Aldehydes and **Ketones**

Part 1

B. Pharm. Semester-1
Course Code: 0510210; Session: 2022-2023

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Learning Outcomes

At the end of this lesson, students will be able to describe

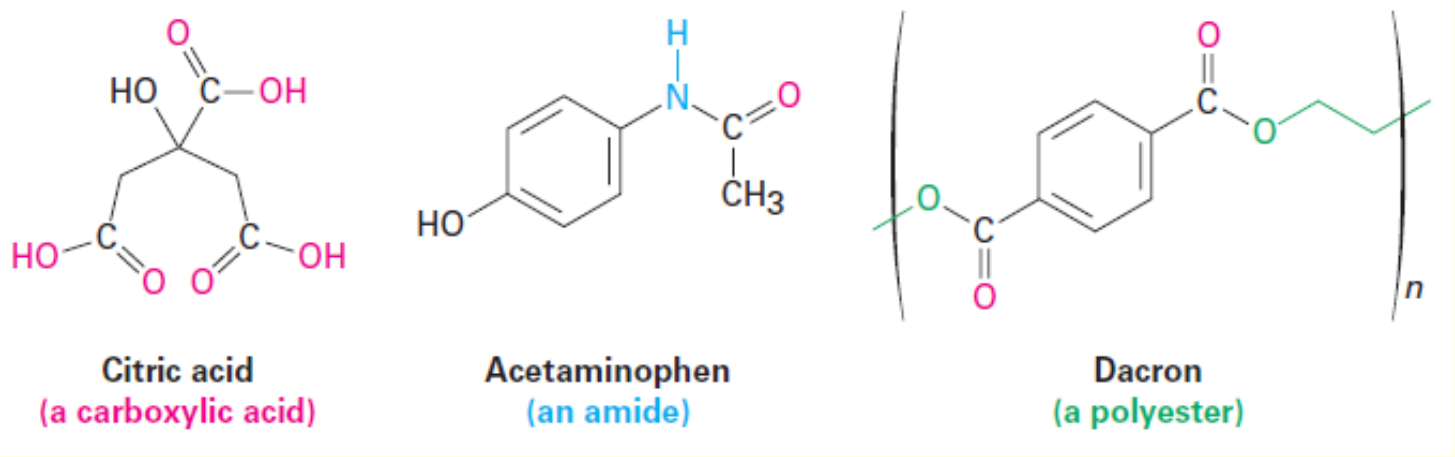
- **Carbonyl Compounds**
- **Aldehydes and Ketones**
- **Naming of Aldehydes and Ketones**
- **Preparation of Aldehydes**
- **Preparation of Ketones**

Objective

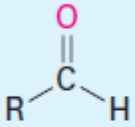
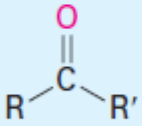
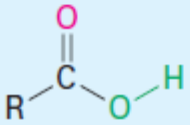
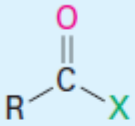
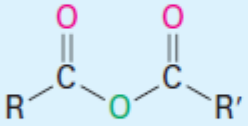
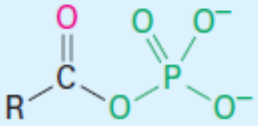
The objective of this course is to give to the students of pharmacy the basic knowledge about the organic chemistry.

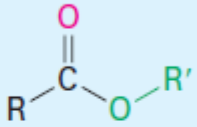
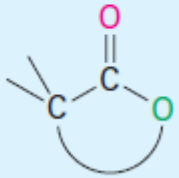
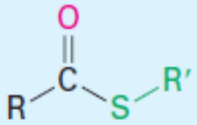
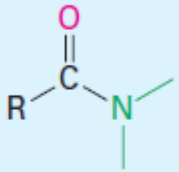
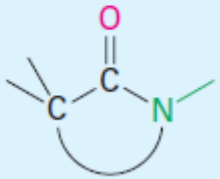
Carbonyl compounds

- Carbonyl compounds are everywhere.
- Most biological molecules, pharmaceutical agents, and chemicals contain carbonyl groups.
- Citric acid, found in lemons and oranges; Acetaminophen;
- Dacron, the polyester material used in clothing
- All contain different kinds of carbonyl groups, All contain an acyl group (R–C=O) bonded to another substituent.

