What is the chemical composition of the cell?

Organisms are made up of a lot of different chemicals. These vary in size, from small molecules like water to large molecules like DNA, and interact and associate in many different ways to generate the processes of life.

Water is the most abundant substance in organisms. Cells are rich in water. Cytoplasm consists of organelles floating in a watery medium called cytosol that also contains proteins.

	PERCENT OF TOTAL CELL WEIGHT	NUMBER OF TYPES OF EACH MOLECULE
Water	70	1
Inorganic ions	1	20
Sugars and precursors	1	250
Amino acids and precursors	0.4	100
Nucleotides and precursors	0.4	100
Fatty acids and precursors	1	50
Other small molecules	0.2	~300
Macromolecules (proteins, nucleic acids, and polysaccharides)	26	~3000

Organization of living things

Atom: the building blocks of all matter, (the smallest unit of an element)

Element: the simplest form of matter. They cannot be broken down chemically

Molecule: two or more atoms combined chemically (the smallest unit of compound)

Organelles: structures within cells that perform specific functions.

Cell: the smallest unit of a living thing.

Tissue: a group of similar cells that perform a similar function. (muscle tissue, bone tissue, skin tissue.

Organ: a group of tissues that work together to perform a specific task. (brain, stomach, heart, etc.)

System: a group of organs that work together to perform a specific task. (skeletal system, digestive system, etc.)

Organism: complete, entire living things may exist as single cells, as simple organisms with tissues but no organs, or they may have organs that are not organized into organ systems. However if multicellular, then organisms are made up of several organ systems.

Cell Organization:

There are three levels of organization to describe the molecules that make up living organisms:

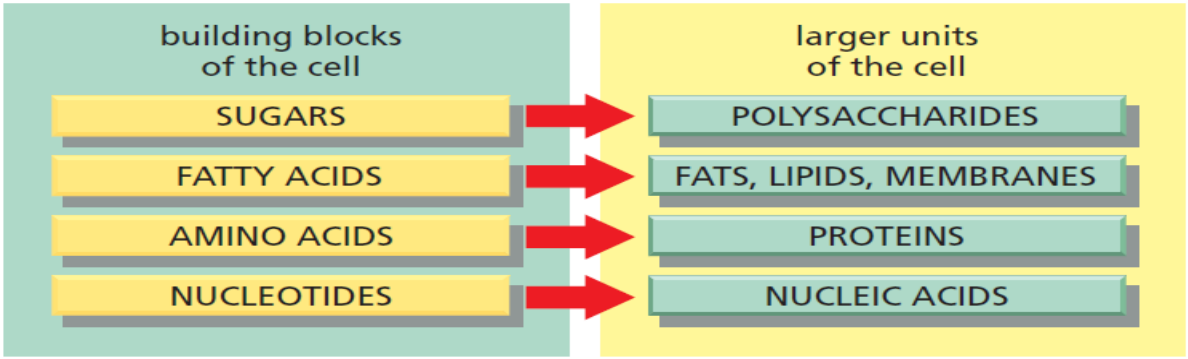
1. The simplest level is the individual elements such as carbon, nitrogen, or oxygen.
2. The basic elements can be arranged into a series of small molecules known as Building Blocks. Building blocks include compounds such as amino acids and nucleic acids.

Elements, Irons and Trace minerals that make up living organisms		
Elements	**Ions**	**Trace minerals**
Oxygen Carbon Nitrogen Hydrogen Phosphorus Sulfur	**Sodium Potassium Magnesium Calcium Chloride**	**Manganese, Iron, Cobalt, Copper, Zinc, Aluminum, Iodine, Nickel, Chromium, Selenium, Boron, Vanadium, Molybdenum, Silicon, Tin and Fluorine**

3. The building blocks are organized into larger compounds, known as Macromolecules. Macromolecules comprise the different structures that are

found in cells. Four different types of macromolecules are used to construct a cell: • Nucleic acids • Proteins • Lipids • Carbohydrates.

