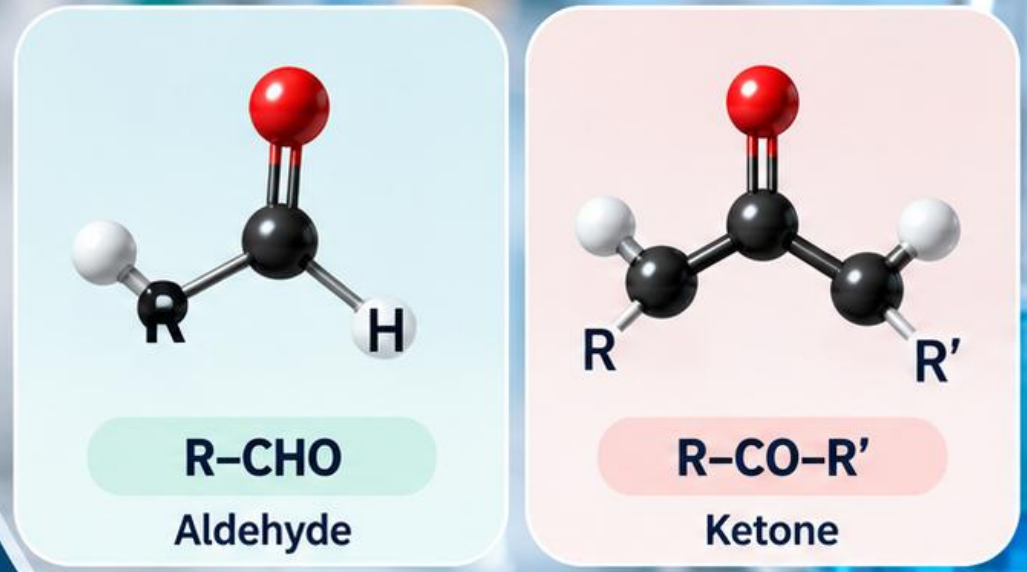
ORGANIC CHEMISTRY II LAB

Identification of Aldehydes and Ketones

SECOND STAGE | LABORATORY

From carbonyl detection to evidence-based differentiation.

Use observations carefully. Explain the full pattern.



Asst. Lect. Gheith M. Abbas Alasadi
M.Sc. Pharmaceutical Chemistry

OPENING MYSTERY · CARBONYL IDENTIFICATION

What is Unknown X?

A single test can reveal a clue — but not the full identity.



One unknown. Two possibilities.

عينة مجهولة... هل هي ألديهايد أم كيتون؟

General Objective and Learning Map

General objective

By the end of this lab session, students will identify aldehydes and ketones using carbonyl screening, oxidation-based differentiation, and selected special tests, while recording observations accurately and safely.

1. **Hook + pre-test**
2. **Carbonyl identity**
3. **2,4-DNP screen**
4. **Tollens + Fehling**
5. **Special tests**
6. **Evidence + post-test**

Engage → Explore → Explain → Practice → Evaluate

Behavioral Learning Objectives

By the end of this lab session, students will be able to…

1. Define aldehydes and ketones using RCHO and R–CO–R′ formulas.
2. Explain why the carbonyl group controls the main properties.
3. Use 2,4-DNP to screen for carbonyl compounds.
4. Differentiate aldehydes from ketones using Tollens and Fehling tests.
5. Apply special tests for methyl carbonyls and selected aldehydes.
6. Justify the final identity from the full evidence pattern.

Now, Let’s Move to Kahoot!

Pre-test activity — answer individually

1. Take out your phone or laptop
2. Scan the QR code or enter the game PIN
3. Answer all questions within the time limit



Ready? Let’s begin.

