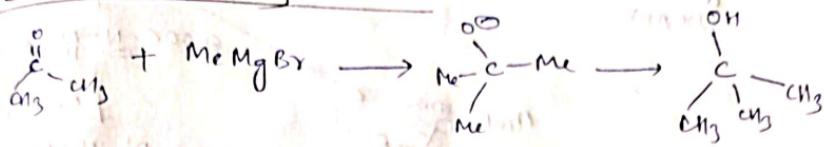


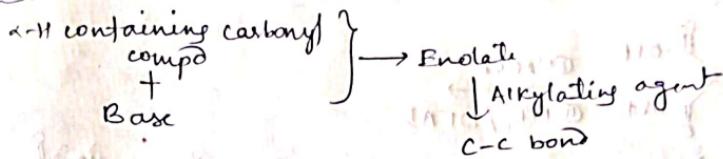
## Unit-3 : C-C and C=C bond forming reactions

### C-C Bond Forming Reactions

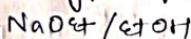


Nucleophilic condensation  $\rightarrow$  enolate + benzaldehyde

### Enolate



Different types of bases used are

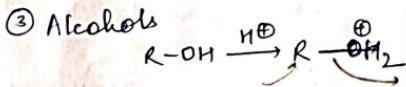
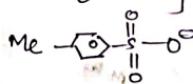
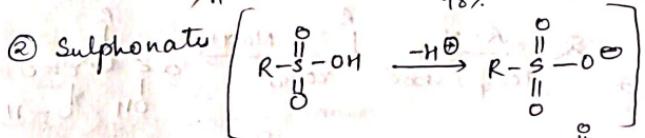
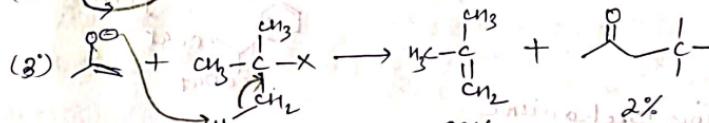
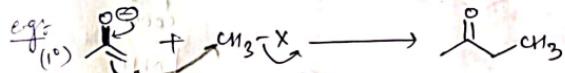


Alkylating agent used are

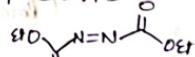
① Alkyl halide

1°, 2°  $\rightarrow$  Reaction occur

but 3°  $\rightarrow$  does not occur.

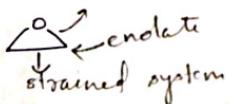


Mitsunobu RXN

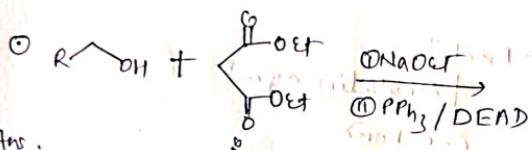
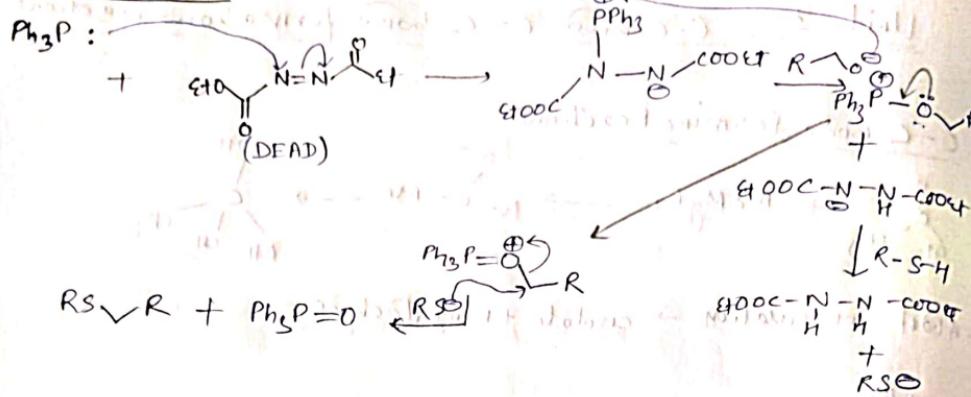


Diethylazodicarboxylate

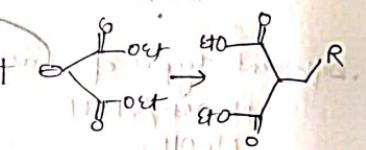
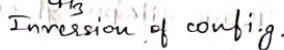
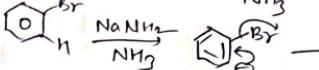
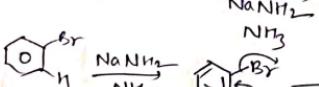
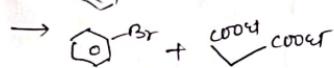
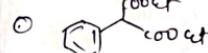
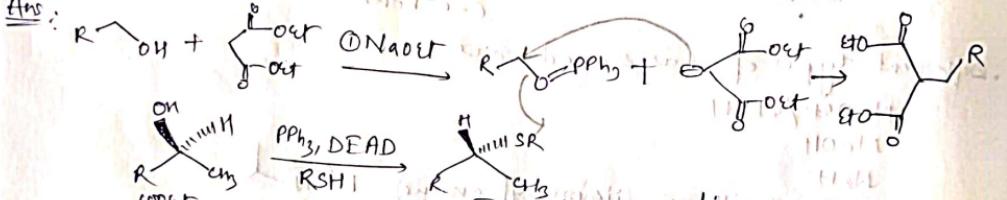
④ Epoxides



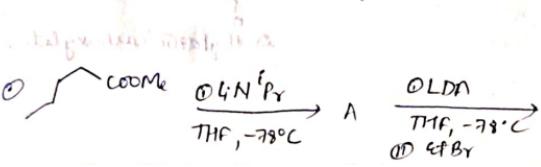
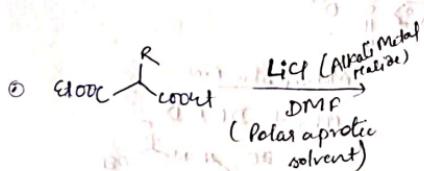
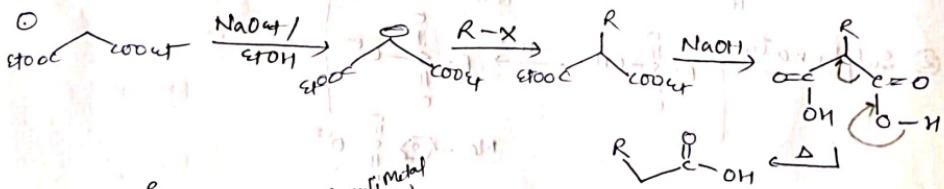
Mitsunobu RXN



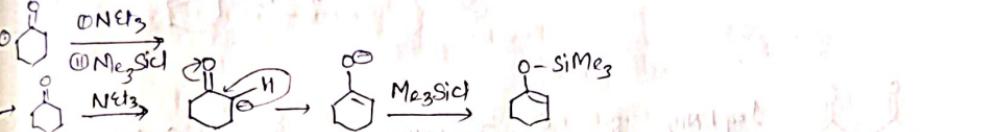
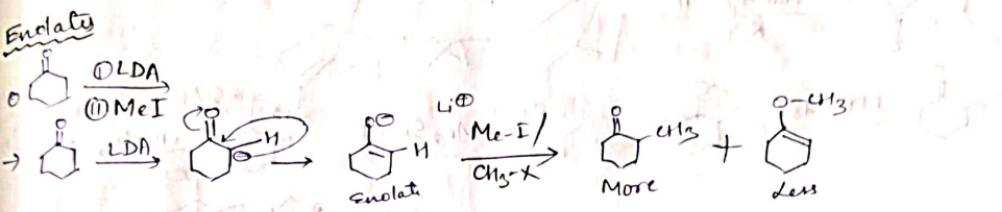
Ans:



## Elimination Addition Mechanism

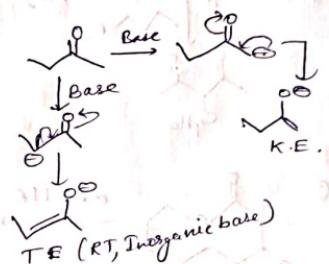
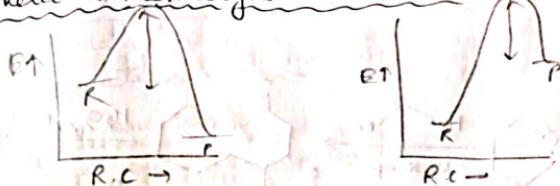


$\text{LiN}^+\text{Pr}$  (Non-nucleophilic)  $\text{Li}^+ \text{O}_2\text{N}-\text{Pr} \rightarrow \text{LDA}$



$\text{O}-\text{Si} \ggg \text{O}-\text{C}$  bond  
 $\text{S}-\text{F}$  bond is also strongest bond.

## Kinetic & Thermodynamic Enolates



## Thermodynamic Endo-Exo

Base: ① NaOH / EtOH

## ⑪ KOH / EtOH

$$\text{④ } \text{I} + \text{e} + \text{D}_2\text{K}^+ / \text{t}$$

(iii)  $t\text{-BuO}^{\ominus}\text{K}^{\oplus}/t\text{-BuOH}$

## Kinetic Equilibrium

① LDA/THF/-78°C

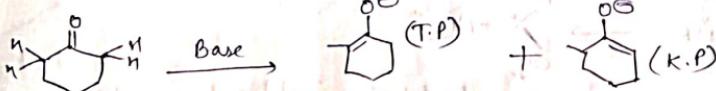
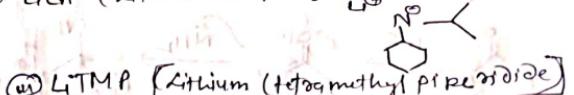
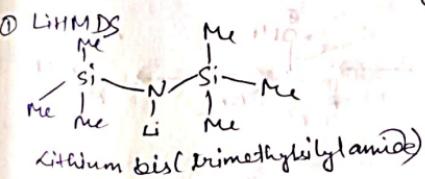
⑩ LiHMDS / THF / -60°C

⑭  $\text{Ph}_3\text{E}^{\oplus}\text{Na}^{\ominus}/\text{Et}_2\text{O}/-78^{\circ}\text{C}$

④ LiClA / THF / -78°C

② LiTMP / THF / 0°C

④ LiCA (Lithium isopropylcarbamoyl)



