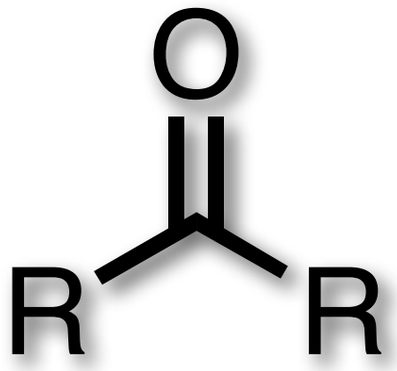
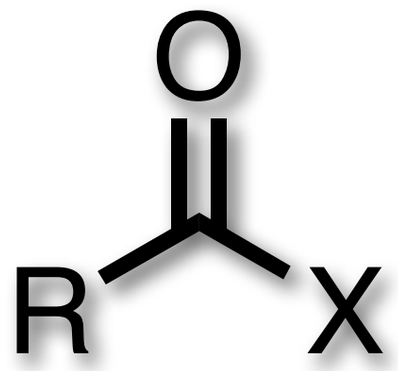
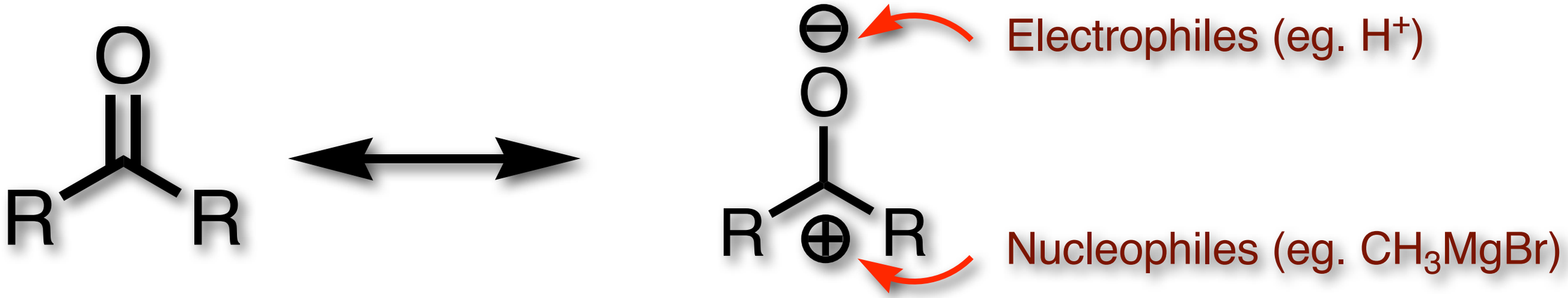
Carbonyl Chemistry



