Chemistry of a living cell

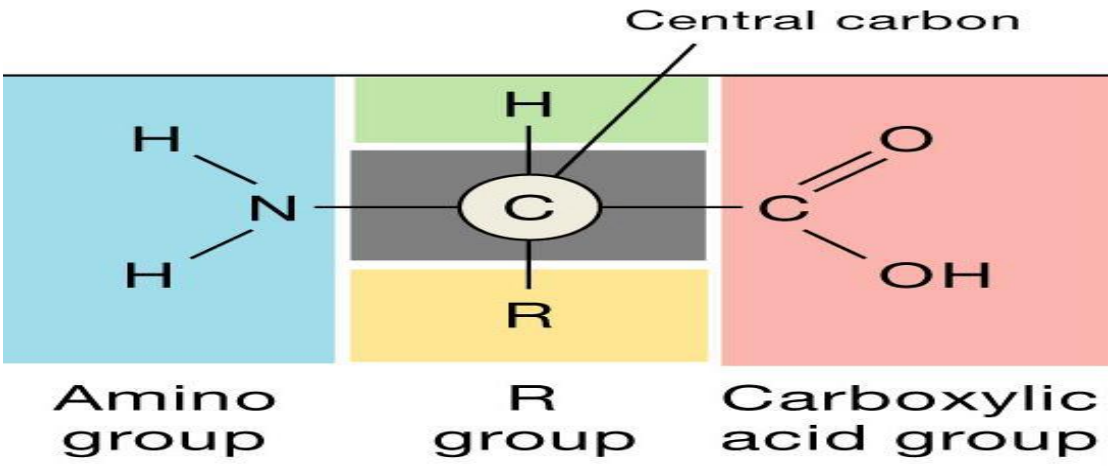
Organic compounds

Dr.Emad Kudhair Abbas

The main types of organic compounds are carbohydrates, lipids, and proteins. All of these organic compounds contain carbon, hydrogen, and oxygen as their main ingredients. Carbohydrates, lipids, and proteins (in addition to minerals, vitamins, and water) must be taken in as part of a normal diet.

Proteins

Proteins are the body's structural materials, found in muscle, bone, and connective tissue. They also make up the pigments that give hair, eyes, and skin their color. Aside from their structural importance, various proteins are essential for body functions. They regulate metabolic reactions and participate in the activities of all systems. Proteins are composed of monomers called amino acids. Amino acids contain an amino group, a carboxylic group and a radical group.



In forming proteins, the acid group of one amino acid can form a covalent bond with the amino group of another amino acid. This bond is called a peptide bond. Many amino acids linked together in this way form a polypeptide, which is essentially a chain of amino acids. Proteins are long polypeptides formed into different three-dimensional shapes. The various shapes are created by other types of chemical bonds within the polypeptide. These bonds may cause the chain to fold into a pleated sheet, or β-sheet.

Other polypeptides coil into a helix (spiral). Such coiled, or fibrous, proteins are important in body structure, as in muscle tissue and bone. Internal bonds may then cause the coiled chain to fold back on itself .Several polypeptide chains also may be folded together.

These folded, or globular, proteins are important in body functions. For example, they form the oxygen-carrying hemoglobin in red blood cells, some hormones, antibodies needed for immunity, enzymes, and many other metabolically active compounds. The overall three-dimensional shape of a protein is important to its function, as can be seen in the activity of enzymes.

Proteins act as transport- they transport small molecules and also act as structural and support- they form many of the cellular structures like collagen and keratin. Proteins act as a receptors -they carry signals to and from the outside of the cell, and within the cell. There are also conjugated proteins, which attached to a nonprotein moiety, such as nucleoproteins associated with nucleic acids, glycoprotein such as chondroitin sulfate. The lipoproteins and chromoproteins that have a pigment as hemoglobulin and cytochromes.