LDA, DME = -78°C

$\text{Ph}_2\text{CLi}$ , DME = -78°C

Ph<sub>2</sub>C Li, DMF

t-BuOK, t-BuON

1%

9%

905

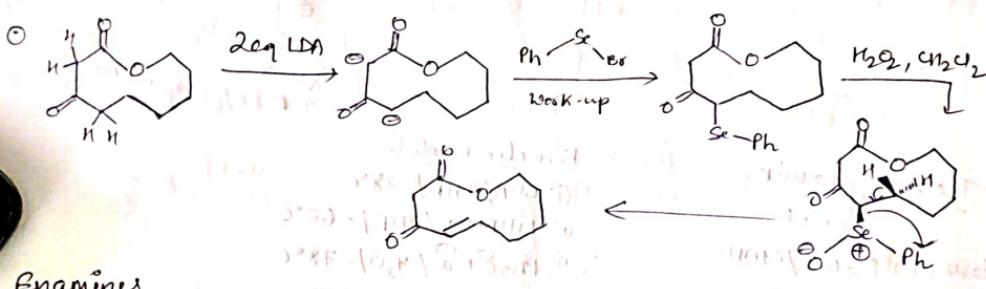
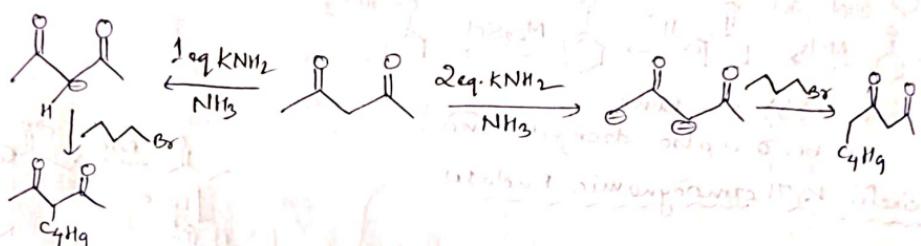
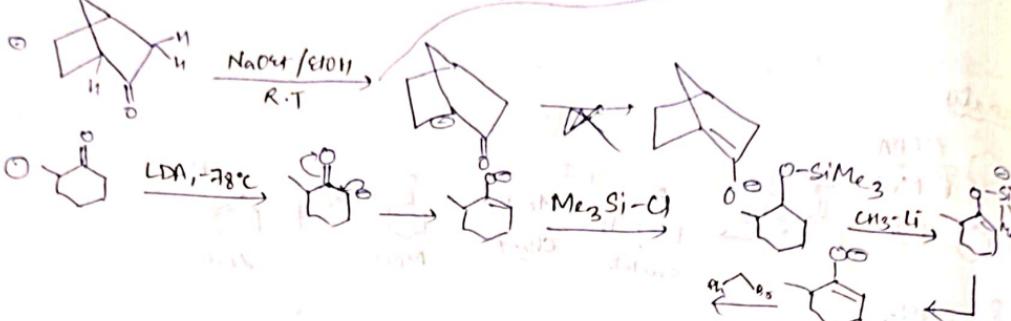
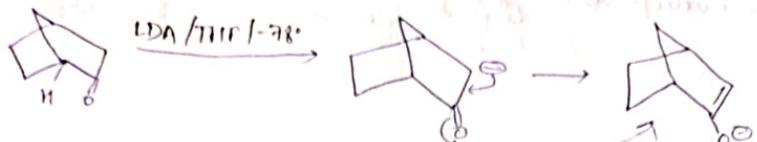
226

80

91%

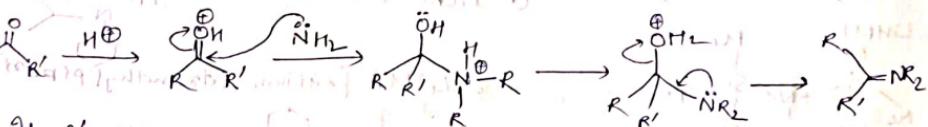
10%

ヨン

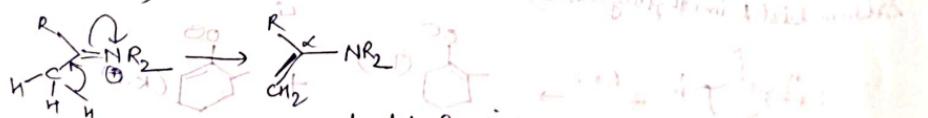


### Enamines

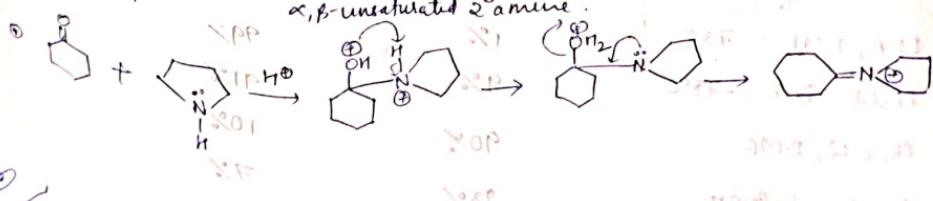
Aldehyde/Ketone +  $2^{\circ}$  Amine  $\xrightarrow{H^{\oplus}}$  Enamine ( $CH_2=C-R-NR_2$ )

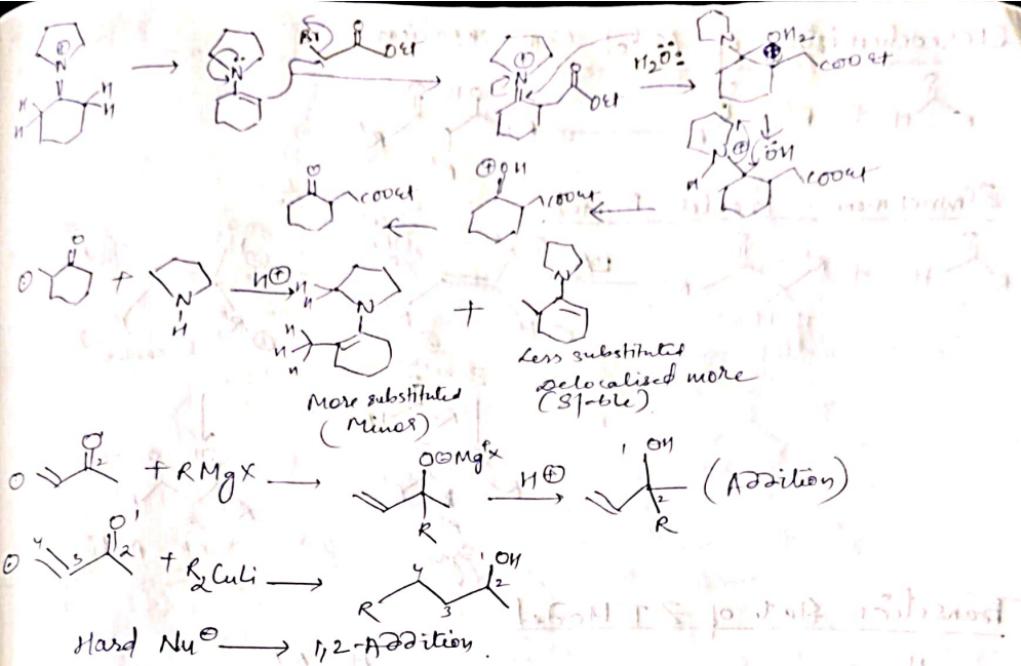


If  $R' = CH_3$



$\alpha,\beta$ -unsaturated  $2^{\circ}$  amine.



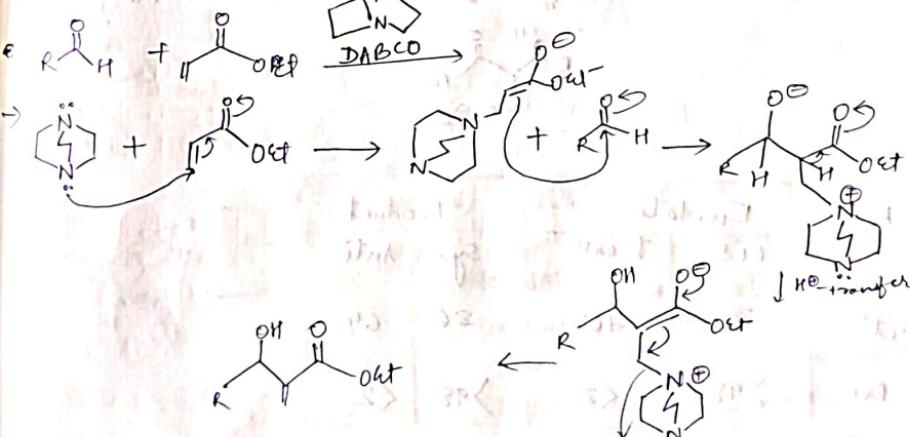
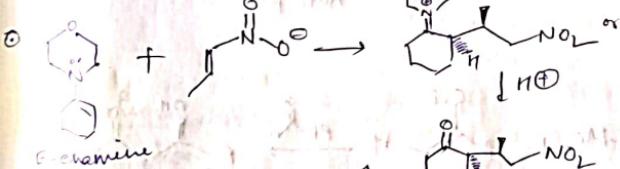


Michaelis Addition

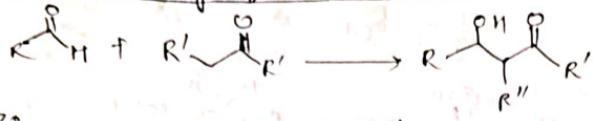
E-enolate/enamine  $\xrightarrow{\text{E2}}$  syn prot  
 Z-enolate/enamine  $\xrightarrow{\text{Anti}}$  anti prot

Aldo Condensation

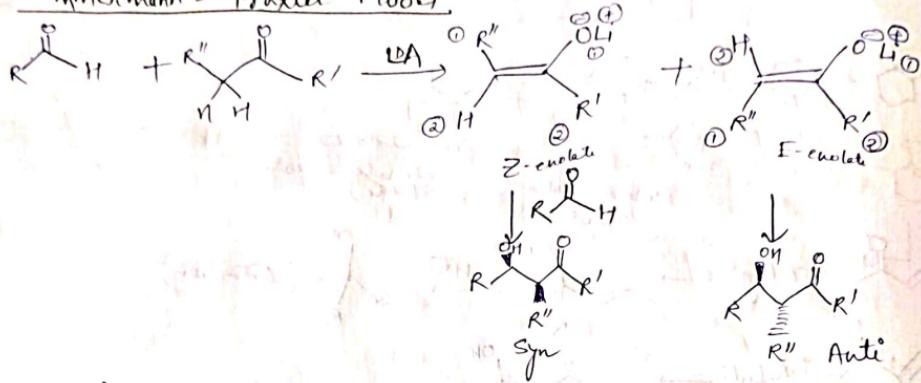
E-enolate/enamine  $\xrightarrow{\text{MES}}$  Anti prot  
 Z-enolate/enamine  $\xrightarrow{\text{syn}}$  syn prot.



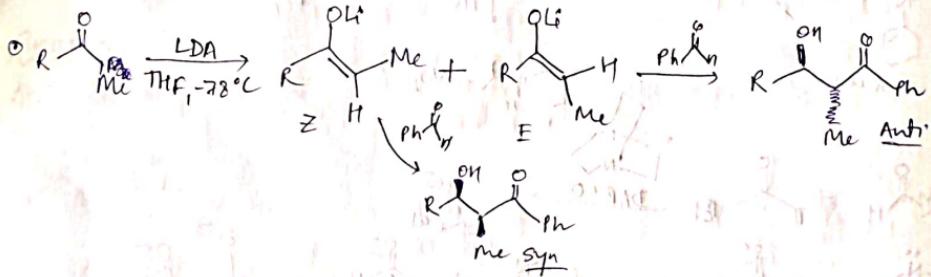
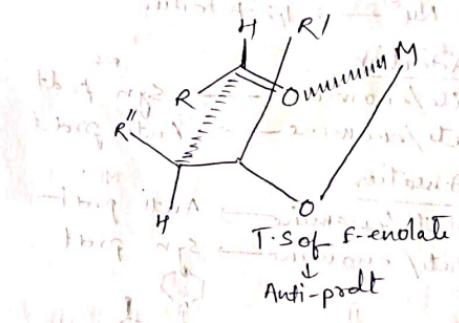
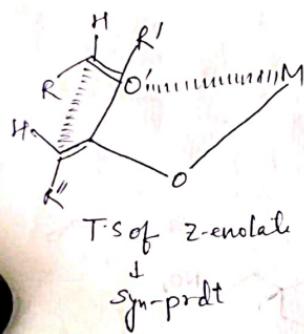
## Stereochemistry of Aldol Condensation