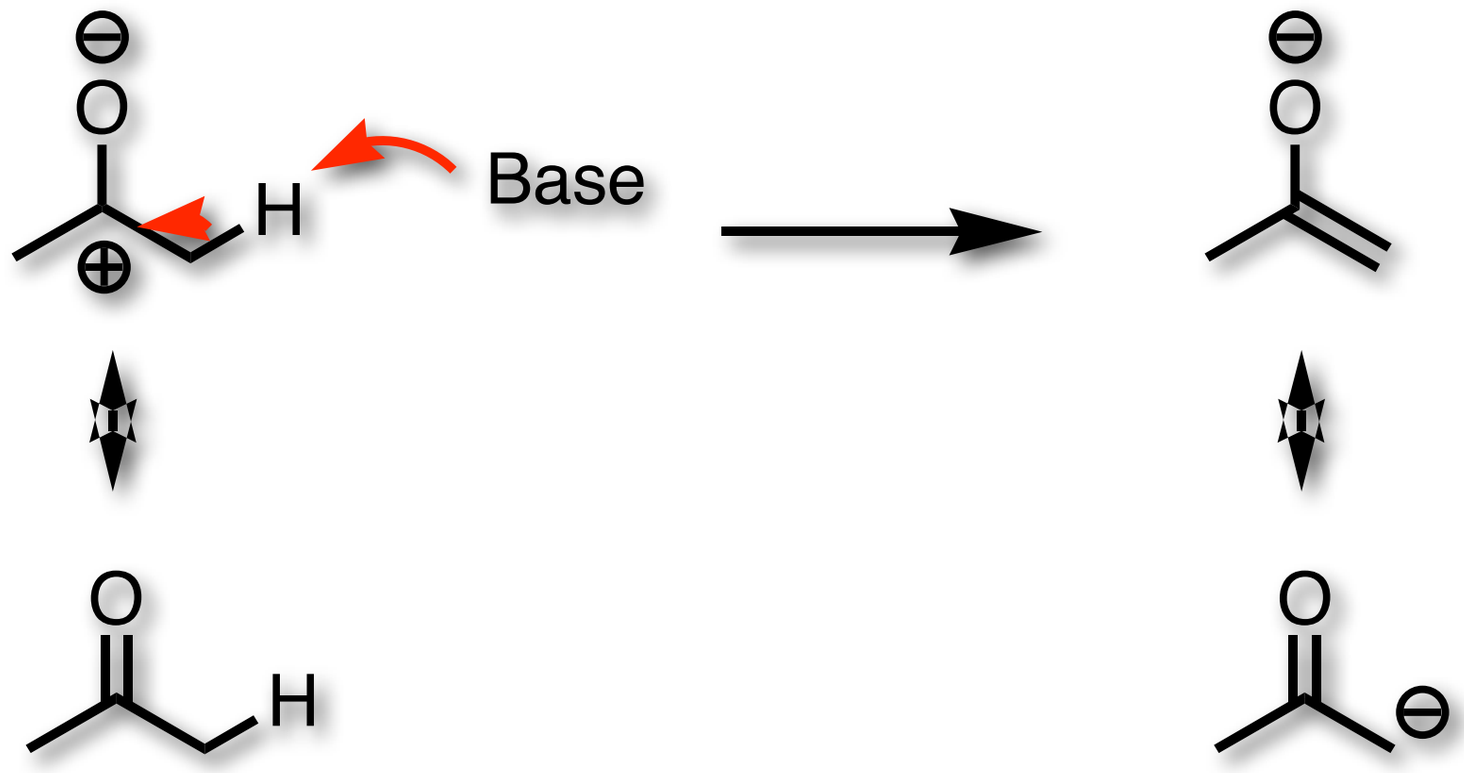


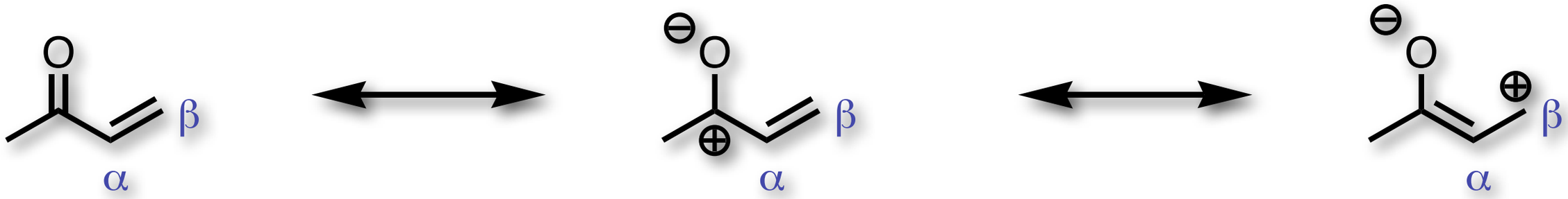
aldehydes
ketones

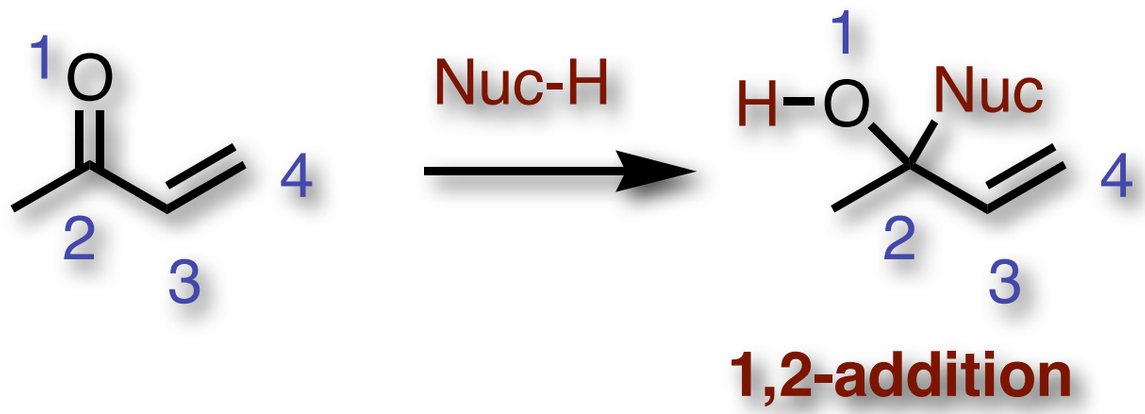
carboxylic acid
and derivatives



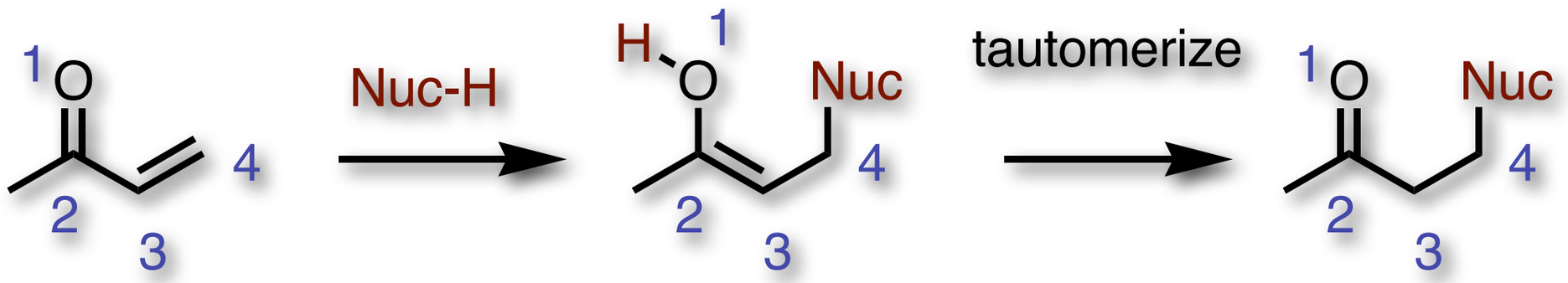
an enolate



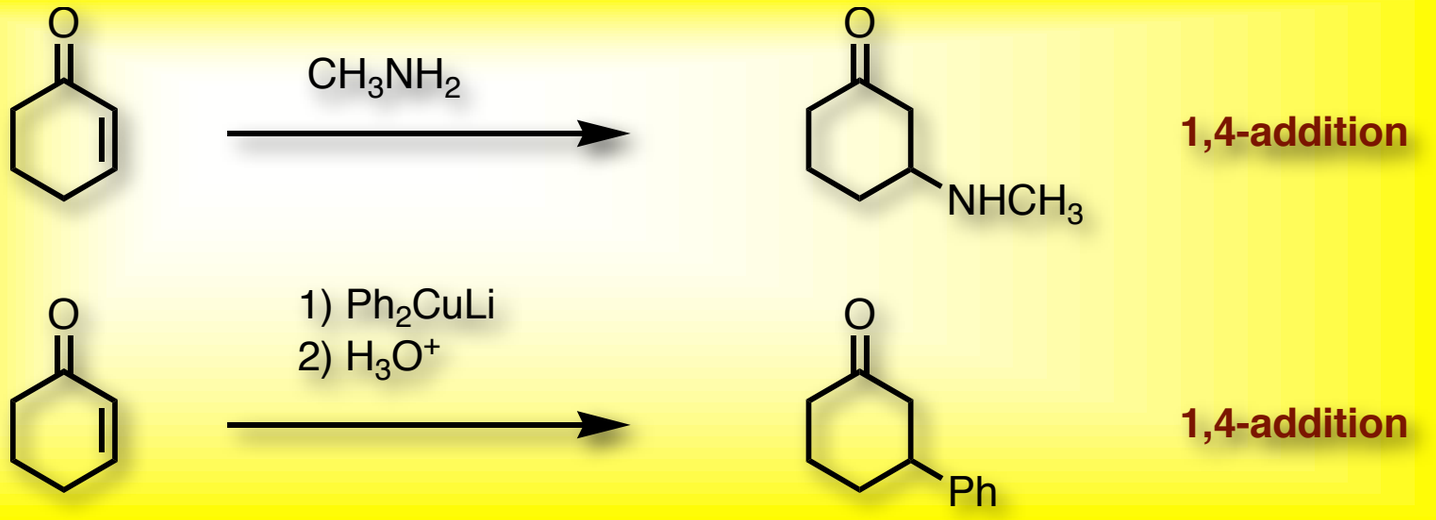


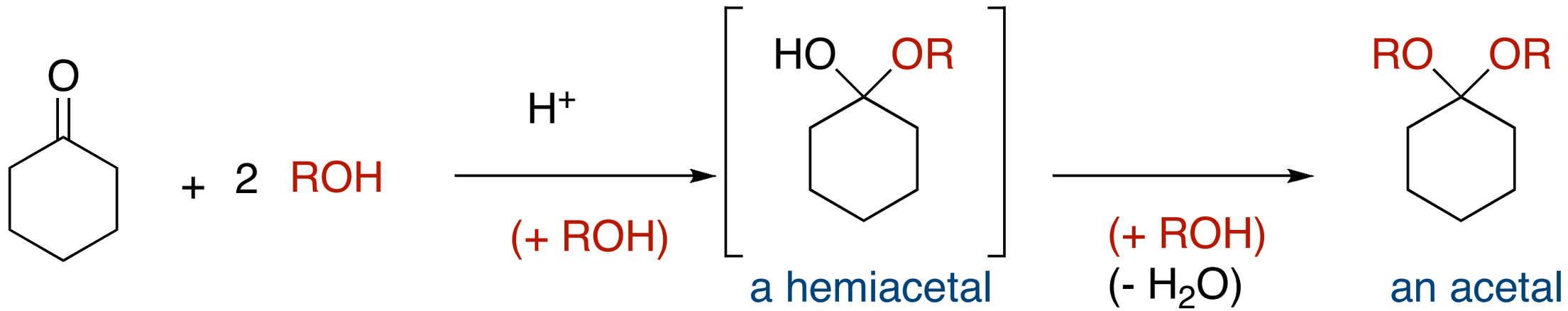


1,2-addition



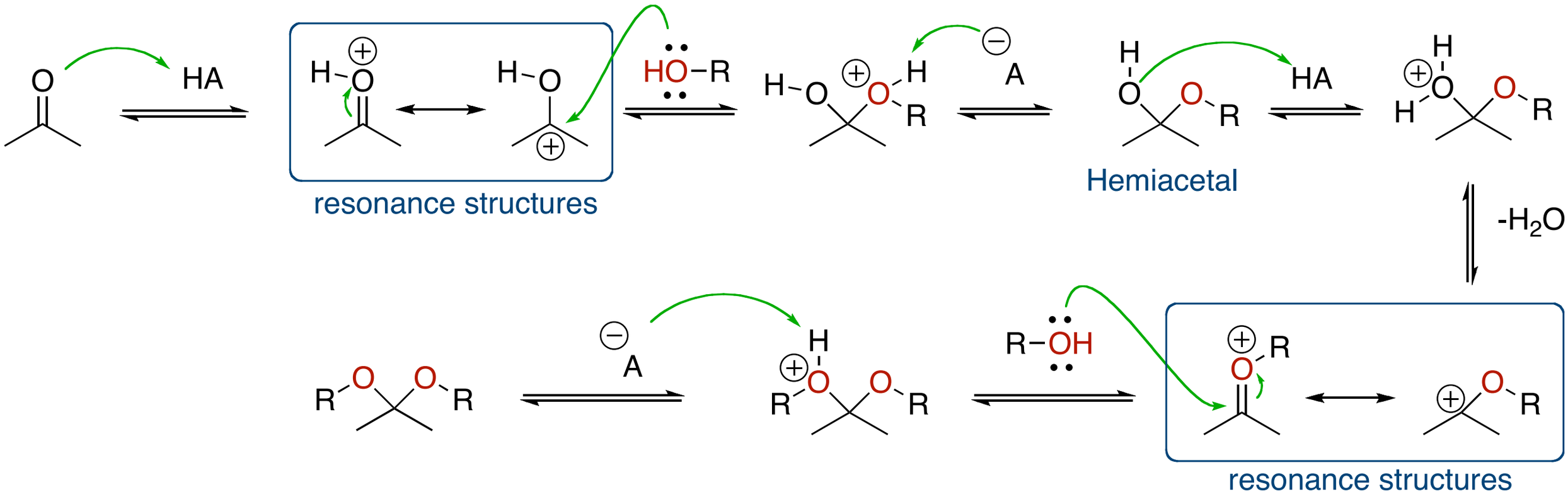
1,4-addition (conjugate addition)


O
CH_3NH_2
O
NHCH$_3$
1,4-addition
O
1) Ph_2CuLi
2) H_3O^+
O
Ph