Three levels of organization describe the compounds that make up living organisms.				
I	Elements			
II	Phosphate Pyrimidines Purines Ribose Deoxyribose	Amino acids	Fatty acids Glycerol Other components	Sugars
III	Nucleic acids	Proteins	Lipids	Carbohydrates or Polysaccharides



Nucleic acids:

It can be subdivided into DNA and RNA.

DNA is composed of two kinds of building blocks,

1-The bases (adenine, guanine, cytosine, and thymine).

2- a sugar phosphate backbone.

DNA is used by the cell as a repository for all of the information necessary to direct synthesis of the macromolecules and to produce energy for this synthesis.

DNA is also used to transmit information from one generation to the next.

RNA has a very similar composition to DNA. The two major differences between DNA and RNA are:

1- The sugar used in the sugar phosphate backbone (ribose for RNA and deoxyribose for DNA)

2- In one of the bases (uracil for RNA and thymine for DNA).

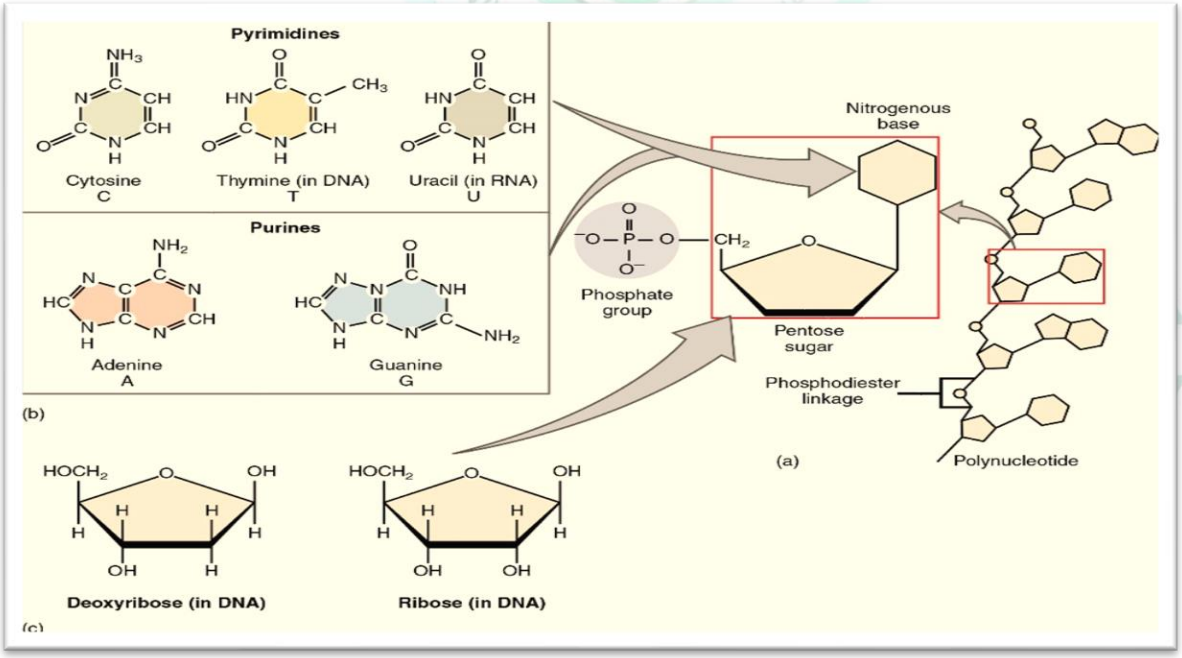
The RNA in the cell has at least four different functions:

A. Messenger RNA (**mRNA**) is used to direct the synthesis of specific proteins.

B. Transfer RNA (**tRNA**) is used as an adapter molecule between the mRNA and the amino acids in the process of making the proteins.

