Biological molecules

Essential elements of life

Objectives :

- State the essential elements and their functions
- State that Carbon atoms can form four covalent bonds allowing a diversity of stable compounds to exist.
- State that life is based on carbon compounds including carbohydrates, lipids, proteins and nucleic acids.
- Define metabolism as the web of all the enzyme-catalyzed reactions in a cell or organism.
- Define anabolism as the synthesis of complex molecules from simpler molecules including the formation of macromolecules from monomers
- Define catabolism as the breakdown of complex molecules into simpler molecules including the breakdown of macromolecules into monomers.

Resources :

Book pages 23 ,24

https://www.youtube.com/watch?v=HrYRMknYHrk metabolism

Biological Molecules | Cells | Biology | FuseSchool – YouTube

Biological molecules include all the molecules within living organisms that are **responsible for the processes of life** and **the interactions within the various systems of a cell.**

Within living organisms, there are many essential elements that are required for life; they are the **building blocks of the biological molecules** that make up the living matter. **Carbon, hydrogen, oxygen and nitrogen** make up the basic structure of the biological molecules in living organisms. Water makes up about 60% of the human body and is considered the medium of life. Carbon compounds are the basis of life and they are commonly **made up of carbon, hydrogen, oxygen and nitrogen atoms.**

Essential elements :

There are around **25 elements** which are known to be essential for life.
Essential elements are needed in specific amounts; some are needed in large amounts while others are needed in small amounts. **Hydrogen, oxygen, carbon and nitrogen** are considered the most frequently occurring elements in living organisms as they are needed for the basic structure of **carbohydrates, lipids, proteins and nucleic acids**. Other elements are required in small amounts, though they have a major role in keeping the body working effectively. Such elements include iron, calcium, phosphorus and sodium. Table 1 indicates some of the essential elements and the role of each inside human bodies.

An essential element is any element that is required for life and its absence causes abnormal development or functioning

Table 1. Some essential elements and their function

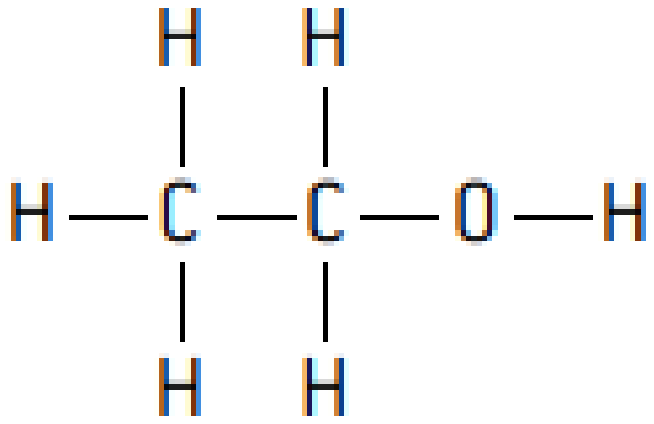
Element	Function
Sulfur	Needed for the synthesis of amino acids
Calcium	Acts as a co-factor in some enzymes. It is also a component of bones
Phosphorus	Needed for the following: • formation of the nucleotides in DNA molecules • formation of phospholipids • formation of ATP
Iron	Needed for the synthesis of hemoglobin, which is a protein that carries oxygen in the blood
Sodium	Needed for osmotic balance. It is also needed in sending nerve impulses

Recap

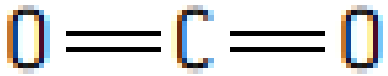
ATOMS AND MOLECULES

An atom is a single particle of an element, consisting of a positively charged nucleus surrounded by a cloud of negatively charged electrons. A molecule is a group of two or more atoms held together by covalent bonds. These can be single, double or even occasionally triple covalent bonds. In simple diagrams to show the structure of a molecule, the atom of an element is shown using the element's symbol and a **covalent bond with a line**

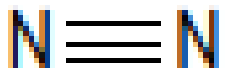
Examples of molecular diagrams



ethanol



carbon dioxide



nitrogen

hydrogen cyanide

Nitrogen is an element but the other three molecules are compounds as two elements are bonded together.
The molecules used by living organisms are based on carbon.
Each carbon atom forms four covalent bonds, allowing **a great diversity of compounds to exist**. Other elements used in molecules mostly form fewer covalent bonds :

Covalent bonds are relatively strong, so molecules can be **stable structures**. Much **weaker bonds** form between molecules. They are called **intermolecular forces.**
The main types of molecule used by living organisms are carbohydrates, lipids, proteins and nucleic acids.

