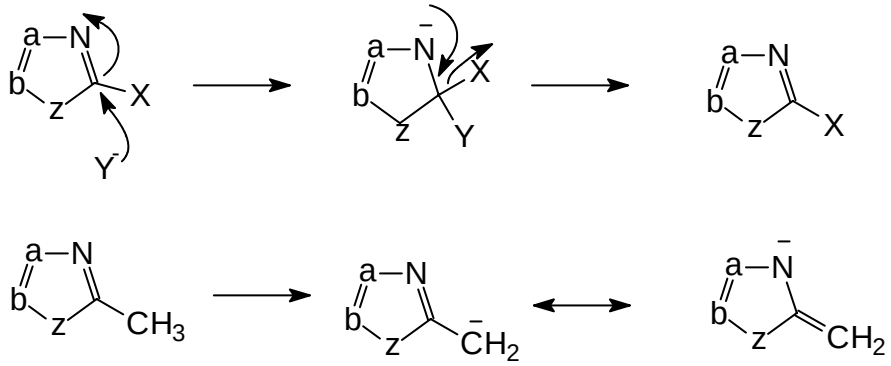
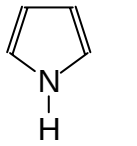
6.7 Five-membered ring compounds with two or more heteroatoms

6.7.1 Introduction

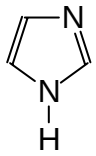


Azoles reactions involving negatively charged intermediates.

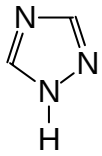
pK_a values of some azoles and azoliums.



16.5



14.52



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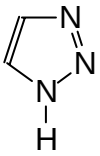

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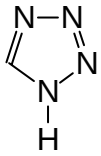

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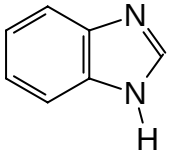

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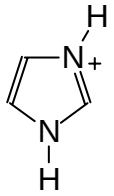

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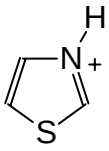
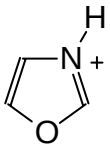


2.53



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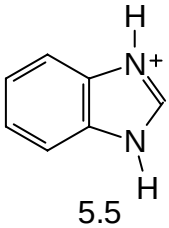

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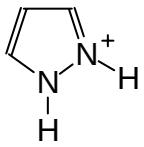

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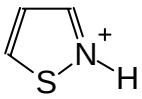

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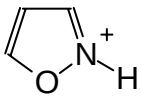

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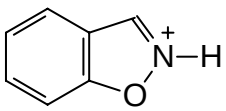

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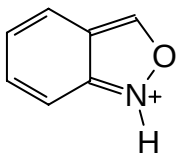
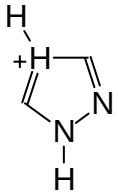


-2.20



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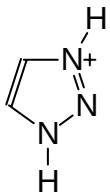
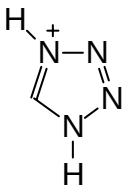
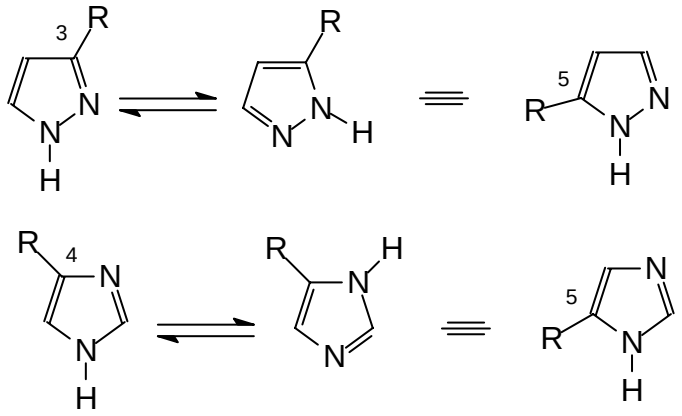


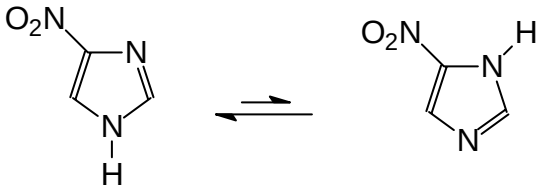
1.2



-3.0



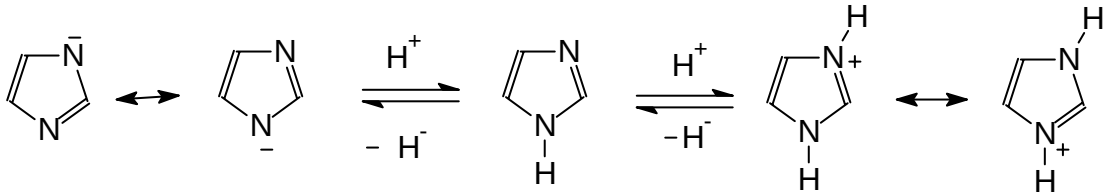
Tautomerism in pyrazoles and imidazoles.



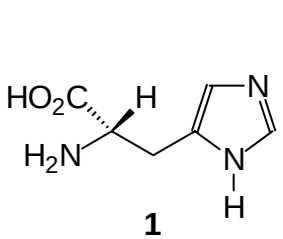
Preference for the 4-nitro structure in 4(5)-nitroimidazole.

6.7.2 Imidazoles

6.7.2.1 Introduction



$pK_a = 14.5$ $pK_a = 7.0$



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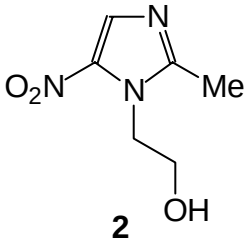

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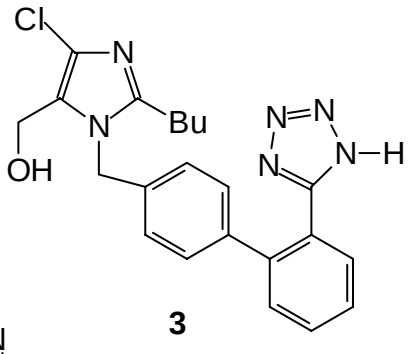

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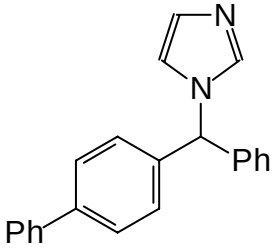

