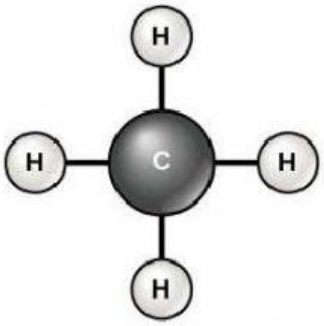
Organic Chemistry

Organic chemistry is the chemistry of the compounds of living materials. The structures are based around **carbon.**

Hydrocarbons: The simplest organic molecules containing hydrogen and carbon.

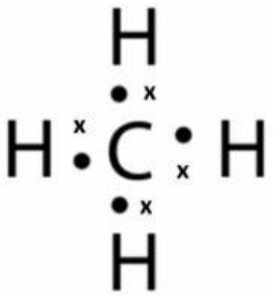
Carbon forms covalent bonds with hydrogen and also with other carbon atoms. Each carbon can form 4 bonds.

e.g.

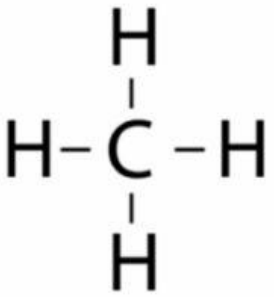


Organic structures can be drawn using a line to represent a single covalent bond.

Electron Dot Diagram



Structural Formula

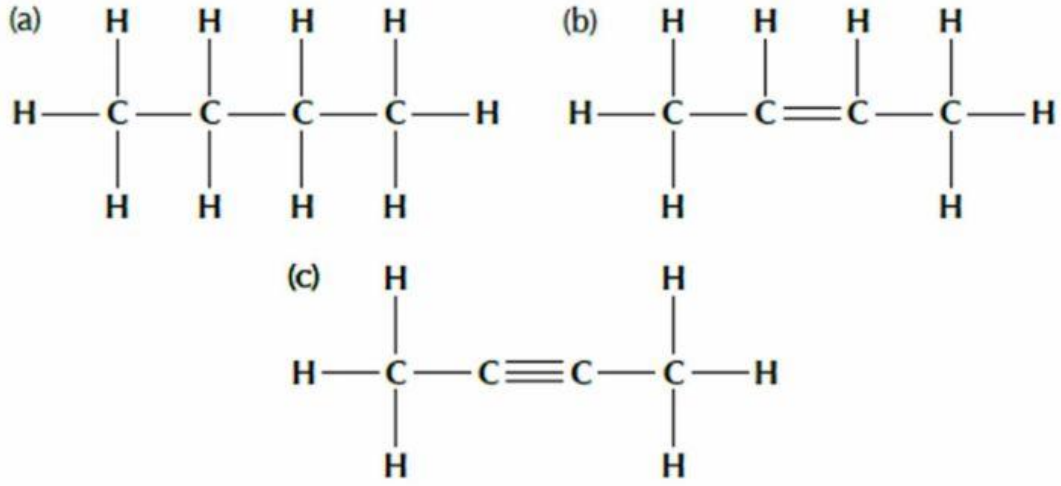


Carbon has a number of unique properties which influence how it behaves and how it bonds with other atoms:

- Carbon (Figure 4.2) has *four valence electrons* which means that each carbon atom can form a maximum of four bonds with other atoms. Because of the number of bonds that carbon can form with other atoms, organic compounds can be very complex.
  - Carbon can form bonds with other carbon atoms to form single, double or triple covalent bonds.
  - Carbon can also form bonds with other atoms like hydrogen, oxygen, nitrogen and the halogens.
  - Carbon can bond to form straight chain, branched, and cyclic molecules.

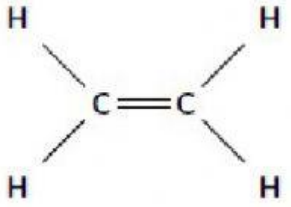
- Because of its position on the periodic table, most of the bonds that carbon forms with other atoms are *covalent*. Think for example of a C – C bond. The difference in electronegativity between the two atoms is zero, so this is a pure covalent bond. In the case of a C – H bond, the difference in electronegativity between carbon (2,5) and hydrogen (2,2) is so small that C – H bonds are almost purely covalent. The result of this is that most organic compounds are non-polar. This affects some of the properties of organic compounds.