Bonds	Element	Symbol
One	Hydrogen	H
Two	Oxygen	O
Three	Nitrogen	N
Four	Carbon	C

CARBON :

Man scientists describe life as "carbon-based", which means that it carbon was not present, life on Earth would not have been possible.

This is because carbon is required for the formation of most of the molecules present in living organisms. Carbon is a relatively small atom. It has six neutrons and six protons inside its nucleus. It has two electrons in its inner shell and four electrons in its outermost shell (figure 1).

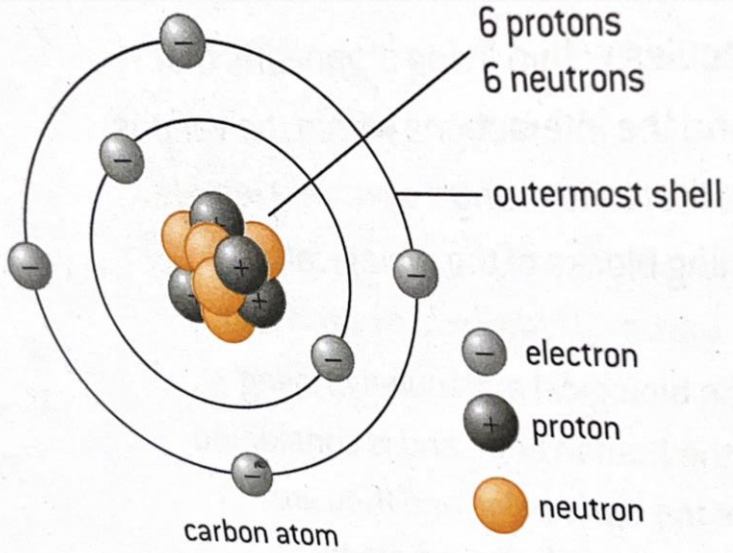


Figure 1. Carbon atom

Carbon can form four covalent bonds with itself or other elements such as hydrogen, oxygen, nitrogen, sulfur and others. The simplest carbon molecule is methane (CH_4), in which carbon binds to four hydrogen atoms, as shown in figure 2.

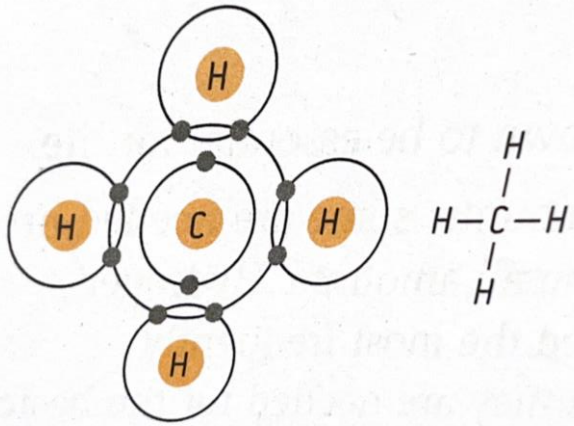


Figure 2. *Two ways of representing methane*

Carbon can form single, double or triple bonds. It can form long branched and unbranched chains, and even rings. It can bond with itself to form extremely strong and stable compounds. The ability of carbon to form different types of bonds enables it to form many different carbon compounds, that range from the simplest hydrocarbons to the most complex carbon compounds that can be found in living organisms.

Metabolism

Metabolism is composed of synthesis (anabolism) and degradation (catabolism) .

It is important to know that the chemical reactions of metabolic pathways do not take place on their own.

Each reaction step is facilitated, or catalyzed, by **a protein called an enzyme**.

Monomers : A molecule that can be bonded to other identical molecules to form a polymer.

Polymer : Are big molecules made by linking up smaller repeating monomer units.

These reactions takes place inside the cells (cellular metabolism)

Catabolism : The breakdown of complex molecules into simpler molecules including the breakdown of macromolecules into monomers.

Anabolism : The synthesis of complex molecules from simpler molecules including the formation of macromolecules from monomers.