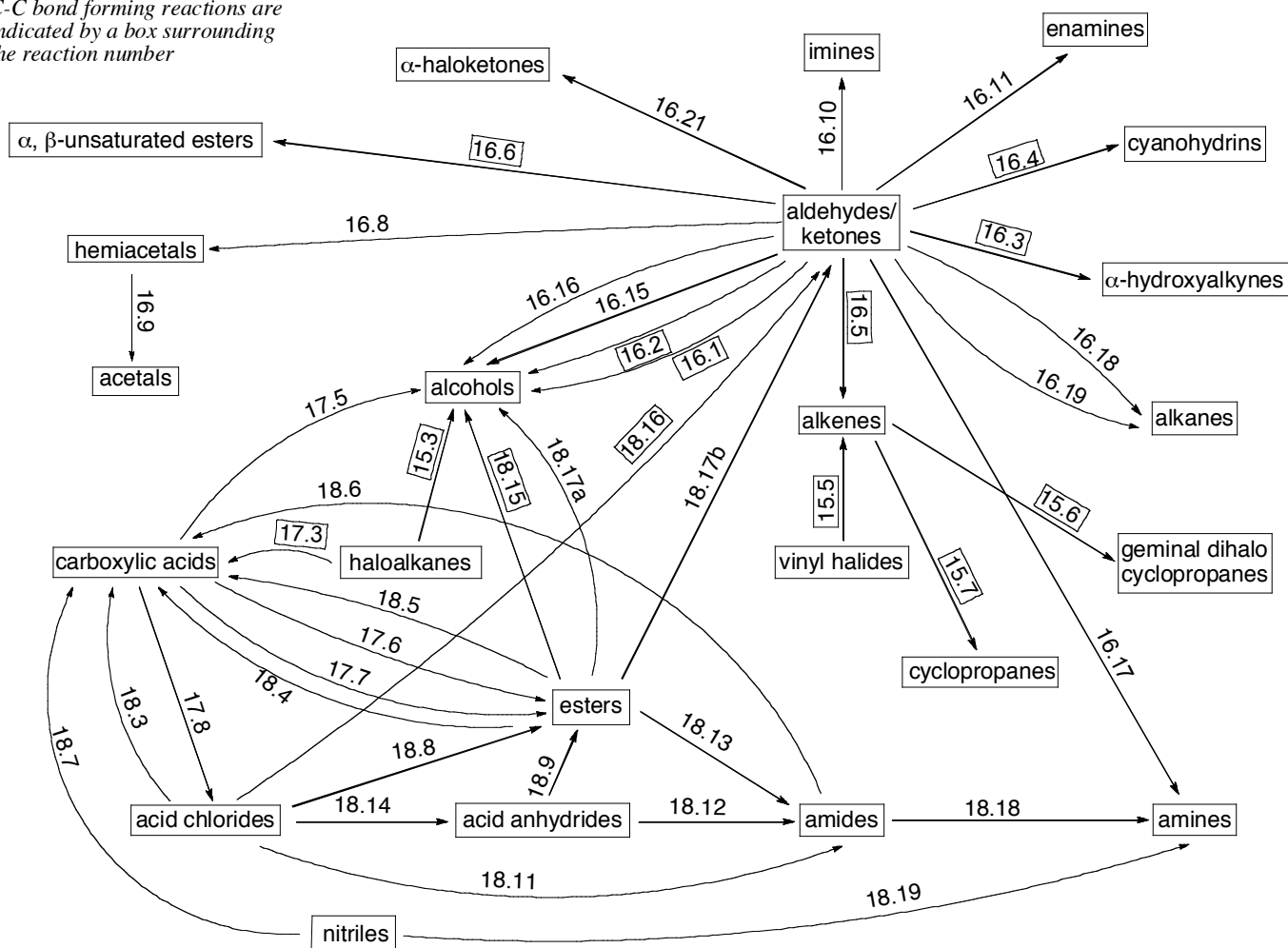


C-C bond forming reactions are indicated by a box surrounding the reaction number



Roadmap Reaction Legend

Reaction 15.3

1. Mg° in ether 2. An epoxide 3. Mild acid

- Grignard reagent
- Carbon acts as a nucleophile and reacts at the least hindered carbon of the epoxide
- Makes a new C-C bond

