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Claisen Condensation Mechanism

Transcript

00:00:00:00 - 00:00:17:78
Dr.Jessie Key: Hello again, Dr. Jessie Key here to show you the Claisen condensation mechanism. Let's go through the mechanism of the example at the start of the topic, ethyl ethanoate undergoing Claisen condensation using sodium methoxide with an acidic aqueous workup to generate ethyl 3-oxobutanoate.

00:00:17:78 - 00:00:48:33
Dr.Jessie Key: You have seen a lot of mechanisms so far in the course, hopefully, you're getting comfortable with them and noticing the repeating patterns or motifs. The Claisen condensation mechanism is no exception, it actually follows the same first two steps of an aldol addition: In the first step, a proton transfer occurs to form an enolate. We can draw an arrow from the ethoxide based lone pair to remove the alpha proton.

00:00:48:33 - 00:01:18:10
Dr.Jessie Key: This causes the C-H sigma bond electrons to form a new alkene pi bond between alpha and carbonyl carbon, which moves the existing carbonyl pi bond up to the oxygen. The second step is nucleophilic attack by the enolate on the carbonyl carbon of a second molecule of the ester. We can show this by having the enolate lone pair electrons move down to re-form the carbonyl carbon.

00:01:18:10 - 00:01:52:65
Dr.Jessie Key: The alkene pi bond then attacks the carbonyl carbon of the second molecule, which forces the carbonyl pi bond of the second molecule to move up on the oxygen. The third step is loss of leaving group step, where the alkoxide lone pair comes down to re-form the carbonyl pi bond, ejecting off ethoxide as leaving group. First instinct is to stop here, which is the desired product, however, you must remember that this reaction is performed under basic conditions, and we now have a beta-keto ester product with very acidic alpha protons.

00:01:52:65 - 00:02:21:96
Dr.Jessie Key: Therefore, an alpha proton is immediately deprotonated under the initial reaction conditions to form a highly resonant stabilized enolate. Formation of this very stable enolate is very favourable, and is a driving force for the equilibrium of the

condensation. We can show this as before with the arrows starting at the ethoxide lone pair and abstracting the alpha proton.

00:02:21:96 - 00:02:58:09
Dr.Jessie Key: The C-H Sigma bond electrons move to form the alkene between alpha and carbonyl carbon, and the carbonyl pi bond moves up to the carbonyl oxygen. A second proton transfer can return us back to beta-keto ester product once the acidic workup is performed. The enolate lone pair moves down to re-form the carbonyl pi bond, causing the alkene pi bond to perform a proton transfer from hydronium added in the workup to give the final beta-keto ester product ethyl 3-oxobutanoate.