C. Ribosomal RNA (**rRNA**) is a structural component of a large complex of proteins and RNA known as the ribosome. The ribosome is responsible for binding to the mRNA and directing the synthesis of proteins.

The fourth class of RNA is a catch-all class. There are small, stable RNAs whose functions remain a mystery.



In general, RNA is used to convey information from the DNA into proteins.

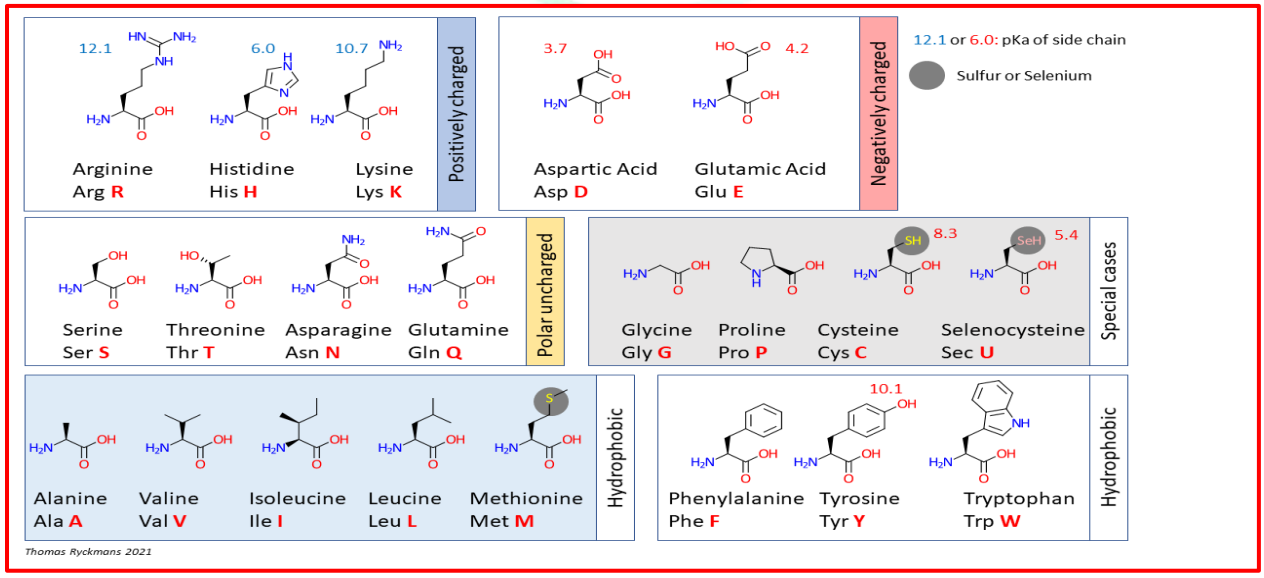
Proteins :

Proteins are composed of amino acids. Most proteins are made from a unique combination of 20 different amino acids . The order in which amino acids appear in a protein are specified by the mRNA used to direct synthesis of the protein.

The amino acids can be grouped together and described by physical properties such as **charge** (acid or basic), **size**, **interactions with water** (hydrophobic water "hating" or hydrophilic water "loving"), a **specific element** (sulfur containing) or structure they contain (aromatic rings).

Proteins perform many duties in the cell

Including functioning as structural and motor components, enzymes, signaling molecules, and regulatory molecules. Some proteins perform only one function while others are multifunctional.



Lipids :

They are an unusual group of molecules that, in bacteria, are used to make the membranes that surround a cell. One type of lipid, known as a fatty acid, is composed of long chains of carbon molecules attached to a smaller head group (Fig. below). The small head group is known as the polar head group.

Saturated fatty acids are flexible and can be tightly packed.

If the fatty acids contain any double bonds they are known as unsaturated fatty acids.

Unsaturated fatty acids have a kink in them and cannot be packed as closely. Membranes usually contain a mixture of fatty acids to maintain the right packing density and fluidity.

