Metabolism: Sum of all biochemical reaction in living organisms (anabolism or catabolism)

Bioenergetics: is the study of energy transformation in cellsfrom the thermodynamic point of view (potential energy not kinetic energy)

♡ Energy is the life ♡

So, many processes in our body need energy: Mechanical, Active transport, Biosynthesis, Heat

Types of energy are:

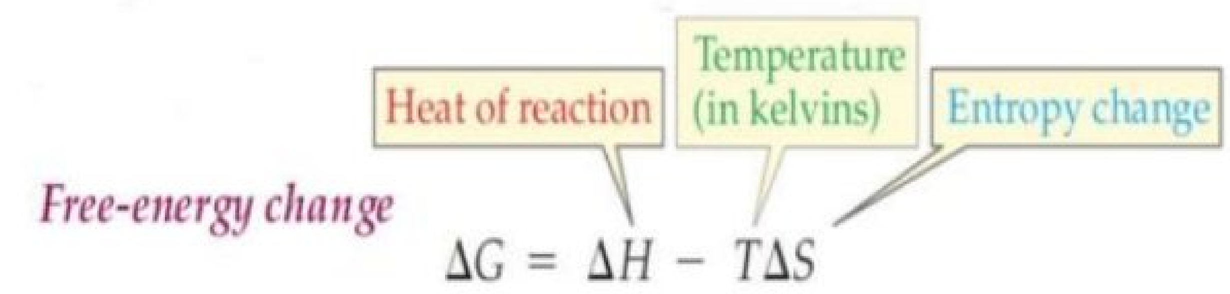
1-Kinetic energy : the energy during motion

2-potential energy : energy stored within materials that can be converted to kinetic energy if needed .

(Energy has inverse relationship with 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)

Enthalpy change(ΔH) : **regular**

bond energy **in** different atoms

Entropy change (ΔS) : **random** :

disorder between the different molecules for nature system Increase in time

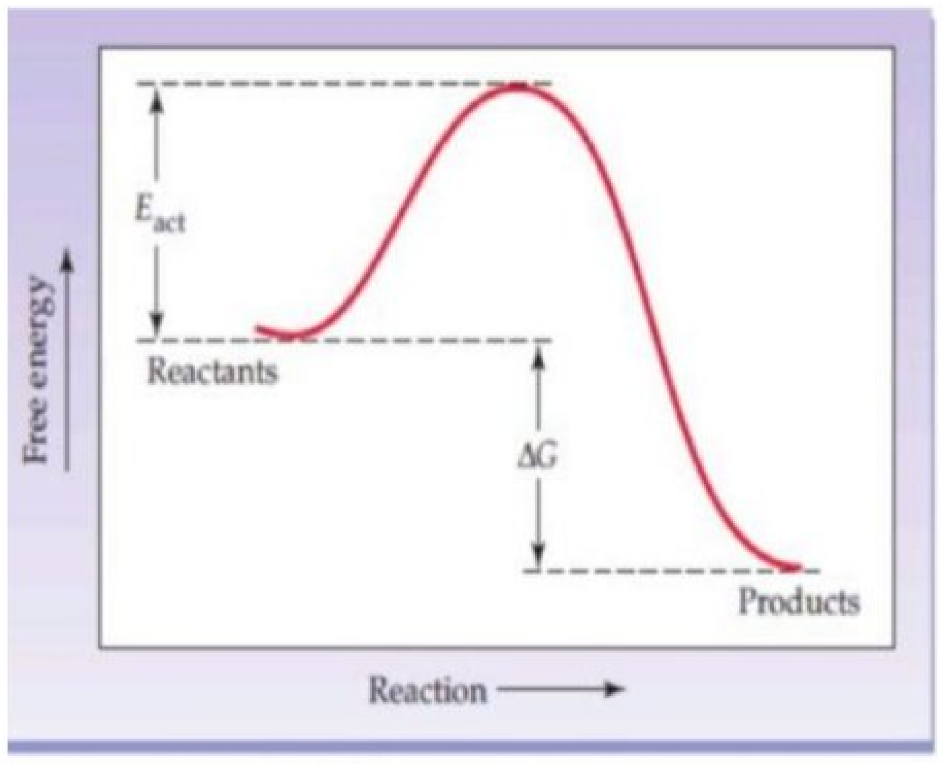
REACTION

ΔG is negative :loss of energy

(product more stable than reactant)

spontaneously (favourable) , exergonic.

Transition state → activation energy



(a) An exergonic reaction

Breaking down all molecules so, releasing energy

** Hydrolysis reactions

** Decarboxylation reactions

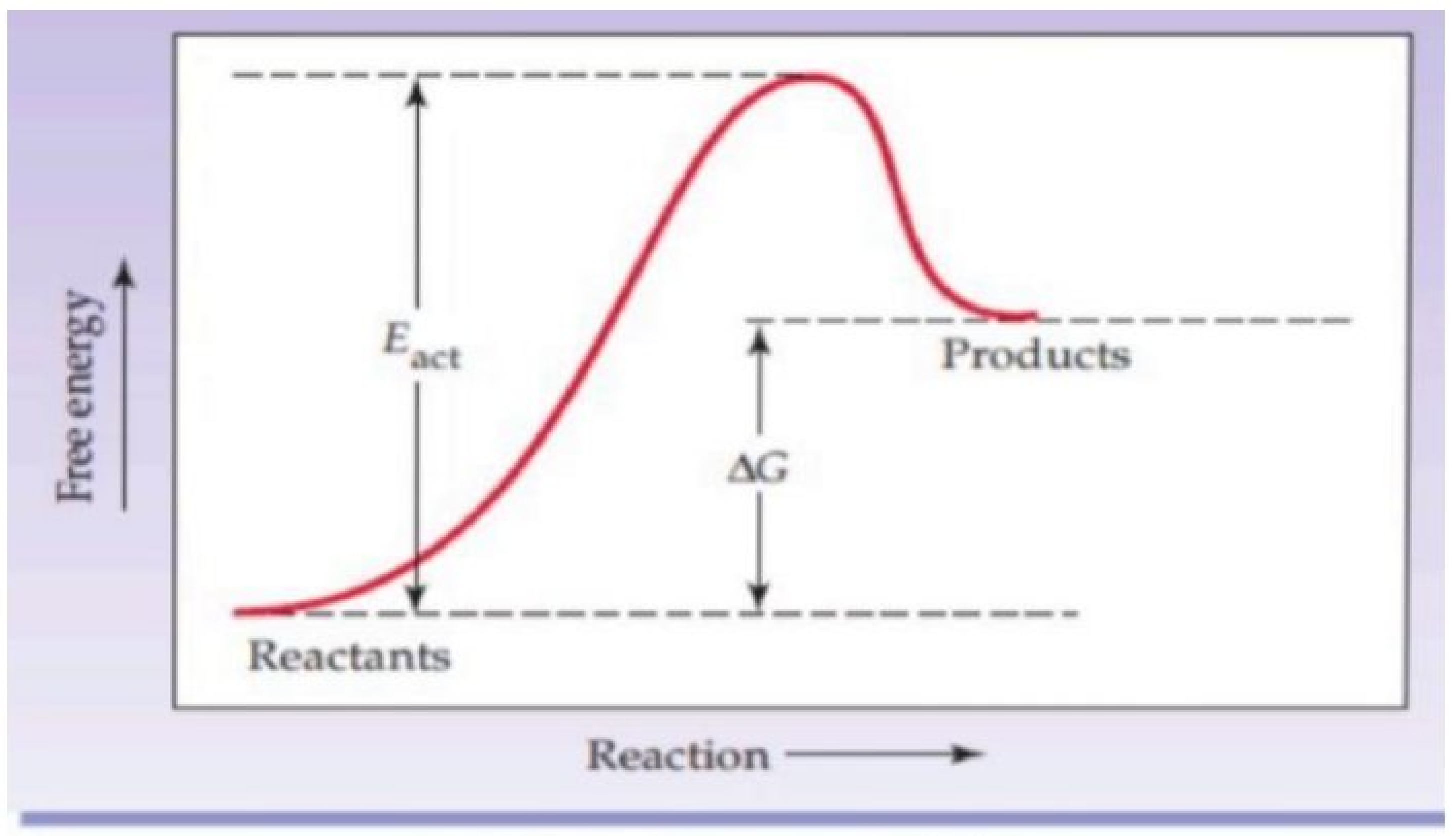
** Oxidation

ΔG is positive

Gain ofenergy (reactant more stable than product)

Not go spontaneously (unfavorable)

endergonic.



(b) An endergonic reaction

*ΔG is not affected by the mechanism of the reaction (presence or absence of enzymes)

**pathway of the reactions only cares about initial and final states " state function "

glucose #

- $A \rightarrow B \rightarrow C$

$\Delta G_{A\rightarrow B}$ = ~~GB~~ - GA

$\Delta G_{B\rightarrow C}$ = GC- ~~GB~~

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

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#Standard free energy change (ΔG_o) VS Free energy change (ΔG)

ΔG = the free energy difference of a system at any condition

{ Determine the favourability of reaction }

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

Equilibrium:

State of balance when 2 rates

(doesn't equally of concentration)

Concentration affect ΔG

Delta G has nothing to do about reaction rate

At equilibrium:

ΔG=0 (since the driving force of any reaction at equilibrium is zero)

