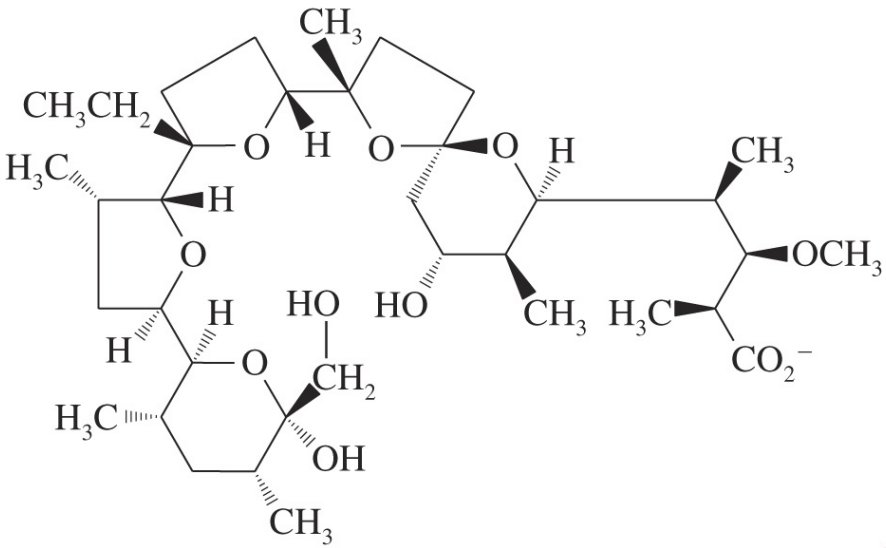
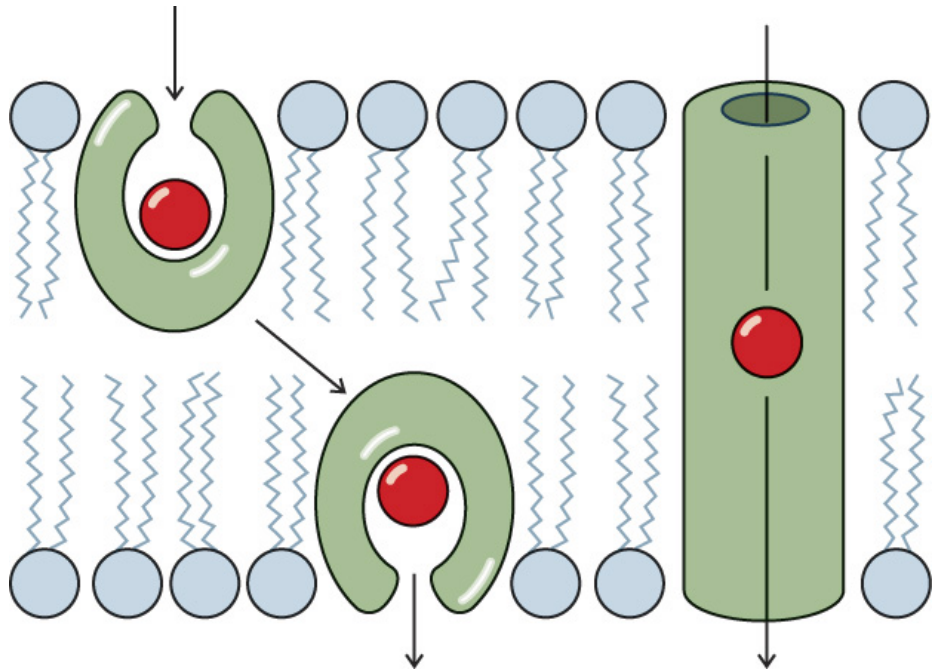
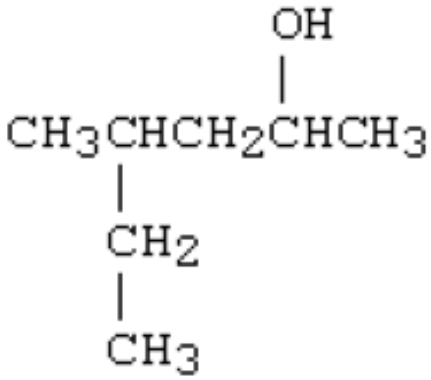
第11章 醇，醚的性質與合成



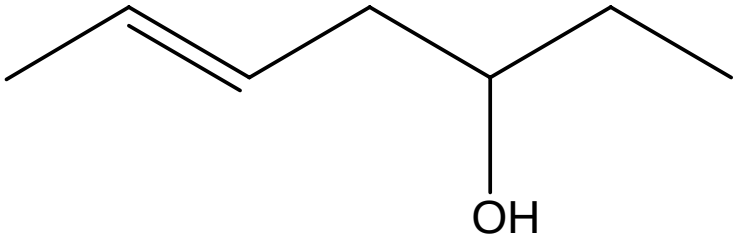
Monensin



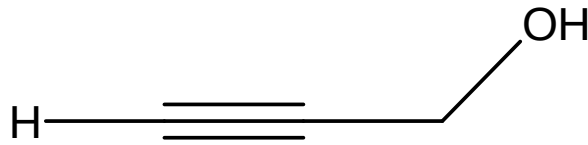
1)醇，醚之IUPAC命名



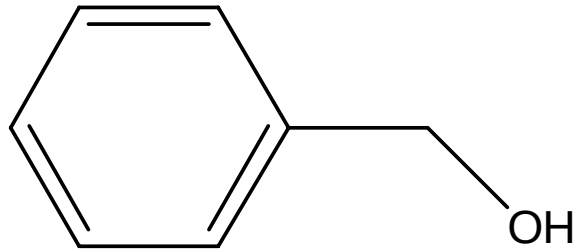
4-methy-2-hexanol



5-Hepten-3-ol



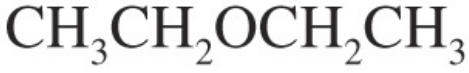
2-Propyn-1-ol



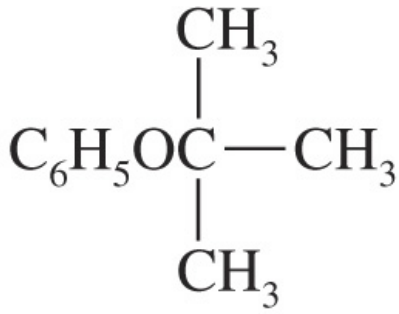
benzyl alcohol

俗名（common name）：

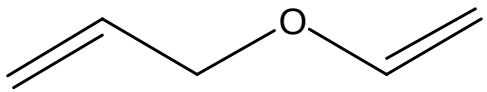
Ethyl methyl ether



Diethyl ether

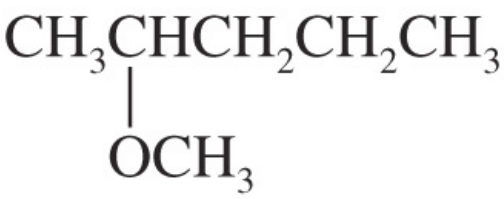


***tert*-Butyl phenyl ether**



Allyl vinyl ether

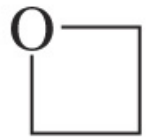
IUPAC命名：



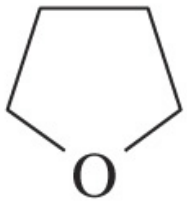
2-Methoxypentane

1,2-Dimethoxyethane

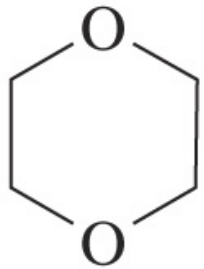
Oxacyclopropane or oxirane (ethylene oxide)



Oxacyclobutane or oxetane



Oxacyclopentane (tetrahydrofuran)

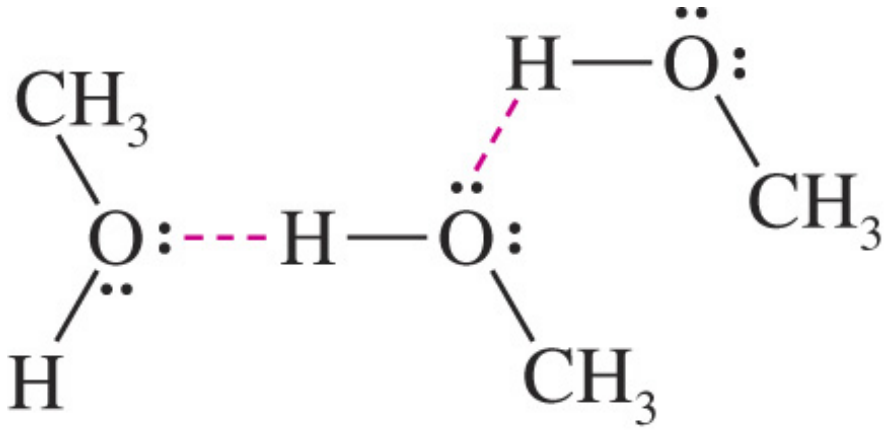


1,4-Dioxacyclohexane (1,4-dioxane)

課堂練習page495:請給出C3H8O和C4H10O所有醇和醚的結構，並予以命名

2)醇，醚之物理性質及醇的酸性比較

a)醇的沸點比同分子量的醚高很多：



Hydrogen bonding between molecules of methanol

b)醇和醚在水中都有一定的溶解度(solubility)

c)醇的酸性：（acidity, PKa）

Relative Acidity

$$H_2O > ROH > RC{\equiv}CH > H_2 > NH_3 > RH$$

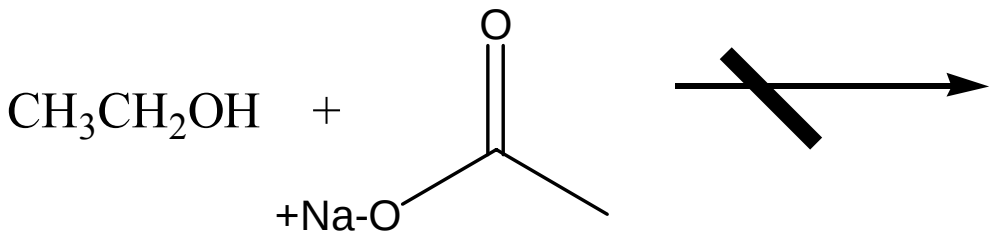
Acid	pK_a
CH_3OH	15.5
H_2O	15.74
CH_3CH_2OH	15.9
$(CH_3)_3COH$	18.0

烷基越多，烷氧陰離子的被水穩定的作用就越小。

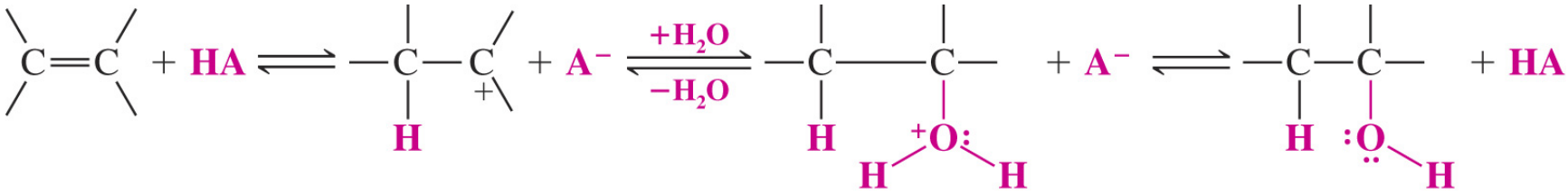
課堂練習 page503;判斷下列酸碱反應是否能發生

$CH_3CH_2OH + NaNH_2 \longrightarrow CH_3CH_2O^-Na^+ + NH_3$

$CH_3CH_2OH + NaC{\equiv}CH \longrightarrow CH_3CH_2O^-Na^+ + HC{\equiv}CH$

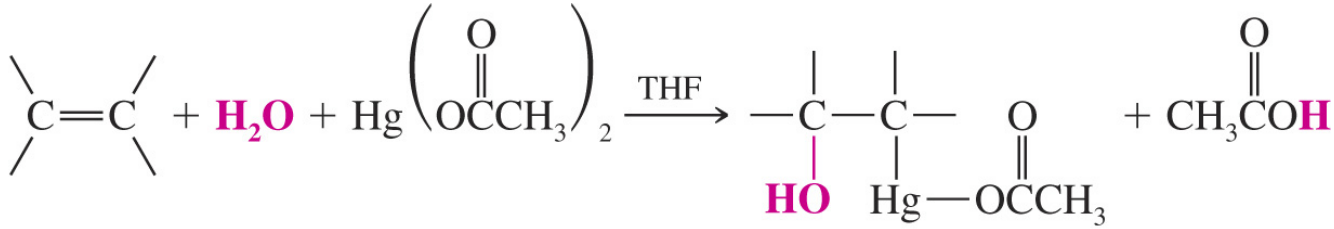


3)醇的合成方法（詳見第九章）

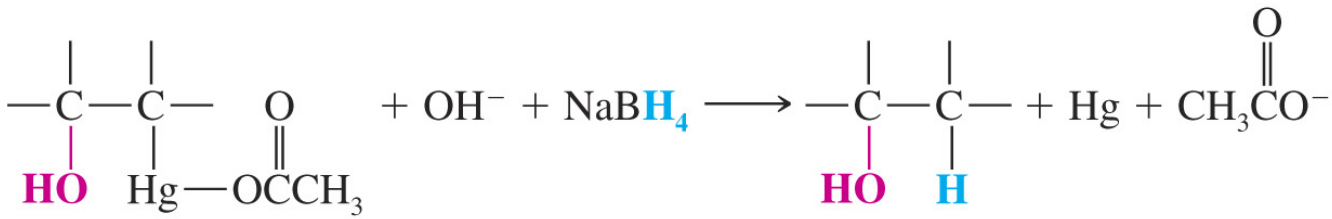


Alkene **Alcohol**

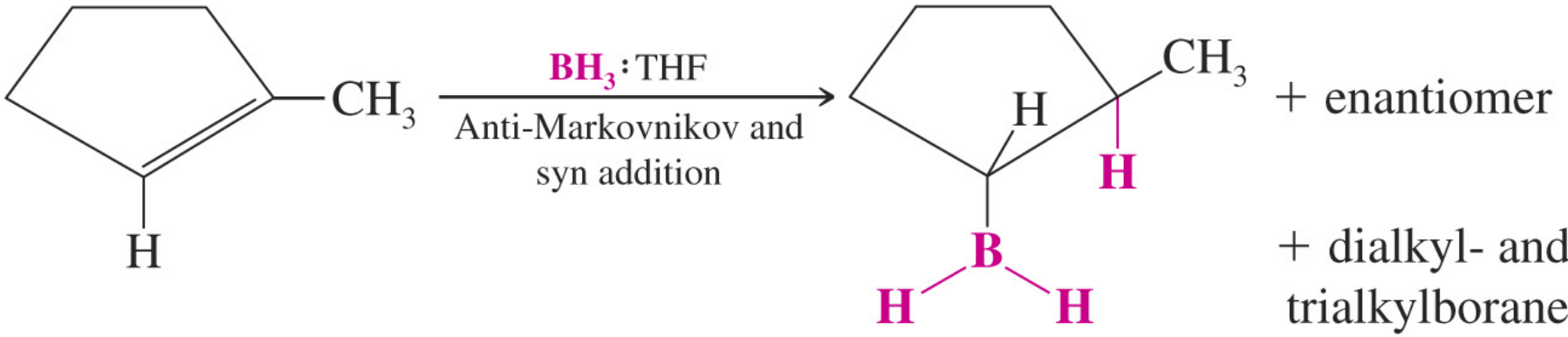
Oxymercuration



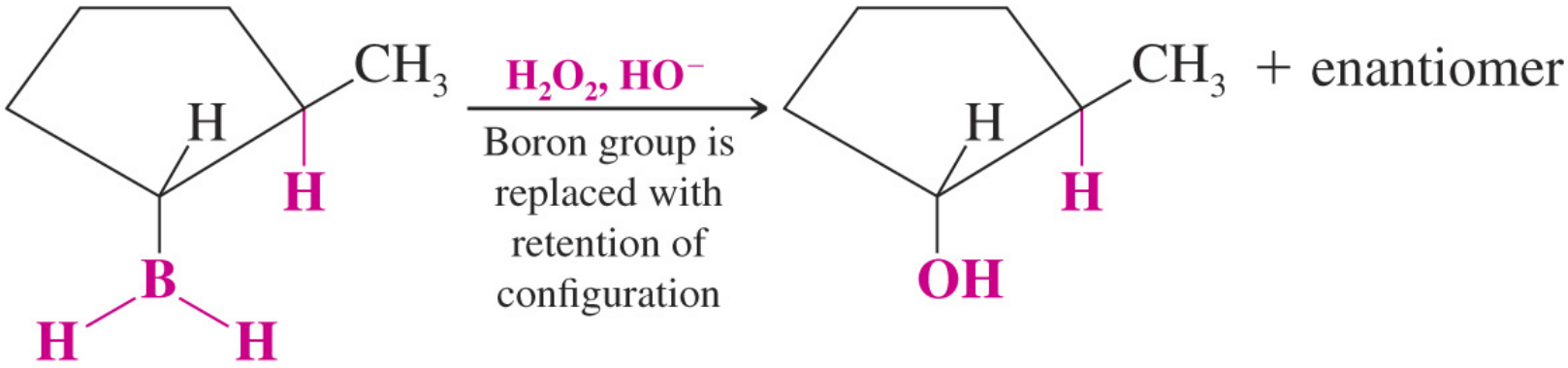
Demercuration



Hydroboration



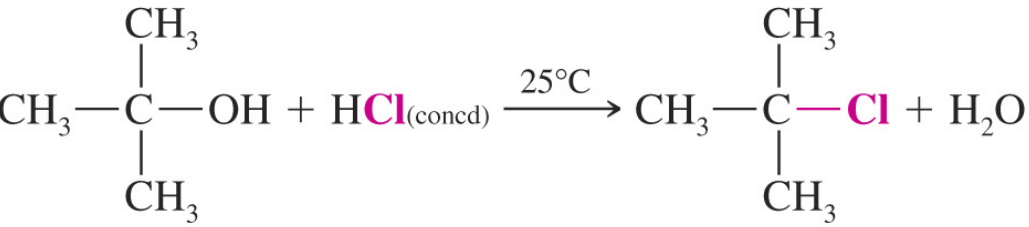
Oxidation



4)醇類的化學反應(合併至下一章)

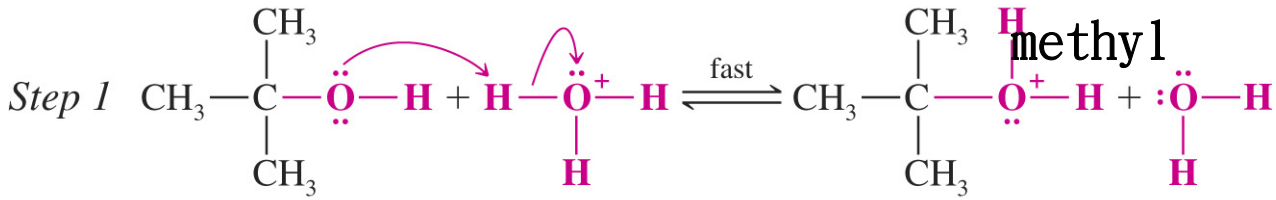
A)將alcohols轉化成alkyl halides之方法

a) Reaction of Alcohols with Hydrogen Halides

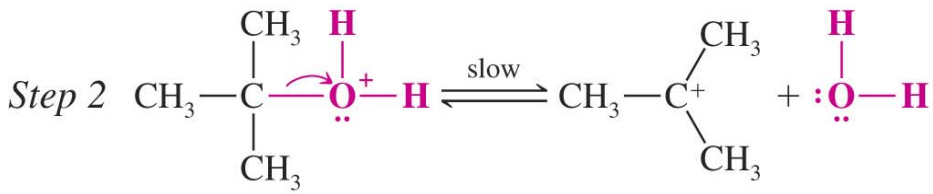


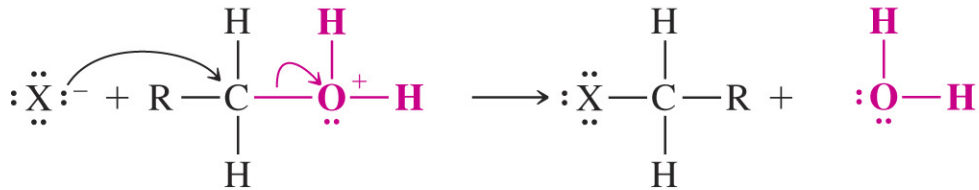
Hydrogen halide HI > HBr > HCl > HF(see page 263)

Type of alcohol 3° > 2° > 1° < methyl



(SN1 3° choloride, bromide)(2° bromide)

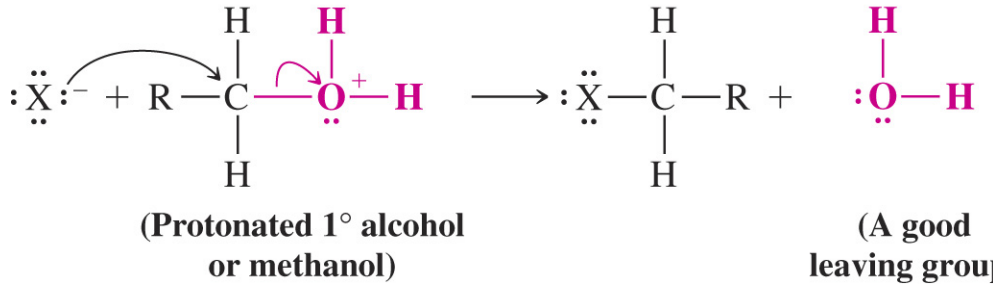




(1° bromide)

$$CH_3CH_2CH_2CH_2OH + HBr_{(concd)} \xrightarrow[\text{reflux}]{} CH_3CH_2CH_2CH_2Br$$

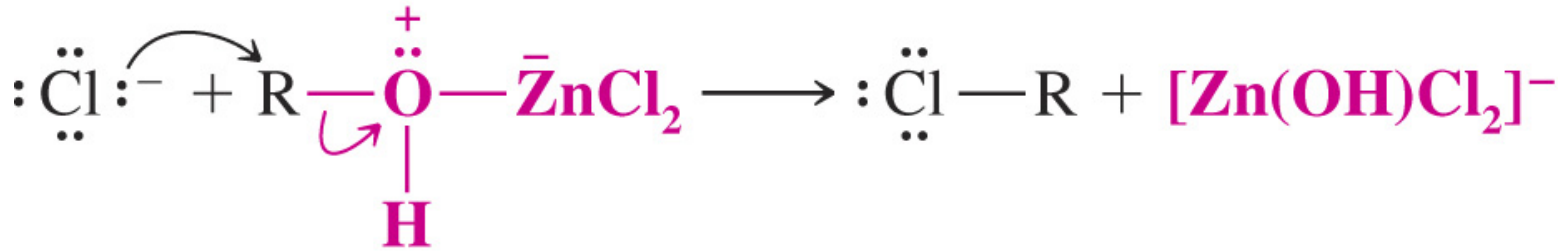
(95%)



Primary and methyl alcohols

由一級，二級醇與鹽酸反應製備chlorides, 由於Cl^-的親核性在protic solvent中較低，故需要Lewis的參與:

$$R-\ddot{O}: + ZnCl_2 \rightleftharpoons R-\overset{+}{\ddot{O}}-\bar{Z}nCl_2$$
(H)



$$[Zn(OH)Cl_2]^- + H^+ \rightleftharpoons ZnCl_2 + H_2O$$

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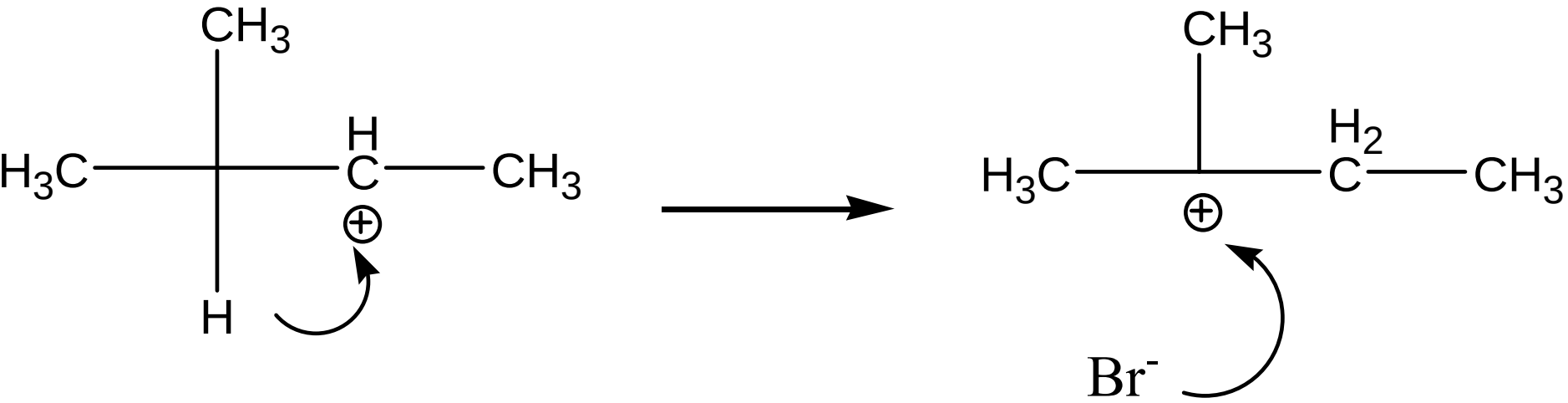
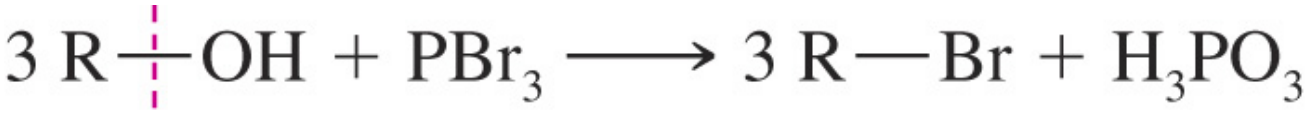
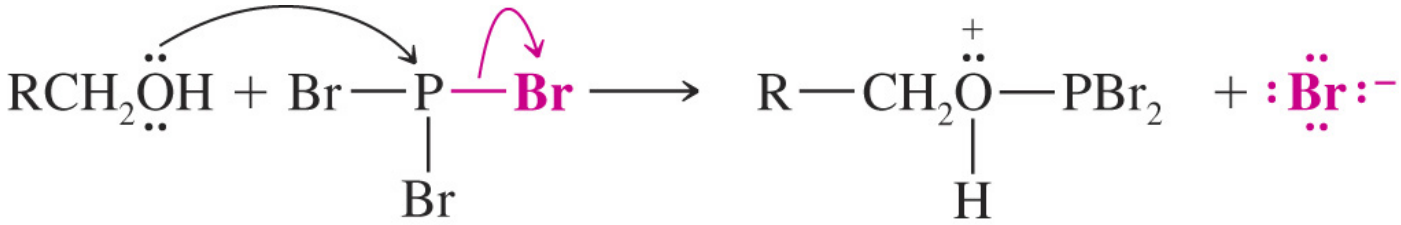
三級醇比二級醇與HX反應快的原因是正碳離子的穩定性。甲醇比一級醇反應快的原因是Sn2反應的立體障礙小。



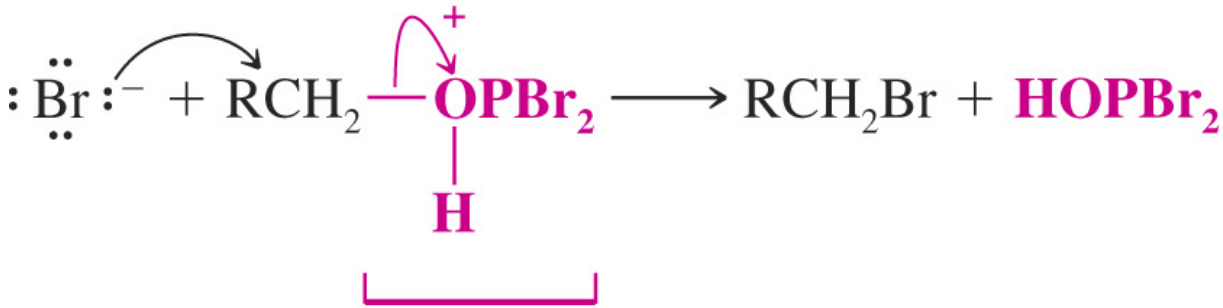
b) Reactions of Alcohols with Reaction of Alcohols with PBr_3 and $SOCl_2$



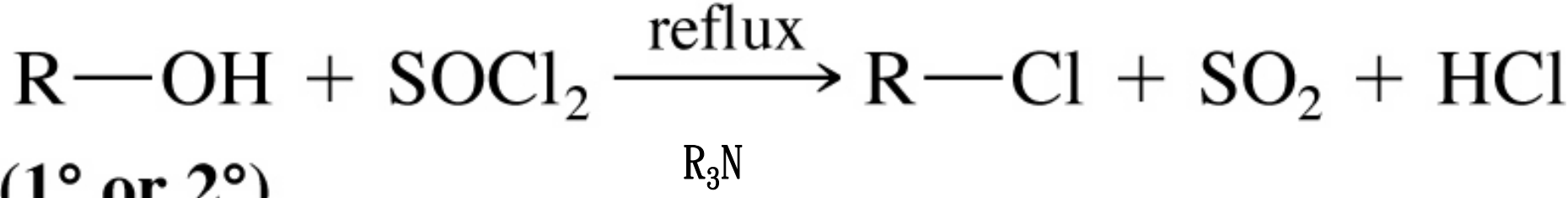
(1° or 2°)

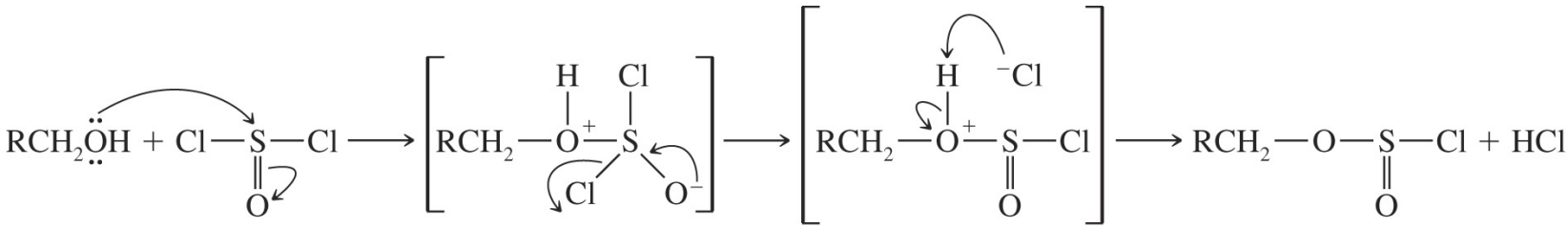


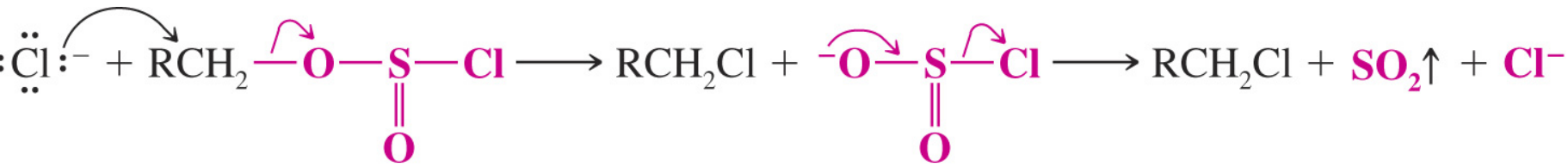
Protonated alkyl dibromophosphite

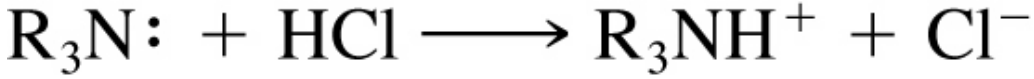


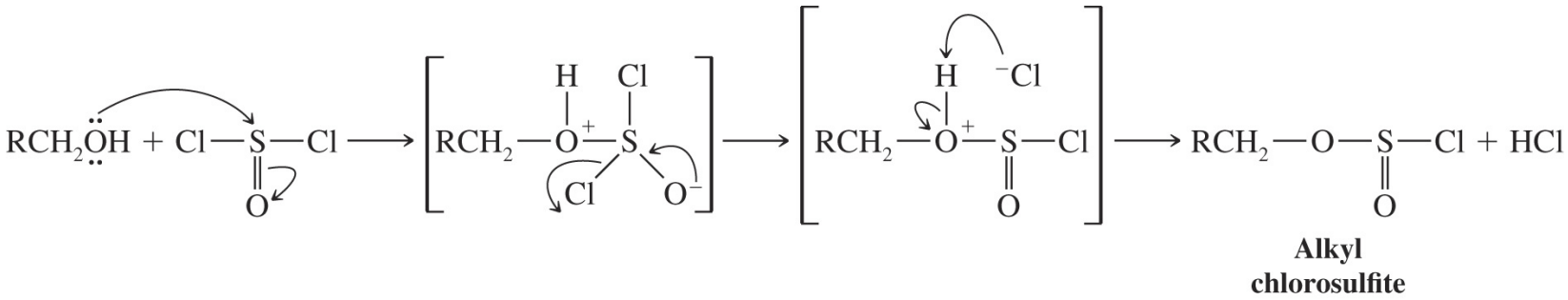
A good leaving group

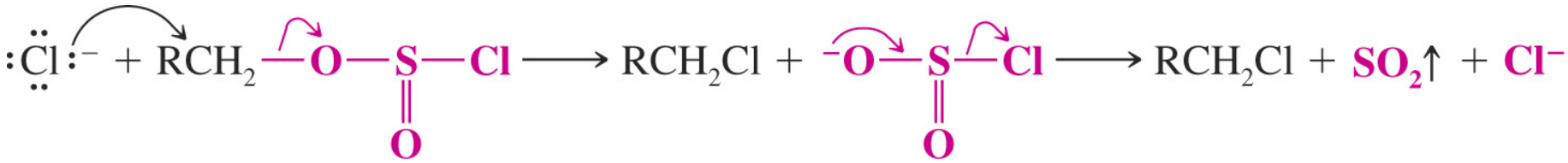

reflux
R—OH + SOCl2
R—Cl + SO2 + HCl
R3N
(1° or 2°)


RCH2OH + Cl—S—Cl
O
RCH2—O+—S
H
Cl
Cl
O−
RCH2—O—S—Cl + HCl
O
Alkyl
chlorosulfite


Cl:− + RCH2—O—S—Cl
O
RCH2Cl + −O—S—Cl
O
RCH2Cl + SO2↑ + Cl−


R3N: + HCl
R3NH+ + Cl−





$$R_3N: + HCl \longrightarrow R_3NH^+ + Cl^-$$

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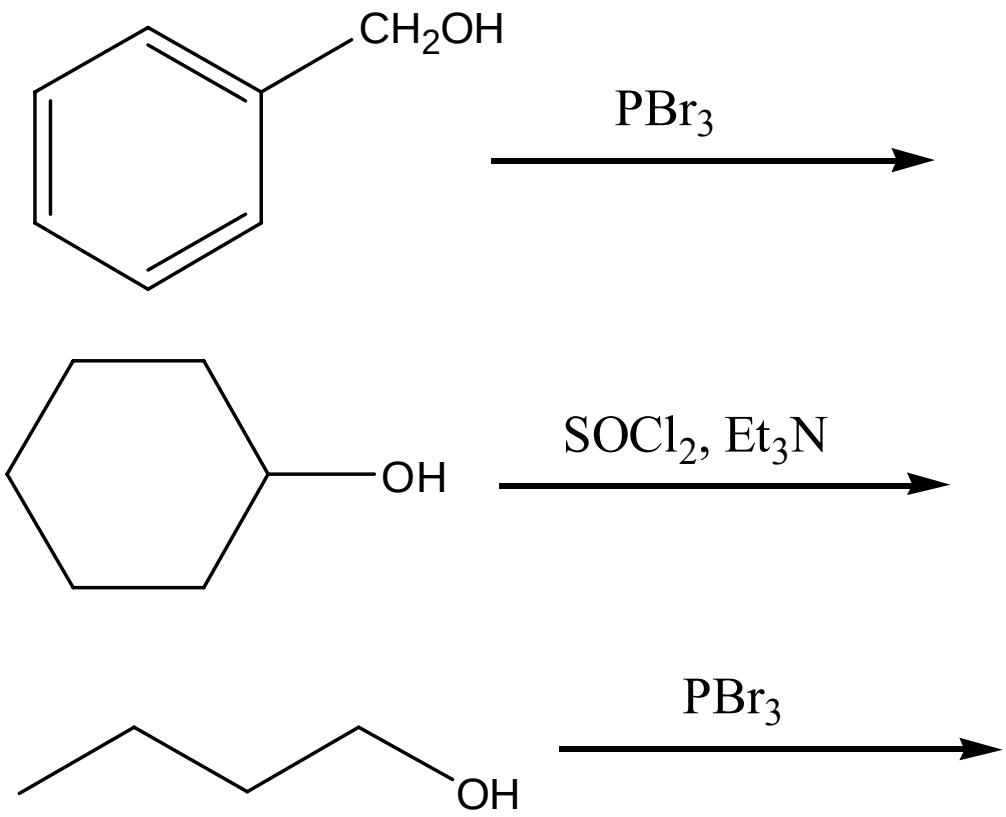
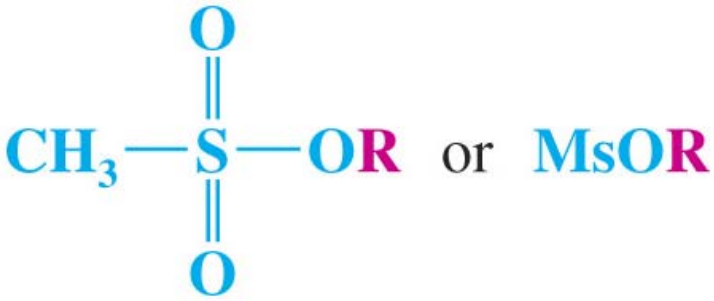


c) Tosylates, Mesylates, and Triflates

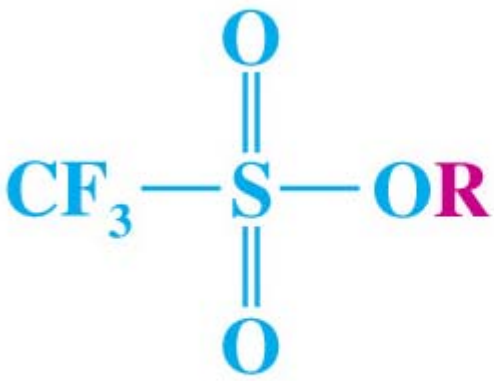


or MsOR

An alkyl mesylate

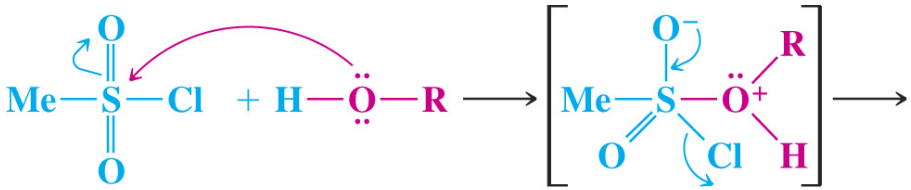
or TsOR

An alkyl tosylate



or TfOR

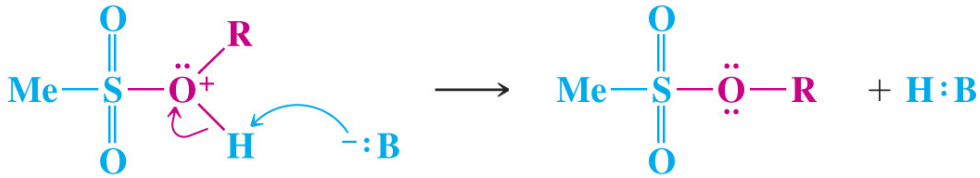
An alkyl triflate



Methanesulfonyl chloride **Alcohol**

The alcohol oxygen attacks the sulfur atom of the sulfonyl chloride.

The intermediate loses a chloride ion.



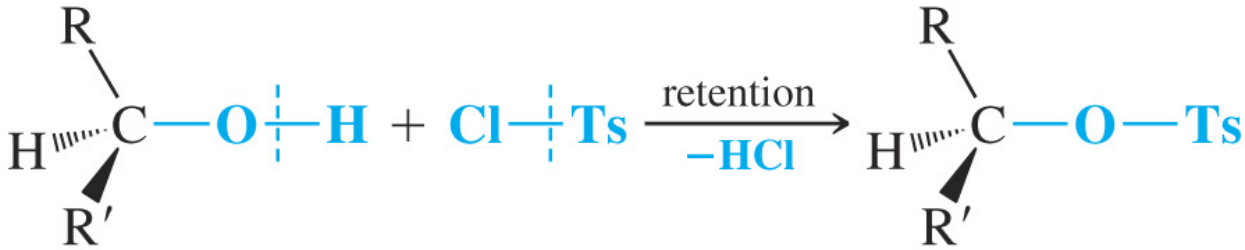
(a base) **Alkyl methanesulfonate**

Loss of a proton leads to the product.

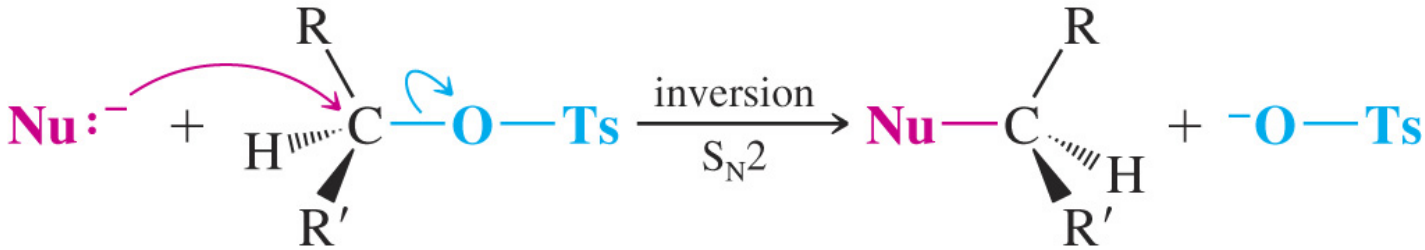
Alkyl sulfonate (tosylate, mesylate, etc.)

Sulfonate ion (very weak base— a good leaving group)

Step 1



Step 2



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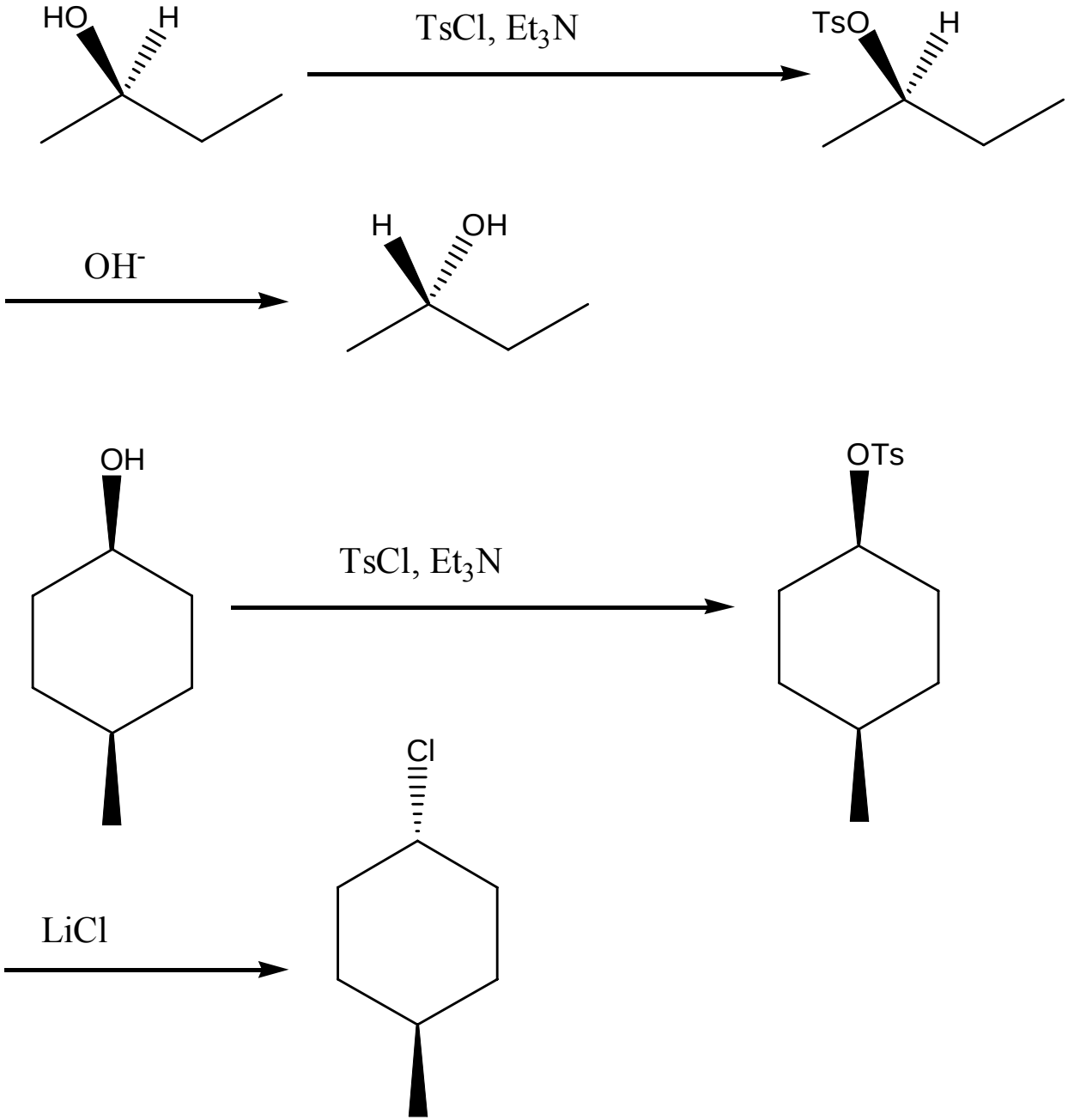
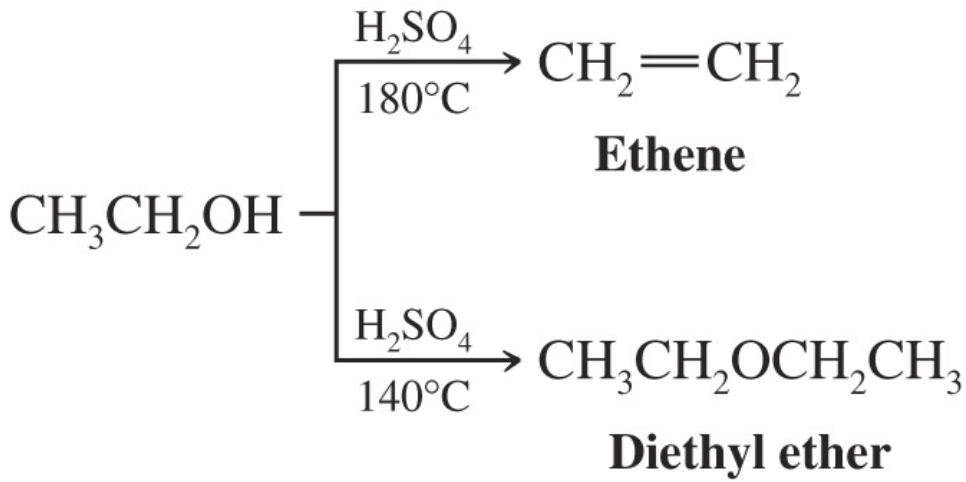
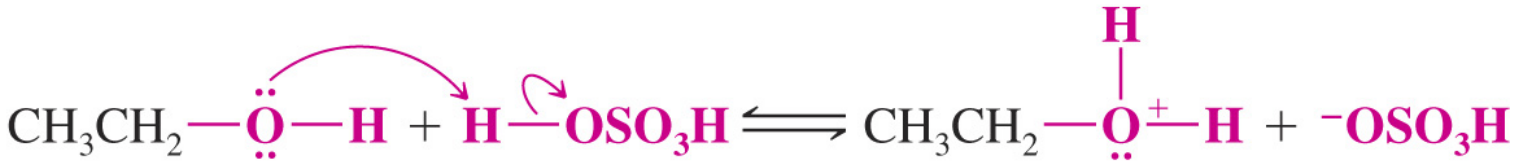


5)醚類化合物的製備

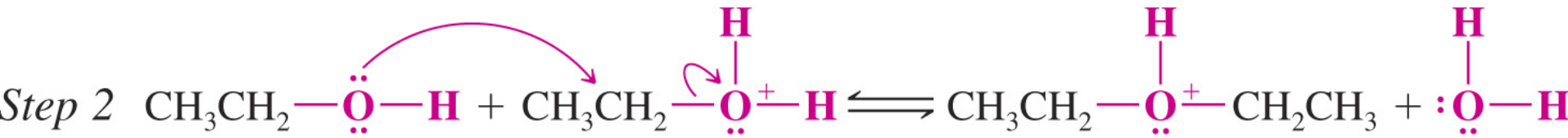
a)醇分子間的酸催化脫水聚合反應(intermolecular dehydration of alcohol)



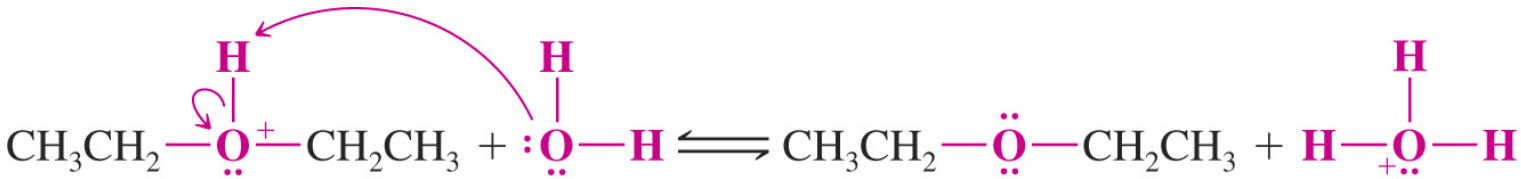
此反應的應用性不高，所生成醚的R基團要相同且為一級

Step 1 

This is an acid–base reaction in which the alcohol accepts a proton from the sulfuric acid.

Step 2 

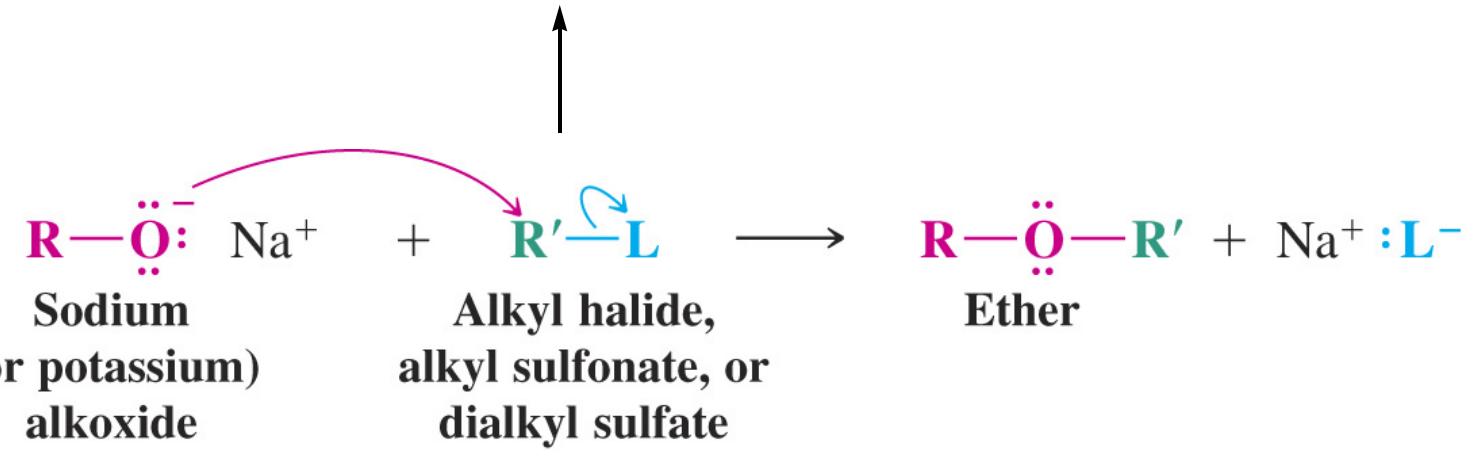
Another molecule of the alcohol acts as a nucleophile and attacks the protonated alcohol in an S_N2 reaction.

Step 3 

Another acid–base reaction converts the protonated ether to an ether by transferring a proton to a molecule of water (or to another molecule of the alcohol).

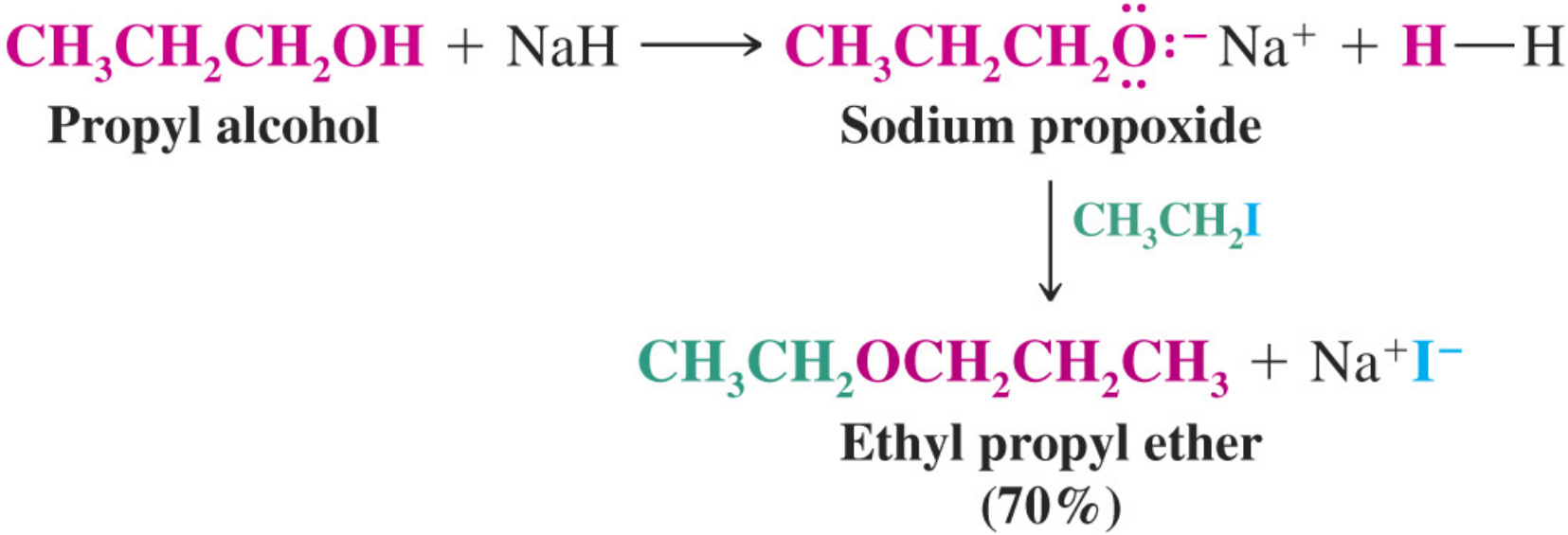
b) Williamson method

R基團爲一級或甲基



The alkoxide ion reacts with the substrate in an S_N2 reaction, with the resulting formation of an ether. The substrate must be unhindered and bear a good leaving group. Typical substrates are 1° or 2° alkyl halides, alkyl sulfonates, and dialkyl sulfates, that is,

—L = —Br:, —I:, —OSO_2R'', or —OSO_2OR''


CH3CH2CH2OH + NaH
Propyl alcohol
CH3CH2CH2O:− Na+ + H—H
Sodium propoxide
CH3CH2I
CH3CH2OCH2CH2CH3 + Na+I−
Ethyl propyl ether
(70%)

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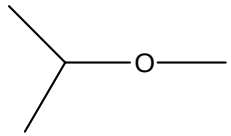
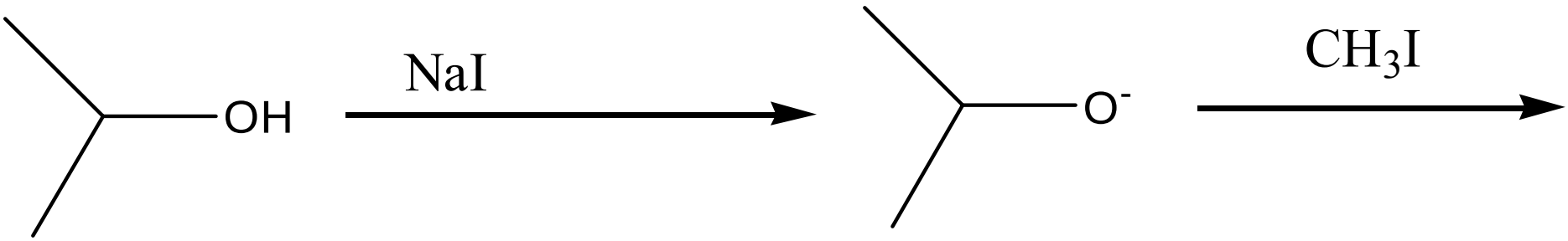
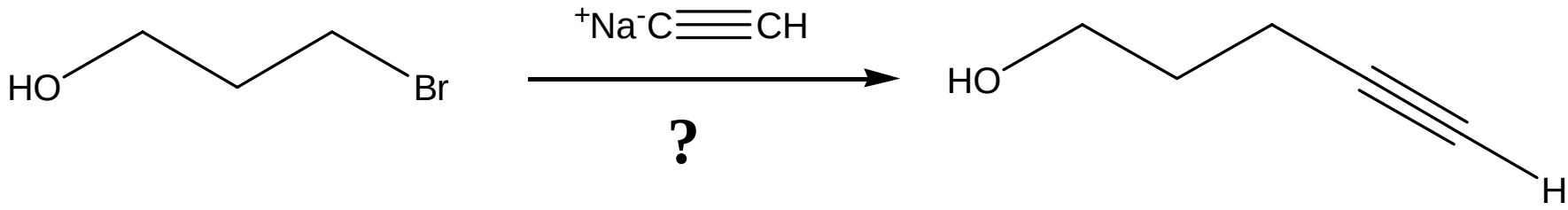
設計合成之路線 



c）官能基之保護: *tert*-butyl ether, silyl ether:

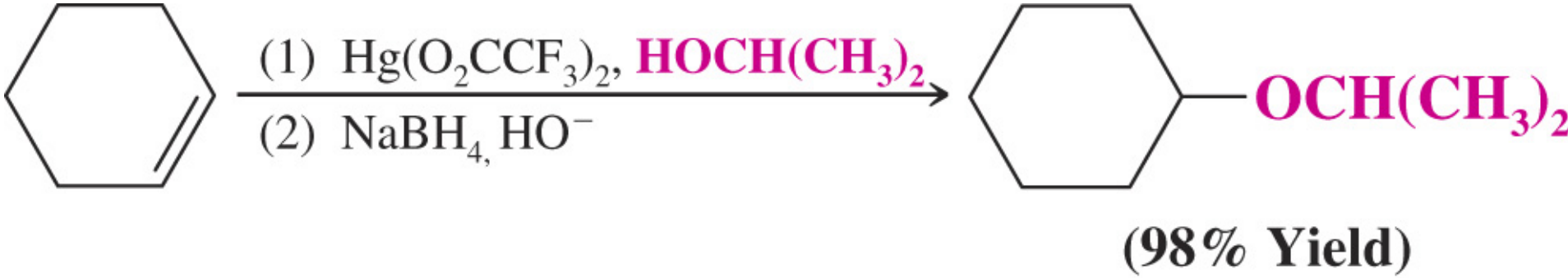


$$HOCH_2CH_2CH_2Br \xrightarrow[(2)\ CH_2{=}C(CH_3)_2]{(1)\ H_2SO_4} (CH_3)_3COCH_2CH_2CH_2Br \xrightarrow{NaC{\equiv}CH}$$

$$(CH_3)_3COCH_2CH_2CH_2C{\equiv}CH \xrightarrow{H_3O^+/H_2O} HOCH_2CH_2CH_2C{\equiv}CH + (CH_3)_3COH$$

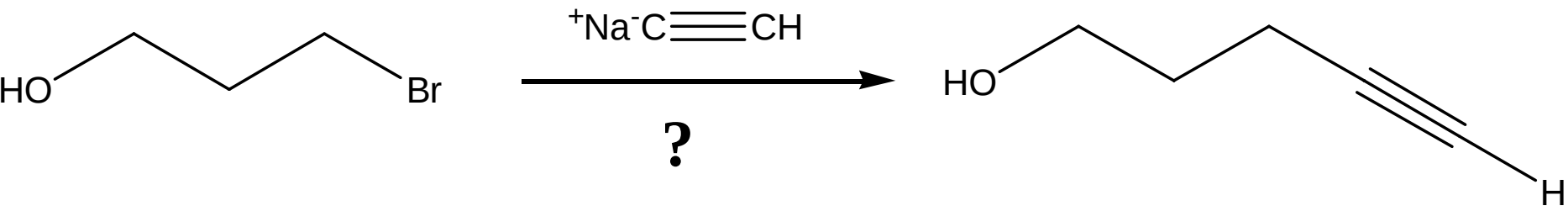
4-Pentyn-1-ol

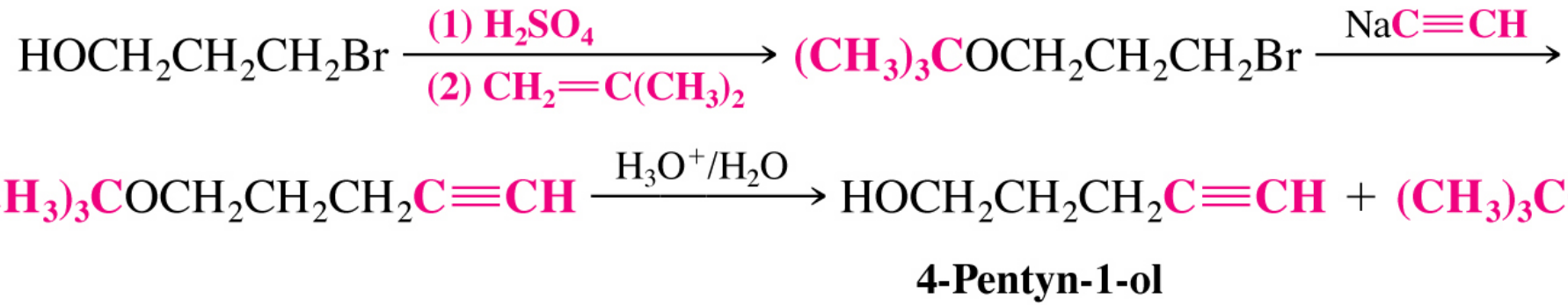
c) Synthesis of Ethers by Alkoxymercuration-Demercuration



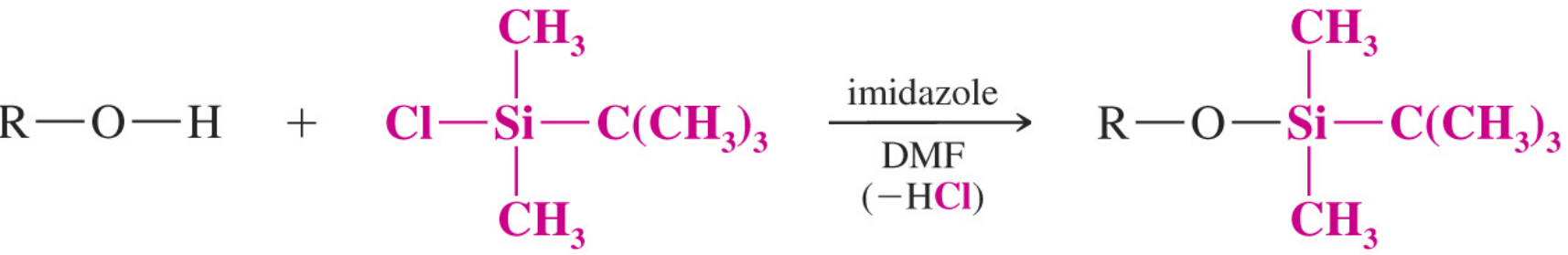
請給出反應機制

d) *tert*-Butyl Ethers c) *tert*-butyl ether, silyl ether:
官能基之保護



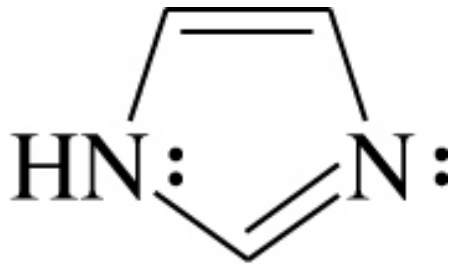

HOCH2CH2CH2Br
(1) H2SO4
(2) CH2=C(CH3)2
(CH3)3COCH2CH2CH2Br
NaC≡CH
(CH3)3COCH2CH2CH2C≡CH
H3O+/H2O
HOCH2CH2CH2C≡CH + (CH3)3COH

4-Pentyn-1-ol

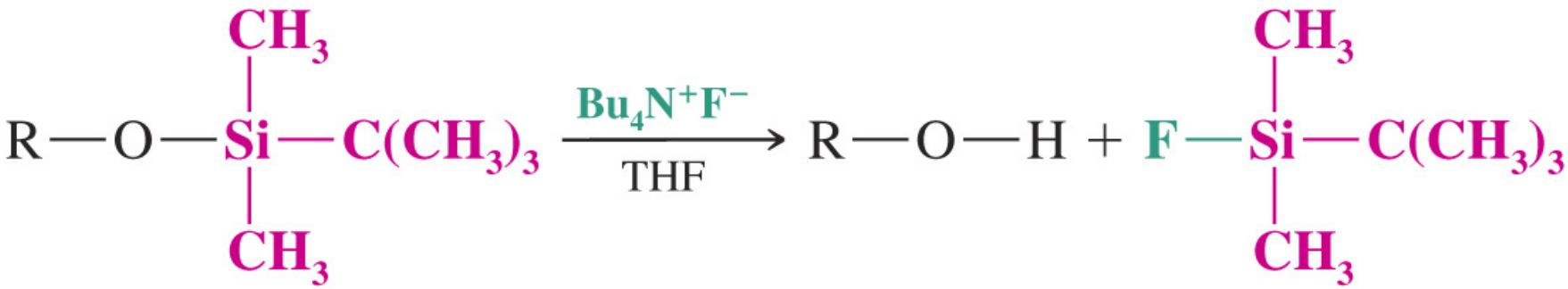


tert-Butylchlorodimethylsilane
(TBDMSCl)

(R—O—TBDMS)

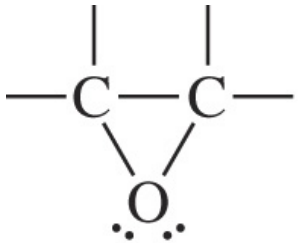


Imidazole

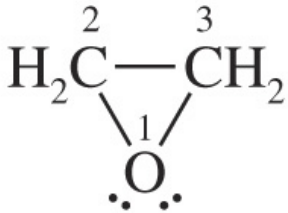


(R—O—TBDMS)

6）環氧化合物的製備及開環反應

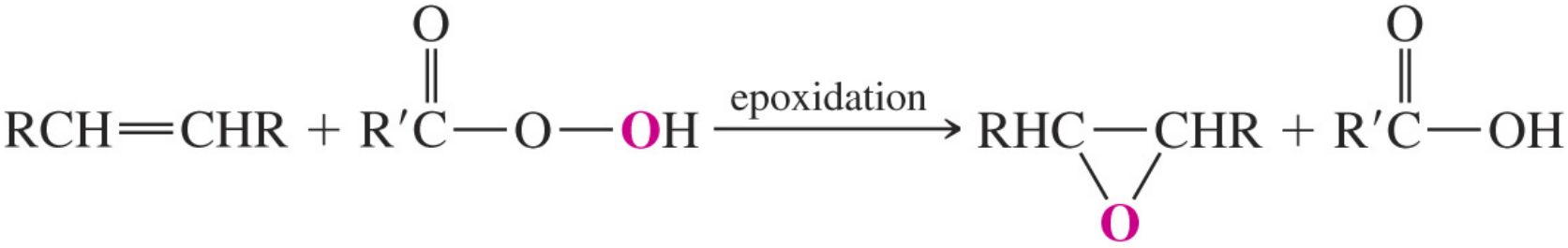


An epoxide

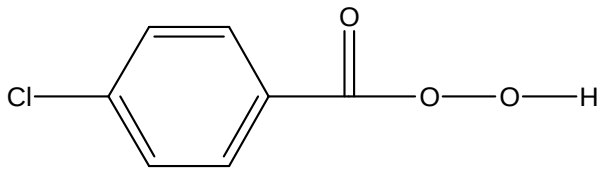


IUPAC name: oxirane
Common name: ethylene oxide

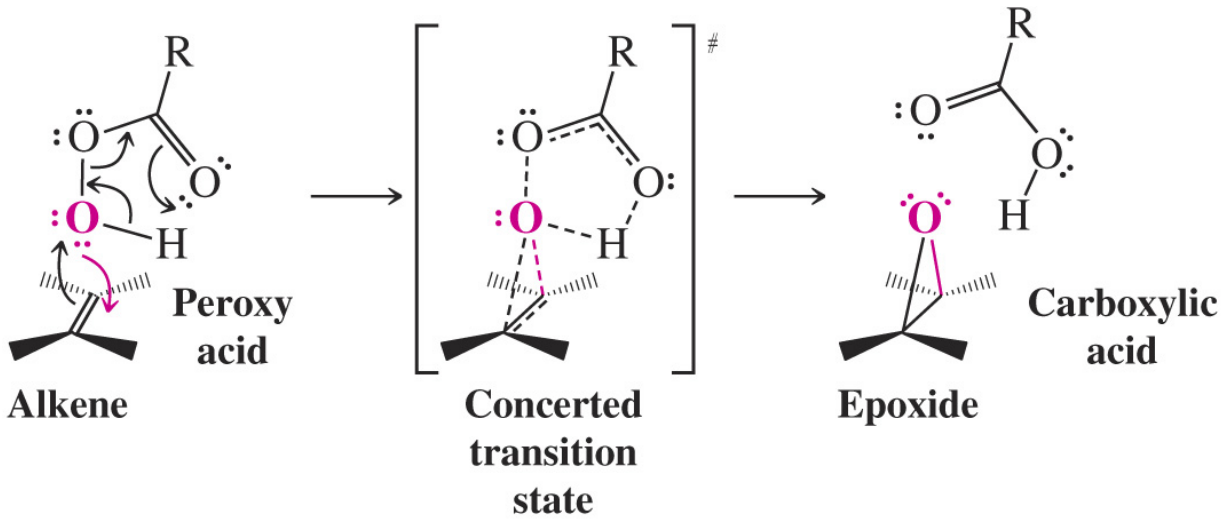
a）環氧化合物的製備



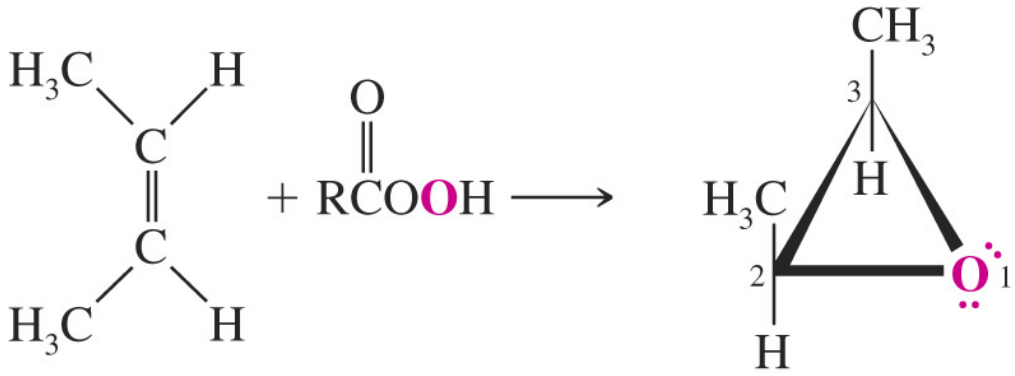
An alkene　　A peroxy acid　　An epoxide (or oxirane)



m-CPBA

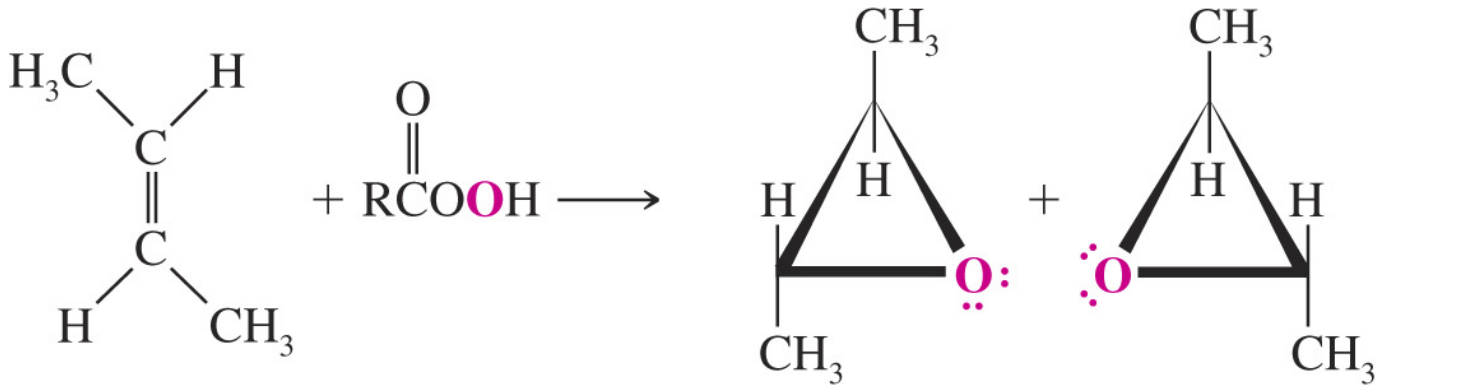


The peroxy acid transfers an oxygen atom to the alkene in a cyclic, single-step mechanism. The result is the syn addition of the oxygen to the alkene, with the formation of an epoxide and a carboxylic acid.



***cis*-2-Butene**

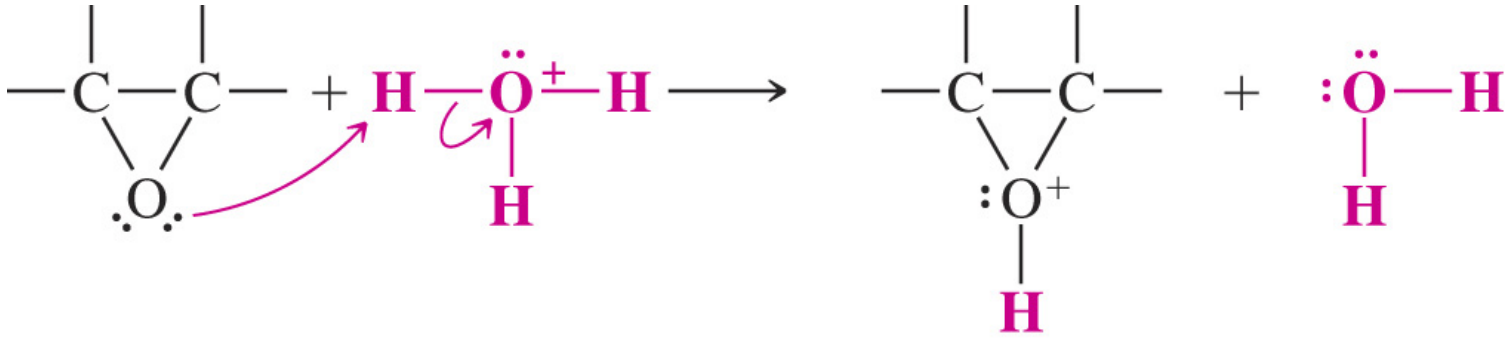
***cis*-2,3-Dimethyloxirane**
(a meso compound)



***trans*-2-Butene**

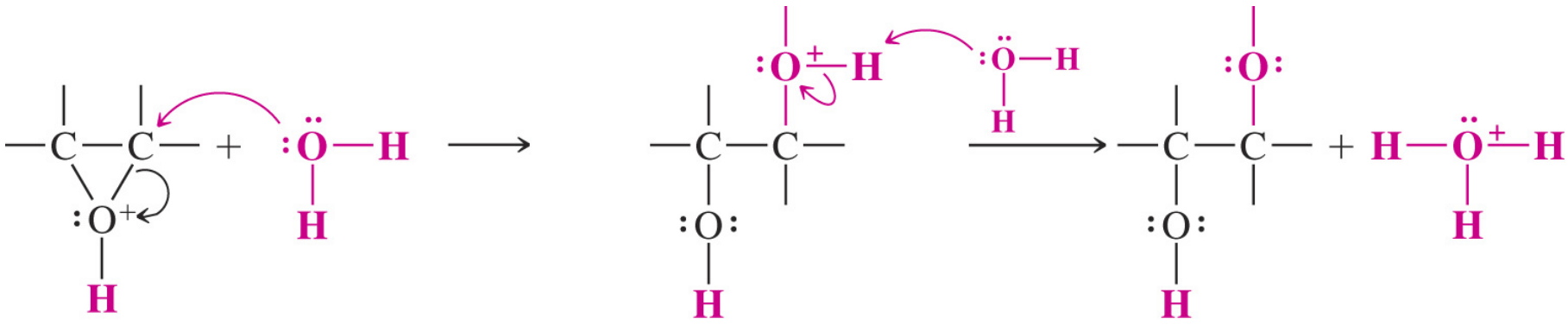
Enantiomeric *trans*-2,3-dimethyloxiranes

b）環氧化合物開環反應



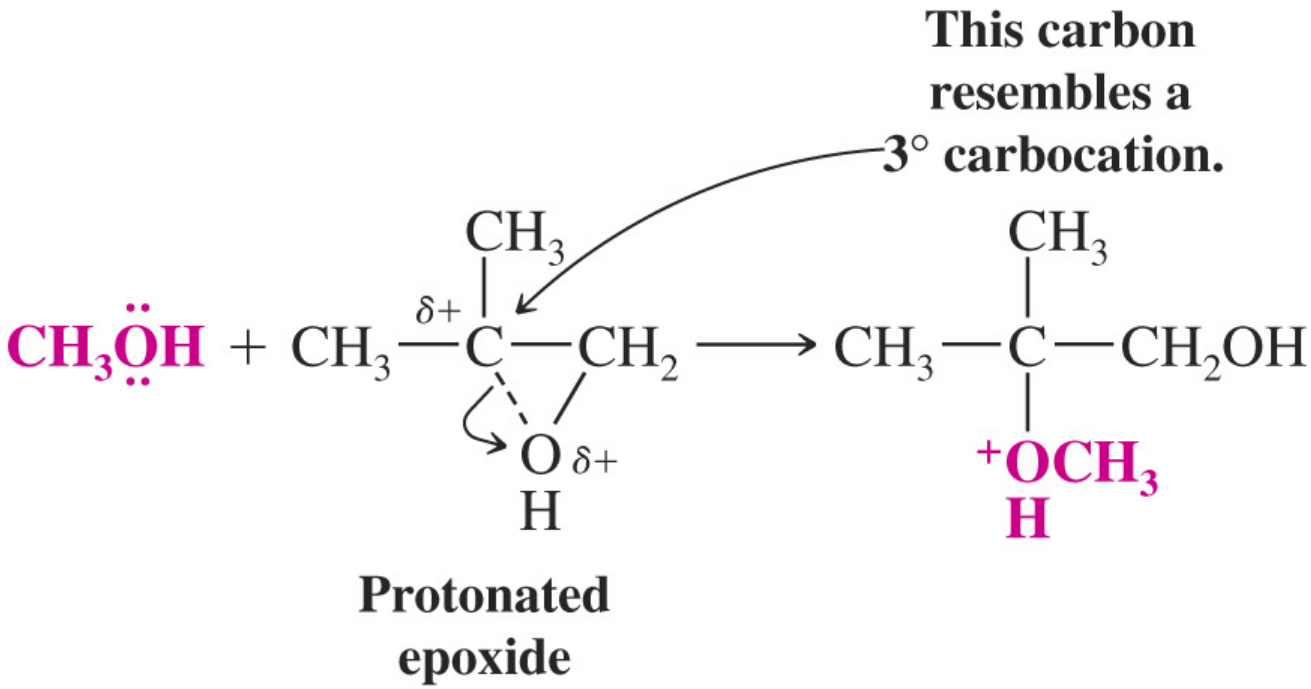
Epoxide **Protonated epoxide**

The acid reacts with the epoxide to produce a protonated epoxide.

