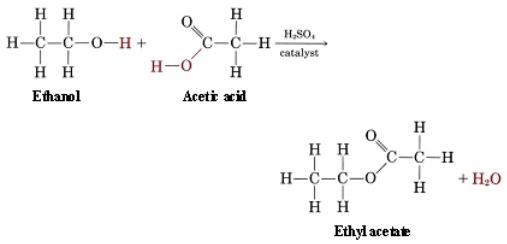
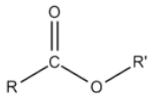
8.18: Esters

Cellulose acetate is a complicated example of another group of organic compounds, **esters**, which can be made by combining alcohols with acids. A simpler case is the reaction of ethanol with acetic acid to give ethyl acetate:



The general formula for an ester can be written



"C" double bonded to "O" and single bonded to a "R" group and an "O". The "O" is bonded to a "R" prime group.

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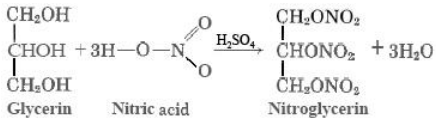
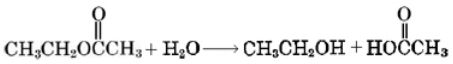
In the case of ethyl acetate, R is CH_3CH_2 and R′ is CH_3. When this notation is used, esters are named based on the number of carbon atoms present in the alcohol and carboxylic acid groups that helped to form it. The term from the alcohol is given the "-yl" suffix, and is followed by the acid term with the suffix "-ate". As an example, the ester formed by the condensation reaction between methanol and butanoic acid would be called "methyl butanoate".

The synthesis of nitroglycerin, was also an example of ester formation, but in that case an inorganic acid, HNO_3, was combined with an alcohol.



Formation of an ester is an example of an important class of reactions called condensations. In a condensation reaction a pair of molecules join together, giving off a small, very stable molecule like H_2O or HCl. In both ethyl acetate and nitroglycerin synthesis, this small molecule is H_2O. A condensation can often be undone if large numbers of the small molecules are added to the product. In the case of an ester, addition of large quantities of H_2O causes **hydrolysis** (literally, “splitting by means of water“):



This is just the reverse of ethyl acetate condensation.

Although the ester functional group has a polar carbonyl, it contains no hydrogen atoms suitable for hydrogen bonding. Therefore esters have low boiling points relative to most molecules of similar size. In many cases, even though its molecules are almost twice as large as those of the constituent alcohol and acid, an ester is found to have a lower boiling point than either. Ethyl acetate, for example, boils at 77.1°C, lower than ethanol (78.5°C) or acetic acid (117.9°C). By contrast to acids and alcohols which have unpleasant and rather weak odors, respectively, esters usually smell good. The odors of many fruits and flowers are due to esters. Ethyl acetate, for example, is the most important factor in the flavor of pineapples.

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