1,4-addition
O
1) PhMgBr
2) H_3O^+
HO
Ph
1,2-addition
O
1) PhLi
2) H_3O^+
HO
Ph
1,2-addition
O
1) $NaBH_4$
2) H_3O^+
HO
H
1,2-addition
O
1) $LiAlH_4$
2) H_3O^+
HO
H
1,2-addition



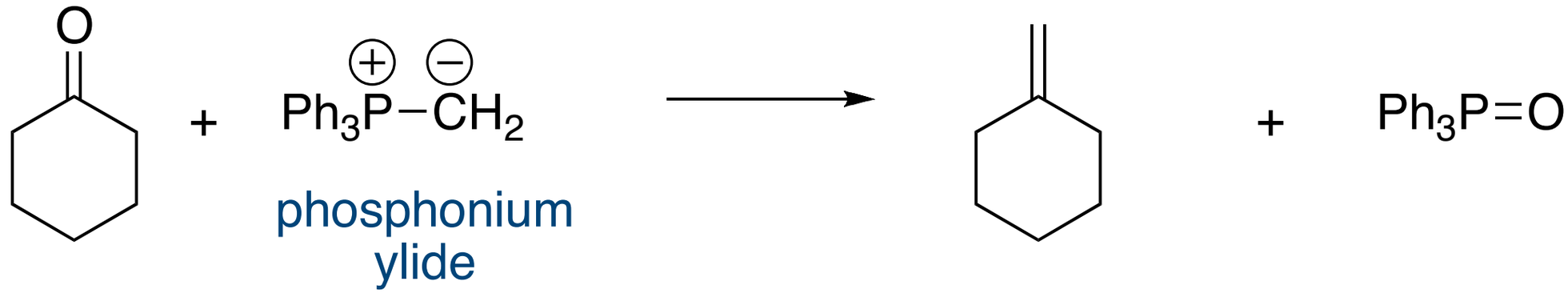
NEED TO KNOW MECHANISM

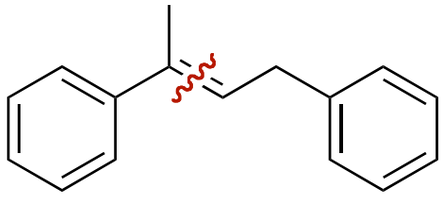
Mechanism for Acetal Formation



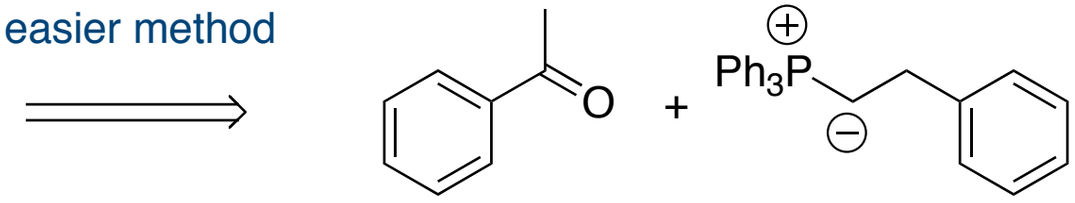
Wittig Reaction

Both aldehydes and ketones participate. The Wittig reagent is made from the alkyl halide by S_N2 reactions.

