MED-HUB

BIOCHEMISTRY

Introduction

Introduction

Biochemistry: It is the science concerned with studying the various molecules that are found in living cells and organisms, and their chemical reactions, the word is made up of two parts: bio which refers to the biological system we are studying the reactions at (which is the cell), and chemistry, which refers to the chemical compounds and their reactions.

Goals of studying biochemistry

- to know the chemical structure of the molecules.
- to understand the function of these molecules.
- to understand the interactions and reactions between them inside the cell.
- to understand bioenergetics and energy flow in the cell.

So, by knowing the normal state of our cells, we can determine when something abnormal happens, and deal with it using biochemistry applications, which will help us to diagnose and monitor diseases, in addition to making drugs for them.

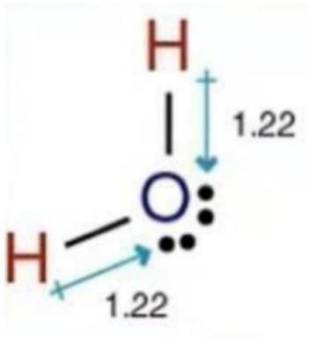
Chemical elements in our bodies

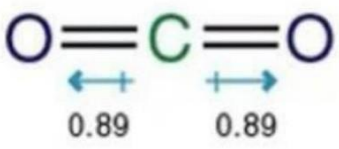
Our bodies are composed of 31 elements, six of them are considered the main ones, C, H, O, N, S, P (Carbon, Hydrogen, Oxygen, Nitrogen, Sulfur, Phosphorus) the others are still important even though found in small concentrations.

Covalent bond

-Covalent bonds are bonds found between atoms in a single molecule (known as covalent molecule), in which electrons are being shared.
-Single, double, or triple bonds may be found between two atoms.
-Bonds can be compared by their strength (triple>double>single), length (single>double>triple), and their orientation.
-Another property of covalent bonds is polarity, which depends on the electronegativity (the ability to attract electrons) between the atoms forming the bond, different atoms will make the bond polar because they have different electronegativity, but the same atoms (or atoms with slight difference in electronegativity like C&H) form non-polar bonds.
-The atom with higher electronegativity will gain a partial negative charge and the atom with lower electronegativity will gain a partial positive charge.

-We have another concept we must be aware of, polar molecule, which is a molecule that has covalent bonds pointing at different directions (like H_2O), but if the bonds were pointing completely against each other (like CO_2) it is a non-polar molecule.





Non-covalent interactions

They are weak interactions and last only for a short time, they often form between two different molecules (unless the molecule is large).

Types of non-covalent interactions

1- Electrostatic interactions: interactions between charged particles whether the charge is partial or full.
2- Hydrogen bond (the strongest): a special type of electrostatic interactions where ahydrogen atom is shared between two highly electronegative atoms (like N&O).
3-Van der Waals interactions (the weakest): this interaction results from the movementof electrons around the nuclei of an atom.

Non-covalent interactions properties

- reversible (short lifetime).
- weak compared to covalent bond.
- only specific molecules can form them.
- contribute to the structure stability.
- can be attractive or repulsive.
- found between molecules or within one large molecule.

Hydrophobic interactions

Not true interactions, forces that drive non-polar molecules away from polar environment and associate them together, in order to minimize unfavorable interactions between polar and non-polar molecules, and they are important for micelle formation and the removal of fat and grease from hands and dishes.

Carbon properties

Carbon is an especially important atom, it can make four bonds and each one of them is stable, it has electronegativity between other atoms, and can form polar and non-polar bonds, pure carbon is not water soluble, but adding other atoms (like O&N) make it more water soluble.

Water importance

- 60% of our body is water.
- 70-85% of each cell is water.
- solvent to many substances in our bodies.
- medium in which acids and bases release their chemical groups to maintain homeostasis.
- buffer that maintains pH.
- temperature regulation due to its high specific heat capacity.
- participant in many biochemical reactions.

a man who weighs 70kg will have 40 liters of water, distributed as 25 liters intracellularly, 10 liters of interstitial fluid, and 5 liters of blood.

Hydrogen bonds in water molecule

The number of hydrogen bonds in liquid water at 10 Celsius is 3.4 (constantly forming and breaking), while in ice crystals it is 4 (the maximum), and we can conclude that less temperature = more hydrogen bonding and vice versa.

Water properties

- water is a polar molecule.
- water is highly cohesive, due to hydrogen bond formation.
- water molecules form a network, due to hydrogen bond formation.
- water is an excellent solvent.
- water acts as a nucleophile (electron-rich molecule).
- water can be ionized to hydronium ion H_3O^+ and hydroxide ion OH^-

Water and thermal regulation

Water can resist sudden and large temperature changes, because of its:

- high thermal conductivity (the heat doesn't just stay in small heated area in our body, but it's conducted and shared by all the water in our body).
- high heat of fusion (large drop in temperature is needed to convert liquid water to ice).
- high heat capacity and heat of vaporization (large amount of energy is absorbed when sweat is converted to gas and evaporates from the skin, that's why we feel a cooling effect).