SHEET NO. 4

METABOLISM

DOCTOR 2019 | MEDICINE | JU

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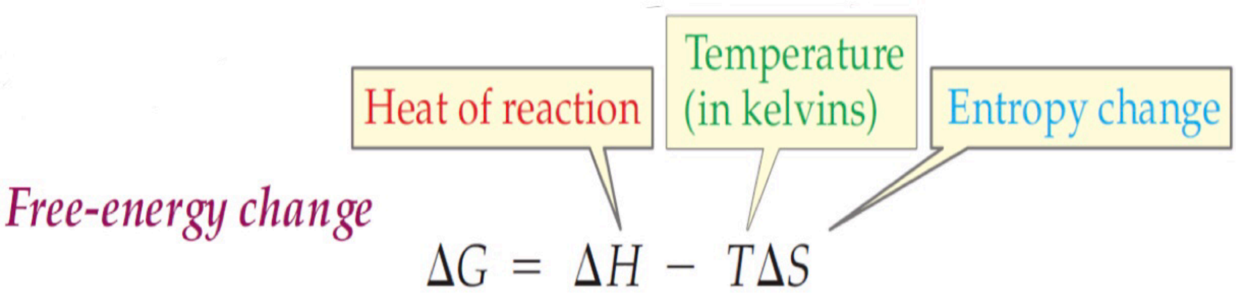
<u>Metabolism</u>: Sum of all biochemical reactions in living organisms (anabolism or catabolism) (building up or breaking down materials)
<u>Bioenergetics</u> :is the study of energy transformation in cells from the thermodynamic point of view (potential energy not kinetic energy within mater)
Energy is the life .
So, many processes in our body need energy : Mechanical, Active transport, Biosynthesis, Heat

<u>types of energy are:</u>
1-Kinetic energy : the energy during motion which deals with movement (that we studied in last semesters)
2-potential energy : energy stored within materials that can be converted to kinetic energy if needed . KEEP in mind that food is an example of potential energy (which is our course). **Energy of Bonds within the molecule itself & others molecules**
Can determine whether the reaction occurs or not (according to favorability we'll discuss in this sheet)

Relation between Energy and stability
(Energy has inverse relationship with stability)
High energy(either potential or kinetic energy) material indicates low stability
Main concept or causes for chemical reaction is to achieve more stable situation.

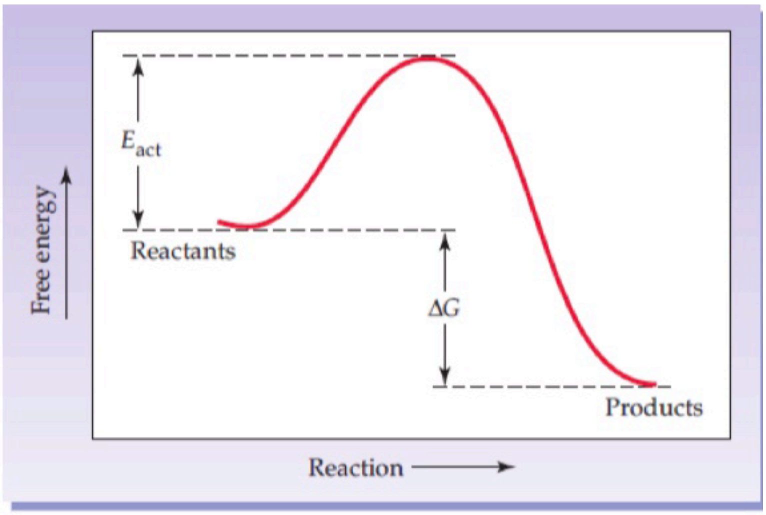
Gibbs Equation



For any delta =final -initial (Difference between the potential energy of product and reactant)
Dr said that we should know the difference between enthalpy change(ΔH) and entropy change(ΔS).