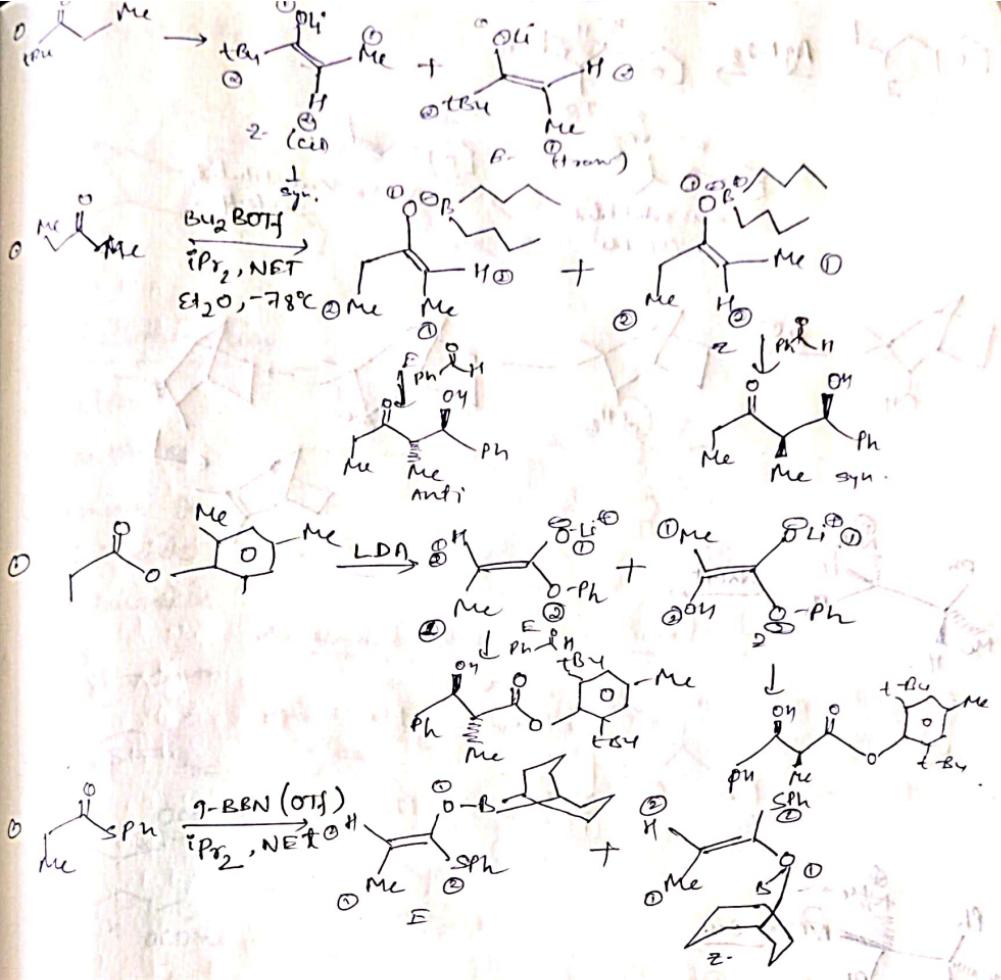
### Zimmermann-Traxler Model



### Transition State of Z-T Model



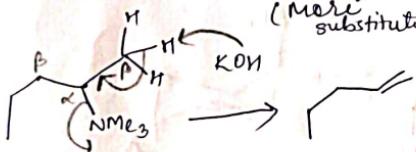
R	Enolate		Product	
	cis	trans	Syn	Anti
Et	30	70	36	64
t-Bu	>98	<2	>98	<2



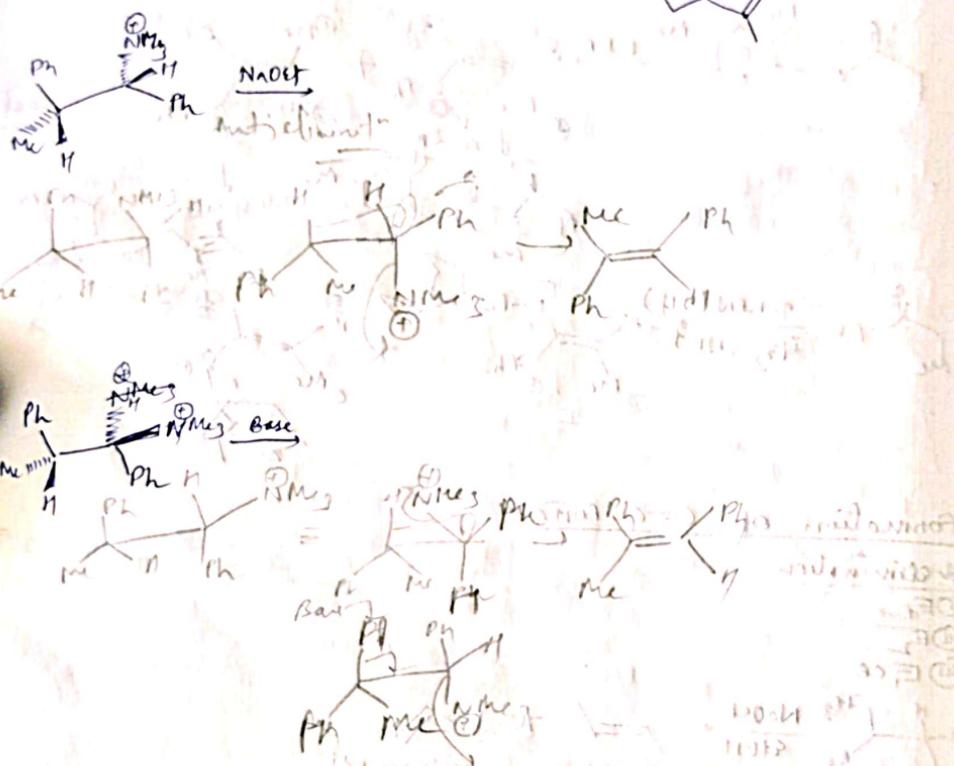
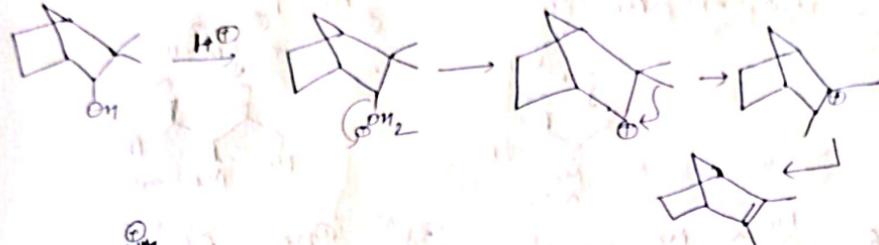
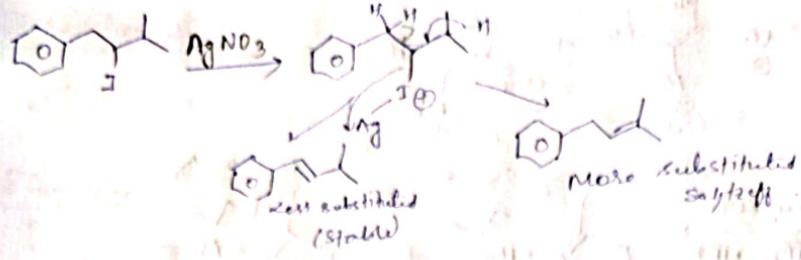
### Formation of C=C bond

#### $\beta$ -elimination

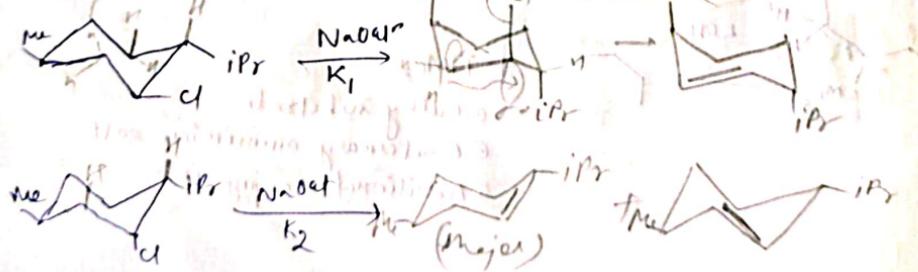
- (I)  $\text{F}_1$
- (II)  $\text{E}_2$
- (III)  $\text{E}_1 \text{CB}$



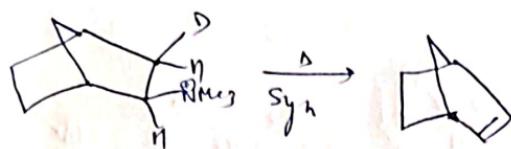
- +  $\text{NMe}_3$
- ① Bulky substrate
- ② Quaternary ammonium salt
- ③ Additional conjugation



which axis is faster and why?



$k_1 \ll k_2$



### Syn-Elimination

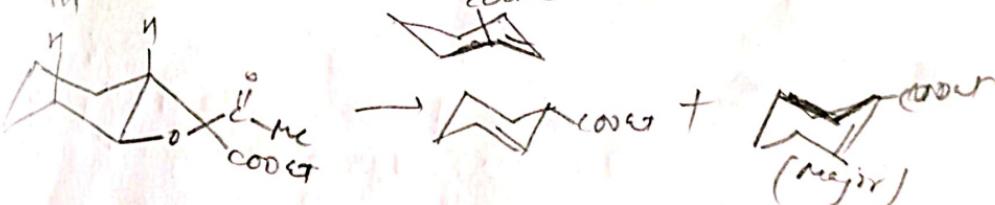
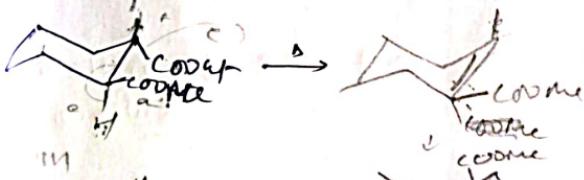
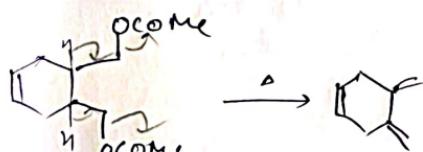
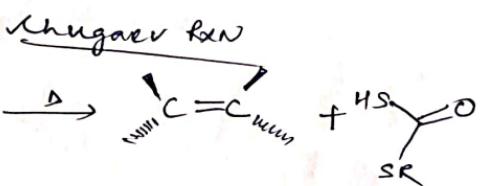
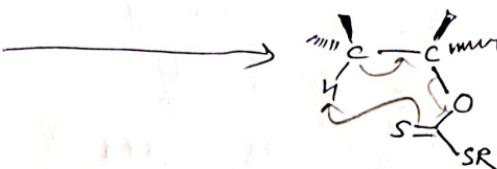
① Esters