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

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

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

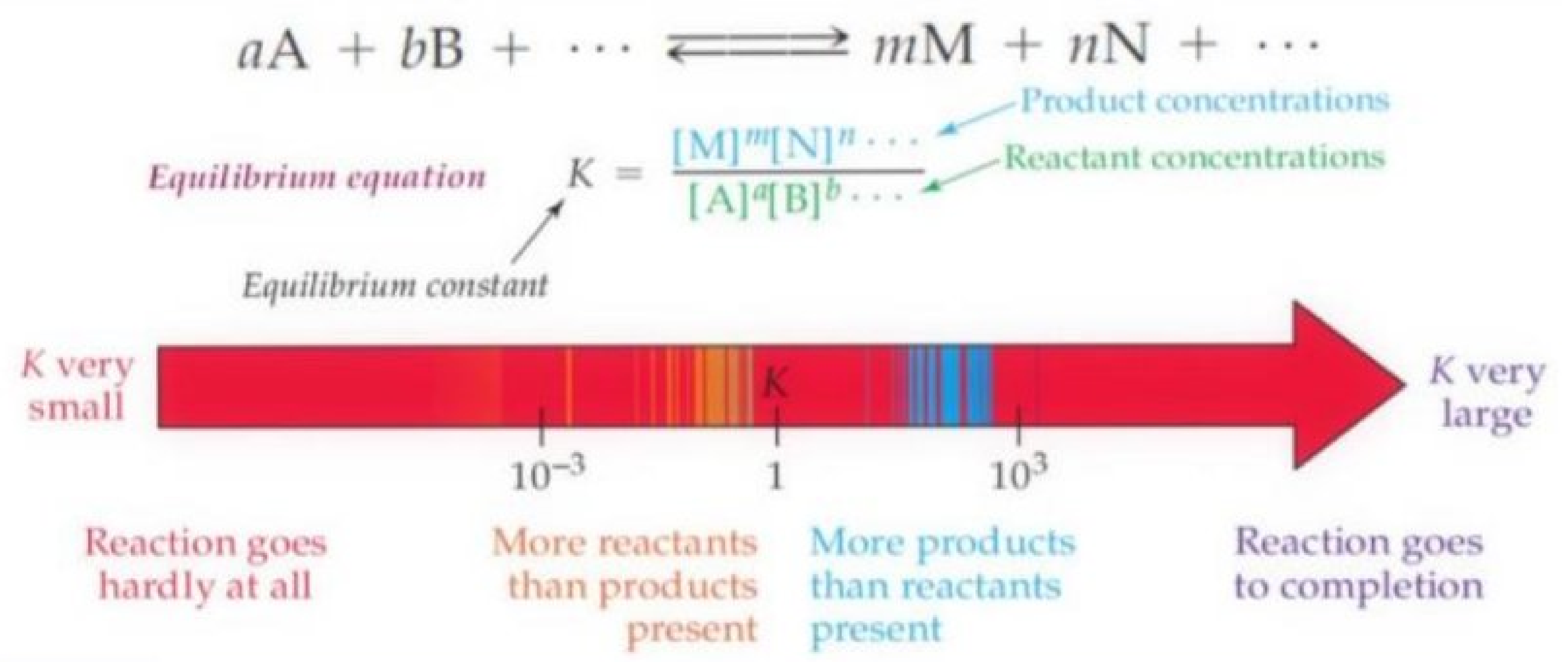
How much change in delta G compared to changes in Keq

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

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

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

Keq=100 that means at equilibrium [P]=100*[R]



The Effect Of Changing Conditions On Equilibrium :

** The equilibrium shifts to relieve the stress

1) Effect Of Changes In Temperature

More reactants (↑ T —> encouraging the backward direction)

More products (↑ T —> encouraging the forward direction)

《 Until we reach the equilibrium state 》

endothermic/exothermic are favoured by increase/decrease in temperature, respectively

2) Effect Of Changes In Concentration

** —>Metabolic reactions sometimes take advantage of this effect

:) no effect of a catalyst (enzyme) on equilibrium ; It just helps the reaction to achieve equilibrium faster, because catalysts play on what is between the reactants and products

—>90% energy (ATP) mitochondria , (10%) glycolysis cytosol

—> The number of mitochondria is greatest in eye, brain, heart, & muscle, where the need for energy is greatest

—>mitochondria is found only in eukaryotic cells (evolution theory)

Reproduction of mitochondria

—>Reproduction of mitochondria is governed (determined) by the need of energy

this is why athletes behave better in exercises than ordinary people, (they have more mitochondria, more oxygen supplies, more ATP)

