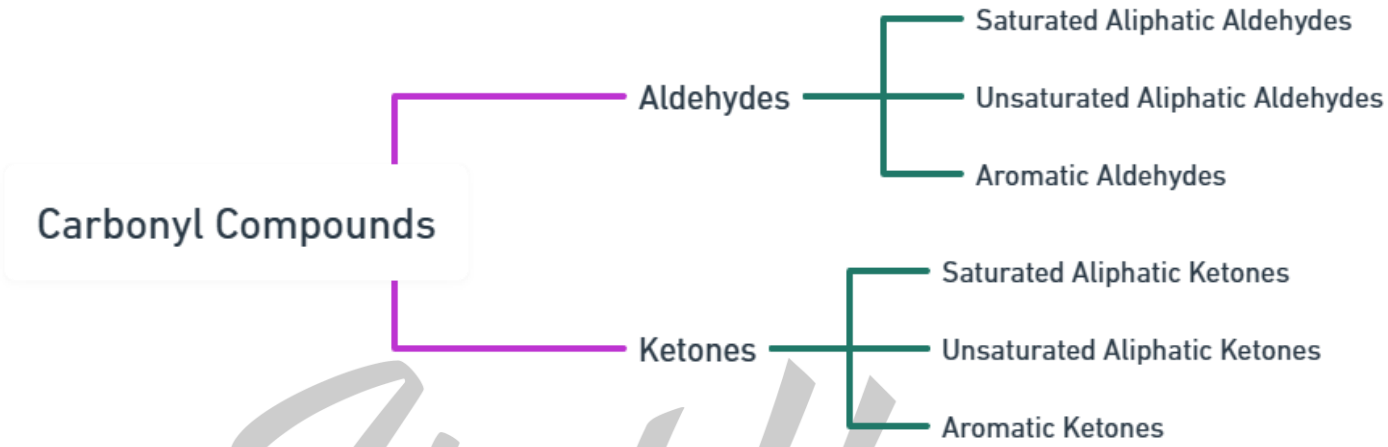
Carbonyl compounds

Carbonyl compounds (Aldehydes and ketones)

- Carbonyl compounds are a significant class of organic compounds, including aldehydes and ketones, characterized by the presence of a carbonyl group (C=O).
- This group, comprising a carbon atom double-bonded to an oxygen atom, contributes to their reactivity and polarity.
- Aldehydes and ketones play vital roles in various industrial and synthetic applications due to their distinctive chemical properties.



First Hope

Aldehydes

- Aldehydes feature a carbonyl group attached to at least one hydrogen atom and either an alkyl or aryl group.
- They are classified based on the nature of the attached carbon chain or ring:

1. **Saturated Aliphatic Aldehydes:**
   - These have a saturated hydrocarbon chain connected to the carbonyl group.
   - Examples include formaldehyde (HCHO) and acetaldehyde (CH_3CHO).
2. **Unsaturated Aliphatic Aldehydes:**
   - Characterized by one or more double bonds within the hydrocarbon chain attached to the carbonyl group.
   - Examples are acrolein (CH_2=CHCHO) and crotonaldehyde (CH_3CH=CHCHO).
3. **Aromatic Aldehydes:**
   - An aryl group is connected to the carbonyl function.
   - Examples include benzaldehyde (C_6H_5CHO) and cinnamaldehyde (C_6H_5CH=CHCHO).

Applications of Aldehydes:

- **Solvents**: Formaldehyde serves as a solvent in some chemical reactions.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

- **Chemical Synthesis Intermediates**: Used in manufacturing plastics, dyes, and perfumes.
- **Preservatives**: Formaldehyde's antimicrobial properties make it useful in medical preservation.
- **Flavorings and Fragrances**: Aromatic aldehydes like cinnamaldehyde and vanillin enhance flavors and scents.

Ketones

- Ketones are characterized by a carbonyl group bonded to two alkyl or aryl groups.
- Their classification is similar to aldehydes but focuses on the nature of the carbonyl-flanking groups:

1. Saturated Aliphatic Ketones:

- These ketones have saturated hydrocarbon chains on both sides of the carbonyl group, with acetone (CH_3COCH_3) and butanone ($CH_3CH_2COCH_3$) being common examples.

