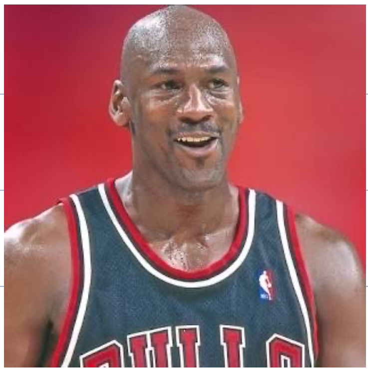


“I've missed more than 9000 shots in my career. I've lost almost 300 games. 26 times, I've been trusted to take the game winning shot and missed. I've failed over and over and over again in my life. And that is why I succeed.” Michael Jordan

<u>Organic Chemistry</u> is the study of carbon-containing molecules. This class has two points.

The first point of the class is to understand the organic chemistry of living systems. We will teach you how to think about and understand the most amazing molecules on the planet!!

You will learn how MRI scans work. 1/18/24

You will learn the basic principles of pharmaceutical science and how many drugs work. 1/23/24

You will learn about the special bond that holds carbohydrates such as glucose in six-membered rings, connects carbohydrate monomers together to make complex carbohydrate structures and is critical to DNA and RNA structure. 2/1/24

You will learn how soap is made from animal fat and how it works to keep us clean. 2/27/24

You will learn the important structural reason proteins, the most important molecular machines in our bodies, can support the chemistry of life. 2/20/24 Amide Day!

You will learn how important antibiotics like penicillins work, including ones that make stable covalent bonds as part of their mode of action.

You will learn why carrots are orange and tomatoes are red.

You will learn the very cool reason that the DNA and RNA bases are entirely flat so they can stack in the double helix structure.

You will learn even more about why fentanyl is such a devastating part of the opioid problem and how Naloxone is an antidote for a fentanyl overdose.

You will learn even more details about why Magic Johnson is still alive, decades after contracting HIV, and how the same strategy is being used to fight COVID.

You will learn about the surprising chemical reason the Pfizer and Moderna mRNA vaccines elicit strong immune responses.

The second point of organic chemistry is the synthesis of complex molecules from simpler ones by making and breaking specific bonds, especially carbon-carbon bonds.

You will learn how carbon-metal bonds lead to new carbon-carbon bonds. 1/18/24

You will learn how most reactions of carbonyl compounds involve only the four common mechanistic elements operating in only a few common patterns. 1/23/24

You will learn how, by simply adding a catalytic amount of base like HO^- to aldehydes or ketones, you can make new carbon-carbon bonds, giving complicated and useful products.

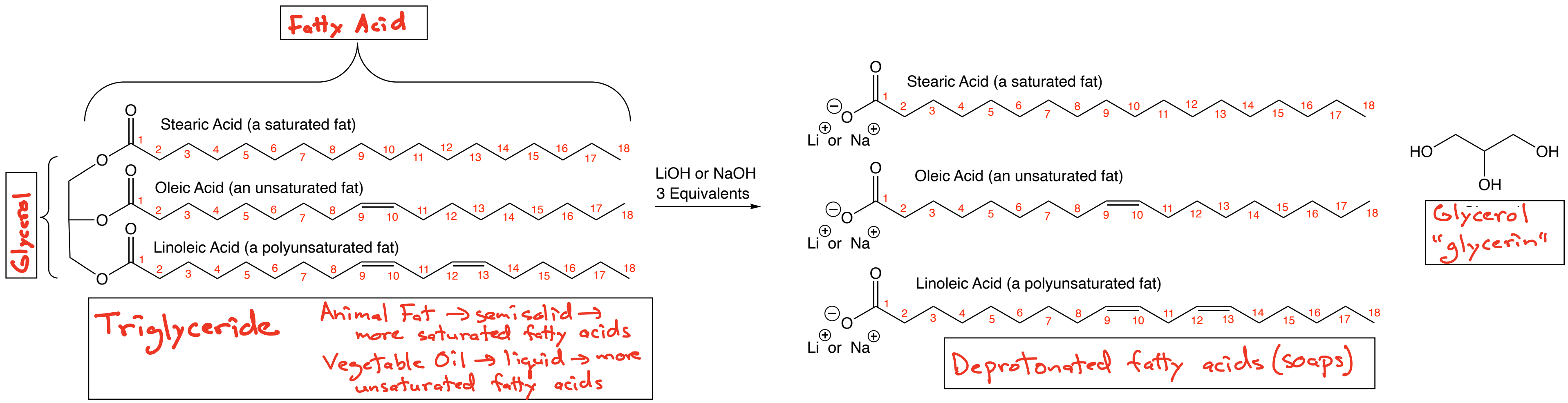
You will learn a reaction that can convert vinegar and vodka into a common solvent. 2/13/24 (Fischer Esterification)

You will learn why molecules with six-membered rings and alternating double bonds are stable.

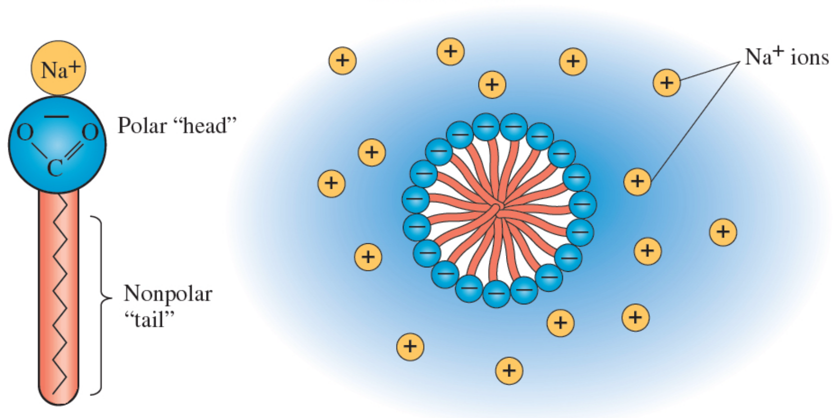
You will learn a reaction that can turn model airplane glue into a powerful explosive.

