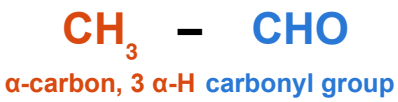
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Aldol Condensation: The Alpha Hydrogen Key

1. The alpha hydrogen

The carbon next to the carbonyl carbon is the **alpha (α) carbon**. An H on it is an **alpha hydrogen**. It is acidic enough for a base to remove.



2. The steps, for ethanal

1. **Enolate:** dilute NaOH removes an α-H: $^{-}CH_2CHO$.
2. **Attack:** the enolate adds to the carbonyl carbon of a second ethanal, a nucleophilic addition.
3. **Aldol:** 3-hydroxybutanal, $CH_3CH(OH)CH_2CHO$. The name joins **ald**ehyde and alcoh**ol**.
4. **Condensation:** heat removes water, giving but-2-enal, $CH_3CH{=}CHCHO$.

$$2\ CH_3CHO \xrightarrow{\text{dil. NaOH}} CH_3CH(OH)CH_2CHO \xrightarrow{\text{heat, } -H_2O} CH_3CH{=}CHCHO$$

3. Who gives it

Compound	α-H atoms	Aldol?
Ethanal	3	Yes
Propanal	2	Yes
Propanone	6	Yes (a ketol)
Methanal	0, no α-carbon	No
Benzaldehyde	0	No
2,2-Dimethylpropanal	0	No

Solved example

Q. 2,2-Dimethylpropanal, $(CH_3)_3CCHO$, has 10 H atoms. Why does it not give aldol condensation?
A. Only an H on the α-carbon matters. Its α-carbon carries three CH_3 groups and no H, so no enolate can form.

Practice questions

1. (MCQ) Which gives aldol condensation? (a) methanal (b) benzaldehyde (c) propanal (d) 2,2-dimethylpropanal
2. (Very short) Name the aldol formed from ethanal.

3. (Very short) What is lost on heating an aldol?
4. (Short) What is an alpha hydrogen?
5. (Short) What role does the enolate play?
6. (Short) Why does benzaldehyde not give aldol condensation?

Answer key

1. (c).
2. 3-Hydroxybutanal.
3. Water.
4. An H on the carbon next to the carbonyl carbon.
5. It is the nucleophile: it attacks a carbonyl carbon.
6. It has no alpha hydrogen, so no enolate can form.

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