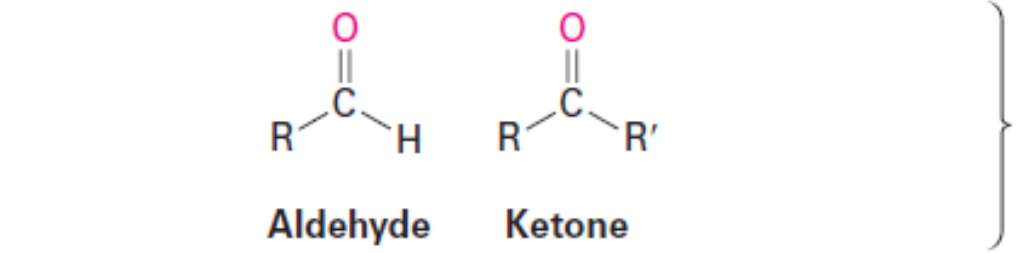


Kinds of Carbonyl compounds

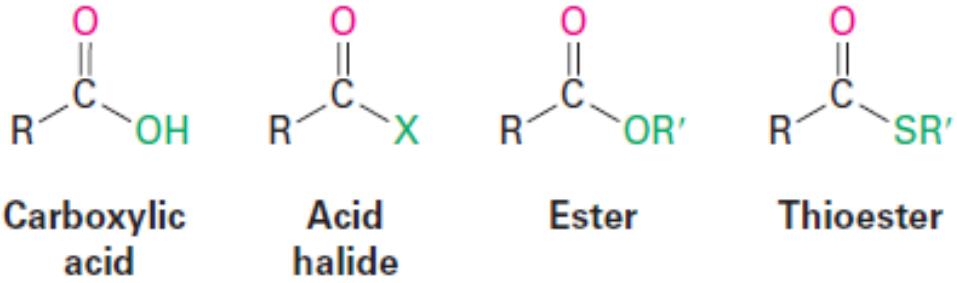
Name	General formula	Name ending
Aldehyde		*-al*
Ketone		*-one*
Carboxylic acid		*-oic acid*
Acid halide		*-yl or -oyl halide*
Acid anhydride		*-oic anhydride*
Acyl phosphate		*-yl phosphate*

Name	General formula	Name ending
Ester		*-oate*
Lactone (cyclic ester)		None
Thioester		*-thioate*
Amide		*-amide*
Lactam (cyclic amide)		None

Kinds of Carbonyl compounds



The –R′ and –H in these compounds *can't* act as leaving groups in nucleophilic substitution reactions.



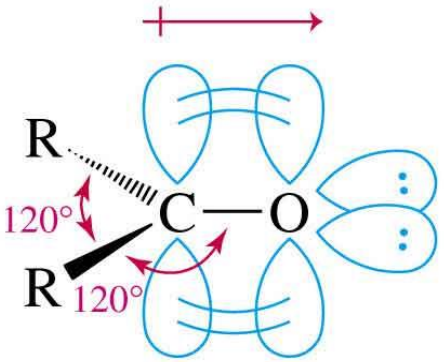
The –OH, –X, –OR′, –SR, $-NH_2$, –OCOR′, and $-OPO_3^{2-}$ in these compounds *can* act as leaving groups in nucleophilic substitution reactions.

Aldehydes and Ketones

✓Aldehydes (RCHO) and ketones (R_2CO) are among the most widely occurring of all compounds and are characterized by the carbonyl functional group (C=O).

✓These compounds occur widely in nature as intermediates in metabolism and biosynthesis.

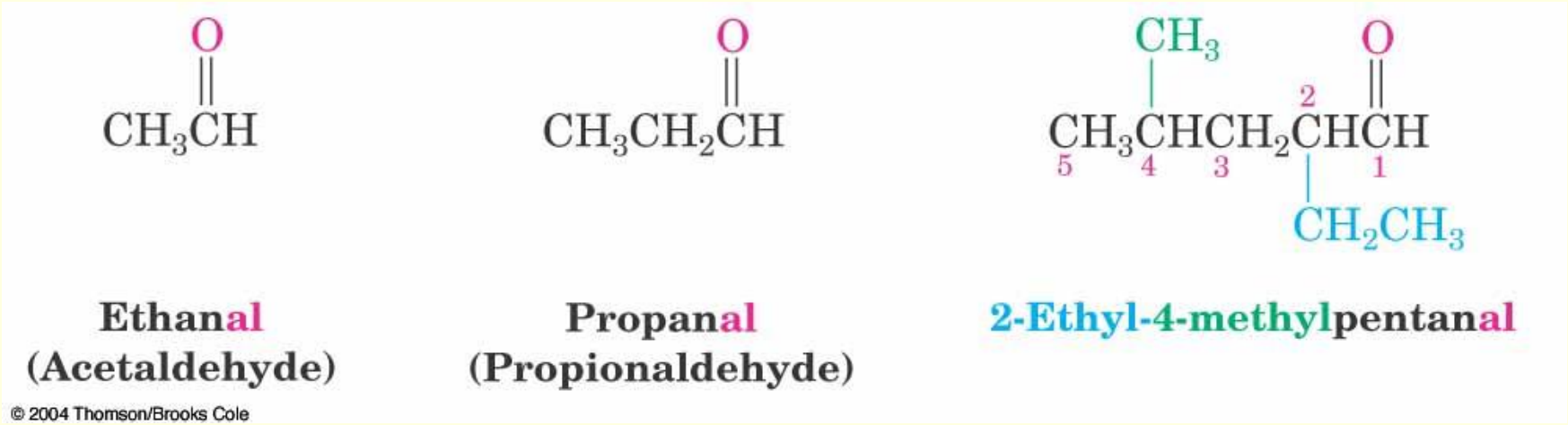
✓They are also present in chemicals, as solvents, monomers, adhesives, agrichemicals and pharmaceuticals.