Maternal inheritance

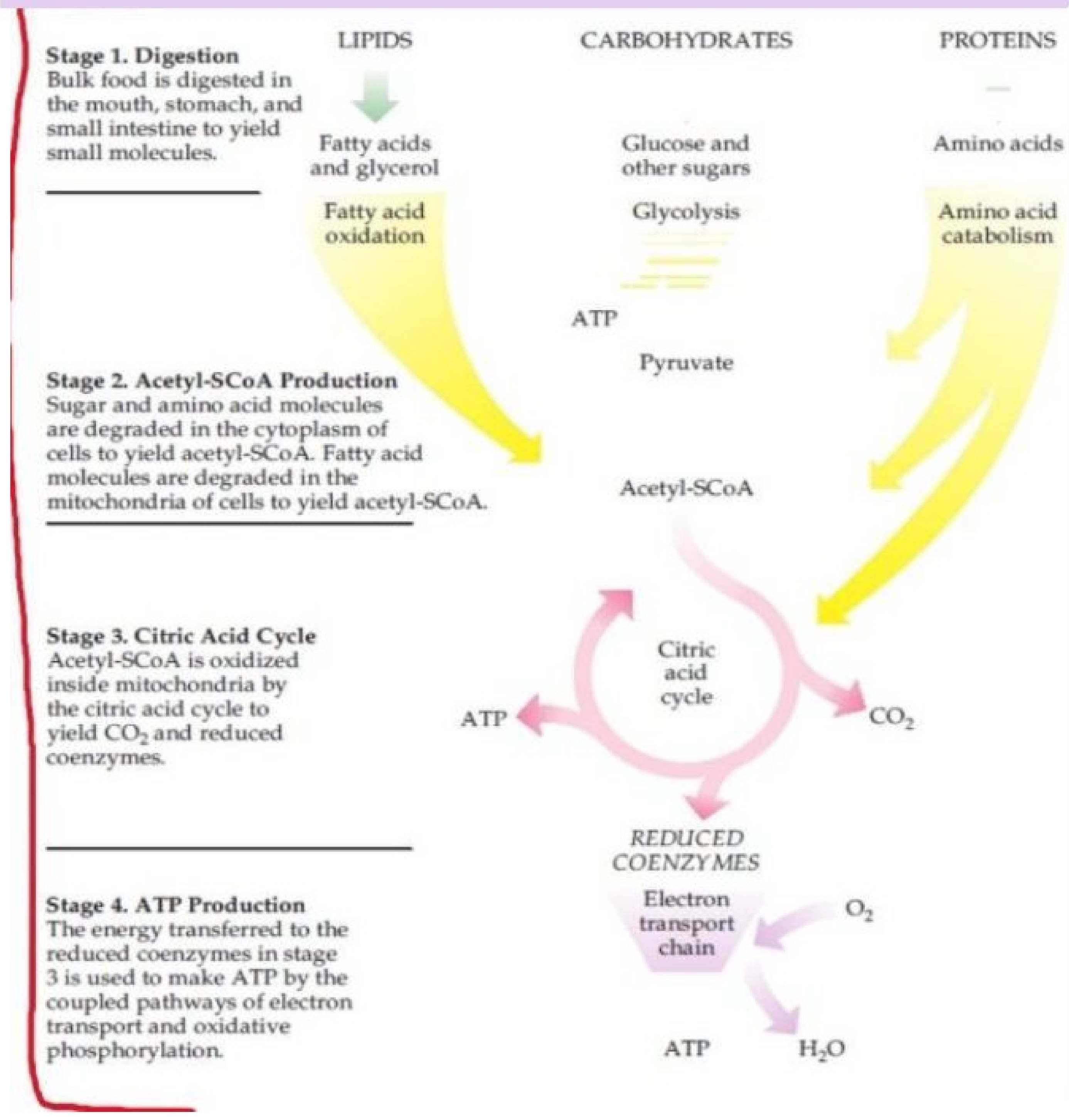
During cell division the mitochondria segregate randomly between the two new cells

As DNA is copied when mitochondria proliferate, they can accumulate random mutations, a phenomenon called heteroplasmy.

○ Mutation (DNA) → all over body [mitosis]

○ Mutation (mitochondria) → one daughter cell

ATP



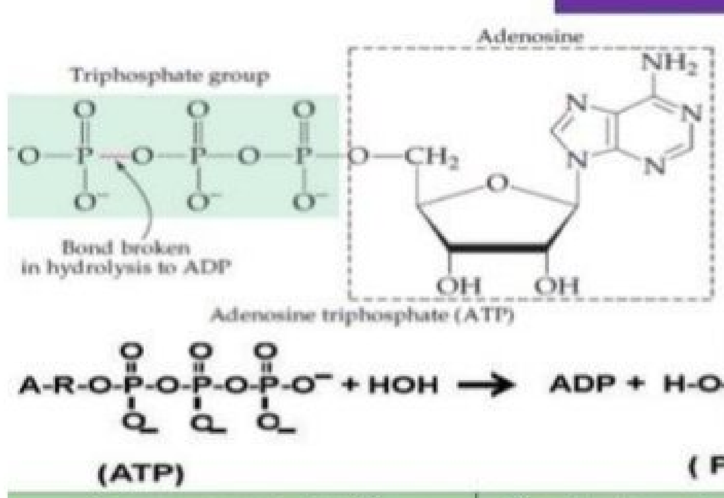
ATP

What determines the amount of energy a bond stores ? atoms / atoms around bond

ATP is the energy currency

—Why ATP is the energy currency of the cell? because it has an intermediate energy value, can be broken down and resynthesized easily