Proteins Levels

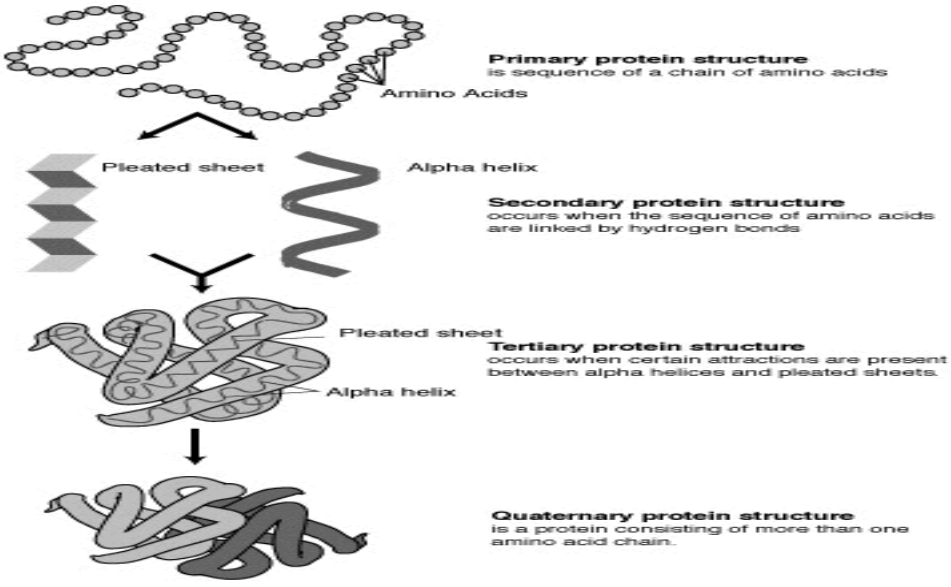
There are four structural levels of proteins:

1-Primary protein structure: Is the sequence of a chain of amino acids

2-Secondary protein structure: Occurs when the sequence of amino acids are linked by hydrogen bonds

3-Tertiary protein structure: Occurs when certain attractions are present between alpha helices and pleated sheets

4-Quaternary protein structure: Is a protein consisting of more than one amino acid chain



Structural levels of protein

Proteins can range from fewer than 20 to more than 5000 amino acids in length. Each protein that an organism can produce is encoded in a piece of the DNA called a —gene . Humans are believed to have about 30,000 different genes (the exact (number as yet unresolved).

Enzymes

Enzymes are proteins that are essential for metabolism. They are catalysts in the hundreds of reactions that take place within cells. Without these catalysts, which increase the speed of chemical reactions, metabolism would not occur at a fast enough rates to sustain life. Because each enzyme works only on a specific substance, or substrate, and does only one specific chemical job, many different enzymes are needed**.**

Like all catalysts enzymes take part in reactions only temporarily; they are not used up or changed by the reaction. Therefore, they are needed in very small amounts. Many of the vitamins and minerals required in the diet are parts of enzymes.

Carbohydrates

The building blocks of carbohydrates are simple sugars, or monosaccharaides. Glucose is a simple sugar that circulates in the blood as a cellular nutrient, is an example of a monosaccharide. Two simple sugars may be linked together to form a disaccharide after lost a water molecule, as represented by sucrose, or table sugar. More complex carbohydrates, or polysaccharides, consist of many simple sugars linked together with multiple side chains. Examples of polysaccharides are starch, which is manufactured in plant cells, and glycogen, a storage form of glucose found in liver cells and skeletal muscle cells. Carbohydrates in the form of sugars and starches are important dietary sources of energy.

In addition to the polysaccharides made of hexose monomers, there are many more complex long molecules that contain amino nitrogen (e.g., glucosamine) or that can in addition be acetylated(e.g., acetylglucosamine). Still more complex are those have a substitution of sulfuric or phosphoric acid. All these polymers are important in molecular organization, particularly as intercellular substances. The large amount of polysaccharide on some plasma membrane is called glycocalyx for adhesive on surfaces.

