

*enzyme

⊛ talking about enzyme, their classification

the sight in which substrate is binding into the enzyme to be converted into product
هو المركب الذي يتفاعل مع الإنزيم

* أنوع co-factors

* الحزازات = الإنزيمات الكليينية

→ أهم الجزيئات للإنزيم

* how they can employed in the clinical yields

→ can be used as biomarker for the diagnosis for different diseases

* Enzyme is a catalyst → محفز

we have 2 types of catalyst

① Organic catalysts ← يتكون من amino acid

Enzymes are protein in nature except Ribosomes

→ Some enzymes in the form of conjugated protein

conjugated protein:

simple protein ~~is~~ consist of amino acids only
conjugated proteins ~~molecule~~

~~protein~~
~~amino acid~~

↳ We have a molecule that is
consisted of two different portion
nucleoprotein → (protein + nucleic acid)
metalloenzyme → (protein + metal ions)

enzymes are organic catalyst

* the function of accelerating the reaction
shorten the time of reaction
(in the femtosecond) ~~is~~ rule

(organic catalyst) is rule
(unorganic catalyst) is rule

metalation → rule

→ hydrogenation reaction: rule
saturation rule substrate rule
of double bond

we have 2 type of catalyst

1) organic catalysts \Rightarrow enzyme

2) unorganic catalysts \Rightarrow Metal ion
[hydrogenation]

*which is better?

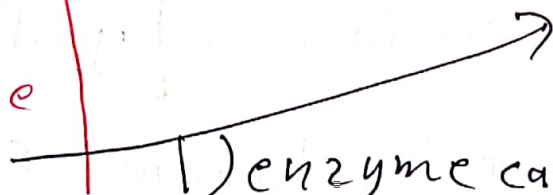
organ catalysts [enzyme]

كيف يعرف بيننا؟

Turn over number في كيمياء حيوية

عدد الجزيئات substrate التي تحولت الى product في انبوبة اختبار الاولى enzyme and the metal ion in the second test tube

number of substrate molecule to be converted into product molecule per unit time per enzyme unit



1) enzyme can convert $10^6 - 10^{12}$ of the substrate molecule

2) metal ion can convert only 10^3 substrate molecule into the product

character of the enzyme 8

1) all enzymes are protein in nature except one type [Ribosomes]

transcription (RNA) کا اظہار
immature ^{غیر ناضج} ribosomes
RNA سے جملے جاتی ہیں
immature ^{غیر ناضج} mature ^{ناضج} maturations

~~ribosomes~~
pieces of RNA that can act for processing RNA

→ have catalytic activity
RNA سے جملے جاتی ہیں
nonfunction ^{غیر ناضج} form into function form

2) the enzymes is never consumed

nor ^{لا بدلتی} altered as a consequence of their participation in a reaction بنتھی من reaction
بروز reaction آتی

A) enzymes consider as [globular protein]

گلوبولر having dynamic function and have short live span

structural \neq (fibrous) structural function

محدد

* enzymes are selective and specific

Ex: Lactate dehydrogenase enzyme is catalyzing oxidation of lactate into pyruvate

← مارح اقدر امكن ان يشتغل على substrate لاني

← لكن خبنا انه في بعض الاماكن فيها enzyme catalyzing two different reactions in two different substrate isocitrate dehydrogenase enzyme

← موجود بال creps cycle

← ~~isocitric~~ isocitric

① في التفاعل الاول

isocitric (oxidation) to be converted into oxalosuccinate acid

* enzymes are site specific

↳ the enzyme acting on the cell membrane and not acting in any another site of the cell

تشارك في التكاثر النووي

* Replication of DNA is taking place on mitochondria

→ site of specific : ان كل جزء من الخلية له انزيمات الخاصة فيه

تشارك في التكاثر

* Thermolabile except some types that can catalyze reaction in a very high temperature (Taq DNA polymerase)

* Any increase or decrease in the temperature will affect the enzymatic reaction activity

Why?

Because ~~the~~ [protein denaturation]

~~convert the protein from tertiary~~

or breaking down the bonds that stabilized the tertiary and quaternary structure

→ the protein molecule will be converted from tertiary or quaternary structure into primary structure

From (Function form) → (not function)
ex: hydrogen bonds / salt bridges
non-hydrophobic / disulfide

→ Stronger peptide →

not existing in all different types of protein

disulfide bond

characteristics of enzyme

- * enzymes are [organic catalysts]
- * protein in nature except ribosomes
- * globular protein
 - have tertiary and quaternary structure
- * have high turn over number (highly efficient)
- * extremely selective catalysts
- * are never consumed and non permanently altered
- * ~~thermostable~~ Thermolabile
- * site specific

Nomenclature of Enzymes :

ببلازیم الی نشیون و بیضین
ase

urea → urease

lactose → lactase

not good

don't detecting the type of reaction

ببلازیم

* Other enzymes

* the best nomenclature of the enzyme which

including the name of substrate to ~~be added to the enzyme~~

o type of reaction

pepsin → historical *

o stomach

↳ main function :

is the first enzyme to act on the protein during digestion.