ATP



What determines the amount of energy a bond stores —>is the atoms that are involved directly in the bond (phosphate and oxygen for example in ATP) and the distribution of atoms around this bond which makes strain on the bond so it changes the energy of the bond.

-7.3 kcal/mole
-3.4 kcal/mole

Compound $+H_2O$	Product + phosphate	ΔG°
Phosphoenol pyruvate	Pyruvate	-14.8
1,3 bisphosphoglycerate	3 phosphoglycerate	-11.8
Creatine phosphate	Creatine	- 10.3
ATP	**ADP**	**- 7.3**
Glucose 1- phosphate	Glucose	-5.0
Glucose 6- phosphate	Glucose	-3.3

ATP is the energy currency of the cell, it has a triphosphate group and breaking down each P-O bond gives energy

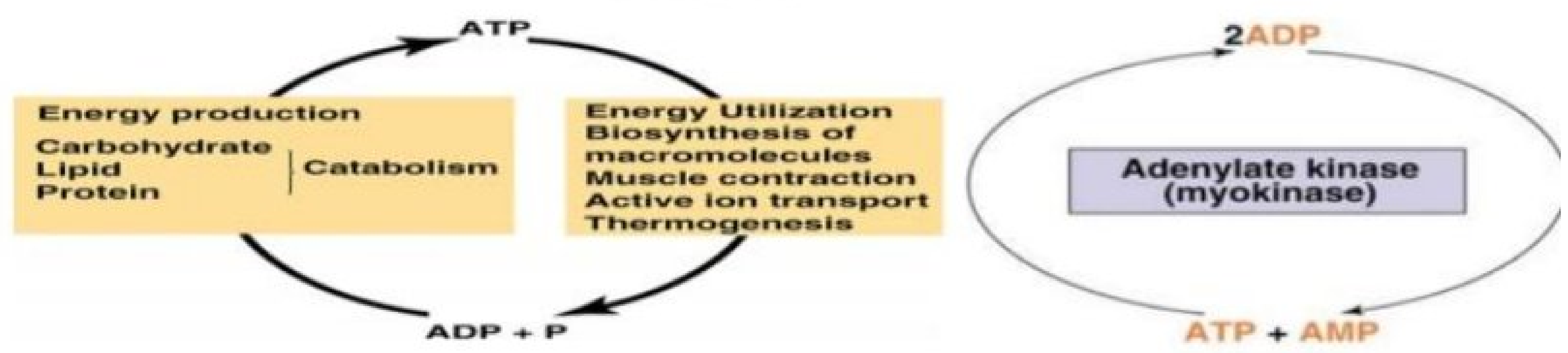
ATP عمله الطاقة في اجسامنا

There is no place where ATP is stored in the

Breakdown ATP ⟶ ADP + P_i [20 Kcal/mol]

Synthesis ATP ⟵ ADP + P_i [20 Kcal/mol]

There are also many reactions that give the same amount of energy that ATP produces so it can compensate ATP. تعويضه



body, energy is stored as bonds in (carbohydrates , lipids ,...) ...Why??
Because we consume a huge amount of ATP everyday that equals 90.6 moles /day

So , you need 49,920 g ATP (approximately 50,000 g ATP)!!!

** That means if your body store energy as ATP molecules you'll add 50 Kg to your weight , also your size after eating will be increased and when you're hungry it'll decrease(unreality) Pathways

Why dowel you like need energy?