	length	*energy*
ketone C═O bond	1.23 Å	178 kcal/mol (745 kJ/mol)
alkene C═C bond	1.34 Å	146 kcal/mol (611 kJ/mol)

Naming of Aldehydes

- ✓ Aldehydes are named by replacing the terminal -e of the corresponding alkane name with –al.
- ✓ The parent chain must contain the -CHO group.
- ✓ The -CHO carbon is numbered as C1.



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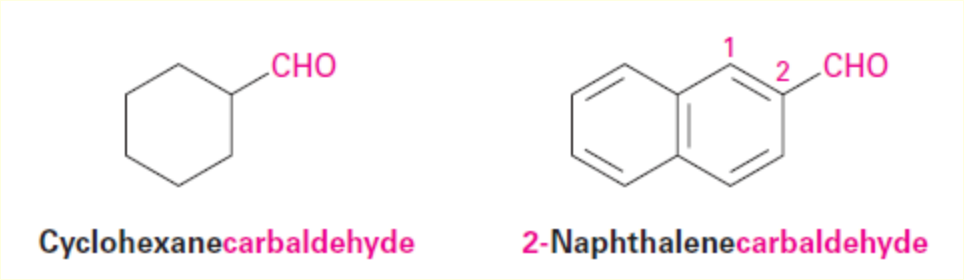
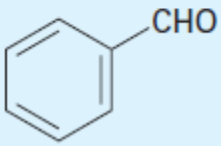
Naming of Aldehydes

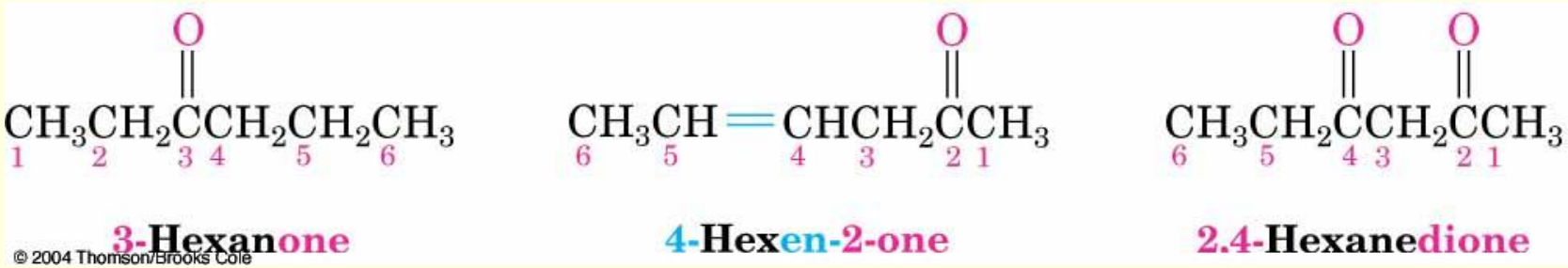
For cyclic aldehydes in which the -CHO group is directly attached to a ring, the suffix -carbaldehyde is used.