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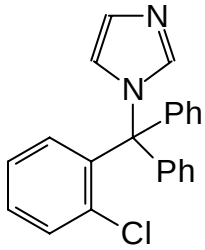
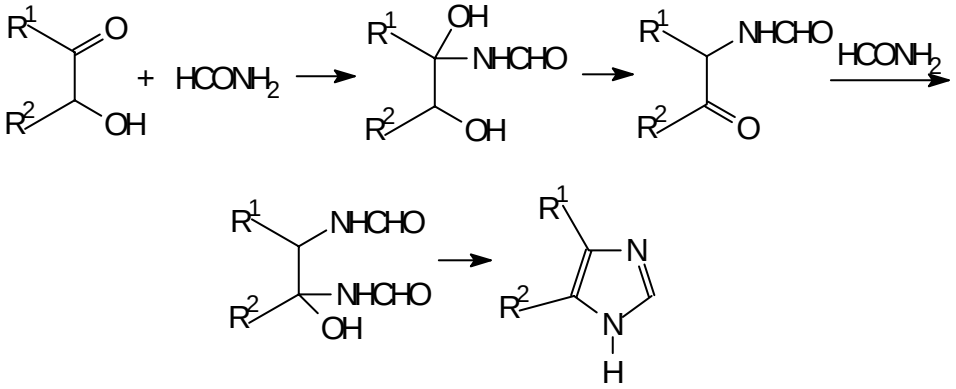
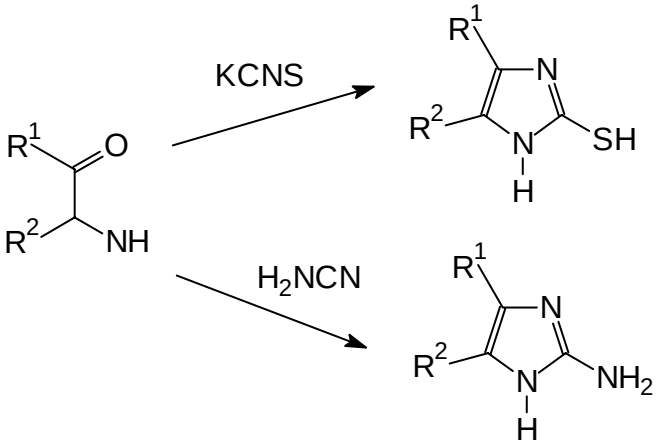
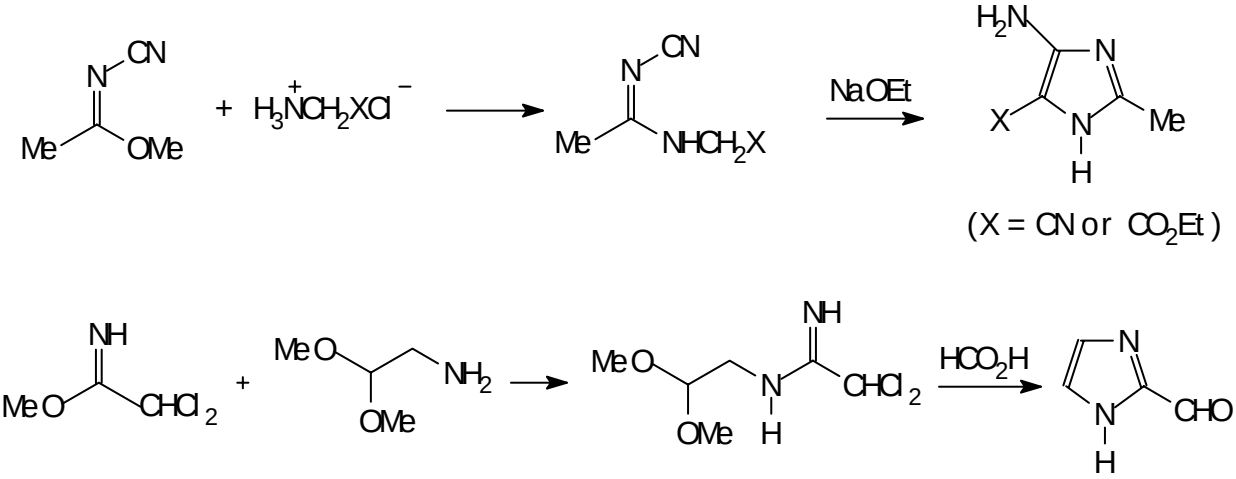


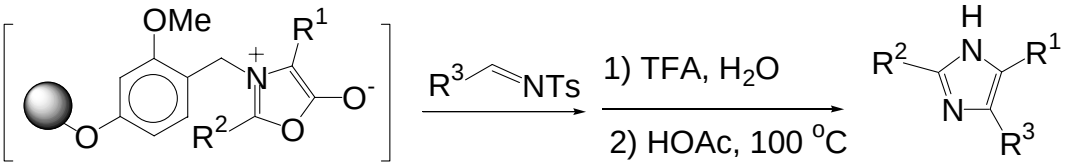
5

6.7.2.2 Ring Synthesis

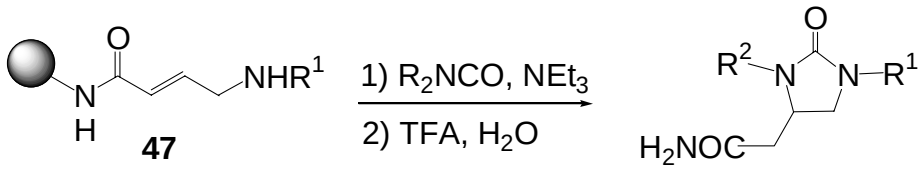






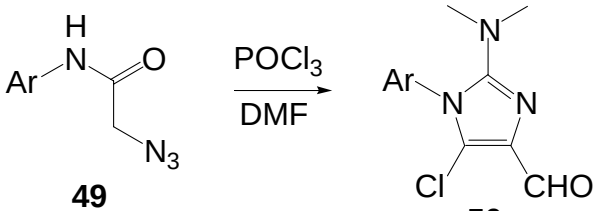


45 **46**



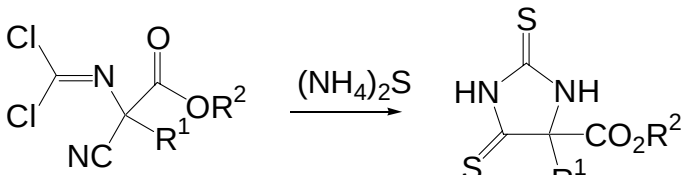
47 **48**

TL, 1998, 1477.



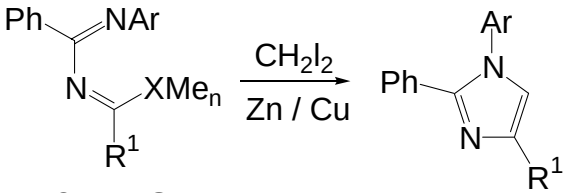
49 **50**

JOC. 1998, 7136.



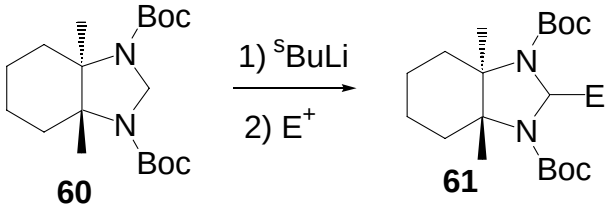
51 **52**

Synthesis, 1998, 1437.



53, X = S, N **54**

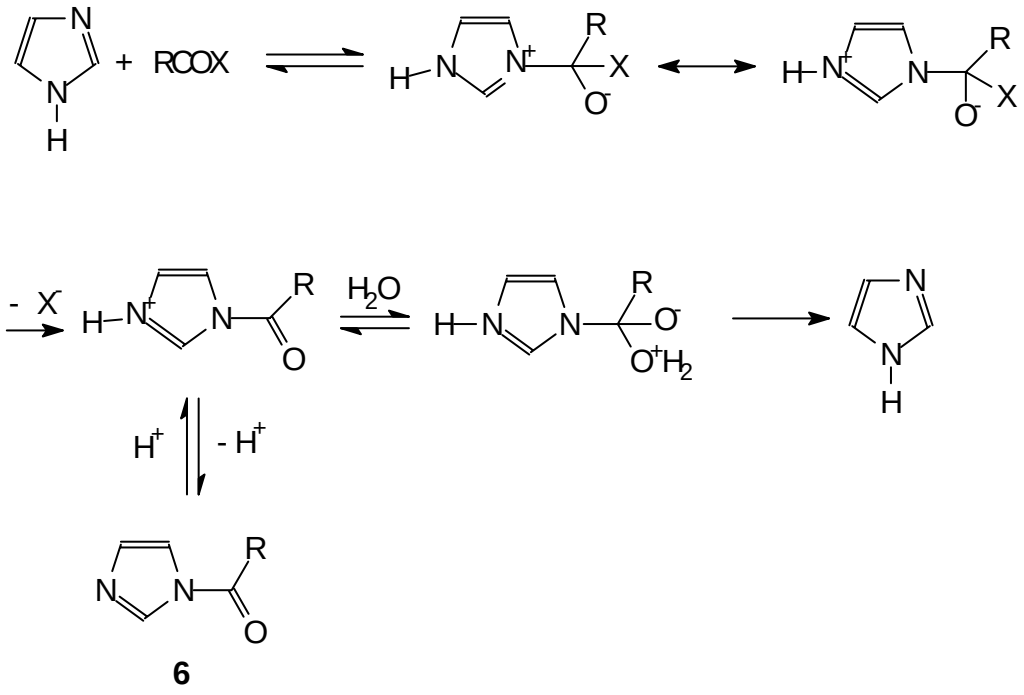
TL, 1998, 4785.