Aldehydes vs Ketones: Structural Identity



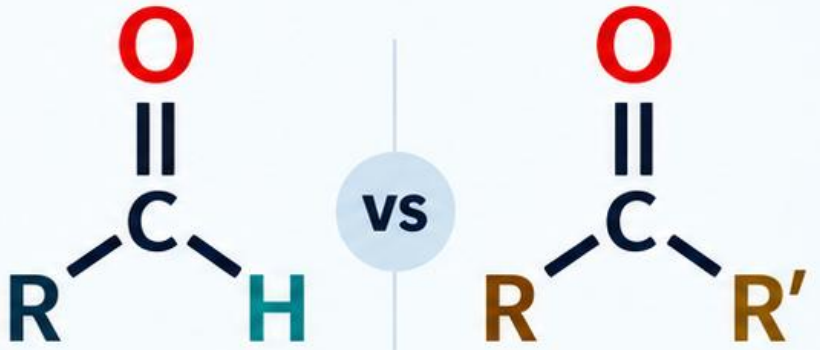
Aldehyde

- General formula: **R–CHO**
- The carbonyl carbon is bonded to one hydrogen.
- Formaldehyde is the simplest aldehyde (R = H).



Ketone

- General formula: **R–CO–R′**
- The carbonyl carbon is bonded to two carbon groups.
- R and R′ may be aliphatic or aromatic.



Both contain C=O; the groups attached to C=O determine the class.

Why the Carbonyl Group Matters



Polar C=O

The carbonyl bond is strongly polar.

This creates an electrophilic carbonyl carbon.



Chemical tests

Most tests exploit carbonyl reactivity or oxidation behavior.



Evidence pattern

One observation is not enough. Use the full pattern before concluding.



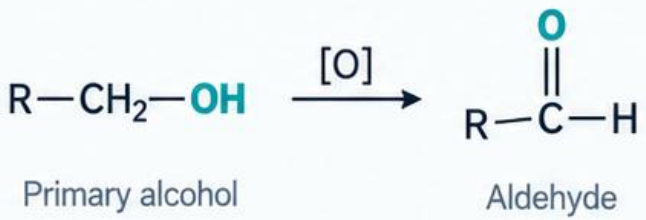
C=O is the functional group that drives the chemistry

Concept Bridge: Alcohol Oxidation to Carbonyls

1 Primary alcohol

Oxidation removes two H atoms.

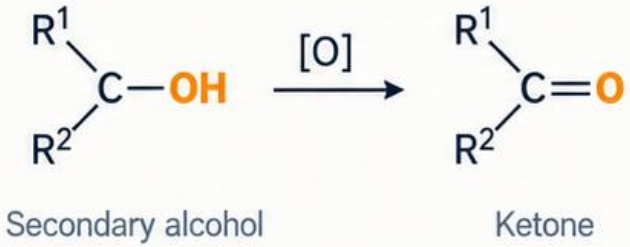
Product: **aldehyde**.



2 Secondary alcohol

Oxidation removes two H atoms.

Product: **ketone**.



3 Tertiary alcohol

No similar oxidation under these conditions.



Aldehydes and ketones are linked to alcohols by oxidation–reduction behavior.

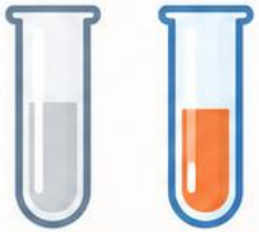
Testing Strategy: Four Complementary Views

1 Screen



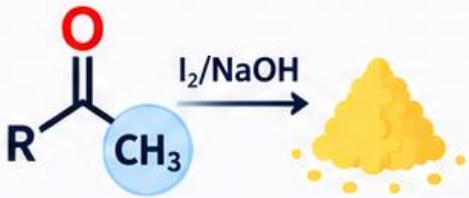
2,4-DNP:
carbonyl present?

2 Differentiate



Tollens / Fehling:
aldehyde or ketone?

3 Special feature



Iodoform test:
methyl ketone?

4 Conclude



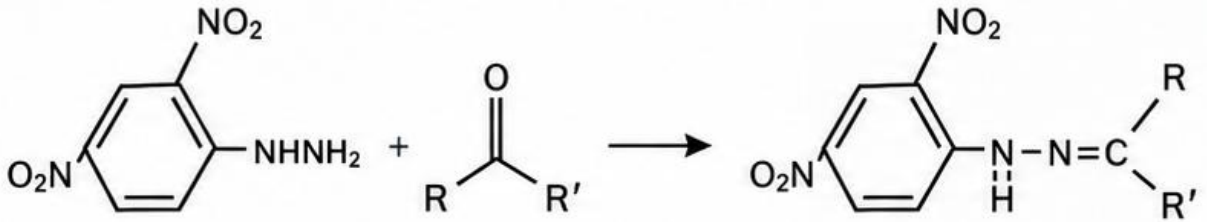
Use the full evidence pattern.

