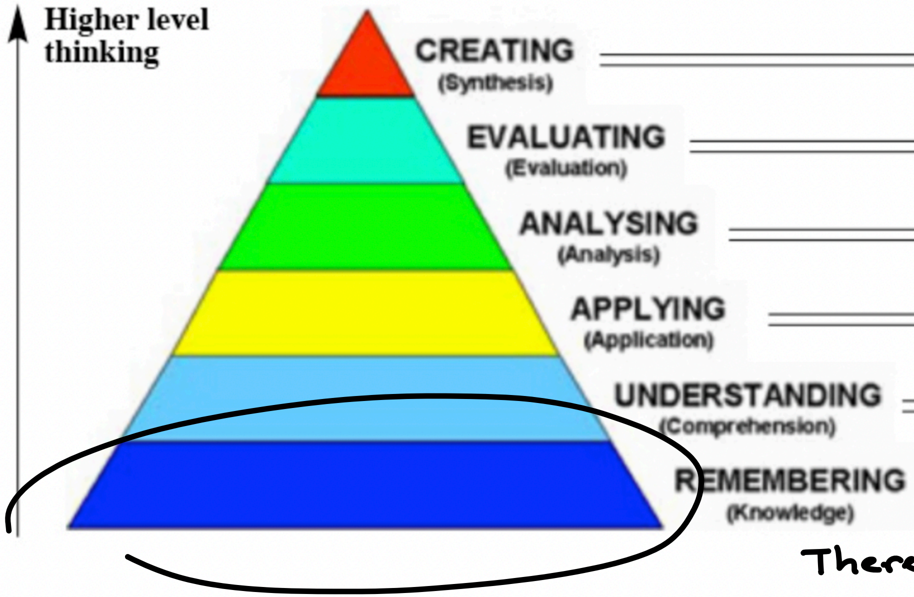
Bloom's Taxonomy of Learning



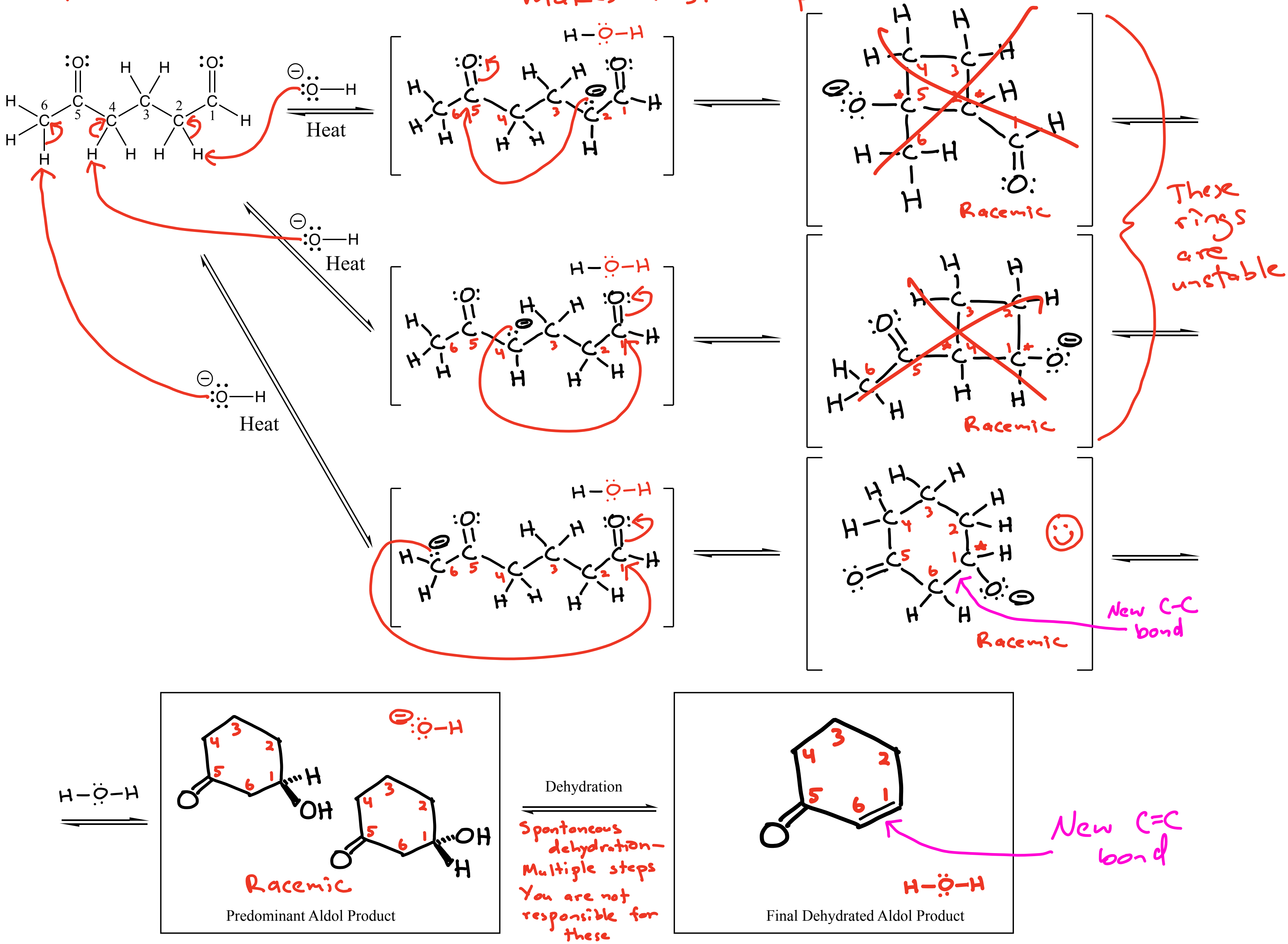
Bloom's Taxonomy of Learning	Organic Chemistry Analog	Tools we created to help you succeed:
CREATING (Synthesis)	Solving synthesis problems	
EVALUATING (Evaluation)	Recognizing reaction products	KRE Table
ANALYSING (Analysis)	Reactions	Roadmaps
APPLYING (Application)	Mechanisms	The 4 mechanistic elements
UNDERSTANDING (Comprehension)	Where are the electrons?	"Personalities of Molecules" Nucleophiles, electrophiles, acids, bases
REMEMBERING (Knowledge)	Structures, bonding, functional groups, reagents, nomenclature, definitions	**Rules of the Day**

There are no short cuts to the top →
you cannot just "remember" any more

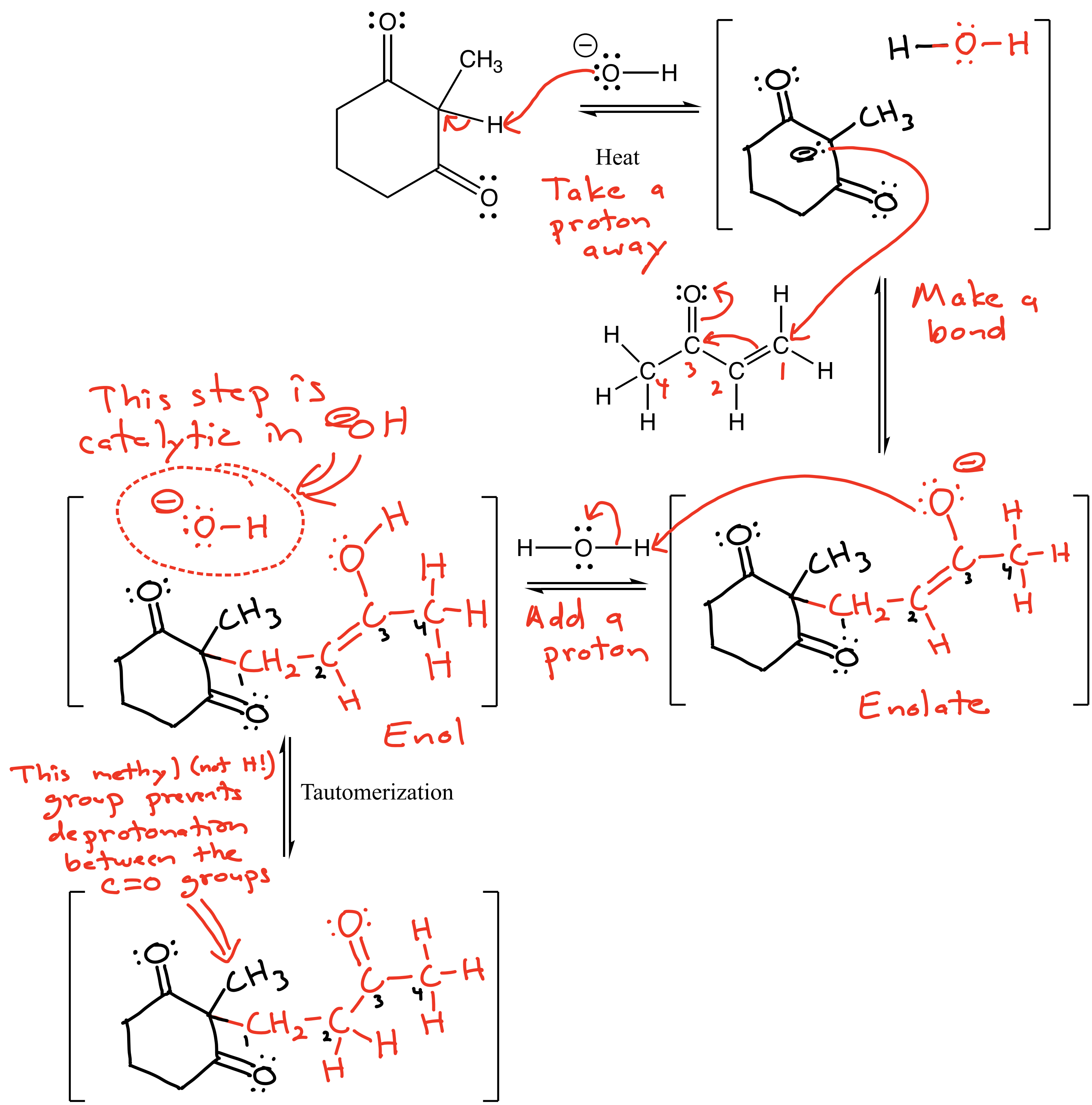
Organic chemistry is difficult because it requires higher order thinking. According to Bloom's taxonomy of learning, the lowest level of learning involves pure memorization ("Remembering") As one moves up the pyramid to higher learning, understanding, applying, analysing, evaluating and creating are reached. I believe there are Organic chemistry analogs of all of these, culminating in synthesis which inolves creativity along with all of the other levels of thinking. It is likely that many of you have never been challenged all the way to the top of the Bloom's taxonomy of learning pyramid before, explaining why this feels different and disorienting. DO NOT GIVE UP. As shown on the right, we have created tools to help you master each step up the ladder. On the above diagram you can cllick on the tools listed to go directly to them. Also, if you have any questions about how to study, click here to read about the way I learned to study. I never earned a grade lower than an A after I started using this method during my own college career.

I understand that most of you are headed to the health professions, so you may be wondering if mastering synthesis problems will be important for you. I assert that it is. Solving a synthesis problem involves the detailed evaluation of a complex molecule while looking for KREs, then working backwards to the starting materials by analyzying possible reactions involved by thinking through your roadmaps, possibly applying your understanding of mechanism to make sure you predict the correct product for each reaction. This is the exact type of thinking you will need to diagnose a patient. A patient will present various complex combinations of symptoms, then you must evaluate which of these are important, then analyze, apply and understand how the patient got that way and how to get them back to their starting state (healthy) again. In other words, you will learn the "KREs of diagnosis" then work backwards to understand what happened to the originally healthy patient! Therefore, learning how to solve synthesis problems will teach you how to use higher level thinking skills, exactly the kind you will need to develop as a health care professional!