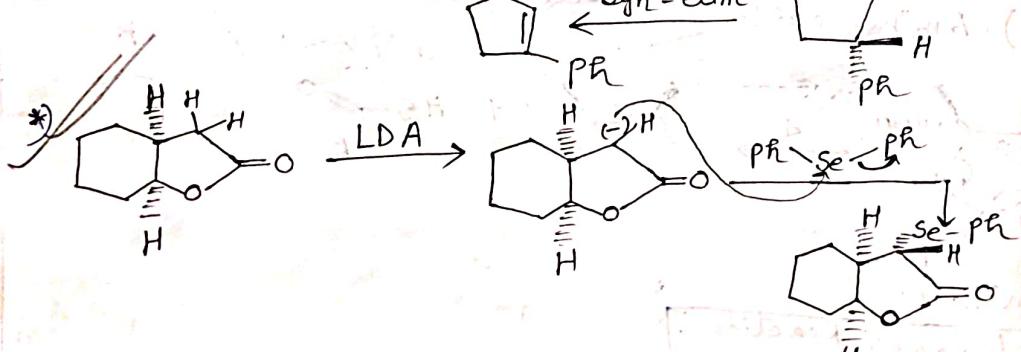
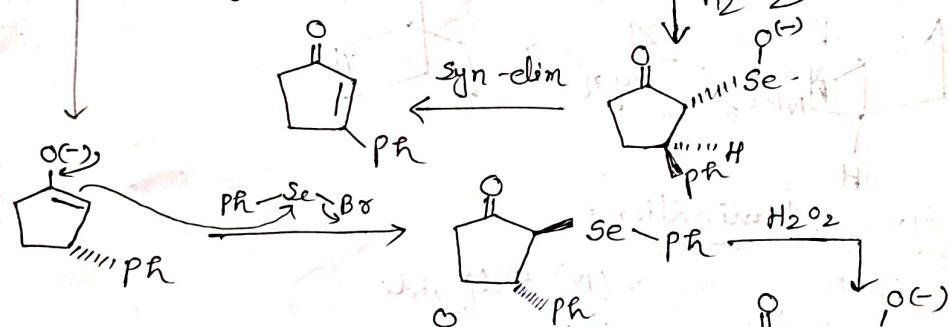
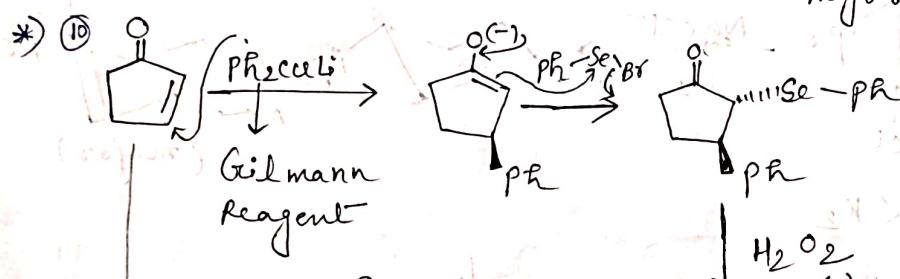
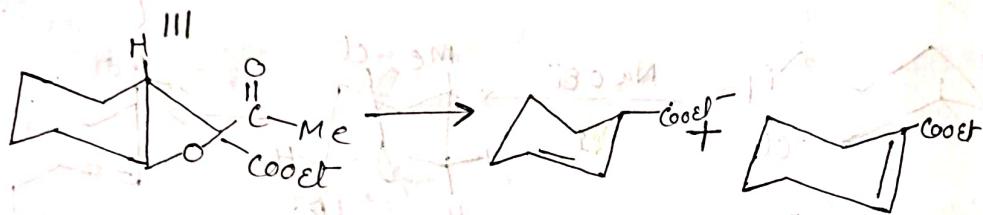
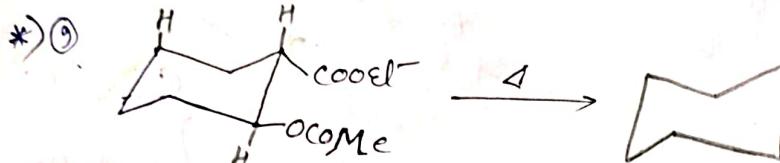
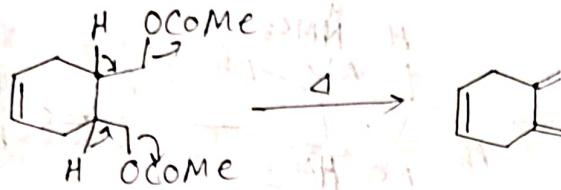
② Xanthates

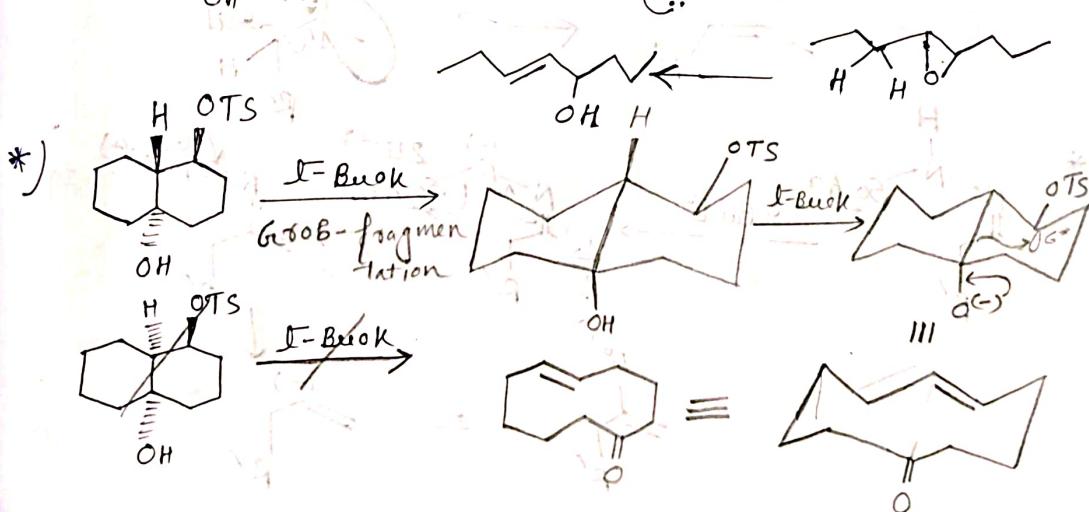
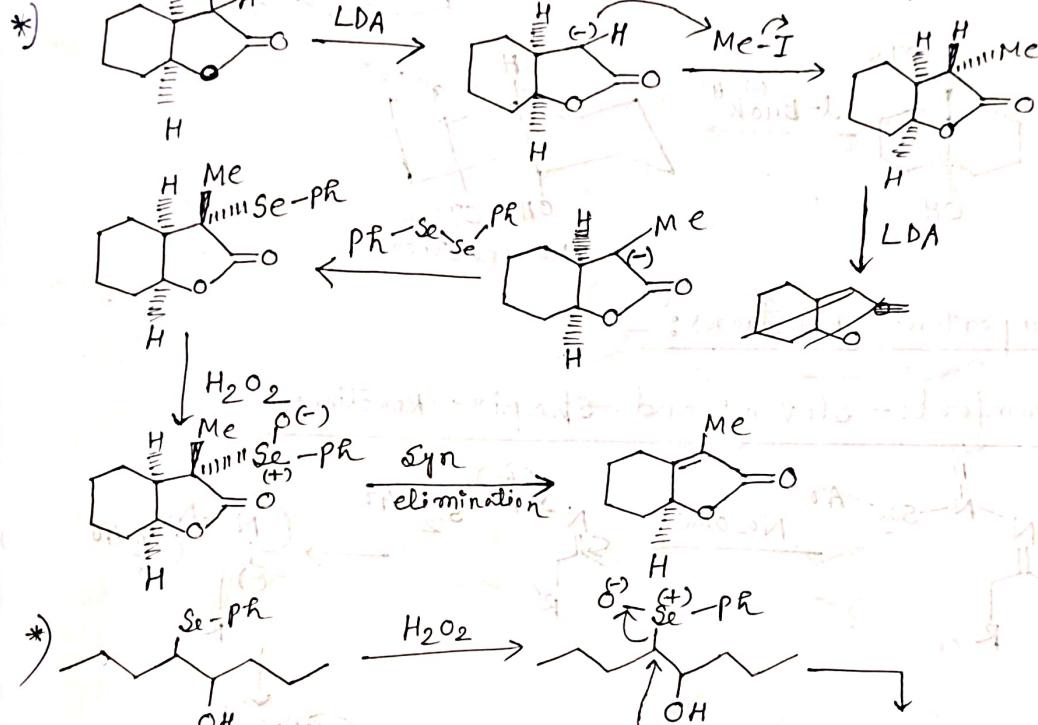
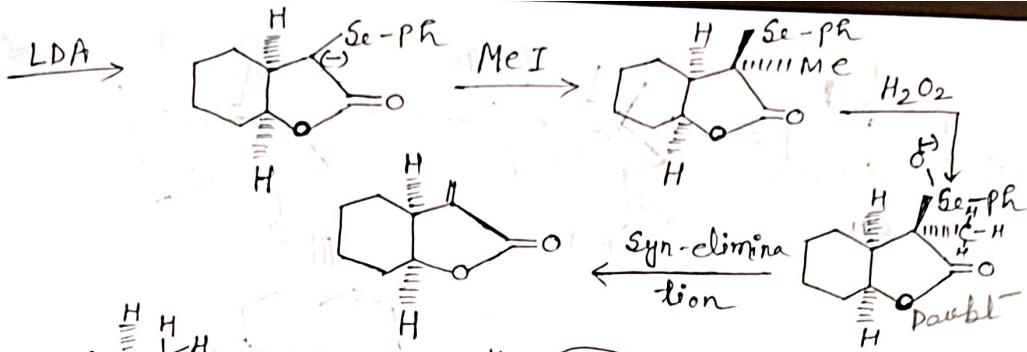
③ Amine Oxide

