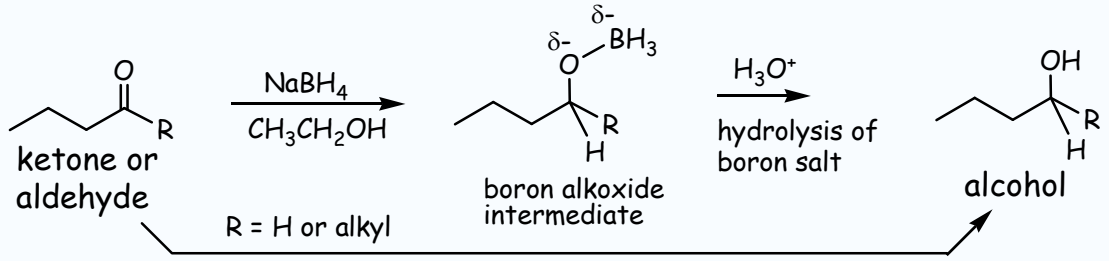
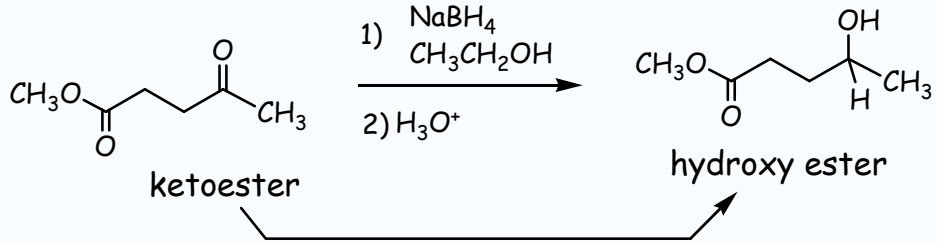
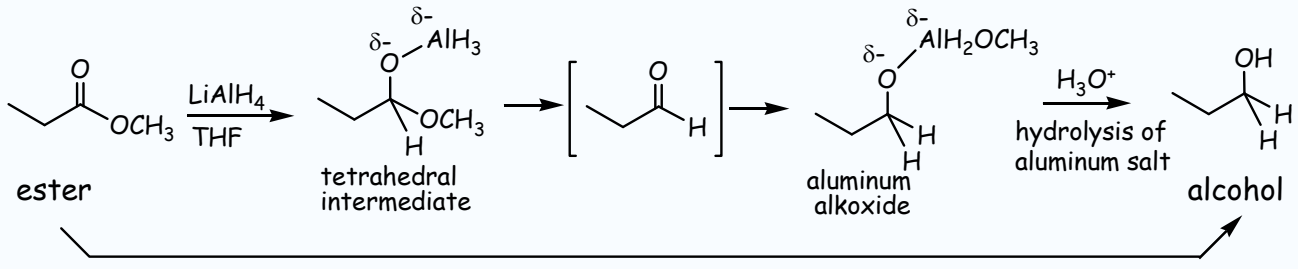
There are two reducing agents that are used for almost all types of reductions, lithium aluminum hydride, $LiAlH_4$ (usually written as LAH) and sodium borohydride ($NaBH_4$). Both of these are called hydride reducing agents since, at least formally speaking, a hydride attacks the carbonyl carbon. Prior to the discovery of hydride reducing agents, most reduction were done using sodium metals in boiling ethanol. We limit our discussion to the hydride reagents, $NaBH_4$ and LAH. $NaBH_4$ is a relatively mild reducing agent since it only reduces aldehydes and ketones; esters are reduced very slowly or not at all. This feature allows for selectivity: aldehydes and ketones can be reduced without reducing an ester group. None of the acid derivatives are reduced with $NaBH_4$. Reduction of aldehydes and ketones provides the corresponding alcohol:



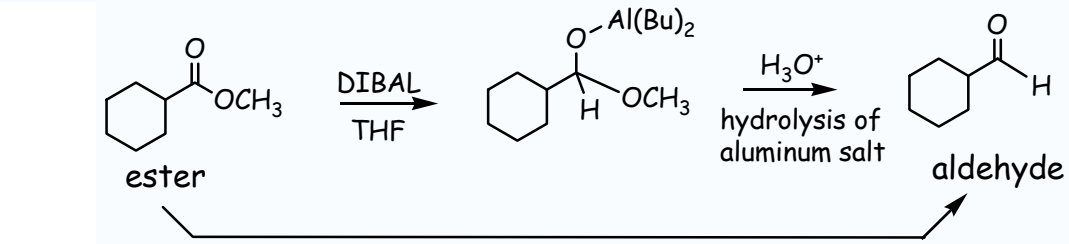


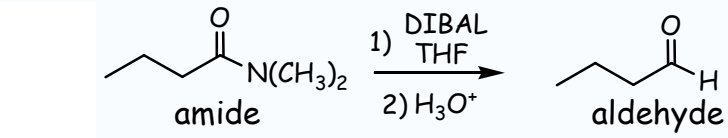
LAH is one of the strongest reducing agents. LAH reduces aldehydes, ketones and all of the carboxylic acid derivatives including nitriles. Epoxides can be reduced as well; the reagent attacks the least hindered carbon atom as expected under strongly basic conditions. Carboxylic acids and derivatives are reduced to the corresponding aldehyde which is quickly reduced further to the alcohol:

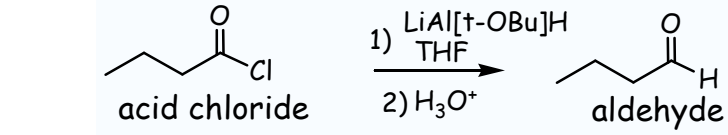


LAH can be modified to decrease its reactivity thereby permitting the partial reduction of an acid derivative to the aldehyde. Two of the most common reagents of this type are diisobutylaluminum hydride (DIBAL) and lithium tri-t-butoxyaluminum hydride ($LiAl[t\text{-}OBu]_3H$).

Each of these reagents contain one equivalent of hydride and are used in an equimolar (stoichiometric) amount. In practice, the reductions are done at low temperature; a temperature of -78°C can be maintained using a dry-ice/acetone bath. High temps and excess reagent usually result in reduction all the way down to the corresponding alcohol. Examples:







The table below should be memorized:

	Aldehydes/ketones	Carb. acids	esters	Acyl chlorides	amides	nitriles
$NaBH_4$	alcohols	N.R.	Very slow	N.R.	N.R.	N.R.
LAH	alcohols	alcohols	alcohols	alcohols	1° amines	1° amines
DIBAL	alcohols	N.R.	aldehyde	aldehyde	aldehyde	aldehyde
$LiAl[t\text{-}OBu]_3H$	alcohols	N.R.	aldehyde	aldehyde	aldehyde	aldehyde

In summary:

- $NaBH_4$ is used primarily for aldehydes and ketones
- LAH is used to reduced all functional groups, indiscriminately
- The modified aluminum hydride reagents, DIBAL and $LiAl[t\text{-}OBu]_3H$, are used for partial reduction to produce aldehydes.