Hydrocarbon Derivatives

- A *hydrocarbon derivative* is a hydrocarbon that contains other atoms such as oxygen, fluorine, chlorine, etc.

Alcohols & Alkyl Halides

- **Alcohols** are hydrocarbon derivatives that contains an –OH, or *hydroxyl*, functional group.

- **Alkyl halides** are hydrocarbon derivatives that contain at least one halogen atom (group 17 atom).

Naming and Drawing Alcohols and Alkyl Halides

Step 1: Identify the root
- Locate the longest carbon chain that contains the hydroxyl group or halogen.

Step 2: Identify the suffix
- All of the alcohols and alkyl halides in chemistry 30 will be alkanes, so the main part of the suffix will be “…ane”.
- All alcohols end with –ol (drop the –e on the end of “…ane” and add –ol).
- The position of the hydroxyl group is indicated by a number in front of the –ol.
- If multiple hydroxyl groups are present, use *di, tri, tetra*, etc. to indicate the number of hydroxyl groups.

Step 3: Identify the prefix
- Name and number any side groups on the main chain using same rules as before.
- When numbering carbons in the main chain or in the ring for cyclic hydrocarbons, priority is always given to the hydroxyl group or halide to have the lowest number.
- Use the prefixes chloro-, fluoro-, bromo-, iodo- to identify the specific halogens.
- Remember to list all side groups and halogens alphabetically (using *di, tri, tetra*, doesn’t count as alphabetical).
EXAMPLES: Name the following organic compounds.

1. 3,4-dimethyl pent-2-ol
   - 5 carbon main chain :: pentane
   - Hydroxyl group on carbon 2

2. Propan-1,2,3-triol
   - 3 carbon main chain :: propane
   - Hydroxyl groups on carbons 1, 2, < 3

3. 1,3-dibromo-4-methyl cyclohexane
   - 6 carbon ring :: cyclohexane
EXAMPLES: Draw the following organic molecules.

a. 2,4-dimethylcyclopentanol

\[
\begin{align*}
\text{CH}_3 & \quad \text{CH} \quad \text{CH} - \text{OH} \\
\text{CH} - \text{CH}_2 & \quad \text{CH}_3
\end{align*}
\]

b. 2,3,4 – triodo-3-methylheptane

\[
\begin{align*}
\text{CH}_3 - \text{CH} - \text{C} - \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3
\end{align*}
\]

• Physical Properties of Alcohols
  o The hydroxyl group is very polar, making small alcohols miscible/soluble in water
  o As the hydrocarbon chain becomes longer, the non-polar property of the hydrocarbon starts to dominate, making larger alcohols less soluble in water
  o Since the hydroxyl group contains a hydrogen atom, hydrogen bonding exists, causing alcohols to have a much higher boiling point than the corresponding alkanes, alkenes, or alkynes

***Now try pg. 567 #28, 29 & pg. 569 #31, 32***

CARBOXYLIC ACIDS

• A **carboxylic acid** is an organic compound that contains a **carboxyl group**, or \(-\text{COOH}\) group

  o Carboxylic acids can still be **saturated** hydrocarbons because the double bond isn’t between carbon-carbon atoms

• Carboxylic acids are weak acids, which means they can donate a hydrogen ion

\[
\begin{align*}
\text{acid} & \quad \text{OH} & \quad \text{H}_2 \text{O} & \quad \text{base} \quad \leftrightarrow \quad \text{acidic hydrogen} & \quad \text{base} \quad \text{conjugate} & \quad \text{conjugate acid}
\end{align*}
\]
• Naming and Drawing Carboxylic Acids

Step 1: Identify the root
  o Identify and name the longest carbon chain (i.e. parent alkane) that includes the carbon in the carboxyl group
  o The carbon in the carboxyl group is always numbered as carbon 1 when numbering the carbons in the main chain

Step 2: Identify the suffix
  o Drop the \(-e\) at the end of the name of the parent \textit{alkane} and replace it with \textit{"-oic acid"}

Step 3: Identify the prefix:
  o Name and number any alkyl side groups attached to the main carbon chain using the same rules as before

\textbf{EXAMPLES:} Name the following carboxylic acids.

