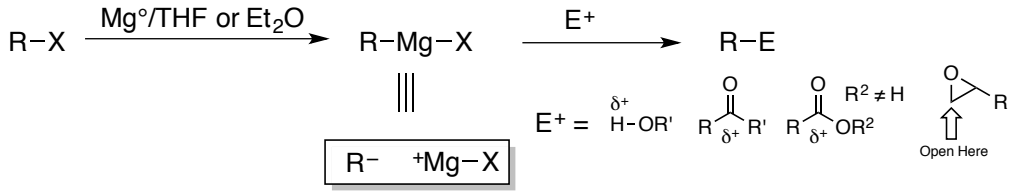
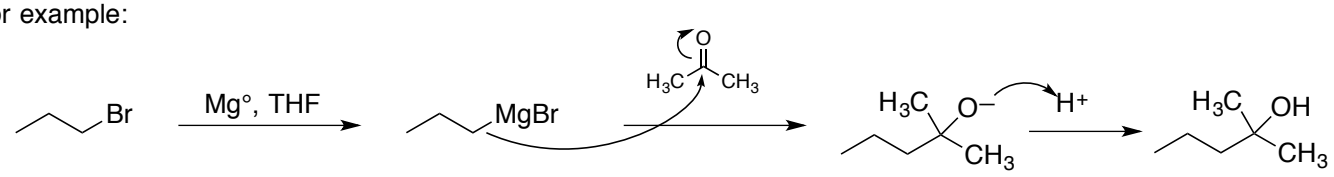
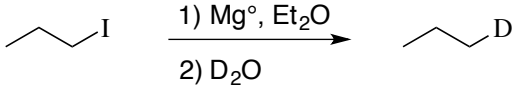


For example:

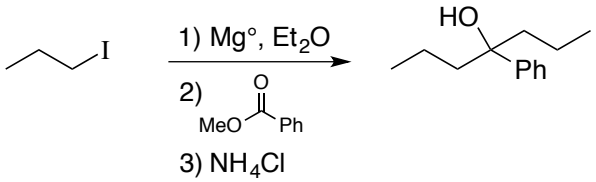
A.



B.



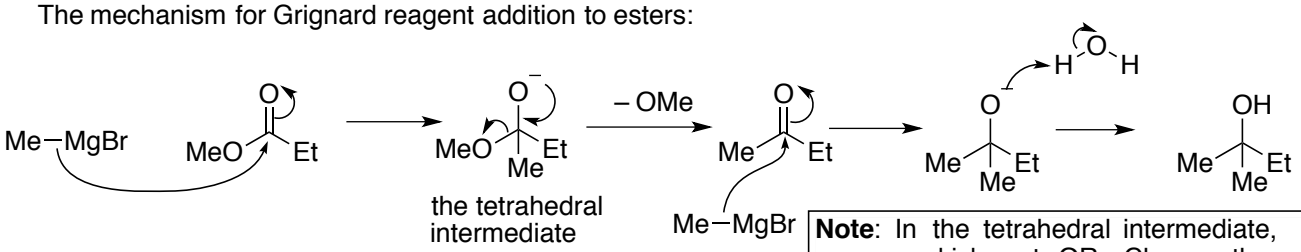
C.



Note 1: NH_4Cl is a weak acid used to quench the alkoxide

Note 2: When using esters assume excess Grignard reagent is used

The mechanism for Grignard reagent addition to esters:



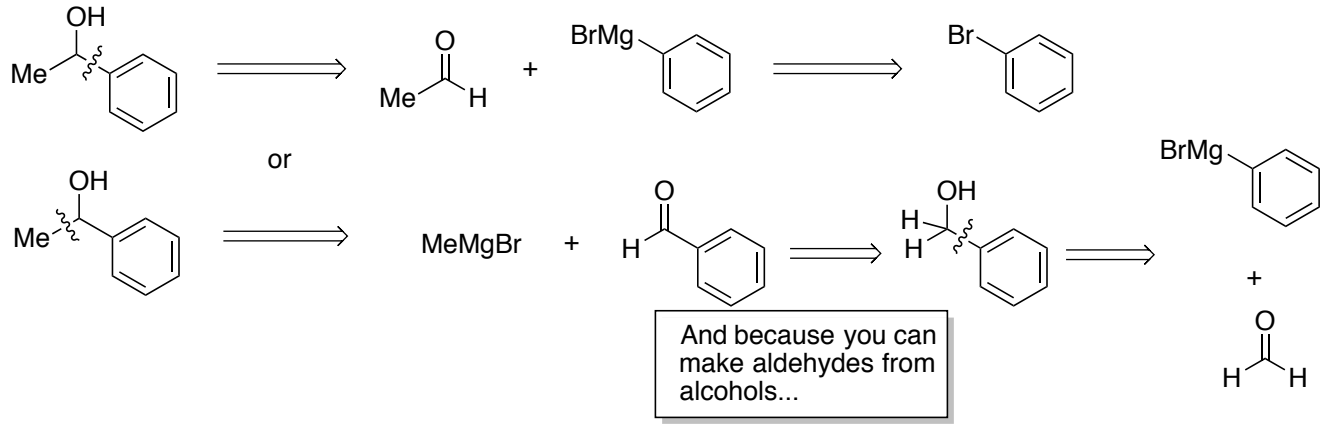
Note: Grignard reagents add to aldehydes faster than to ketones Grignard reagents add to ketones much faster then to esters

Note: In the tetrahedral intermediate, you can kick out OR, Cl, or other common leaving group. You cannot have an alkyl (R) group or hydrogen as the leaving group

---

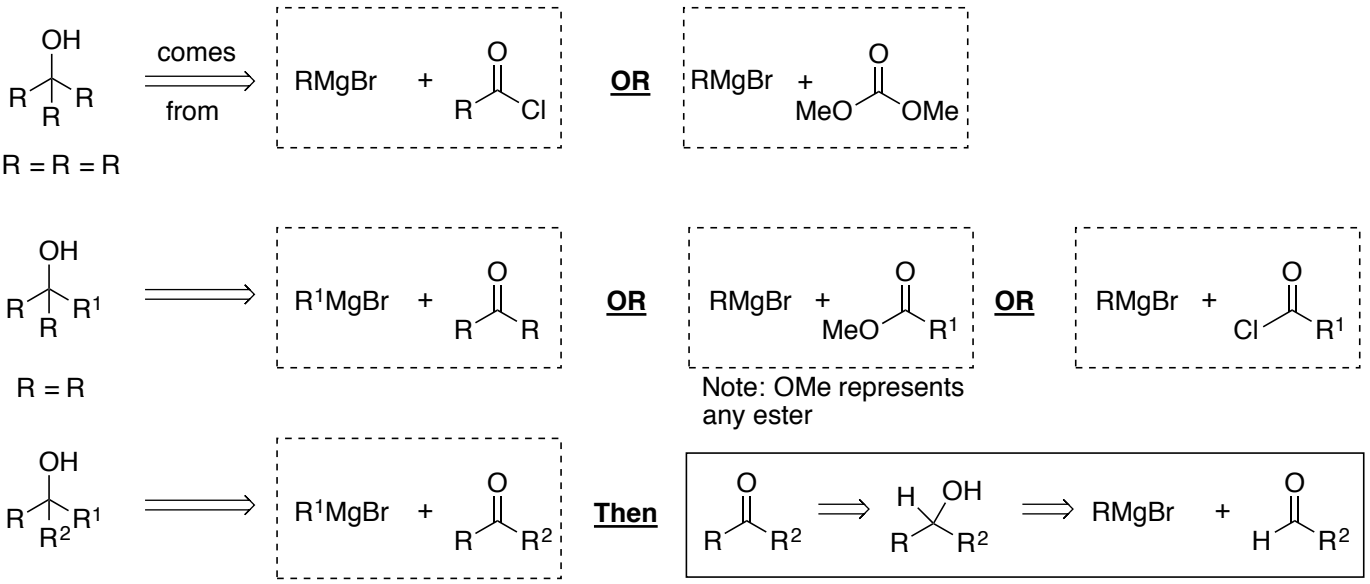
Using Grignard reagents to synthesize alcohols:

Nearly all carbon-carbon bonds at an alcohol functional group could be prepared using Grignard technologies.

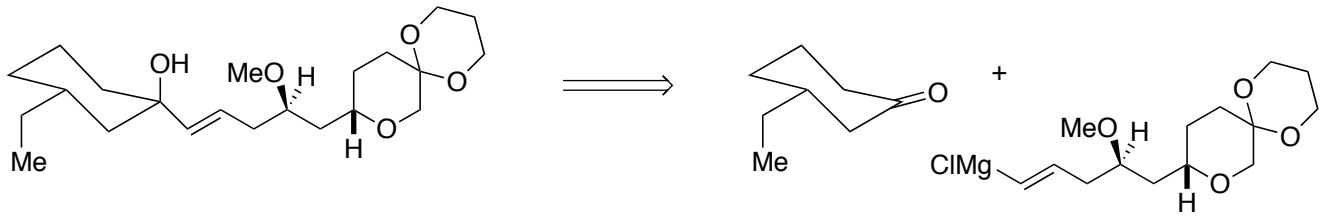


And because you can make aldehydes from alcohols...

Retrosynthetic analysis tips:



For Example:



Three last notes on Grignard reagents:

1) Grignard reagents are nucleophiles that add to the specific types of electrophiles shown in this handout (ie. that are <u>not</u> generally used for S_N2 reactions on alkyl halides).

2) Alkyl Na, Li, and K reagents (i.e. $H_3CC{\equiv}CNa$) react very similarly to Grignard reagents.

3) An R^- addition to a carbonyl is a reduction just like a hydride H^- delivered from BH_4^-

---

Reducing Reagents

H_2

Na, Li, or K : Used to reduce alkynes to *trans*-alkenes

BH_3 : Adds to alkenes and alkynes (reducing them)
With the CBS Catalyst, reduces ketones to alcohols, enantioselectively
Selectively reduces carboxylic acids to alcohols (Does react with esters)

$NaBH_4$: Reduces aldehydes, acid chlorides, and ketones to the corresponding alcohol (reduces esters very slowly)

$LiBH_4$: Reduces esters, ketones, acid chlorides, and aldehydes to the corresponding alcohol

$LiAlH([OC(CH_3)_3]_3$: Used to reduce acid chlorides and esters (at –78 °C) to aldehydes (stops at the aldehyde!)
Reduces ketones, acid chlorides,and aldehydes to the corresponding alcohol

i-Bu_2AlH (DIBAL): Used to reduce esters and acid chlorides (at –78 °C) to aldehydes (stops at the aldehyde!)
Reduces ketones, acid chlorides,and aldehydes to the corresponding alcohol

$LiAlH_4$: (LAH) Very powerful reducing agent also reduces carboxylic acids
Reduces ketones, acid chlorides,and aldehydes to the corresponding alcohol
Reduces amides to the corresponding amine