60 **61**

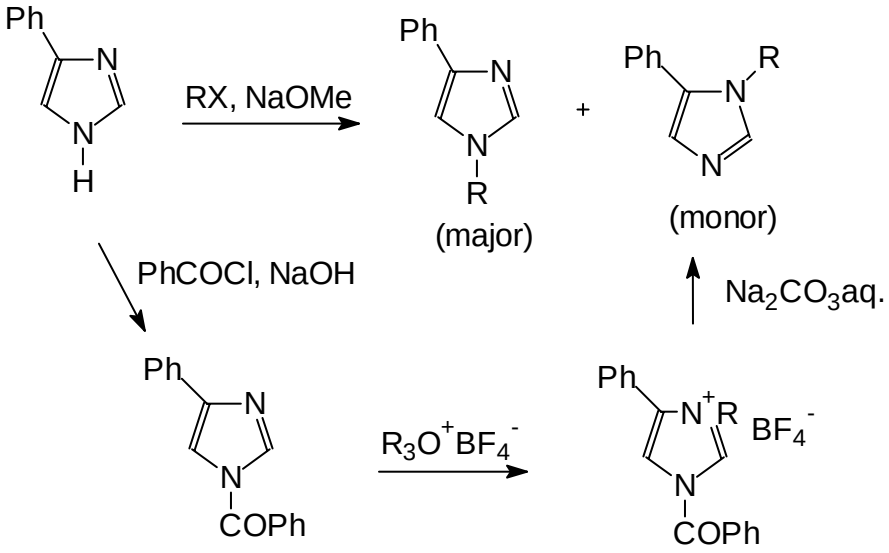
TL, 1998, 4255.

6.7.2.3 Reactions

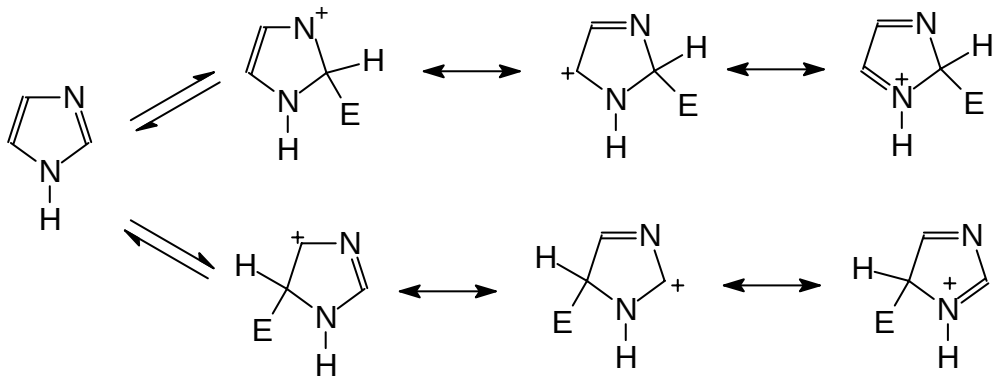


6

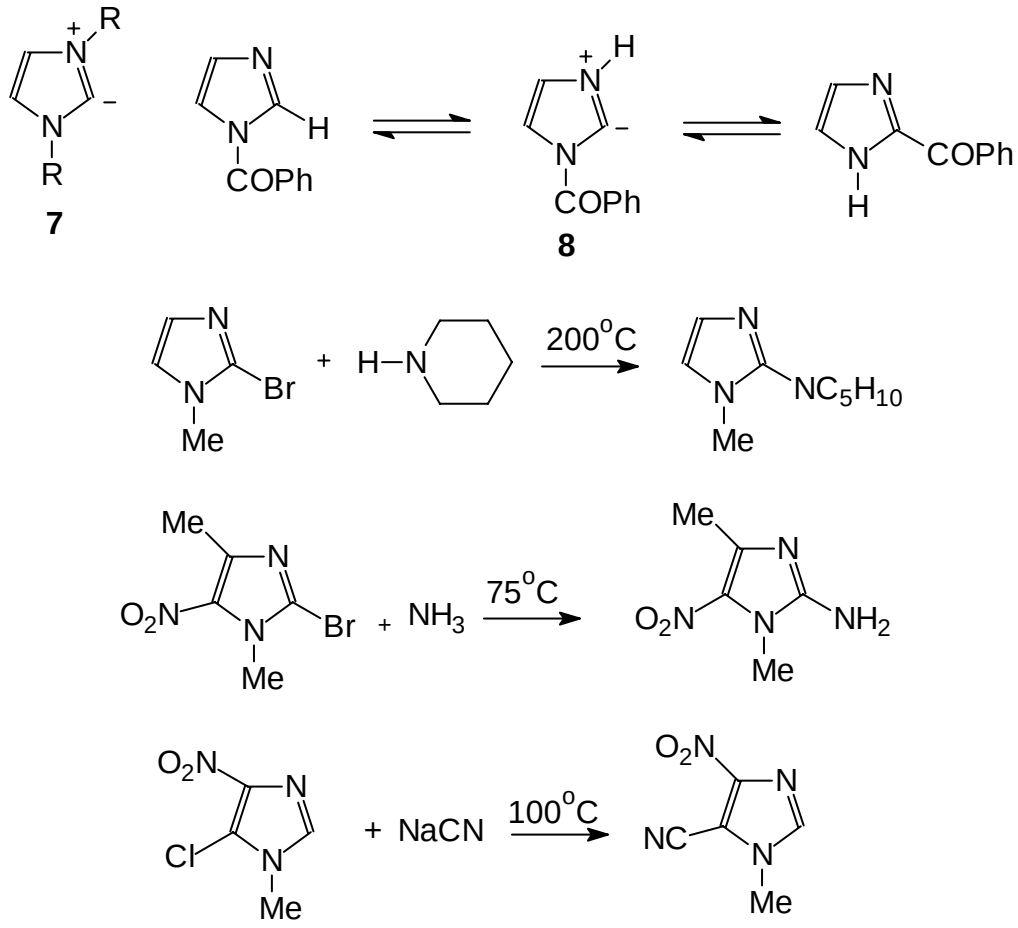
Hydrolysis of N-acylimidazole, 6, and nucleophilic catalysis by imidazole of hydrolysis of RCOX.



