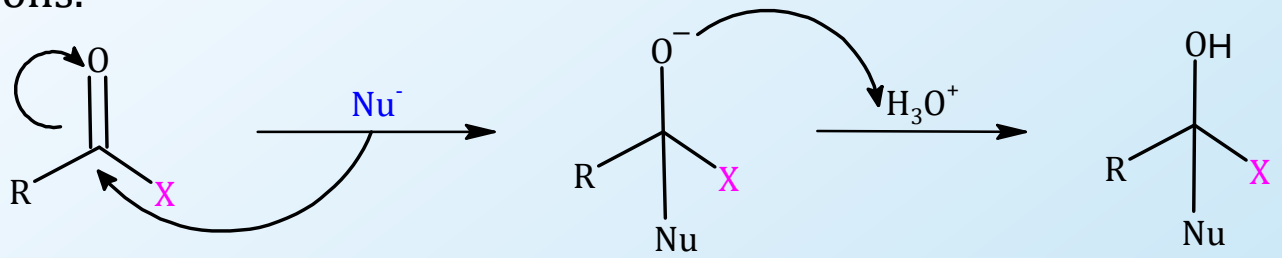
Carboxylic Acid Derivatives
3 – Organometallic and Reduction Reactions

Dr. Sapna Gupta

Reactivity of the Derivatives – Nu Addition

In the two kinds of reactions that occur for acid derivatives we will now cover nucleophilic addition.

In Nucleophilic addition the carbonyl carbon is the electrophile a strong nucleophile is needed to carry out the reaction. The sp^2 hybridized carbonyl C changes to a sp^3 tetrahedral carbon. A chiral center can be generated in these reactions.

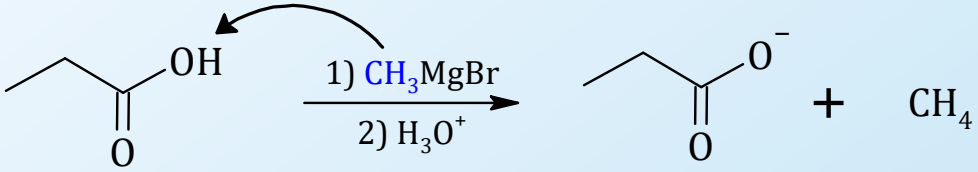


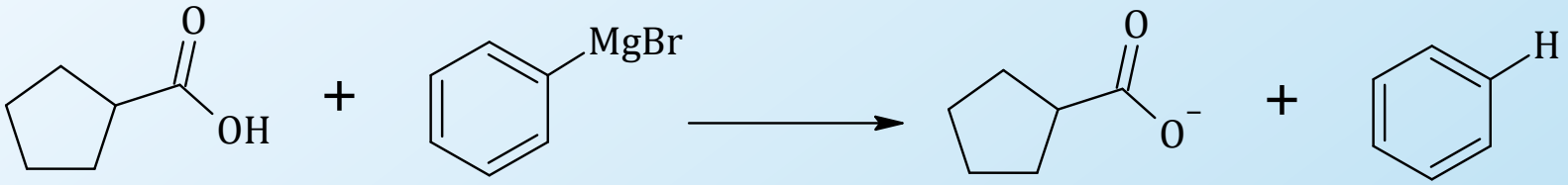
The nucleophile should be strong in these reactions. The nucleophiles covered here are organometallic reagents (carbonanion) and hydride (reduction),

Grignard Reagent and Carboxylic Acids

Grignard reagents (GR) are strong nucleophiles and can react readily with carbonyls to give alcohols. They give different reactions with the different derivatives of acids.

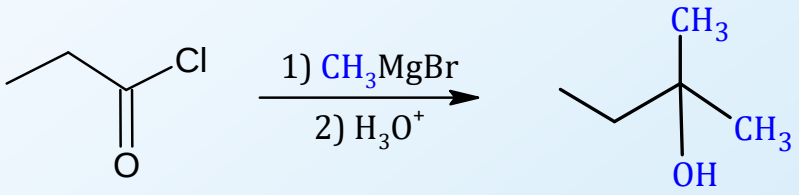
1) **Carboxylic Acids**: These are strong acids and their acidic proton will react with the strong carbonanion of the GR and give an alkane. In other terms, they can destroy the Grignard reagent.

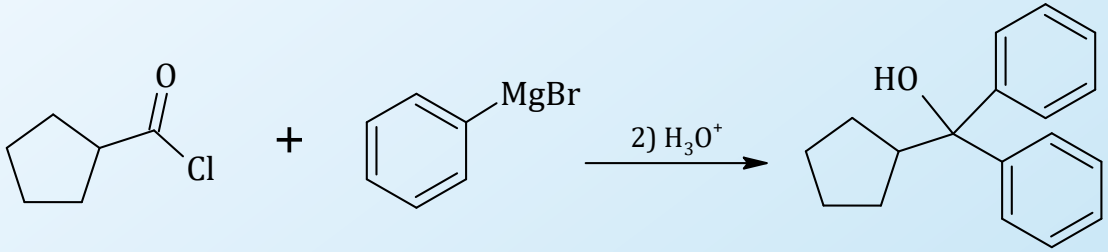




Grignard Reagent and Acyl Chlorides

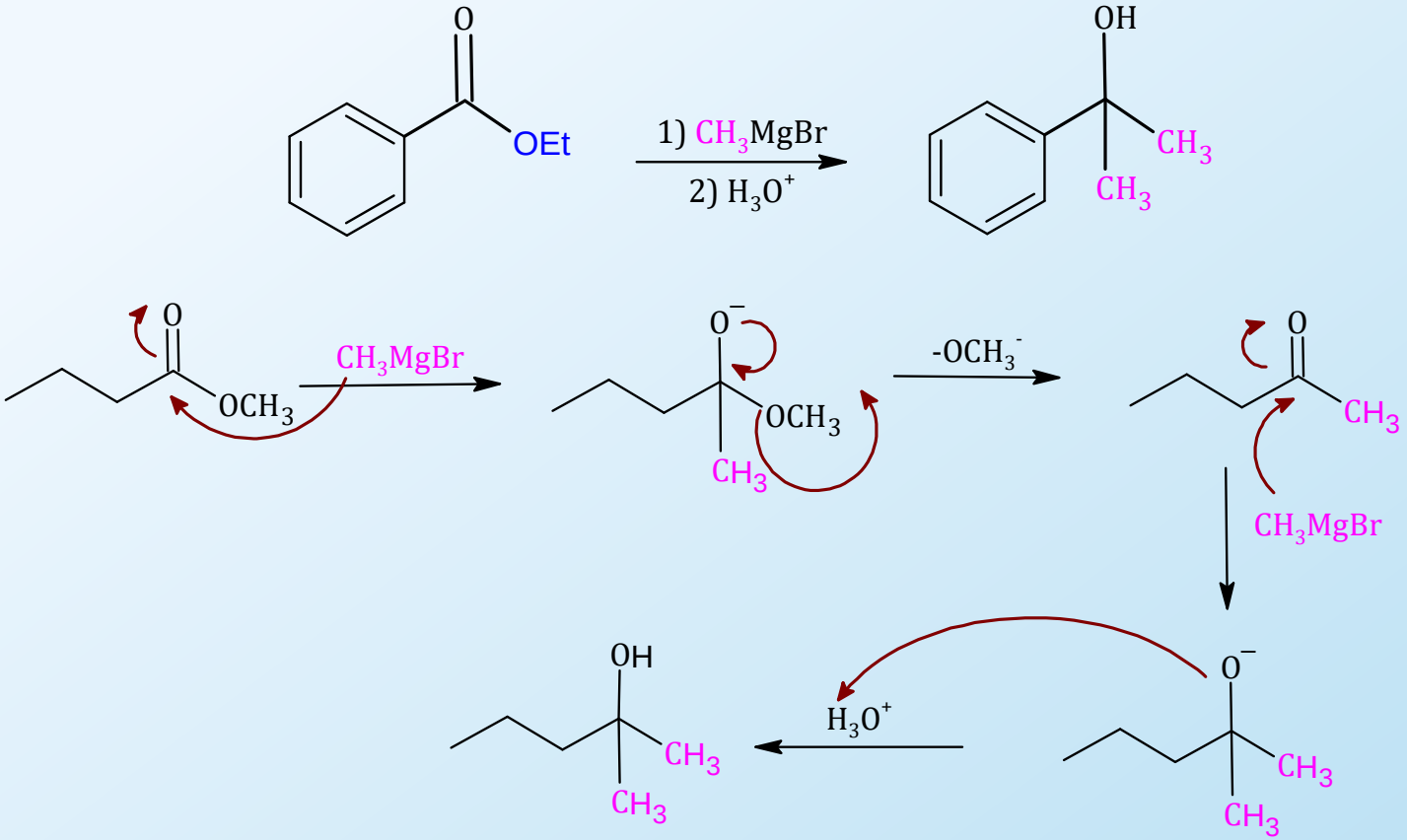
2) <u>Acyl chlorides</u> – These will give tertiary alcohols as products. Note that **two mols of Grignard reagent** are used for every mol of acyl chloride.





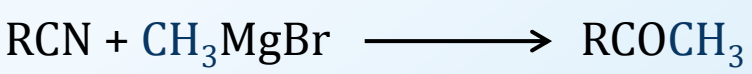
Grignard Reagent and Esters

3) <u>Esters</u> – Esters also gives tertiary alcohols. There are two key things to keep in mind: a**) two mols of Grignard reagent** are used for one mol of ester and b) the reaction cannot be stopped in the middle to give ketone (see mechanism below).

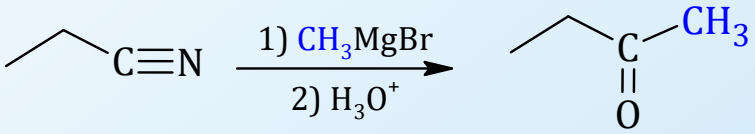


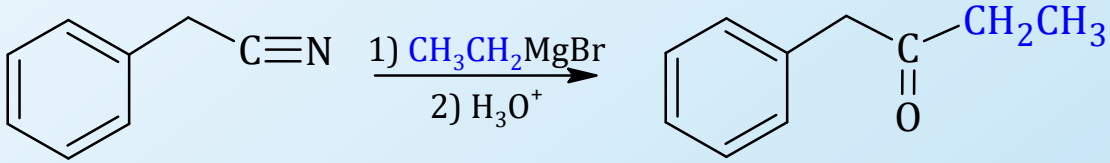
Grignard Reaction and Nitriles

4) Nitriles– Nitriles give ketones with Grignard reagents.



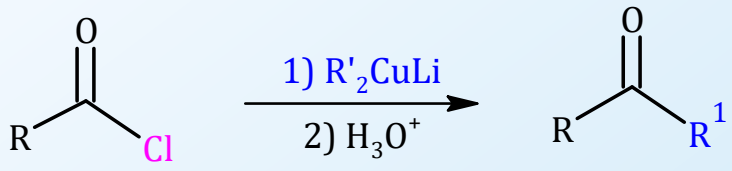
Examples

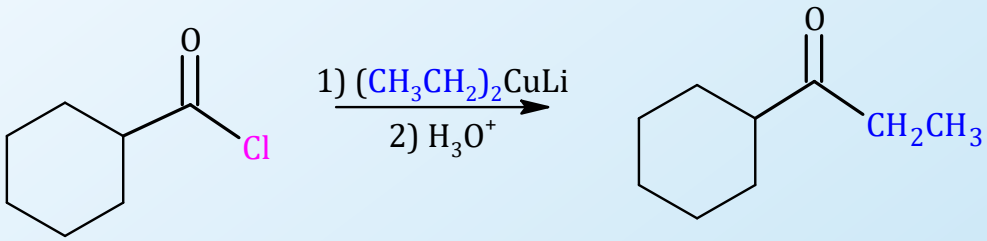




Dialkyl Cuprate Reagents

Acyl chlorides – Acyl chlorides are reactive enough to react with the copper reagents. The alkyl groups of copper reagents are not as nucleophilic and react in a controlled way and thus give ketones as products.





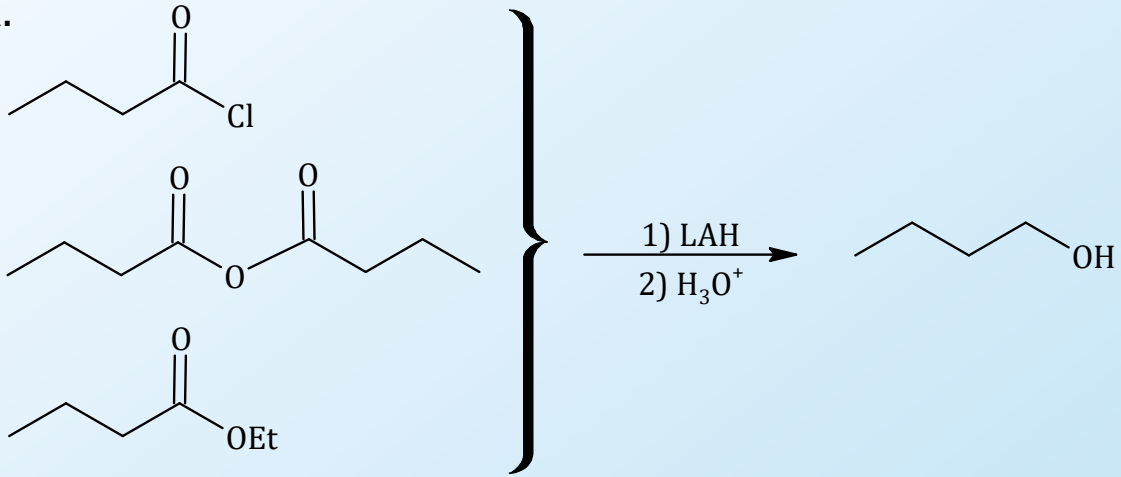
Reduction of Carboxylic Acid Derivatives: LAH

1) <u>Lithium Aluminum Hydride</u>: A strong reducing agent can be used on almost all carboxylic acid derivatives to give 1° alcohols. It is better not to use carboxylic acids since their acidic proton can react with the hydride of the reducing agent. It is better to convert the acid to one the derivatives below and then reduce them.

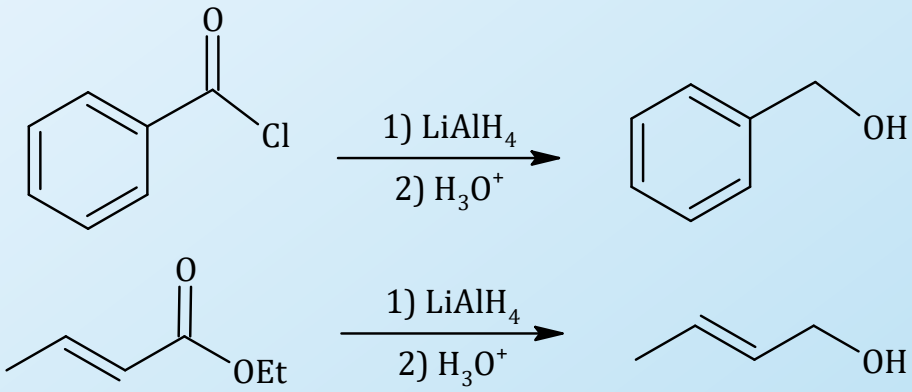
Acyl Chlorides

Anhydrides

Esters

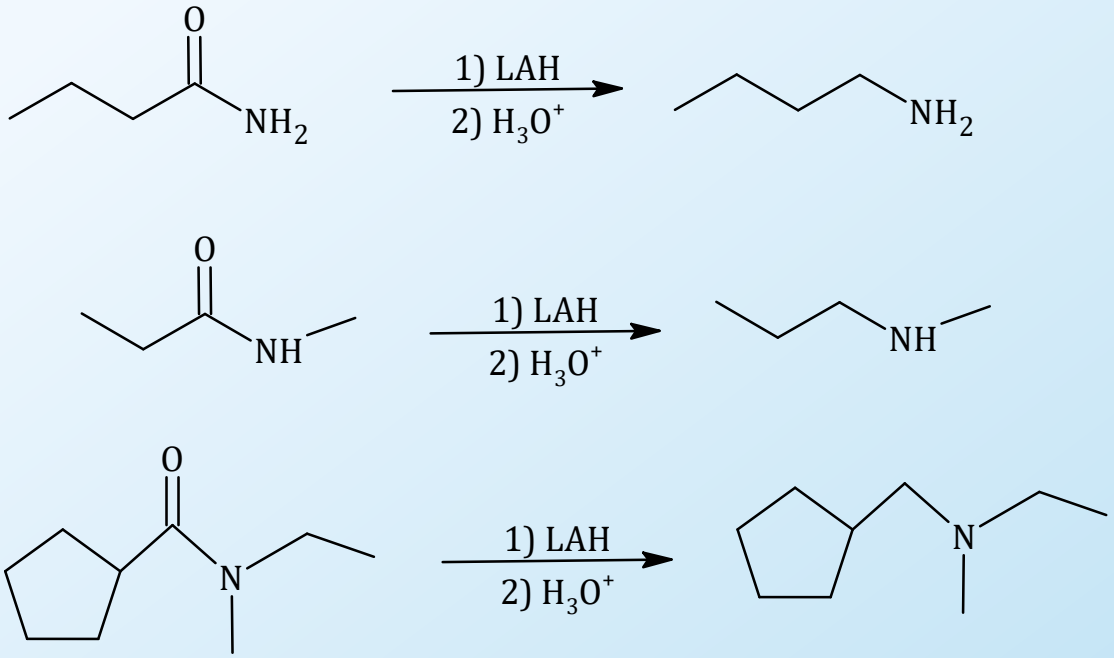


<u>Examples</u>



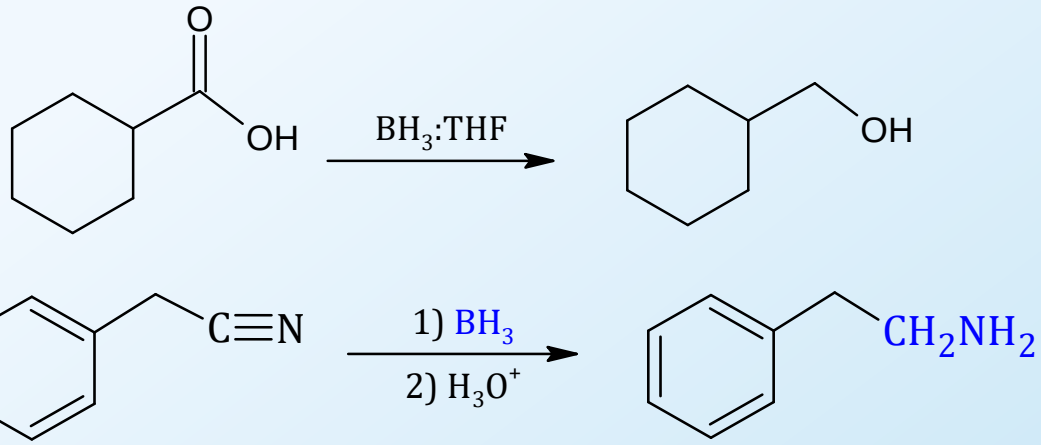
Reduction of Amides - LAH

Amides give amines on reduction with lithium aluminum hydride (LAH). Weak reducing agents cannot be used here. Note that you have an amide group and not a ketone and amine functional groups.

