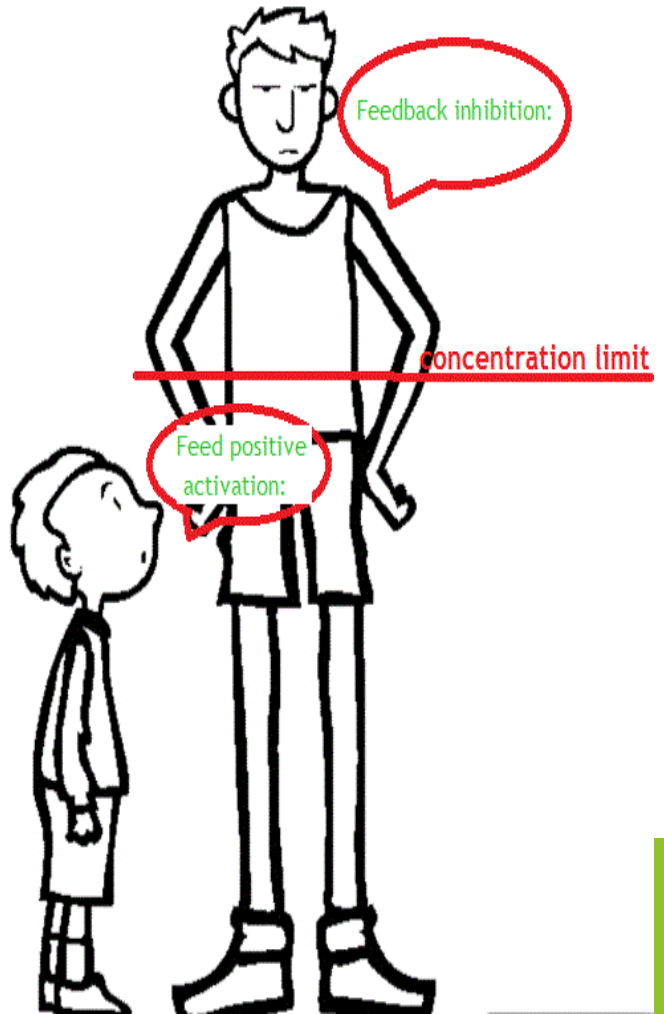
-The committed step is an effectively irreversible enzymatic reaction.

Feedback inhibition

When the end product of a metabolic pathway exceeds its concentration limit, it **inhibits** the regulatory enzyme to normalize the pathway

Feed positive activation

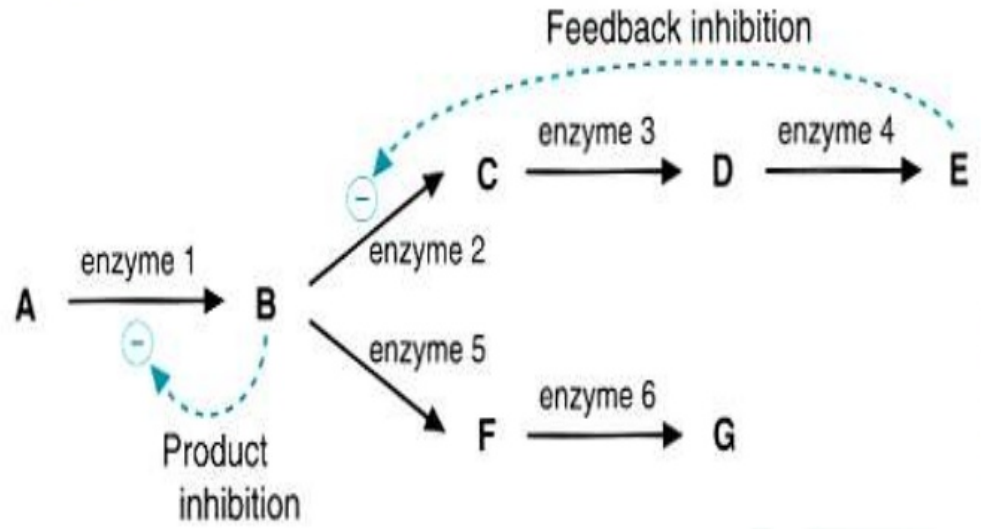
When the end product of a metabolic pathway is below its concentration limit, it **activates** the regulatory enzyme to normalize the pathway.