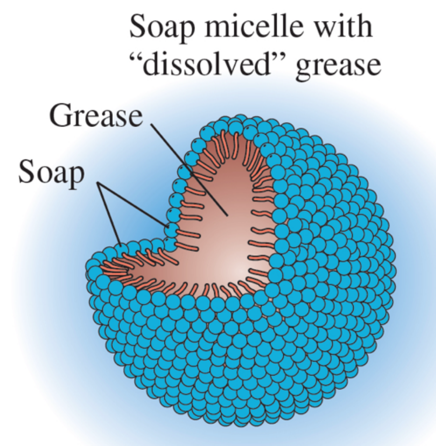
Most important, you will develop powerful critical thinking skills:

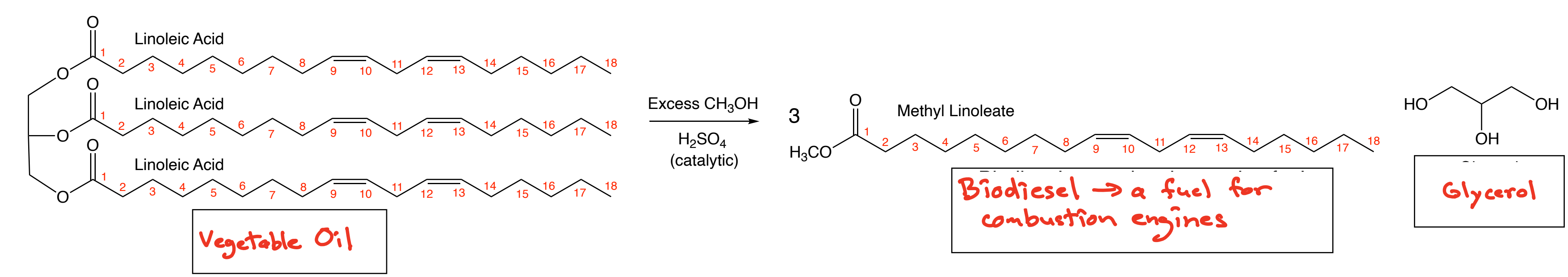
1. You will learn how to look at a molecule and accurately predict which atoms will react to make new bonds, and which bonds will break during reactions.
2. You will learn how to analyze a complex molecule's structure so that you can predict ways to make it via multiple reactions starting with less complex starting molecules.



(a) A soap **(b)** Cross section of a soap micelle in water





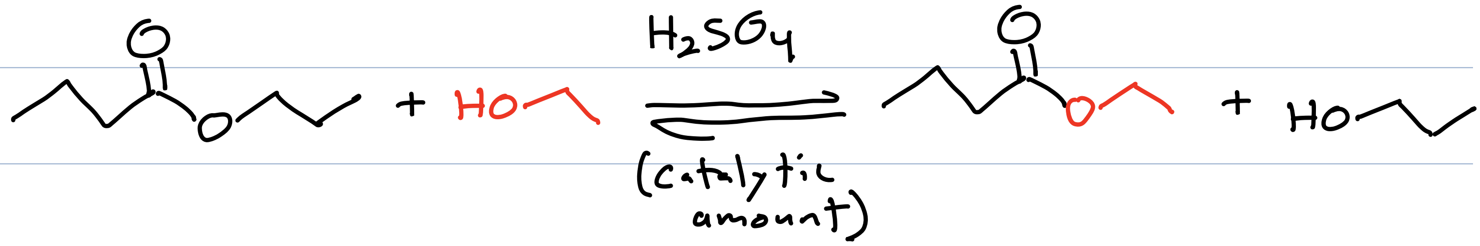


$$R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OR' + R''OH \underset{\text{(catalytic amount)}}{\overset{H_2SO_4}{\rightleftharpoons}} R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OR'' + R'OH$$

Transesterification → the chemistry behind biodiesel production (see handout)

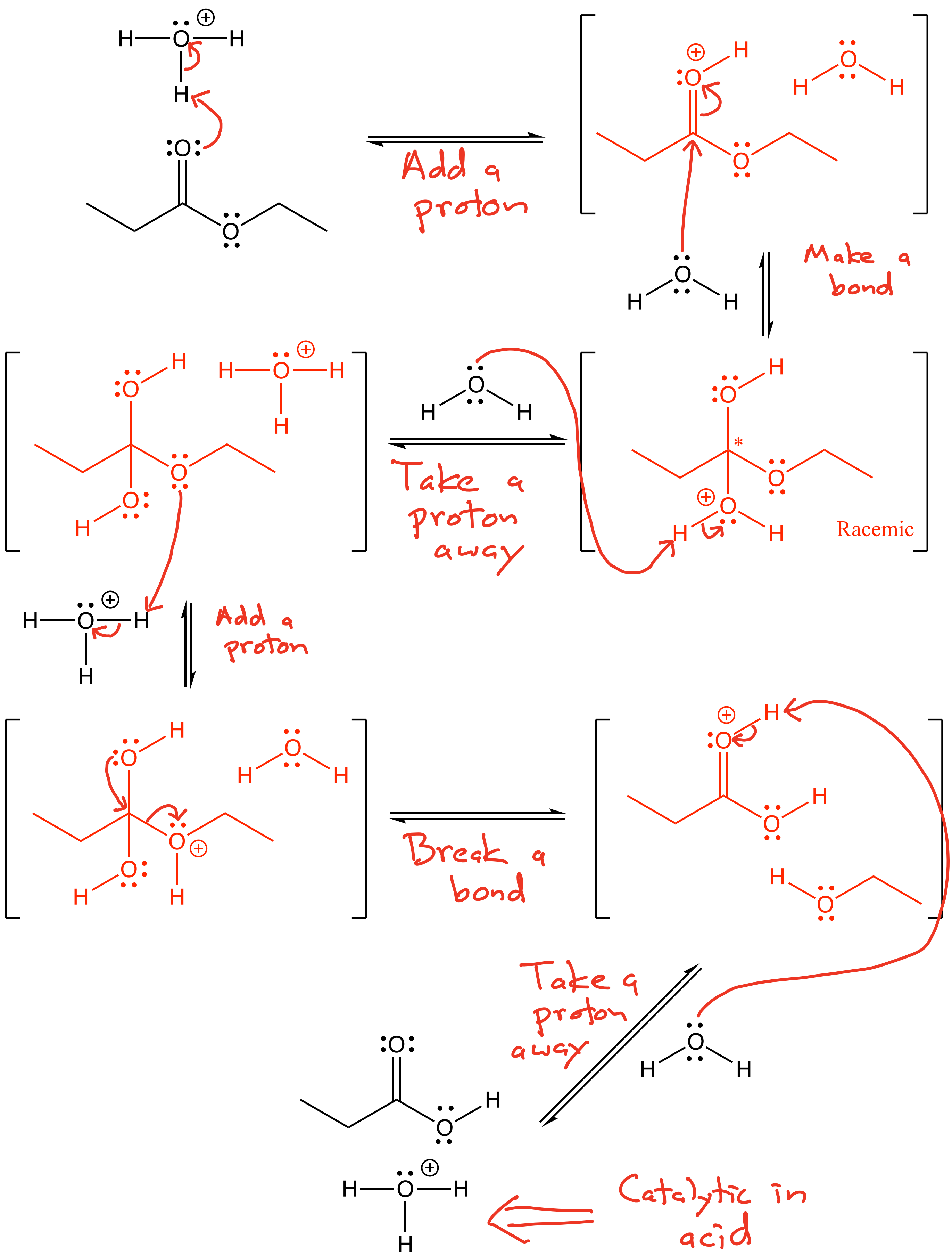
"Transfer" Not cis-trans

Example

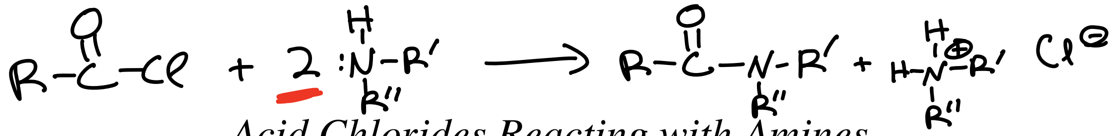


Warmup!

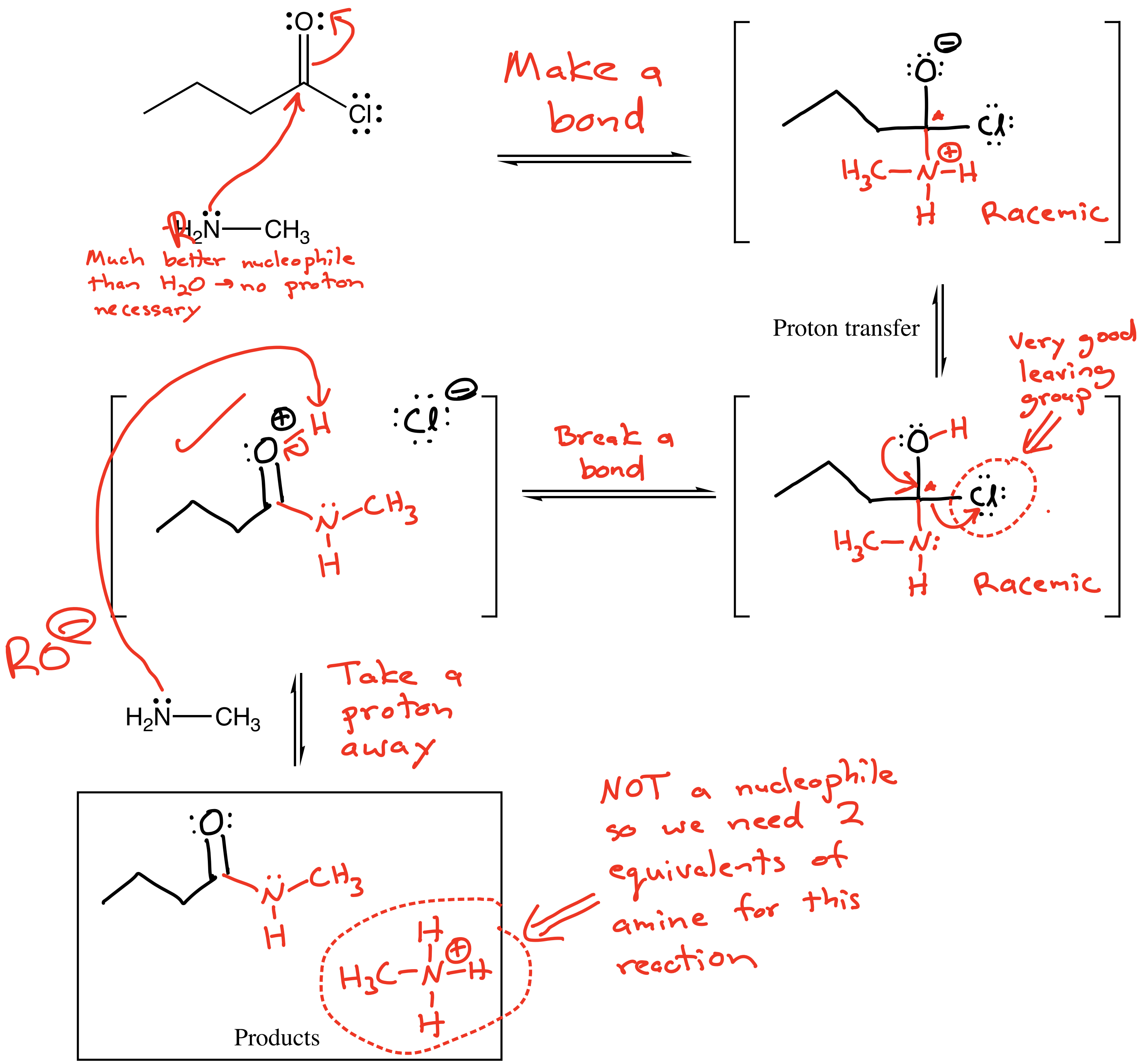
Microscopic Reversibilty: Acid Catalyzed Ester Hydrolysis-Fischer Esterification