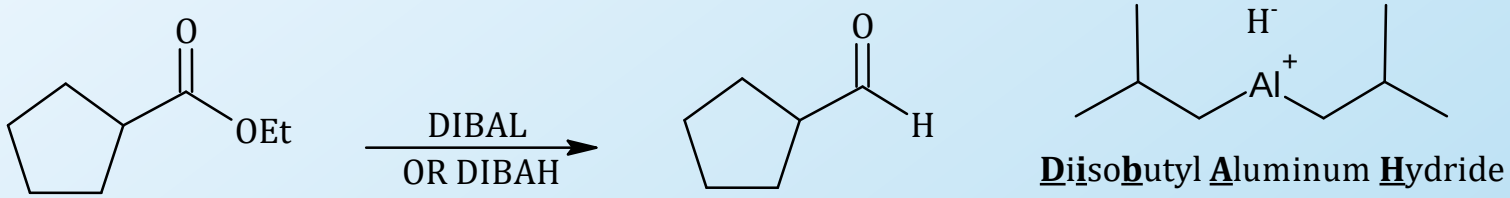


Reduction of Carboxylic Acid Derivatives -2

2) <u>Borane</u>: Another reducing agent is borane reduces carboxylic acids to 1° alcohol and nitriles to amines.

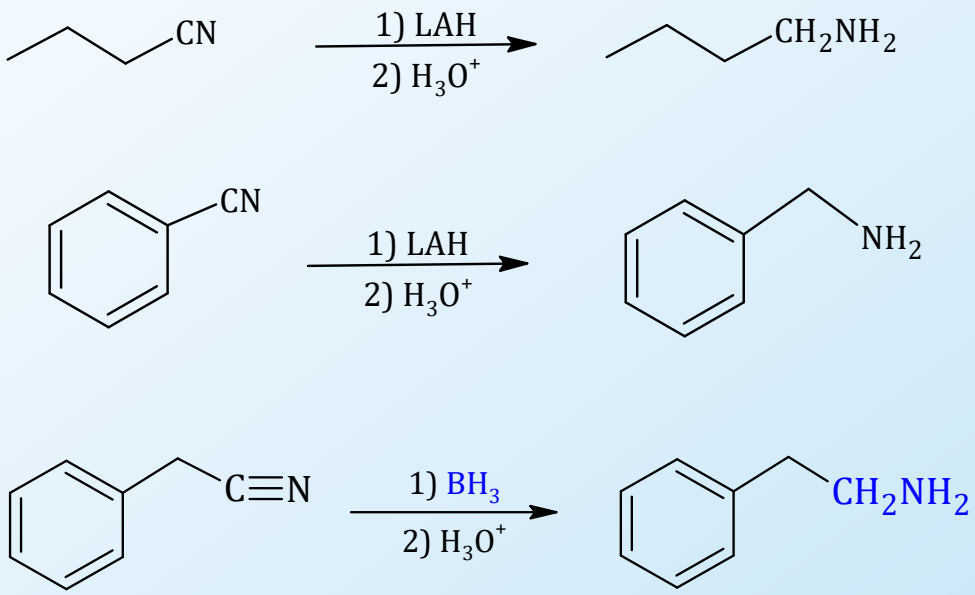


3) <u>Diisobutylaluminum hydride</u>: Using a weak reducing agent on carboxylic acid derivatives gives aldehydes.