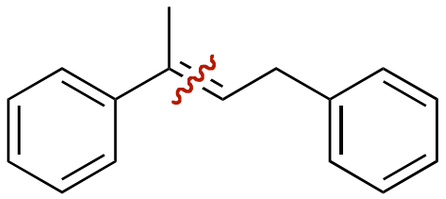




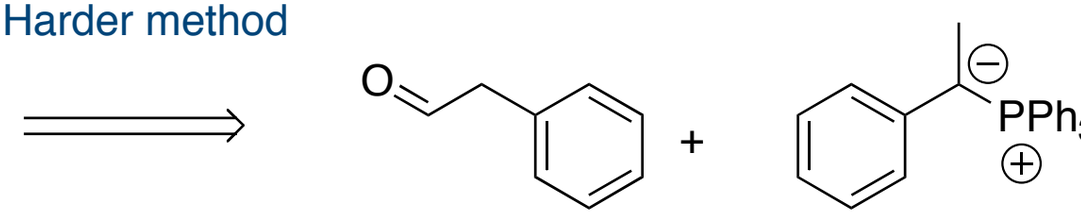
easier method

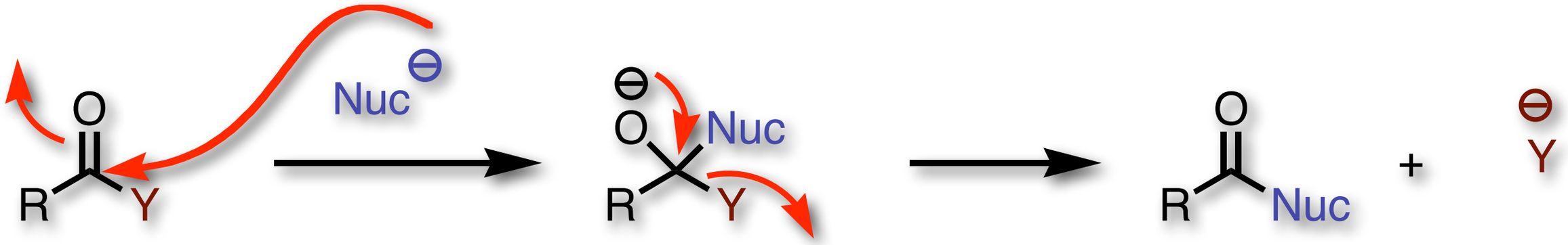


easier to prepare Wittig reagent - substitution on a primary bromide.



Harder method





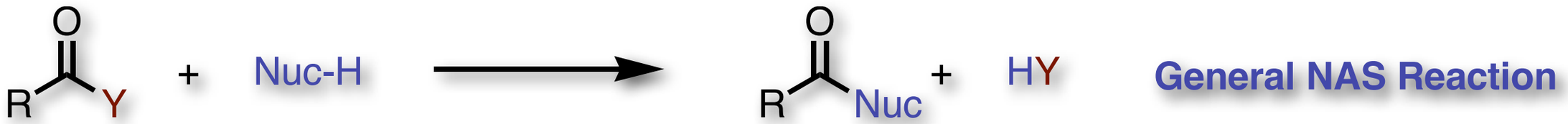
Acid Halides
(acetyl chloride)

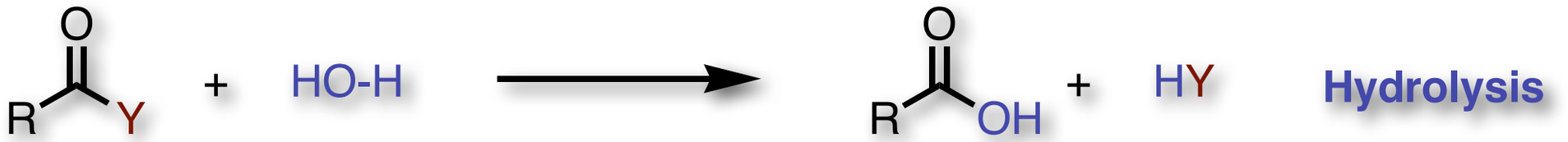
Acid anhydrides
(acetic anhydride)

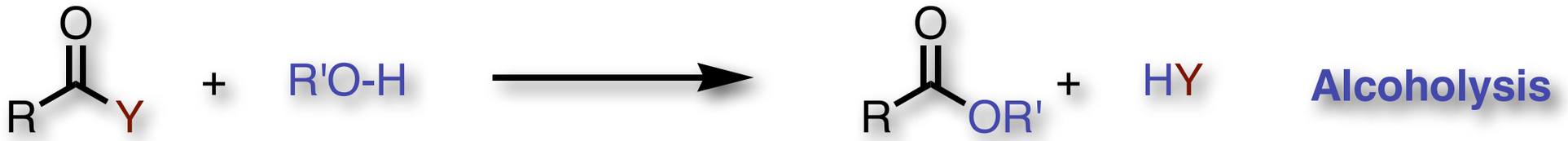
Esters
(methyl acetate)

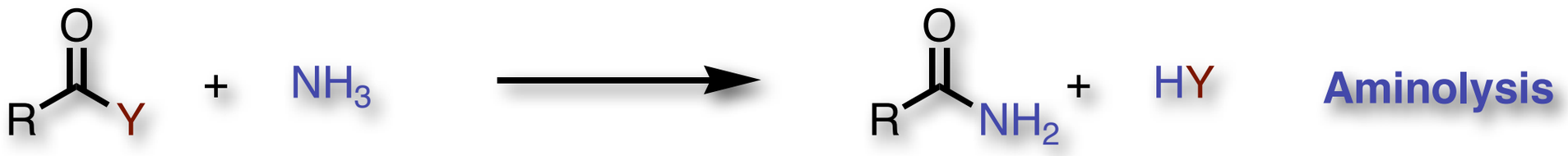
Amides
(acetamide)

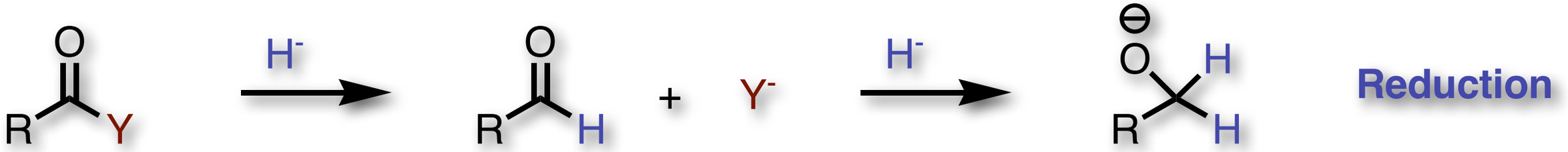
More Reactive → Less Reactive


O
R
Y
+
Nuc-H
Nuc
HY
General NAS Reaction


O
R
Y
+
HO-H
OH
HY
Hydrolysis

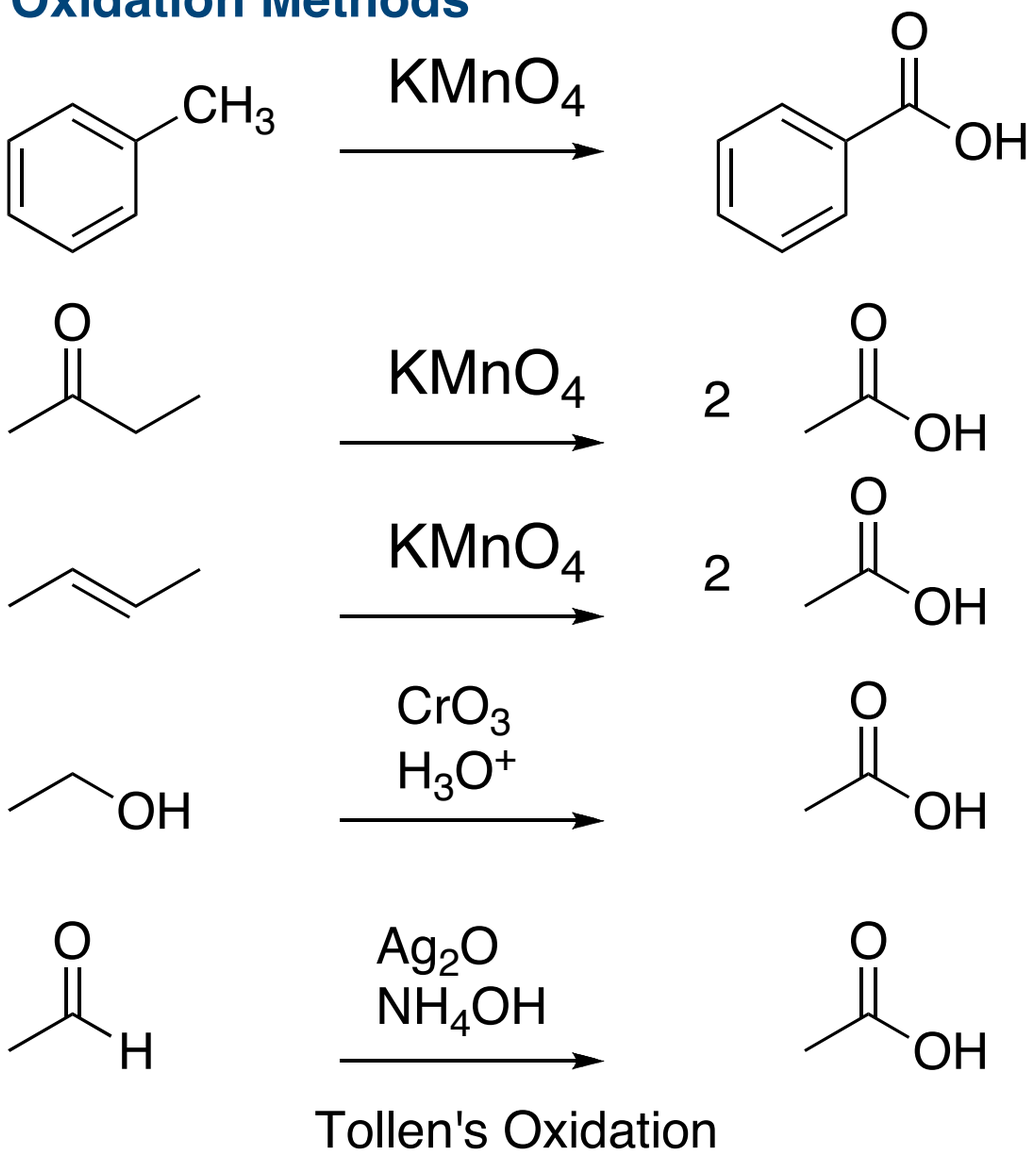

O
R
Y
+
R'O-H
OR'
HY
Alcoholysis


O
R
Y
+
NH3
NH2
HY
Aminolysis


O
R
Y
H-
O
R
H
+
Y-
H-
O
H
R
H
Reduction
O
R
Y
R'MgB r
O
R
R'
+
HY
R'MgB r
O
R'
R
R'
Grignard