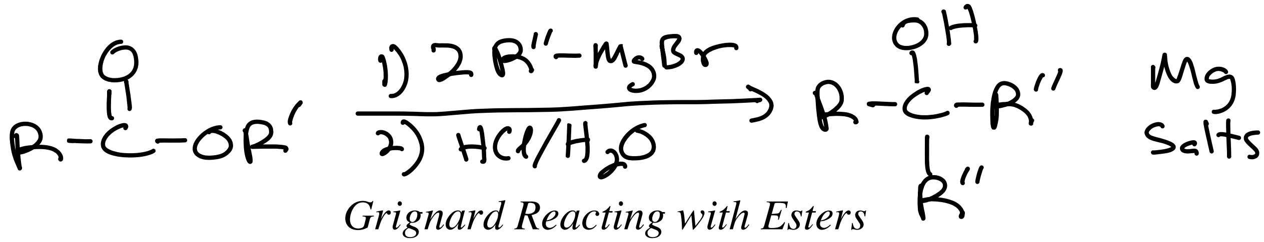
Review



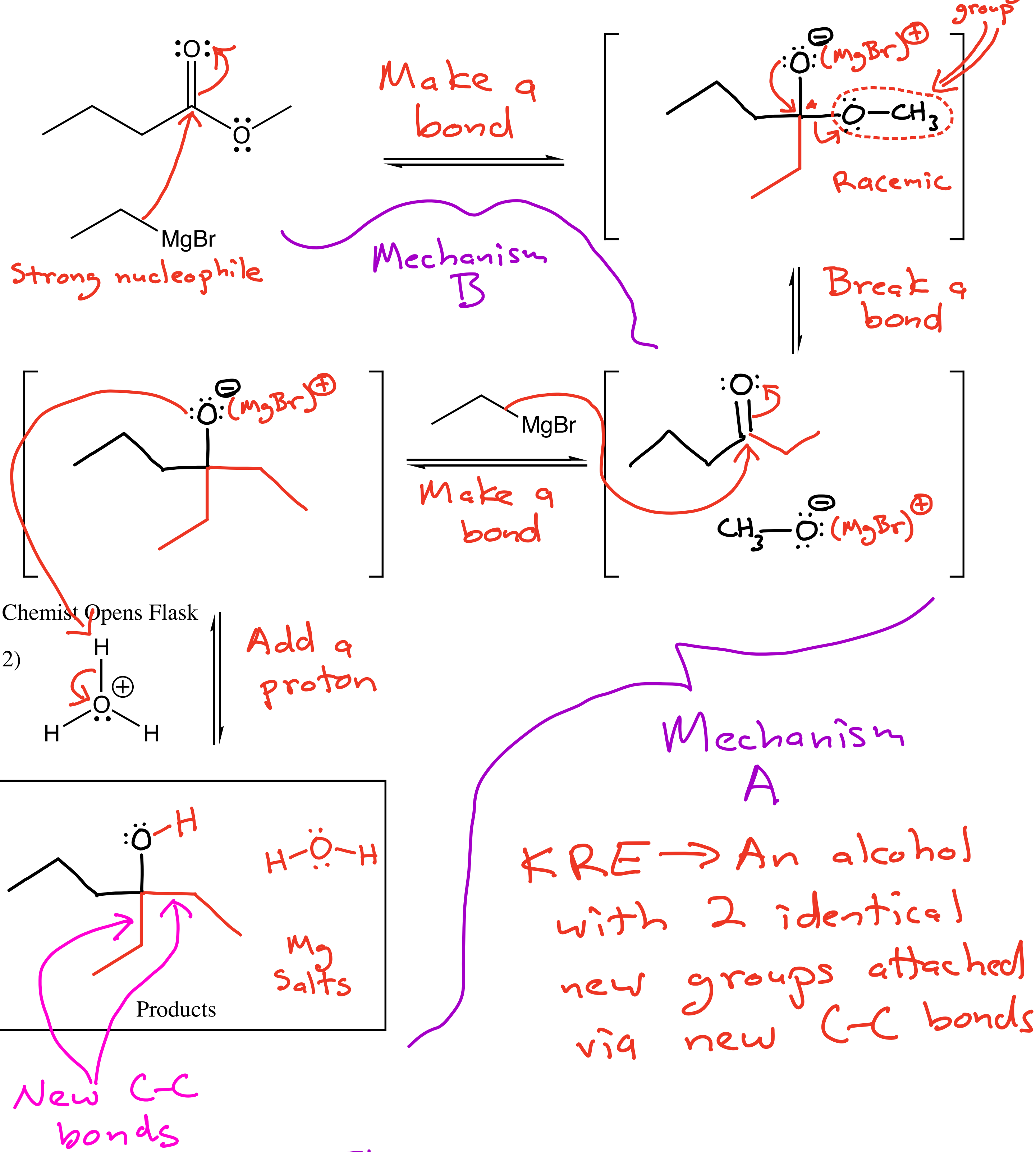
Acid Chlorides Reacting with Amines



3 New Reactions

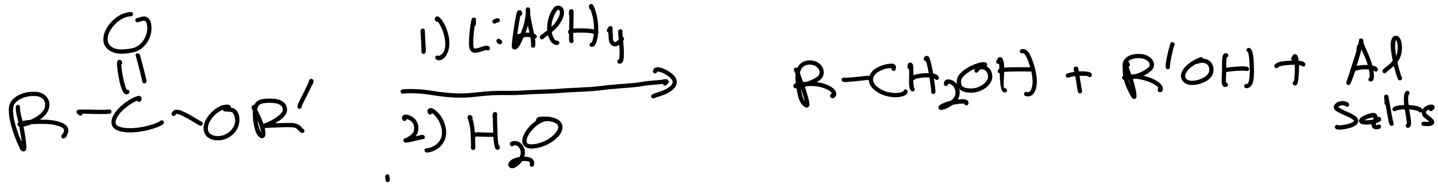


Grignard Reacting with Esters

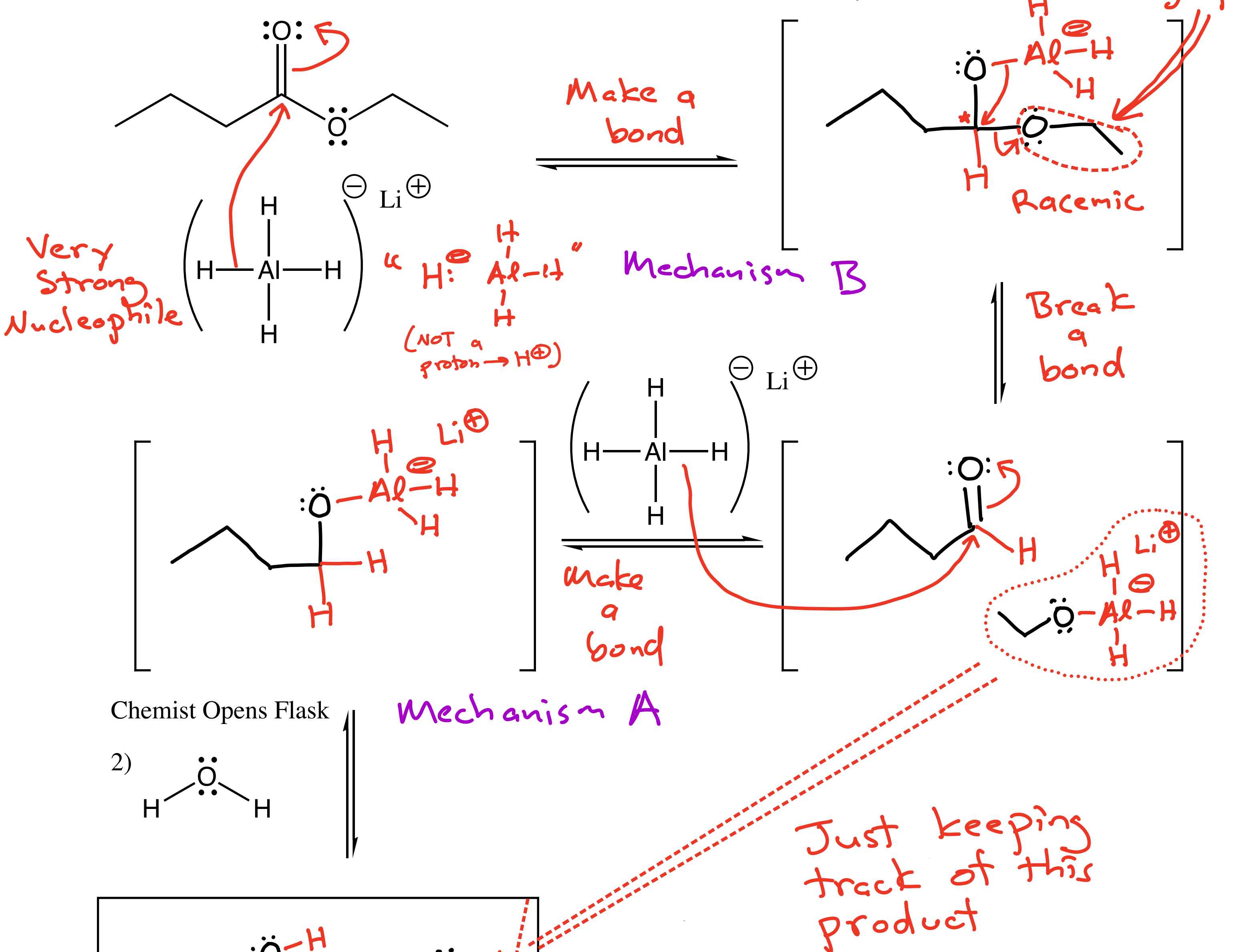


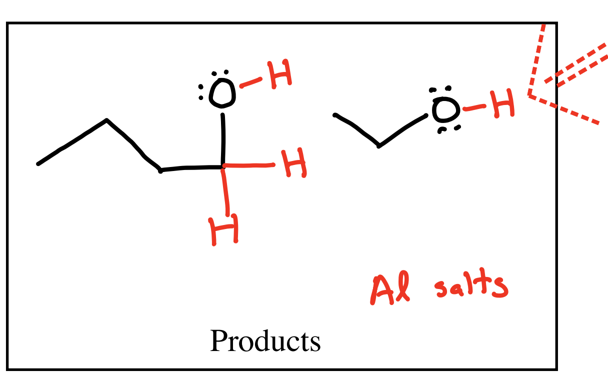
The overall reaction mechanism is Mechanism B followed by Mechanism A

⇒ Same as the next reaction!



