

# Aldehydes and ketones

by

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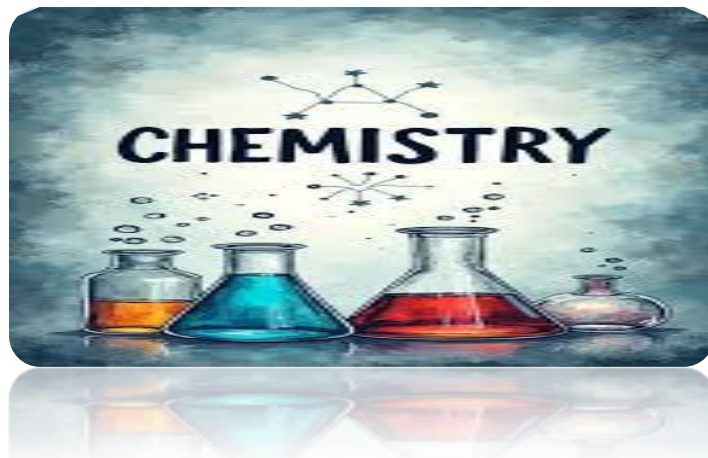
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**Lab. of Medical Chemistry**

**First stage**

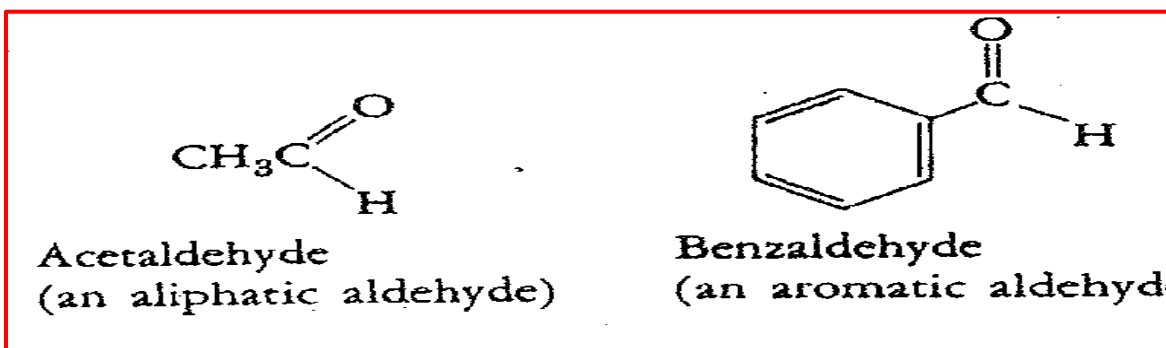
**Collage of Dentistry**

exp. Number (6)



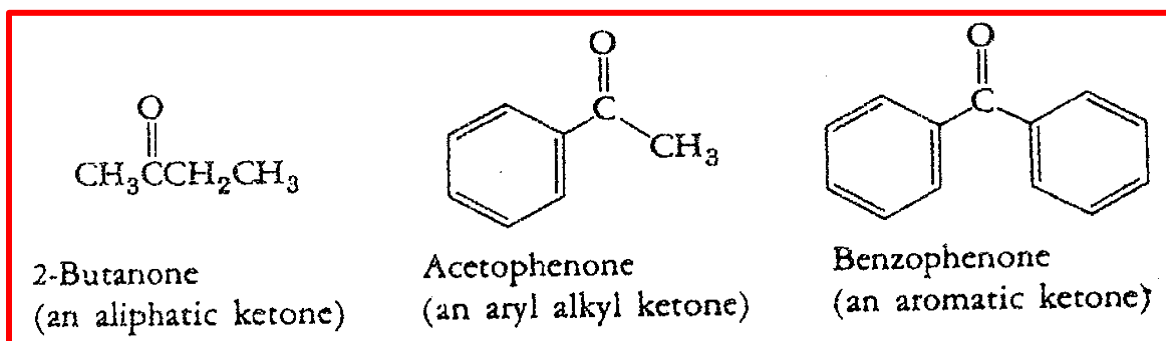
## Aldehydes and ketones

Aldehydes and ketones are two classes of compounds that contain a carbonyl group. An aldehyde contains a carbonyl group in which the carbon is bonded to one hydrogen and either an alkyl or an aryl group. For example:

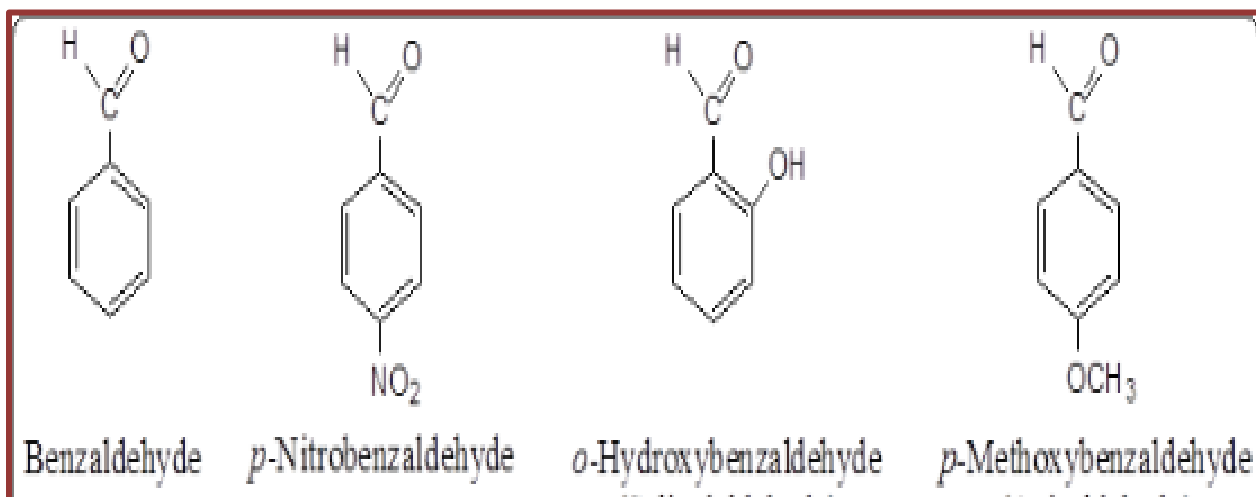


The aldehyde group is also written RCHO

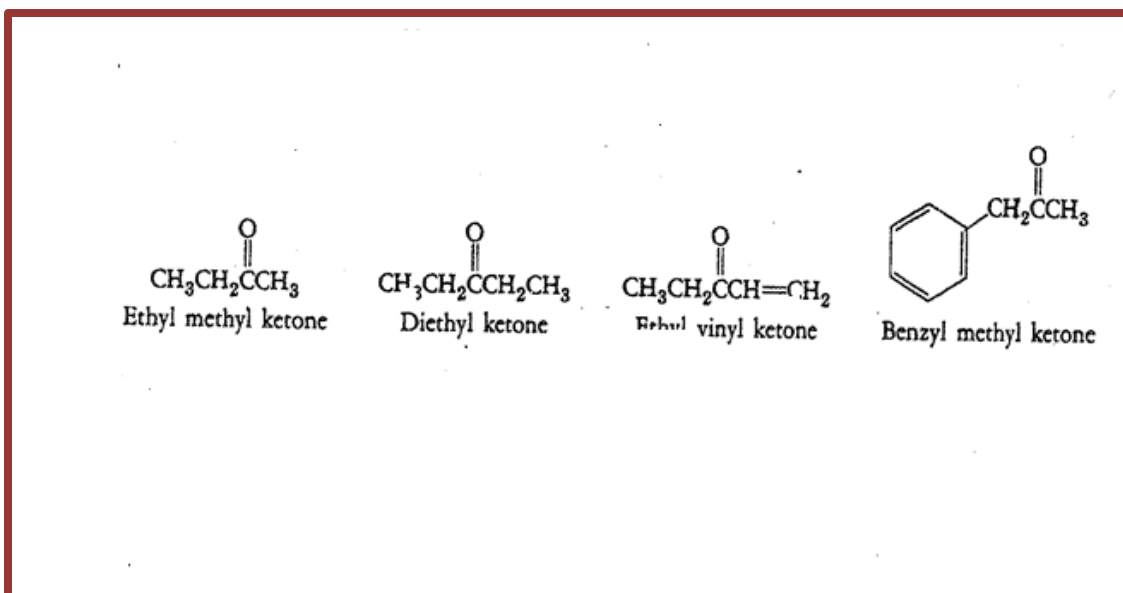
A ketone contains a carbonyl group in which the carbon is bonded to two alkyl groups, two aryl groups, or one alkyl and one aryl group. The groups need not be identical. For example:



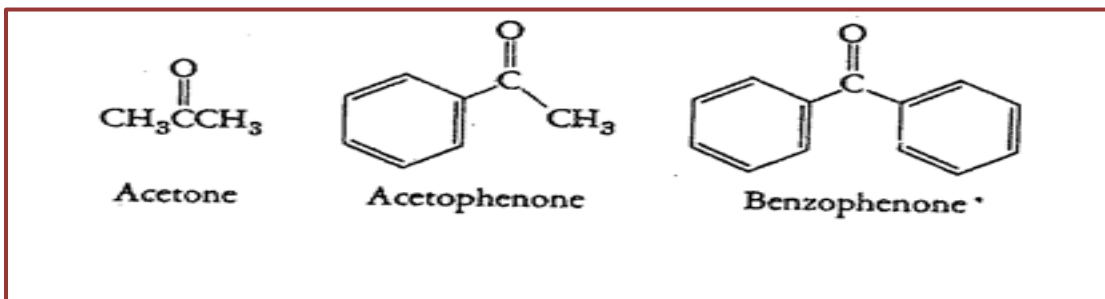
**Aromatic aldehyde** is usually designated as derivatives of the simplest aromatic aldehyde, benzaldehyde.



The common names of ketones are formed by placing the names of the groups attached to the carbonyl group as prefixes to the word ketone. The names are written as separate words, for example:



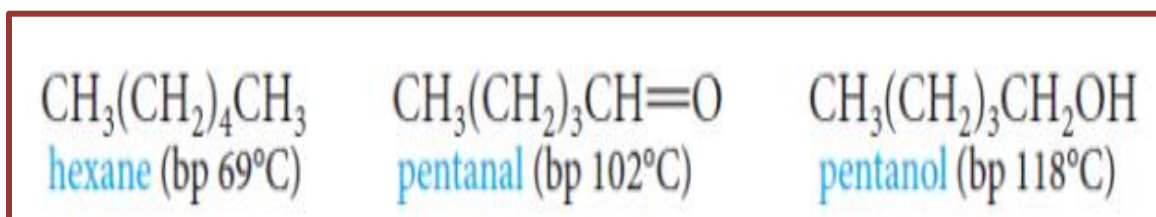
The following ketones are known generally by their trivial names



## Physical Properties of Aldehydes and Ketone

### 1- Boiling Points

Carbonyl compounds boil at higher temperatures than hydrocarbons, but at lower temperatures than alcohols of comparable molecular weight.



This is due to the intermolecular forces of attraction, called dipole-dipole interactions in carbonyl group, which is stronger than van der Waals attractions in hydrocarbon, but not as strong as hydrogen bonds in alcohol.

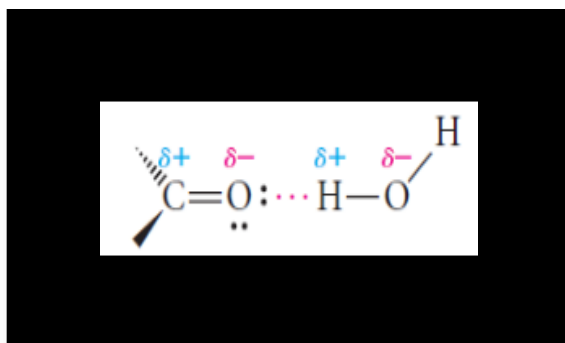
### 2- Solubility

Carbonyl compounds as aldehydes and ketones have a  $\text{C}=\text{O}$  bond, but no  $\text{O}-\text{H}$  bond, cannot form hydrogen bonds with themselves.

**-The polarity of the carbonyl group also affects the solubility properties of**

**aldehydes and ketones.**

**- Carbonyl compounds with low molecular weights are soluble in water as they can form hydrogen bonds with O-H or N-H compounds.**



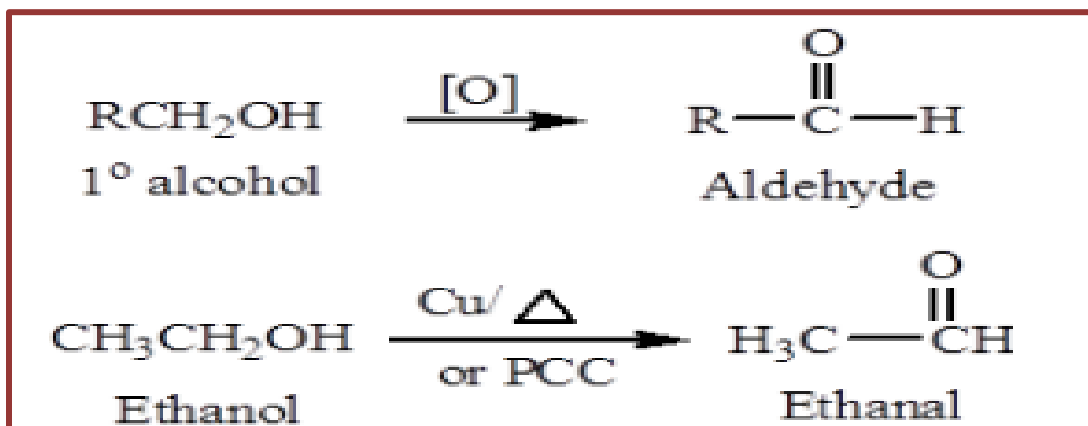
## **Preparation of Aldehydes and Ketones**