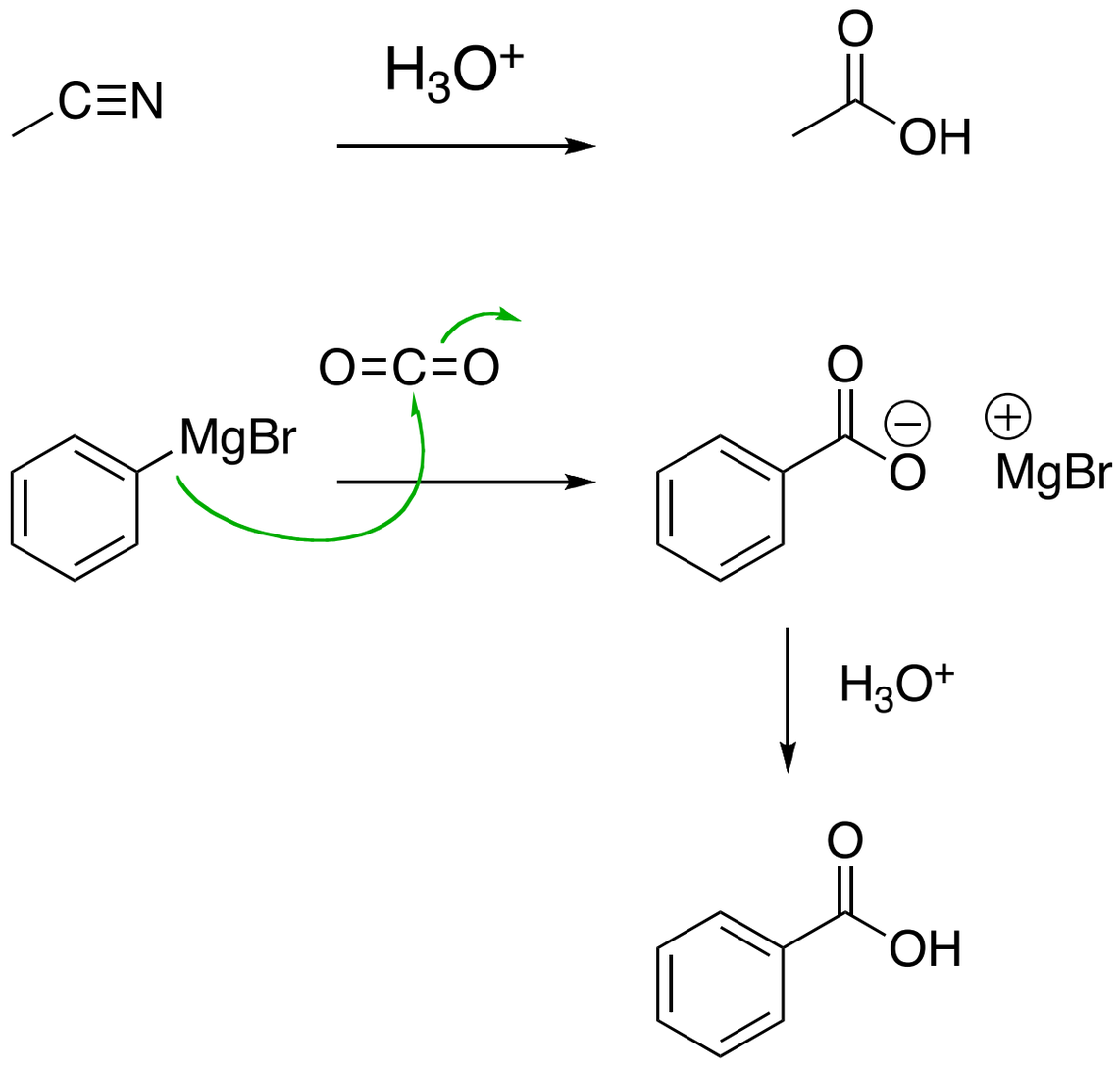

O
R
Cl
R'2CuLi
O
R
R'
O
R
OCH3
DIBAL
O
R
H

Oxidation Methods

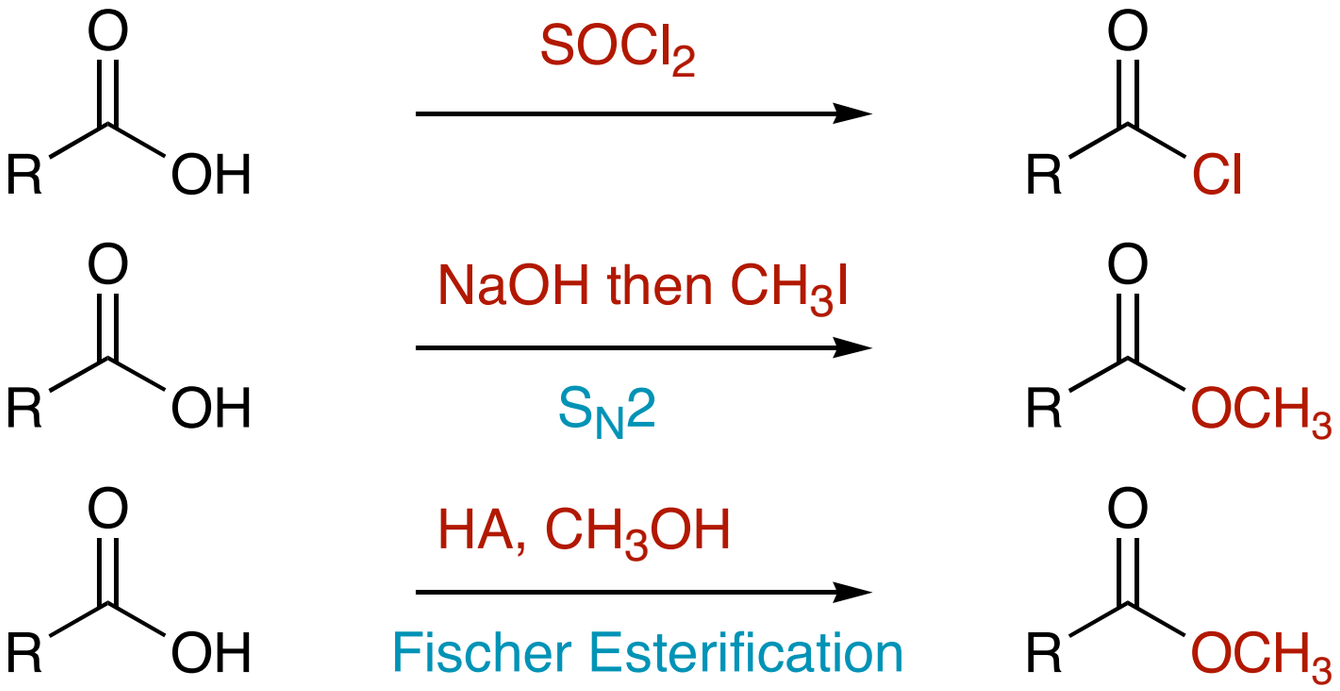


Tollen's Oxidation

Other Methods



Carboxylic Acids

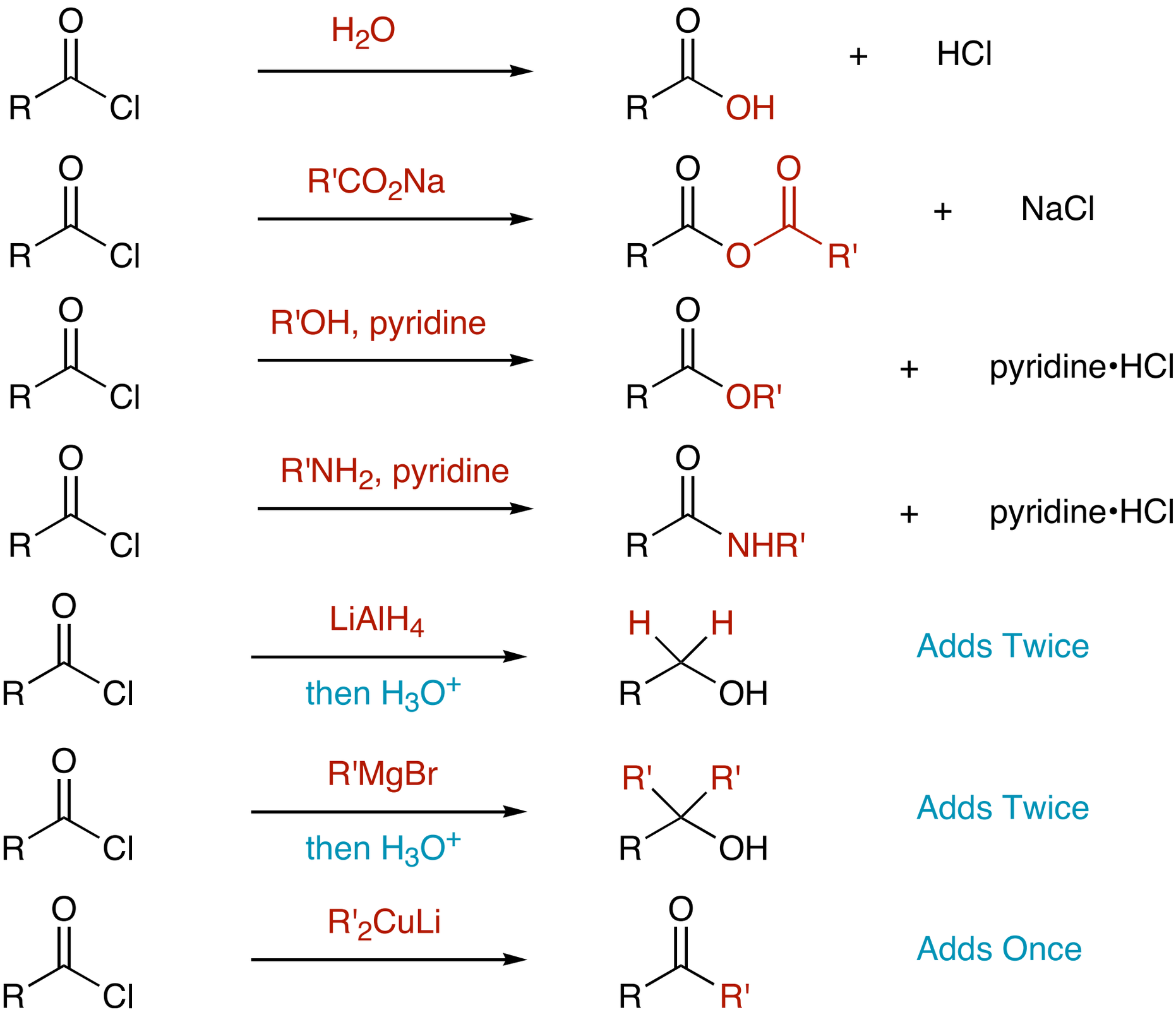


limited to primary alkyl halides

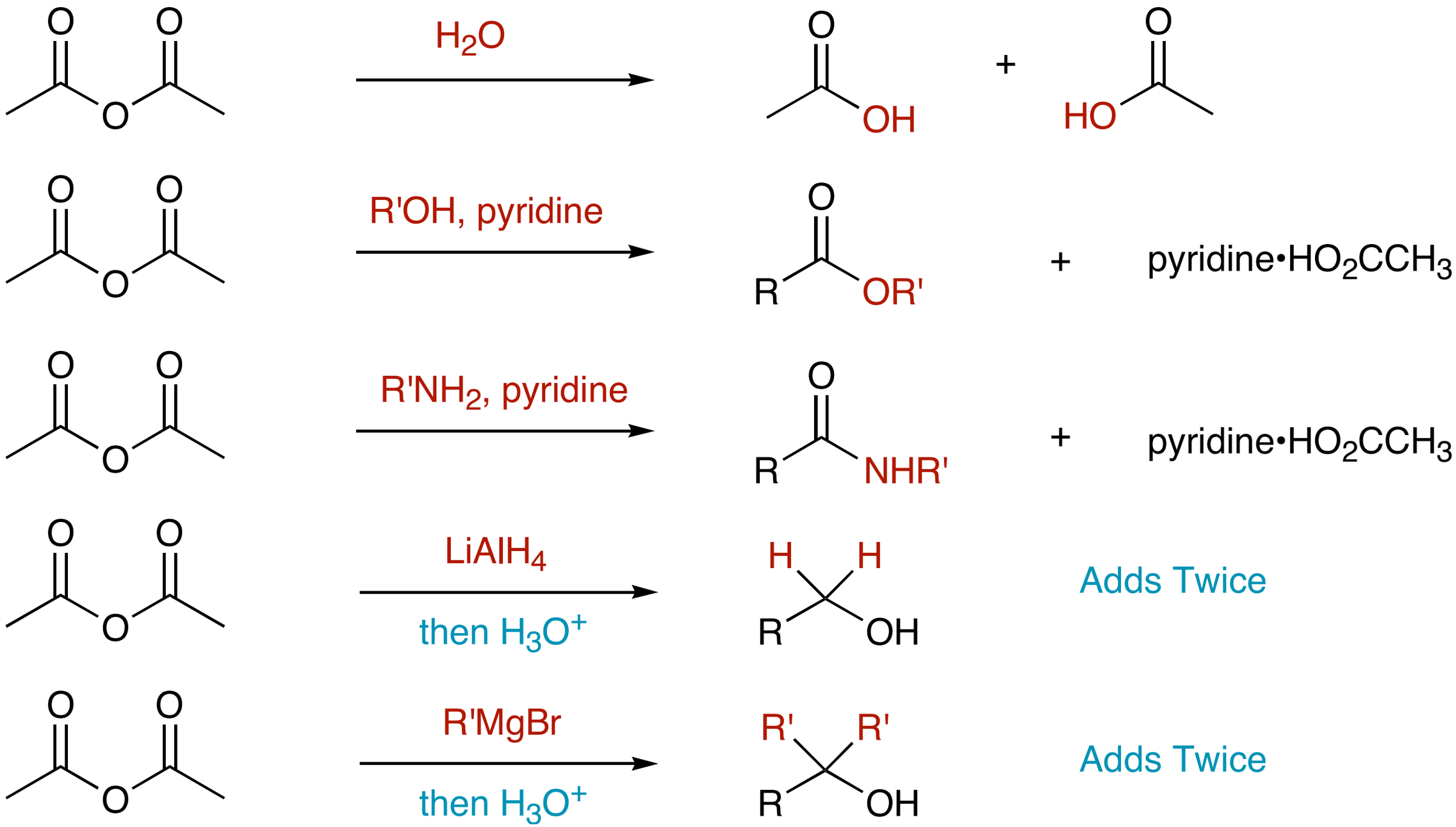
limited to inexpensive alcohol solvents - methanol and ethanol most practical