Cyclic Aldol Reaction → 3 different enolates are possible, but only one makes a stable product

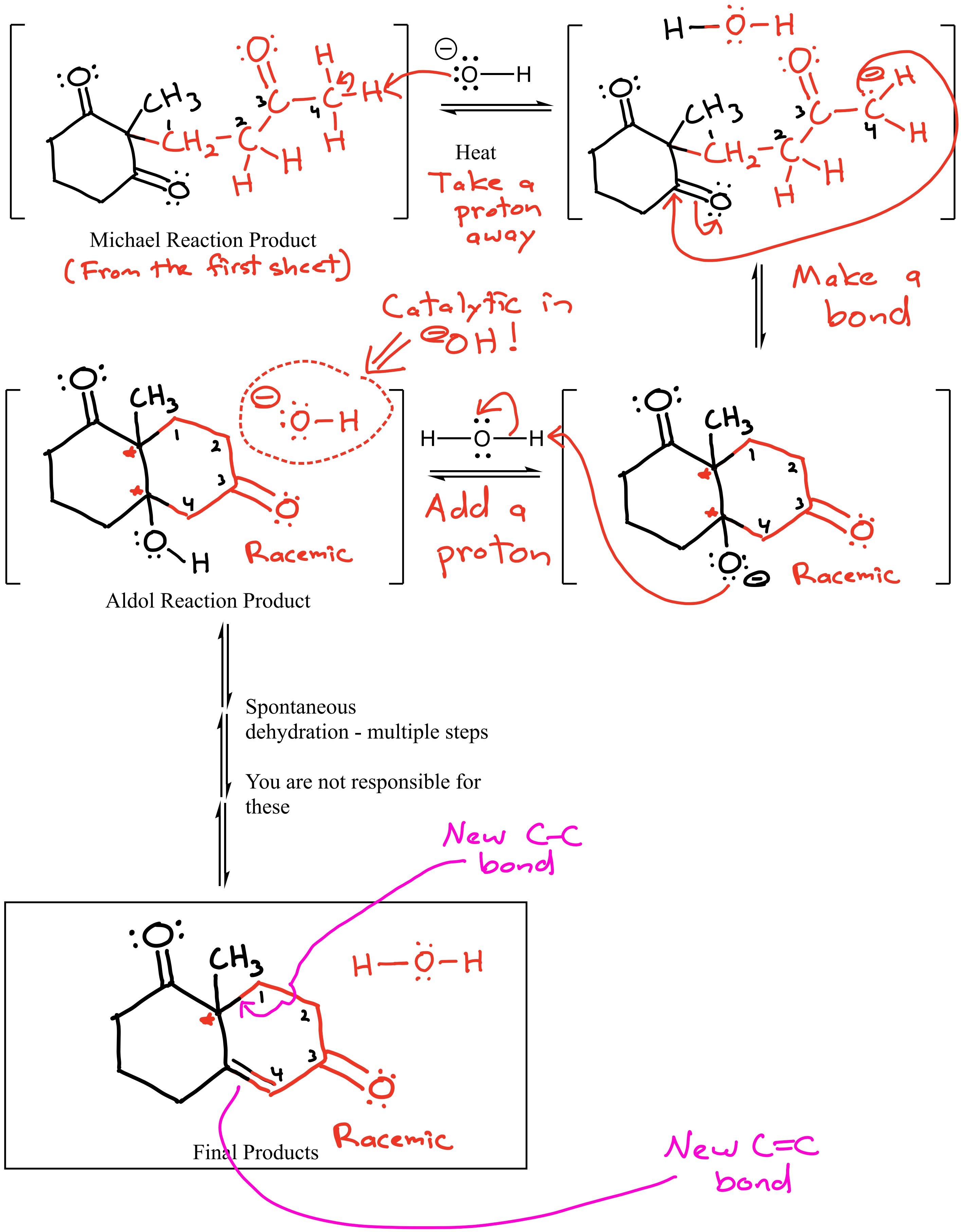


Robinson Annulation Part 1 - Michael Reaction Steps



Michael Reaction Product

Robinson Annulation Part 2 - Aldol and Dehydration Steps



File:Dream Team Basketball 1992 Olympic Games Barcelona.jpg

From Wikipedia, the free encyclopedia

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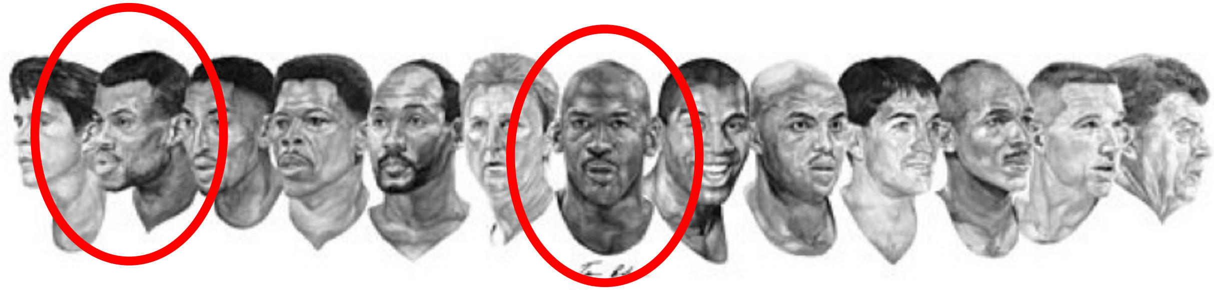
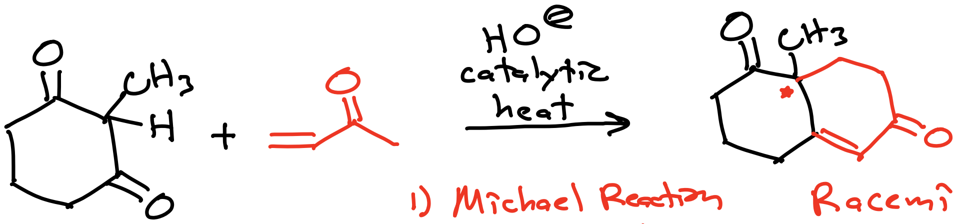