Selective alkylation of 4-phenylimidazole



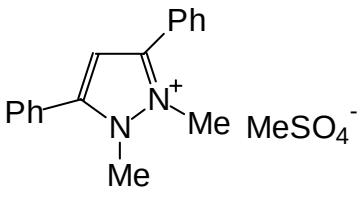
Electrophilic attack at C-2 and C-5 of imidazole



The nucleophilic displacement in imidazoles

6.7.3 Pyrazoles, triazoles and tetrazoles

6.7.3.1 Introduction



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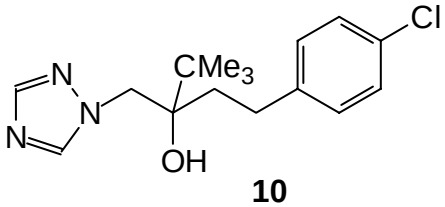

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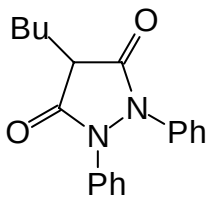
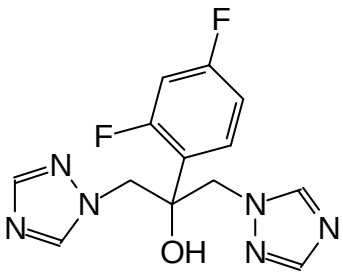
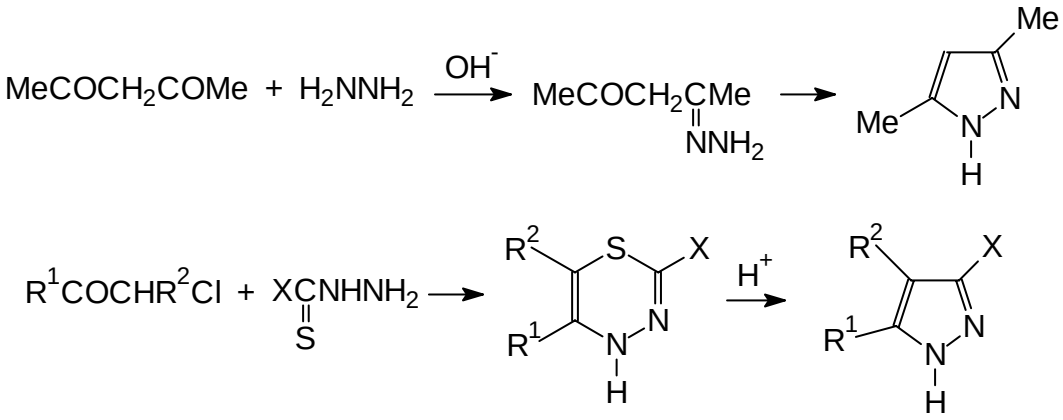