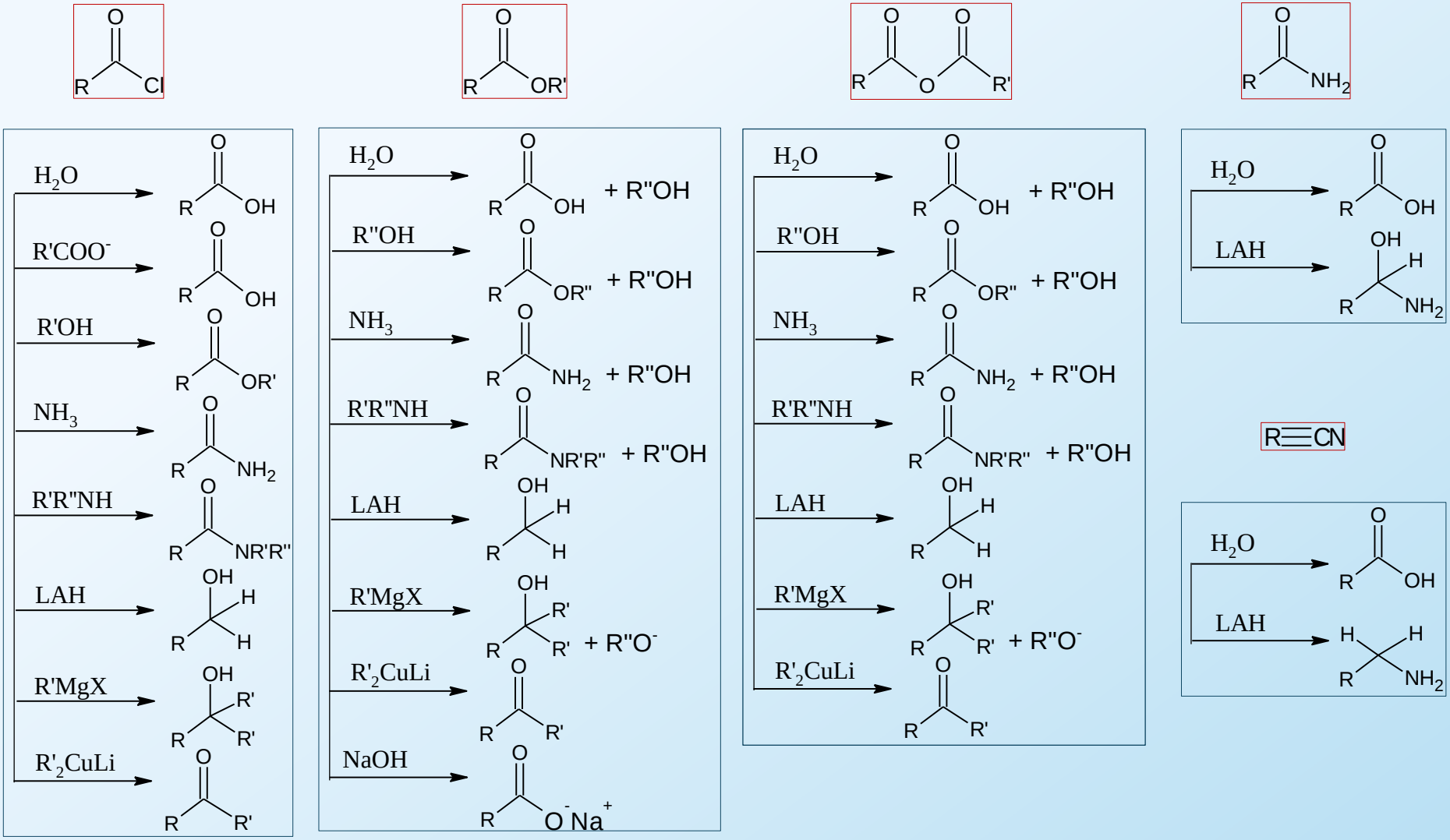


Reduction of Nitriles – LAH and Borane

Nitriles give amines with LAH and borane.