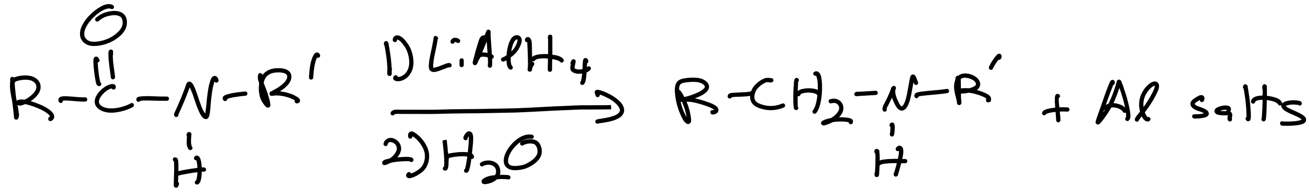
Reduction of Esters with $LiAlH_4$



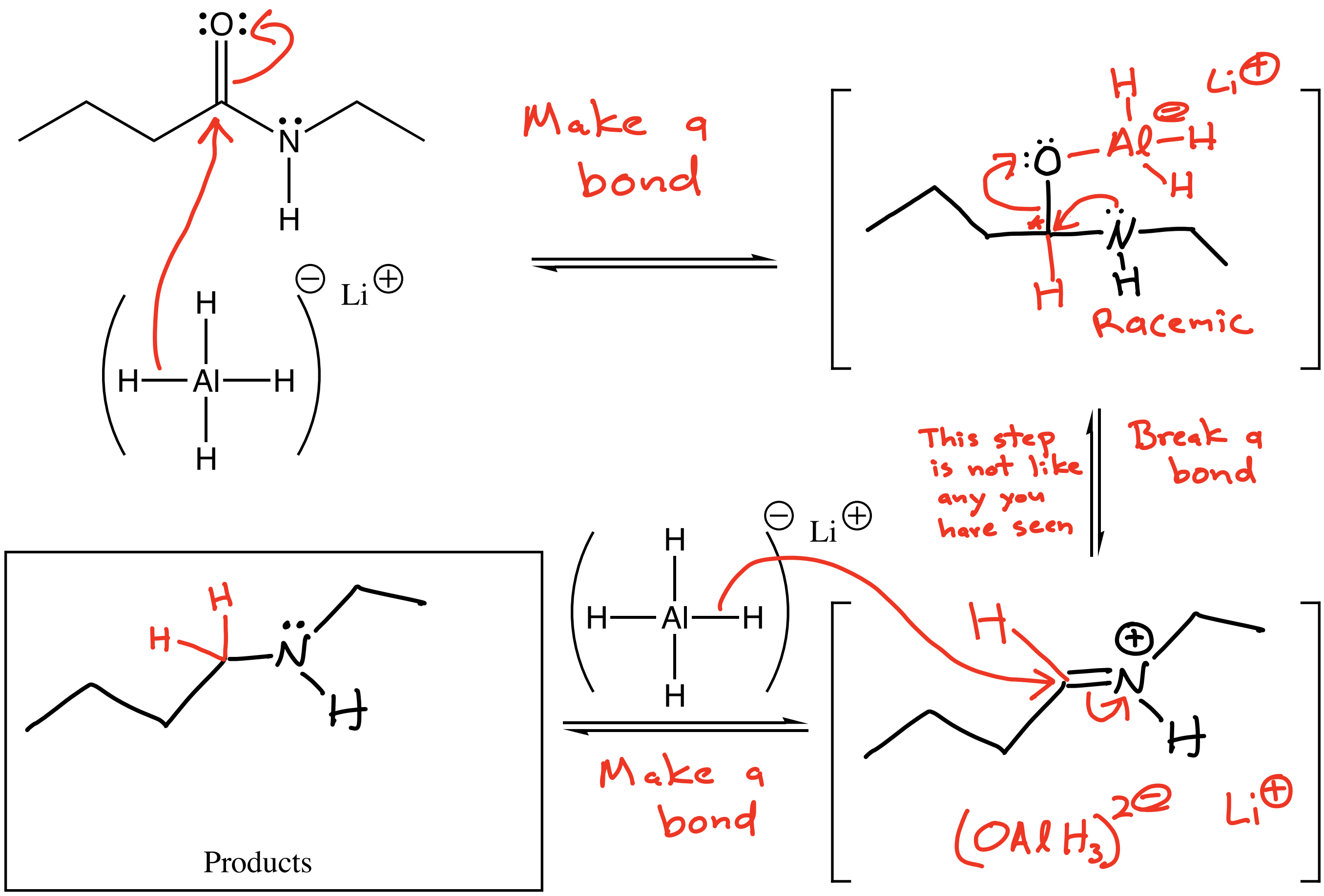


KRE → converts an ester into two alcohols → breaks C–O bond

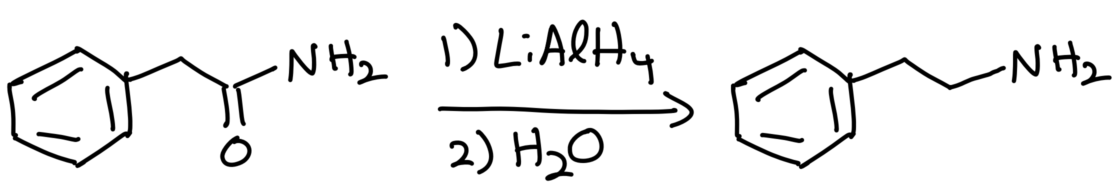
Note the extreme similarities between these last two mechanisms! ⇒ Mechanism B followed by Mechanism A just like the last reaction!



