Unit 3 – Organic Chemistry

5.1 – Hydrocarbons

Hydrocarbons are organic compounds that contain *only hydrogen and carbon atoms* in its molecular structure.

There is an enormous variety of hydrocarbons, from small molecules that are mainly gases like propane and butane to very large molecules that tend to be solid like asphalt that is used for roads, candle wax and tar.

Carbon atoms have the ability to form up to four covalent bonds with other carbon atoms, hence the reason for so many possible structures.

In all hydrocarbon molecules, the carbon atoms are joined to each other with single, double, or triple bonds to form a *backbone*. The backbone may be in the form of a straight chain, a branched chain, or a ring structure.

cyclic hydrocarbon a hydrocarbon whose molecules have a closed ring structure

Hydrocarbons are classified by the kinds of carbon-carbon bonds in their molecules. In **alkanes**, all atoms are bonded to other atoms by *single bonds*. In **alkenes**, one or more of the carbon-carbon bonds are *double bonds*. In **alkynes**, one or more of the carbon-carbon bonds are *triple bonds*.

aliphatic hydrocarbon a compound that has a structure based on straight or branched chains or rings of carbon atoms; does not include aromatic compounds such as benzene

aromatic hydrocarbon a compound with a structure based on benzene: a ring of six carbon atoms

IUPAC International Union of Pure and Applied Chemistry; the organization that establishes the conventions used by chemists

Alkanes and related Alkyl groups

Prefix	IUPAC name	Formula	Alkyl group	Alkyl formula
meth-	methane	$CH_{4(g)}$	methyl-	$-CH_3$
eth-	ethane	$C_2H_{6(g)}$	ethyl-	$-C_2H_5$
prop-	propane	$C_3H_{8(g)}$	propyl-	$-C_3H_7$
but-	butane	$C_4H_{10(g)}$	butyl-	$-C_4H_9$
pent-	pentane	$C_5H_{12(l)}$	pentyl-	$-C_5H_{11}$
hex-	hexane	$C_6H_{14(l)}$	hexyl-	$-C_6H_{13}$
hept-	heptane	$C_7H_{16(l)}$	heptyl-	$-C_7H_{15}$
oct-	octane	$C_8H_{18(l)}$	octyl-	$-C_8H_{17}$
non-	nonane	$C_9H_{20(l)}$	nonyl-	$-C_9H_{19}$
dec-	decane	$C_{10}H_{22(l)}$	decyl-	$-C_{10}H_{21}$

A – Naming Hydrocarbons (Alkanes)

When naming hydrocarbons you must:

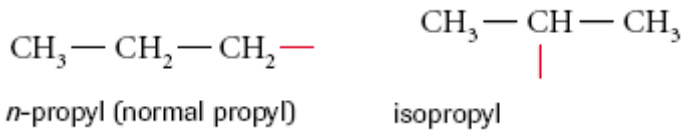
1. The prefix used indicates the number of carbon atoms in the longest carbon chain.
2. The suffix used indicates whether the hydrocarbon is an alkane, an alkene, or an alkyne.

ALKANES

Naming
Step 1 – Count the number of carbons. Look up appropriate prefix in the above chart.
Step 2 – Add the suffix *–ane*

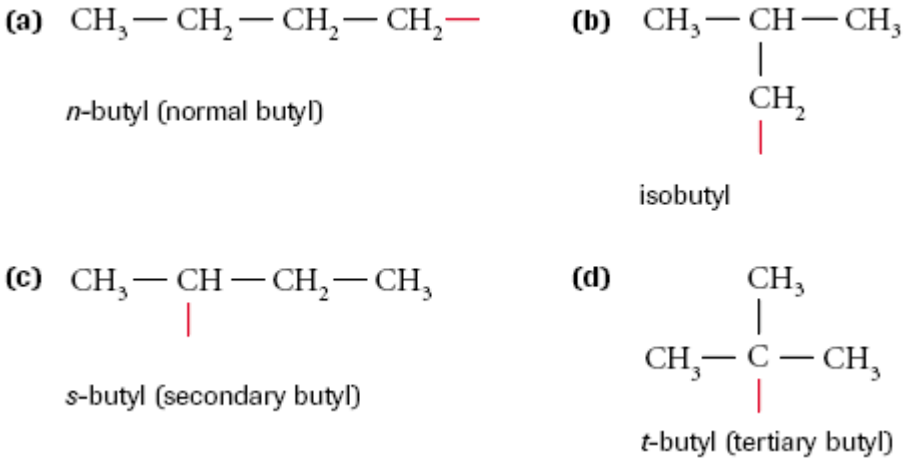
Drawing
Step 1 – Write Carbon Backbone of Appropriate Length
Step 2 – Add Single Lines to Each Carbon, to a Total of Four Lines
Step 3 – Fill Remaining Bonds with Hydrogen Atoms

Any alkyl branches in the carbon chain are named with the prefix for the branch, followed by the suffix *-yl*.



n-propyl (normal propyl) isopropyl

The two arrangements are structural **isomers** of each other, and are commonly known by their nonsystematic names. The prefix *n*- (normal) refers to a straight-chain alkyl group, the point of attachment being at an end C atom. The isomer of the *n*-propyl group is the isopropyl group.



n-butyl (normal butyl) isobutyl *s*-butyl (secondary butyl) *t*-butyl (tertiary butyl)

The above figure shows the common names for isomers of the butyl group; we will not concern ourselves with isomers of alkyl groups greater than 4 C atoms.

Naming Branched Alkanes

Step 1 Identify the longest carbon chain; note that structural diagrams can be deceiving—the longest chain may travel through one or more “branches” in the diagram.

Step 2 Number the carbon atoms, starting with the end that is closest to the branch(es).

Step 3 Name each branch and identify its location on the parent chain by the number of the carbon at the point of attachment. Note that the name with the lowest numerals for the branches is preferred. (This may require restarting your count from the other end of the longest chain.)

Step 4 Write the complete IUPAC name, following this format: (number of location)-(branch name)(parent chain).

Step 5 When more than one branch is present, the branches are listed either in alphabetical order or in order of complexity; in this book, we will follow the alphabetical order.

Note: When naming cyclic hydrocarbons, the carbon atoms that form the ring structure form the parent chain; the prefix *cyclo*- is added to the parent hydrocarbon name, and the naming of substituted groups is the same as for noncyclic compounds.