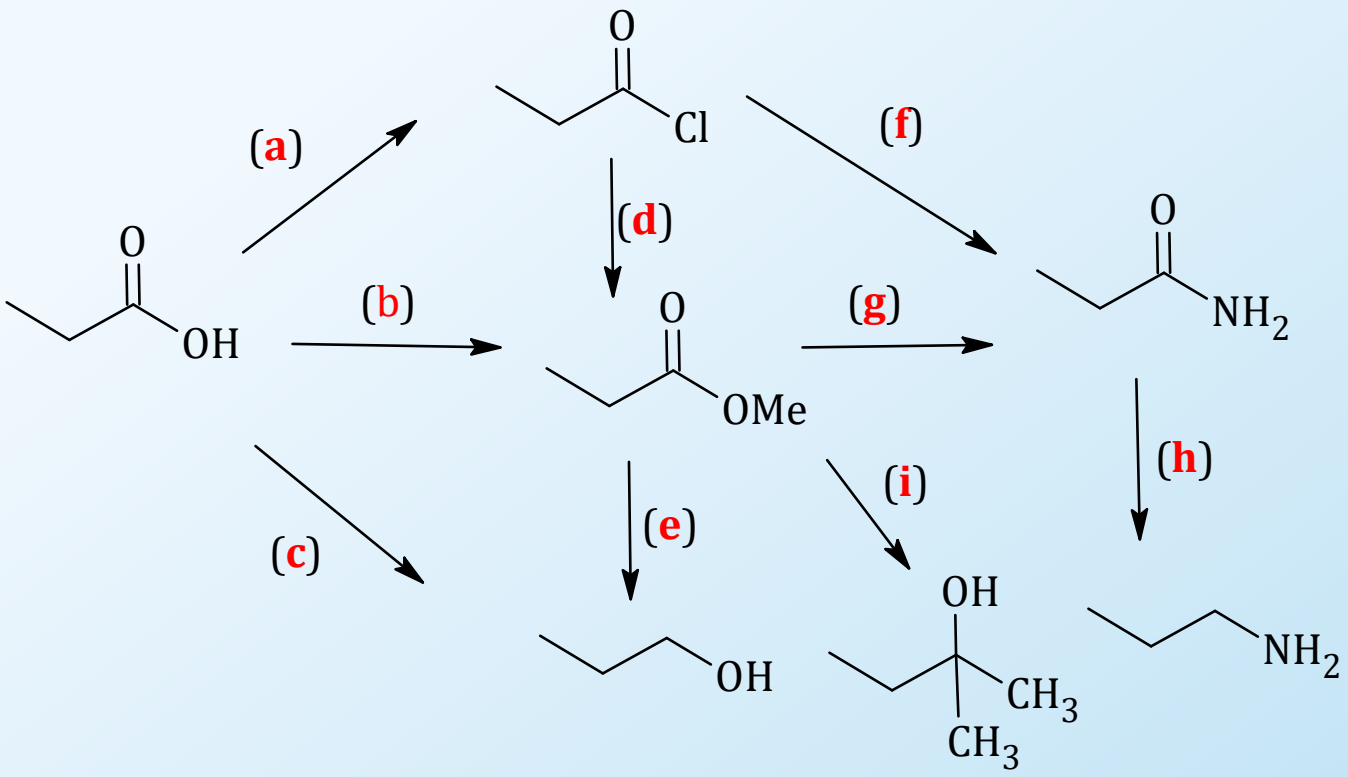


All Reactions



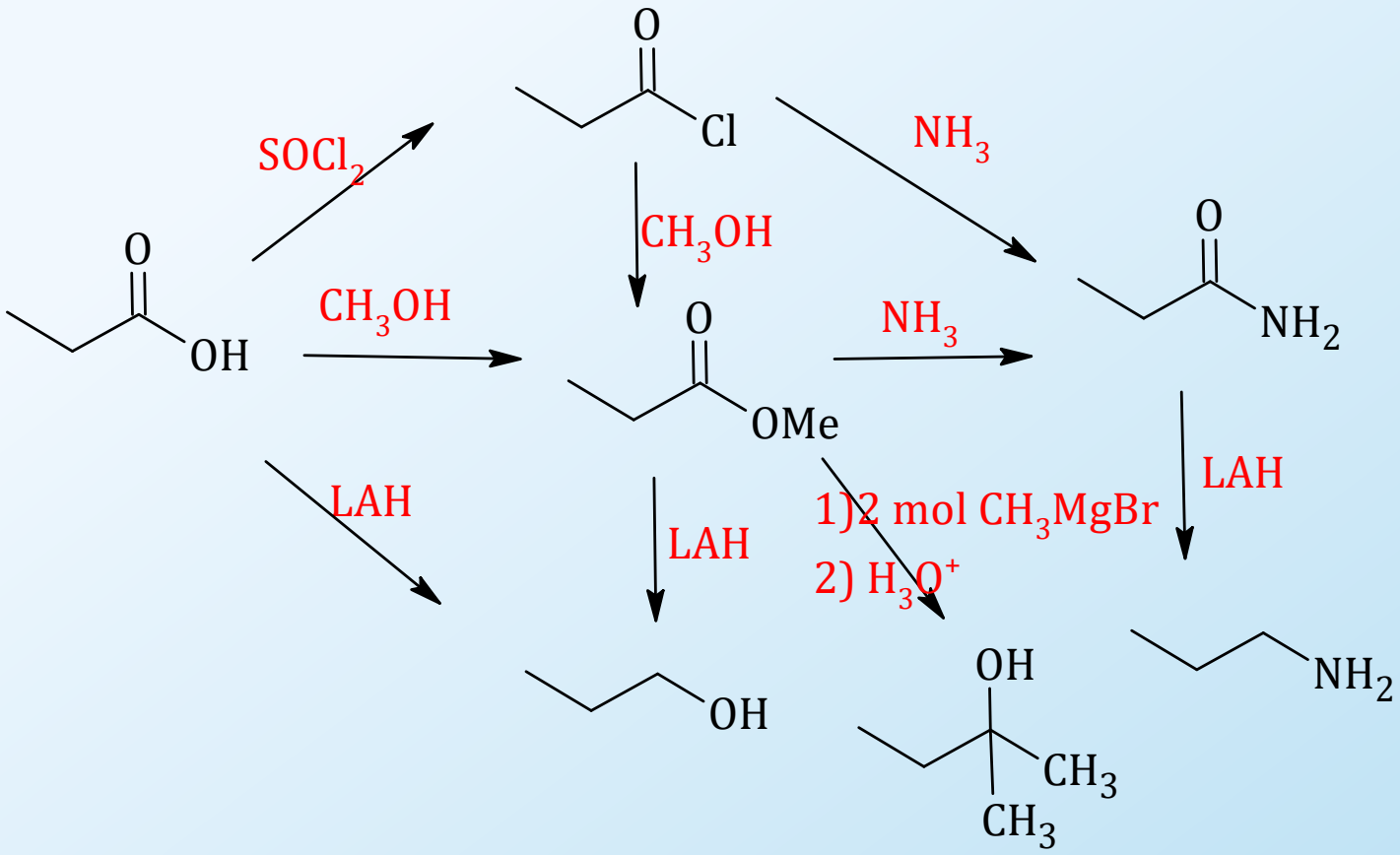
Reaction Web- Practice

Problem: Show reagents to bring about each reaction.