Michael

Robinson

Iverson

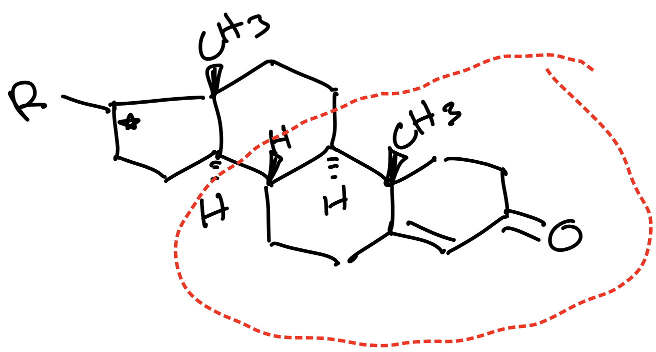
This is the only Robinson annulation reaction you will see on exams



Racemic

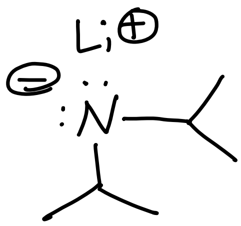
1) Michael Reaction
2) Aldol Reaction
3) Dehydration

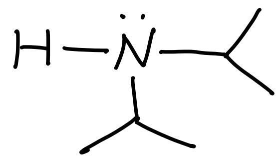
AKA "Dream Team" of reactions that happen in a cascade



The Robinson annulation can be used to assemble complex molecules like this steroid

The wicked strong base that changes things





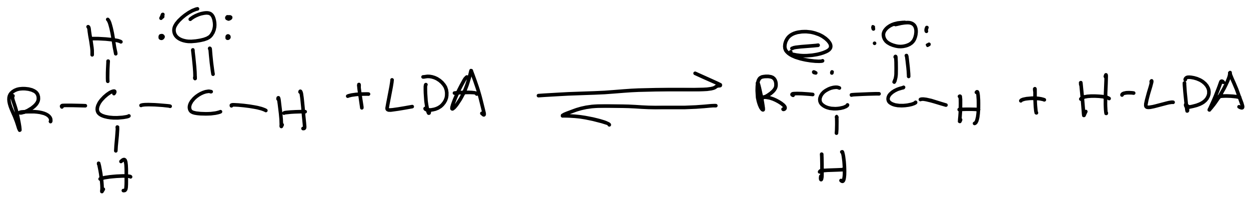
Lithium Diisopropylamide "LDA"

$pK_a \cong 40$ "H-LDA"

Not a nucleophile because of the two isopropyl groups

LDA will quantitatively deprotonate aldehydes, ketones and esters to make enolates!

Aldehydes

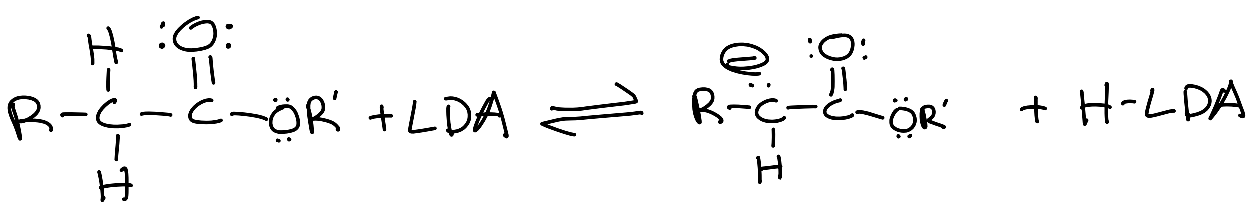


$pK_a = 18\text{-}20$

$pK_a = 40$

This side is favored by $\sim 10^{20}$!

Esters

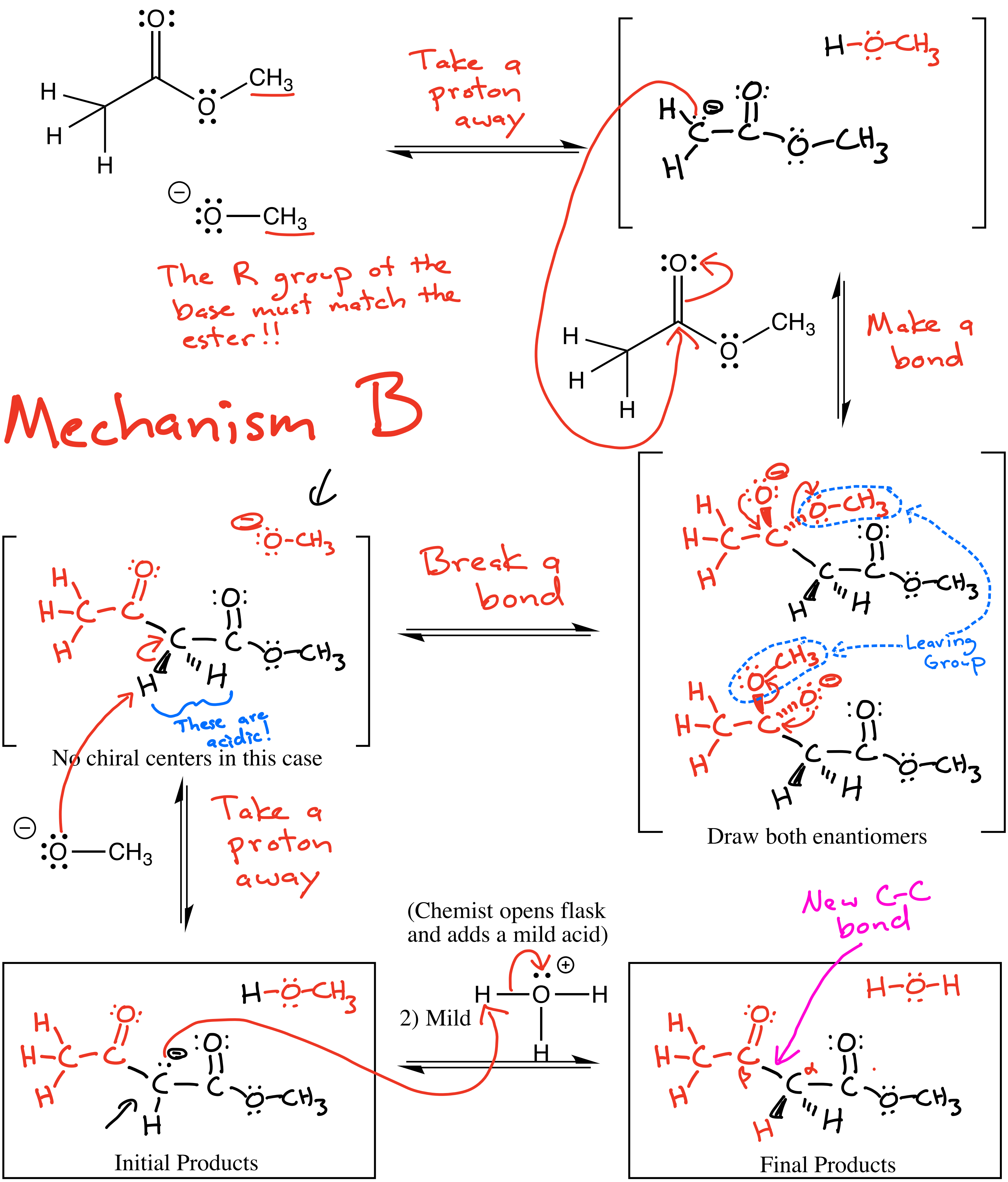


$pK_a = 23\text{-}25$

$pK_a = 40$

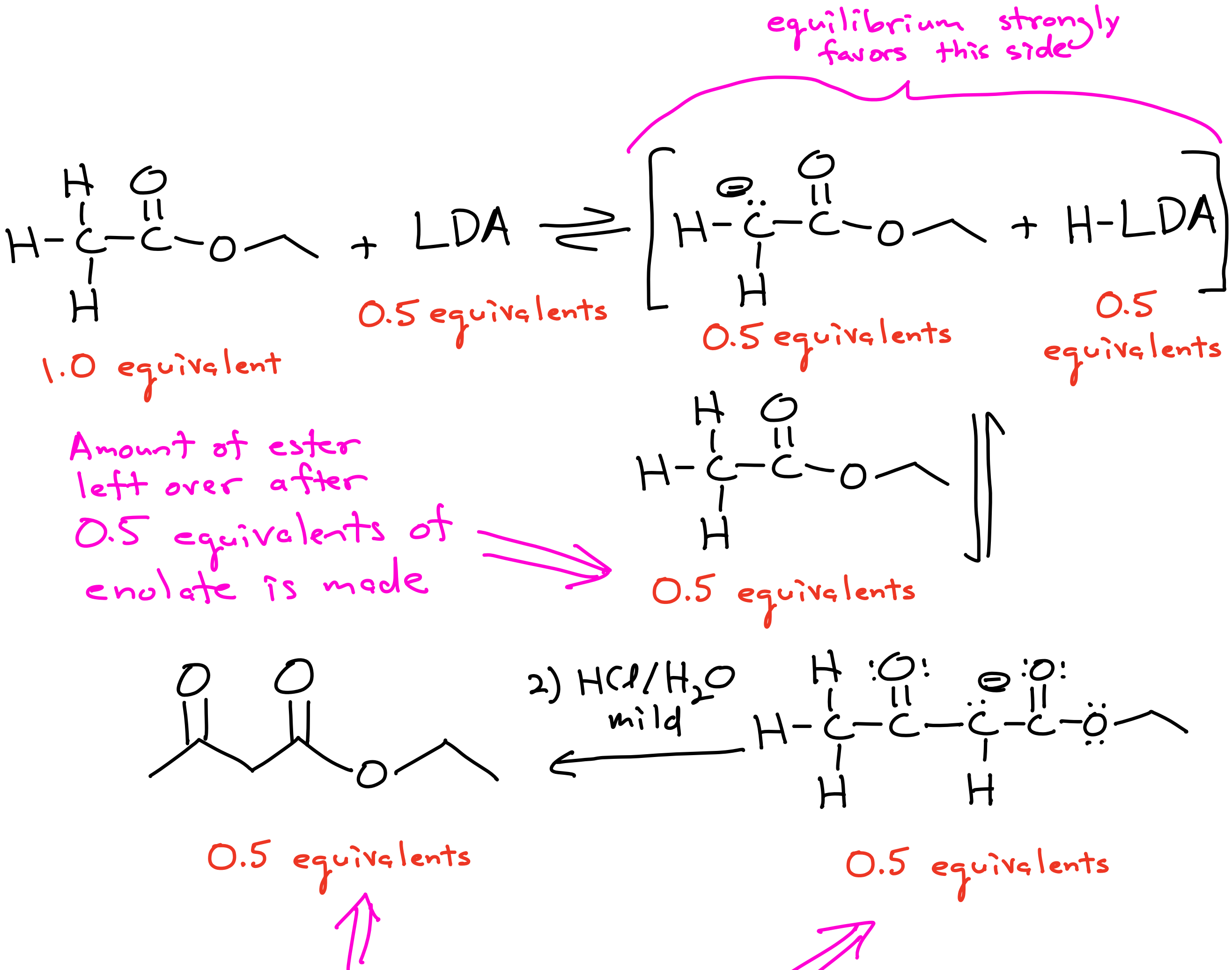
This side is favored by $\sim 10^{15}$!