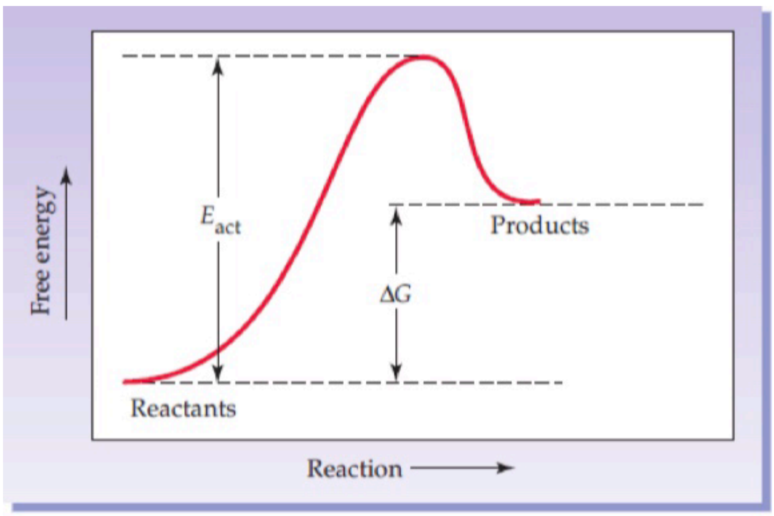
$$\Delta H = \Delta G + T\,\Delta S$$

Enthalpy change(ΔH) : measure the bond energy in between different atoms and different molecules in materials
Entropy change (ΔS) : measure the disorder between the different molecules (close or farther to each other, they can go randomly , etc…) for nature system increase in time



(a) An exergonic reaction

🌸ΔG is negative, there is a loss of energy (product more stable than reactant)
🌸Reaction goes spontaneously(favorable)
🌸The reaction is exergonic.
#it isn't spontaneously as it state , because it should go to a high energy state (transition state) and the energy that is needed is called activation energy .

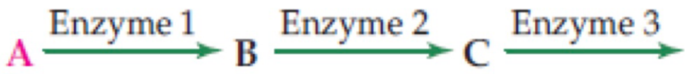


(b) An endergonic reaction

🌸ΔG is positive, there is a gain of energy (reactant more stable than product)
🌸Reaction does not go spontaneously (unfavorable)
🌸The reaction is said to be endergonic.

spontaneousity is determined by ΔG

*ΔG is not affected by the mechanism of the reaction (presence or absence of enzymes)
*ΔG is not affected by the pathway of the reactions only cares about initial and final states ,so that we called it state function . (ΔG from A to B to C = ΔG from A to C)



- $A \longrightarrow B \longrightarrow C$

$$\Delta G_{A\rightarrow B} = \cancel{GB} - GA$$
$$\Delta G_{B\rightarrow C} = GC - \cancel{GB}$$
$$GC - GA = \Delta G_{A\rightarrow C}$$

For example: combustion of glucose outside the body will release (— 680 kcal/mol)
Inside the body glucose undergo 10 steps to be oxidise but also it will release (—680kcal/mol)
So, we will repeat that ΔG cares ONLY about initial and final states .

Glucose + O_2 → CO_2 + H_2O ΔG = - 680 kcal/mol
In the cell

$\boxed{\text{Glucose} \rightarrow\rightarrow\rightarrow\rightarrow\rightarrow\rightarrow\rightarrow CO_2 + H_2O\ \Delta G = -680\ \text{kcal/mol}}$

#Standard free energy change (ΔGo) VS Free energy change (ΔG)
ΔG = the free energy difference of a system at any condition (may be different because of changing concentration or temperature, etc…)
Determine the favorability of reaction

ΔGo= the free energy difference of a system at standard conditions (25C o & 1 atmospheric pressure, 1M concentration of reactants & products, pH = 7)
It is always constant

Our body have changing conditions such as temperatures , concentration and pressure so the same reaction in different region may have different ΔG value , but the same(ΔGo) value

$$\Delta G = \Delta G^{o} + RT \ln \frac{[\text{Products}]}{[\text{Reactants}]}$$

$$\Delta G = \Delta G^{o} + RT\ 2.3 \log \frac{[\text{Products}]}{[\text{Reactants}]}$$

***ΔG o= the free energy difference of a system at standard conditions**
***R is the gas constant**
***T is the absolute temperature (K)**
In represents the natural logarithm
#KEEP in mind that , if the value of

$\frac{[\text{Products}]}{[\text{Reactants}]}$

= 1 the ln will be zero
Greater than 1 ln will be +ve
Less than 1 ln will be -ve

In other words , if [P] = [R] ln equals zero
[P] > [R] ln has positive value
[P]< [R] ln has negative value

اعتمادًا على المعادلة ، لنفترض قيمة دلتا في الظروف المعيارية = 4 ، كان تركيز المتفاعلات أعلى من النواتج و بالتالي قيمة اللوغاريتم سالبة و بتساوي -5 و حسب القانون $\Delta G = 4 - 5 = -1$ و نستنتج انه
An endergonic reaction under standard conditions can be exergonic under physiological conditions.

Equilibrium

Equilibrium: is the state of balance when 2 rates(rate of products converting to reactants, and rate of reactants converting to products) are equal .
But , that doesn't mean that equilibrium is equally of concentration to both reactant and product .

You can have an equilibrium in a reaction without having an equal concentration just have a equal rates of both forming products & reactants

معلومتين حبيت أوضحهم بالعربي ....

1)How does the concentration affect ΔG???