11

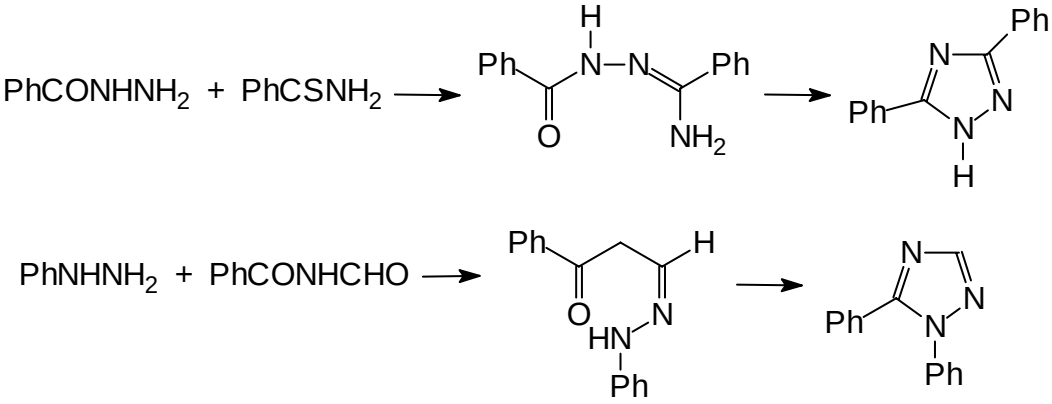


12

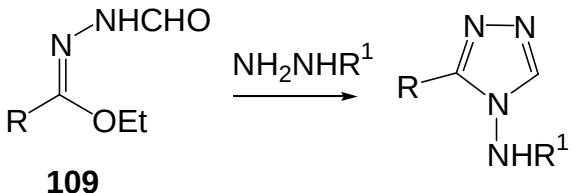
6.7.3.2 Ring synthesis



Routes to pyrazoles



Routes to 1,2,4-triazoles



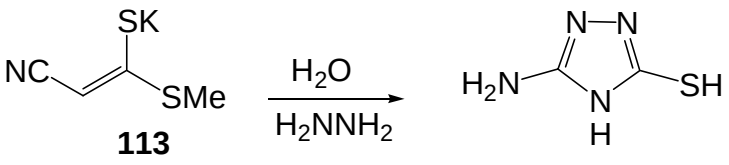
109

110, R^1 = H

111, R^1 = CO_2Et

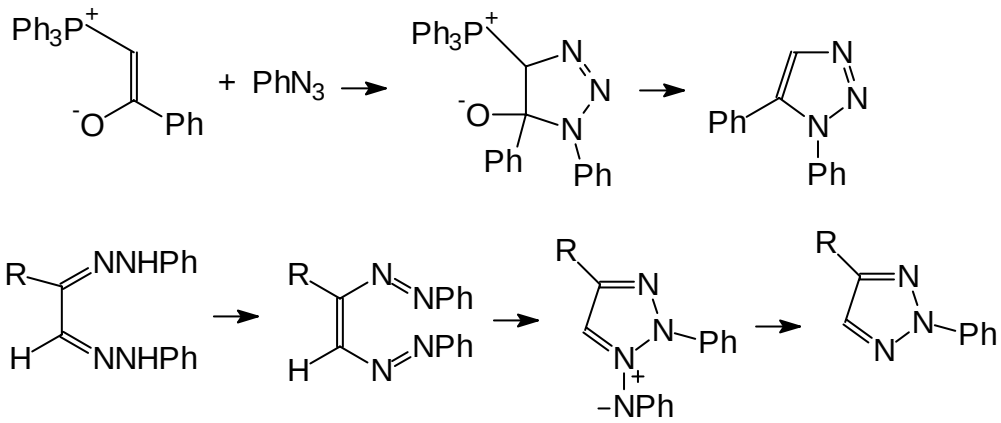
112, R^1 = $CO_2{}^tBu$

J. Heterocyclic Chem. 1998, 377

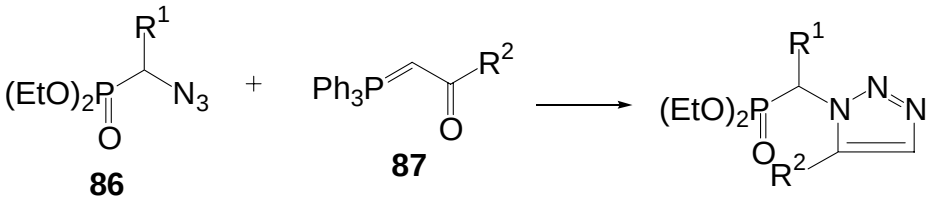


113 **114**

J. Heterocyclic Chem. 1998, 827.

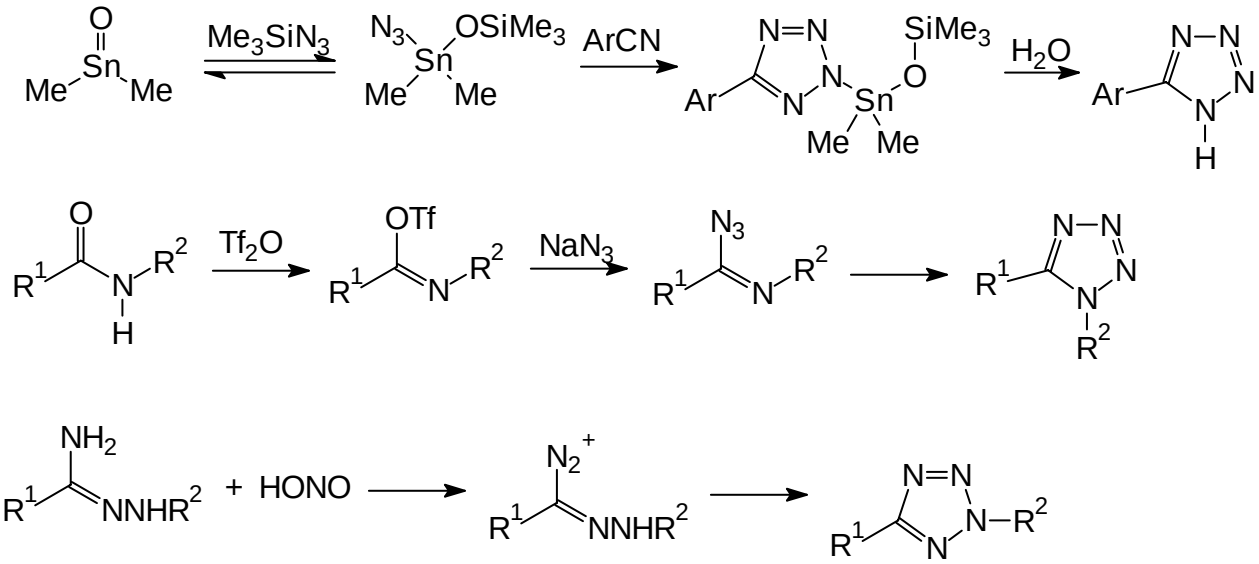


Routes to 1,2,3-triazoles

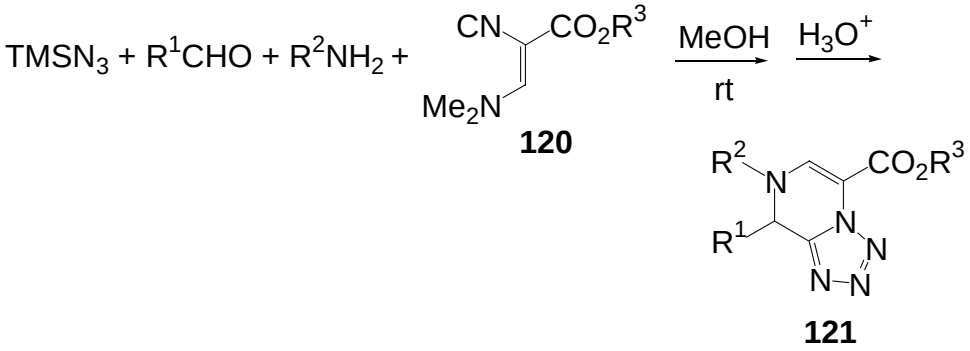


86 **87** **88**

Synth. Commun. 1998, 1215.

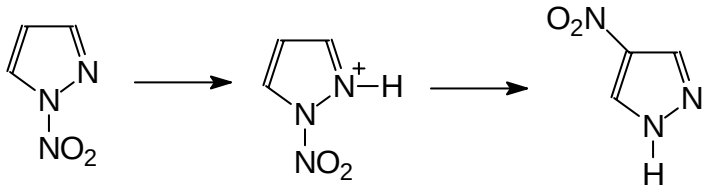


Routes to tetrazoles

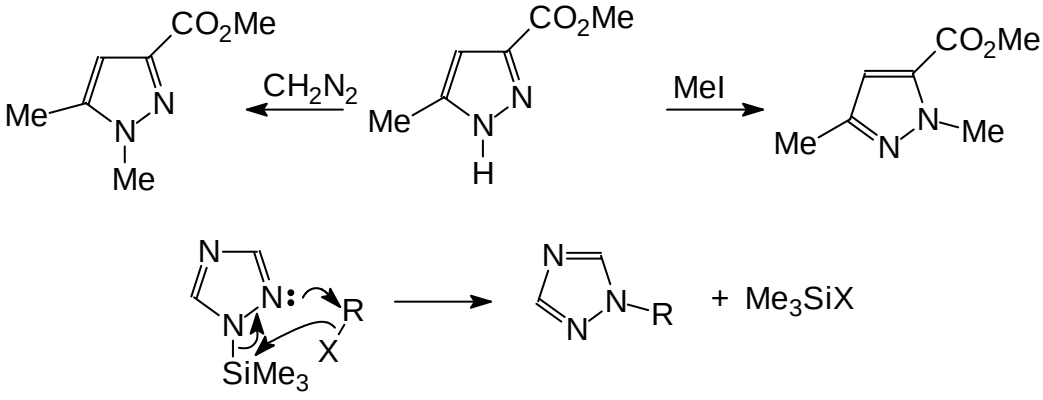


TL, 1998, 2735.