2. Unsaturated Aliphatic Ketones:

- These contain at least one unsaturated hydrocarbon chain. Methyl vinyl ketone ($CH_3COCH{=}CH_2$) and mesityl oxide ($CH_3C(O)CH{=}C(CH_3)_2$) exemplify this category.

3. Aromatic Ketones:

- Here, one or both alkyl groups are replaced with aryl groups. Benzophenone ($5C_6H_5COC_6H_5$) and acetophenone ($CH_3COC_6H_5$) are notable aromatic ketones.

Applications of Ketones

- **Solvents**: Acetone and methyl ethyl ketone are key solvents in paints, coatings, and adhesives.
- **Organic Synthesis Intermediates**: Ketones are pivotal in producing pharmaceuticals, dyes, and polymers.
- **Flavorings and Fragrances**: Muscone and civetone, for example, are used for their unique scents in the fragrance industry.
- **Laboratory Reagents**: Ketones serve as essential reagents in Grignard reactions, aldol condensations, and other laboratory processes.

physical and chemical properties of Carbonyl compounds (Aldehydes and ketones)

Physical Properties

1. Molecular Structure:

- The carbonyl group consists of a carbon atom double-bonded to an oxygen atom, creating a site of high electron density.
- In aldehydes, the carbonyl group is bonded to a hydrogen atom and an alkyl or aryl group. In ketones, it is bonded to two alkyl or aryl groups.

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

2. **Polarity:**
   - The carbon-oxygen bond is highly polar due to the electronegativity difference between the atoms, resulting in a significant dipole moment.
3. **Boiling Points:**
   - Aldehydes and ketones have higher boiling points than hydrocarbons of similar molecular weight due to dipole-dipole interactions.
   - Their boiling points are lower than alcohols and carboxylic acids, as they cannot form hydrogen bonds as effectively.
4. **Solubility:**
   - They are generally soluble in organic solvents and somewhat soluble in water.
   - Lower molecular weight aldehydes and ketones are more water-soluble because they can form hydrogen bonds with water molecules.

Chemical Properties

1. **Nucleophilic Addition:**
   - The electrophilic carbon in the carbonyl group is susceptible to attack by nucleophiles.
   - This forms the basis of many reactions, such as with amines, hydrides, and cyanides.
2. **Oxidation and Reduction:**
   - Aldehydes are easily oxidized to carboxylic acids by oxidizing agents like $KMnO_4$ or $K_2Cr_2O_7$.
   - Ketones are more resistant to oxidation but can be reduced to alcohols using reducing agents like $NaBH_4$ or $LiAlH_4$.
3. **Formation of Hemiacetals and Acetals:**
   - Aldehydes and ketones can react with alcohols to form hemiacetals and acetals under acid catalysis.
4. **Aldol Condensation:**
   - Aldehydes and ketones can undergo aldol condensation in the presence of a base or acid, forming β-hydroxy aldehydes or ketones.
5. **Cannizzaro Reaction:**
   - Aldehydes without an α-hydrogen undergo the Cannizzaro reaction with strong bases, producing a mixture of a carboxylic acid and an alcohol.

Preparation of Carbonyl compounds (Aldehydes and ketones)

First Hope

Copyright by Engacy Learning Private Limited. All rights reserved. Reproduction or distribution without written consent is strictly prohibited.

First Hope

FREE PREVIEW

Click here to visit our website

PHARMACY PREMIUM NOTES

Complete subject and semesters are available on FirstHope app only.

Scan or click here

Click here to get the app >

Available on Google Play

JOIN THE FIRSTHOPE COMMUNITY

Join our Telegram channel

Click here to join Telegram >

Scan or click here

@FirstHopeNotes

Instagram

@firsthope.official

Click here to follow >

YouTube channel

FirstHope-Pharmacy / Live streams

Click here to watch >

WhatsApp channel

Follow FirstHope on WhatsApp

Click here to join >

FirstHope website

firsthope.co.in

Click here to visit >

B.Pharm / D.Pharm / M.Pharm / Pharm.D

Preview notes. Complete subjects and semesters in the FirstHope app.