مادة تركيزها واحد مول لما اكسرها بتعطيني 5كالوري بس لو استخدمت بدل واحد مول 2مول رح تصير تعطيني 10كالوري و بالتالي زيادة التركيز بتأثر على قيمة ΔG

2)Delta G has nothing to do about reaction rate

تخيل انه فيه غرفتين الأولى فيها 100طالب و الثانية فيها 10 طلاب (يعني تركيز الأولى أعلى من الثانية) يعني ؟ حسب كلامنا الفوق الأولى دلتا جي فيها أعلى من الثانية
عملت حركة منتظمة للطلاب بحيث ينتقل 3طلاب كل دقيقة من الغرفة الأولى للغرفة الثانية و 3طلاب من الثانية للأولى (يعني rateتبعهم نفسه و يساوي 3طلاب بكل دقيقة على الرغم من الاختلاف الكبير بالدلتا)
و هيك بنفهم كيف انه **Delta G has nothing to do about reaction rate**

At equilibrium:
ΔG=0 (since the driving force of any reaction at equilibrium is zero) substitute ΔG=0 we get;

$$\cancel{\Delta G} = \Delta G^\circ + RT \ln \frac{[Products]}{[Reactants]}$$

$$K_{eq} = \frac{[products]}{[reactants]}$$

$$\Delta G^\circ = -RT \ln K$$

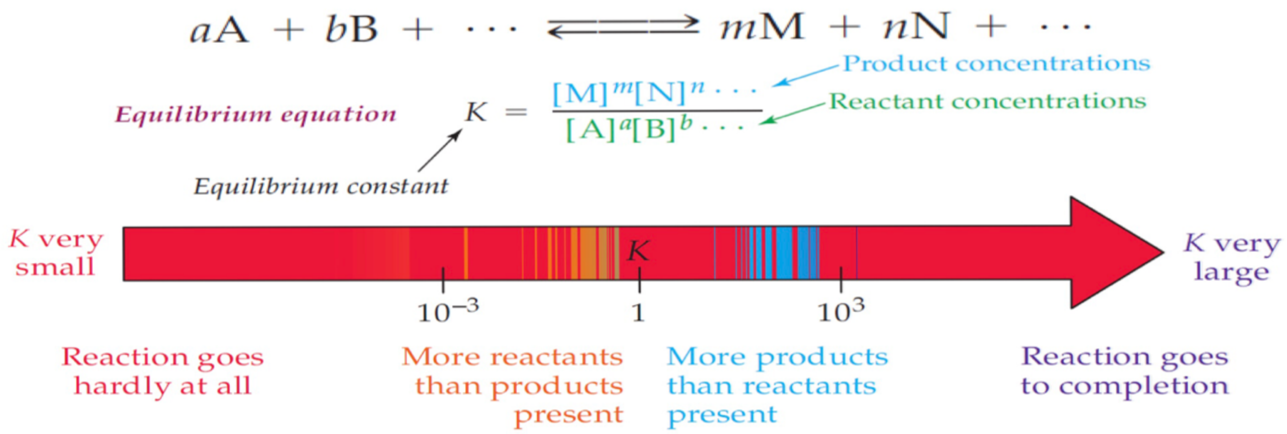
How much change in delta G
compared to changes in Keq

If $K_{eq} = 1$, then $\Delta G^\circ = 0$

If $Keq > 1$, then $\Delta G^\circ < 0$

If $Keq < 1$, then $\Delta G^\circ > 0$

where Keq is the equilibrium constant. So, once we know the Keq for a reaction we can tell the ratio between products and reactants when the reaction reaches equilibrium.
e.g. if the Keq=100 that means at equilibrium [P]=100*[R]
If K eq is high (>1000) then we know that at equilibrium the reaction is mostly composed of products and a small proportion of reactants, thus we can say that the reaction is almost completed.
while when K eq is low (<0.001) we can say that the reaction is hardly going.



The Effect Of Changing Conditions On Equilibrium

$$\text{defining } K'_{eq} = \left(\frac{[C]\,[D]}{[A]\,[B]}\right)$$

$$\Delta G^{o\prime} = -RT \ln K'_{eq}$$

How the equilibrium is getting affected by different factors?
What are the factors that affects the equilibrium?

When a stress (any change that disturbs the original equilibrium) is applied to a system at equilibrium, the equilibrium shifts to relieve the stress.

1)Effect Of Changes In Concentration
What happens if a reactant/product is continuously supplied/removed?
—>If you have an equilibrium state, and you increase the reactants concentration, the reaction will go forward, until achieving a balance state
—>If you have an equilibrium state, and you increase the products concentration, the reaction will go backward, until achieving a balance state
—>Metabolic reactions sometimes take advantage of this effect