Claisen Condensation → "Aldol with Esters"



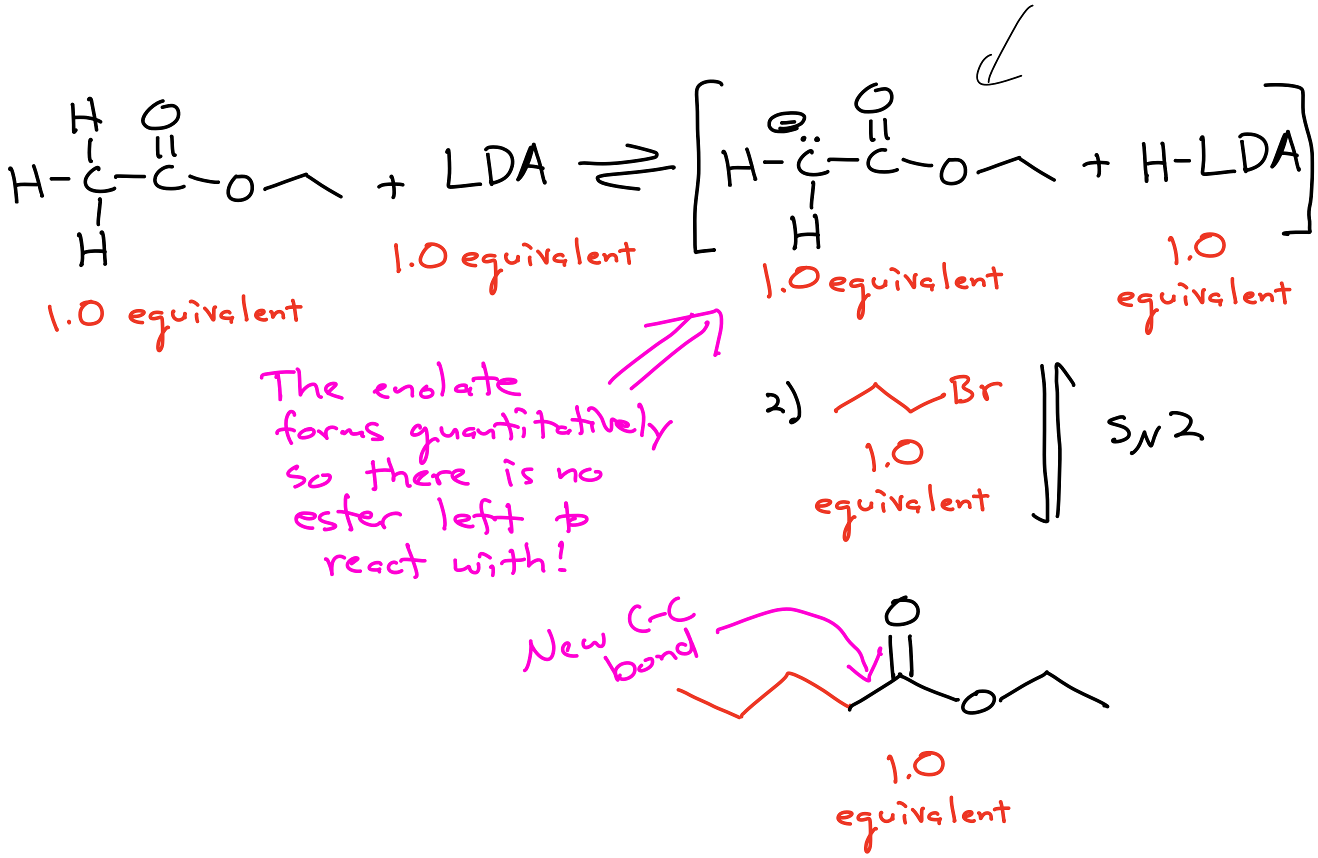
This is a much more stable anion compared to ⊖OCH3, providing a strong driving force (motive) for the Claisen condensation reaction

What if we use 0.5 equivalents of LDA with an ester?

