1.1: What is organic chemistry?

Learning Objectives

- Recognize organic compounds from their formula.
- Understand some logical reason for why nature has selected C and H as the main constituent of organic compounds.

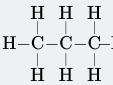
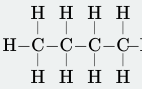
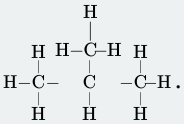
What are organic compounds?

The compounds usually synthesized in living things are called organic compounds. The organic compounds are primarily composed of carbon (C) and hydrogen (H). For example, methane (CH_4) produced by decaying plant materials is composed of one C and four H′s. Often one or more atoms of elements other than C and H are also present in organic compounds, like oxygen (O), nitrogen (N), phosphorous (P), sulfur (S), etc. For example, O atoms are present in glucose ($C_6H_{12}O_6$). The atoms other than C and H, e.g., O in $C_6H_{12}O_6$, are called **heteroatoms**. Figure 1.1.1 illustrates fruits and vegetables composed of organic compounds.

Figure 1.1.1: Fruits and vegetables comprise organic compounds. (Copyright; oy, CC BY 2.0, via Wikimedia Commons)

Why has nature chosen C and H as primary constituents of organic compounds?

Nature has chosen C and H as primary constituents composing the organic compounds because of several reasons, some of which are the following.

- C is a member of second-row elements in the periodic table that usually make stronger and more stable bonds than the elements in the higher rows.
- C makes four bonds in neutral molecules, which is higher than any other element of the second row can make. For example, C has for bonds in a methane molecule represent as:  , where each line represents a bond.
- C can make chains and rings, e.g., ethane:  , and a propane:  are chains of two and three C′s. The ability of C to make a chain of atoms is called **catenation**.
- A C atom can make bonds with more than two C′s resulting in branched compounds that increases the number of compounds possible, e.g. four C′s molecule can be in a straight chain as in n-butane:  or in a branched chain as in isobutane:  .
- Two C′s can make single, double, or triple bonds with each other allowing more variations. For example, ethane () has all single bonds; ethene () as double bond; and acetylene ( ) has a triple bond between C′s.
- H is the lightest monovalent atom that can occupy the valencies of C′ not used in C to C bonds.

- H bonded with a strongly electronegative atom like O or N can interact with a O or N atom of a neighboring molecule through hydrogen bonding that plays a vital role in the functioning of organic molecules in living things.
- C or H in an organic compound can be replaced with a heteroatom that tremendously increases the variety of organic compounds available to living things.

Some other elements have the desired characteristics of C and H but are associated with significant disadvantages. For example, silicon (Si), like C, makes i) four bonds, ii) straight and branched chains, and iii) a single bond with hydrogen. The drawbacks of Si are i) it is two times heavier than C, ii) it makes weaker unstable Si−Si, and Si−H bonds compared to C−C and C−H bonds, and iii) its oxidation product is solid silicon dioxide (SiO_2) which is insoluble in water and would have been difficult to excrete than the gaseous CO_2 from the C compounds which are easier to exhale. Similarly, halogens are monovalent like hydrogen, but halogens are significantly heavier than H and make weaker bonds with C than C−H bonds.

What is organic chemistry?

Organic chemistry is the study of the properties and reactions of organic compounds.

The following section describes chemical bonding that determines the compound's physical properties and chemical reactivities.