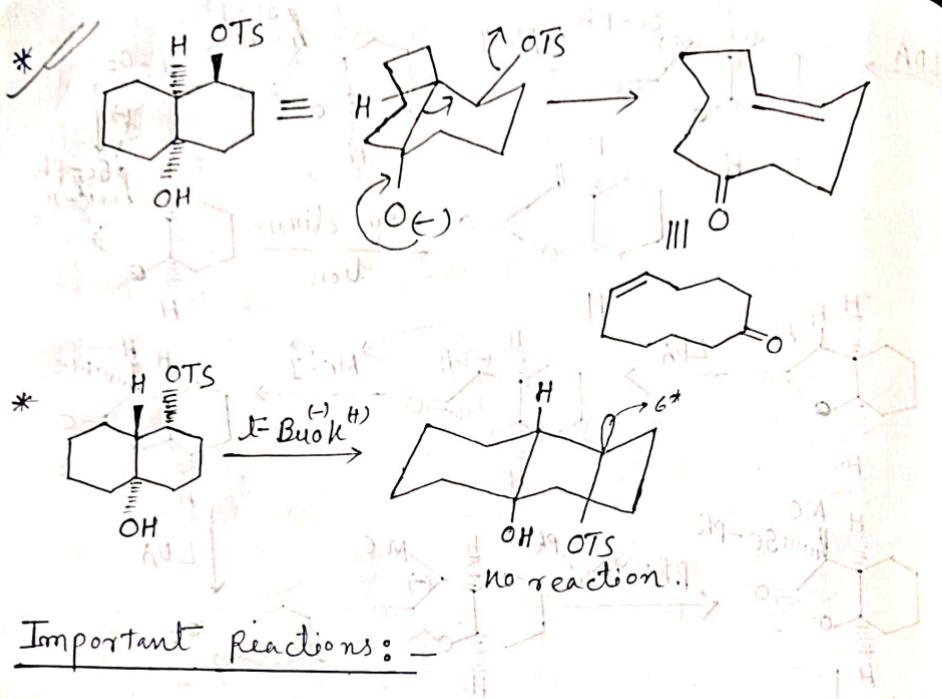
④ Sulfoxide

⑤ Selenoxide



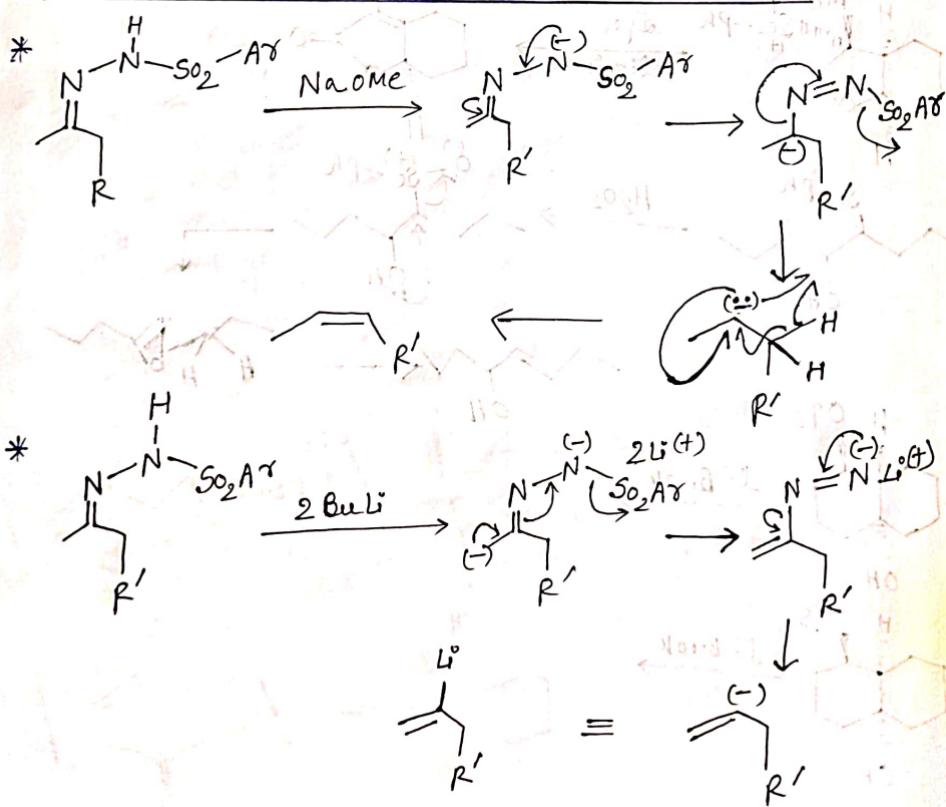


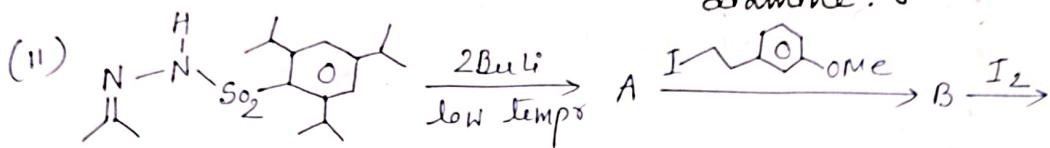
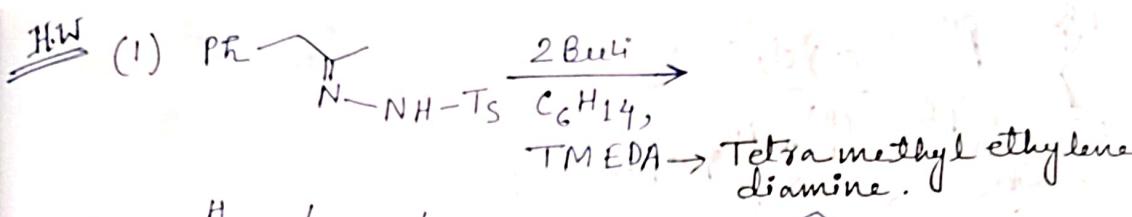




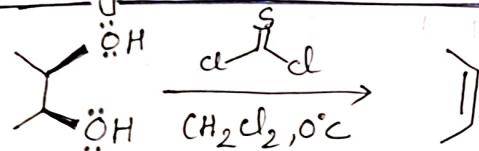
### Important Reactions:

#### (1) Bamford - Stevens and Shapiro Reaction:

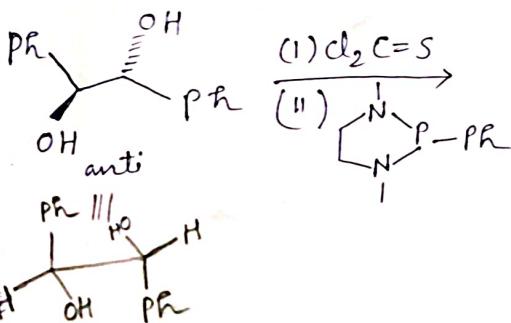
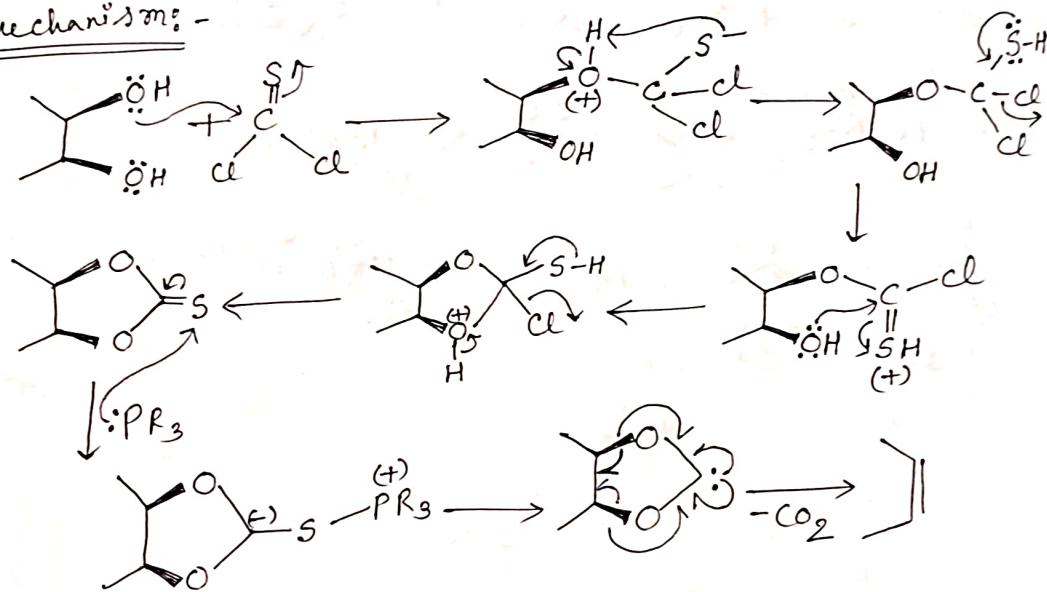


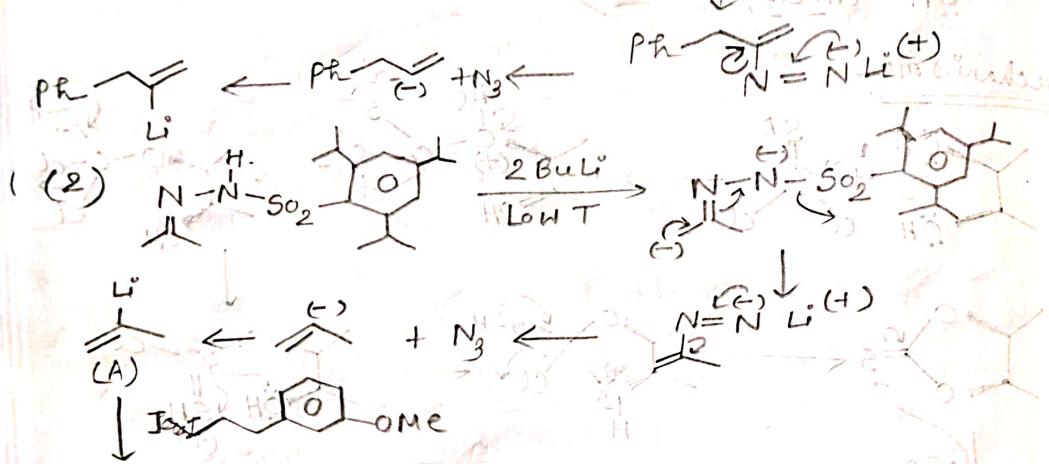
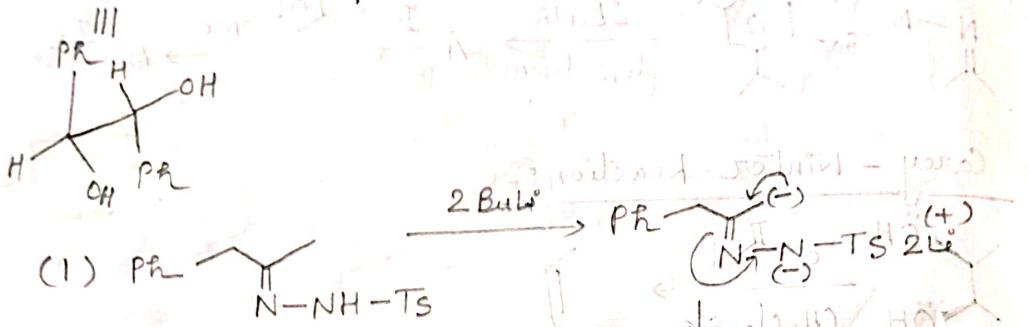
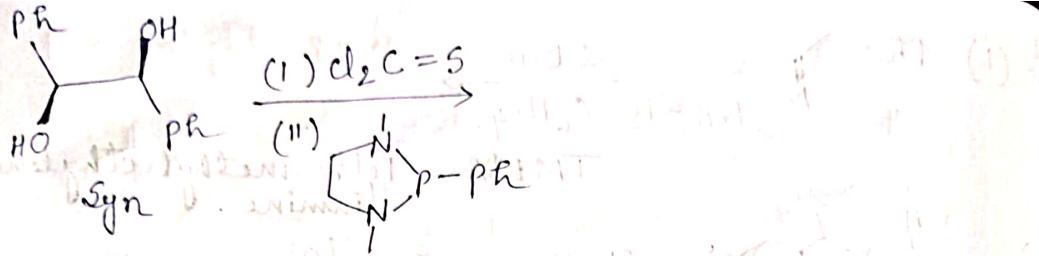


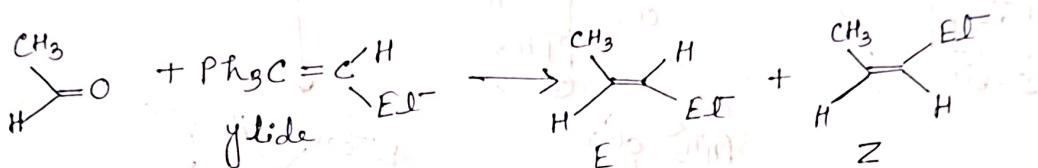
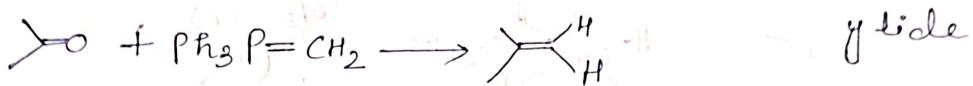
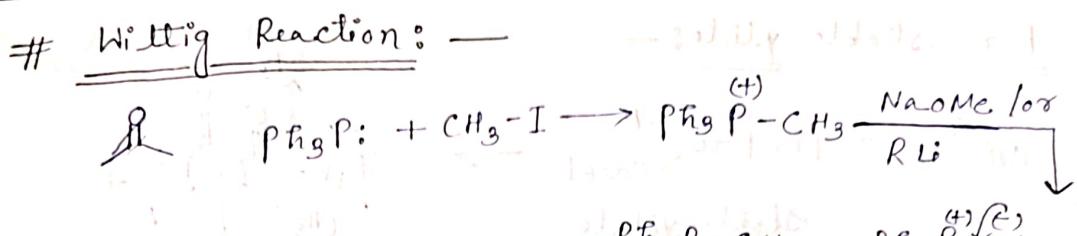
# Corey - Winter Reaction:-