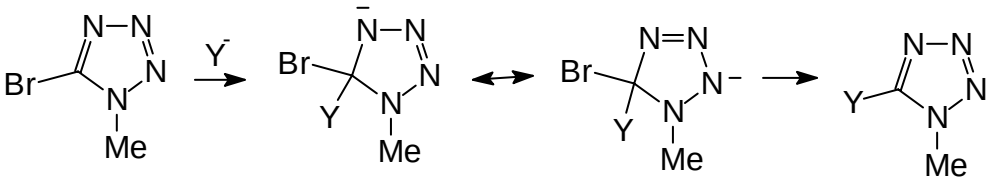
6.7.3.3 Reactions

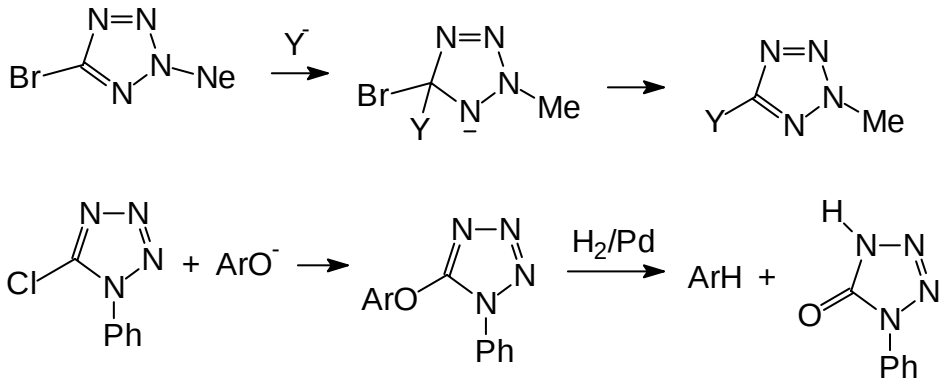


Rearrangement of 1-nitropyrazole in sulfuric acid

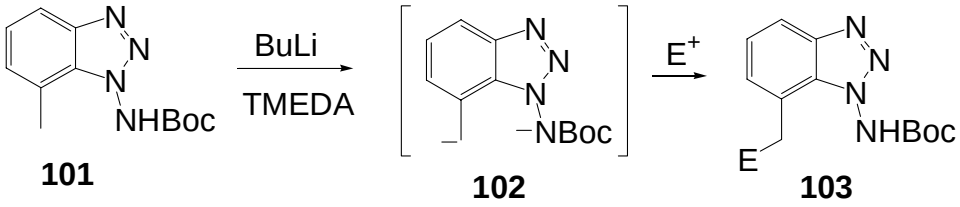


Alkylation of pyrazoles and triazoles

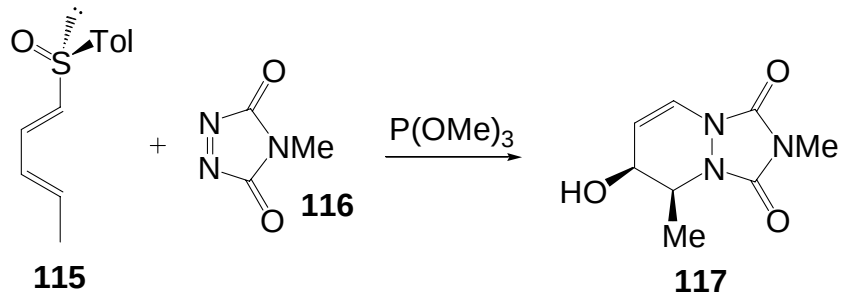




Nucleophilic displacement reactions of 5-halotetrazoles

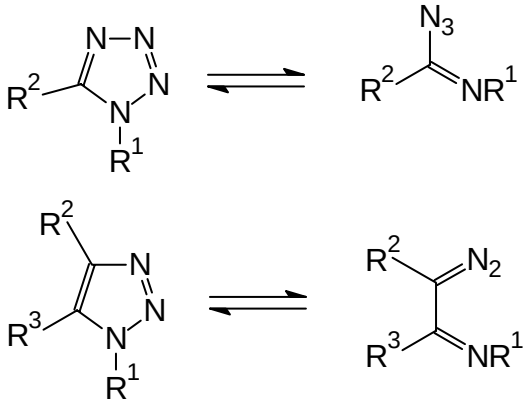


JCS P1, 1998, 2301.

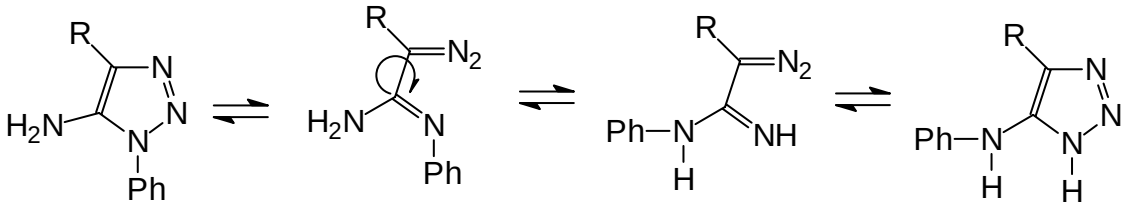


TL, 1998, 1405.

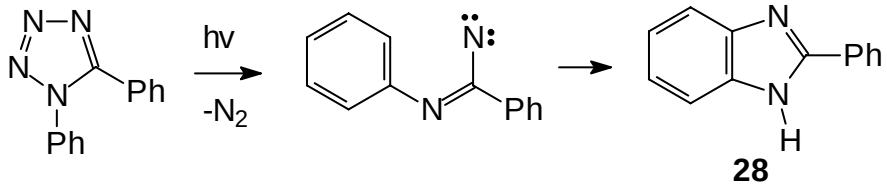
6.7.3.4 Ring cleavage



Ring-chain tautomerism in tetrazoles and in 1,2,3-triazoles

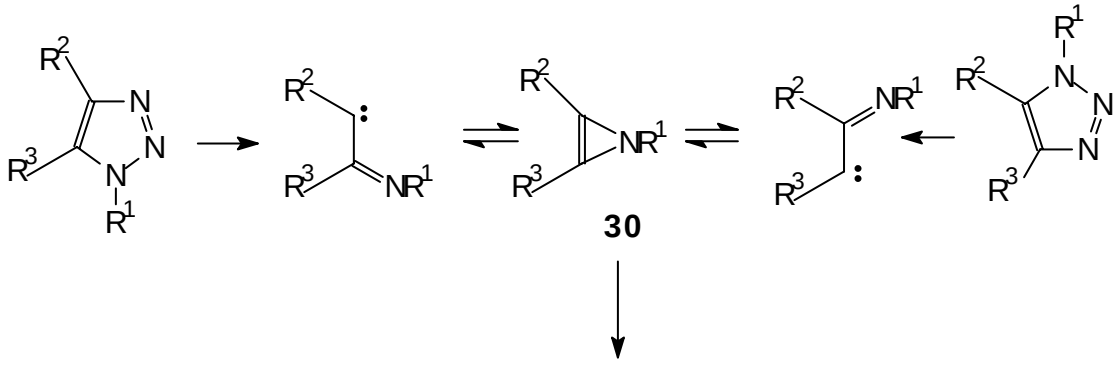


The Dimroth rearrangement



28

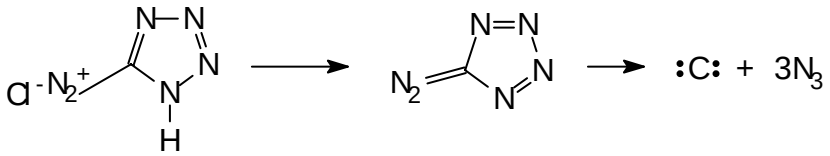
Photolysis of 1,5-disubstituted tetrazoles



