Rules for Naming Organic Molecules

Nomenclature II
Why?

- The carbon atom is unique in its bonding in that it can form stable molecules consisting of chains of carbon atoms of any length.
- Coupled with the observation that each carbon atom forms four bonds to other atoms, this leads to incomprehensibly large numbers of possible molecules.
How?

• Because every organic compound contains carbon, and almost every one contains hydrogen, the names of these two elements do not appear directly in the compound names.

• At its simplest, the name for an organic compound contains two parts:
  – (1) a root indicating the number of carbon atoms in the longest continuous chain of carbon atoms
  – (2) a prefix and/or suffix to indicate the functional group to which the compound belongs
  – Example: “ethanol” indicates a carbon chain of length two (eth-) and an OH functional group (-anol)
Six Step Process

1) Find the longest carbon chain
2) Name it
3) Determine any ending
4) Number the carbon atoms
5) Separate and name side/substituent groups
6) List side/substituent groups alphabetically
Step 1: Find the longest carbon chain

- Find the longest, uninterrupted, continuous carbon chain
- It is not required that in the picture or drawing of the carbon chain that atoms all are in line only that it is the longest continuous carbon chain
Step 2: Name it

• Name it.
• Count the number of carbons in the chain and select the appropriate root name based on the number of carbon atoms on the chain.

- Butane
- Ethane
- Octane
<table>
<thead>
<tr>
<th>Number of Carbon Atoms</th>
<th>Root Name</th>
<th>Number of Carbon Atoms</th>
<th>Root Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>meth</td>
<td>11</td>
<td>undec</td>
</tr>
<tr>
<td>2</td>
<td>eth</td>
<td>12</td>
<td>dodec</td>
</tr>
<tr>
<td>3</td>
<td>prop</td>
<td>13</td>
<td>tridec</td>
</tr>
<tr>
<td>4</td>
<td>but</td>
<td>14</td>
<td>tetradec</td>
</tr>
<tr>
<td>5</td>
<td>pent</td>
<td>15</td>
<td>pentadec</td>
</tr>
<tr>
<td>6</td>
<td>hex</td>
<td>20</td>
<td>icos</td>
</tr>
<tr>
<td>7</td>
<td>hept</td>
<td>21</td>
<td>henicos</td>
</tr>
<tr>
<td>8</td>
<td>oct</td>
<td>22</td>
<td>docos</td>
</tr>
<tr>
<td>9</td>
<td>non</td>
<td>30</td>
<td>triacont</td>
</tr>
<tr>
<td>10</td>
<td>dec</td>
<td>40</td>
<td>tetracent</td>
</tr>
</tbody>
</table>
Step 3: Determine any ending

- Determine if any ending needs to be added to the base name
- This is determined by the presence of a **functional group** on any of the carbon atoms
  - A list of functional groups and their structure can be found on the reference link of the class website.

Butane

Ethanol

Octane
<table>
<thead>
<tr>
<th>Compound Class</th>
<th>Ending</th>
<th>Functional Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkanes</td>
<td>-ane</td>
<td>None</td>
</tr>
<tr>
<td>Haloalkanes</td>
<td>-ane</td>
<td>–X</td>
</tr>
<tr>
<td>Alcohols</td>
<td>-ol</td>
<td>–OH</td>
</tr>
<tr>
<td>Ethers</td>
<td>ether</td>
<td>–O—</td>
</tr>
<tr>
<td>Alkenes</td>
<td>-ene</td>
<td><img src="image" alt="Alkene" /></td>
</tr>
<tr>
<td>Alkynes</td>
<td>-yne</td>
<td>–C≡C—</td>
</tr>
<tr>
<td>Aldehydes</td>
<td>-al</td>
<td><img src="image" alt="Aldehyde" /></td>
</tr>
<tr>
<td>Ketones</td>
<td>-one</td>
<td><img src="image" alt="Ketone" /></td>
</tr>
<tr>
<td>Carboxylic Acids</td>
<td>-oic acid</td>
<td><img src="image" alt="Carboxylic Acid" /></td>
</tr>
<tr>
<td>Esters</td>
<td>-oate</td>
<td><img src="image" alt="Ester" /></td>
</tr>
<tr>
<td>Anhydrides</td>
<td>anhydride</td>
<td><img src="image" alt="Anhydride" /></td>
</tr>
<tr>
<td>Amides</td>
<td>-ide</td>
<td><img src="image" alt="Amide" /></td>
</tr>
<tr>
<td>Nitriles</td>
<td>-ile</td>
<td>–C≡N</td>
</tr>
<tr>
<td>Amines</td>
<td>-amine</td>
<td><img src="image" alt="Amine" /></td>
</tr>
</tbody>
</table>
Step 4: Number the carbon atoms