Mechanism:-

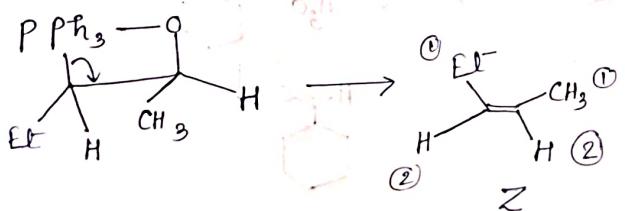
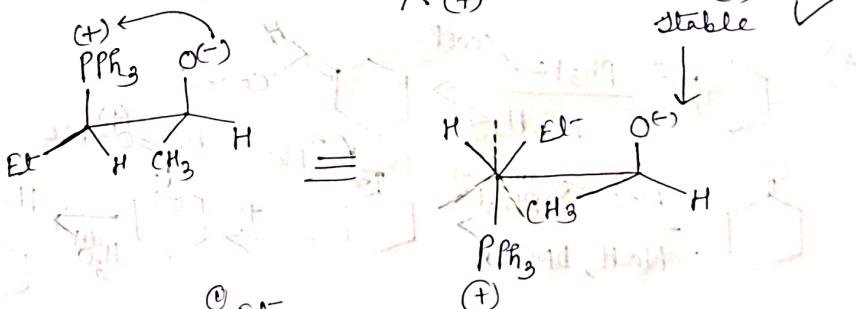
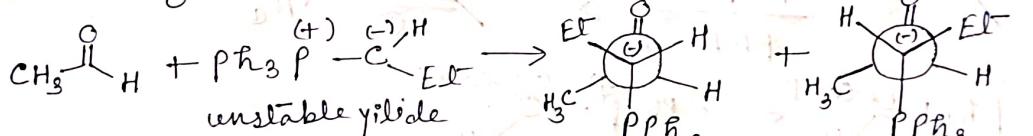
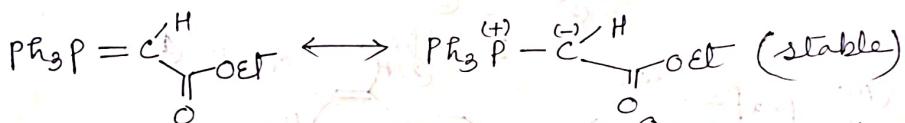
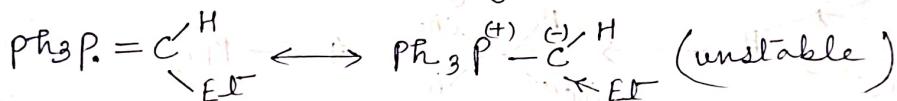




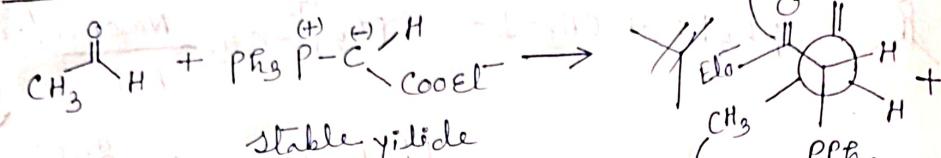


Stabilized ylide  $\rightarrow$  E-alkene

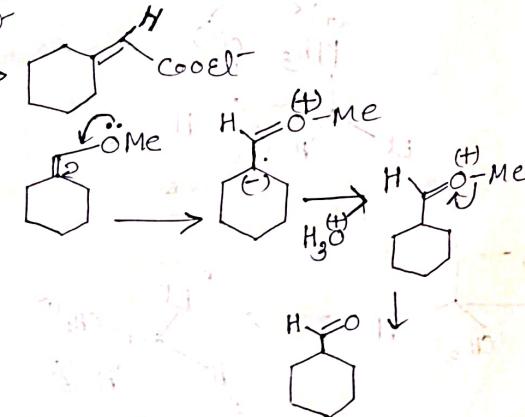
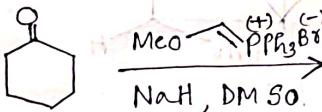
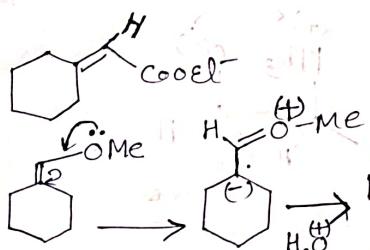
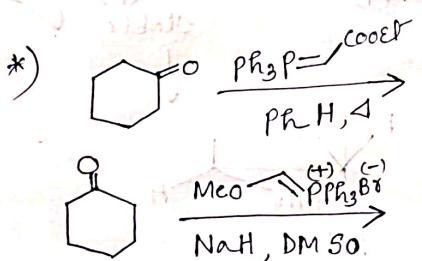
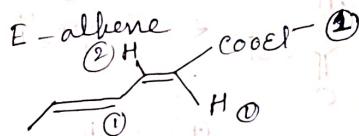
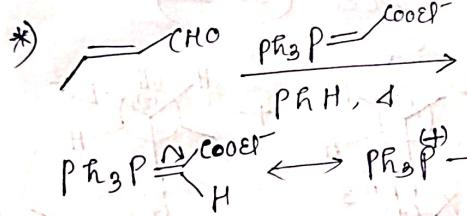
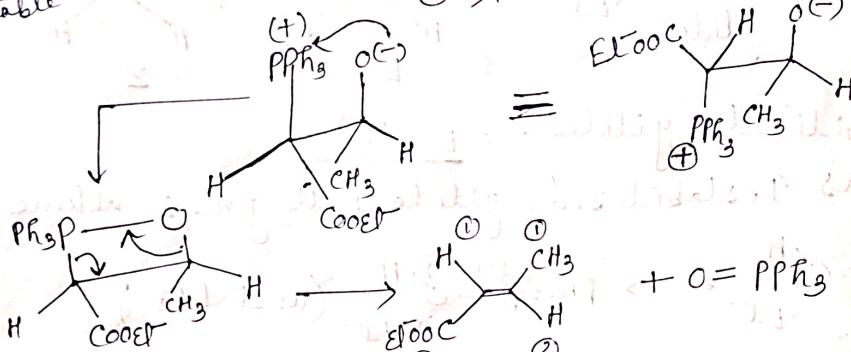
Whereas Destabilized ylide will give Z-alkene.



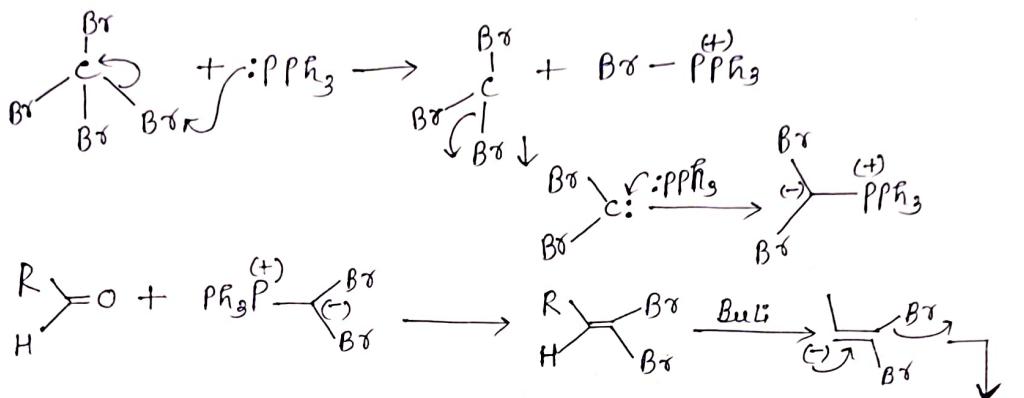
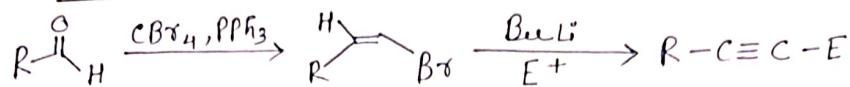
For stable ylide: —



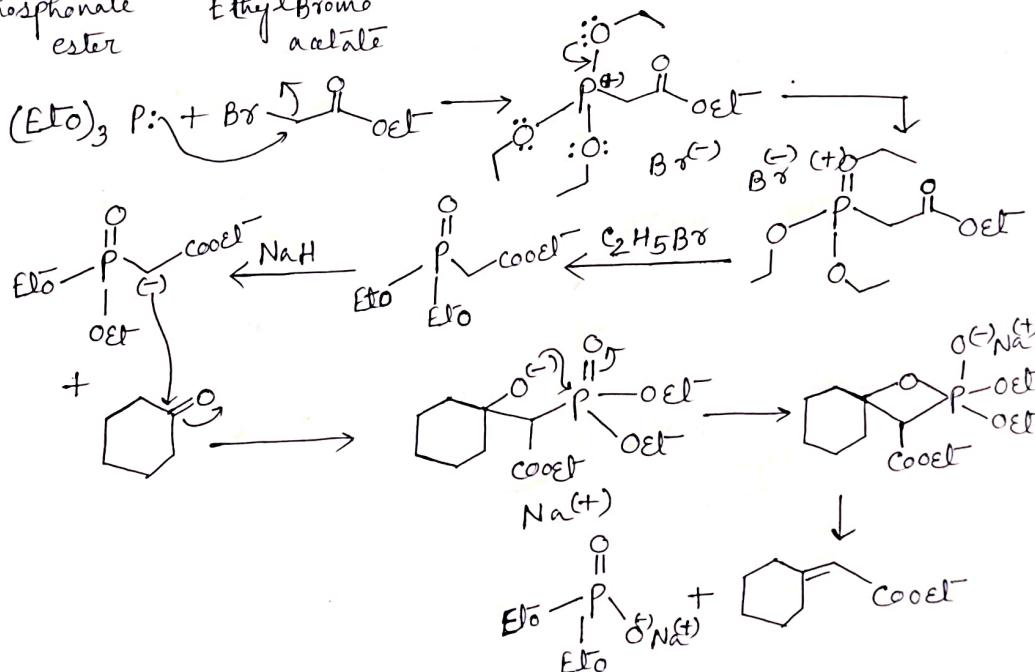
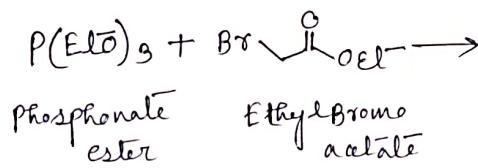
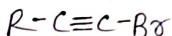
$\boxed{\text{O}=\text{P}}$   
stable



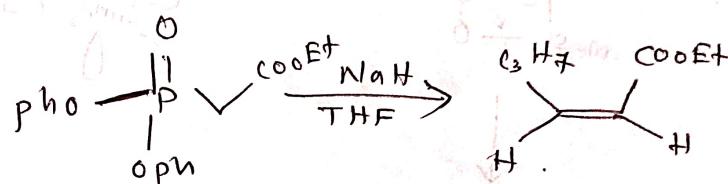
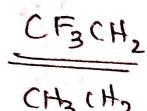
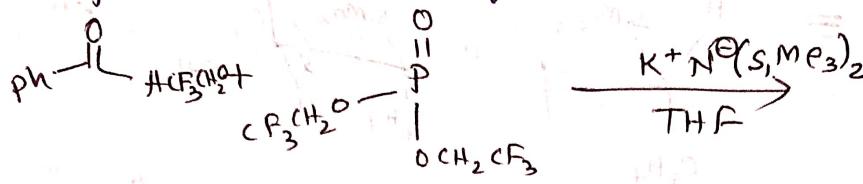
## # Corey Fuchs Reaction: - (variant of Wittig rxn)



## Horner - Wadsworth reaction: -



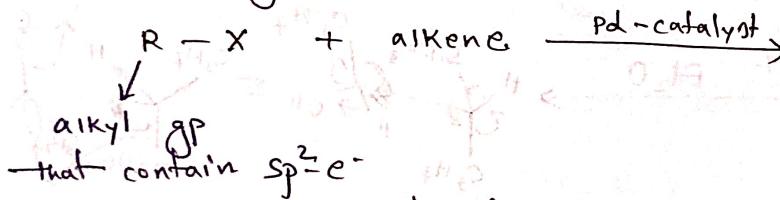
Exceptional cases of H.W.E  $RX^n$  -



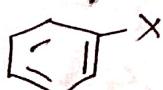
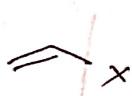
Coupling Reaction

19/09/25

Heck coupling

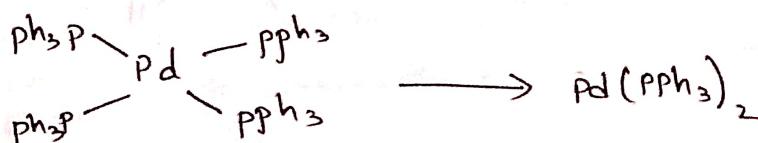


X = Good L.G.