A valid conclusion should **explain all positive** and **negative** observations.

General Test: 2,4-Dinitrophenylhydrazine

What it detects

- Both aldehydes and ketones react with 2,4-DNP.
- Positive result: **yellow or orange precipitate.**



2,4-dinitrophenylhydrazine (2,4-DNP)

Aldehyde or ketone

2,4-dinitrophenylhydrazone (yellow–orange precipitate)



Interpretation

A positive 2,4-DNP test supports the presence of a carbonyl compound; it does not distinguish aldehyde from ketone.

2,4-DNP: Source Procedure and Observation

1 1. Add sample

To 2 drops of the compound add 3 drops of 2,4-DNP reagent.

2 2. If insoluble

Dissolve in 1 mL methanol, then add the reagent.

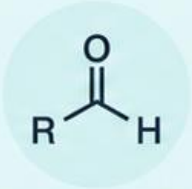
3 3. Record

Presence, color, and amount of yellow/orange precipitate.

Do not call it aldehyde or ketone yet — this is only the carbonyl screen.

Differentiation Logic: Aldehydes Oxidize Easily

Aldehydes

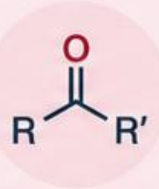


Easily oxidized to carboxylic acid / carboxylate.

They reduce Tollens and Fehling reagents.



Ketones



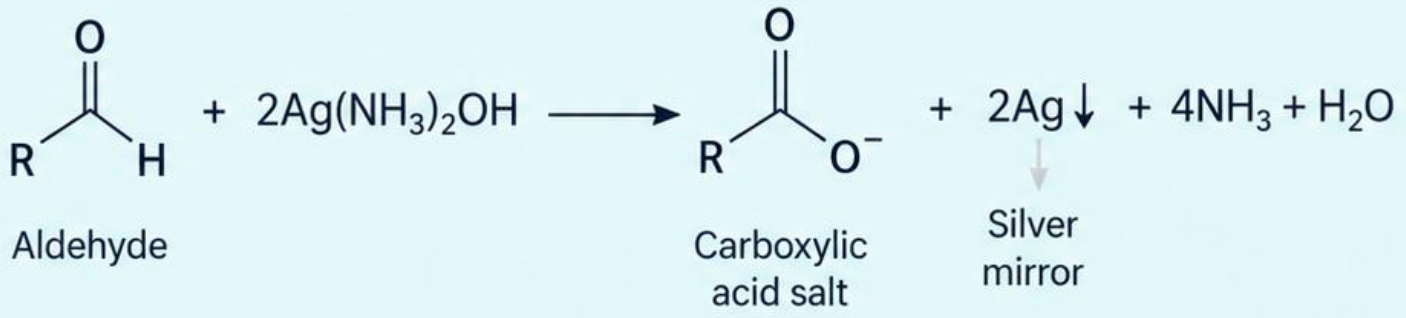
Do not oxidize easily under these test conditions.

Usually negative with Tollens and Fehling.



Key idea: oxidation behavior differentiates aldehydes from ketones.

Tollens Test: Silver Mirror Is Evidence



What to record

- Silver mirror on the inner wall
- Gray/black granular silver if tube is not clean
- Whether water bath warming was needed

Tollens Reagent: Preparation and Cautions

1 Prepare fresh

$AgNO_3$ + NaOH forms a brown Ag_2O precipitate.

2 Add ammonia

Add very dilute NH_3 dropwise until the brown precipitate dissolves.

3 Avoid false positives

Warm only if needed. Excessive heating may decompose reagent and give false positive.

$$2AgNO_3 + 2NaOH \longrightarrow \underset{\text{brown ppt.}}{Ag_2O\downarrow} + 2NaNO_3 + H_2O$$

$$Ag_2O + 4NH_3{\cdot}OH \longrightarrow 2Ag(NH_3)_2OH + 3H_2O$$

Fehling Test: Blue Solution to Red Cu_2O

1 Starting reagent

Fresh Fehling solution is deep blue.

2 Positive aldehyde

Blue → green/orange → red precipitate or copper mirror.

3 Ketone

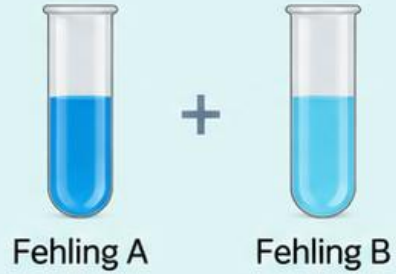
No change under this test.

Result is not sharp with aromatic aldehydes.

Fehling confirms reducing aldehydes by forming red cuprous oxide precipitate.

Fehling Procedure: Prepare, Add, Heat

1 Mix fresh



Mix equal volumes of Fehling A and Fehling B immediately before use.

2 Add sample



Add 5 drops of compound to 1 mL Fehling solution.

3 Heat



Heat in a water bath for 5 minutes; shake if water-insoluble.

Record colour sequence, not only the final colour.

Tollens vs Fehling: Use Both Results Wisely

1 Tollens positive



- Silver mirror / silver deposit.
- Strong support for aldehyde.

2 Fehling positive



- Red Cu_2O precipitate.
- Supports reducing aldehyde, less sharp for aromatic aldehydes.

3 Both negative



- After positive 2,4-DNP, this pattern often supports ketone — but check solubility and special cases.

Decision rule: never identify the unknown from one tube alone.

Special Tests: Terminal Methyl Carbonyl Group



Positive candidates

Acetaldehyde, acetone, acetophenone, and benzyl methyl ketone have a methyl group attached to C=O.

1 Iodoform test

Use the previously learned haloform test procedure.

2 Sodium nitroprusside

A red complex is a positive test after NaOH addition.

Sodium Nitroprusside Test: A Colour Clue

1 Procedure



Compound (few drops)

1 mL sodium nitroprusside solution + excess 30% NaOH

2 Positive result



Formation of a red coloured complex.

3 Meaning

Supports a terminal methyl carbonyl feature; use with the full evidence pattern.

Colour is a clue, not a standalone identity.

Polymerization Reaction: Formaldehyde / Salicylaldehyde

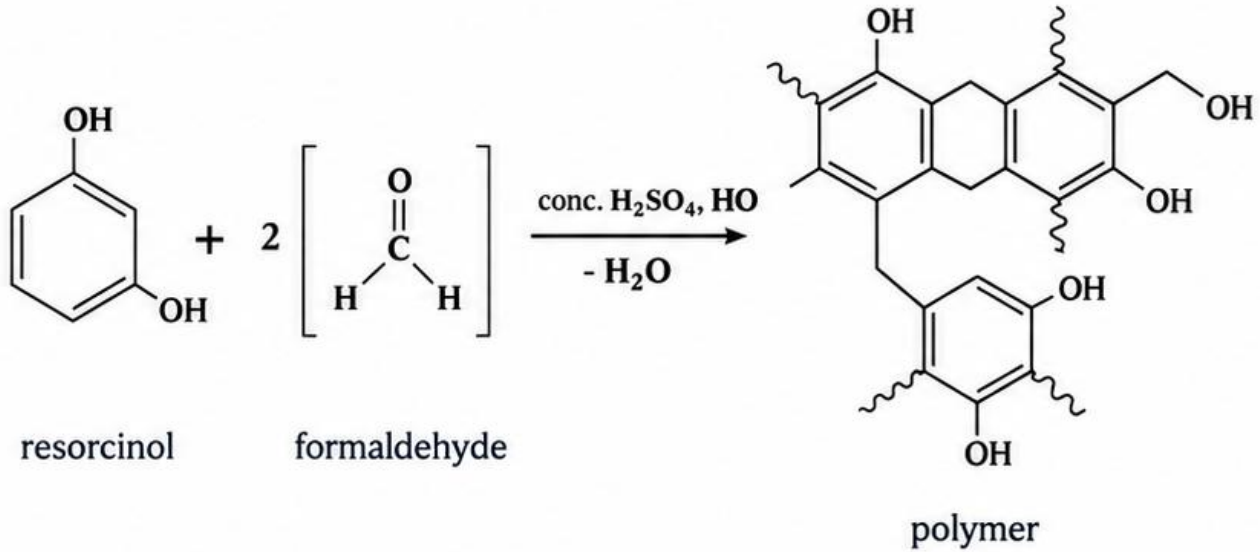
1 Source procedure



0.5 mL formaldehyde or salicylaldehyde

0.2 g resorcinol

Add conc. H_2SO_4 dropwise.