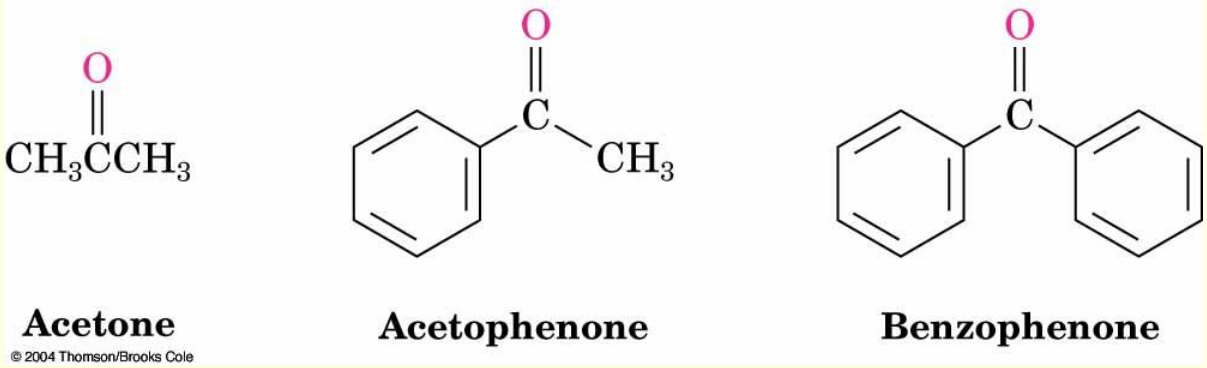


Formula	Common name	Systematic name
HCHO	Formaldehyde	Methanal
CH_3CHO	Acetaldehyde	Ethanal
$H_2C{=}CHCHO$	Acrolein	Propenal
$CH_3CH{=}CHCHO$	Crotonaldehyde	2-Butenal
	Benzaldehyde	Benzenecarbaldehyde

Naming of Ketones

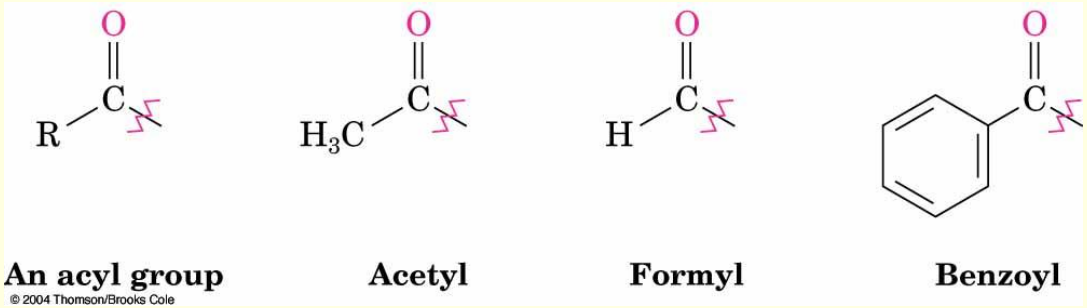
- Ketones are named by replacing the terminal -e of the corresponding alkane name with -one.
- The parent chain is the longest one that contains the ketone group, and the numbering begins at the end nearer the carbonyl carbon.





Aldehydes and Ketones as Substituents

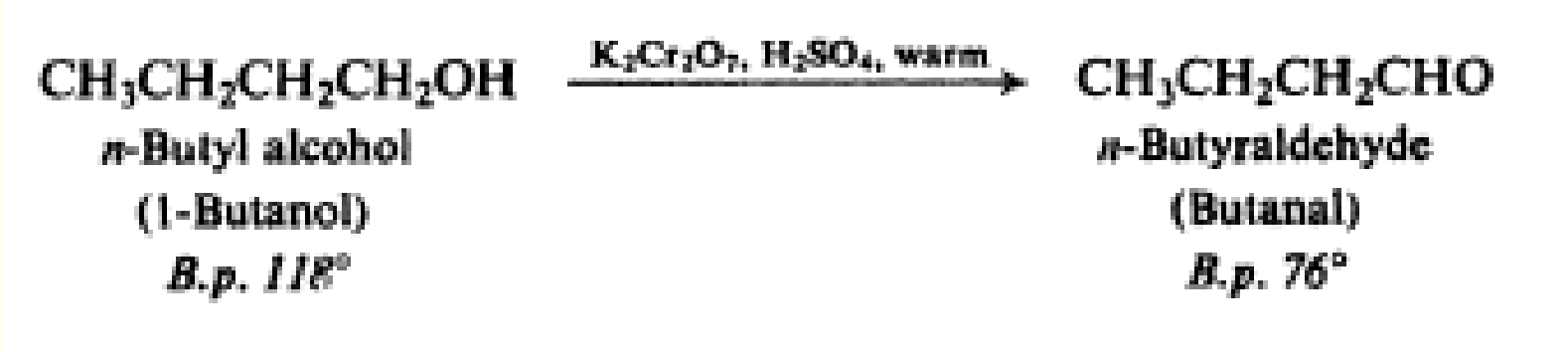
- The R–C=O as a substituent is an acyl group is used with the suffix -yl from the root of the carboxylic acid
- CH_3CO: acetyl; CHO: formyl; C_6H_5CO: benzoyl
- The prefix oxo- is used if other functional groups are present and the doubly bonded oxygen is labeled as a substituent on a parent chain.