selective for carboxylic acid reduction - will not react with esters

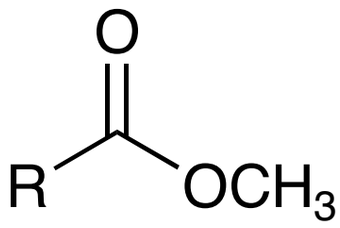
Acid Chlorides



Acid Anhydrides

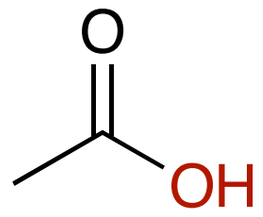


Esters

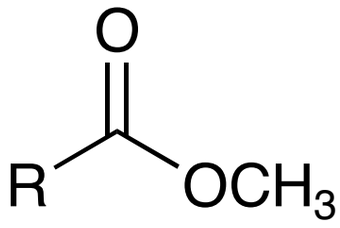


H_2O, NaOH

then H_3O^+

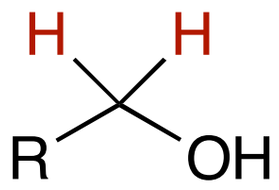


+ $HOCH_3$

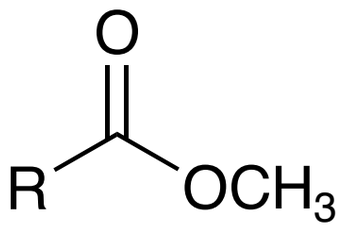


$LiAlH_4$

then H_3O^+

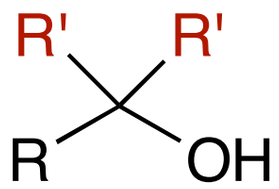


Adds Twice

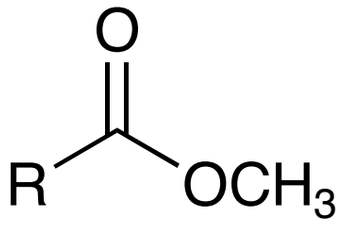


R'MgBr

then H_3O^+

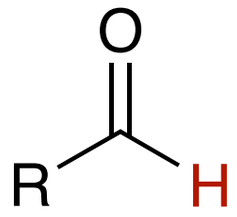


Adds Twice



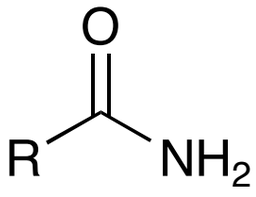
DIBAL

then H_3O^+



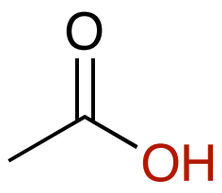
Adds Once

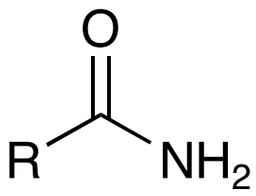
Amides



H_2O, H_3O^+

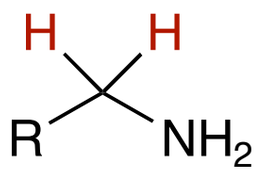
heat





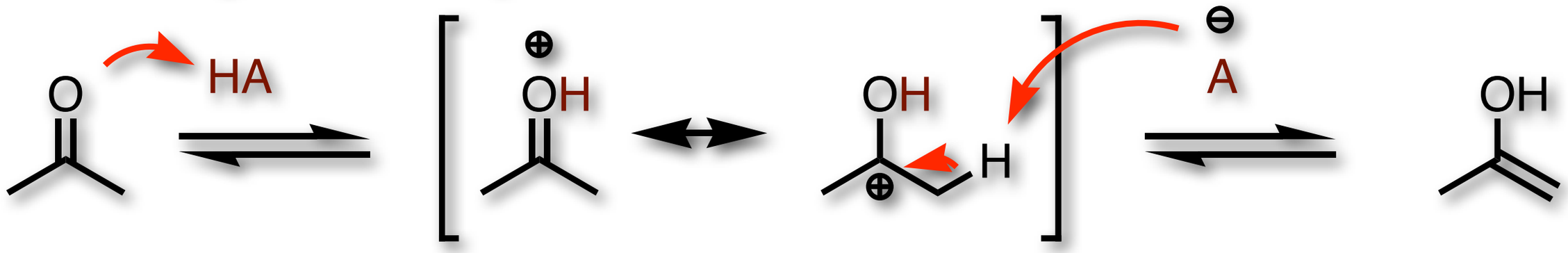
$LiAlH_4$

then H_3O^+

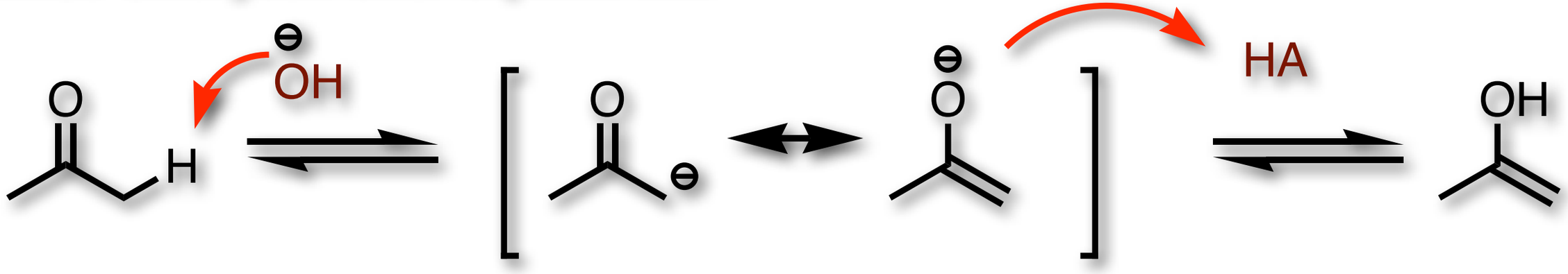


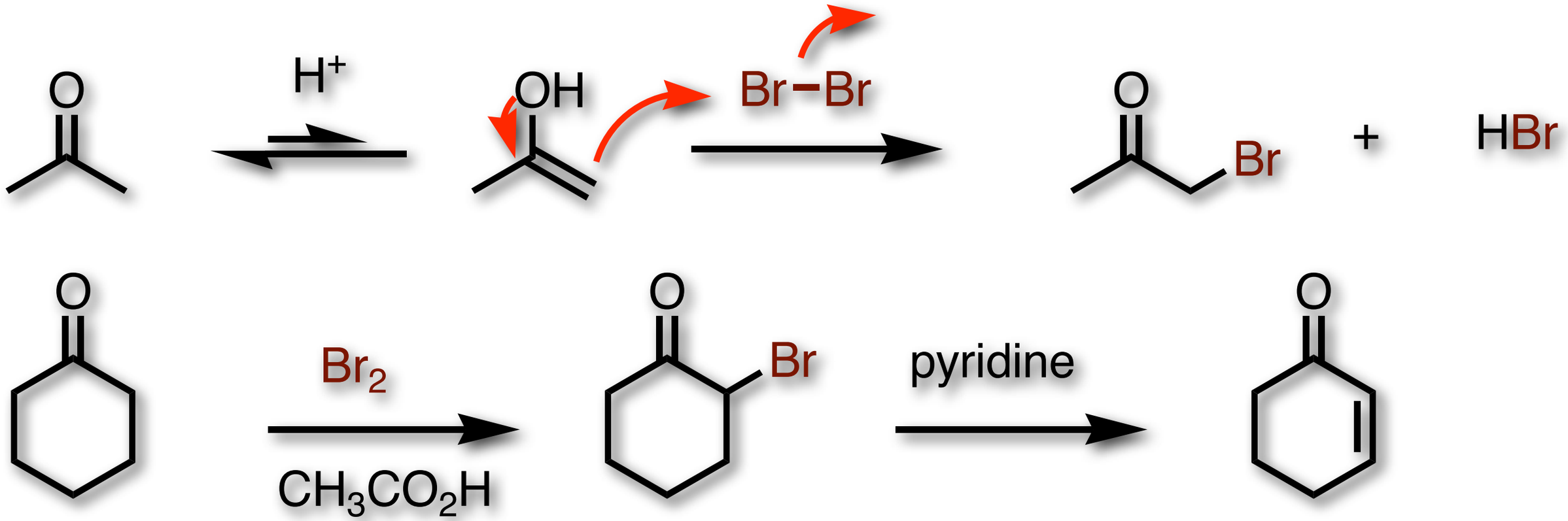
Adds Twice - Nitrogen is retained.

