Introduction to Biochemistry

Historical Perspectives Carl Alexander Neuberg (29 July 1877 – 30 May 1956) was an early pioneer in biochemistry, and he is often referred to as the "father of modern biochemistry". The discovery of the first enzyme, diastase in 1833 by Anselme Payen, may have marked the beginning of biochemistry. Although the term "biochemistry" seems to have been first used in 1882, it is generally accepted that the formal coinage of biochemistry occurred in 1903 by Carl Neuberg, a German chemist.

Biochemistry has its roots and practical applications in two major scientific disciplines i.e.; **Biology** and **Chemistry.** Biochemistry broadly deals with the chemistry of life and living processes. Living organisms whether they are plants, animals or microorganisms, all are made up off basically "cell" which has some chemical components. Biochemistry is the study of how these chemical components are synthesize and utilized by the living organisms in the life process. The **Aim of Biochemistry** is to understand life in molecular terms. Molecular biology is a fusion of biochemistry, cell biology and genetics.

- ✓ Biochemistry is the branch of science concerned with the chemical and physio-chemical processes and substances (bio-molecules and their reactions) that occur within living organisms.

Biochemistry can be divided into three principal areas

(a) Structural Chemistry

The structural chemistry of the components of living matter and the relationship of biological function to chemical structure.

(b) Metabolism

Metabolism is the totality of chemical reactions that occur in living organisms.

(c) Chemistry of processes

The chemistry of processes and substances that store and transmit biological information (molecular genetics, i.e. heredity and the expression of genetic information in molecular terms)

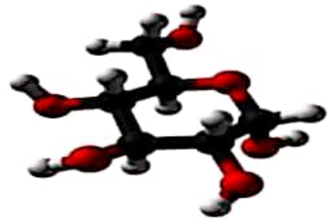
Much of biochemical inquiry deals with the structures, functions and interactions of biological macromolecules — large molecules (such as proteins) which provide the structure of cells and perform many of the functions associated with life.

The chemistry of the cell also depends on the reactions of smaller molecules and ions. These molecules can be organic (e.g. the amino acids that are used to synthesize proteins) or inorganic (e.g. water and metal ions).

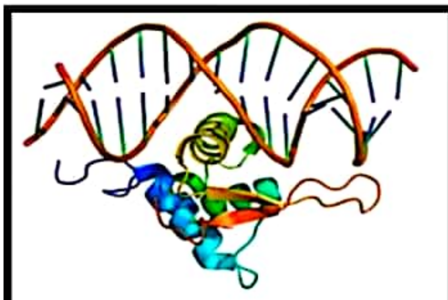
There are four classes of biochemical compounds: carbohydrates, proteins, lipids (fats), and nucleic acids. We get these from our food. Carbohydrates are molecules made up of carbon, oxygen, and hydrogen.

Carbohydrates are molecules made up of carbon, oxygen, and hydrogen. They usually have twice as much hydrogen as oxygen. Examples of carbohydrates include sugars, starches and cellulose.

Proteins are molecules made up of long chains of amino acids. They are more complex than carbohydrates and contain carbon, oxygen, hydrogen, nitrogen, and sulfur. Examples of proteins include hormones and enzymes.



Example of a carbohydrate (glucose)

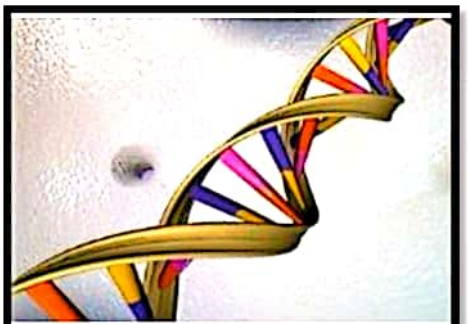


Example of a protein

Lipids are small, hydrophobic molecules built from fatty acids. They're not soluble in water, but can be dissolved in organic solvents. Like carbohydrates, they usually contain only carbon, oxygen, and hydrogen. Examples of lipids include the fat stores around your body, but also oils and waxes.

Nucleic acids are biological polymers made from nucleotides. They're the most complex of the classes of biochemical compounds and are built from many parts, including sugars, which are themselves carbohydrates. They contain the same elements as proteins, except tend to have phosphorus instead of sulfur. But it's the way those elements are bonded together that makes them nucleic acids. Examples of nucleic acids include DNA and RNA.