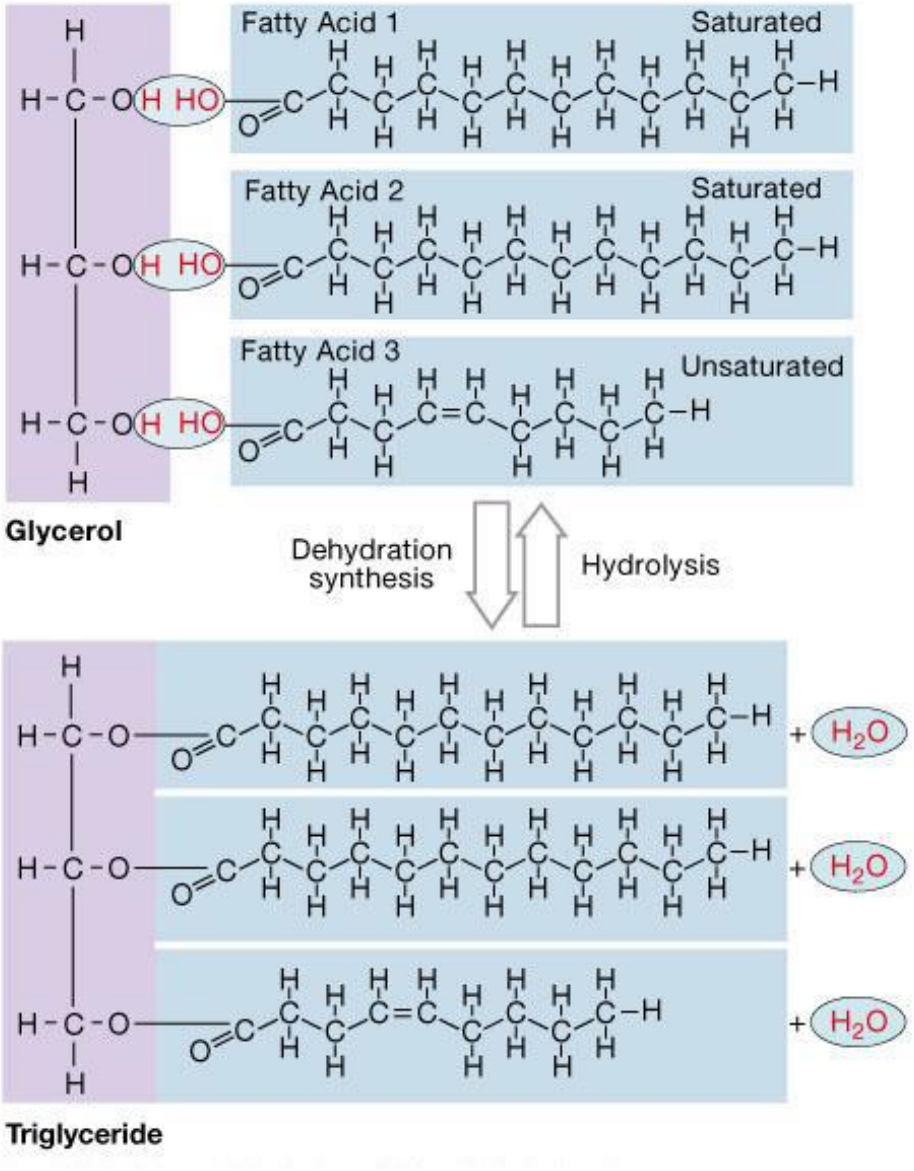
Lipids

Lipids are a class of organic compounds that are not soluble in water. They are mainly found in the body as fat. Simple fats are made from a substance called glycerol, commonly known as glycerin, in combination with three fatty acids .

One fatty acid is attached to each of the three carbon atoms in glycerol, so simple fats are described as triglycerides.

Fats insulate the body and protect internal organs. In addition, fats are the main form in which energy is stored.Lipids form the framework of biological membranes, anchor soluble proteins to the surfaces of membranes and store energy.

Lipids include fats, oils, and waxes which have six classes. Fatty acids, glycosides, steroids, phospholipids, glycosides, glycolipids and eicosanoids.



