Libri di testo

John McMurry
Chimica Organica
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Brown W.H.; Foote, C.S.; Iverson, B.L.
Chimica Organica
EdiSES

Janice Gorzynski Smith
Organic Chemistry
McGraw-Hill

Vollhardt K. Peter; Schore Neil E.
Chimica organica
Zanichelli

Solomons T.W. Graham;
Fryhle Craig B.
Chimica organica
Zanichelli

Seyhan N. Ege
Chimica Organica: Struttura e reattività
Idelson-Gnocchi
Non-Living Entities: Inorganic

Living World: Organic

Vital Spark

Inorganic Compounds: Definite Proportions

Es. \( \text{NH}_3, \text{H}_2\text{O} \)

Organic World: Vitalism

\[
\begin{align*}
\text{CH}_4 & & \text{C}_2\text{H}_6 & & \text{C}_n\text{H}_{2n+2} \\
\text{C}_2\text{H}_4 & & \text{C}_2\text{H}_2 & & \text{C}_n\text{H}_{2n} \\
\end{align*}
\]

Joseph Proust 1754-1826
1828: The End of Vitalism

Friedrich Woehler
1800-1882

\[
Pb(OCN)_2 + 2 \text{NH}_4\text{OH} \rightarrow Pb(\text{OH})_2 + 2 \text{CO(NH}_2\text{)_2}
\]
Organic Compounds are Ubiquitous

- There are approximately 60,000,000 organic molecules.
  - Carbohydrates, lipids, proteins and nucleic acids are produced by living organisms.
  - We make extensive use of natural products derived, from plants (cotton, paper, wood), from animals (leather, silk, wool), from fossil oil (benzin, oils).
  - By modifying natural compounds (mainly oil) we also manufacture a wide variety of synthetic products, such as drugs, plastics, paints, dyes, artificial fibres, fertilizers, aromas, cosmetics, detergents, parfumes, sweeteners, etc.
The Carbon Atom

• Atomic Number: 6

• 2 Isotopes

  $^{12}\text{C}$ (99.98%): 6 protons, 6 neutrons

  $^{13}\text{C}$ (1.11%): 6 protons, 7 neutrons

• Electron Configuration: $1s^2$

  $2s^2 \ 2p^2$
1. Carbon Forms Covalent Bonds With Many Other Elements
2. Carbon Is Tetravalent

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</tbody>
</table>

Periodic Table of Elements
3. Carbon Forms Very Strong Bonds

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Dissociation Energy (kJ/M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C—C</td>
<td>360</td>
</tr>
<tr>
<td>C—H</td>
<td>400-550</td>
</tr>
<tr>
<td>C—O</td>
<td>350-400</td>
</tr>
<tr>
<td>C—N</td>
<td>360</td>
</tr>
<tr>
<td>N—N</td>
<td>250</td>
</tr>
<tr>
<td>O—O</td>
<td>180</td>
</tr>
</tbody>
</table>
4 Carbon forms chains

<table>
<thead>
<tr>
<th>Bond</th>
<th>Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-C</td>
<td>360</td>
</tr>
<tr>
<td>N-N</td>
<td>230-280</td>
</tr>
<tr>
<td>O-O</td>
<td>160-200</td>
</tr>
</tbody>
</table>

C: 2s\(^2\)2p\(^2\)

S: 3s\(^2\)3p\(^4\)
## 5. Carbon Forms Multiple Bonds

<table>
<thead>
<tr>
<th>Bond</th>
<th>Bond Dissociation Energy (kJ/M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C—C</td>
<td>360</td>
</tr>
<tr>
<td>C=C</td>
<td>700</td>
</tr>
<tr>
<td>C≡C</td>
<td>950</td>
</tr>
<tr>
<td>C—O</td>
<td>400</td>
</tr>
<tr>
<td>C=O</td>
<td>750</td>
</tr>
<tr>
<td>C=N</td>
<td>360</td>
</tr>
<tr>
<td>C≡N</td>
<td>700</td>
</tr>
<tr>
<td>C≡≡N</td>
<td>950</td>
</tr>
</tbody>
</table>
Organic Chemistry

- Structure
- Reactivity
- *Structure* and *reactivity* are correlated.
Goals

• Assign Structure and Name to Organic Compounds.
• Predict:
  – The tridimensional structure
  – The effects on reactivity (reaction rates and equilibrium constants)
• Design simple synthetic pathways
• Communicate with an appropriate language
Drawing molecules
Condensed Formula

- Different degrees of condensation

\[\text{Condensed Formula}\]

\[\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_2-\text{CH}_3\]

\[\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3\]

\[\text{CH}_3(\text{CH}_2)_4\text{CH}_3\]

\[\text{H}_3\text{C} \equiv \text{C} \equiv \text{CH}_3\]

\[\text{C}(\text{CH}_3)_4 \text{ or } (\text{CH}_3)_4\text{C}\]

Certain bonds are maintained.
The double bond is maintained

Condensed Formula

\[
\text{H-C-C=C-C-H} \quad = \quad \text{CH}_3\text{CH}=\text{CHCH}_3
\]

\[
\text{H-C-C-C-H} \quad = \quad (\text{CH}_3)_2\text{CHCH}_2\text{OH}
\]

\[
\text{Cl: C-C-C-O-C-CH}_3 \quad = \quad \text{Cl}_2\text{CHCHCH}_2\text{OC(CH}_3)_3 \quad = \quad \text{Cl}_2\text{CH(CH}_2)_2\text{OC(CH}_3)_3
\]

lone pairs are omitted
• Complex structures can be written on a single line using parentheses.

\[
\text{CH}_3\text{-CH-CH-CH}_2\text{-CH}_3 = \text{CH}_3\text{CH}(\text{CH}_3)\text{CH}({\text{CH}_2\text{CH}_3})\text{CH}_2\text{CH}_3
\]

The middle CH\textsubscript{3} group is bonded outside the chain.

Branched alkanes
Skeletal (Linear) Formula

Minimal, non ambiguous, information

- Carbon atoms are omitted and lie on interceptions between bonds and at the end of the chain.
- Hydrogen atoms are omitted. Each carbon atom free valence is saturated with hydrogens.
- Atoms other than C and H (heteroatoms) are not omitted.
Skeletal (Linear) Formula

\[
\begin{align*}
\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \\
\text{CH}_3\text{CH}=&\text{CHCH}_3 \\
\text{H}=&\text{C}≡\text{C}−\text{CH}_3 \\
\text{CH}_3\text{C}=&\text{C}−\text{CH}_2\text{CH}_3
\end{align*}
\]
Examples

\[
\begin{align*}
H-C-C-C-C-C-C-H & \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \\
\text{CH}_3\text{CH}_3 & \rightarrow \text{CH}_3\text{CH}_2\text{Cl} \\
\text{CH}_3\text{C}=\text{CCH}_3 & \rightarrow \text{CH}_3\text{CH}=(\text{CH}_2)\text{CH}_2\text{OH} \\
\text{CH}_3\text{C}=\text{OCH}_3 & \rightarrow \text{CH}_3\text{CH}-(\text{CH}_2)\text{OH} \\
\end{align*}
\]