

# HYDROCARBONS

Carbon atoms have the unique ability to form long chains while retaining their ability to bond covalently with other elements. Aside from carbon and hydrogen, organic compounds may also contain oxygen, nitrogen, sulfur, chlorine, bromine, and iodine. According to its Lewis dot diagram, a carbon atom has a



single electron on each of its four sides, meaning that it can bond with four other atoms. Carbon also has the unique ability to form double and triple bonds within long carbon chains. As a result of these many unique characteristics, the number of possible organic molecules is virtually infinite. In fact, the number of organic molecules that have been identified number in the millions; whereas the number of inorganic molecules that have been identified number in the thousands. The enormous variety of organic compounds, and the importance of these compounds to life, makes organic chemistry arguably the most important branch of chemistry. In this unit we will examine the simplest category of organic molecules: the hydrocarbons.

1. Read pg. 508 – 509. Pay special attention to table 1: “the alkane family of organic compounds”.
2. Hydrocarbons contain only which 2 elements? (Answer this & other questions on a separate sheet).
3. Get a molecular model kit. Build hexane – a 6 carbon molecule similar to the 5 carbon molecule shown in fig.5). Use short grey “single” bonds to connect atoms. Notice that hexane rotates & bends.
4. What problem exists with your model (i.e. how is figure 5 less accurate than figure 6)?
5. For hexane, draw a) complete structural diagram, b) condensed structure, c) line structural diagram.
6. Count the number of carbon atoms and the number of hydrogen atoms in your model. By which formula is an alkane (like hexane) more accurately described:  $C_nH_{2n}$ ,  $C_nH_{2n+2}$ , or  $C_nH_{2n-2}$ ?
7. Is hexane a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
8. Convert your hexane molecule into a hexene molecule by making the bond between the first and second carbon a double bond (you will need to remove a hydrogen from each carbon involved in the bond, and you will have to use two long grey bonds in place of the short grey “single” bond).
  - i) Draw the a) complete structural diagram, b) condensed structure, c) line structural diagram.
  - ii) By which formula is an alkene (like hexene) more accurately described:  $C_nH_{2n}$ ,  $C_nH_{2n+2}$ , or  $C_nH_{2n-2}$ ?
  - iii) Is hexene a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
9. Convert your hexene molecule into a hexyne molecule by replacing the double bond between the 1<sup>st</sup> & 2<sup>nd</sup> carbon with a triple bond. Notice that the carbons in double & triple bonds are not free to rotate.
  - i) Draw the a) complete structural diagram, b) condensed structure, c) line structural diagram.
  - ii) By which formula is an alkyne more accurately described:  $C_nH_{2n}$ ,  $C_nH_{2n+2}$ , or  $C_nH_{2n-2}$ ?
  - iii) Is hexyne a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
10. Convert the hexyne molecule back into hexane. Now create a cyclohexane molecule by removing a hydrogen from each end and bonding the ends together. Note the limited movement that is possible.
  - i) Draw the a) complete structural diagram, b) condensed structure, c) line structural diagram.
  - ii) By which formula is a cycloalkane more accurately described:  $C_nH_{2n}$ ,  $C_nH_{2n+2}$ , or  $C_nH_{2n-2}$ ?
  - iii) Is cyclohexane a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
11. Convert cyclohexane into a benzene molecule by making every second C-C bond a double bond. Notice that benzene is a completely inflexible molecule.
  - i) Draw the a) complete structural diagram, b) condensed structure, c) line structural diagram.
  - ii) Is benzene a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
12. Convert your benzene molecule into toluene by replacing a hydrogen with a methyl group ( $-CH_3$ ).
  - i) Is toluene a) an acyclic aliphatic, b) a cyclic aliphatic, or c) an aromatic?
13. Using short grey bonds, construct a 3 carbon cyclic aliphatic – this is a difficult task. Notice how the molecule springs into a different shape when a bond is broken. This is called “ring strain” and causes a molecule to be unstable. What is the fewest number of carbons needed to eliminate ring strain?