Butter contains mostly fats, which are a type of lipid



Example of a nucleic acid: a DNA molecule

- ✓ The living matter is composed of mainly six elements-carbon, hydrogen, oxygen, nitrogen, phosphorus and sulfur. These elements together constitute about 90% of the dry weight of the human body. Several other functionally important elements are also found in the cells. These include Ca, K, Na, Cl, Mg, Fe, Cu, Co, l, Zn, F, Mo and Se.
- ✓ **Carbon-a unique element of life**

Carbon is the most predominant and versatile element of life. It possesses a unique property to form infinite number of compounds. This is attributed to the ability of carbon to form stable covalent bonds and C-C chains of unlimited length. lt is estimated that about 90% of compounds found in living system invariably contain carbon.

- ✓ **Chemical molecules of life**

Life is composed of lifeless chemical molecules. A single cell of the bacterium, Escherichia coli contains about 6.000 different organic compounds. It is believed that man may contain about 100,000 different types of molecules although only a few of them have been characterized.

- ✓ **Complex Biomolecules:**

The organic compounds such as amino acids, nucleotides and monosaccharide serve as the monomeric units or building blocks of complex biomolecules-proteins, nucleic acids (DNA and RNA) and polysaccharides, respectively. The important biomolecules (macromolecules) with their respective building blocks and major functions are given in Table 1.1. As regards lipids, it may be noted that they are not biopolymers in a strict sense, but majority of them contain fatty acids

The major complex biomolecules of cells			
Biomolecules		Building block (repeating units)	Major Functions
1.	Protein	Amino acids	Fundamental basis of structure and function of cell (static and dynamic function)
2.	Deoxyribonucleic acid (DNA)	Deoxyribonucleotides	Repository of hereditary information.
3.	Ribonucleic acid (RNA)	Ribonucleotides	Essentially required for protein synthesis
4.	Polysaccharide (glycogen)	Monosaccharides (glucose)	Storage form of energy to meet short term demands
5.	Lipid	Fatty acids, glycerol	Storage form of energy to meet long term demands; structural components of membranes.

- ✓ **Structural hierarchy of an organism**

The macromolecules (proteins, Lipids, nucleic acids and polysaccharides) form supramolecular assemblies (e.g. membranes) which in turn organize into organelles, cells, tissues, organs and finally the whole organism.

- ✓ **The cell**

The cell is the structural and functional unit of life. It may be also regarded as the basic unit of biological activity. The concept of cell originated from the contributions of Schleiden and

Schwann (1838). However, it was only after 1940, the complexities of cell structure were exposed.

✓ **Prokaryotic and eukaryotic cells**

The cells of the living kingdom may be divided into two categories

1. Prokaryotes (Greek: pro - before; karyon - nucleus) lack a well defined nucleus and possess relatively simple structure. These include the various bacteria.

2. Eukaryotes (Greek: eu-true; karyon-nucleus) possess a well defined nucleus and are more complex in their structure and function. The higher organisms (animals and plants) are composed of eukaryotic cells.

A comparison of the characteristics between prokaryotes and eukaryotes is listed in Table

Comparison between Prokaryotic and eukaryotic cells

Characteristics		**Prokaryotic Cell**	**Eukaryotic Cell**
1.	Size	Small (generally 1-10 μm)	Large (generally 10-100μm)
2.	Cell membrane	Cell is enveloped by a rigid cell wall	Cell is enveloped by a flexible plasma membrane
3.	Sub Cellular Organelles	Absent	Distinct organelles are found (e.g. mitochondria, nucleus, lysosomes)
4.	Nucleus	Not well defined; DNA is found as nucleiod, histones are absent	Nucleus is well defined, surrounded by a membrane; DNA is associated with histones
5.	Energy Metabolism	Mitochondria absent, enzymes of energy metabolism bound to membrane	Enzymes of energy metabolism are located in mitochondria
6.	Cell division	Usually fission and no mitosis	Mitosis
7.	Cytoplasm	Organelles and cytoskeleton absent	Contain Organelles and cytoskeleton (a network of tubules and filaments)

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