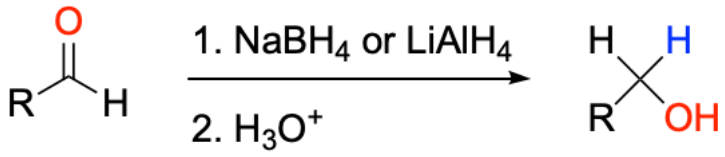
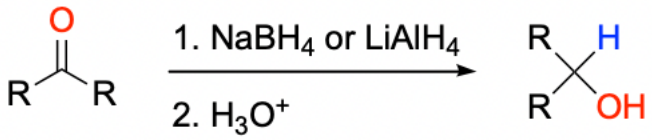
How to Synthesize Alcohols via Reduction

1. **$NaBH_4$** (little hammer) will only reduce aldehydes and ketones
2. **$LiAlH_4$** (big hammer) will reduce aldehydes, ketones, esters, and carboxylic acids
3. When **Ketones** are reduced, it will reduce to a **secondary** alcohol

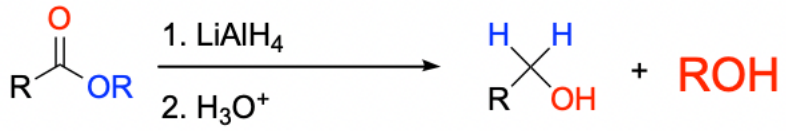
1) Aldehyde to 1° Alcohol



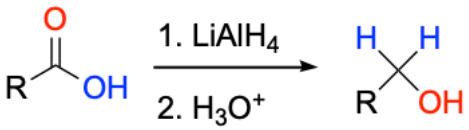
2) Ketone to 2° Alcohol



3) Ester to 1° Alcohol



4) Carboxylic Acid to 1° Alcohol

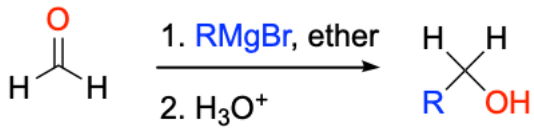


How to Synthesize Alcohols via Grignard Addition:

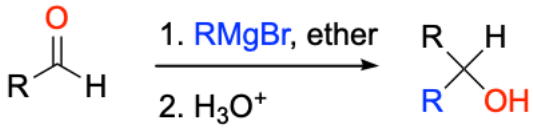
Notes:

- The acidic workup H_3O^+ removes MgBr
- When adding a radical group to an ester, that radical group will be added to the carbon twice

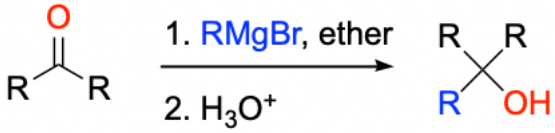
1. Formaldehyde to 1º Alcohol



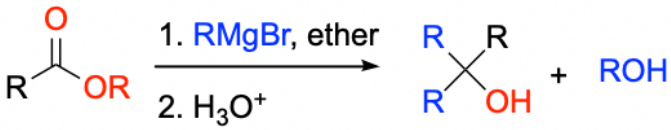
2. Aldehyde to 2º Alcohol



3. Ketone to 3º Alcohol

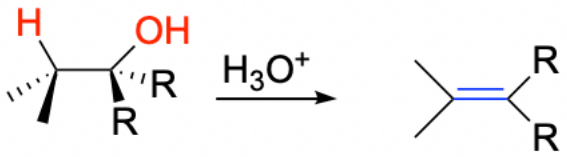


4. Ester to 3º Alcohol

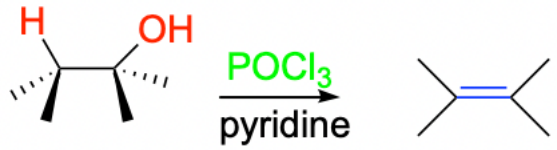


How to Convert Alcohols to Alkenes (Dehydration)

1) 3º Alcohols to Alkenes

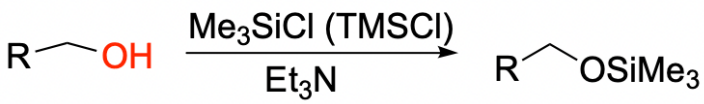


2) 2º and 3º Alcohols to Alkenes

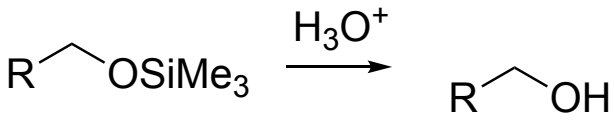


Protection of Alcohols

- Add a protecting group when you don't want the hydroxyl group to be oxidized or deprotonated by another reagent
- Is done in three steps:
    - Step One: Add Protecting Group



    - Step Two: Do Other Reaction/s, (Grignard for example)
    - Step Three: Remove Protecting Group



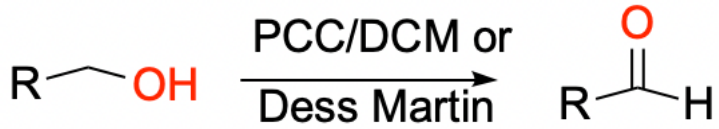
California State University SAN MARCOS

Oxidation of Alcohols

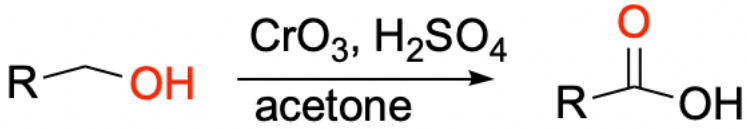
Notes:

- 1º Alcohols oxidize to aldehydes and carboxylic acids (depending on how strong of an oxidizing agent you use)
- 2º Alcohols oxidize to ketones
- 3º Alcohols do not oxidize because the carbon attached to the hydroxyl group lacks a hydrogen, and thus cannot form a carbonyl group
- Examples of oxidizing agents that will oxidize 1º Alcohol to aldehyde (weak): PCC/DCM and Dess Martin
- Examples of oxidizing agents that will oxidize 1º Alcohol to carboxylic acid (strong): Jones Reagent (CrO_3/H_2SO_4/acetone) and $KMnO_4/H_3O^+$

1) 1º Alcohol with weak oxidizing agents → aldehyde



2) 1º Alcohol with strong oxidizing agents → carboxylic acid



3) 2º Alcohol with any type of oxidizing agent → ketone

