Hey guys! This week, you all will be switching gears, away from aromatics, to focus on the carbonyl group. Don’t forget to study for your upcoming test too!

In-person group tutoring sessions will take place every Wednesday from 5:15 to 6:15 PM in Sid Rich Room 74. For more information about tutoring, and getting help, you can follow the link: www.baylor.edu/tutoring.

**TOPIC OF THE WEEK:** Aldehydes and Ketones (Chapter 19)

**Keywords:** Carbonyl, Wittig, Wolff-Kishner, Baeyer-Villiger

Aldehydes and ketones are both molecules with a carbonyl (C=O), with aldehydes having a terminal carbonyl, while ketones have theirs situated in the molecule.

![Aldehyde and Ketone Structures](image)

The process used to name both types of molecules is very similar:
1. Identify the parent chain (which has the carbonyl group)
2. Identify and number all substituents, with the carbonyl being of the highest priority
3. Name the molecule as you normally would. For aldehydes, the name will end in -al, and -one for ketones.

![Names of Aldehydes and Ketones](image)

Nucleophilic Addition Reactions:
Because of the carbonyl group, which has an induced dipole, the carbon is a great candidate in nucleophilic attack. This results in the carbonyl being reduced to an alcohol in each reaction. This reaction can be performed in both acid or basic conditions, and follows a similar mechanism:
Here is a list of nucleophiles and their product. Some of them you have covered before, such as Grignard Reagents, or using LiAlH₄ to reduce a carbonyl.

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNH₂ (Primary Amine)</td>
<td><img src="image" alt="Imine" /></td>
</tr>
<tr>
<td>R₂NH (Secondary Amine)</td>
<td><img src="image" alt="Enamine" /></td>
</tr>
<tr>
<td>H₂N-H₂N</td>
<td><img src="image" alt="Hydrazone" /></td>
</tr>
<tr>
<td>NH₂-OH</td>
<td><img src="image" alt="Oxime" /></td>
</tr>
<tr>
<td>Reaction</td>
<td>Structure</td>
</tr>
<tr>
<td>----------</td>
<td>-----------</td>
</tr>
<tr>
<td>2 RSH (Thiol)</td>
<td><img src="image" alt="Thioacetal" /></td>
</tr>
<tr>
<td>CN</td>
<td><img src="image" alt="Cyanohydrin" /></td>
</tr>
<tr>
<td>ROH (Ether)</td>
<td><img src="image" alt="Hemi-ketal" />, <img src="image" alt="Acetal" />, <img src="image" alt="Ketal" /></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td><img src="image" alt="Cyclic Acetal" /></td>
</tr>
</tbody>
</table>

**Highlight #1: Useful Reactions!**

**Wittig Reactions:**
This type of reaction is very useful, as it can create a carbon-carbon double bond, using a carbonyl. To do so, this reaction uses a molecule known as a *ylide* which will add onto the carbonyl. Because carbonyls have a dipole, both the negative and positive ends will attack the charged ends of ylide to start the reaction.
Wolff-Kishner Reaction:
This reaction is quite useful if we want to easily reduce a ketone completely to hydrogens, using a hydrazone intermediate. By getting a hydrazone (which a ketone can be easily turned into), we can simply use a base and water in heat to pluck off the two nitrogens as a leaving group, replacing them with hydrogens.

Baeyer-Villiger Oxidation:

This is a very odd reaction, which can turn a ketone or aldehyde, into an ester, by putting an Oxygen atom within one of the R groups of a ketone.

\[
\begin{align*}
\text{Ketone} & \quad \xrightarrow{\text{RCO}_3\text{H}} \quad \text{Ester} \\
\end{align*}
\]

This reaction is selective, and sensitive to how many bonds each R group has. As the number of bonds go down (tertiary \(ightarrow\) secondary \(ightarrow\) primary), the oxidation is less likely to happen, meaning that if a ketone were to have both a tertiary and secondary R group, the oxidation would take place at the tertiary position. Despite this, the hydrogens on aldehydes are the \textbf{MOST} reactive.

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**PRACTICE PROBLEMS!!!**

Provide a synthesis for each problem:

![Chemical structures](image)
THINGS YOU MAY STRUGGLE WITH:

- Because many reactions in this chapter follow a similar mechanism, and have similar products, you may confuse yourself with what products go with what reactions. It would be a good idea to keep everything memorized very well.
- Additionally, many problems in this chapter can involve many steps (and thus many reactions / mechanisms), so it is very easy to get lost when doing something if you do not pay good attention.

Answers to the problems:

1.

\[
\begin{align*}
\text{Cl} & \quad \text{O} \\
1. \text{Cl} & \quad 2. \text{FeCl}_3 \\
\text{C}_6\text{H}_5 & \quad \text{C}_6\text{H}_5
\end{align*}
\]

2.

\[
\begin{align*}
\text{H}_2\text{N} & \quad \text{NH}_2 \\
\text{C}_6\text{H}_5 & \quad \text{C}_6\text{H}_5
\end{align*}
\]
3.

- Reaction with HBr: 
  - Conversion of alkene to alkyl halide

- Reaction with -OH: 
  - Conversion of alkyl halide to alcohols

- Reaction with PCC: 
  - Conversion of alcohols to ketones

- Reaction with $\text{H}_2\text{C} \rightleftharpoons \text{PPh}_3$: 
  - Conversion of ketones to alkenes

- Reaction with EtOH: 
  - Conversion of cycloalkanes to alkenes
All tables are courtesy of Organic Chemistry by David Klein. All drawings of molecules and mechanisms are made by me.