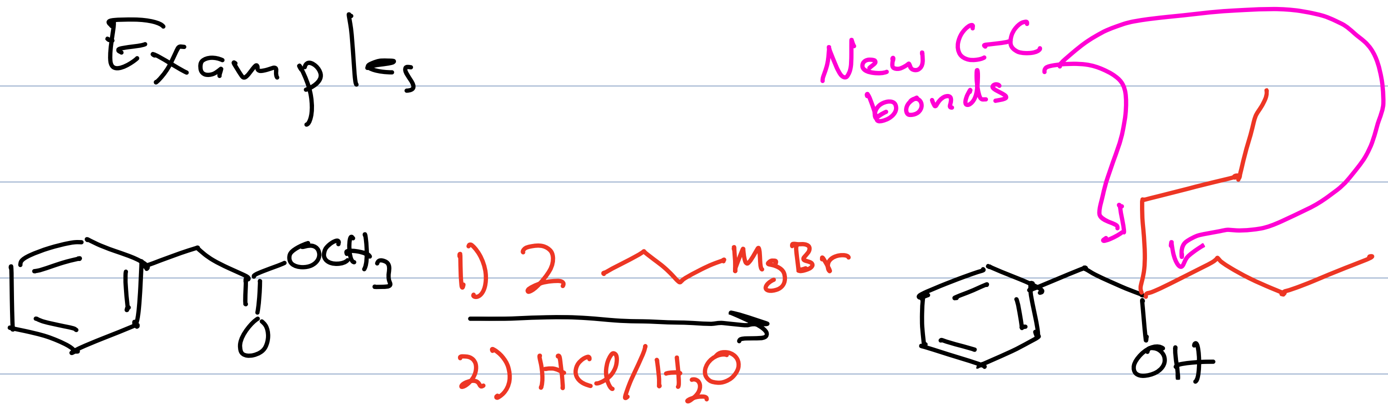
Reduction of Amides with $LiAlH_4$

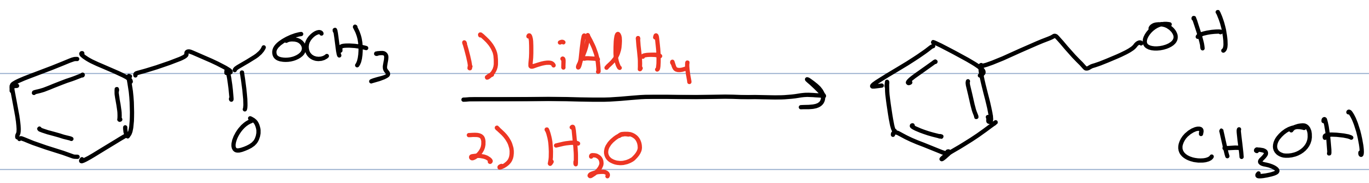


Note: In this reaction the chemist opens the flask and adds water in a second step that quenches any excess $LiAlH_4$. Therefore, you need a second step to add water when using this reaction in synthesis even though it is not shown in the mechanism above.



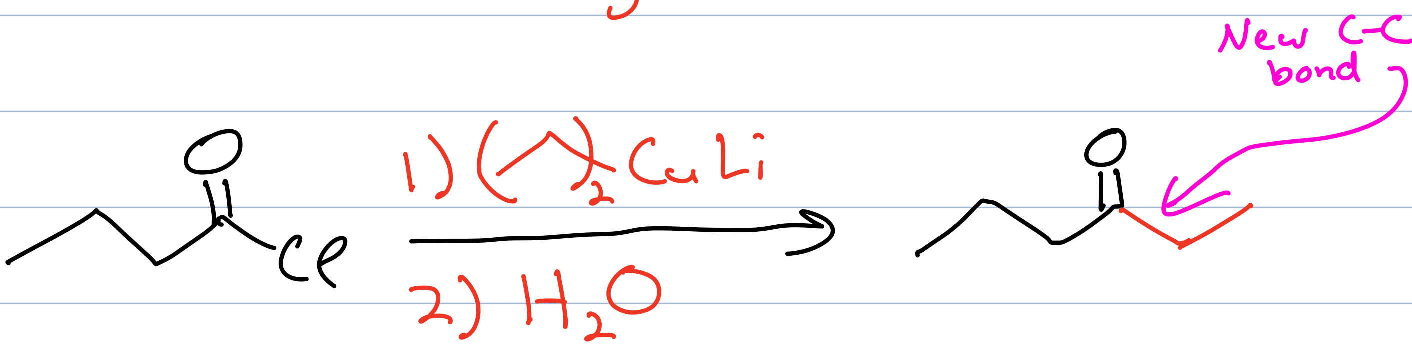
Examples





Great new reaction → Not responsible for the mechanism

→ Reacting an acid chloride with a Gilman reagent to give a ketone



KRE → A new C–C bond next to the C=O of a ketone

Warning → These two reactions are specific → DO NOT "mix and match"

Grignard + Ester → Alcohol

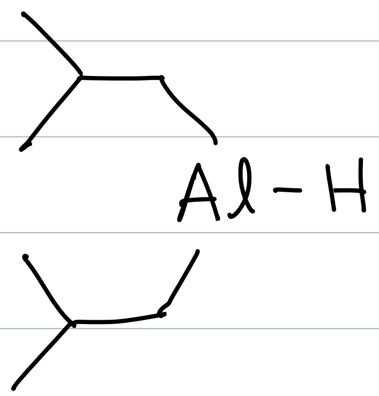
Gilman + Acid Chloride → Ketone

~~Grignard + Acid Chloride~~

~~or~~

~~Gilman + Ester~~

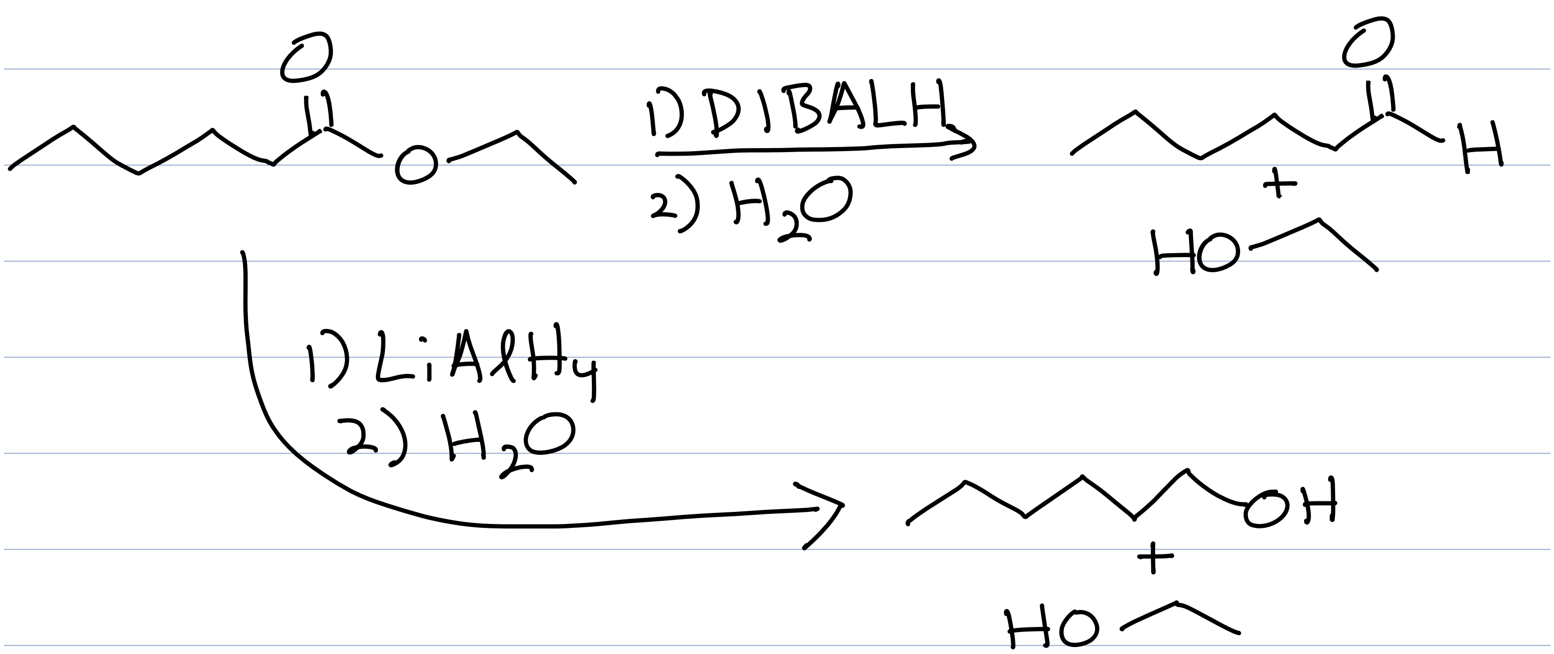
Note: An aldehyde is produced as an intermediate when esters react with $LiAlH_4$