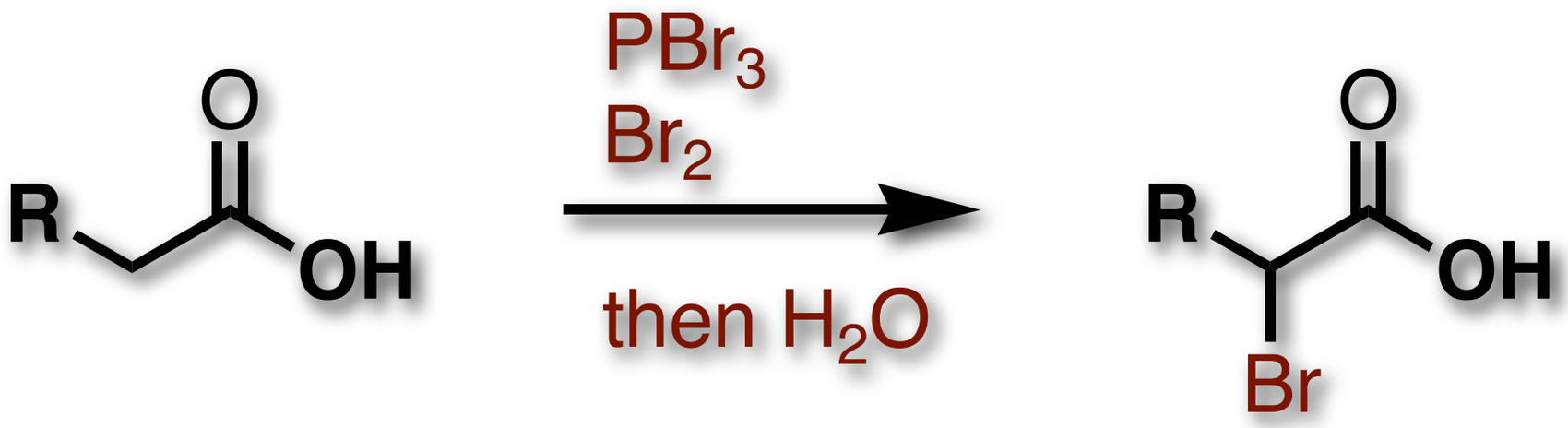
Acid Catalyzed Enol Equilibrium



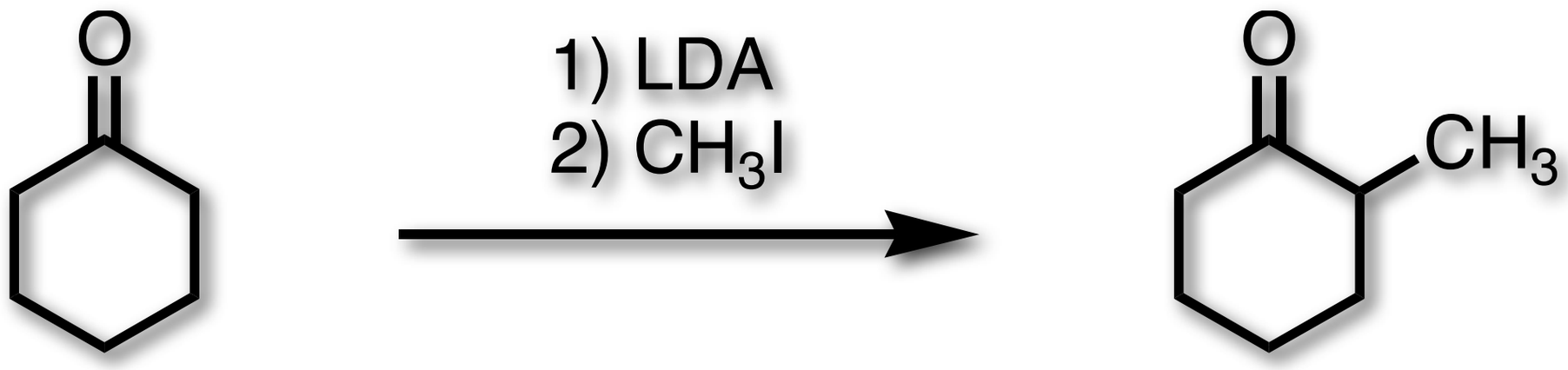
Base Catalyzed Enol Equilibrium

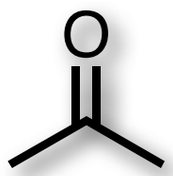



H+
OH
Br–Br
Br
+
HBr
Br2
CH3CO2H
Br
pyridine

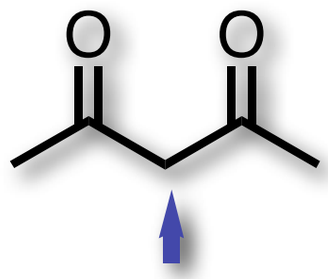

R
OH
PBr3
Br2
then H2O
R
OH
Br

LDA
lithium
diisopropyl
amide

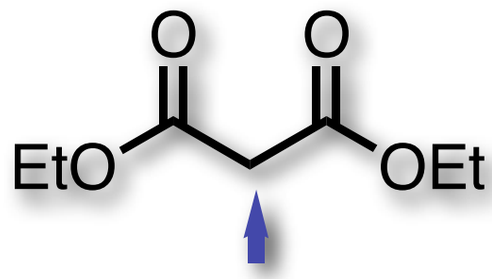




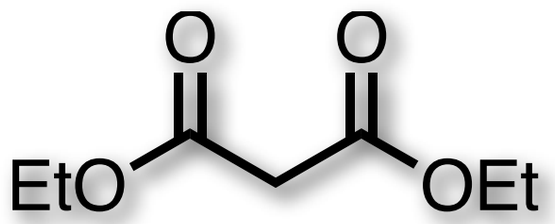
$pK_a = 20$

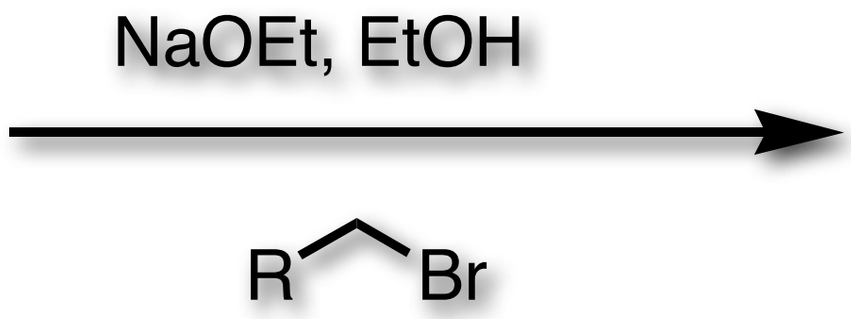


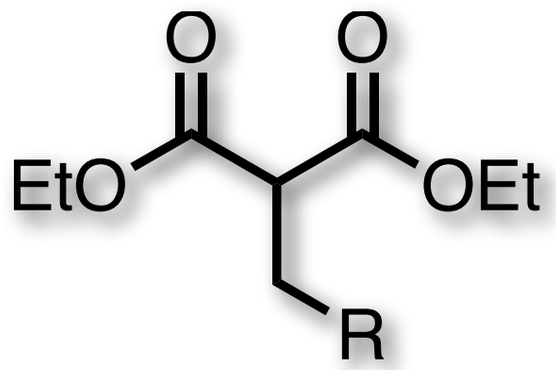
$pK_a = 9$

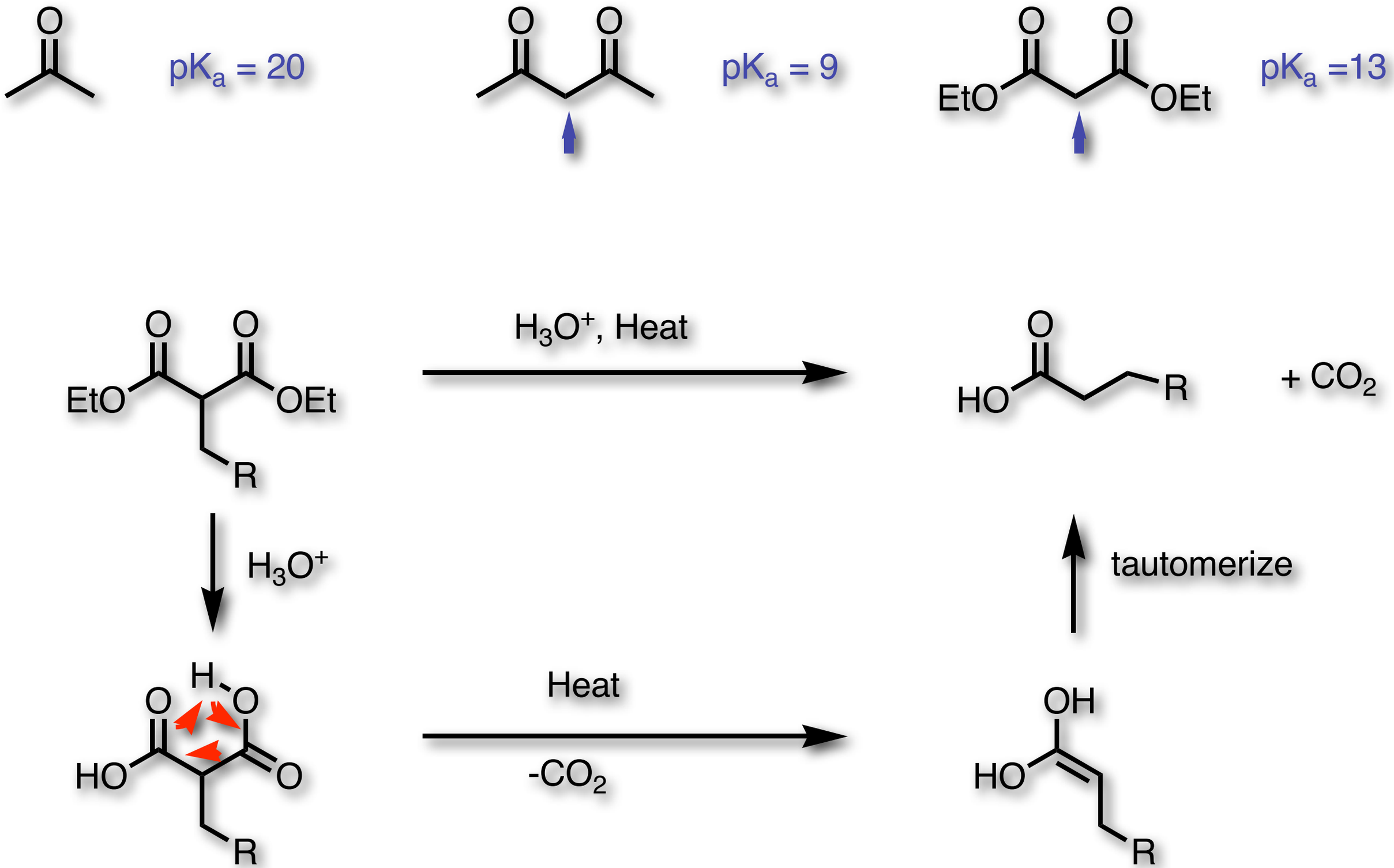


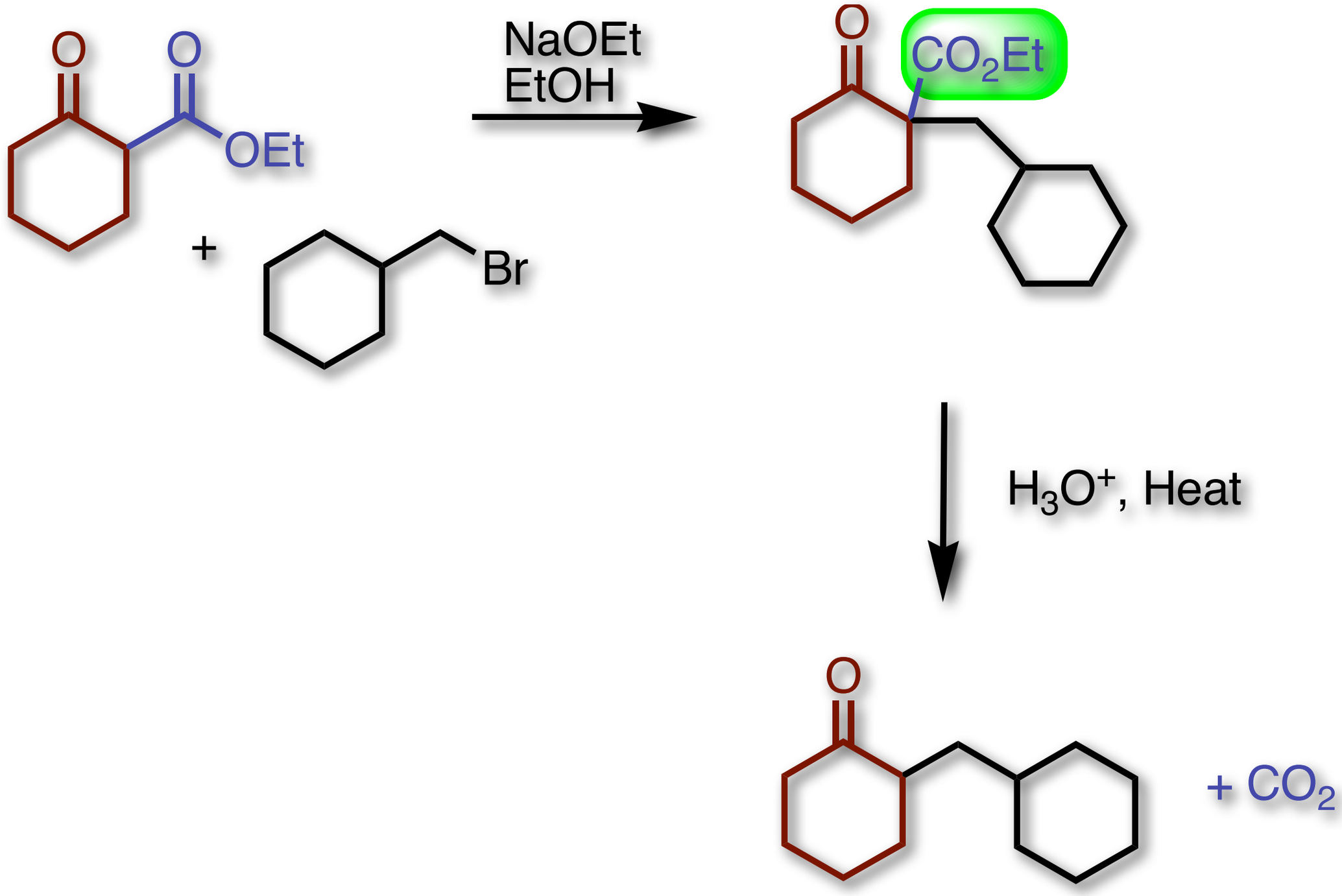
$pK_a = 13$



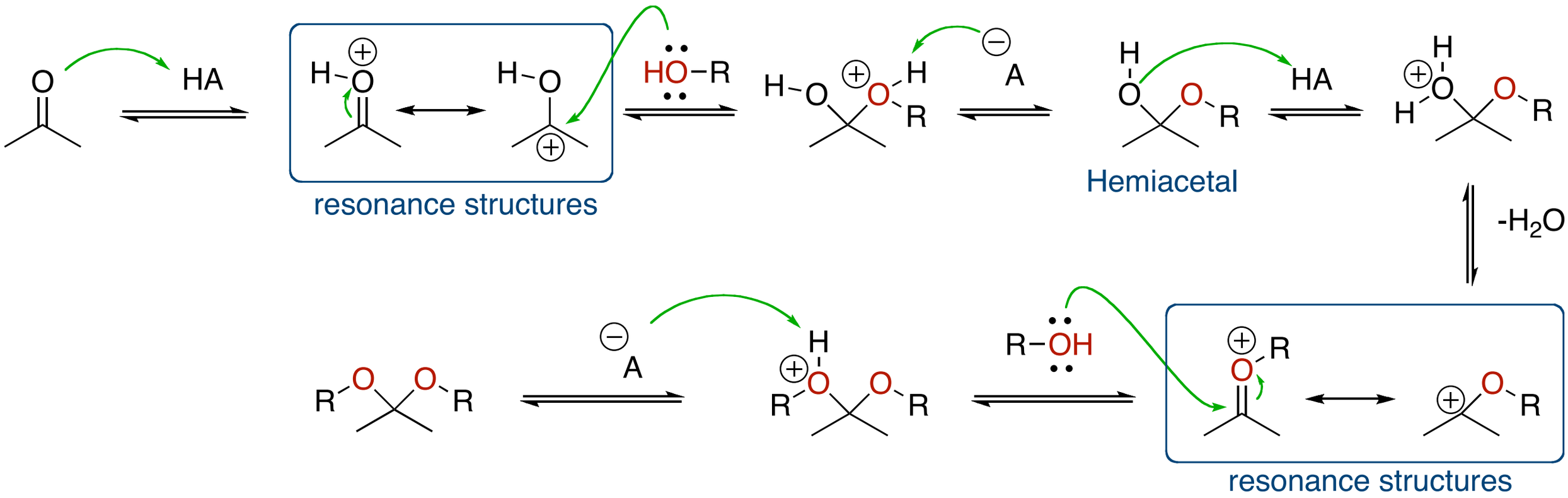





pKa = 20
pKa = 9
pKa =13
EtO
OEt
R
H3O+, Heat
HO
+ CO2