1. \begin{itemize}
   \item 5 carbon main chain \textit{\textbullet;} pentane
   \item 3-methylpentanoic acid
\end{itemize}

2. \begin{itemize}
   \item 6 carbon main chain \textit{\textbullet;} hexane
   \item 2-ethyl-4,5-dimethylhexanoic acid
\end{itemize}
**EXAMPLE:** Draw and name two different carboxylic acids that have the molecular formula $C_4H_8O_2$.

- Carboxyl groups only found at end of carbon chain
- Butanoic acid
- 2-Methyl propanoic acid

- Physical Properties of Carboxylic Acids
  - The presence of both the $-C=O$ group and the $-OH$ group make the carboxyl group very polar.
  - The very polar carboxyl group makes carboxylic acids (with 10 carbon atoms or less) soluble in water.
  - The carboxyl group also allows carboxylic acid molecules to form hydrogen bonds with one another, causing the boiling points of carboxylic acids to be much higher than the corresponding hydrocarbons (alkanes, alkenes, or alkynes) and even alcohols.

<table>
<thead>
<tr>
<th>Compound</th>
<th>Boiling Point ($^\circ$C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>butane</td>
<td>-0.5</td>
</tr>
<tr>
<td>butan-1-ol</td>
<td>117.2</td>
</tr>
<tr>
<td>butanoic acid</td>
<td>165.5</td>
</tr>
</tbody>
</table>

***Now try pg. 570 # 33, 34***
**Esters**

- An ester is a hydrocarbon derivative that contains the following functional group
  - General formula for an ester is RCOOR' where the symbol R represents any hydrocarbon or just a hydrogen atom. The symbol R' represents a hydrocarbon that **cannot** be a hydrogen atom. *The molecule would be a carboxylic acid!*

- Naming and Drawing Esters
  - When naming esters, keep in mind the following reaction

  ![Reaction Diagram]

  **Step 1:** Identify root
  - The longest carbon chain that is attached and includes the carbon in the C=O group (i.e., acid part) is the root name of the ester.
  - The root now also includes any side groups coming off this main chain. Use the same rules as before for identifying side groups.

  **Step 2:** Identify the suffix
  - Remove the "-oic acid" from the name of the parent acid and replace it with "-oate."

  **Step 3:** Identify the prefix
  - To form the prefix, consider the alcohol part of the ester. Count the number of carbon atoms in the chain that is attached to the oxygen in the alcohol part. This alkyl group is the prefix.
  - There is always a space between the alkyl group/prefix and the root.

**Examples:** Name the following esters.

1. ![Diagram](image)
   - 1 carbon of acid component
   - Prefix = propyl
   - Propyl methanoate
   - 3 carbon alcohol component
EXAMPLE: Draw the following ester.

ethyl 3,3-dimethylbutanoate

Physical Properties of Esters

- The -C=O groups makes esters somewhat polar, making esters with 4 or fewer carbons are soluble in water; larger esters are not water soluble
- The boiling point of esters is lower than the corresponding alcohol and carboxylic acid because there is no hydrogen bonding due to the absence of the hydroxyl group
- Esters usually have a smell/aroma; usually pleasant, fruity odours
<table>
<thead>
<tr>
<th>Compound</th>
<th>Boiling Point (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>butene</td>
<td>-6.3</td>
</tr>
<tr>
<td>butane</td>
<td>-0.5</td>
</tr>
<tr>
<td>butyne</td>
<td>8.1</td>
</tr>
<tr>
<td>butanoate</td>
<td>~102</td>
</tr>
<tr>
<td>butan-1-ol</td>
<td>117.2</td>
</tr>
<tr>
<td>butanoic acid</td>
<td>165.5</td>
</tr>
</tbody>
</table>

***Now try pg. 572 #37, 38***