* not act on the starch

* this acting for the digestion of protein (partial)

→ the final digestion of the protein is not taking place in the stomach, they take place at intestine.

classification of enzymes

International union of biochemists
and molecular Biologists (IUBMB)

4 digit numbers → Combinations

← كلاسز سے جوڑے اور

المرق الاول

group to which the enzyme is belonging
~~to which group to which the enzyme~~
~~is belonging~~ ← بعضی کے لئے

① **oxidoreductases** : oxidation and reduction reaction

② **transferases** : methyl transferase enzyme

• (methyl) المرق الاول
group

from donor to acceptor

③ **hydrolases** : cleaving molecule by adding

المرق الاول ← water

④ **lyases** : creating or breaking down
the double bond

⑤ **isomerases** : from isomers to unisomers

⑥ **ligases** : ligation (المرق الاول)

2nd] subclass
→ type of substrate or bond
cleaved

3rd] sub-subclass
→ group acted upon
cofactor required

~~4th~~ 4th] → serial number
indicating the order in which the enzyme
is added to the list.

①

⊗ oxidoreductases

will in the biological system

[oxidation never happen without
reduction]

Loss of hydrogen

Loss of electrons

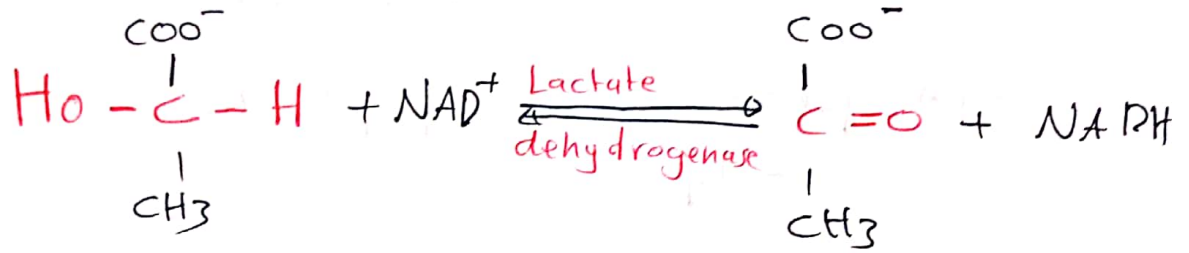
⊗ why the hydrogen is not allowed
to be free intracellularly or
~~extra~~ extracellularly?

* pH intracellularly will be
less than pH in the blood

← affect the activity of enzyme → ~~the pH~~ will be more acidic
~~to shifting the~~

