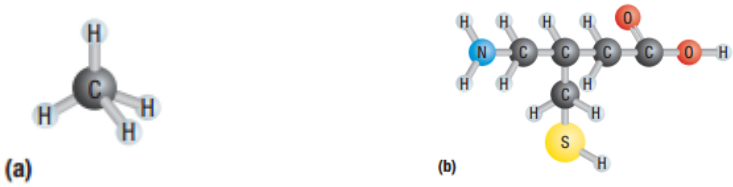
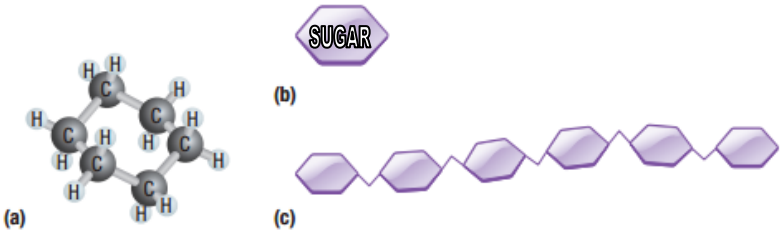
The Carbon Chemistry of Life

Carbon atoms make up the base of every organic molecule, including the molecules within cells. They have four electrons in their valence shells and therefore each carbon atom is capable of forming four **covalent** bonds with other atoms. As a result, carbon can form multi-ring molecule, diamonds, and nanotubes as they branch out in up to four directions making an almost limitless array of possible molecules.

Molecules consisting of only carbon atoms bonded to hydrogen atoms are called **hydrocarbons**. Since carbon always has four bonds, if carbon is bond by two other carbons, the remaining bonds are available to bond to hydrogen, an addition carbon or other elements.



Carbon skeletons can be linear or branched or form a closed ring shape, as **cyclohexane**. Many carbon containing rings can join together to produce polymers, such as strings of sugar molecules that make up a complex sugar chain.



The molecules of living organisms almost invariably contain other elements in addition to **C** and **H**. These other elements give the biological molecules different functional properties. These molecules fall into four major groups based on their function:

1. Carbohydrates,
2. Lipids (fats),
3. Proteins,
4. Nucleic acids

Functional Groups

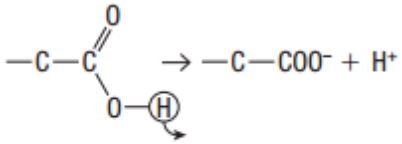
Functional group - is a group of atoms that affects the function of a molecule by participating in chemical reactions.

Functional groups are usually **strongly polar** or **ionic**. This makes them very attracted to other ionic or polar molecules, including water molecules. Therefore, the chemical or physical properties of a large biological molecule are influenced by the polar and ionic characteristics of its functional groups.

The **non-polar** portions of a large biological molecule do not attract other molecules, therefore they do not help initiate chemical reactions.

The carboxyl, amino and phosphate groups are **ionic functional groups**.

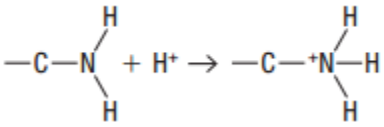
The carboxyl group, COOH, can release a proton to become COO^-. The release of H^+ in water makes the carboxyl group an acid.



carboxyl group ionized form

(a)

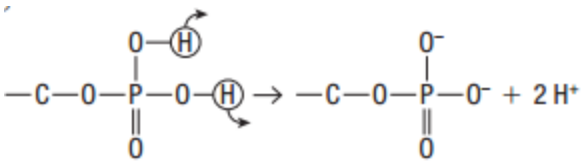
The amino group, NH_2, can attract and bond to an H^+ proton to become an NH_3^+ group. This characteristic makes the amino group a weak base.



amino group ionized form

(b)

The phosphate functional groups are also acidic. These groups lose their H+ ions and become negatively charged.



phosphate group ionized form

(c)