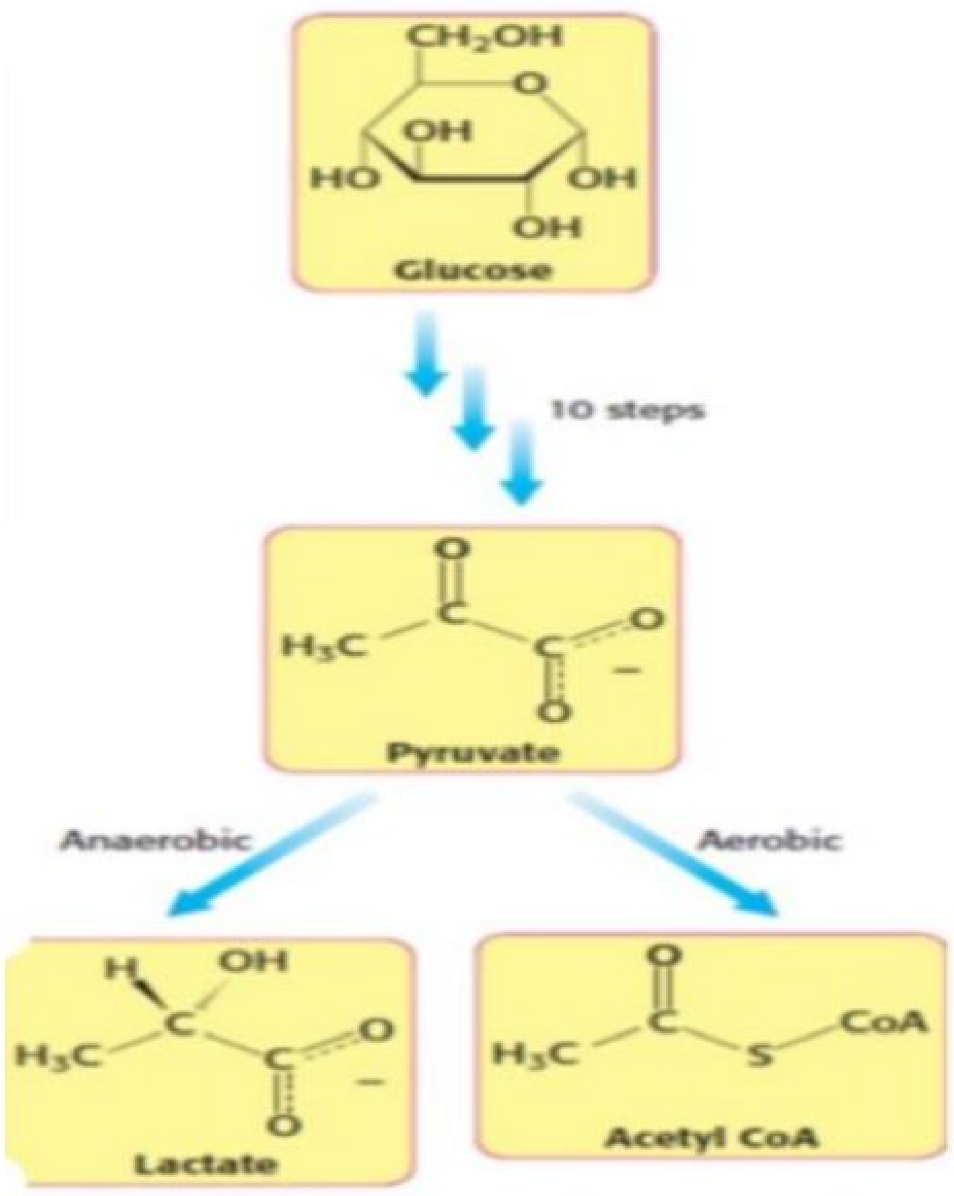
1. mechanical work
2. active transport
3. synthesis of macromolecules

Sun is the main source of energy

plants (autotrophs)

animals (heterotrophs)

human can eat both of them to get his food.



Pathways in our body ;