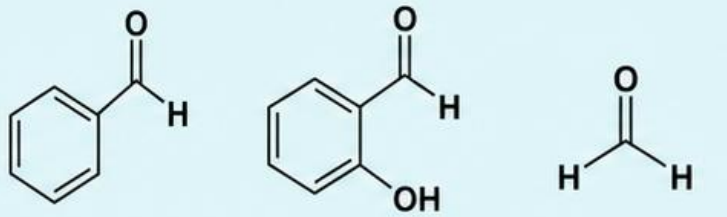
resorcinol formaldehyde polymer

2 Observation

Red or reddish-violet colour, or a white ring that changes to reddish-violet.

Cannizzaro Reaction: No α-Hydrogen

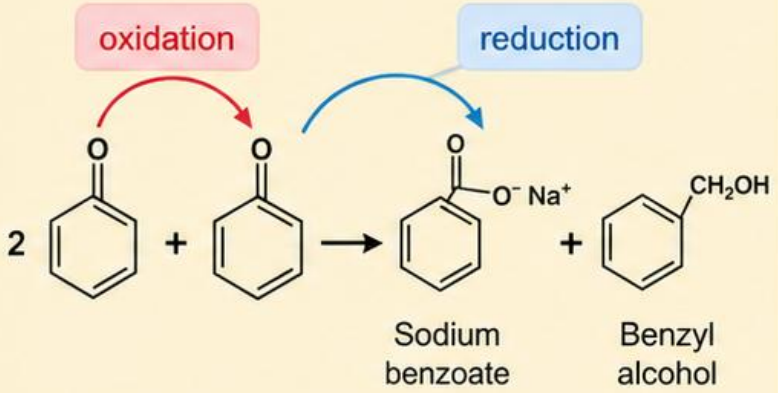
1 Who reacts?



Benzaldehyde | Salicylaldehyde | Formaldehyde

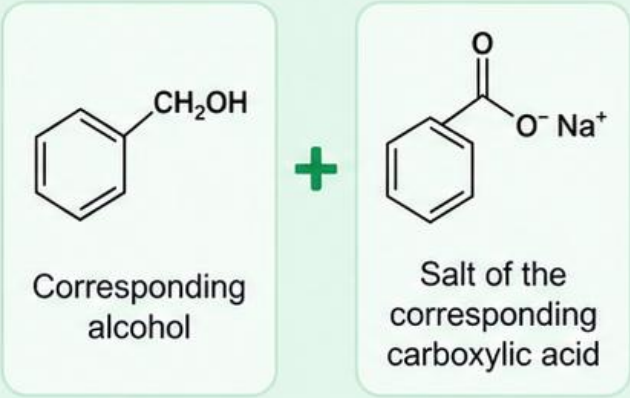
Benzaldehyde, salicylaldehyde and formaldehyde can undergo Cannizzaro reaction because they lack an alpha hydrogen.

2 Reaction type



Self oxidation–reduction in strong base.

