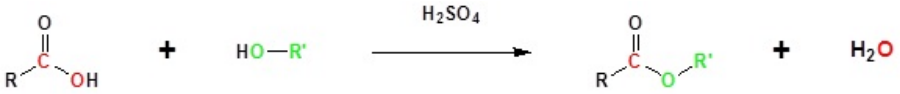
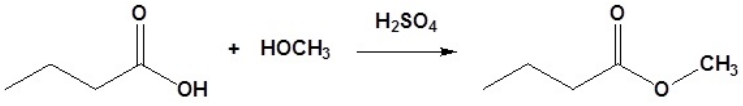
21.6: CONDENSATION OF ACIDS WITH ALCOHOLS- THE FISCHER ESTERIFICATION

Carboxylic acids can react with alcohols to form esters in a process called Fischer esterification. An acid catalyst is required and the alcohol is also used as the reaction solvent. The oxygen atoms are color-coded in the reaction below to help understand the reaction mechanism.

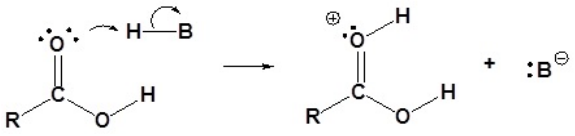


For example, butanoic acid reacts with methanol to synthsize methylbutanoate. It is important to note that any proton source can be used as the catalyst. Sulfuric acid is shown in the example below.

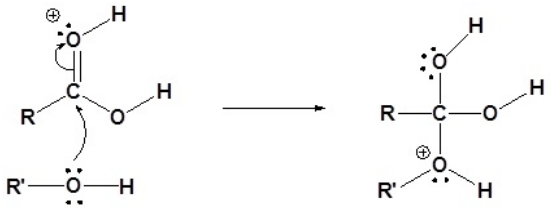


MECHANISM

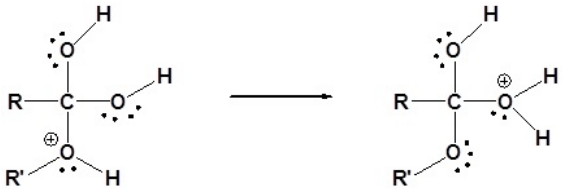
1) Protonation of the carbonyl by the acid. The carbonyl is now activated toward nucleophilic reactions.



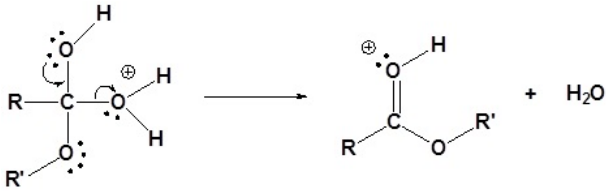
2) Nucleophilic reaction at the carbonyl



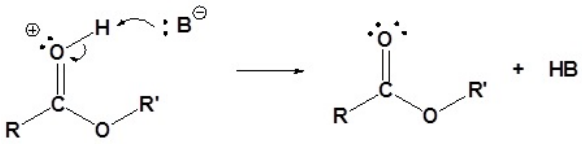
3) Proton transfer



4) Water leaves

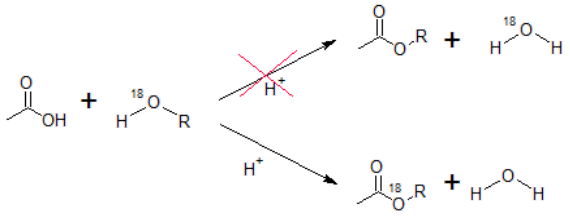


5) Deprotonation



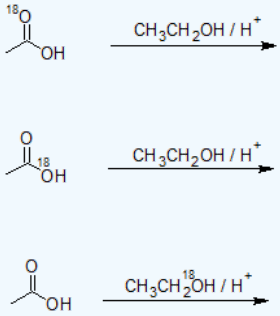
ISOTOPIC LABELING

Evidence to support the Fischer esterfication mechanism comes from isotopic labeling experiments with oxygen-18. If the reaction is carried out with oxygen-18 labeled alcohol, the isotope is found exclusively in the ester and not the water generated.



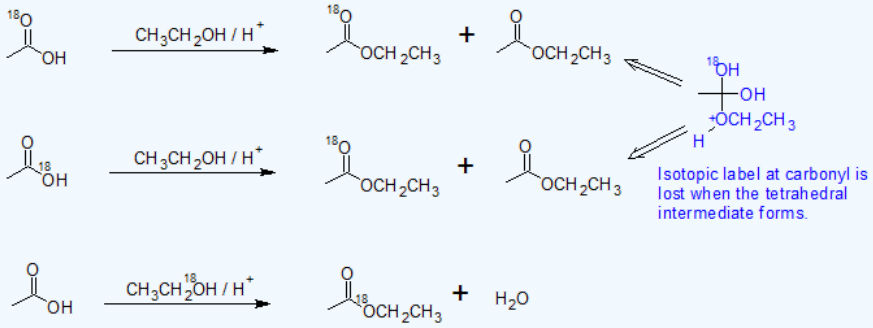
Exercise

6. Draw the bond-line structures for the products of the following reactions.



Answer

6.



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