### **1-Oxidation of Primary and Secondary Alcohols**

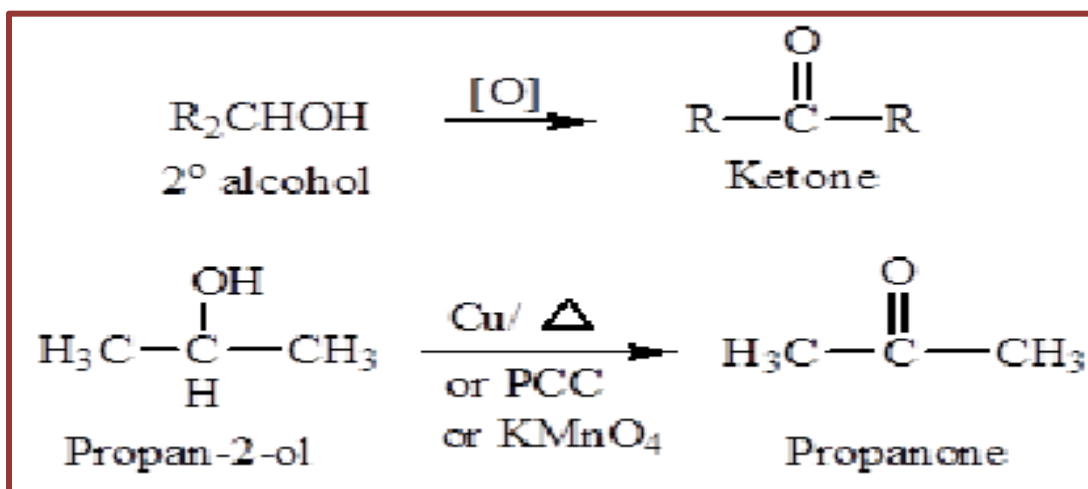
**Chromium reagents, such as pyridinium chlorochromate (PCC)**