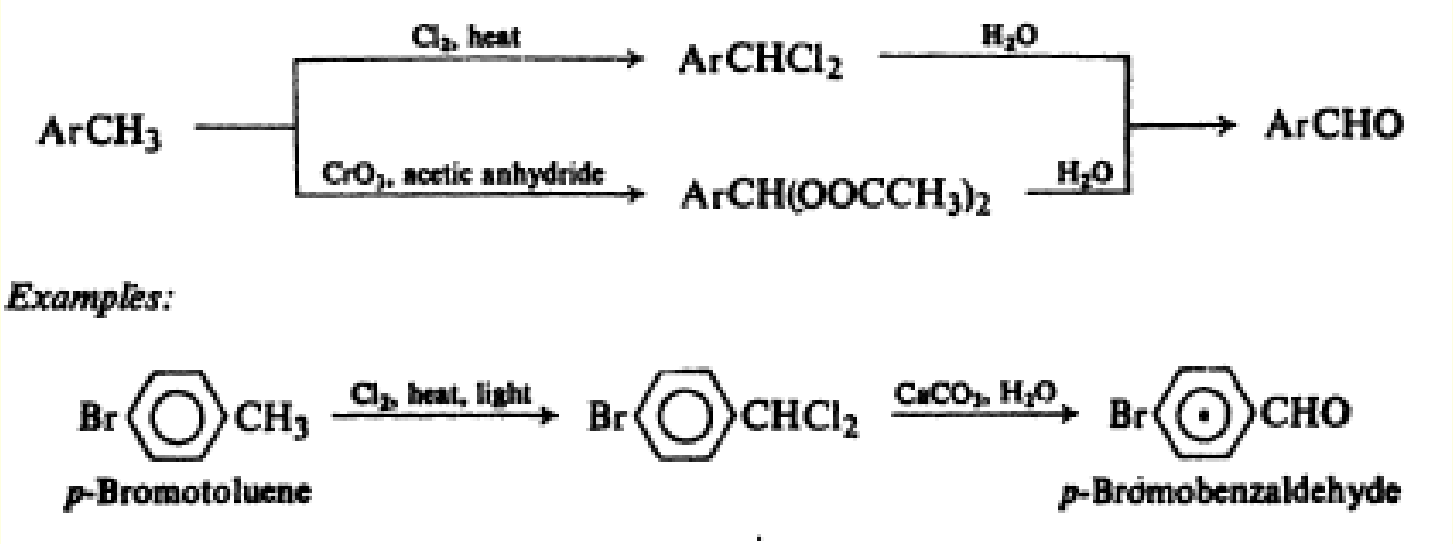
Preparation of Aldehydes

1. Oxidation of primary alcohols
2. Oxidation of methylbenzenes
3. Reduction of acid chlorides
4. Reimer-Tiemann reaction: Phenolic aldehydes

1. Oxidation of Primary Alcohols



2. Oxidation of Methyl benzenes

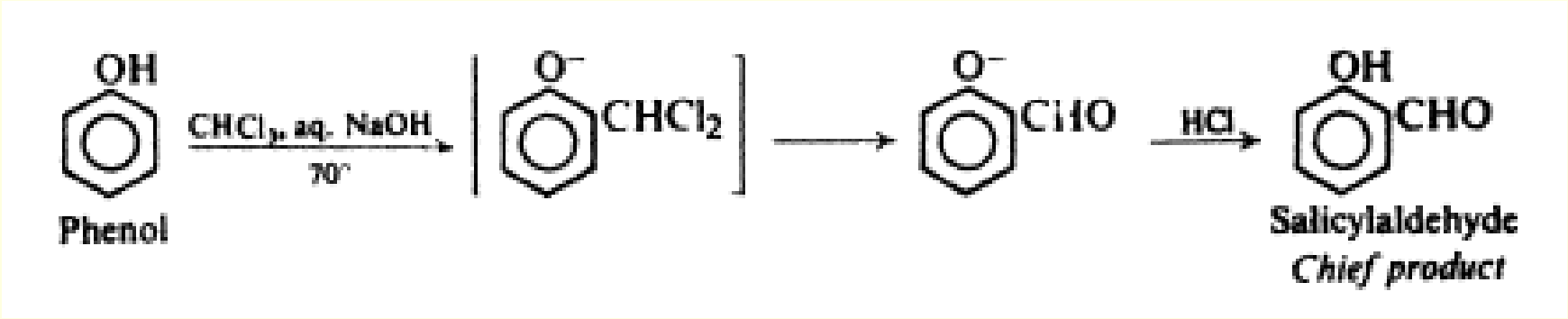


3. Reduction of acid chlorides

Examples:

4. Reimer-Tiemann reaction: Phenolic aldehydes

Treatment of a phenol with chloroform and aqueous hydroxide introduces an aldehyde group (R-CHO) into the aromatic ring, generally ortho to the OH group. This reaction is known as the Reimer-Tiemann reaction.

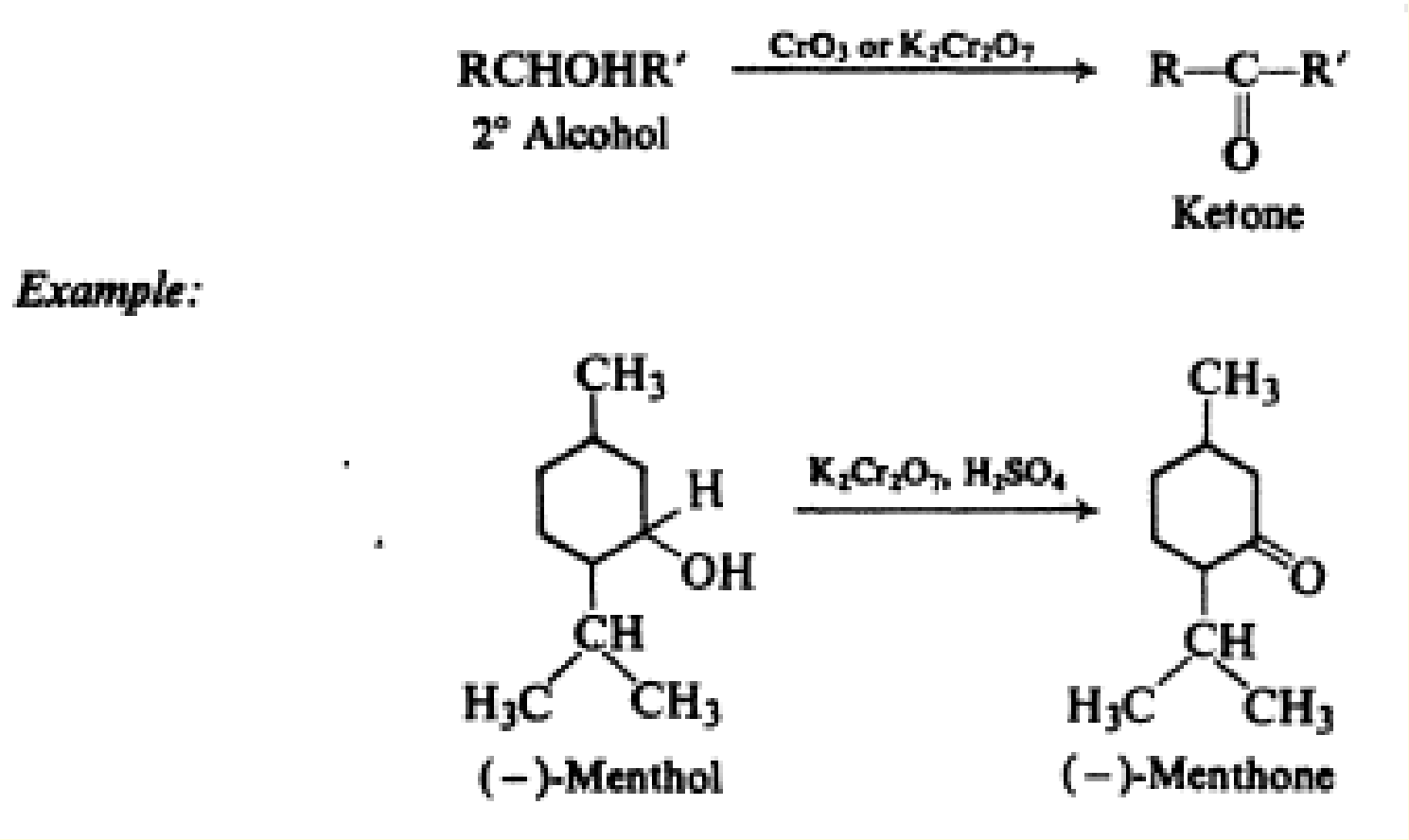


A substituted benzal chloride is initially formed, but is hydrolyzed by the alkaline reaction medium.