\* alkene can either be e-rich or e-poor or neutral molecule.

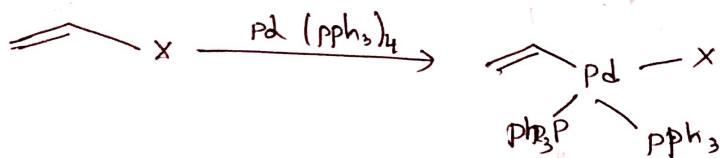
\* Both intramolecular and intermolecular coupling possible.



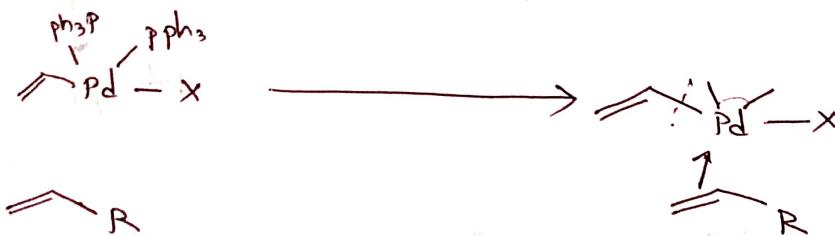
For two  $\text{PPh}_3$  to take place, one remove from it to make it go

## Mechanism!

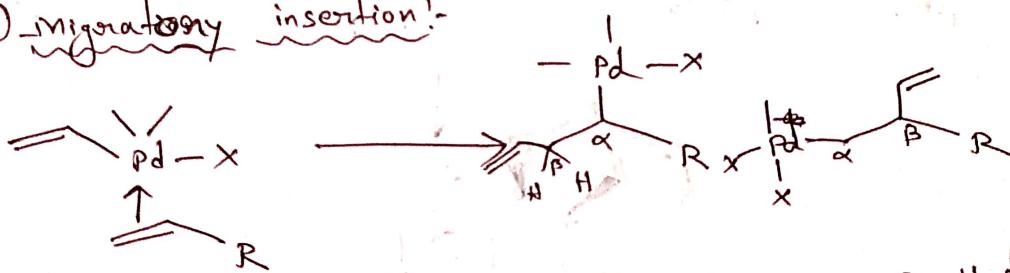
### ① oxidative addition



### ② Addition of olefin.

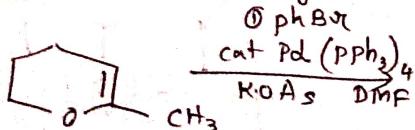


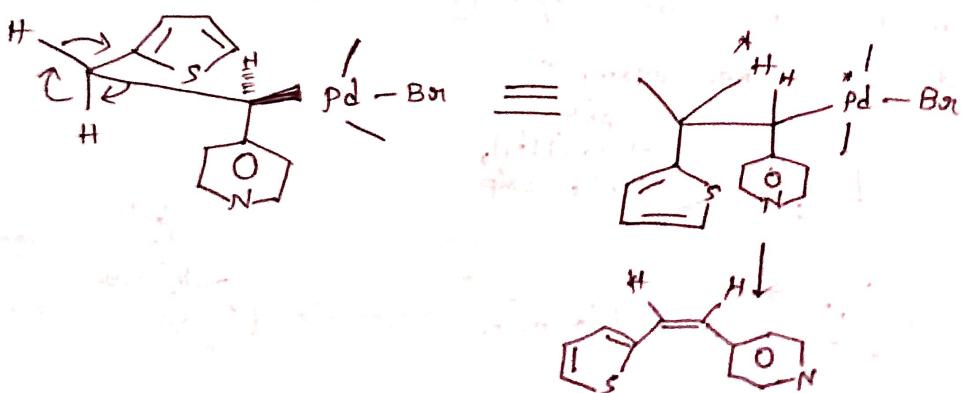
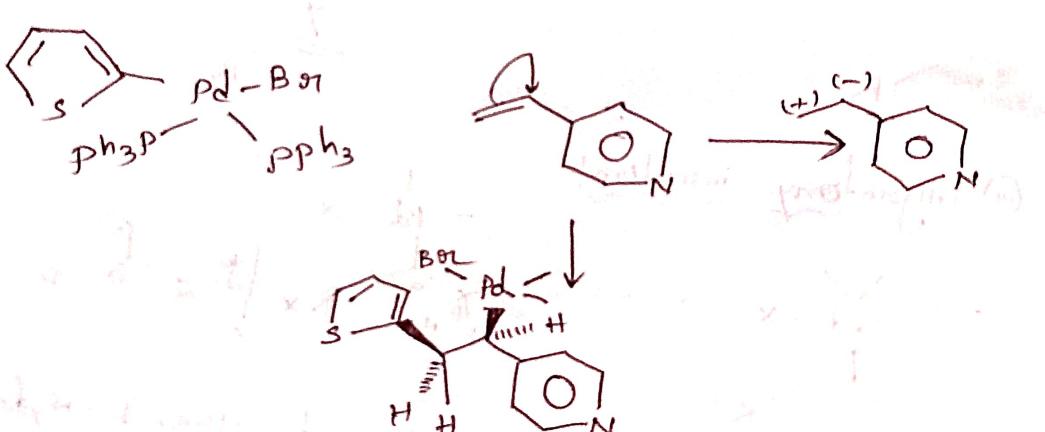
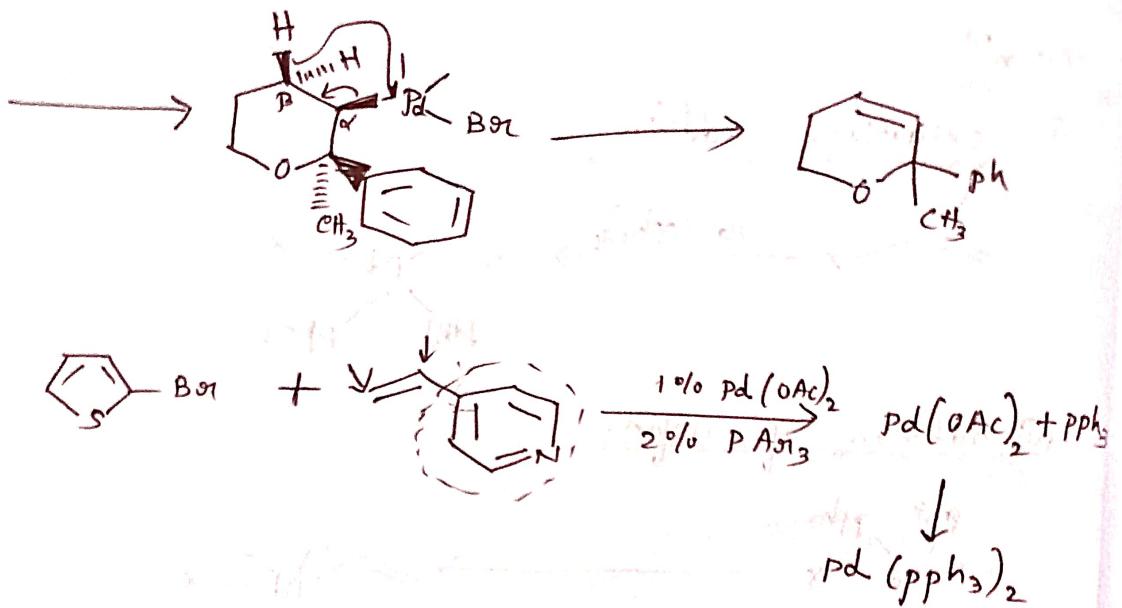
### ③ migratory insertion-

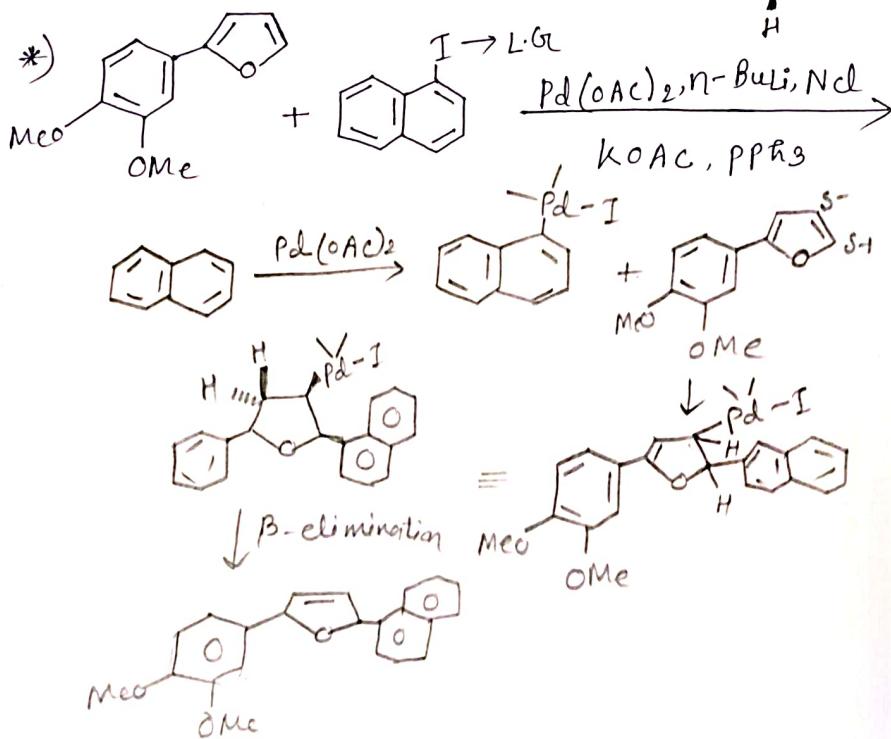
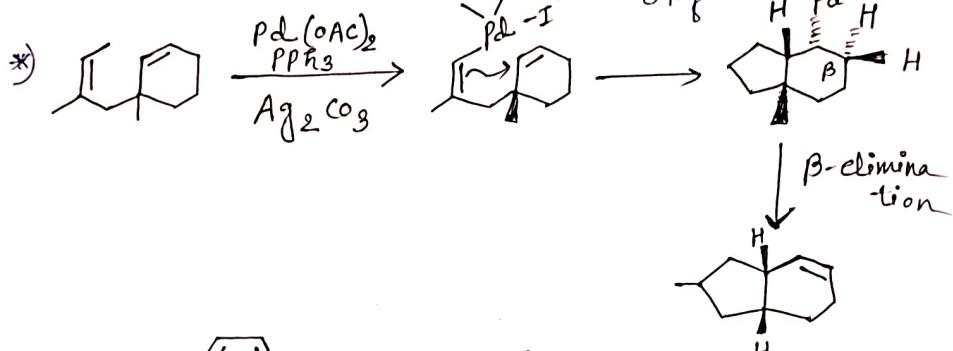
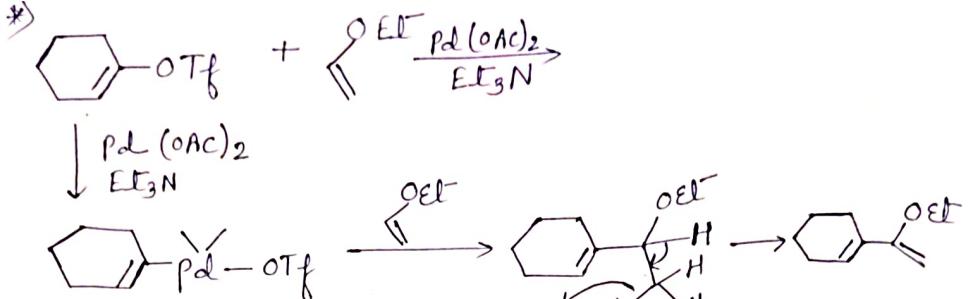