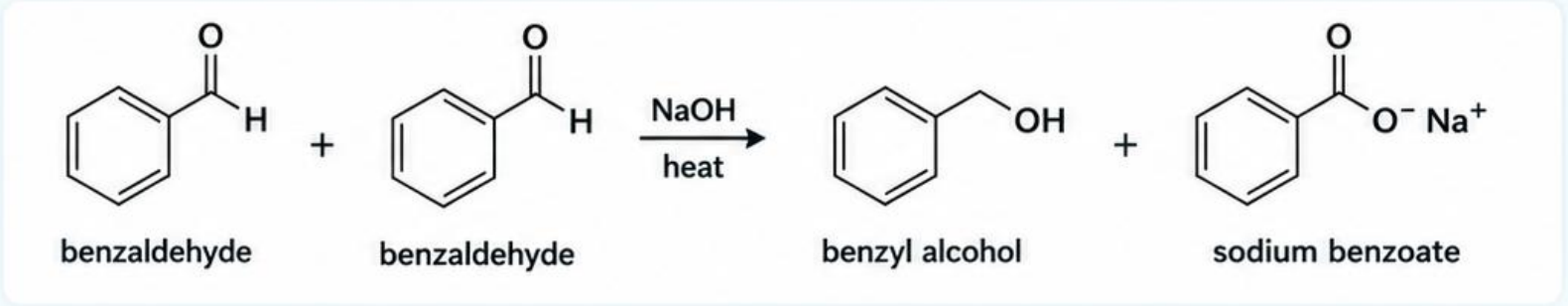
3 Products



Corresponding alcohol + salt of the corresponding carboxylic acid.

One aldehyde molecule is oxidized; another is reduced.

Cannizzaro Procedure: From Benzaldehyde to Benzoic Acid



1 Strong base



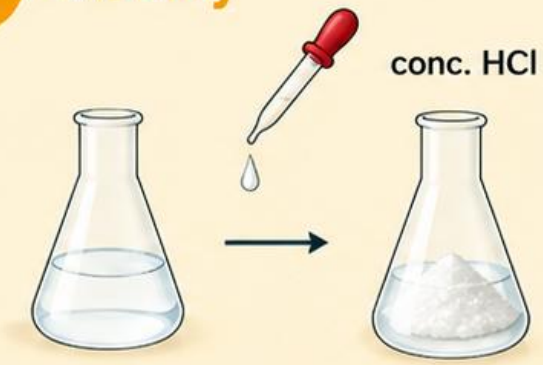
Few drops benzaldehyde + 0.5 mL 30% NaOH; warm gently 5 min.

2 Dissolve salt



Sodium benzoate precipitate dissolves with a few drops of distilled water.

3 Acidify



Add conc. HCl to liberate benzoic acid as white precipitate.

Safety First: Chemical Tests Need Control

1 Fresh reagents



Prepare Tollens reagent freshly and avoid excessive heating.

2 Heating control



Use water bath warming where stated. Do not overheat test tubes.

3 Strong reagents



Handle NaOH, ammonia, nitric acid, hydrochloric acid and sulfuric acid under instructor guidance.

Run only tests and conditions approved by the laboratory instructor.

Formative Checkpoint: Predict → Observe → Explain

1 Predict

What result do you expect if the unknown is an aldehyde?

2 Observe

Record colour, precipitate, mirror, heating, and solubility behavior.

3 Explain

What does this result support? What limitation remains?

“I observed _____. This supports _____, but it does not prove _____ alone.”

Group Activity: Build the Carbonyl Decision Pathway

Task: Arrange the cards in the correct logical order, then justify why Card --- must be last.

C — Fehling test

Red Cu_2O?
Reducing aldehyde.

D — Special tests

Iodoform / nitroprusside / Cannizzaro when needed.

A — 2,4-DNP screen

Yellow/orange precipitate?
Carbonyl likely.

B — Tollens test

Silver mirror?
Aldehyde evidence.

E — Conclusion

Use full pattern + limitations.

1 → 2 → 3 → 4 → 5

? Place the correct card here

? Place the correct card here

? Place the correct card here

? Place the correct card here

? Place the correct card here

Student Practice: Build an Evidence Table

Complete the table during the experiment before writing the final conclusion.

Stage	Observation	Chemical meaning	Decision / action
2,4-DNP			
Tollens			
Fehling			
Special test			
Final conclusion			

Rule: no final identity without a complete evidence pattern.

Post-Test: Evidence of Learning

Students answer individually after the discussion.

Lecture Summary: Three Things to Remember

1 Structure



Aldehyde | **Ketone**

Aldehydes and ketones share C=O but differ in what is attached to the carbonyl carbon.

2 Tests



2,4-DNP (carbonyl screen) | **Tollens** (aldehydes) | **Fehling** (aldehydes)

2,4-DNP screens for carbonyls; Tollens and Fehling help differentiate aldehydes.

3 Evidence



Special tests and limitations must be used before final identification.

Good identification = correct test sequence + careful observation + honest interpretation.

Thank You

Questions and Discussion

Observe carefully.

Explain honestly.

Think critically.