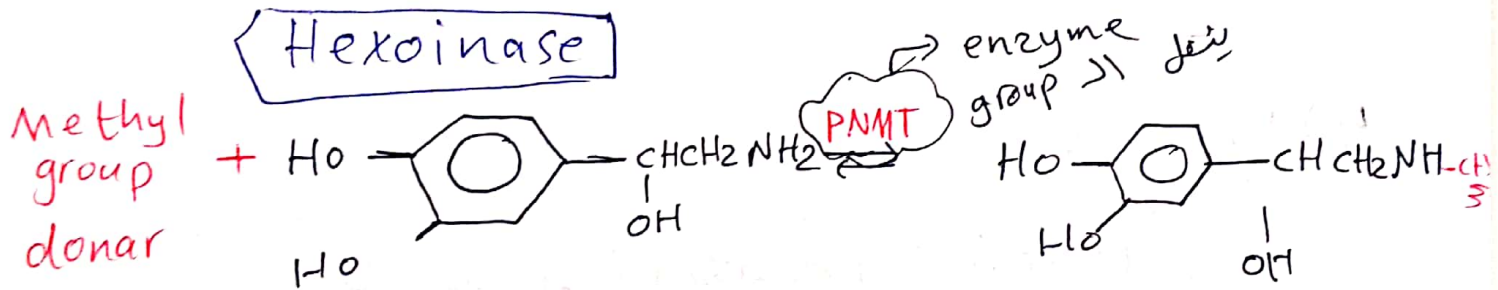
- Reductases

- oxidases



2) transferases

transfers the group from ~~acceptor~~ ~~to donor~~ donor to acceptor

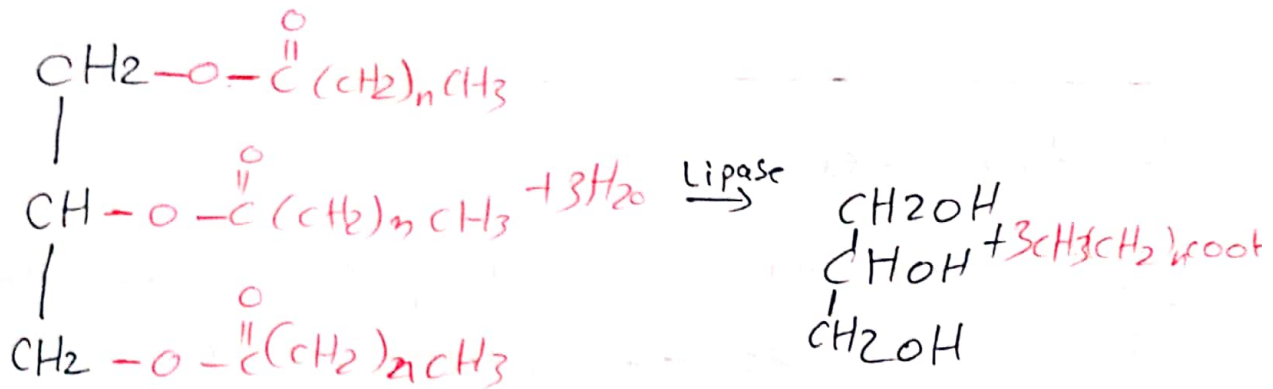


* Transaminases catalyze transfer of an aminogroup

A) Kinases transfer a phosphate group

3) Hydrolases :
 cleave bonds by adding water
 Alkaline phosphatase

- phosphatase
- lipases
- peptidases

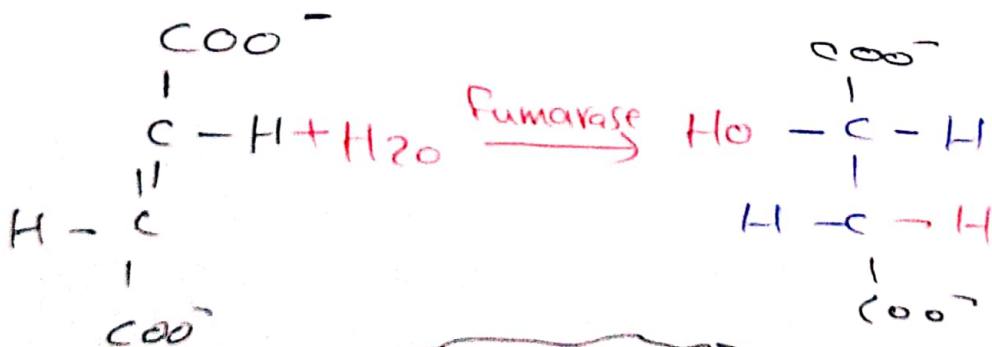


4) Lyases :

[creation/reversing] of double bond

Pyruvate decarboxylase

- Decarboxylases
- synthases



fumarate acid \rightarrow breaking down of double bond \rightarrow malate acid

malate acid $\text{C}_4\text{H}_5\text{O}_6$

- isomerases :

(تحويل)

- Alanine racemase } intermolecular rearrangement
* Epimerases } * galactose is an epimer
* Mutases } of glucose

A) Epimer molecule having the same chemical composition but they are different in the configuration around ~~the~~ a single carbon

* ~~lyso~~ Ligases :

توصيف

isoleucine - tRNA Ligase enzyme

↳ by ~~the~~ sigma of the ~~the~~ DNA to give continuity of the molecule of DNA

work with presence of ~~ATP~~ ATP

Active site

it is the site of enzyme to which the substrate is binding or catalyzing reaction

small cleft / portion

→ what ~~the~~ are the characters of the Active site?

to allow the binding of the substrate to the enzyme

3D dimensional configuration

①
شبه جزيء

Complementarity ~~جزيء~~

between the active site of the enzyme and the substrate [شبه جزيء]

→ they should be specific reactive groups in the active sites of the enzyme

① reactive groups in the active site

② reactive groups in the binding sites of the substrate

شبه جزيء

→ the substrate should be stabilized to the active site

reactive groups of active site [مجاذب]

* acidic amino acids [glutamate and aspartate]

why [are ionized] both when ionized give the negative charge

* basic amino acid [lysine/histidine/arginine]

* Sulpha-hydric containing amino acid

[cysteine] (ionization of different groups to facilitate the interaction between the enzyme binding site and the binding site of substrate)

المجاذب التي تتفاعل مع الركيزة في الموقع النشط

المجاذب التي تتفاعل مع الركيزة في الموقع النشط [substrate]

- it should be stabilized [enzyme substrate] complex

transition state. the energy on the substrate converted into product

* When we have enzyme consisted of two protein molecule, where the reactive site can be located?

→ in the interface ~~out~~ between the two polymer (subunit)

very good
why

can attract functional group from the first polymer and will attract functional group from second polymer and this will facilitate the binding and the stabilizing of substrate into the active site

* 2 models of binding the substrate to the active site

* key and lock model

rigid / not flexible

→ this model is nonchangeable model

غير قابل للتغير

نموذج القفل والمفتاح

* If there is not complementarity between the substrate binding site and the active site of the enzyme there will be no reaction.

* Induced-fit model

إذا ما كان \rightarrow active site مناسب

* active site of the enzyme

to be suitable for binding the substrate

* binding of the substrate to the original form of the active site is not good because there are no complementarity between the two active site

(كان)

once there partial binding of the substrate to the active site of the enzyme

تغييرات متساوية

{ conformational changes } active site in

to be fit for binding ~~active site~~ the substrate

model 1	model 2
rigid	flexible
unchangeable	changeable
binding if there are complementarity	partial binding to be suitable for binding the substrate

Mechanism of Action of enzymes

Enzyme

test tube

substrate

a unit of an enzyme

formation of what we called enzyme substrate complex

transition state

enzyme و تفاعل

Substrate into product

enzyme + substrate → Enzyme substrate complex → Enzyme + product

(K1) enzyme + substrate → Enzyme substrate complex

(K-1) Enzyme substrate complex → enzyme + substrate

(K2) Enzyme substrate complex → Enzyme + product

product

(K-2) substrate complex

$k_1 \rightarrow$ for the formation of enzyme substrate complex

$k_{-1} \rightarrow$ for the dissociation of enzyme substrate complex

$k_2 \rightarrow$ for the conversion of the substrate into the product

$k_{-2} \rightarrow$ for the conversion of the product into the substrate complex (reverse)

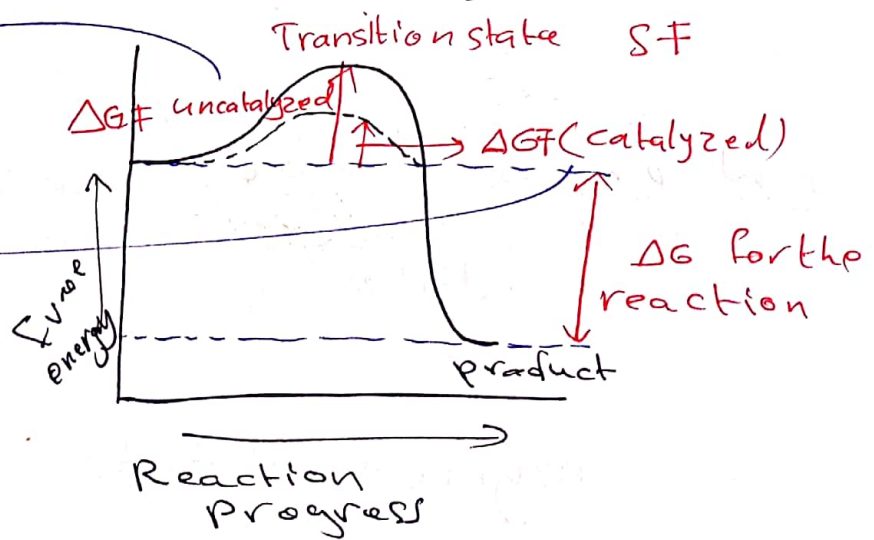
مجموعه سوالیہ جوابتیں $[K_m]$

اولیٰ ترتیب (enzyme) substrate کے بعد بعض التفصیلات

① Thermodynamic changes

تغییرات حراریہ

تغییرات حراریہ کے بیرون انڈیکس
تغییرات حراریہ کے بیرون انڈیکس



enzyme کے ذریعے
shortening the time to be converted into transition state
energy of activation transition state

A) The molecules of the substrate will have enough energy to be in the transition state and to allow the conversion of the substrate into product