**Oxidation of primary alcohols, under controlled conditions, yields aldehydes**

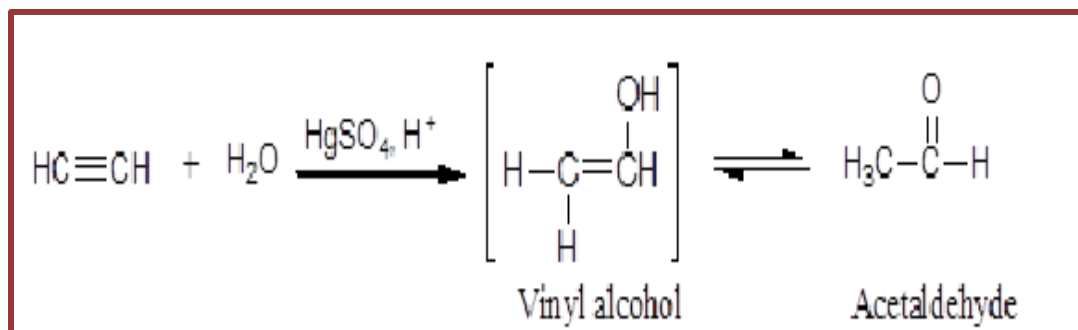


**Oxidation of secondary alcohols yields ketones.**

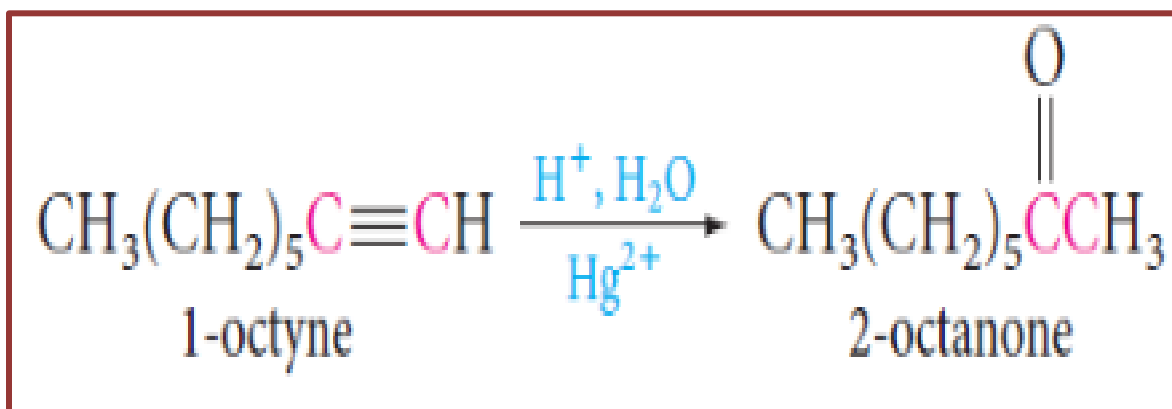


## 2-Hydration of Alkynes:

**Hydration of acetylene yields acetaldehyde (catalyzed by acid and mercuric)**



**Hydration of terminal alkynes EXCEPT acetylene yields ketones (catalyzed by acid and mercuric)**

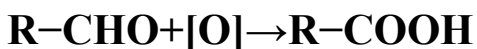


## Chemical Properties of Aldehydes and Ketone

### 1-Oxidation

#### Aldehydes

**Easily oxidized to carboxylic acids**



**Mild oxidizing agents can be used:**

**Tollens' reagent**

**Fehling's solution**

## **Ketones**

**Resistant to oxidation**

**Strong oxidants break them into smaller acids**

**This difference is important for distinguishing tests**

## **2-Reduction**

**Both aldehydes and ketones can be reduced:**

**Aldehydes → Primary alcohols**



**Ketones → Secondary alcohols**



## **Reducing agents**

- $\text{NaBH}_4$
- $\text{LiAlH}_4$

## **3- Reaction with Alcohols**

**Aldehydes → acetals**

**Ketones → ketals**

## Steps:

- ❖ Formation of hemiacetal
- ❖ Formation of acetal (in acidic medium)

## 4- Reaction with Grignard Reagents (RMgX)

- Aldehydes → secondary alcohols
- Ketones → tertiary alcohols

## Tests to Differentiate Aldehydes and Ketones

### 1- Tollens' Test (Silver Mirror Test)

#### Reagent

Tollens' reagent = ammoniacal silver nitrate  $[\text{Ag}(\text{NH}_3)_2]^+$

#### Principle

Aldehydes are easily oxidized → reduce  $\text{Ag}^+$  to metallic silver

#### Observation

- Aldehydes: Silver mirror or black Ag precipitate forms
- Ketones: No reaction

## Reaction (simplified)



## 2- Fehling's Test

### Reagent

Fehling's solution ( $\text{Cu}^{2+}$  complex)

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### Principle

Aldehydes reduce  $\text{Cu}^{2+} \rightarrow \text{Cu}_2\text{O}$  (red precipitate)

### Observation

- ❖ Aldehydes: Brick-red precipitate
- ❖ Ketones: No reaction

**Note:** Aromatic aldehydes may give negative result

## 3- Benedict's Test

### Reagent

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Benedict's solution (similar to Fehling's)

### Observation

Aldehyde: Green  $\rightarrow$  yellow  $\rightarrow$  red precipitate

Ketones: No change

## 4- Iodoform Test (Haloform Test)

**Reagent**  $I_2 / NaOH$

### Principle

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Detects methyl ketones ( $-COCH_3$  group)

### Observation

**Aldehydes:** Negative (except acetaldehyde)

**Ketones:** Yellow precipitate ( $CHI_3$ ) if methyl ketone present

## 5- 2,4-Dinitrophenylhydrazine (2,4-DNP Test)

### Reagent

2,4-DNP (Brady's reagent)

### Observation

- **Aldehydes:** Orange/yellow precipitate
- **Ketones:** Orange/yellow precipitate

## Summary Table

Test	Aldehydes	Ketones
Tollens' Test	Silver mirror ✓	No reaction ✗
Fehling's Test	Red precipitate ✓	No reaction ✗
Benedict's Test	Colored precipitate ✓	No reaction ✗
Iodoform Test	Negative (except ethanal)	Positive for methyl ketones ✓
2,4-DNP Test	Positive ✓	Positive ✓

## Conclusion

Aldehydes and ketones are fundamental **carbonyl compounds**

Their chemistry is dominated by:

- ❖ Polarity of C=O
- ❖ Aldehydes are generally **more reactive** than ketones due to:
  - Less steric hindrance
  - Presence of hydrogen atom