Carbohydrates

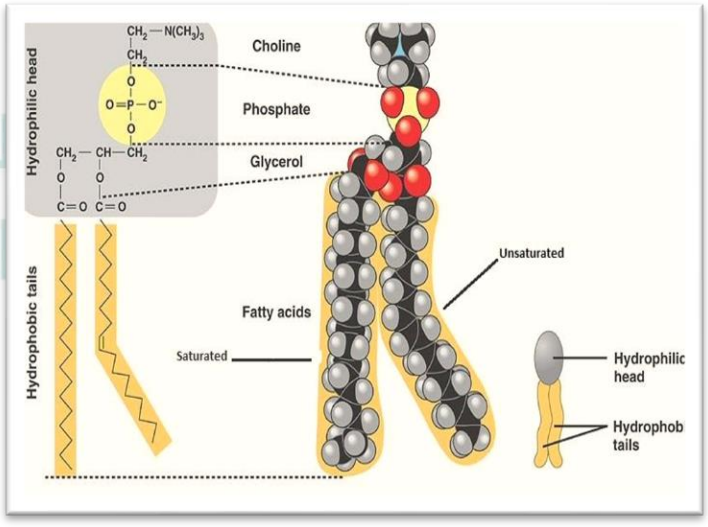
It was composed of simple sugars . They can be used as:

1- Immediate source of energy.

2- Stored source of energy.

3- Structural components of the cell. In bacteria, carbohydrates that are used as immediate.

The fatty acid attached carbohydrates help protect the cell from detergents and antibiotics. A complex mixture of carbohydrates is used to make the cell wall. Cell walls maintain the shape of the cell.

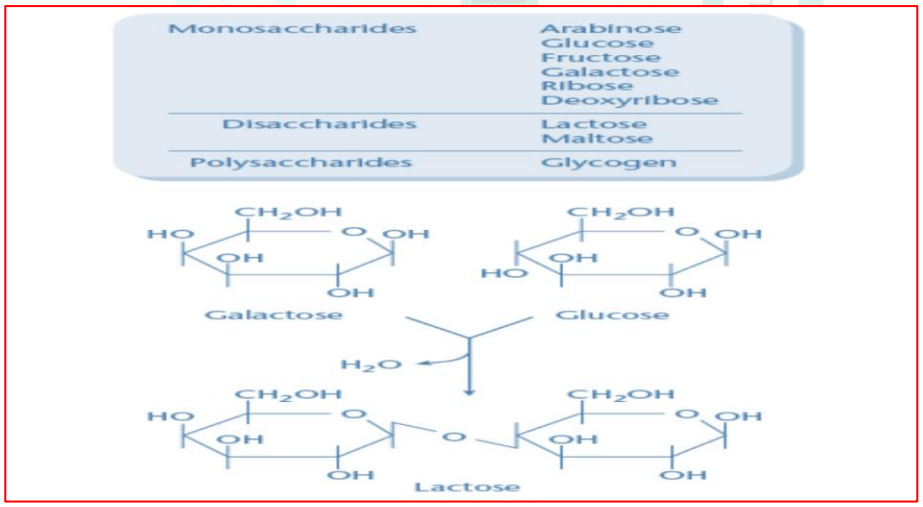


Lipid molecules. (a) The general structure of a saturated fatty acid. (b) The structure of membranes with two leaflets. (c) The general structure of an unsaturated fatty acid.

Carbohydrate Function:

- ➢Production and storage of energy (glycogen)
- ➢Mechanical support (cellulose, chitin)
- ➢Integration in the membranes (glycolipids)
- ➢Signaling (glycosaminoglycans)

Each of the four types of macromolecules provides unique functions to the cell. For some of the cell's requirements, a single type of macromolecule suffices



Types and general structures of carbohydrates. The polymerizing of galactose with glucose results in the formation of lactose upon liberation of one H2O molecule.