- Because of this, long *chain structures* can form. This is known as **catenation** - the bonding of atoms of the same element into longer chains. These chains can either be *unbranched* (Figure 4.3) or *branched* (have a branched group, Figure 4.4) and can contain single carbon-carbon bonds only, or double and triple carbon-carbon bonds as well.



Saturated compound: A substance in which the carbons are linked by single bonds (has no double or triple bonds between carbons). (Saturated because the structure is fully bonded – no space to add any more atoms.)

Unsaturated compound: A substance in which some of the carbons are linked with double or triple bonds. (Unsaturated because if you break those double or triple bonds you can add more atoms to the molecule.)



Alkanes

The simplest organic molecules are made up of saturated chains of hydrocarbons (i.e. carbons and hydrogens with no double bonds). This "family" of organic compounds is called ALKANES.

[Note: the proper word to describe the different "families" in organic chemistry is HOMOLOGOUS SERIES. We will come back to a definition of this later… ☺]

Alkane molecules are named in a way that describes how many carbons are in the chain, and they all end with "**-ane**" so that you know which Homologous Series the molecule belongs to. (A bit like your surname shows which family you belong to!)

e.g.

The first 10 alkanes are:

Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}
Hexane	C_6H_{14}
Heptane	C_7H_{16}
Octane	C_8H_{18}
Nonane	C_9H_{20}
Decane	$C_{10}H_{22}$

This way of writing the molecule is called the MOLECULAR FORMULA

You can see that the beginning of each name (prefix) changes depending on how many carbons are in the chain.

- The root name of the compound is based upon the number of carbon atoms in the **longest continuous chain**.

Number of C atoms	Root
1	Meth-
2	Eth-
3	Prop-
4	But-
5	Pent-
6	Hex-
7	Hept-
8	Oct-
9	Non-
10	Dec-

Alkanes can get more complicated than this when you add side branches of carbons to the main chain, but we'll come back to that later.

Every homologous series has a general formula that describes all molecules in the series.

For alkanes:

The general formula for (linear and branched) alkanes is:

$$C_nH_{2n+2}$$

So an alkane containing 4 carbons will have (2 x 4) + 2 = 10 hydrogen atoms.

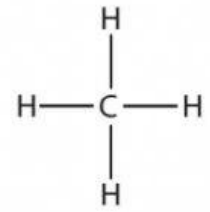
An alkane containing: 1 carbon will have _____ hydrogen atoms

2 carbons will have _____ hydrogen atoms

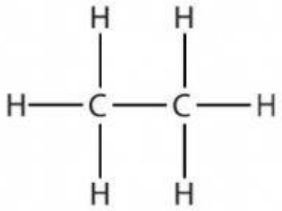
3 carbons will have _____ hydrogen atoms

We can represent these alkanes with a **STRUCTURAL FORMULA** that looks like this:

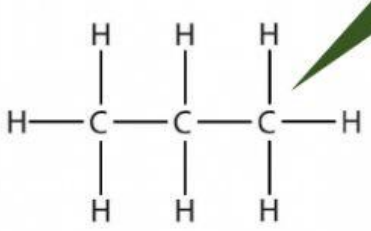
methane, CH_4



ethane, C_2H_6



propane, C_3H_8



Note that every C must have 4 bonds; every H can only have 1 bond

Properties of ALKANES in summary:

1 ALKANES C_nH_{2n+2}

- - ane
- Single bonds between carbons
- Saturated (only single bonds)
- Non-polar (doesn't dissolve in water)
- Weak London forces (IMF)
- Unreactive
- 1-4 C = gas
- 5-17 C = liquid
- >17 C = waxy solids (vaseline)

Fill in the MOLECULAR FORMULA for each of the following alkanes in the spaces provided and then draw their STRUCTURAL FORMULA in your books:

Eg 1) butane

2) pentane

3) heptane

4) nonane