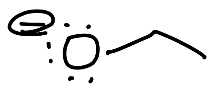


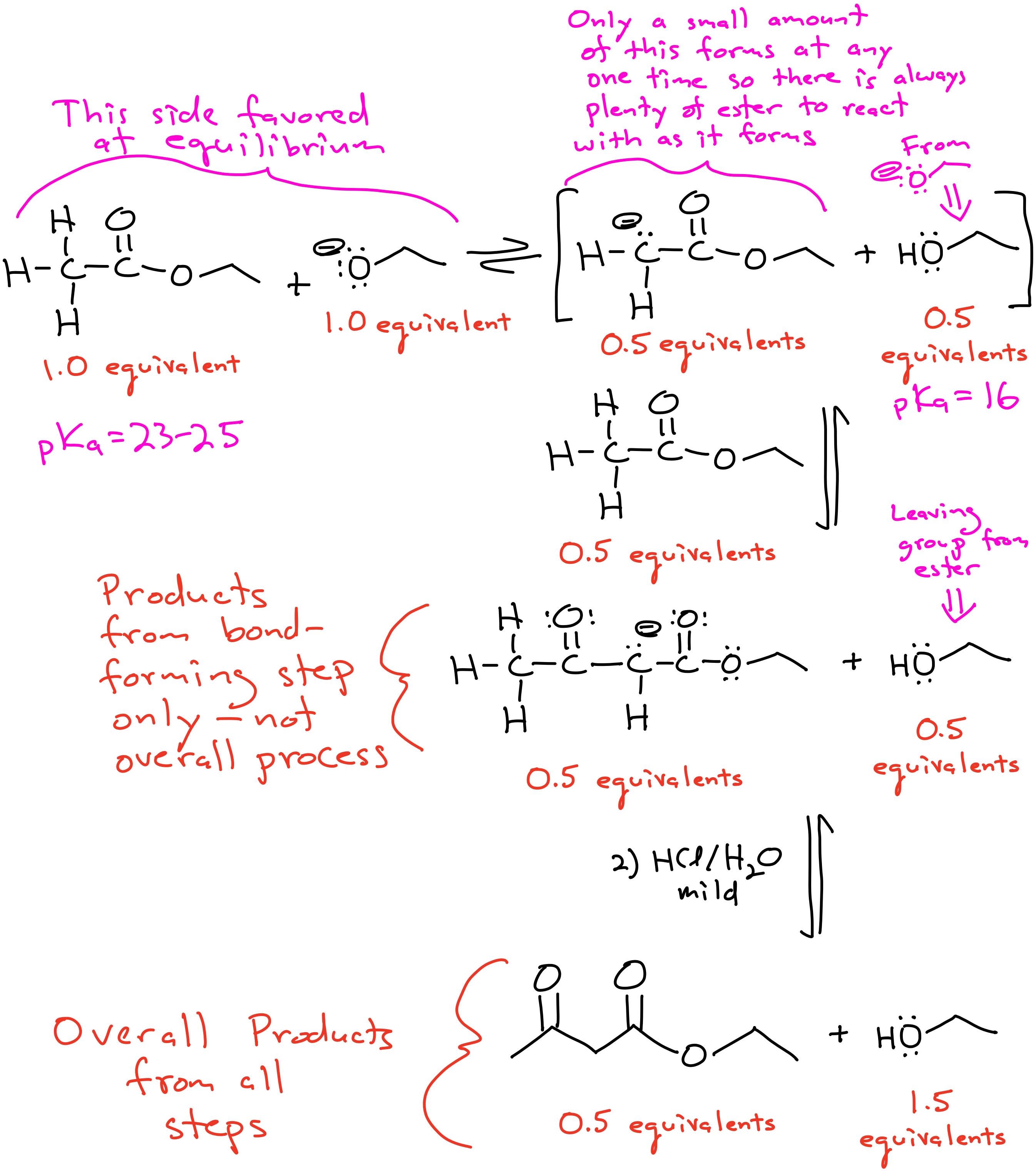
(There are 2 ester molecules used for each product molecule so there can only be half the number of product molecules compared to starting ester molecules)

What if we use 1.0 equivalent of LDA with an ester?

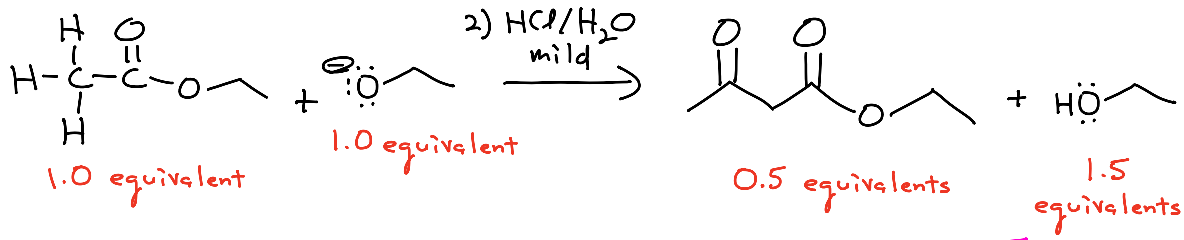


All of the starting ester molecules end up as a the same number of product molecules with a new C-C bond!

What if we use 1.0 equivalent of  with an ester?