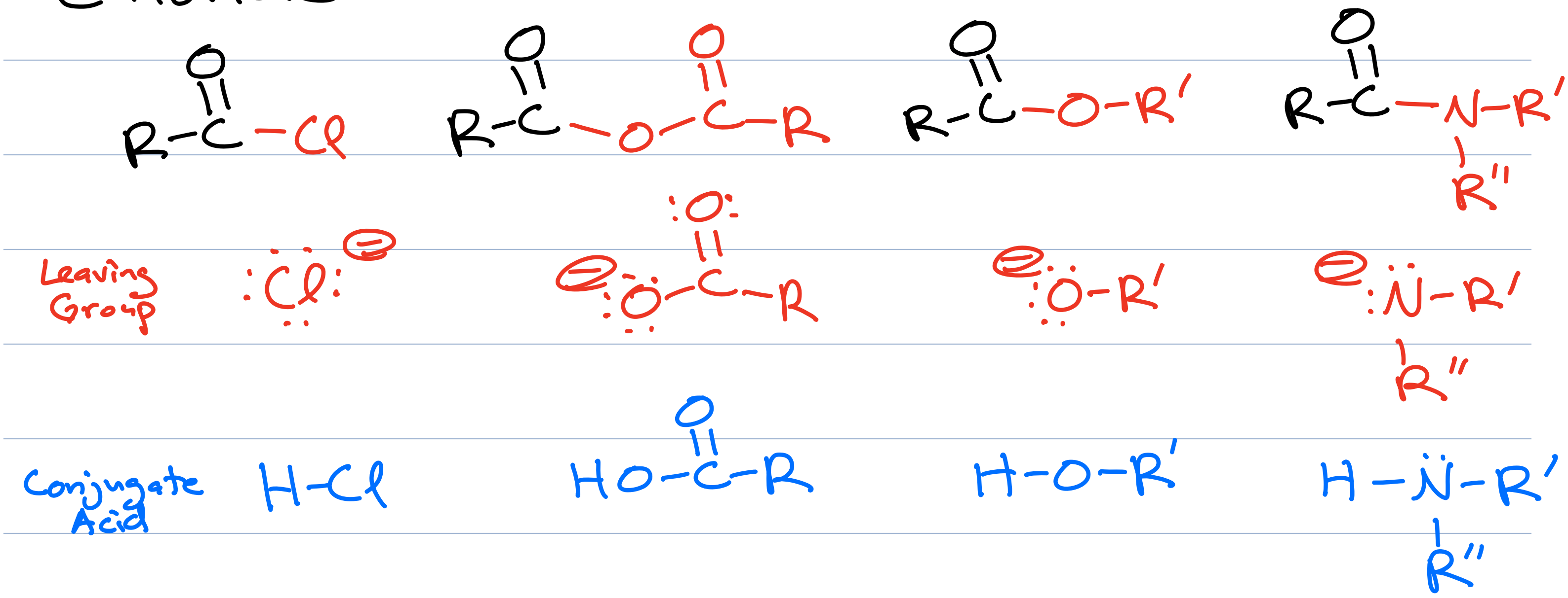
Diisobutylaluminum hydride

DIBALH

→ Reaction stops at the aldehyde!



