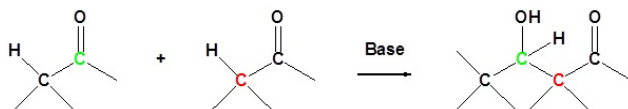


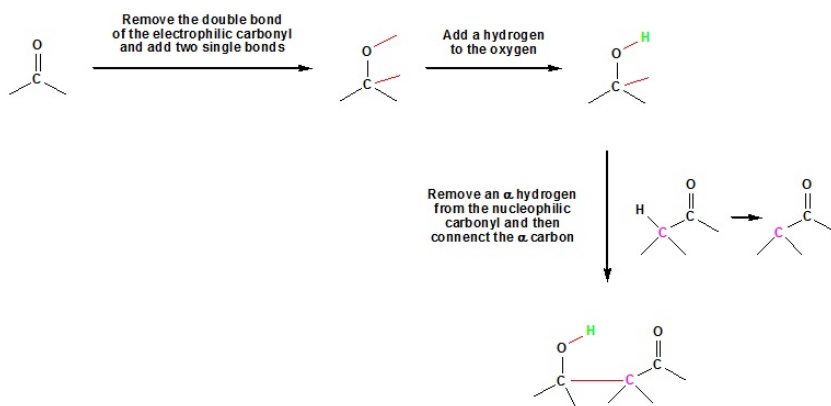
## 22.1: The Aldol Reaction

A useful carbon-carbon bond-forming reaction known as the **Aldol Reaction** is yet another example of electrophilic substitution at the alpha carbon in enolate anions. The fundamental transformation in this reaction is a dimerization of an aldehyde (or ketone) to a beta-hydroxy aldehyde (or ketone) by alpha C–H addition of one reactant molecule to the carbonyl group of a second reactant molecule. Due to the carbanion like nature of enolates they can add to carbonyls in a similar manner as [Grignard reagents](#). For this reaction to occur at least one of the reactants must have  $\alpha$  hydrogens.

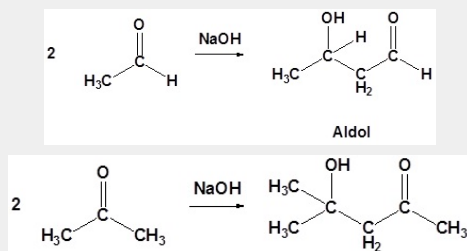
### General Aldol reaction



### Going from reactants to products simply

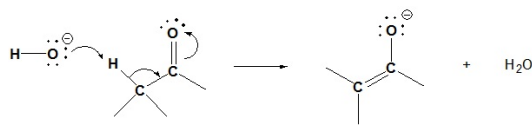


### Example 1: Aldol Reactions

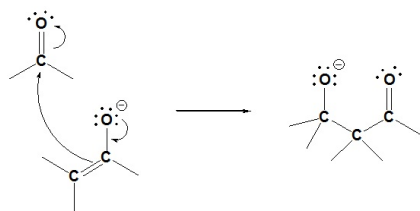


### Aldol Reaction Mechanism

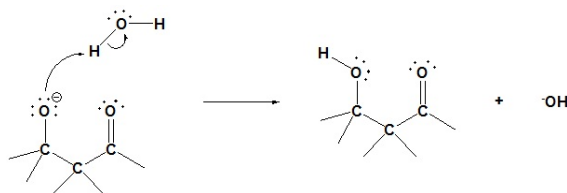
#### Step 1: Enolate formation



Step 2: Nucleophilic attack by the enolate

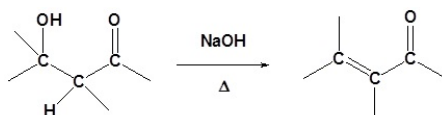


Step 3: Protonation



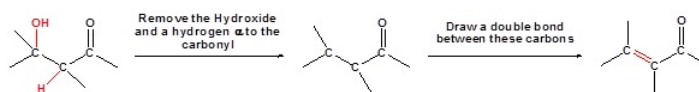
### Aldol Condensation: the dehydration of Aldol products to synthesize $\alpha, \beta$ unsaturated carbonyl (enones)

The products of aldol reactions often undergo a subsequent elimination of water, made up of an  $\alpha$ -hydrogen and the  $\beta$ -hydroxyl group. The product of this  **$\beta$ -elimination** reaction is an  $\alpha, \beta$ -unsaturated aldehyde or ketone. Base-catalyzed elimination occurs with heating. The additional stability provided by the conjugated carbonyl system of the product makes some aldol reactions thermodynamically and mixtures of stereoisomers (E & Z) are obtained from some reactions. Reactions in which a larger molecule is formed from smaller components, with the elimination of a very small by-product such as water, are termed **Condensations**. Hence, the following examples are properly referred to as **aldol condensations**. Overall the general reaction involves a dehydration of an aldol product to form an alkene:



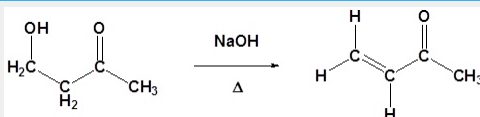
**Figure:** General reaction for an aldol condensation

Going from reactants to products simply



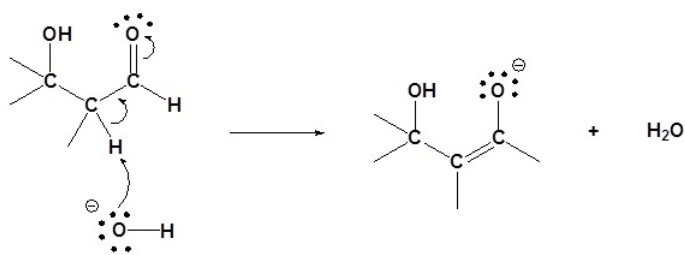
**Figure:** The aldol condensation example

#### Example 2: Aldol Condensation

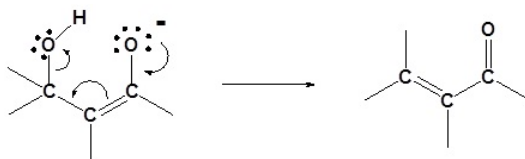


### Aldol Condensation Mechanism

1) Form enolate

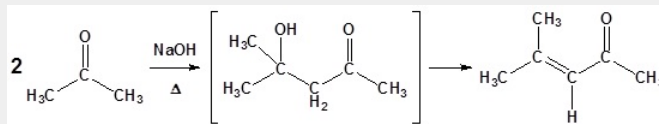


2) Form enone



When performing both reactions together always consider the aldol product first then convert to the enone. Note! The double bond always forms in conjugation with the carbonyl.

#### Example



#### Contributors

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Prof. Steven Farmer ([Sonoma State University](#))

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