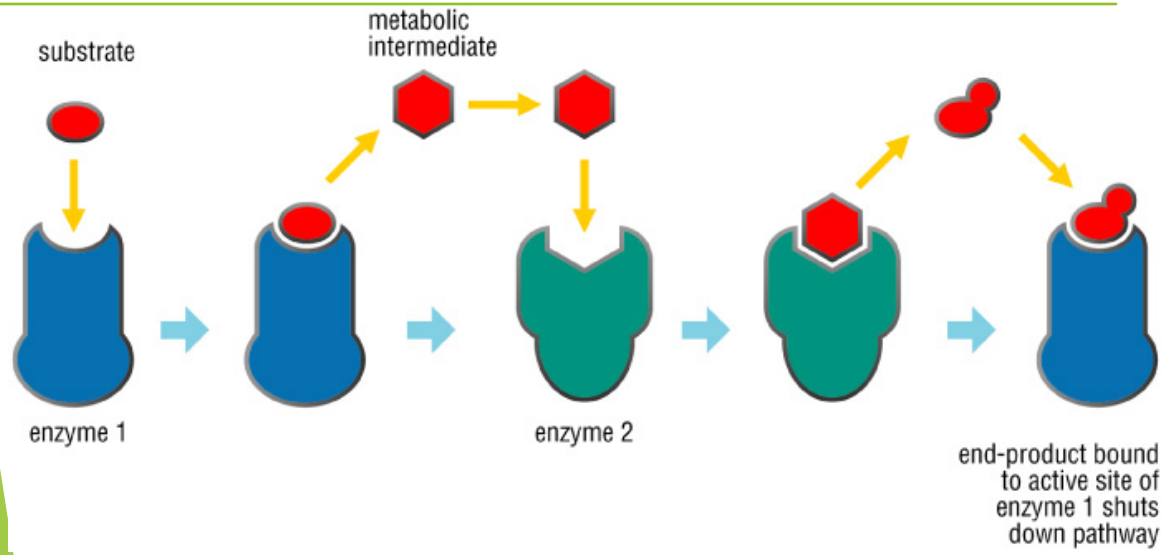


أحد التطبيقات العملية على الإنزيمات هي كونها من أهم أجزاء الـ pathways metabolicالتي تتم في أجسامنا على مدار الثانية. الإنزيمات تحفز أو تثبط التفاعلات بشكل عام, ولكن بشكل خاص هناك جزء من الإنزيمات تسمى enzymes Regulatory وهو المنظم الأساسي لاتجاه سير التفاعل (كإشارة المرور في الطرقات) وعدم توفره يعني عدم وجود الـ pathway من الأساس

MED435

Feedback Inhibition





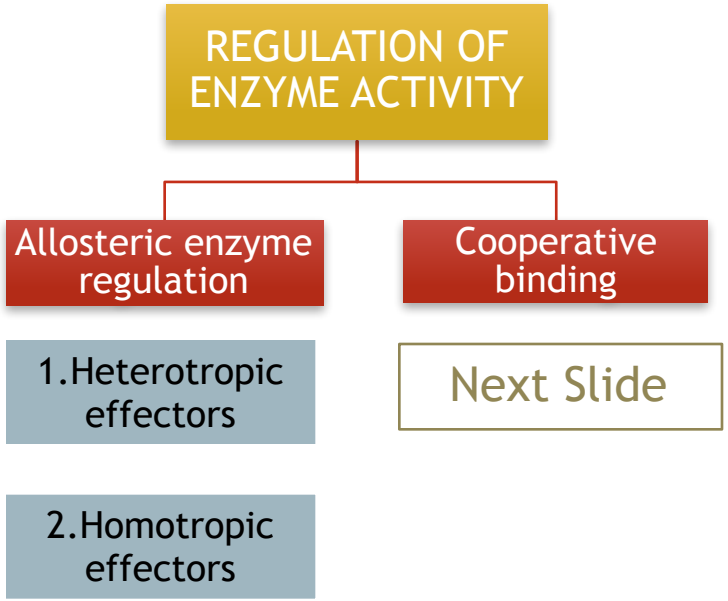
Still can't get it ?

-Feedback Inhibition of biochemical pathways :

https://www.youtube.com/watch?v=n3i7XMQTZ_s

- Feedback Inhibition or End Product Inhibition of Enzymes:

https://www.youtube.com/watch?v=bRGsmNLMn4I



Regulation of allosteric enzymes

The term "allosteric" came from Greek word "allos" meaning "other"

Allosteric Enzymes:
The enzymes in metabolic pathways whose activities can be regulated by certain compounds (ligand) that bind to enzyme other than the catalytic site (active site)

Homotropic: Effect of one ligand on the binding of the same ligand (a regulatory enzyme modulated by its own substrate).

When the substrate itself serves as an effector the effect is said to be homotropic.

Most often, an allosteric **substrate** functions as a **positive effector.** In such a case, the presence of a **substrate** molecule at one site on the enzyme **enhances(+)** the **catalytic** properties of the other substrate-binding sites—that is, their binding sites exhibit cooperativity.

Heterotropic: Effect of one ligand on the binding of a different ligand.

The **effector** may be **different** from the **substrate**, in which case the effect is said to be heterotropic

https://youtu.be/qgHr0dWKhSc?t=2m1s (2:00-4:20)

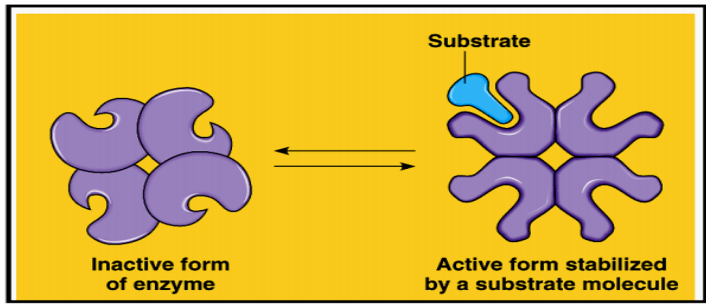
-NOTE : Allosteric enzymes are regulated by molecules called effectors (also called modifiers) that bind non-covalently at a site other than the active site. These enzymes are usually composed of multiple subunits, and the regulatory (allosteric) site that binds the effector may be located on a subunit that is not itself catalytic. The presence of an allosteric effector can alter the affinity of the enzyme for its substrate , or modify the maximal catalytic activity of the enzyme, or both.

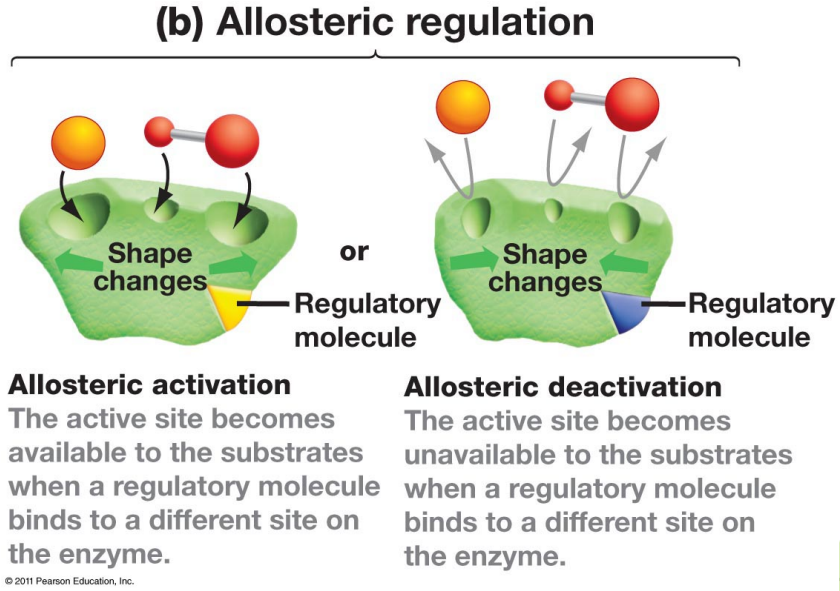
Definition: a ligand is an ion or molecule (functional group) that binds to a central metal atom to form a coordination complex.

Cooperative binding

- It is the process by which binding of a **ligand** to a **regulatory site affects** binding of the same or of another **ligand** to the **enzyme.** بمعنى ارتباط المادة مع الانزيم في منطقة وحدة يحفّز المناطق الأخرى بنفس الإنزيم.
- Binding of an allosteric modulator causes a change in the **conformation** of the enzyme
- This causes a change in the binding affinity of enzyme for the substrate
- The effect of a modulator may be positive (**activation**) or negative (**inhibition**)
- Positive: increased E, S affinity
- Negative decreased E, S affinity

- Most allosteric enzymes are oligomers (two or more polypeptide chains or subunits)
- The subunits are known as protomers





Effectors that inhibit enzyme activity are termed negative effectors, whereas those that increase enzyme activity are called positive effectors.

Between brackets: doctor's notes

Enzymatic diagnosis and prognosis of diseases

Enzymes are used clinically in three ways:

1-(markers)
As indicators of enzyme activity or conc. In body fluids (serum, urine) in the diagnosis/prognosis of diseases

2- as analytical reagents in measuring activity of other enzymes or compounds in body fluids

3-(treatment)
As therapeutic agents

The most commonly used body fluids for measuring enzyme activity are:

Serum

Serum markers in the diagnosis of diseases:
1- heart diseases
2- pancreatic diseases
3- liver diseases

Plasma

There are
1- plasma specific enzymes
(Present in plasma)
2- non-plasma specific enzymes
(Specific tissue markers for tissue injury)

Extra information from the book.

(Many diseases that cause tissue damage result in an increased release of intracellular enzymes into the plasma)

بعض الإنزيمات توجد بشكل طبيعي في البلازما لكن كثرتها أو قلتها الغير طبيعية دليل على وجود مرض والبعض الآخر من الإنزيمات لا يتواجد في البلازما أو يتواجد بنسبة قليلة وغالباً ما تكون تلك النسبة ثابتة فلو وجد فهذا دليل على المرض.
- أيضاً نسبة هذه الإنزيمات تحدد في أي مرحلة من المرض يمر بها المريض.
*مثال: يوجد إنزيمات خاصة في الكبد بنسبة ثابتة في الدم لكن في حالة شخص يعاني من مرض بالكبد ترتفع هذه النسبة ويمكن ملاحظة ذلك عن طريق أخذ عينة من المريض. وهذا المثال ينطبق على الإنزيمات الخاصة بأعضاء أخرى.

Summary

- ✓ -Regulatory enzymes usually catalyze the first or an early reaction in a metabolic pathway.
- ✓ -There are two types of regulation allosteric enzyme regulation and cooperative binding
- ✓ -Feedback inhibition inhibits the regulatory enzyme to normalize the pathway (feedback inhibition) while **the feedback positive activiation**
- ✓ activates the regulatory enzyme to normalize the pathway.
- ✓ -Two types of interactions occur in allosteric enzymes:
- ✓ Homotropic: Effect of one ligand on the binding of **the same** ligand .
- ✓ Heterotropic: Effect of one ligand on the binding of **a different** ligand.
- ✓ Enzymes are used clinically in three ways.

	Competitive inhibition	Noncompetitive
meaning	similar to the structural of the substrate and competes with it for binding at the active site	The inhibitor does not have structural similarity to the substrate.The inhibitor binds to the enzyme at a site away from the substrate binding site
V_{max}	V_{max} is unchanged in the presence and the absence of inhibitor	The value of V_{max} is decreased by the inhibitor
K_m	K_m is increased because substrate and inhibitor compete for binding at the same site	K_m is unchanged because the affinity of S for E is unchanged

MCQs + Videos

- Most commonly used body fluids for measuring enzyme activity are :

A- serum B- interstitial C-plasma D-A&B E-A&C

- Heterotropic: Effect of one ligand on the binding site of the same ligand

A- TRUE B- FALSE

- K_i is a measure of affinity of the inhibitor for the enzyme

A- TRUE B- FALSE

- In competitive inhibition ….. is unchanged in the presence and the absence of inhibitors

A- K_{max} B- V_{max} C- V_{avg} D- V

- Competitive inhibition
- K_i (dissociation constant)
- Allosteric enzyme regulation
- Cooperative binding

1- E
2- B
3- A
4- B

- Girls team members:

1- زينة الكاف.
2- هيفاء الوعيل.
3- ريم السرجاني.
4- سمية الغامدي.
5- لمى الفوزان.
6- مها الغامدي.
7- نورة الشبيب.
8- أسيل السليماني.
9- شهد السويدان.
10- جومانا القحطاني.
11- نجود العنزي.
12- شذا الغيهب.
13- سارة الشمراني.
14- لجين الزيد.
15- روان الوادعي.
16- منيرة الضفيّان.
17- بثينة الماجد.

- Boys team members:

1- محمد المهوس.

-Team leaders:

نوره السهلي.
عبدالله المانع.

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