Energy and Life

Metabolism is all of the cell's chemical reactions that take place to build o break down molecules.

Common factors of all metabolic pathways:

1: Begin with a starting molecule and finishes with a product.
2: They require Enzymes to catalyze each step.
3: Require multiple steps.

The type of energy that we are interested in is free energy, and it's the energy in the system that is available to do work (G)

> Energy can be transferred or transformed but neither created nor destroyed
> Every energy transfer or transformation increases the disorder (entropy) of the universe.

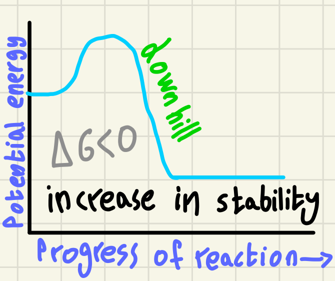
Metabolic Pathways:

Catabolic Pathway. Keywords:

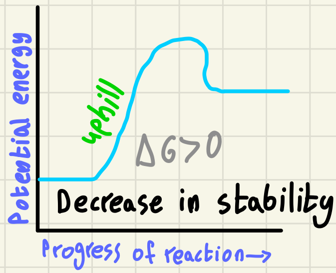
1) Exergonic reaction
2) Spontaneous
3) Release of energy (free energy)
4) ΔG is negative
5) Breaking down ......
6) Cellular respiration

Anabolic pathways. Keywords:

1) Endergonic reaction
2) non spontaneous
3) Absorbtion of energy (free energy)
4) ΔG is positive
5) Building of ......
6) Photosynthesis



Exergonic reaction



Endergonic reaction

- Example of exergonic reactions: Cellular respiration
- Example of endergonic reactions: Photosynthesis.

- Exergonic reactions move towards equilibrium. However, endergonic reactions move away from equilibrium. Therefore, a normal reaction (one that has both types of reaction) don't reach equilibrium (Only reactions in closed systems reach equilibrium)

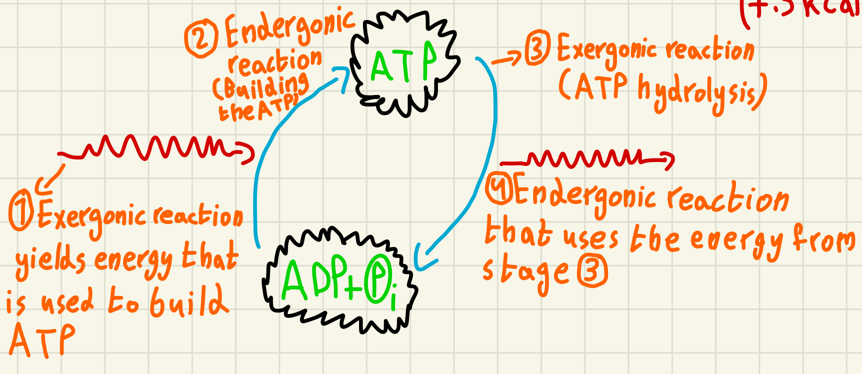
- We can conclude that our bodies -cells- never reach equalibrium since they are open systems

- Most reactions in cells are endergonic. They get their energy from exergonic reactions. This is called coupling reactions.

This energy is primarly found in ATP.

- ATP is highly unstable due to the 3 negatively charged O (Repulsion happens) Therefore, the 3rd "P" can easily be removed via hydrolysis, releasing energy.

1ATP ⟶ 1ADP + Iorganic phosphate + Energy (7.3 KCal/mol) (negative)



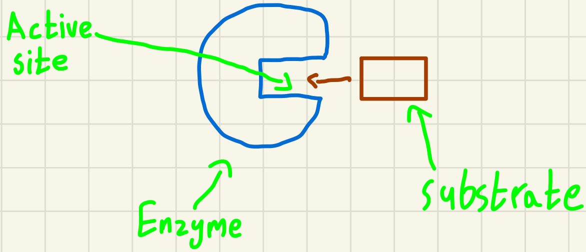
Enzymes – The catalytic protein

Enzymes help to speed up reactions by lowering the activation energy WITHOUT being consumed

- Most enzymes are made of mainly proteins. Some are RNA, and thus calling them Ribozymes.

- Enzymes are very specific with the substrates they bind with

- Enzymes are bound to their substrates by weak bonds (So that the interactions between them is temporary; until the products are made)



The Possible Enzyme-Substrate Complex Models

1) Lock and Key model: States the the substrate is at perfect fit with the active site of the enzyme.

2) The induced fit model: States that the enzyme gradually changes (The active site) conformation to fully wrap around the substrate.

After the enzyme links with its substrate(s), It lowers the E_A by:

1) Orienting the substrates correctly.
2) Straining / Stressing the substrates' bonds.
3) Providing a favorable microenvironment.
4) Covalently bonding to the substrates

One of the most defining features of enzymes after the reactants are turned into products is that the enzymes DON'T get consumed from the reaction.

Enzymes have both:

Non protein enzyme helpers (Cofactors):
1) Inorganic helpers (like metal ion)
2) Organic molecules Coenzyme (like vitamens)

Opposities ⟷

Inhibitors:
1) Competitive inhibitors:
Attaches to the enzyme's active site and thus preventing the substrate to bind.
We can fix this problem by increasing the concentration of the substrate(s).
2) Noncompetitive inhibitors:
Alters the shape of the enzyme, and thus greatly reducing its effectiveness to the substrate.

Allosteric enzyme → Regulatory molecule (Activator or Inhibitor) → Stabalized active form / Stabalized inactive form

The allosteric enzyme oscillates between these 2 forms.

Cooperativity is a form of allosteric regulation

Side notes:

I) For a reaction to happen, the molecules should
1) Receive energy enough for the activation energy
2) Get very close to each other in the correct orientation

II) Enzymes have the suffix "ase"

III) Enzymes behaviour depend on all 4 of its structures (Primary, secondary.....)

IV) The interactions between the enzymes and their substrates are either:
1) Hydrogen bonds
2) Ionic bonds

V) Some enzymes participate directly in the catalytic reaction * (The 4th point on how enzymes lower E_A)

VI) ΔG when an enzyme is used is not affected.

VII) The enzyme Pepsin is at optimal activity in acidic environment (The stomach) (PH=2).

VIII) The enzyme Trypsin is at optimal activity in basic environment (The Intestine) (PH=8).

IX) Enzymes have optimal performance in a specific temperature/PH (Performance is affected if the optimal decreases or increases)

X) Competitive inhibitors also have the ideal shape to bind to the active site.

XI) The regulatory molecules bind with the regulatory site, not the active site.