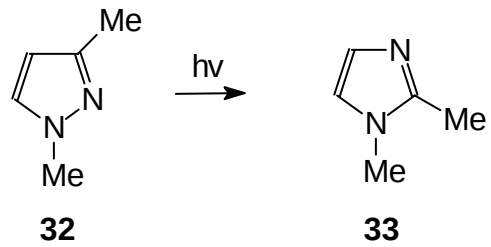
30

Products

Decomposition of 1,2,3-triazole

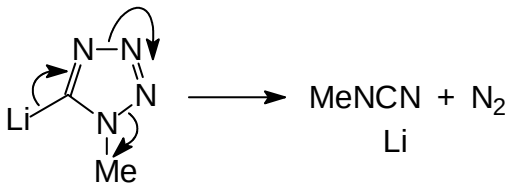


Decomposition of tetrazole-5-diazonium chloride



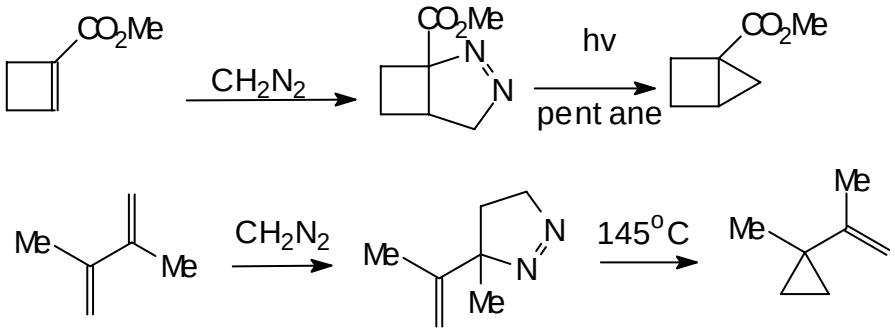
32 **33**

Photochemical rearrangement of 1,3-dimethylpyrazole



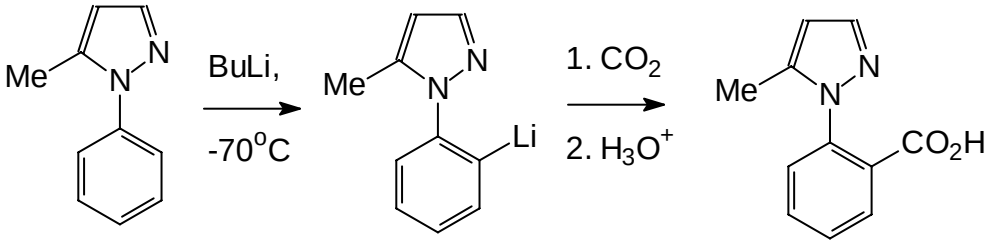
34

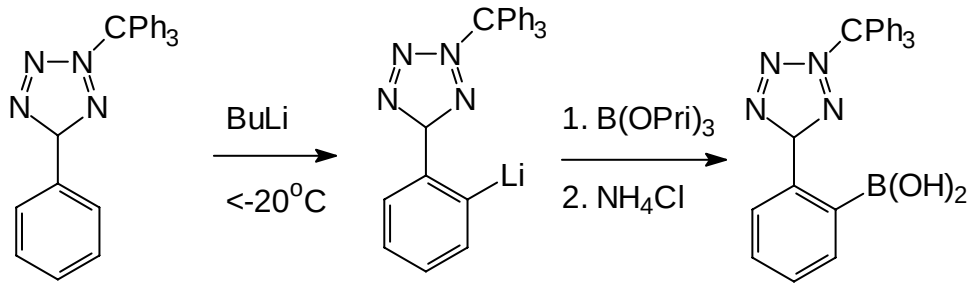
Cleavage of 5-litho-1-methyltetrazole



Formation and decomposition of 4,5-dihydro-3H-pyrazoles

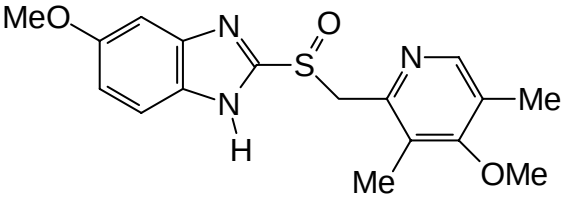
6.7.3.5 Azoles as ortho-directing groups for metallation





Azoles as substituents for directed lithiation

6.7.4 Benzodiazoles and benzotriazoles



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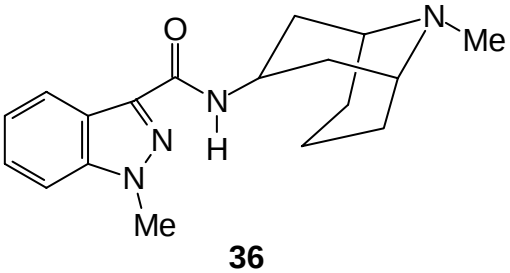

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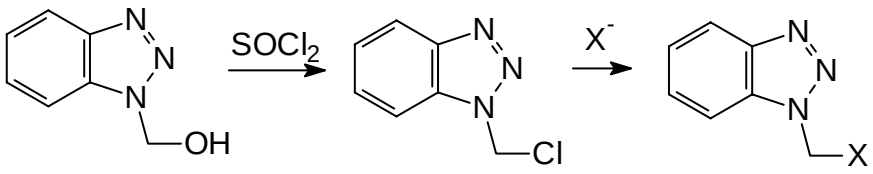
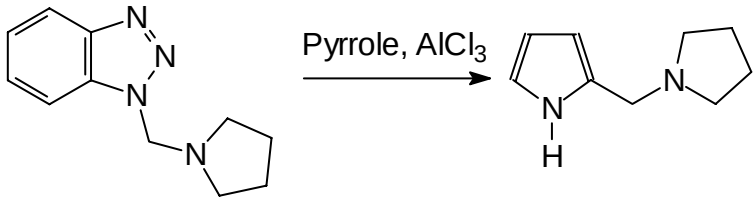
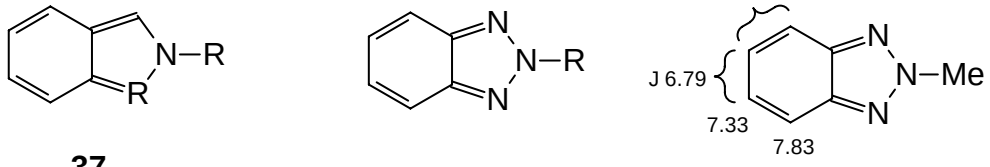


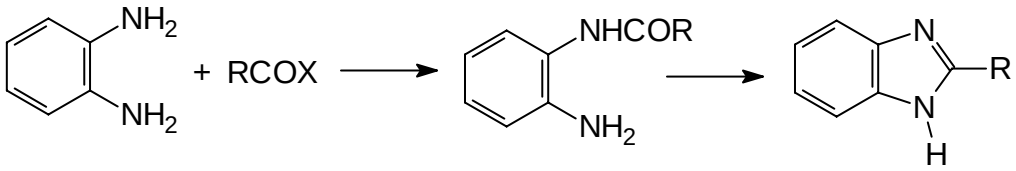
(X = OR, NR_2, CN, N_3, etc.)



1-Alkyl-substituted benzotriazoles as reagents

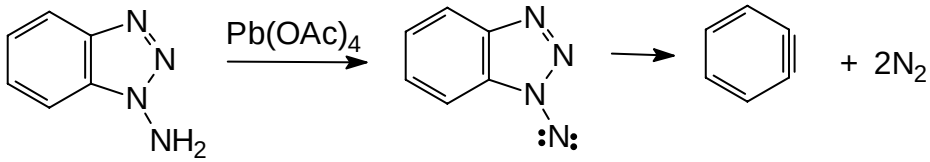


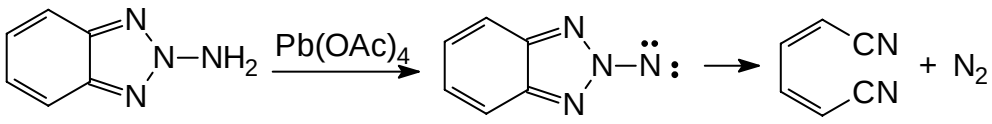
37 **38** **39**



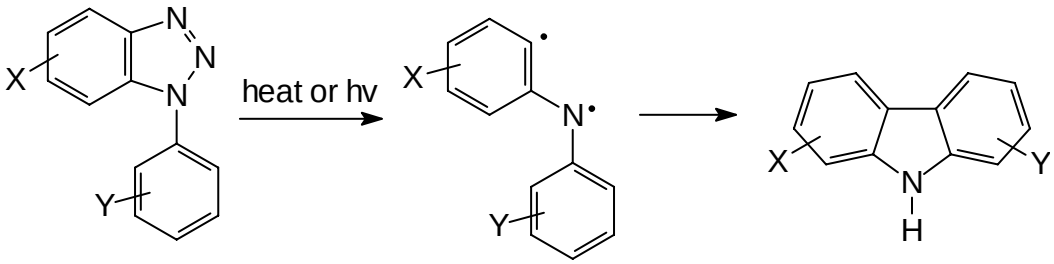
40

Synthesis of benzimidazoles from benzene-1,2-diamine





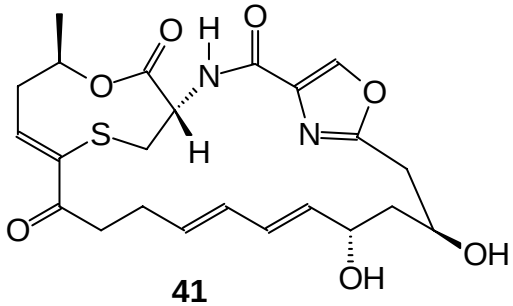
Oxidative fragmentation of 1- and 2-aminobenzotriazole