Acid Chloride	Anhydride	Ester	Amide



pKa	-7	3-5	16	38

← Anion Stability

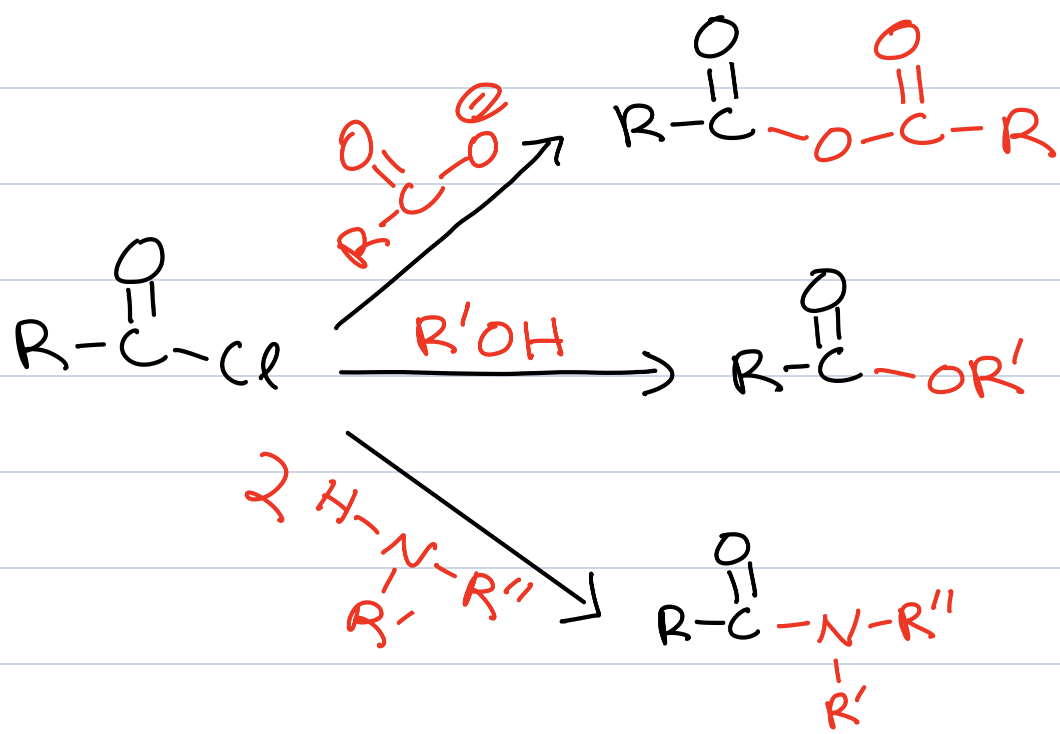
← Better Leaving Group Ability

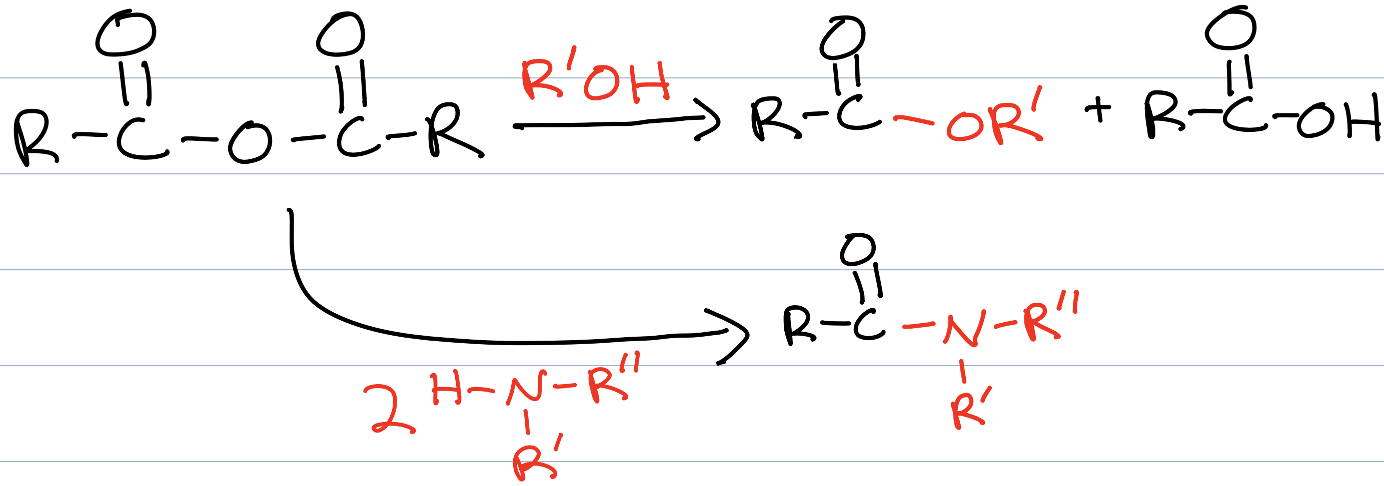
← Reactivity of Carboxylic Acid Derivative

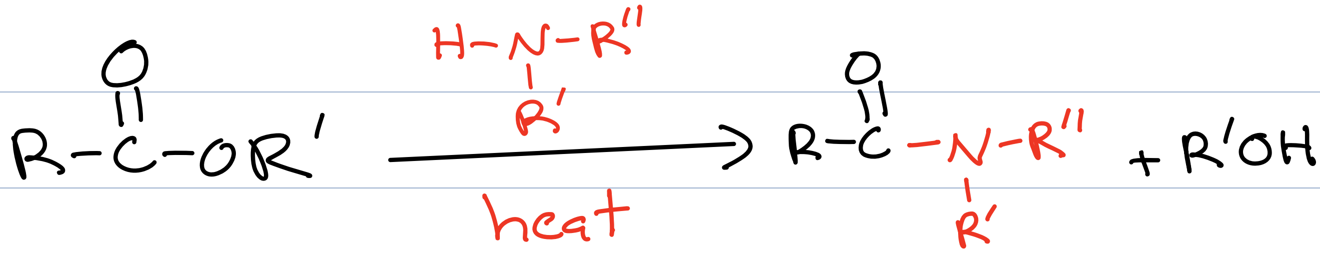
Think of carboxylic acid derivatives ⟹ C=O with a leaving group attached

Here is the big rule → You can make any of the less reactive carboxylic acid derivatives from any of the more reactive carboxylic acid derivatives using the appropriate nucleophiles

Note: Acid chlorides and anhydrides spontaneously react with nucleophiles at room temperature, esters usually need some heat.



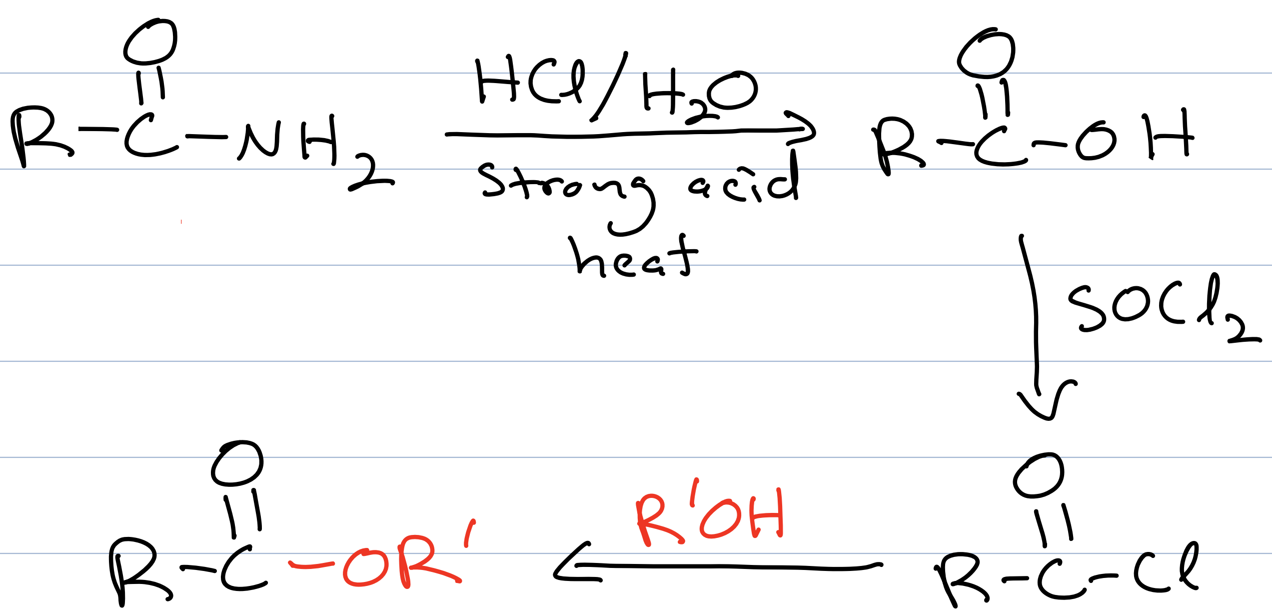




Note: For the last reaction, only 1 equivalent of $HN(R')-R''$ is used because the leaving group $R'\ddot{O}:^{-}$ is a much stronger base than $H-N(R')-R''$

However: You can make a less stable carboxylic acid derivative from a more stable carboxylic acid derivative, but only if you:

1) You hydrolyze the carboxylic acid derivative to the carboxylic acid
2) You react the carboxylic acid with $SOCl_2$ to make an acid chloride



Interconversion of Carboxylic Acid Derivatives