Reaction 15.6

CHX_3 and $\text{KO}t\text{Bu}$

- Works if $X=\text{Cl}$ or Br
- Reaction involves a dihalocarbene intermediate
- Makes two C-C bonds

Reaction 16.1

1. RMgX 2. HCl , H_2O

- The Grignard reagent attacks the electrophilic carbonyl C atom to create an alkoxide intermediate
- The chemist adds mild acid to give the alcohol
- Makes a new C-C bond

Reaction 16.3

1. $\text{RC}\equiv\text{C}^-$ 2. HCl , H_2O

- The alkyne anion attacks the electrophilic carbonyl C atom to create an alkoxide intermediate
- The chemist adds mild acid to give α -hydroxyalkyne
- Makes a new C-C bond

Reaction 15.5

$(\text{R})_2\text{CuLi}$

- Gilman reagent
- The Gilman reagent is made from two equivalents of an alkyl lithium reacting with CuI
- Makes a new C-C bond

Reaction 15.7

CH_2I_2 and $\text{Zn}(\text{Cu})$

- The Simmons-Smith reaction
- Reaction involves formation of an organozinc reagent
- Makes two C-C bonds

Reaction 16.2

1. RLi 2. HCl , H_2O

- The organolithium reagent attacks the electrophilic carbonyl C atom to create an alkoxide intermediate
- The chemist adds mild acid to give the alcohol
- Makes a new C-C bond

Reaction 16.4

HCN / NaCN

- The cyanide anion attacks the electrophilic carbonyl C atom to create an alkoxide intermediate
- HCN protonates the alkoxide to give the cyanohydrin
- Makes a new C-C bond

Reaction 16.5

$\text{RHC}^-\text{P}^+(\text{Ph})_3$ (a phosphonium ylide)

- The Wittig reaction
- Ylides with anion stabilizing groups are
- E-selective, non-stabilized ylides are Z-selective
- Four-membered ring oxaphosphetane intermediate
- Makes a new C=C bond

Reaction 16.8

ROH and acid

- Carbonyl is protonated, facilitating attack of alcohol
- Hemiacetals are not stable unless they are cyclic

Reaction 16.10

RNH_2 and weak acid

- Primary amines react with the carbonyl to give a tetrahedral addition intermediate that adds a proton and loses water to make an imine

Reaction 16.15

1. NaBH_4 or LiAlH_4 2. H_2O

- The hydride attacks the electrophilic carbonyl C atom to give a tetrahedral addition intermediate that adds a proton to give the alcohol product
- Will not reduce C=C bonds

Reaction 16.17

RNH_2 and NaBH_3CN

- Reductive amination
- Initially formed imine is reduced to an amine by the NaBH_3CN

Reaction 16.19

H_2NNH_2 and KOH

- Wolff-Kishner reduction
- The hydrazine reacts with the carbonyl to give a hydrazone that is deprotonated in base and loses N_2 .
- This reaction is useful when the other functional groups present are stable to base

Reaction 17.3

1. Mg, ether 2. CO_2 3. HCl, H_2O

- The Grignard reagent attacks the electrophilic CO_2 carbonyl C atom to create a carboxylate intermediate
- The chemist adds mild acid to give the alcohol
- Makes a new C-C bond and adds one carbon atom

Reaction 17.6

ROH and catalytic H_2SO_4

- The acid catalyst protonates the carboxylic acid facilitating attack by the ROH
- The reaction is reversible

Reaction 17.8

SOCl_2

- Similar mechanism to conversion of alcohol into a chloroalkane
- Important reaction for generating a highly reactive derivative of a carboxylic acid

Reaction 18.3

H_2O

- The hydrolysis reaction occurs spontaneously and does not need acid or base catalysis
- The mechanism involves direct attack of H_2O at the electrophilic carbonyl carbon atom

Reaction 16.6

$(\text{CH}_3\text{O})_2\text{P}(\text{CH}_2\text{C}(\text{O})\text{OR})$ / Base

- Horner-Emmons-Wadsworth modification of Wittig reaction
- Starting reagent is derived from trimethylphosphite reacting with an α -haloester
- Highly E-selective
- Makes a new C=C bond