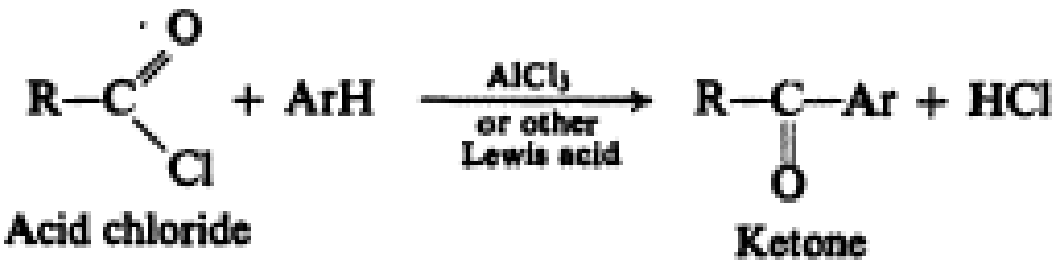
Preparation of Ketones

1. **Oxidation of secondary alcohols**
2. **Friedel-Crafts acylation**
3. **Reactions of acid chlorides with organocadmium compounds**
4. **Acetoacetic ester synthesis**

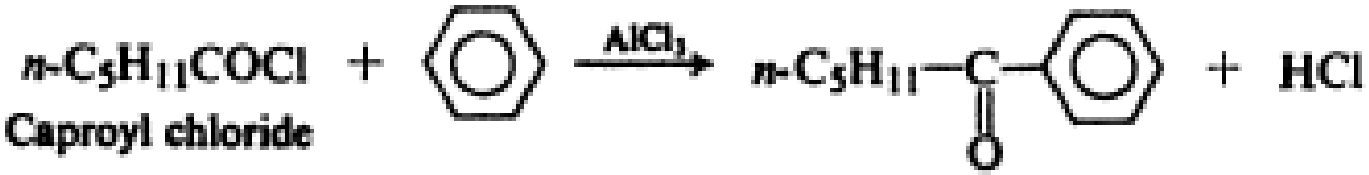
1. Oxidation of Secondary Alcohols



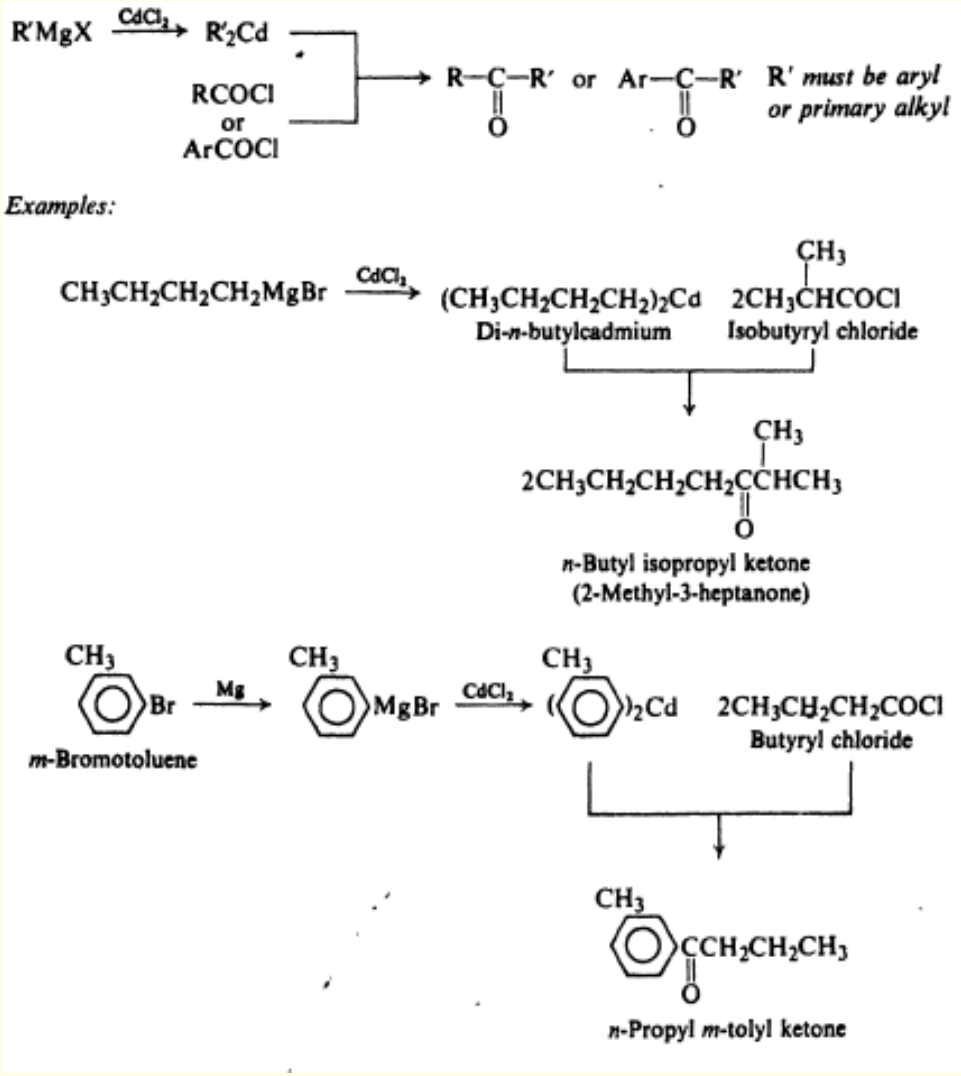
2. Friedel-Crafts acylation



Examples:

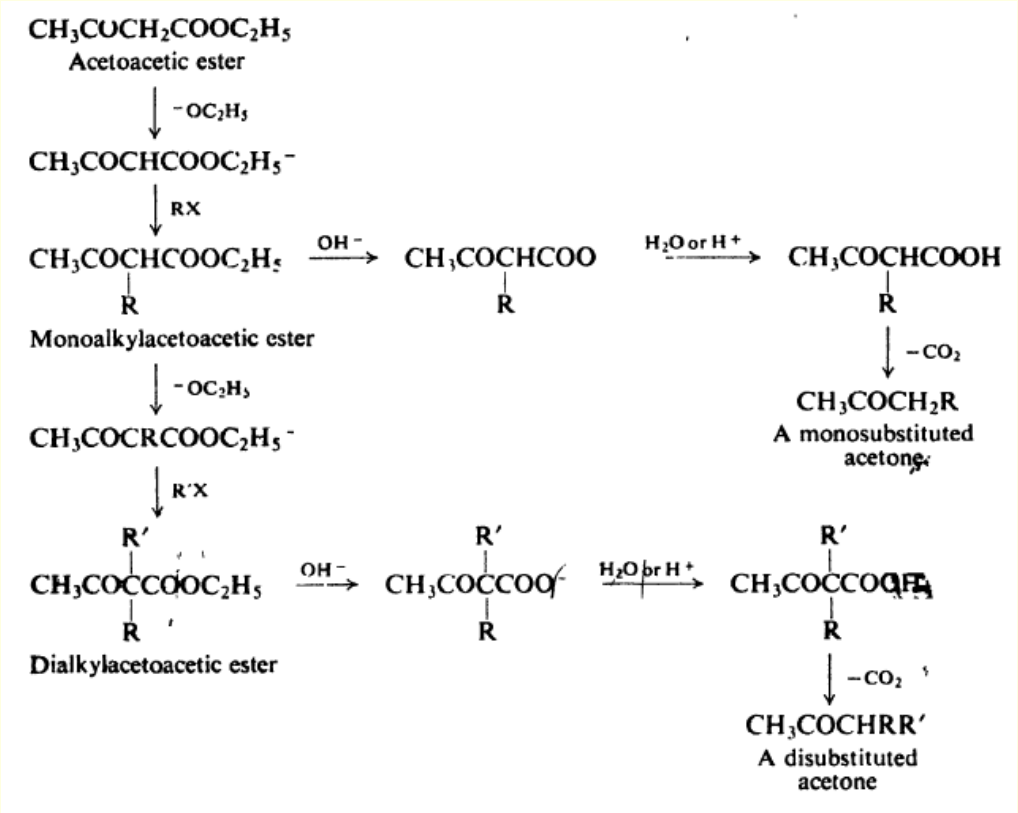


3. Reaction of acid chlorides with organocadmium compounds



4. Acetoacetic ester synthesis

One of the most valuable methods of preparing ketones makes use of **ethyl acetoacetate** (acetoacetic ester), **$CH_3COCH_2COOC_2H_5$** and is called the acetoacetic ester synthesis of ketones.



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3. **Textbook of Organic Chemistry, 22nd Edition, 2022, Authors: Arun Bahl & B S Bahl, Publisher: S Chand, ISBN: 978-9352531967.**

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