Reaction Web- Practice - Answers

Problem: Show reagents to bring about each reaction.



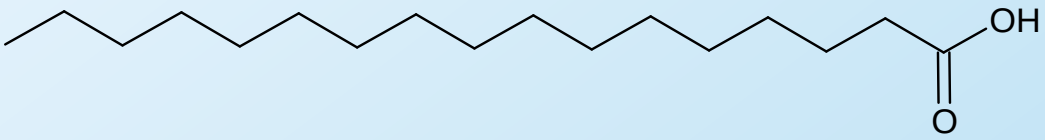
Applications

Now that you know about all the reactions of carboxylic acids do go back to carboxylic acid derivatives notes to see the applications and you will recognize a number of functional groups from this chapter.

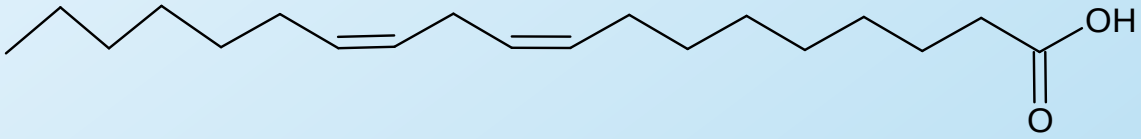
But to review, we can find carboxylic acids in:

1) Fruit juices: e.g. citric acid.
2) They are products of fermentation (e.g. vinegar); and vinegar has many uses!
3) A number of fats are found as fatty acids: saturated and unsaturated. They are required for building the cell wall, providing insulation and energy in the body; hence important in diet. (stored in the body as triglycerides)

Stearic acid



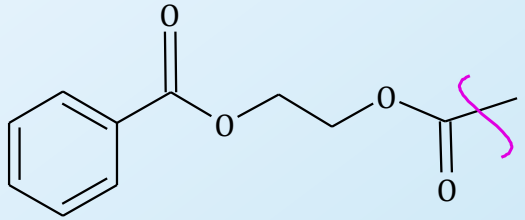
Oleic acid



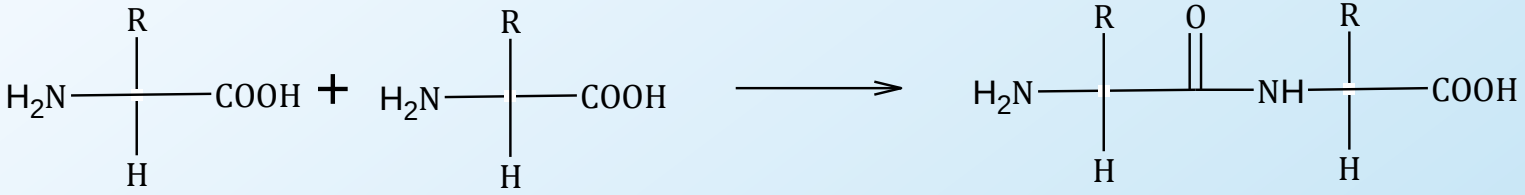
Applications – Condensation Polymers

4) **Polymers:** Here again are some polymers of esters and amides

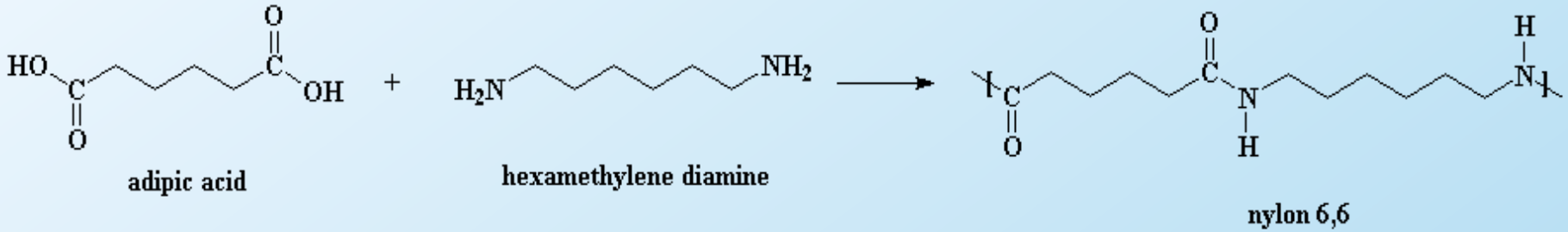
a) Polyesters: dicacid + dialcohol give polyesters.



b) Peptides: amino acid + amino acid gives proteins.



c) Polyamides: diacid + diamine gives polyamides.



Key Concepts

- Organometallic reactions on carboxylic acid derivatives.
- Reduction of carboxylic acid derivatives.