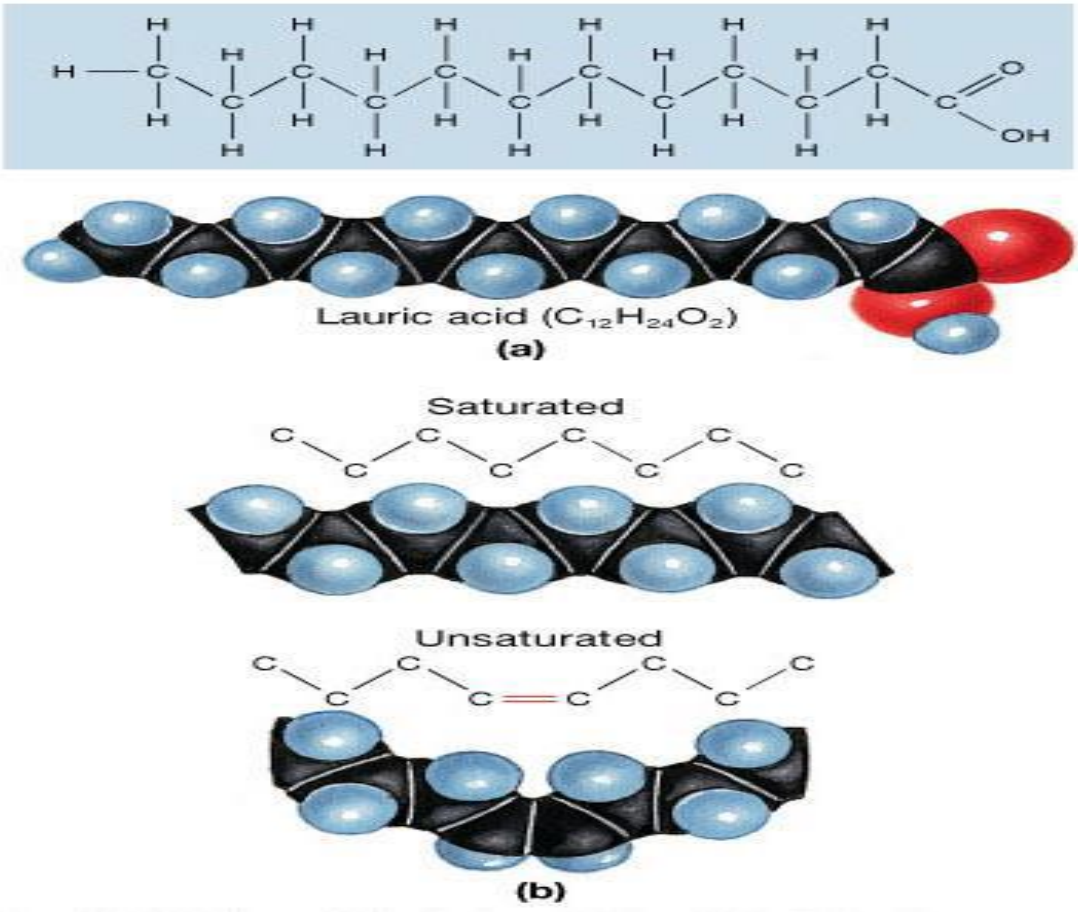
Steroids are lipids that contain rings of carbon atoms, involved in cell membrane structure 20%and important in lipid digestion. They include cholesterol, another component of cellular membranes, and certain hormones, such as cortisol, produced by the adrenal glands and the sex hormones produced by the ovaries and testes.

There are three types of fatty acids molecules according to the length of carbon atom chains, and the way carbon atom combine:

1-Saturated fatty acids (saturated with hydrogen atoms): All carbon atoms joined by single bond and solid in room temperature.

2-Unsaturated fatty acids (not maximum bound with hydrogen atoms): Contain one or more double bonds between carbon atoms.

3-Poly saturated fatty acids: Have many double bonds.