### ④ $\beta$ -elimination! - The metal and the $\beta$ -Hydrogen must be in syn geometry

Let us take example,

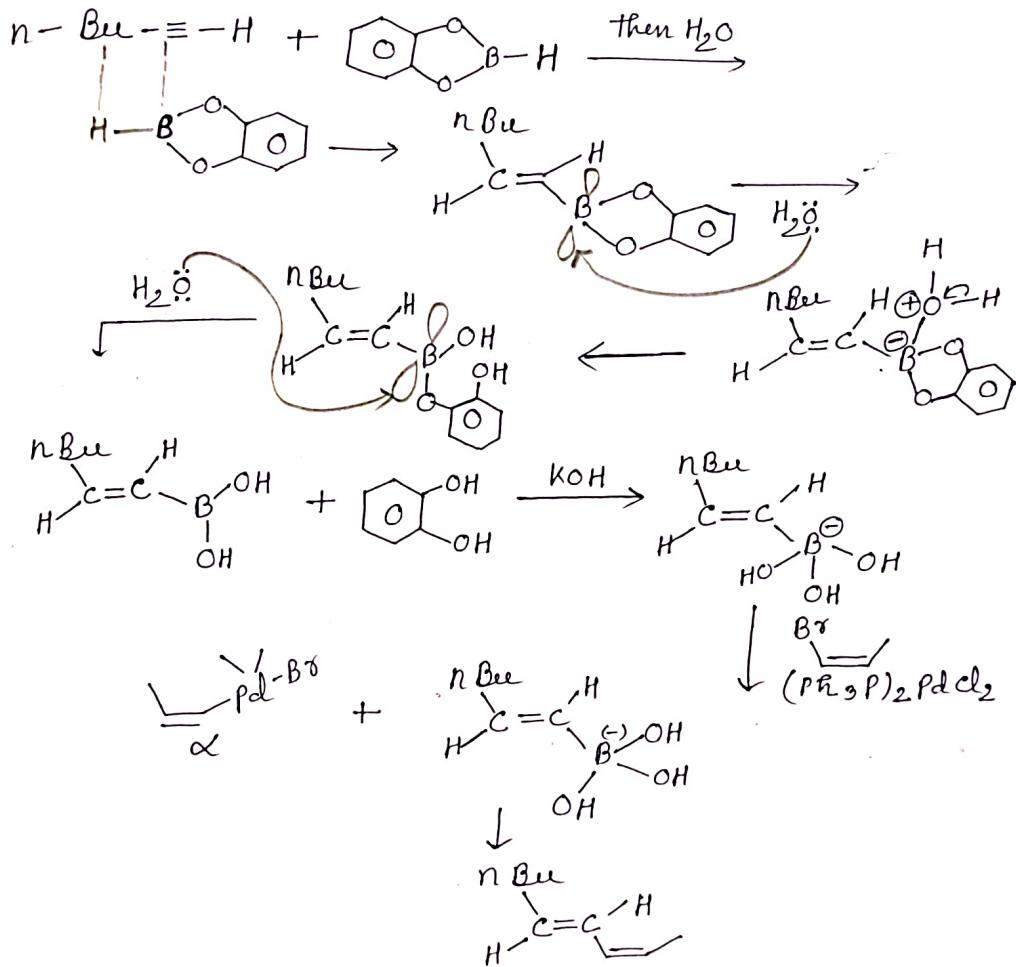


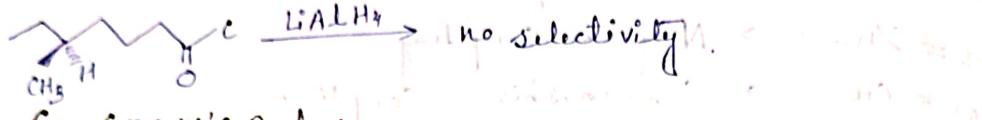
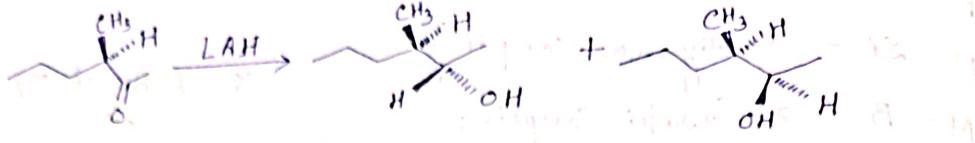




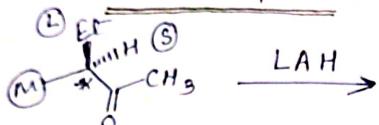
- \*  $R-X + R'-M \xrightarrow{Pd^0} R-R'$
- M = Li  $\rightarrow$  Hiyama coupling  
 M = B  $\rightarrow$  Suzuki Coupling  
 M = Zn  $\rightarrow$  Negishi Coupling  
 M = Cu  $\rightarrow$  Sonogashira Coupling  
 M = Sn  $\rightarrow$  Stille Coupling.
- X = I, Br, Cl, OTf,  
 OTs

## # Suzuki Coupling :-



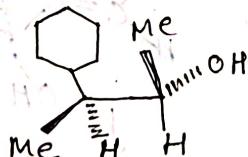
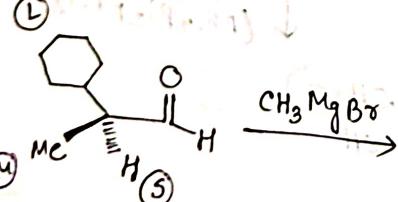
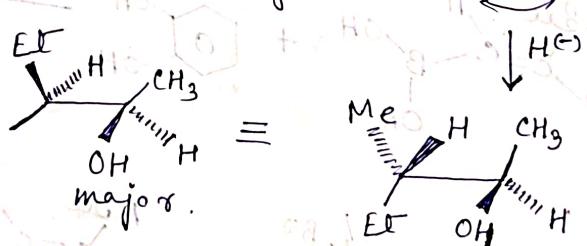
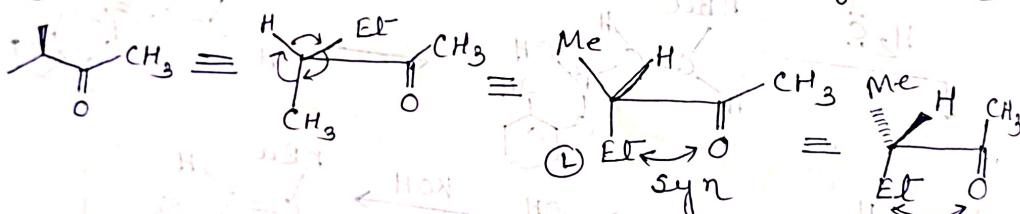


for Cram's Rule:

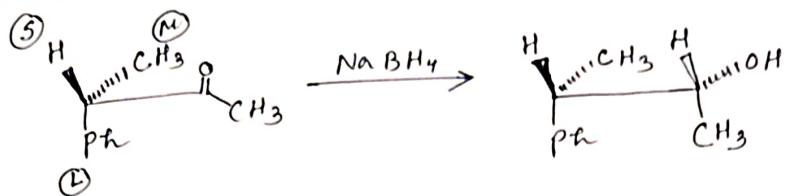


If ① is 'syn' to the  $C=O$  group, the nucleophile ( $H^-$ ) will attack the carbonyl carbon from the (M) side.

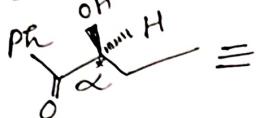
If ① group is 'anti' to the  $C=O$  group, the nucleophile ( $H^-$ ) will attack the carbonyl carbon from the (S) side.



attack from the side of ②



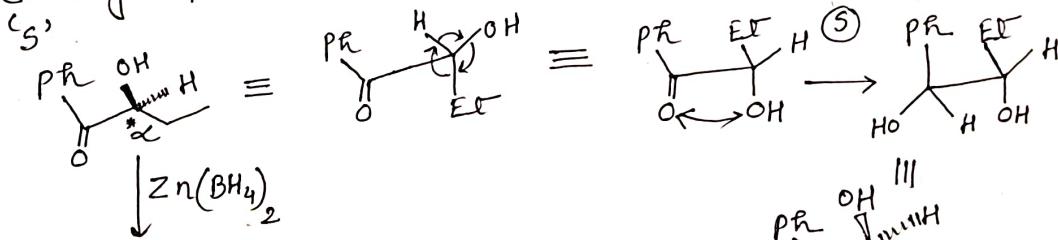
\* Cram's Chelate model:-



- 1) If  $\alpha$ -Carbon has a group that contain a lone pair of electrons then, Brønsted's chelate model is used. for eg; - $\ddot{\text{O}}\text{H}$ , - $\ddot{\text{O}}:$ , - $\ddot{\text{N}}\begin{matrix} \text{R} \\ \backslash \\ \text{R} \end{matrix}$ , - $\ddot{\text{N}}\text{H}_2$ , - $\overset{\text{O}}{\underset{\text{C}}{\text{C}}}=\text{NH}_2$ , - $\ddot{\text{S}}\text{H}$ , - $\ddot{\text{S}}\text{R}$ , - $\ddot{\text{S}}$  - But this model does not work when there is halogen (-F, -Cl, -Br, -I).

2) If the reagent used contain metal ion such as  $\text{Mg}^{2+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Ti}^{4+}$ ,  $\text{Ce}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Li}^+$  chelate formation takes place. But  $\text{Na}^+$  and  $\text{K}^+$  does not consider

3) If the lone pair containing group is  $\text{syn}^\circ$  to the  $\text{C=O}$  group, the nucleophile will attack from the side of



$\text{NaBH}_4$ , MeOH  $\longrightarrow$  Gram's Rule

$\text{NaBH}_4$ ,  $\text{CeCl}_3 \longrightarrow$  Gram's chelate rule