Reaction 16.9

ROH and acid

- Hemiacetals can react with another hydroxyl group to make the more stable acetal

Reaction 16.11

R_2NH and weak acid

- Secondary amines react with the carbonyl to give a tetrahedral addition intermediate that adds a proton and loses water to make an enamine

Reaction 16.16

H_2 and transition metal

- Pt or Ni are often used
- This reaction will also reduce a C=C

Reaction 16.18

Zn(Hg) and HCl

- Clemmensen reduction
- The reaction is useful when the other functional groups present are stable to acid

Reaction 16.21

Br_2 and $\text{CH}_3\text{CO}_2\text{H}$

- Bromination occurs on the enol form of the ketone or aldehyde

Reaction 17.5

1. LiAlH_4 2. H_2O

- The carboxylic acid is reduced all the way to an alcohol
- NaBH_4 is not strong enough to use for this reaction

Reaction 17.7

CH_2N_2

- Very efficient reaction for preparation of methyl esters
- Warning, diazomethane is an explosive and toxic gas

Reaction 18.4

H_2O

- The hydrolysis reaction occurs spontaneously and does not need acid or base catalysis
- The mechanism involves direct attack of H_2O at the electrophilic carbonyl carbon atom

Reaction 18.5

H₂O with acid or base

- The reaction in acid requires only a catalytic amount of acid and involves an initial protonation of the carbonyl group followed by water attack
- The reaction in base requires one equivalent of HO⁻ and involves an initial attack of HO⁻ on the carbonyl carbon

Reaction 18.7

H₂O with acid or base

- The reaction in acid requires one equivalent of acid and involves an initial protonation of the nitrile carbon atom followed by water attack
- The reaction in base requires one equivalent of HO⁻ and involves an initial attack of HO⁻ on the nitrile carbon that leads to an amide.

Reaction 18.9

ROH

- The reaction does not need acid or base and involves an initial protonation attack of the carbonyl carbon atom by the alcohol O atom

Reaction 18.12

2 R₂NH, R can be H

- The mechanism involves attack of the amine on the carbonyl carbon atom
- The second equivalent of amine is protonated during the reaction

Reaction 18.14

RCO₂⁻

- The mechanism involves attack of the carboxylate on the carbonyl carbon atom

Reaction 18.16

1. R₂CuLi 2. H₂O

- This reaction stops at the ketone
- Makes new C-C bond

Reaction 18.17b

1. DIBALH 2. HCl, H₂O

- The reaction cleaves the ester but stops at the aldehyde

Reaction 18.19

1. LiAlH₄ 2. H₂O

- The reaction does not cleave the nitrile, it reduces it to a primary amine
- The mechanism involves attack of hydride anion on the nitrile carbon atom

Reaction 18.6

H₂O with acid or base

- The reaction in acid requires one equivalent of acid and involves an initial protonation of the carbonyl group followed by water attack
- The reaction in base requires one equivalent of HO⁻ and involves an initial attack of HO⁻ on the carbonyl carbon

Reaction 18.8

ROH

- The reaction does not need acid or base and involves an initial protonation attack of the carbonyl carbon atom by the alcohol O atom

Reaction 18.11

2 R₂NH, R can be H

- The mechanism involves attack of the amine on the carbonyl carbon atom
- The second equivalent of amine is protonated during the reaction

Reaction 18.13

R₂NH, R can be H

- The mechanism involves attack of the amine on the carbonyl carbon atom
- The reaction can require heating

Reaction 18.15

1. 2 RMgX 2. HCl, H₂O

- The product tertiary alcohol has two identical R groups
- The mechanism involves formation of a ketone that is then attacked by the second equivalent of Grignard reagent
- Makes new C-C bond

Reaction 18.17a

1. LiAlH₄ 2. HCl, H₂O

- The reaction cleaves the ester and makes two alcohols
- The mechanism involves attack of hydride anion on the carbonyl carbon atom

Reaction 18.18

1. LiAlH₄ 2. H₂O

- The reaction does not cleave the amide, it reduces the carbonyl group all the way to methylene.
- The mechanism involves attack of hydride anion on the carbonyl carbon atom followed by loss of the O atom attached to the Lewis acidic Al atom