(Types of fatty acid)

Nucleotides

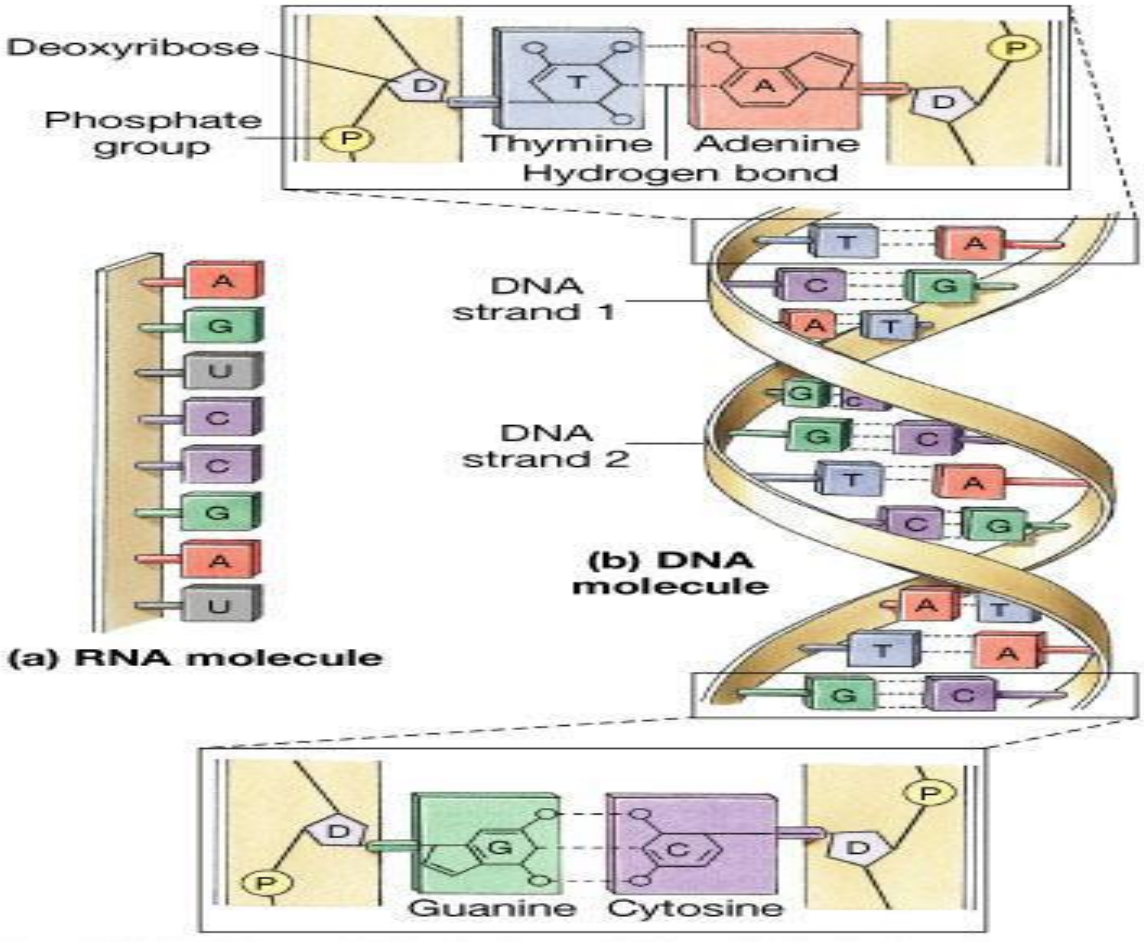
A nucleotide contains:

1-A nitrogenous (nitrogen-containing) base

2-A sugar, usually a sugar called ribose or a related sugar called deoxyribose, which has one less oxygen atom.

3-A phosphate group, which contains phosphorus. There may be more than one phosphate group in the nucleotide.

The nucleic acids DNA and RNA involved in the transmission of genetic traits and their expression in the cell are composed of nucleotides.



High energy compounds store cellular energy in high energy bonds:

Adenosine triphosphate (ATP): Made by adding a phosphate group to adenosine diphosphate (ADP) in a process referred to as phosphorylation.