Overall Reaction

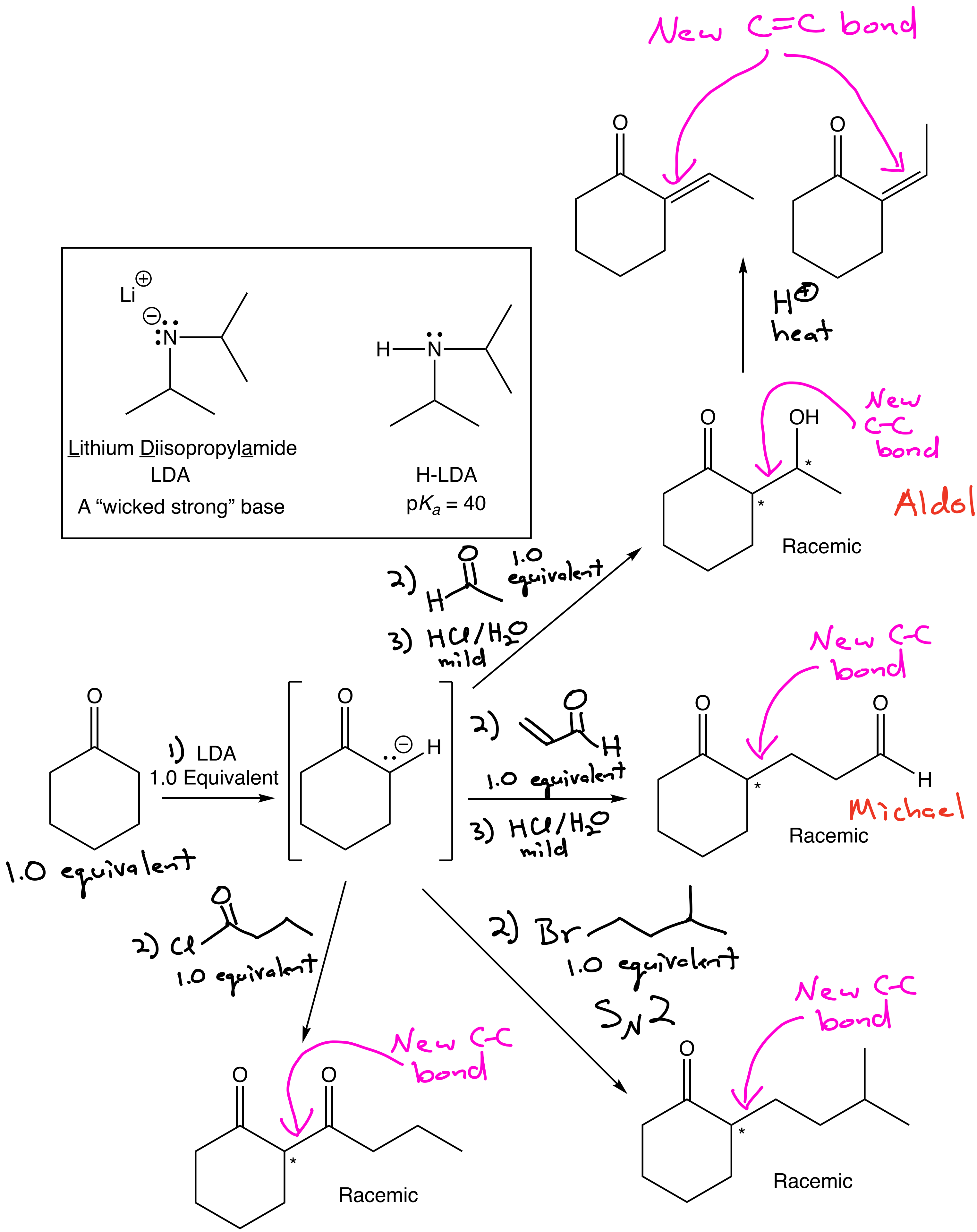


0.5 equivalents comes from first step, formation of the enolate

0.5 equivalents comes from second step, loss of ⊖:Ö⌃ leaving group from ester (see mechanism)

0.5 equivalents is left over from original ⊖:Ö⌃ that was not used

Note: Considerable detail was added to the preceding four pages compared to what I wrote in lecture — I wanted to capture more of the key points for you to study


New C=C bond
H⊕
heat
Lithium Diisopropylamide
LDA
A "wicked strong" base
H-LDA
pK_a = 40
O
OH
New C-C bond
Aldol
Racemic
2) 1.0 equivalent
3) HCl/H_2O mild
1) LDA
1.0 Equivalent
1.0 equivalent
2) 1.0 equivalent
3) HCl/H_2O mild
New C-C bond
Michael
Racemic
2) Cl 1.0 equivalent
2) Br 1.0 equivalent
S_N2
New C-C bond
Racemic
New C-C bond
Racemic

β-Substituted aldehydes, nitriles, ketones, or esters

α,β-Unsaturated, nitriles, ketones, or esters

β-Keto esters

α,β-Unsaturated aldehydes

Acid Chlorides

β-Hydroxy aldehydes

Aldehydes

Ketones

Carboxylic esters

β-Ketoaldehyde

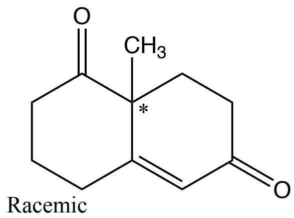
β-Diketone

Carboxylic acids

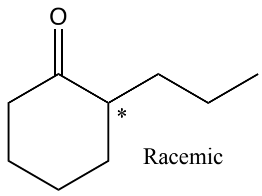
Substituted aldehyde

Substituted ketone

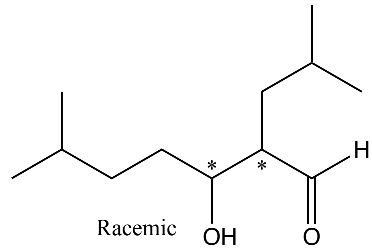
β-Diester



Racemic



Racemic



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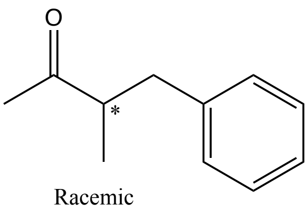

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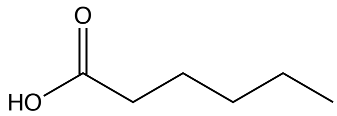

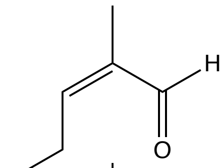

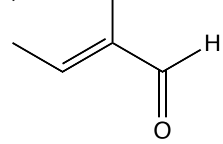

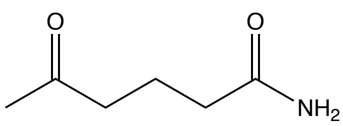

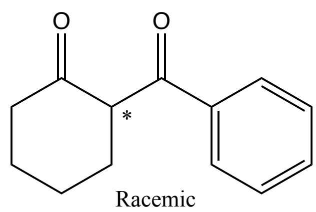

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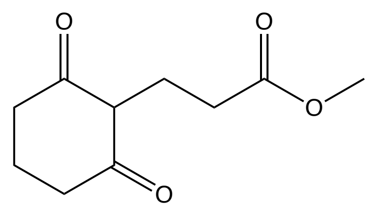

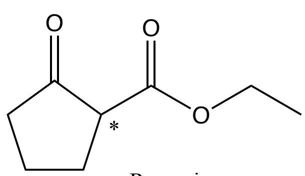

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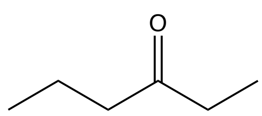

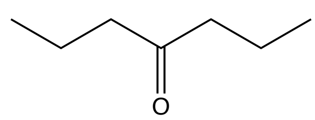

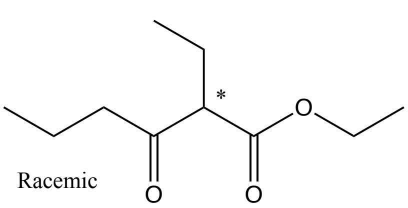

Racemic