ORGANIC CHEMISTRY

A. Carbon compounds
- organic chemistry is the chemistry of carbon compounds
- most chemicals of biological importance or used as fuels are composed primarily of carbon. Other organic compounds include plastics, drugs, pesticides, solvents, synthetic fibres, enzymes, and hormones.
- the major sources of organic compounds for manufacturing are coal, petroleum, crude oil and natural gas.
- carbon compounds are a large and diverse group of chemicals because of the bonding characteristics of carbon:

\[
\begin{align*}
&\text{C} & & \text{carbon atoms tend to form 4 bonds} \\
&1s^2 & 2s^2 & 2p^2
\end{align*}
\]

- the carbon atoms tend to form the "backbone" of the organic compounds.

B. Hydrocarbons
- compounds containing only carbon and hydrogen are called hydrocarbons.
- the longest carbon chain is referred to as the backbone and is used for naming the compounds.

1. alkanes
   - single-bonded carbon atoms only
   - referred to as saturated

\[
\text{eg. } \quad \begin{array}{c}
\text{H} \\
\text{H} \quad \text{C} \\
\text{H} \quad \text{H} \\
\text{H}
\end{array}
\]

2. alkenes
   - one or more carbon carbon double bonds
   - unsaturated (if more than one double bond - polyunsaturated)

\[
\text{eg. } \quad \begin{array}{c}
\text{H} \\
\text{H} \quad \text{C} \quad \text{C} \\
\text{H} \quad \text{H}
\end{array}
\]

3. alkynes
   - one or more carbon carbon triple bonds
   - unsaturated (if more than one triple bond - polyunsaturated)

\[
\text{eg. } \quad \begin{array}{c}
\text{H} \\
\text{H} \quad \text{C} \quad \text{C} \\
\text{H}
\end{array}
\]
<table>
<thead>
<tr>
<th># of carbon atoms</th>
<th>chemical formula</th>
<th>structure</th>
<th>structural formula</th>
<th>name</th>
<th>boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH$_4$</td>
<td><img src="structure1.png" alt="Structure" /></td>
<td>CH$_4$</td>
<td>methane</td>
<td>-162°C</td>
</tr>
<tr>
<td>2</td>
<td>C$_2$H$_6$</td>
<td><img src="structure2.png" alt="Structure" /></td>
<td>CH$_3$CH$_3$</td>
<td>ethane</td>
<td>-89°C</td>
</tr>
<tr>
<td>3</td>
<td>C$_3$H$_8$</td>
<td><img src="structure3.png" alt="Structure" /></td>
<td>CH$_3$CH$_2$CH$_3$</td>
<td>propane</td>
<td>-42°C</td>
</tr>
<tr>
<td>4</td>
<td>C$<em>4$H$</em>{10}$</td>
<td><img src="structure4.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_2$CH$_3$</td>
<td>butane</td>
<td>0°C</td>
</tr>
<tr>
<td>5</td>
<td>C$<em>5$H$</em>{12}$</td>
<td><img src="structure5.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_3$CH$_3$</td>
<td>pentane</td>
<td>36°C</td>
</tr>
<tr>
<td>6</td>
<td>C$<em>6$H$</em>{14}$</td>
<td><img src="structure6.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_4$CH$_3$</td>
<td>hexane</td>
<td>69°C</td>
</tr>
<tr>
<td>7</td>
<td>C$<em>7$H$</em>{16}$</td>
<td><img src="structure7.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_5$CH$_3$</td>
<td>heptane</td>
<td>98°C</td>
</tr>
<tr>
<td>8</td>
<td>C$<em>8$H$</em>{18}$</td>
<td><img src="structure8.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_6$CH$_3$</td>
<td>octane</td>
<td>126°C</td>
</tr>
<tr>
<td>9</td>
<td>C$<em>9$H$</em>{20}$</td>
<td><img src="structure9.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_7$CH$_3$</td>
<td>nonane</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>C$<em>{10}$H$</em>{22}$</td>
<td><img src="structure10.png" alt="Structure" /></td>
<td>CH$_3$(CH$_2$)$_8$CH$_3$</td>
<td>decane</td>
<td></td>
</tr>
</tbody>
</table>
II. ALKENES NAMING AND FORMULAE

-named as for the same number alkane but an "-ene" ending is substituted for the "-ane".
-if more than one version is possible then numbers are used to differentiate. Always name so that you use the longest carbon chain and number from the end nearest to the double bond.
-ISOMERS- are compounds with the same formula but different structures

eg. ethene 
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

eg. 1 - pentene 
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

-CIS AND TRANS ISOMERS - the carbon carbon double bond does not rotate, so the groups attached can either both be on the same side of the bond or the different side. 
-those on the same side are called CIS and the ones on the opposite side are called TRANS.

eg. cis-butene
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

trans-butene
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

-DIENES - are compounds with two double bonds.

eg. 2,4 hexadiene
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

- TRIENES - are compounds with three double bonds.

eg. 1,2,4 hexatriene
\[ \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \quad \begin{array}{c}
H \\
\hat{C} \\
\hat{H}
\end{array} \]

III. ALKYNES NAMING AND FORMULAE

-named as for the same number alkane but an "yne" ending is substituted for the "ane".
-if more than one version is possible then numbers are used to differentiate.

eg. ethyne

\[ \text{H} - \text{C} \equiv \text{C} - \text{H} \]

eg. 1 - butyne

\[ \text{H} - \text{C} \equiv \text{C} - \text{C} - \text{C} - \text{H} \]

eg. 2 - butyne

\[ \text{H} - \text{C} - \text{C} \equiv \text{C} - \text{C} - \text{H} \]

IV. SUBSTITUTING H WITH OTHER HYDROCARBONS

-short chain hydrocarbons can be added to the chain by attaching them instead of a hydrogen atom.
-substituted groups are named in alphabetical order before the name of the backbone chain and their positions are numbered if required.
-groups which are typically substituted are named:

-\( \text{CH}_3 \) methyl
-\( \text{CH}_2\text{CH}_3 \) ethyl
-\( \text{CH}_2\text{CH}_2\text{CH}_3 \) propyl

eg. methyl propane

\[ \text{H} - \text{C} - \text{H} \ ]

eg. 2,3-dimethyl butane

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \]

eg. 3-ethyl, 2-methyl hexane

\[ \text{H} - \text{C} - \text{C} - \text{C} - \text{C} - \text{C} - \text{H} \]
V. CYCLIC HYDROCARBONS

-some hydrocarbons form rings of carbon atoms or cyclic compounds
-C$_3$H$_6$ is the formula for propene but a structural isomer can be drawn which doesn’t contain a double bond. This would be cyclopropane:

-cyclic compounds can have 3, 4, 5 or more carbon atoms in a ring.
-cyclic compounds are often represented by their geometric shapes.

eg. cyclopentane

cyclobutene

eg. cyclohexyne