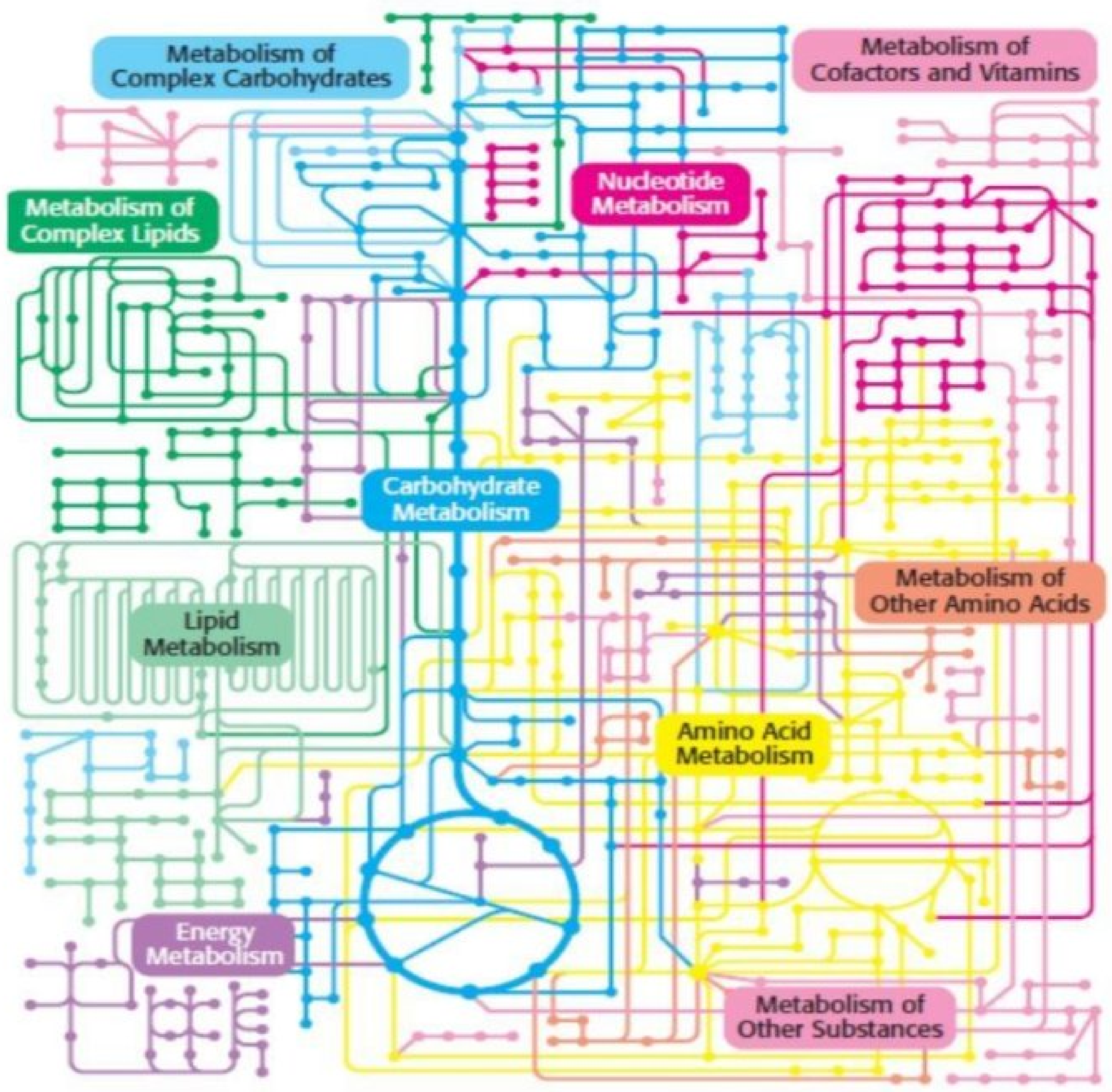
1.Linear pathway : every material converted to another material (different enzymes)

2.cyclic pathway : by the end of pathway , first material (different enzymes)

3.spiral pathway : different materials , same set of enzymes

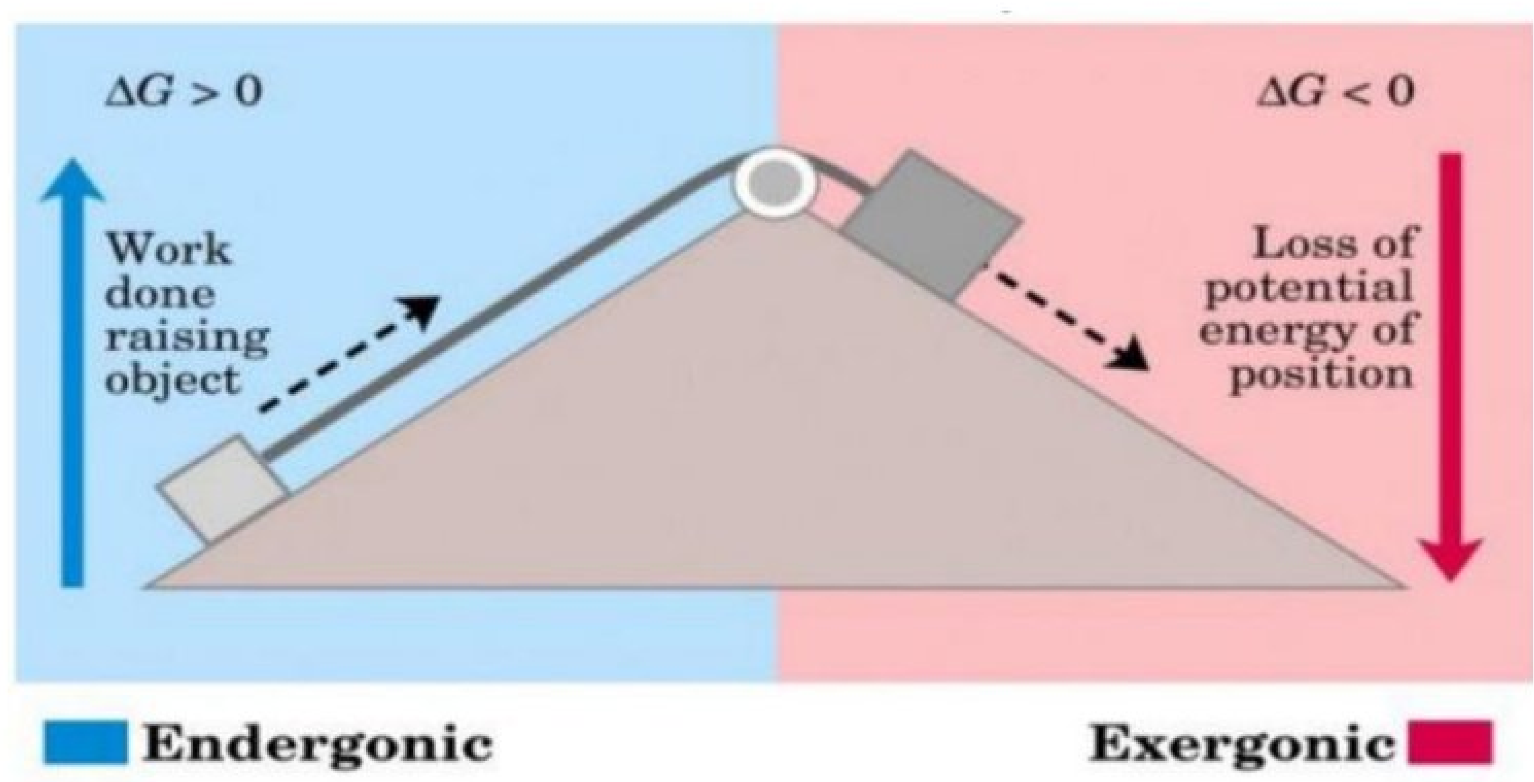
All pathways in our body need to understand each other to conserve energy from loosing , allosteric enzyme helps in this process... How?