H3O+
tautomerize
Heat
-CO2
OH
HO
R

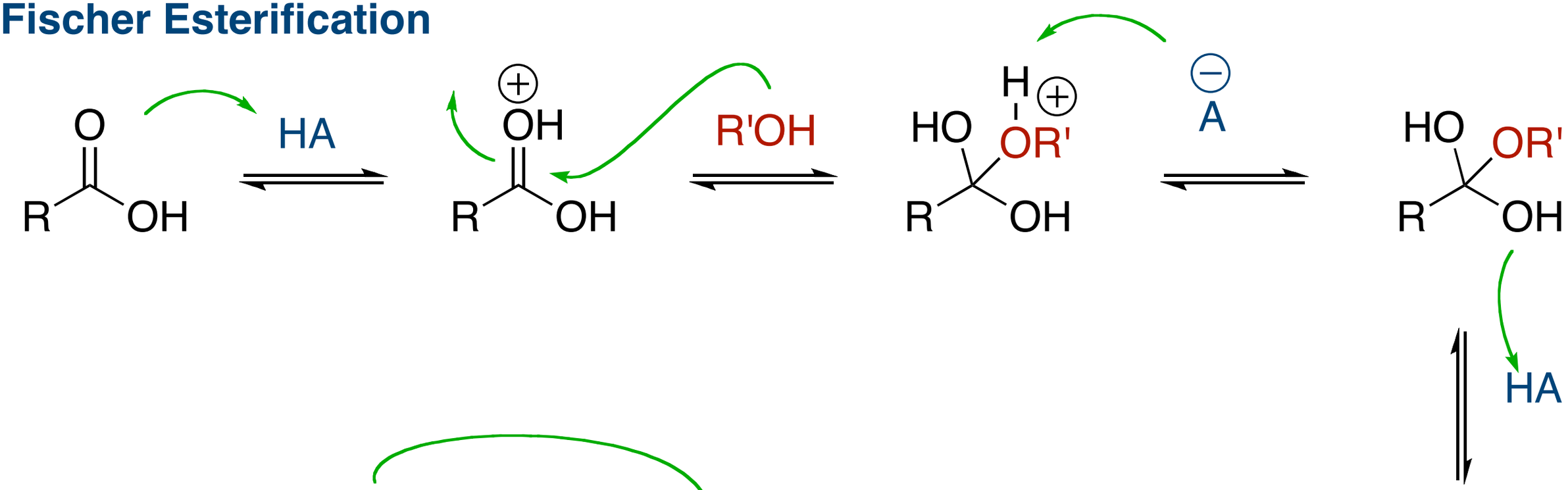

O
O
OEt
+
Br
NaOEt
EtOH
O
CO2Et
H3O+, Heat
O
+ CO2

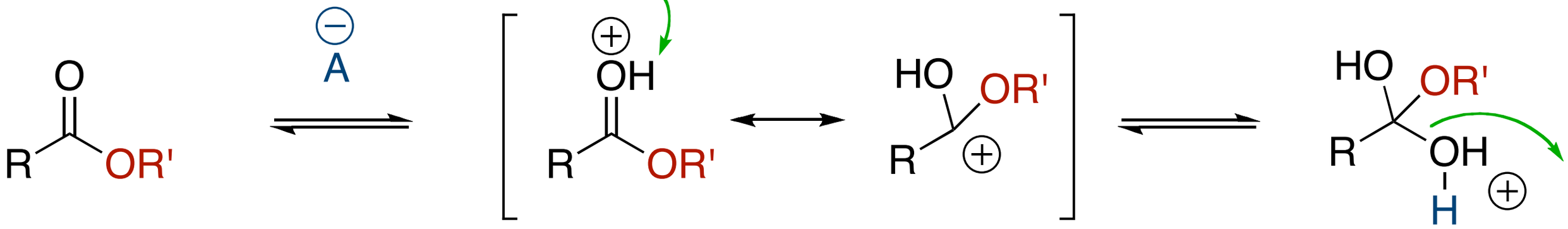
Mechanism for Acetal Formation



NEED TO KNOW MECHANISM

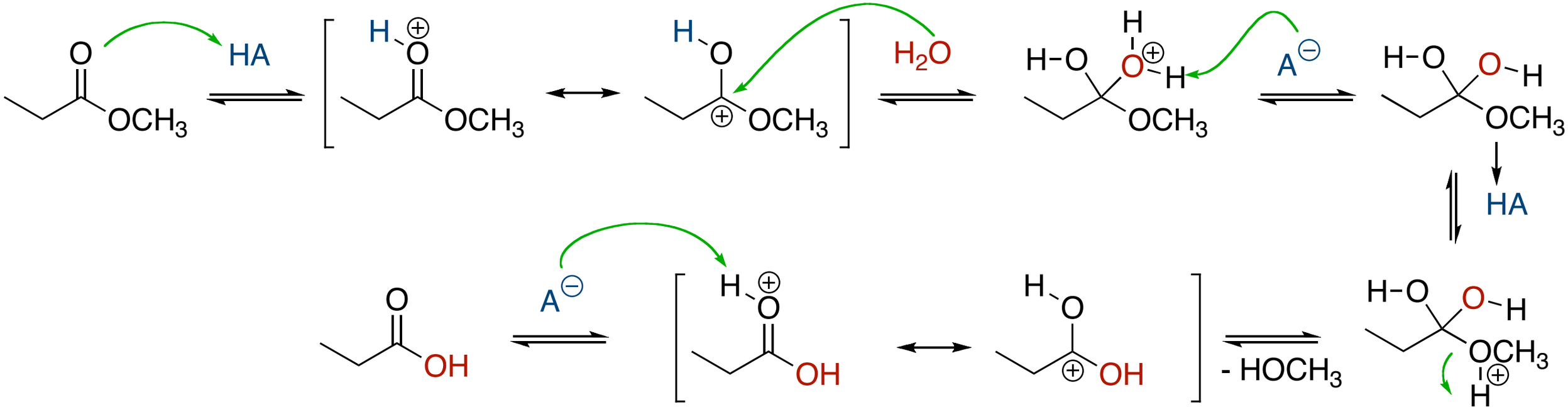
Fischer Esterification





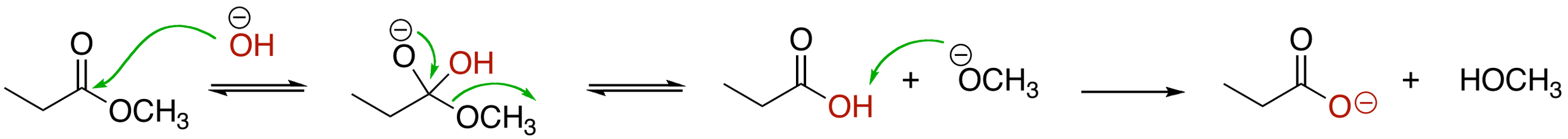
NEED TO KNOW MECHANISMS

Acid Catalyzed Hydrolysis



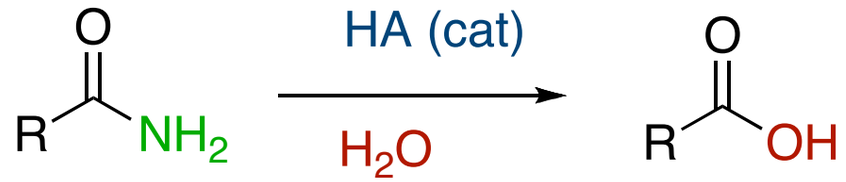
BEST METHOD

Base Catalyzed Hydrolysis (Saponification)



Rapid acid-base reaction takes place

Carboxylate is a thermodynamic sink and makes the reaction essentiall non-reversible. To get the carboxylic acid, add acid to protonate.



Amide Hydrolysis

NEED TO KNOW MECHANISMS

Acid Catalyzed Hydrolysis