- Start at both ends of the carbon chain, naming the first carbon #1, the next #2, and so on
  - Find which end leads to or arrives at a side group first
  - That end then becomes the carbon #1 end
- Number each carbon continuously through to the other end of the main chain starting with #1
Step 4: Number the carbon atoms

- If both ends of the chain come to a side group with the same number of carbons, then the side with the more complex group (contains more atoms) becomes the end that receives the #1 label on its end carbon.
  - If that also is a tie then the next tie breaker is alphabetizing the side groups.
  - The higher order or first occurring alphabetical character side group becomes carbon #1.
Step 5: Separate and name substituent groups

- Separate out and individually name all the substituent side groups or chains, sometimes referred to as pendant groups.
- The common names for side groups are:
  - Cl = chloro
  - F = fluoro
  - Br = bromo
  - OH = hydroxy
  - NH₂ = amino
  - CN = cyano
  - NO₂ = nitro

There is a list of additional substituent groups on the reference page of the class webpage.

1, 3 - dibromo - 2 - butanone

Substituent group = Side group
<table>
<thead>
<tr>
<th>Structure</th>
<th>Common Name</th>
<th>Systematic Name</th>
<th>Derived From</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Isopropyl structure" /></td>
<td>Isopropyl</td>
<td>1-Methylethyl</td>
<td>Propane</td>
<td>Secondary</td>
</tr>
<tr>
<td><img src="image" alt="Isobutyl structure" /></td>
<td>Isobutyl</td>
<td>2-Methylpropyl</td>
<td>2-Methylpropane (Isobutane)</td>
<td>Primary</td>
</tr>
<tr>
<td><img src="image" alt="Sec-Butyl structure" /></td>
<td>sec-Butyl</td>
<td>1-Methylpropyl</td>
<td>Butane</td>
<td>Secondary</td>
</tr>
<tr>
<td><img src="image" alt="Tert-Butyl structure" /></td>
<td>tert-Butyl</td>
<td>1,1-Dimethylethyl</td>
<td>2-Methylpropane (Isobutane)</td>
<td>Tertiary</td>
</tr>
<tr>
<td><img src="image" alt="Neopentyl structure" /></td>
<td>Neopentyl</td>
<td>2,2-Dimethylpropyl</td>
<td>2,2-Dimethylpropane (Neopentane)</td>
<td>Primary</td>
</tr>
</tbody>
</table>
Step 5: Separate and name substituent groups

- The presence of a double bond between two carbons gives the \(-ene\) ending to the root and the number of carbon of the pair is put proceeding the root.

- A triple bond gives a \(-yne\) ending, and the same proceeding number system.

\[ \text{2HC} \quad \text{CH} \quad \text{CH} \quad \text{CH}_2 \quad \text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{CH} \]

- Butadiene
- 1-Butyne
Step 5: Separate and name substituent groups

- If two of the same atoms appear in a molecule, the word “di” is used to describe it
- If three similar atoms appear in a molecule, the word “tri” is used to describe it
  - 4-tetra
  - 5-penta
- These prefixes are inserted directly before the name of the group

\[\text{2HC} \quad \text{CH} \quad \text{CH} \quad \text{CH}_2\]

butadiene

\[\text{C} \quad \text{C} \quad \text{F} \quad \text{F} \quad \text{F} \quad \text{F}\]

tetrafluoroethylene
Step 6: List substituent chains in alphabetical order

- Write in alphabetical order all substituent chains or groups preceded by the carbon atom number where they are attached

1, 6 – Dichloro – 2, 5 – dimethyl – 3 – hexyne
Step 6: List substituent chains in alphabetical order

The convention requires a parenthesis to be placed around the substituent chains or groups if it is more than a single atom or molecule.

Commas are placed between numbers and dashes are placed between numbers and letters and in front of the parenthesis.

A group of atoms appearing in the brackets is alphabetized by the real first letter of the group, whereas, normal convention does not treat the di’s or tri’s as part of the alphabetizing process.
Example: tryptophan synthetase A protein, a 1,913-letter enzyme with 267 amino acids.

This will be on the exam!
For Extra Help:

• Tutorials
  – [http://people.ouc.bc.ca/woodcock/nomenclature/index.htm](http://people.ouc.bc.ca/woodcock/nomenclature/index.htm)

• Practice Problems with Answers: