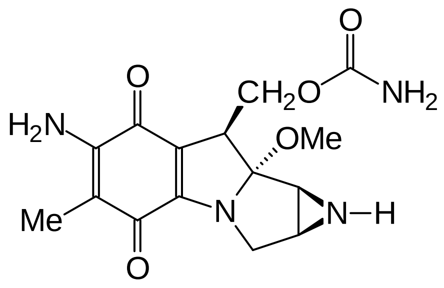
Chapter 5 Three and Four-Membered Ring Systems

5.1 Aziridines

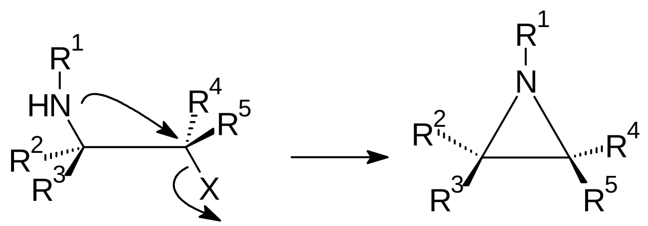
Aziridines are good alkylating agents because of their tendency to undergo ring-opening reaction with nucleophiles。

例如 mitomycin C 具有 antibiotic and antitumor activity 是因含有 aziridine ring。



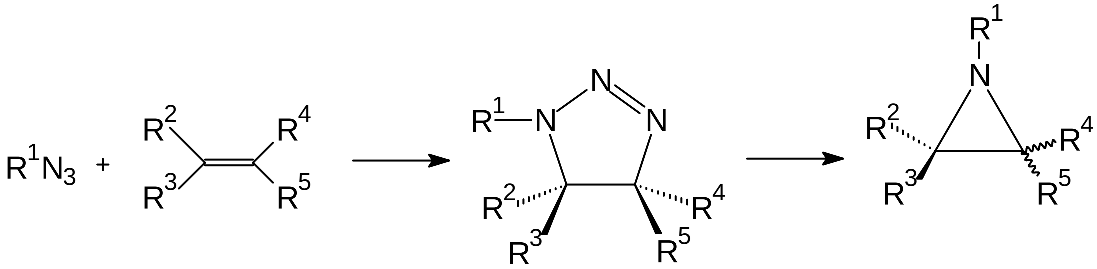
mitomycin C

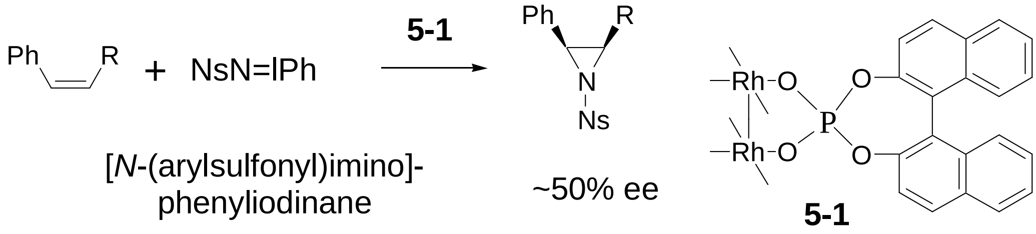
5.1.1 Ring Synthesis



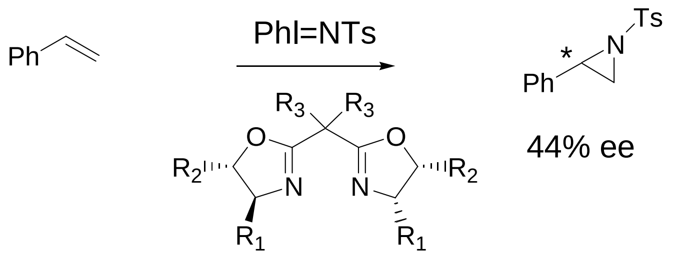
X	Method	Notes
OSO_3H	aminoalcohol + H_2SO_4 or $ClSO_3H$	Wenker synthesis
OSO_2R	aminoalcohol + RSO_2Cl	
$OPPh_3{}^+Br^-$	aminoalcohol + Ph_3PBr_2	
Cl	chloroamine + NaH in DMSO	Gabriel synthesis
I	olefin, INCO, ROH	
I	olefin, IN_3, then $LiAlH_4$ or PPh_3	

Azidines from azides and olefins

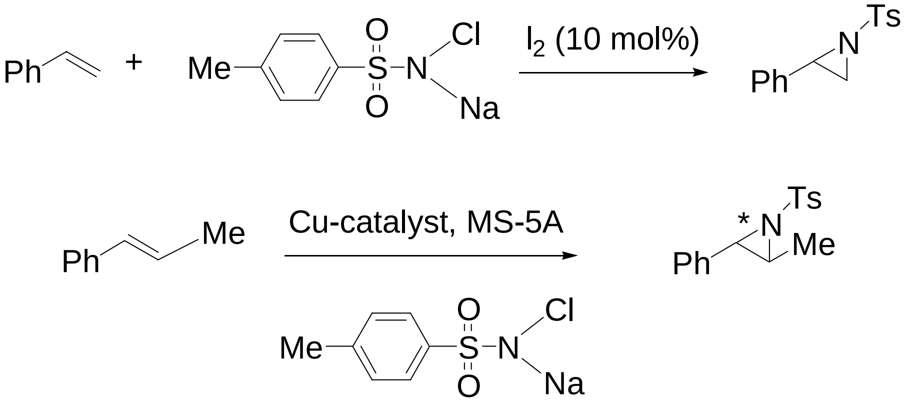




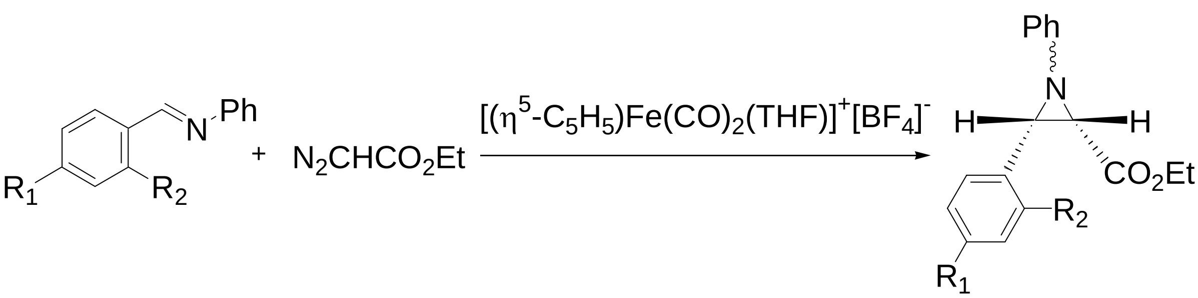
J. Phys. Org. Chem. **1998**, 597; *Can. J. Chem*. **1998**, 738.



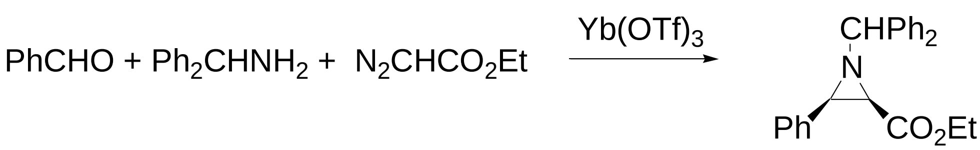
Chem. Commun. **1998**, 1601.



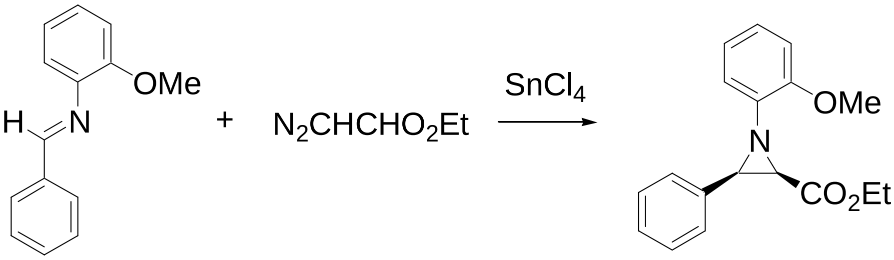
Tetrahedron, **1998**, 13485; *Tetrahedron Lett*. **1998**, 309.



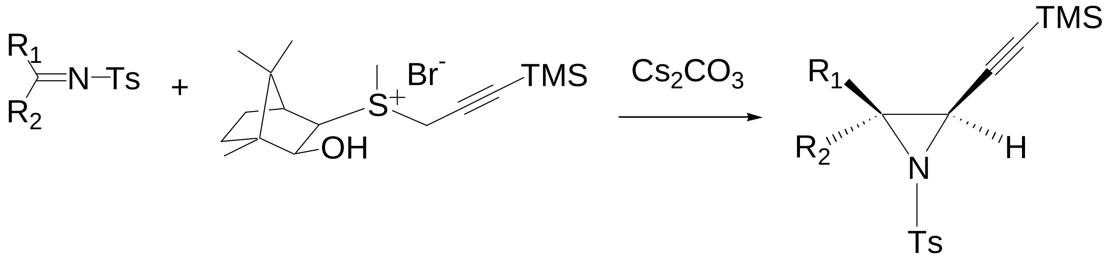
J. Org. Chem. **1998**, 6839.



Chem. Lett. **1998**, 685.



J. Chem. Soc. Perkin Trans. 2, **1998**, 1347.

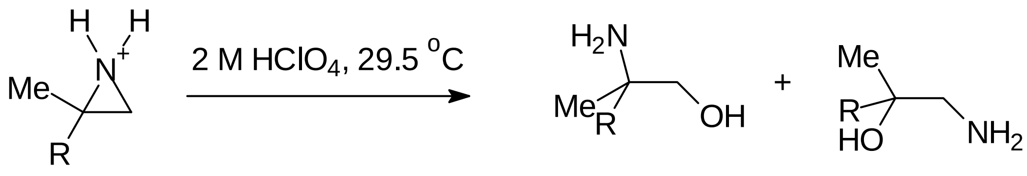


J. Org. Chem. **1998**, 4338.

5.1.2 Functionalization at nitrogen

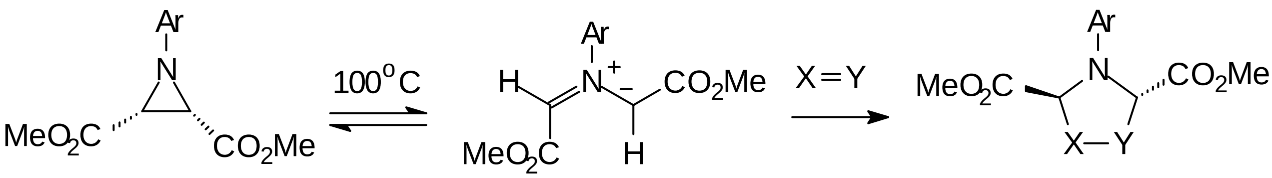
N-Substituent	Reagent
CH_2CO_2Me	$ClCH_2CO_2Me$, Et_3N
$CH(OH)CCl_3$	Cl_3CCHO
$(CH_2)_3Me$	$Me(CH_2)_3Cl$, $PhCH_2N^+Et_3Cl^-$
CH_2CH_2CN	$CH_2{=}CHCN$
CH=CHCOPh	ClCH=CHCOPh
COMe	$CH_2{=}C{=}O$
SO_2Me	$MeSO_2Cl$
Cl	NaOCl

5.1.3 Ring-opening reactions

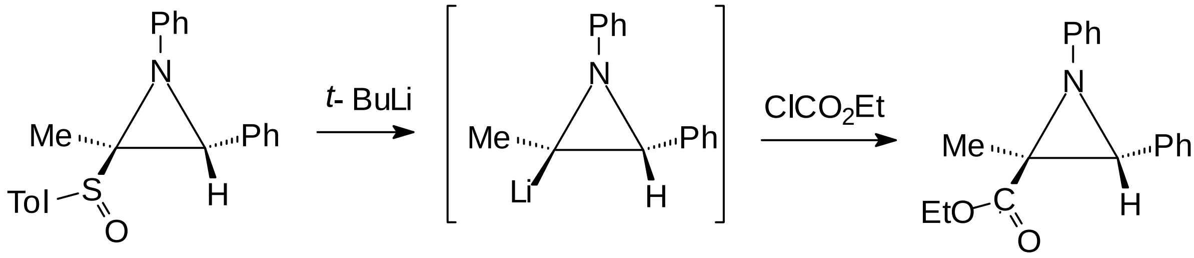


R = H	58	42
R = Me	7	93

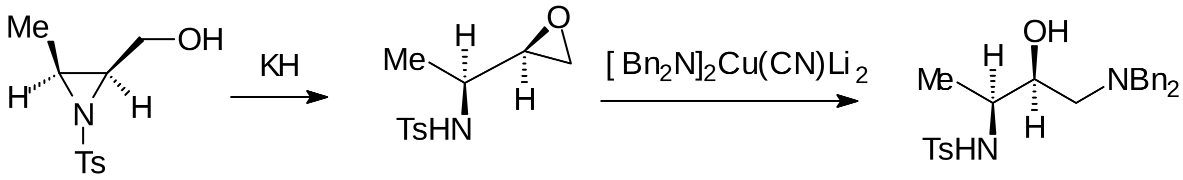
J. Am. Chem. Soc. **1974**, 2855.



The ring-opening of aziridines to azomethine ylides and subsequent cycloaddition.
Ar = C_6H_4OMe-4, PhCHO;
X=Y = $MeO_2CCH=CHCO_2Me$, $EtO_2CN=NCO_2Et$, PhCH=NMe, norbornene.
Tetrahedron Lett. **1971**, 473.

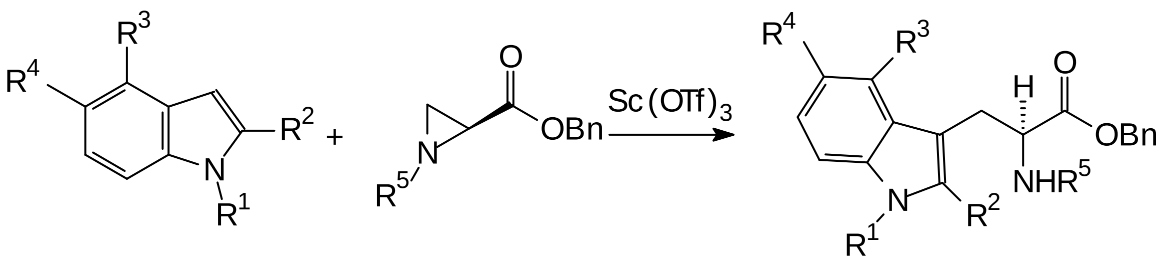


Tetrahedron Lett. **1998**, 2345.

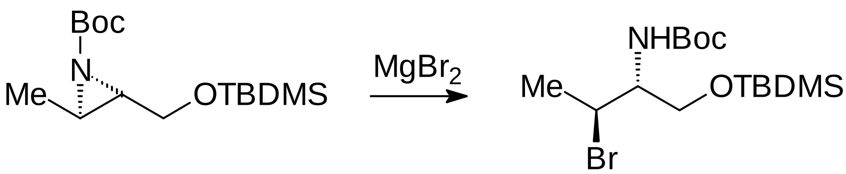


aza-Payne rearrangement.

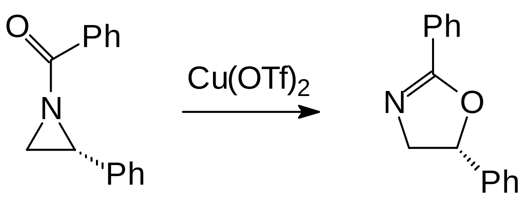
Chem. Soc. Rev. **1998**, 145.



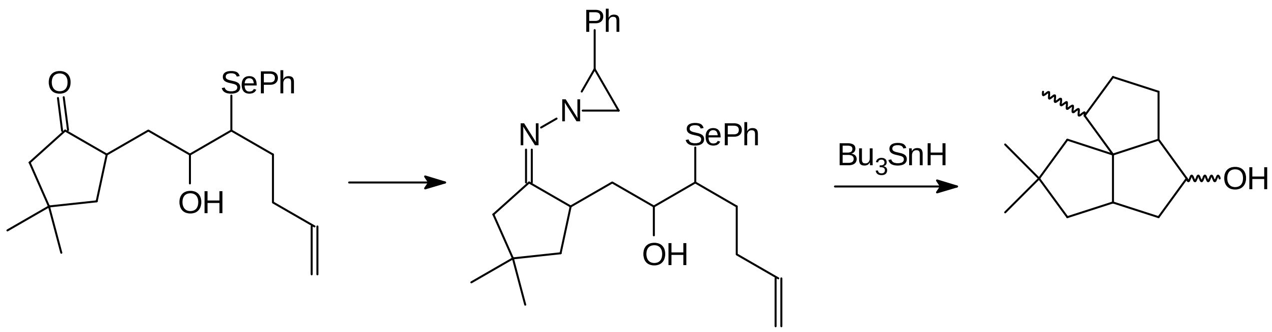
Synlett, **1998**, 754.



Tetrahedron Lett. **1998**, 2385.

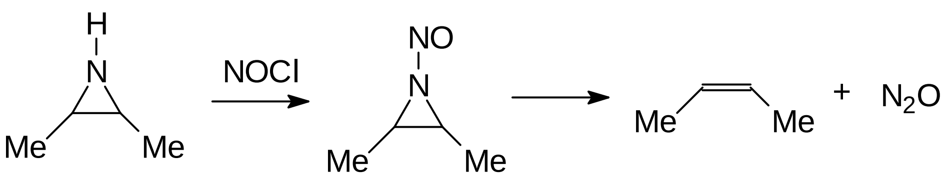


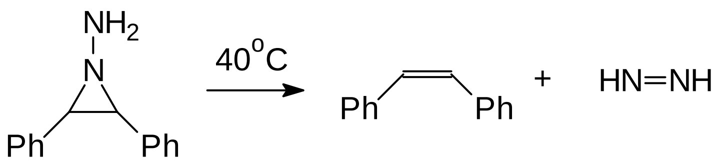
J. Org. Chem. **1998**, 4568.

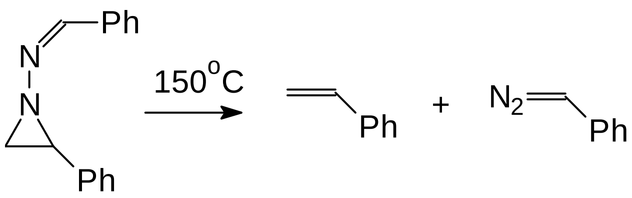


Synlett, **1998**, 981.

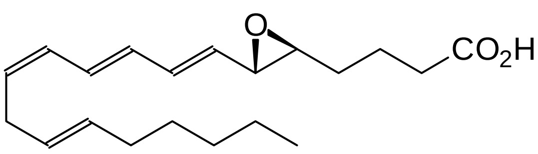
5.1.4 Fragmentation reactions

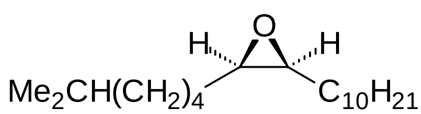




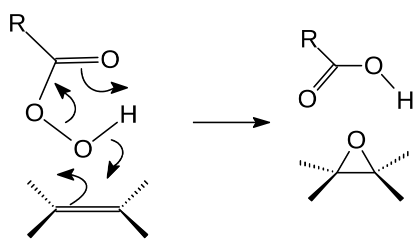


5.2 Oxiranes (Epoxides)

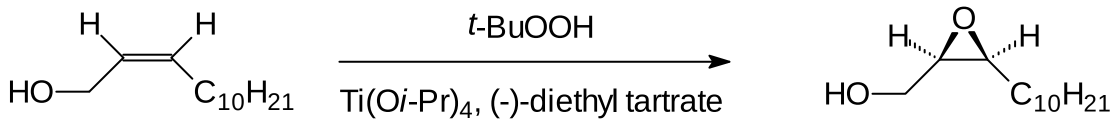




5.2.1 Ring Synthesis

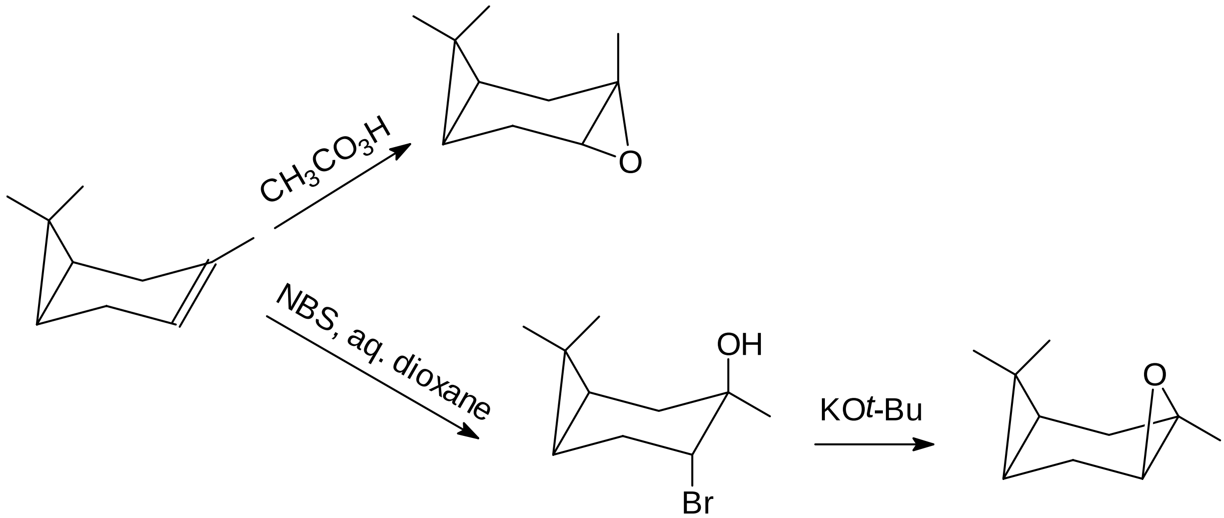


Mechanism of epoxidation by peroxy acids.



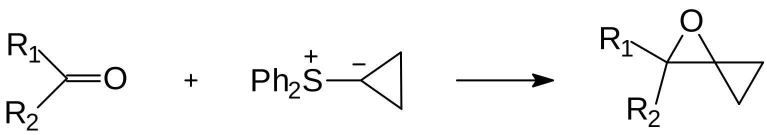
Asymmetric epoxidation of an allylic alcohols.

Pure & Appl. Chem. **1983**, 1823. *Organic Reactions*, **1996**, *48*, 1.



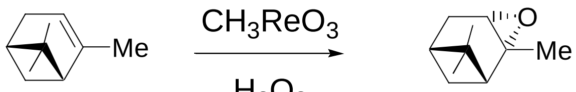
Selectivity of epoxide formation.

J. Chem. Soc. Perkin Trans. 2, **1993**, 641.



Darzens reaction.

Comprehensive Organic Synthesis, Vol. 2, **1991**, p. 409.



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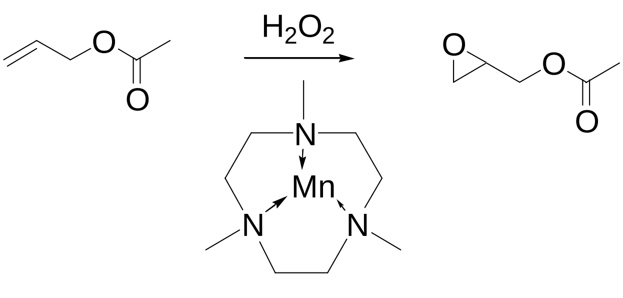
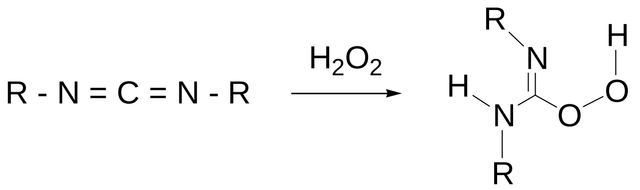
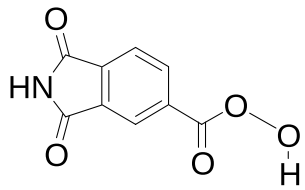
Tetrahedron Lett. **1998**, 8521.



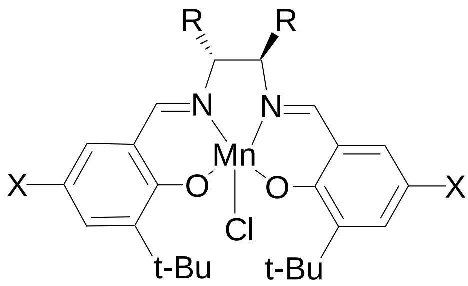
Tetrahedron Lett. **1998**, 3221.



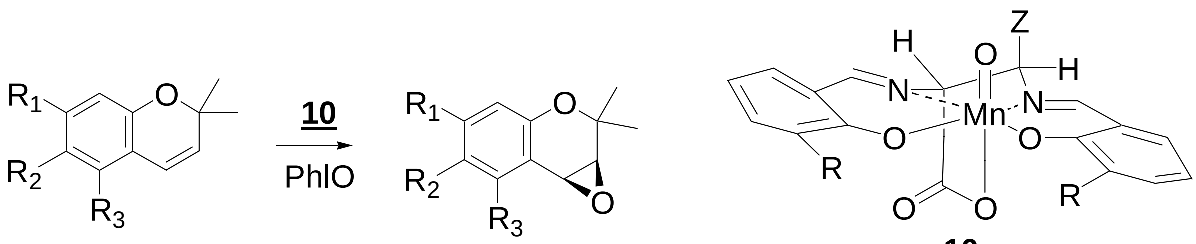
J. Org. Chem. **1998**, 2564.



Chem. Commun. **1998**, 429.



J. Am. Chem. Soc. **1998**, 948.



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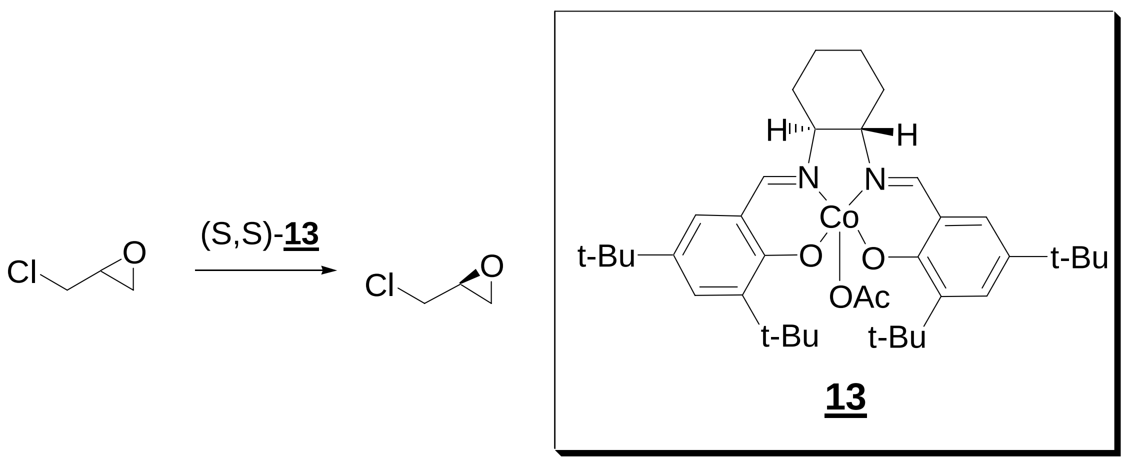
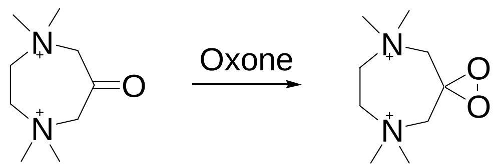
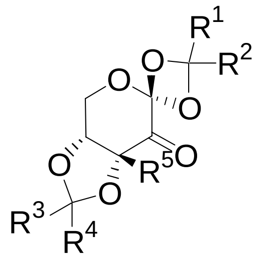
Tetrahedron Lett. **1998**, 4325.



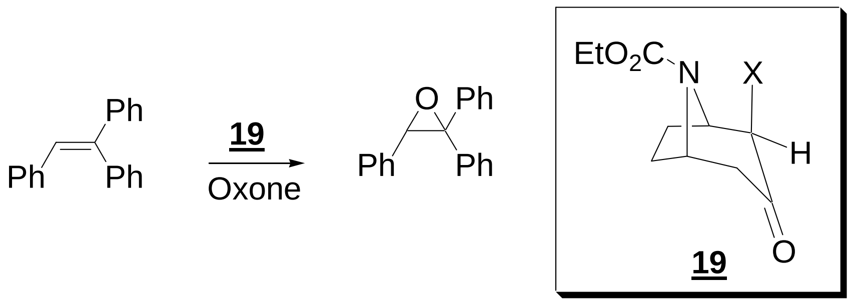
J. Org. Chem. **1998**, 6776.



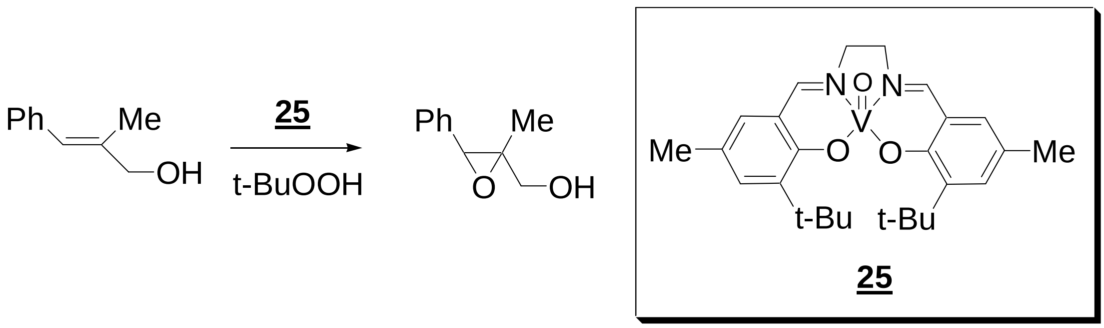
J. Org. Chem. **1998**, 2810.



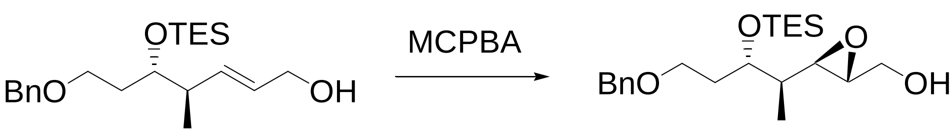
J. Org. Chem. **1998**, 8475.



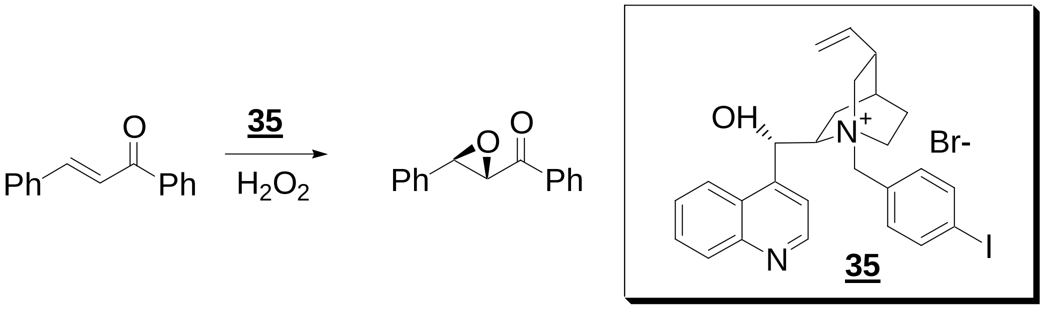
Chem. Commun. **1998**, 621.



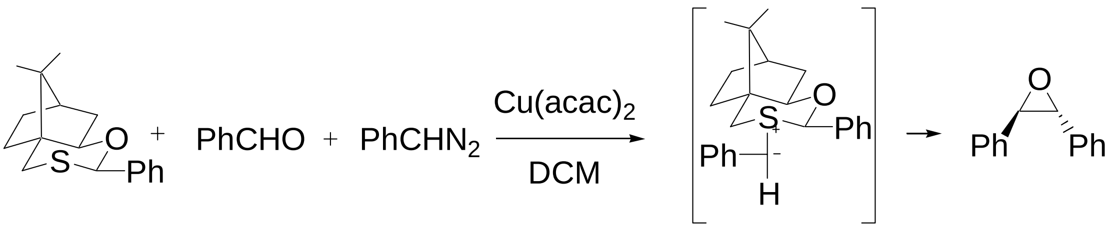
Tetrahedron Lett. **1998**, 5923.



Tetrahedron Lett. **1998**, 4517.



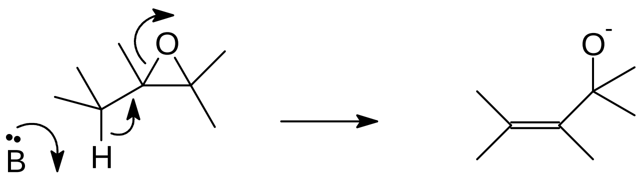
Chem. Commun. **1998**, 1159.



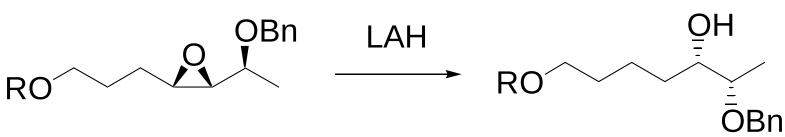
J. *Am. Chem. Soc.* **1998**, 8328.

J. Org. chem. **1998**, 4532.

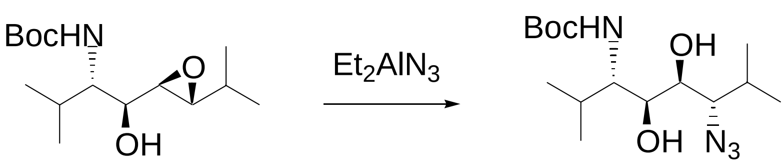
5.2.2 Reactions



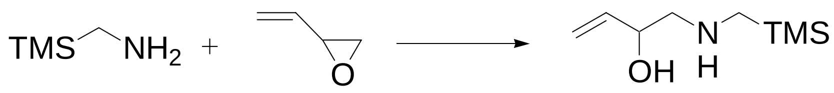
E2 elimination and ring opening of oxiranes



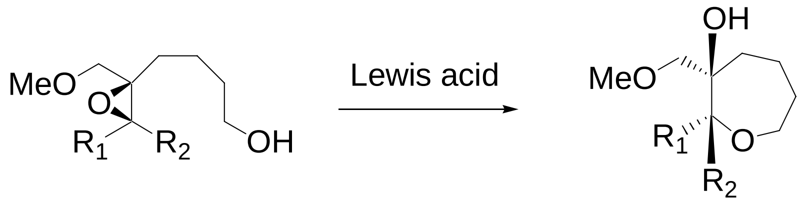
J. Heterocyclic Chem. **1998**, 865.



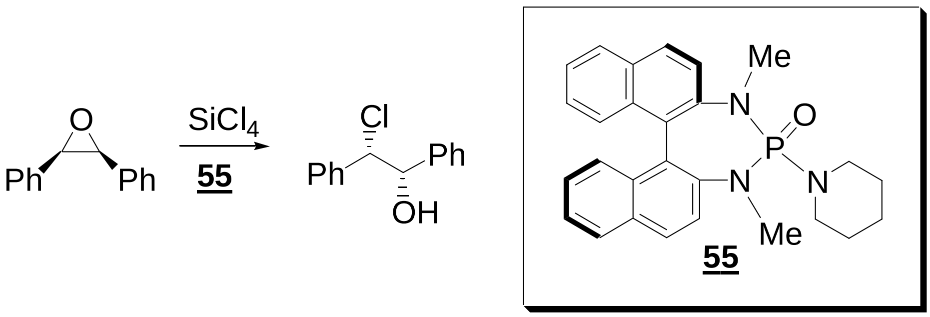
Tetrahedron Lett. **1998**, 7971.



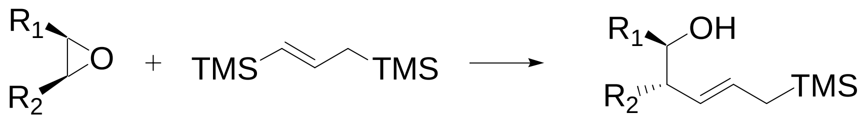
Synlett, **1998**, 510.



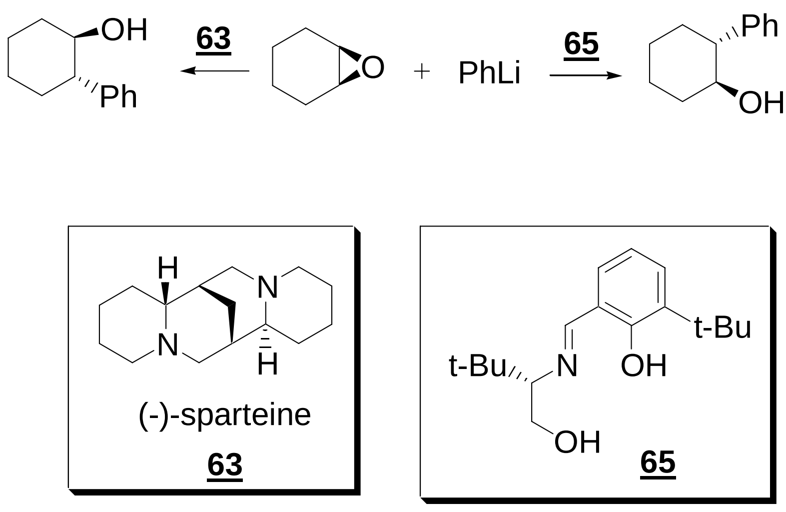
Tetrahedron Lett. **1998**, 393.



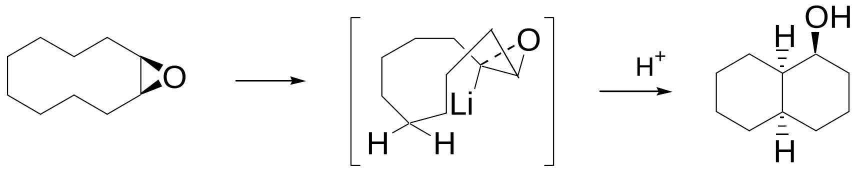
J. Org. Chem. **1998**, 2429.



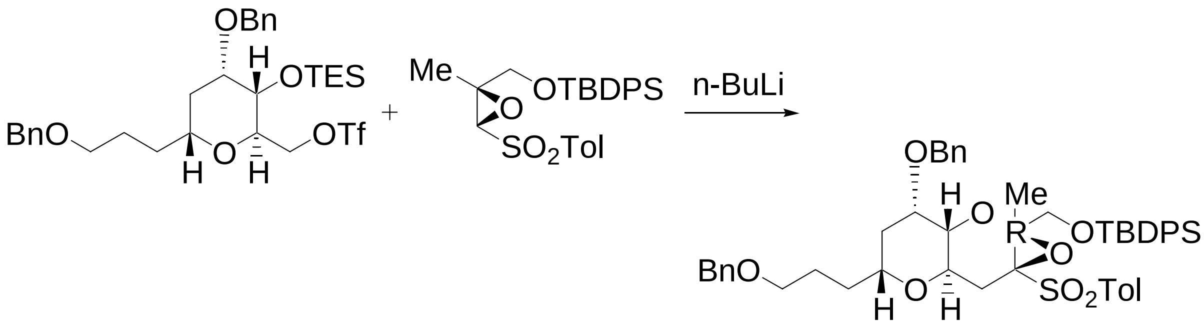
Tetrahedron Lett. **1998**, 529.



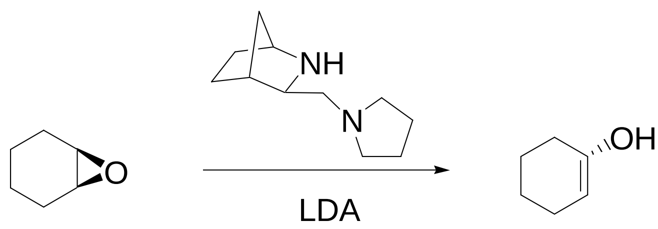
Symlett, **1998**, 1165. *Tetrahedron Lett.* **1998**, 9023.



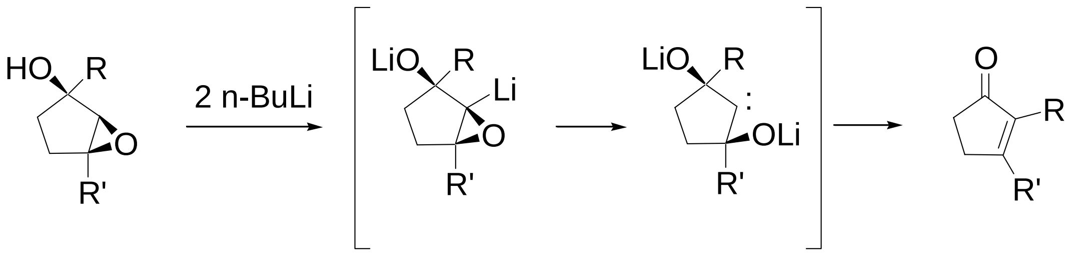
J. Chem. Soc. Perkin 1, **1998**, 2151.



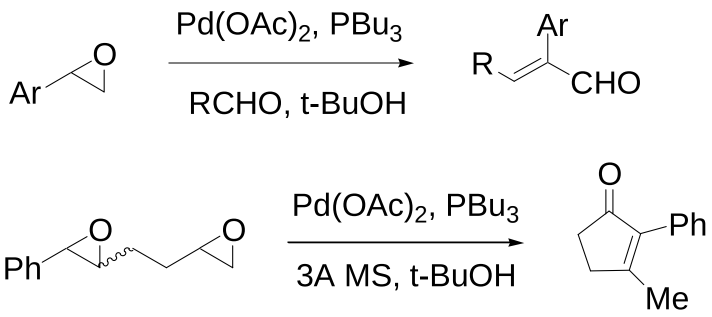
J. Org. Chem. **1998**, 6200.



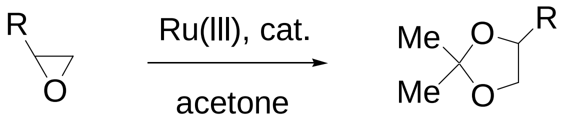
J. Am. Chem. Soc. **1998**, 10760.



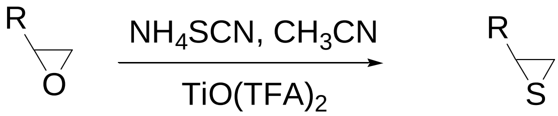
J. Org. Chem. **1998**, 3808. *Synlett*, **1998**, 337.



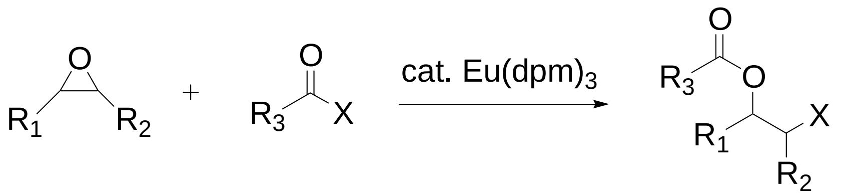
Tetrahedron, **1998**, 1361. *Tetrahedron Lett*. **1998**, 3107.



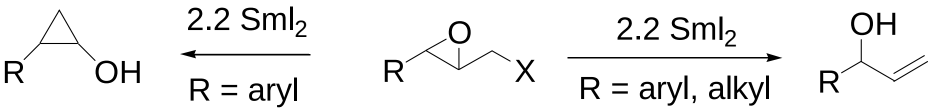
Syn. Commun. **1998**, 3189.



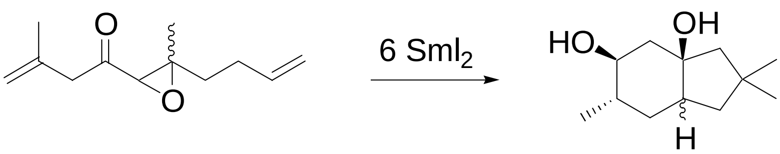
Syn. Commun. **1998**, 3913.



Tetrahedron Lett. **1998**, 4559.

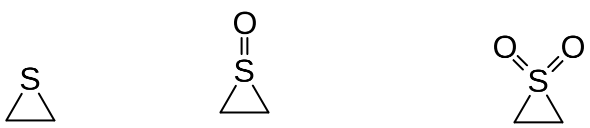


Synlett, **1998**, 1073.

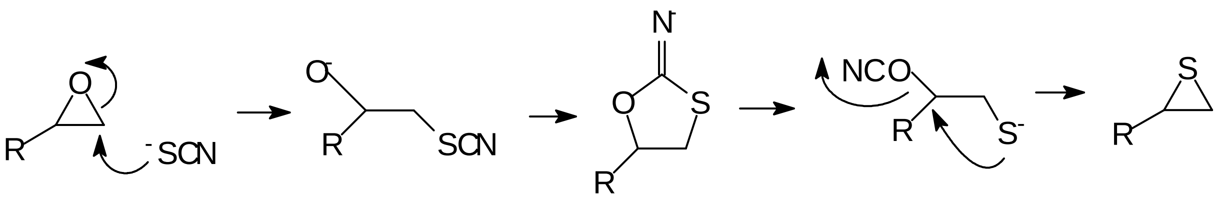


Tetrahedron, **1998**, 5819.

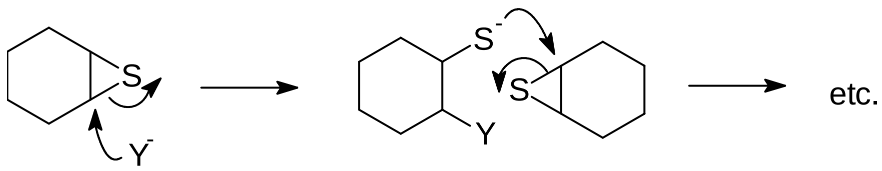
5.3 Thiiranes



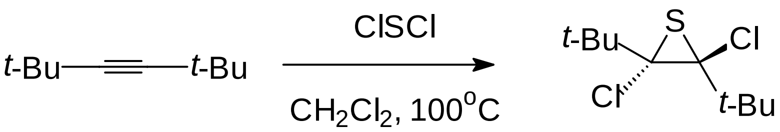
thiirane thiirane-1-oxide thiirane-1,1-dioxide



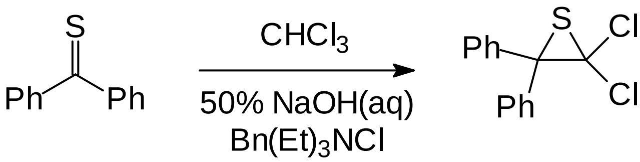
Synthesis of thiiranes from oxiranes



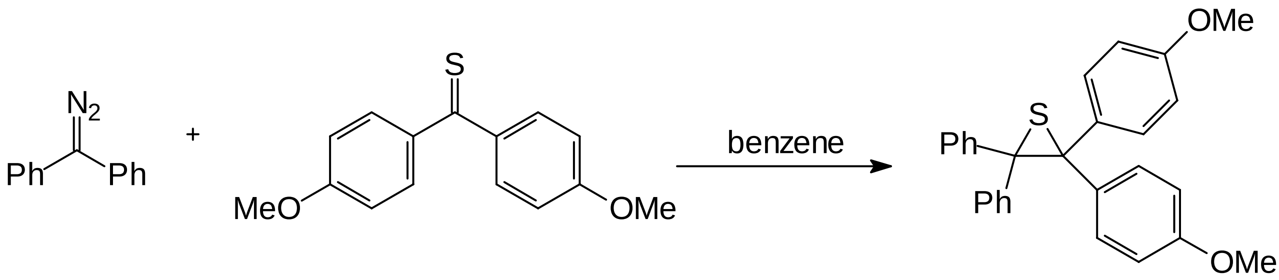
Polymerization initiated by nucleophilic attack.



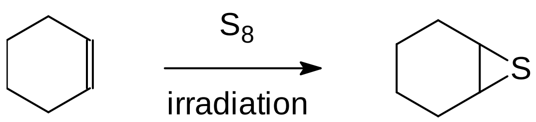
Tetrahedron Lett. **2001**, 4017.



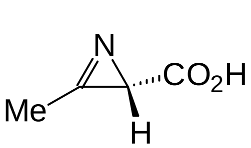
Helv. Chim. Acta. **1999**, 946.

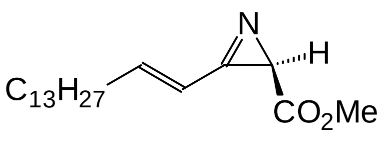


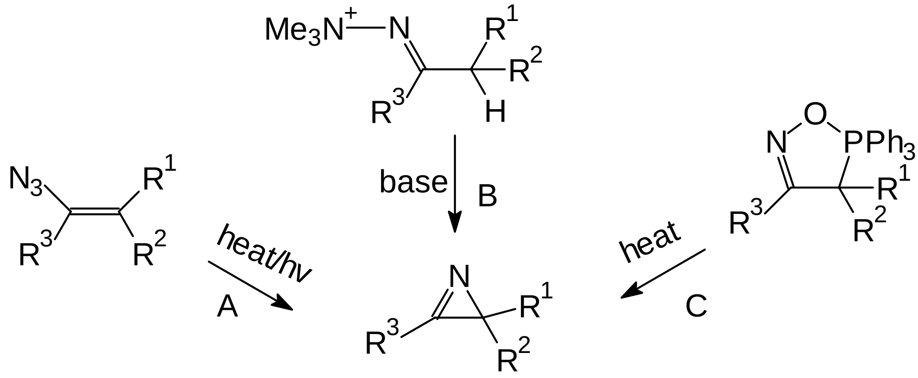
Helv. Chim. Acta. **1920**, 838.



5.4 2*H*-Azirines







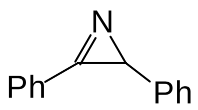
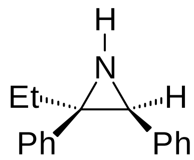
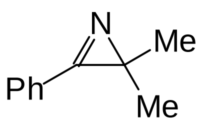
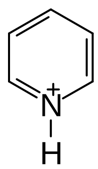
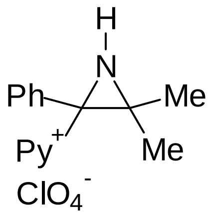
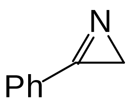
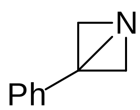
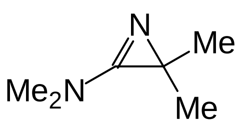
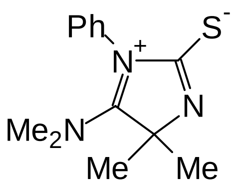
A: $R^1 = R^2 = H$, $R^3 = Ph$, 110^{o}C, 63%. $R^1 = R^2 = Me$, $R^3 = Net_2$, 20^{o}C, 94%, $R^1 = H$, R^2, $R^3 = (CH_2)_6$, $h\nu$, pentane, 93%.

B: $R^1 = H$, $R^2 = Me$, $R^3 = Ph$, NaH, Me_2SO, 20^{o}C, 63%.

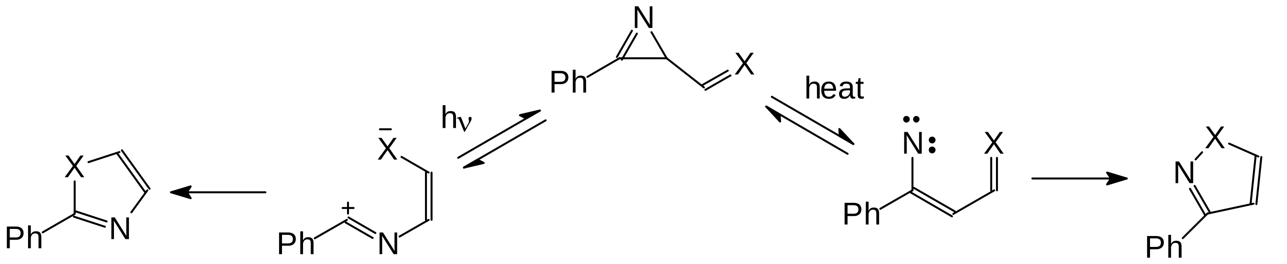
C: $R^1 = R^2 = H$, $R^3 = Bu^t$, 120^{o}C, 57%.

Tetrhedron Lett. **1995**, 4665. *J. Am. Chem. Soc*. **1995**, 3651.

Examples of addition reactions to C=N bond of azirines

Azirine	Reagent	Product	Ref.
	EtMgBr		a
			b
	$Me_2\overset{+}{S}\overset{-}{C}H_2$		c
	PhNCS		d

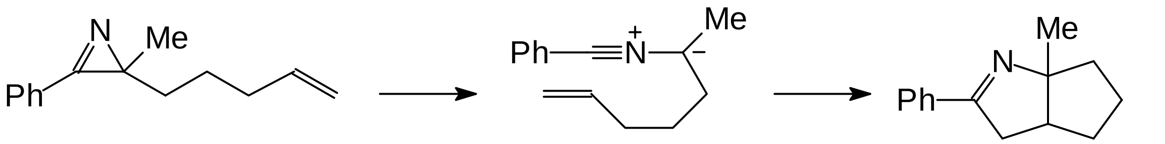
a. *Tetrahedron lett*. **1969**, 4001.
b. *J. Am. Chem. Soc*. **1967**, 4456.
c. *J. Am. Chem. Soc*. **1972**, 2758.
d. *Helv. Chim. Acta*. **1979**, 160.

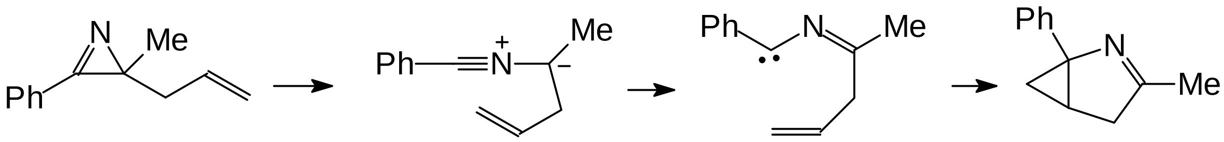


X = O, 70%
X = NPh, 90%

X =O, 200^{o}C, 80%.
X =NPh, 140^{o}C, 87%.

Thermal and photochemical isomerization of 3-phenylazirines bearing conjugative substituents.

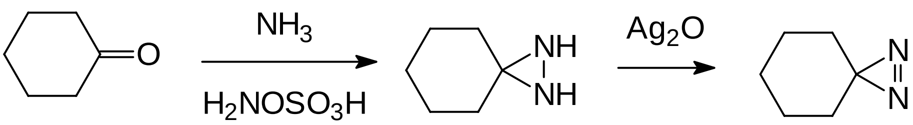


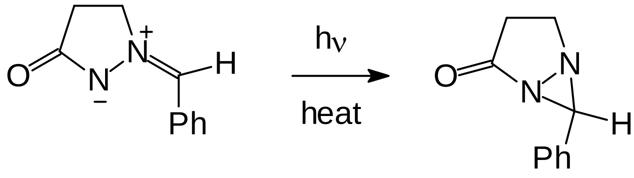


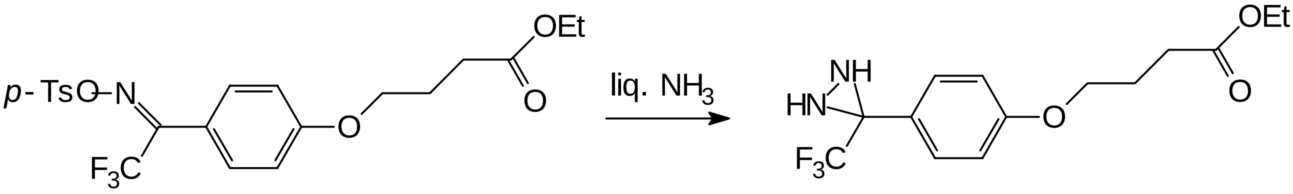
Internal addition of nitrile ylides derived from azirines.

5.5 Diaziridines and 3H-diazirines

diaziridine 3*H*-diazirine

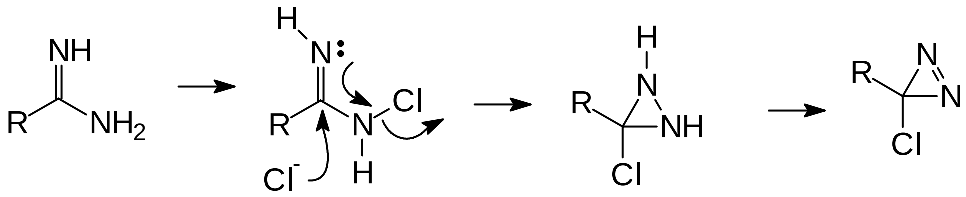




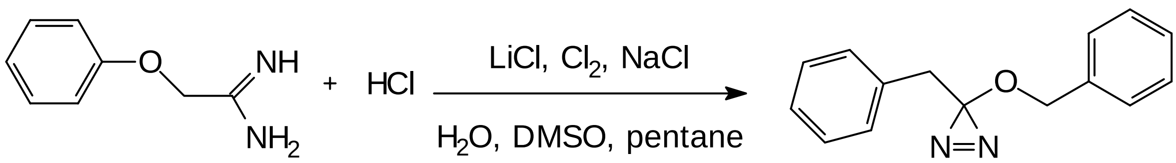


Tetrahedron Lett. **2000**, 6737.

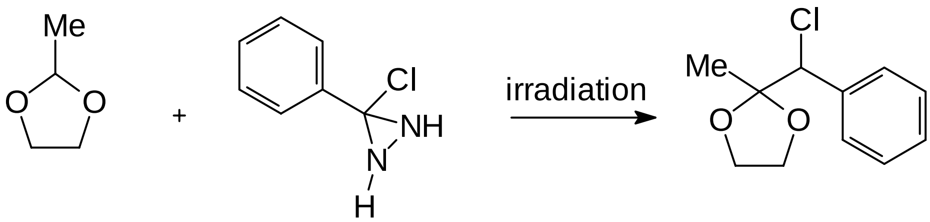
Synthesis of diaziridines



Synthesis of 3-chlorodiaziridines from amidines

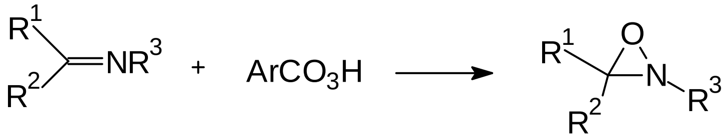


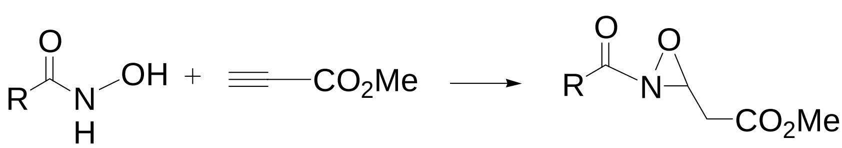
J. Am. Chem. Soc, **1992**,959.



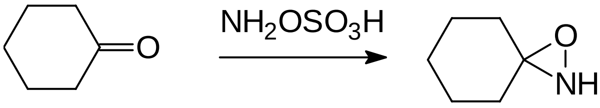
Tetrahedron lett. **1998**, 9381.

5.6 Oxaziridines

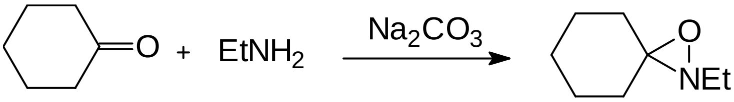




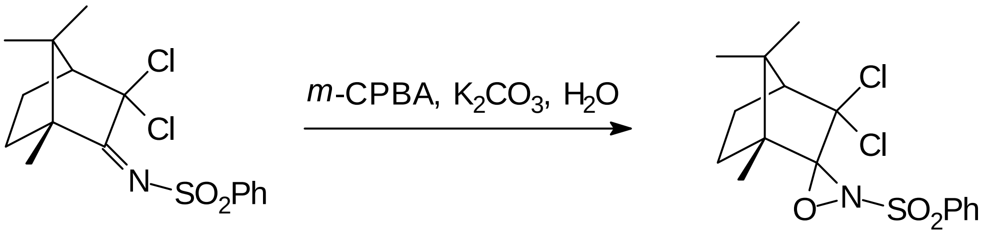
Tetrahedron Lett. **1998**, 6227.



Bull. Acad. Sci. USSR Div. Chem. Sci. **1989**, 793.

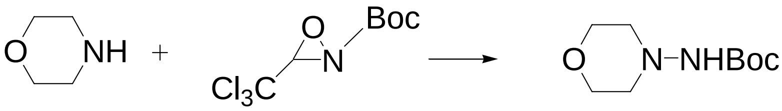


Chem.. Ber. **1958**, 1057.

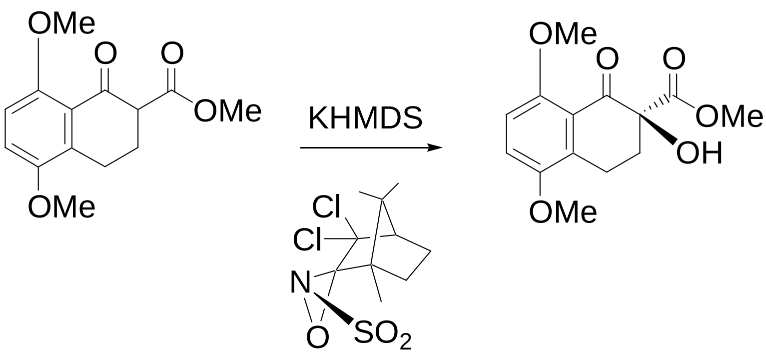


J. Am. Chem. Soc. **1989**, 5964.

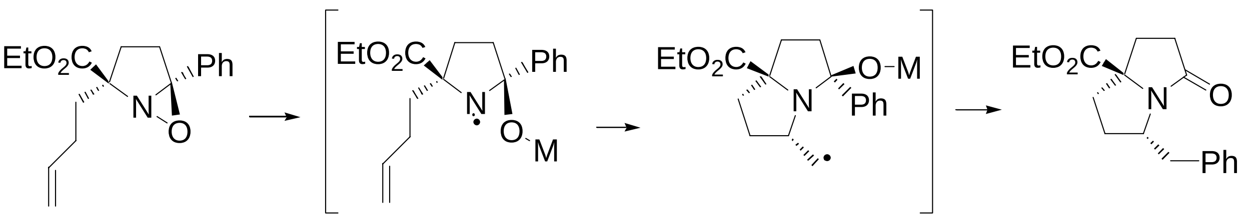
As reagent for asymmetric oxygen transfer, *Pure Appl. Chem*. **1993**, 633.



Tetrahedron Lett. **1998**, 8845.

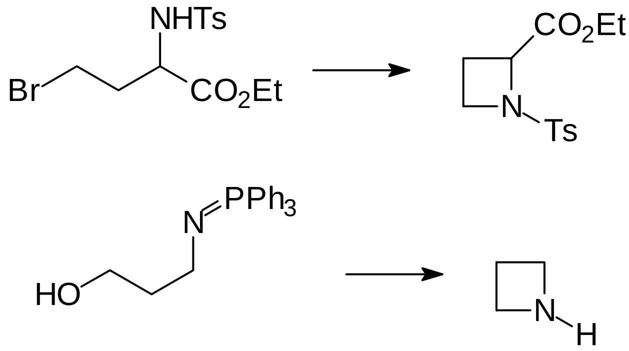


Tetrahedron, **1998**, 10481.

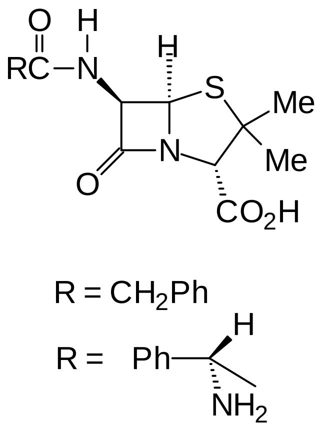


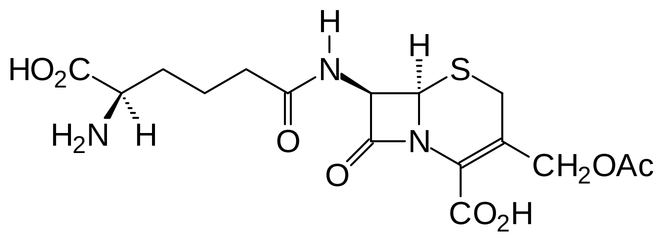
Tetrahedron Lett. **1988**, 5855.

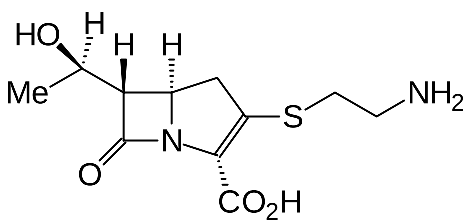
5.7 Azetidines and azetidinones

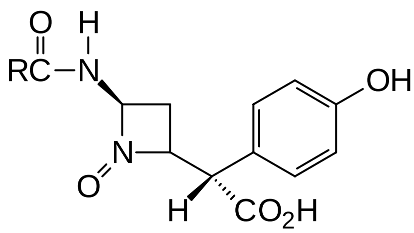


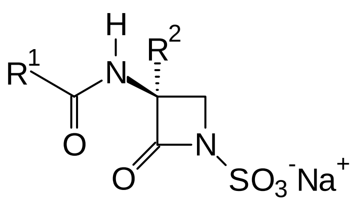
J. Org. Chem. **1981**, 3562.

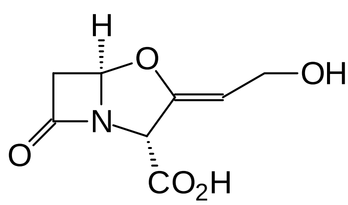


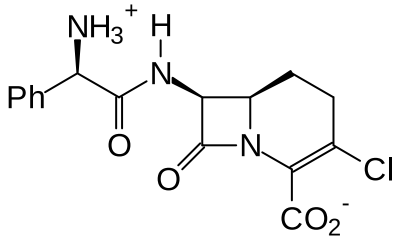


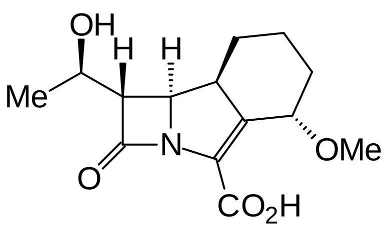


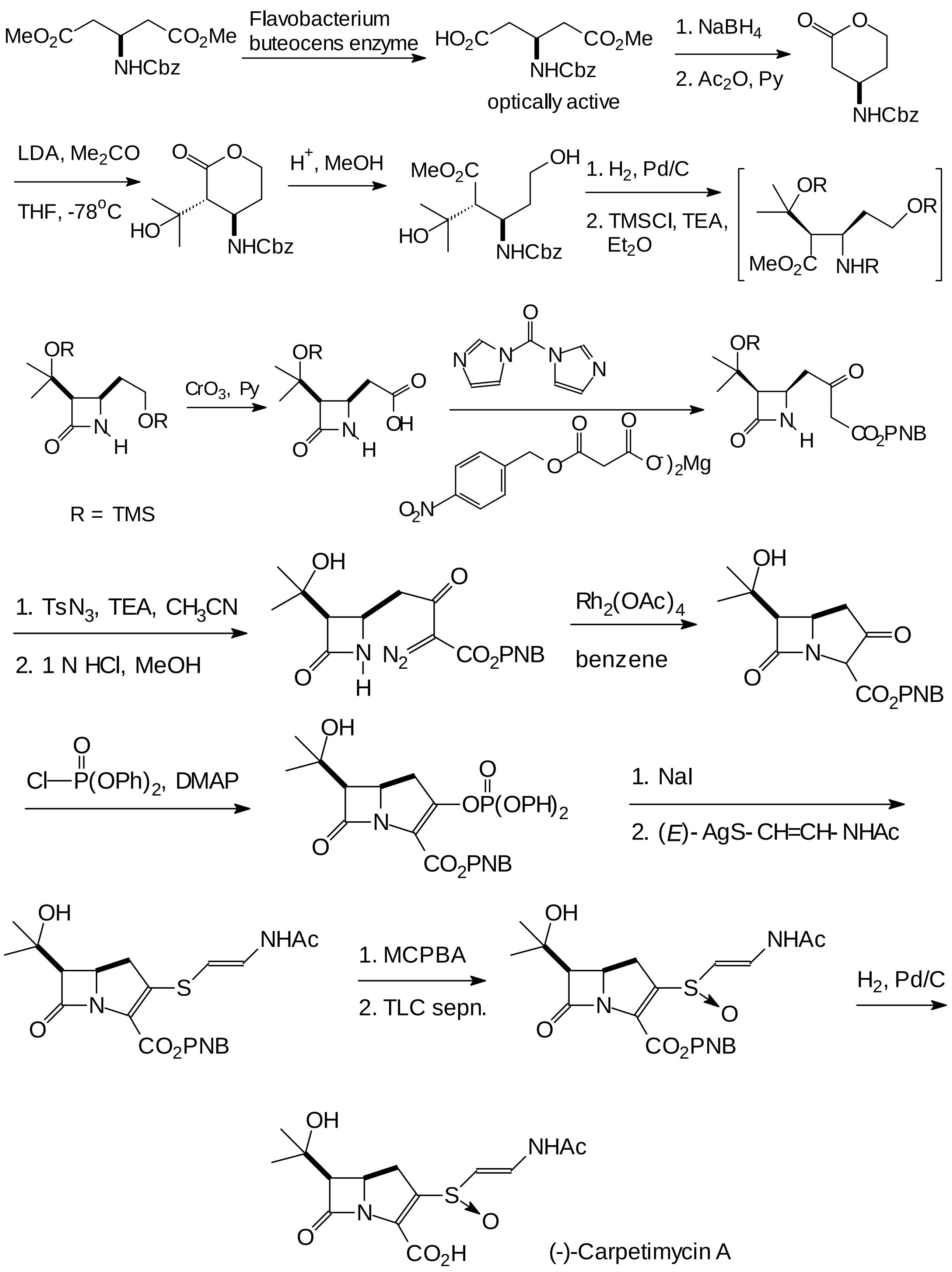






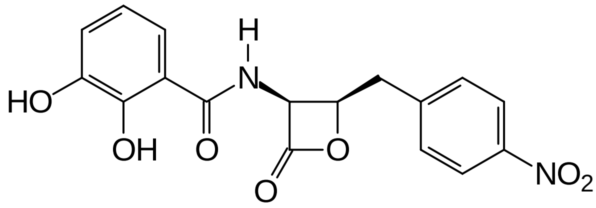




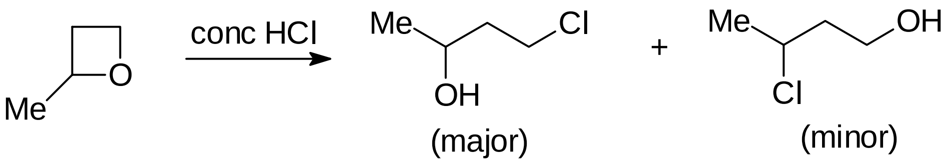


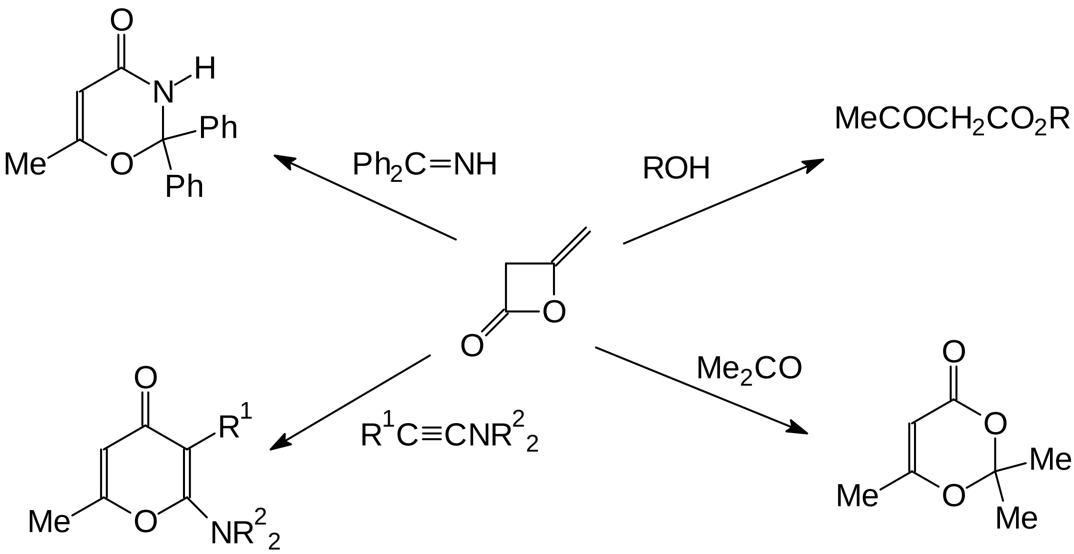
5.8 Other four-membered heterocycles

5.8.1 Oxetanes

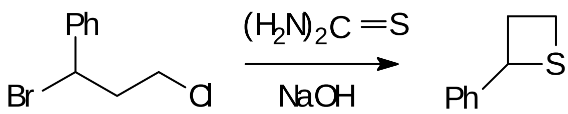


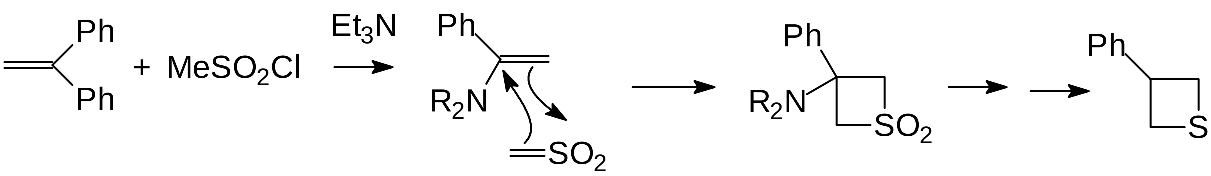
obafluorin

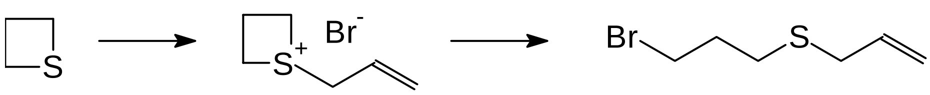


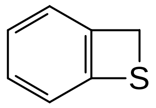


5.8.2 Thietanes

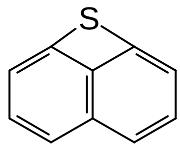




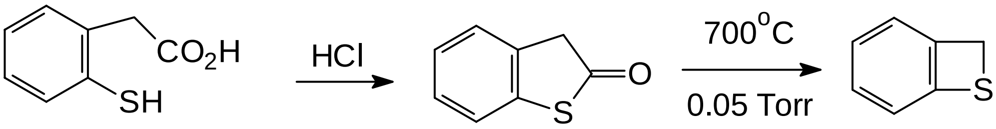




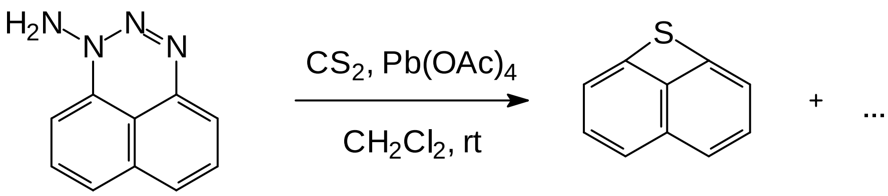
benzothietane



naphtho[1,8-*bc*]thiete

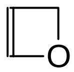


J. Chem. Soc. **1952**, 2127. *Tetrahedron Lett*. **1980**, 343.

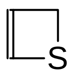


J. Chem. Soc. Perkin Trans.1, **1981**, 413.

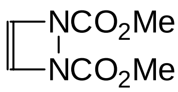
5.8.3 Some unsaturated four-membered rings



oxete



thiete



dimethyl 1,2-dihydrodiazete-1,2-dicarboxylate

2,3-dihydroazete