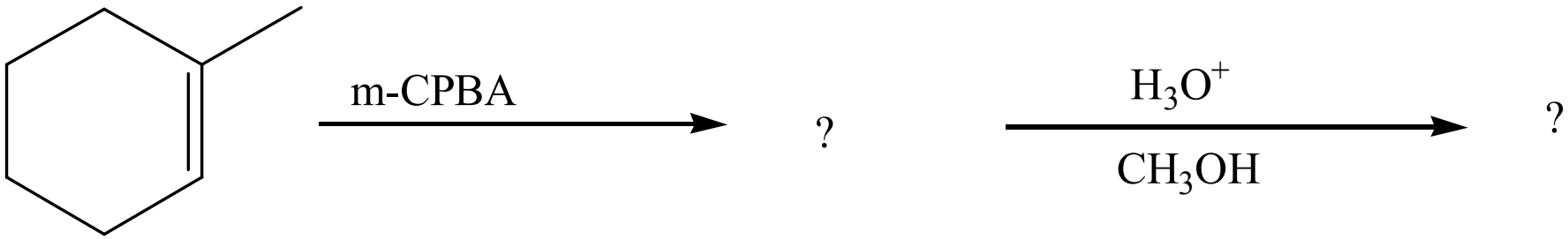


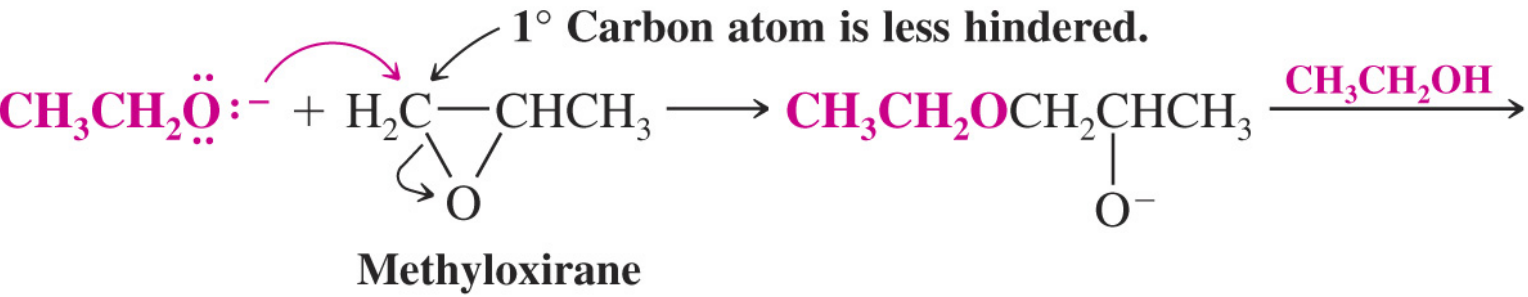
Protonated epoxide **Weak nucleophile** **Protonated 1,2-diol** **1,2-Diol**

The protonated epoxide reacts with the weak nucleophile (water) to form a protonated 1,2-diol, which then transfers a proton to a molecule of water to form the 1,2-diol and a hydronium ion.

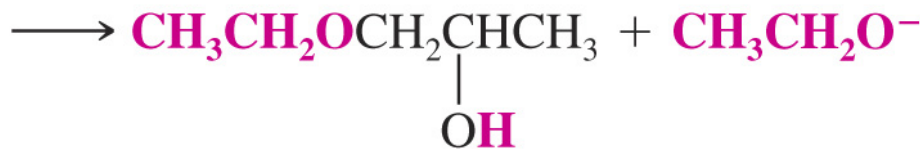

This carbon resembles a 3° carbocation.
CH3OH + CH3—C—CH2
δ+
CH3
O δ+
H
Protonated epoxide
CH3—C—CH2OH
CH3
+OCH3
H

課堂練習 給出產物結構


m-CPBA
?
H3O+
CH3OH
?

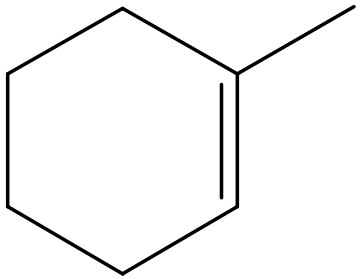


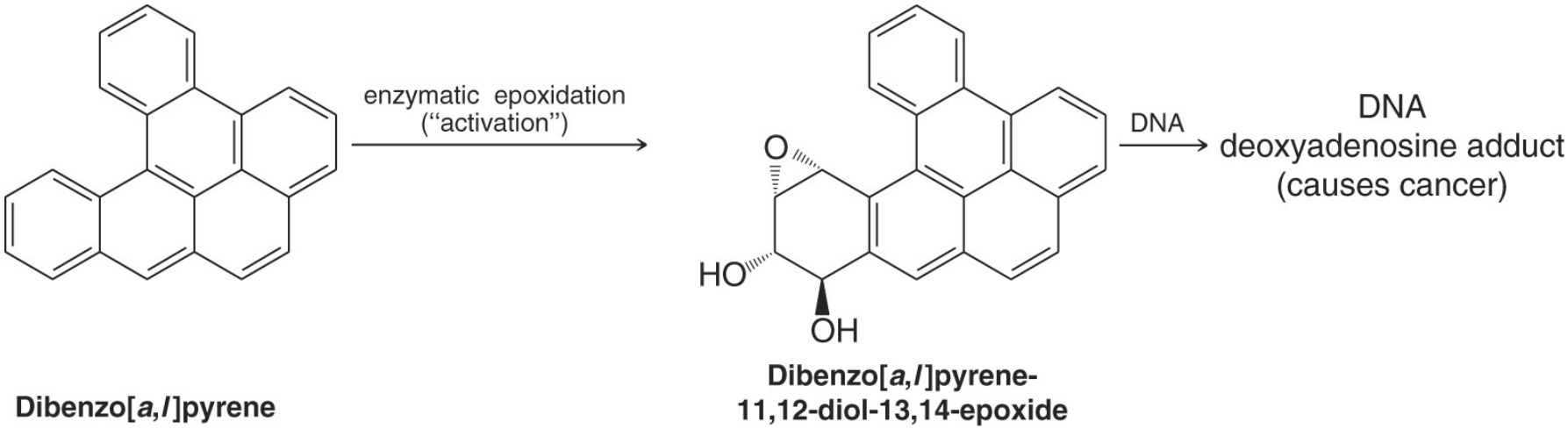
Methyloxirane



1-Ethoxy-2-propanol

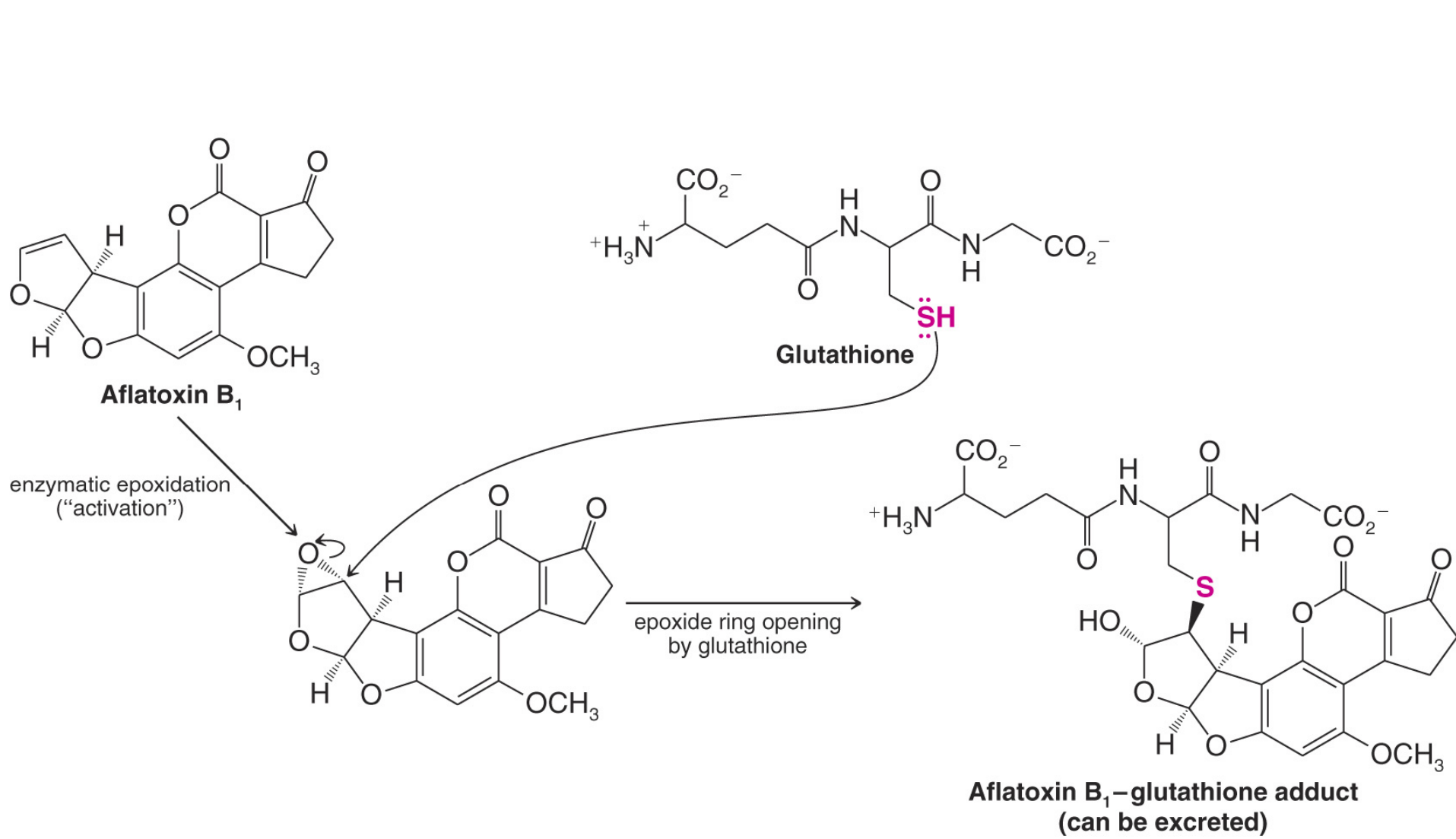
課堂練習 給出產物結構





Dibenzo[*a,l*]pyrene

**Dibenzo[*a,l*]pyrene-
11,12-diol-13,14-epoxide**


Aflatoxin B1
Glutathione
enzymatic epoxidation
("activation")
epoxide ring opening
by glutathione
Aflatoxin B1–glutathione adduct
(can be excreted)