Allosteric enzyme : enzyme that have multiple binding sites for different molecules from different pathways and areas ,that helps molecules to collaborate with each other and conserve energy



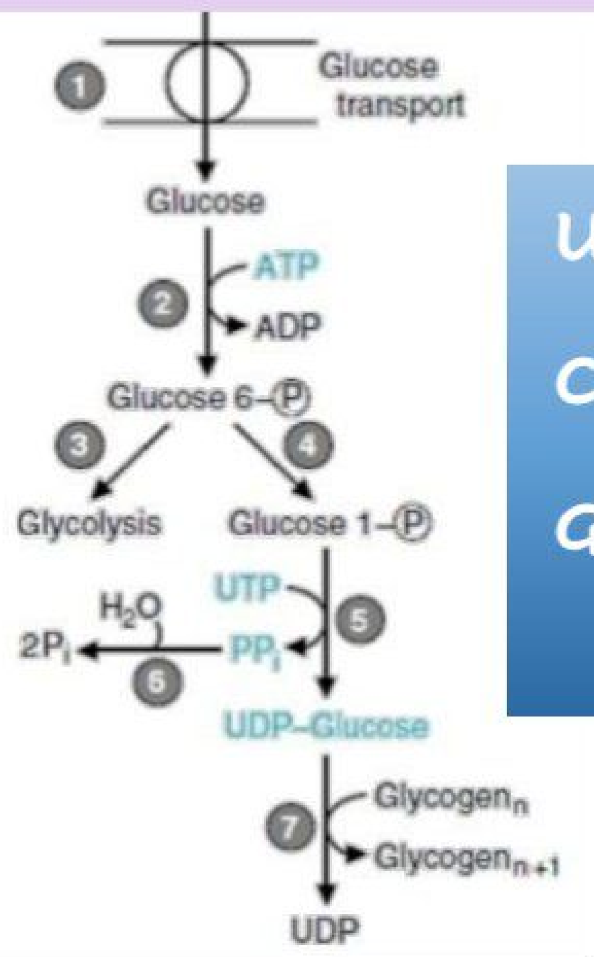
Coupling a reaction consume energy to Add certain material and other reaction release energy and that material, too.

(REALEASE ENERG , MATERIALS)



EXAMPLE : Phosphorylation transfer reaction

Thermogenesis:



UTP = SUGAR

CTP = LIPID SYNTHESIS

GTP = PROTEIN SYNTH

Thermogenesis:

✓ Is the first law of thermodynamics

- It is the energy expended for generating heat (370C) in addition to that expended for ATP production الطاقة المستهلك في توليد حرارة الجسم الطبيعية 27 °و طاقة

Shivering thermogenesis

(ATP utilization)

asynchronous muscle contraction due to sudden change in the body temperature

More ATP and generate heat

(Heat production is a natural consequence of "burning fuels")

Non-shivering thermogenesis

(adaptive thermogenesis)

the percentage of energy that you are ingesting inside your body to make heat (ATP production efficiency)

الطاقة الحرارة العادية ♡