The Graebe-Ullmann carbazole synthesis

6.7.5 Oxazoles and thiazoles and their benzo derivatives

6.7.5.1 Introduction



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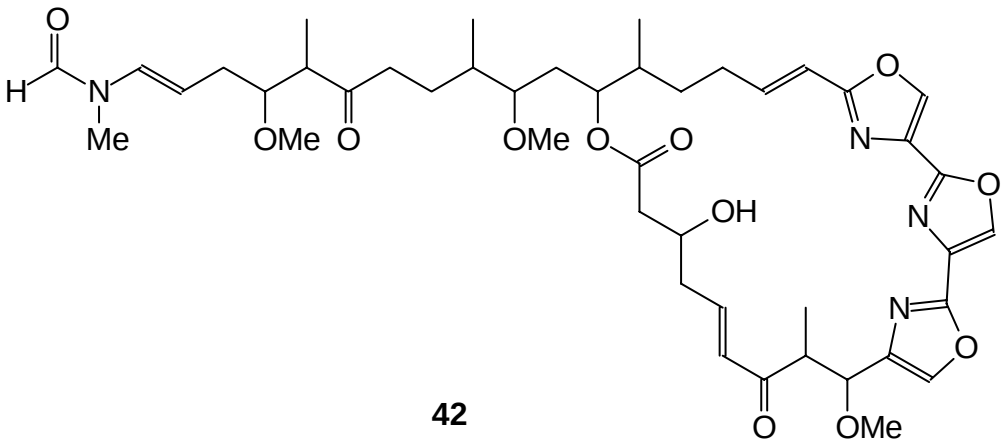

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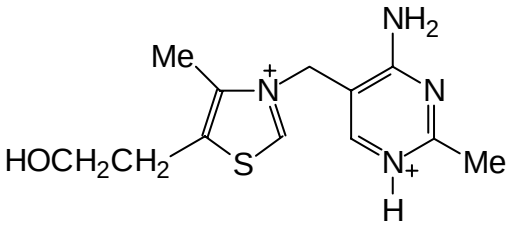

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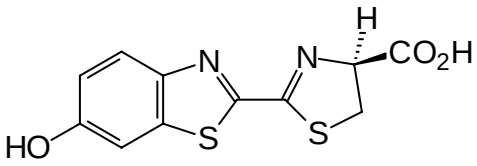
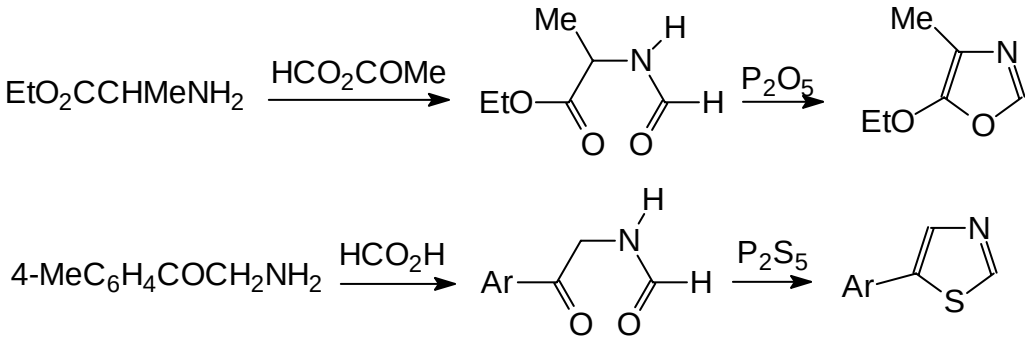
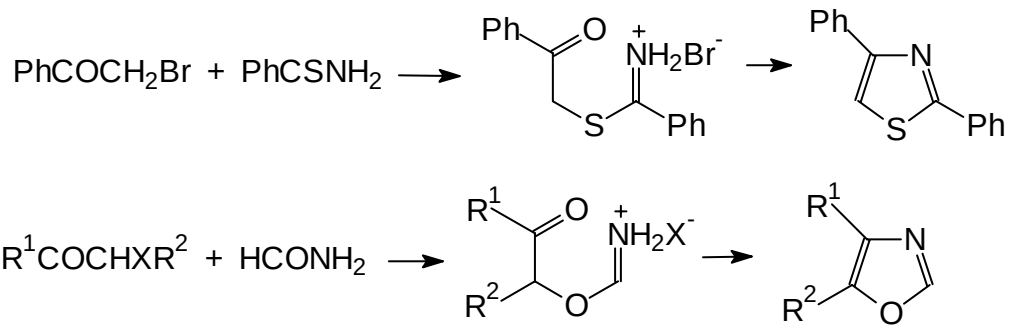


44

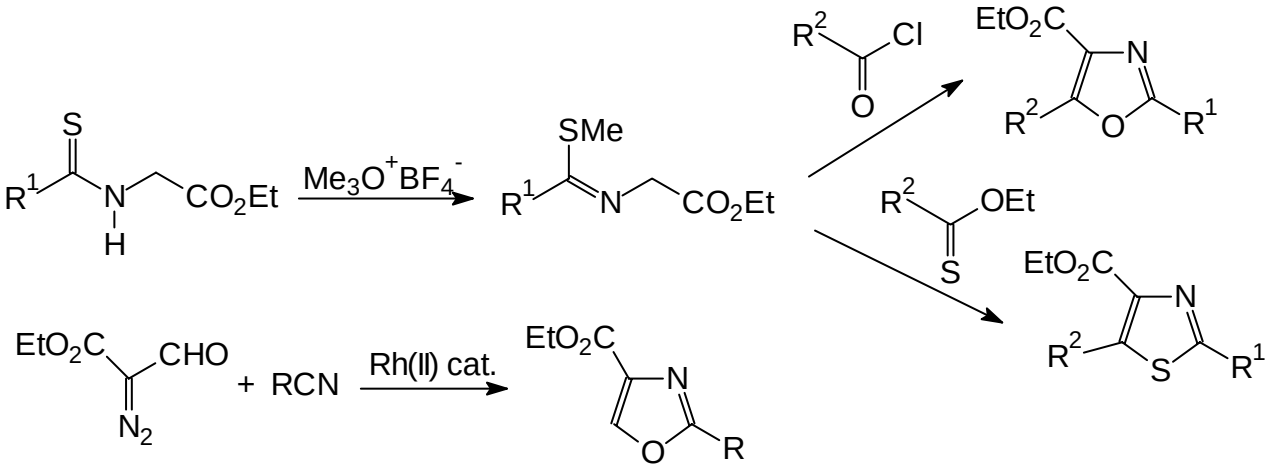
6.7.5.2 Ring synthesis



Oxazole and thiazole synthesis

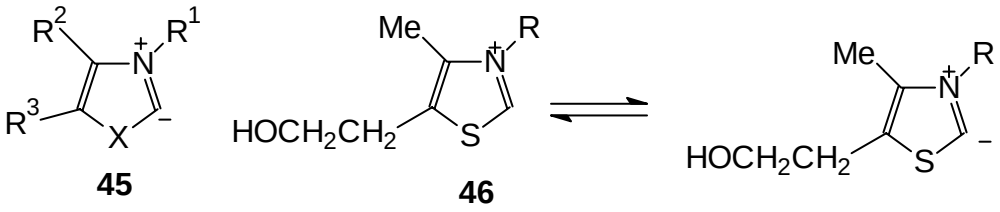


Synthesis of thiazoles and oxazoles from α-haloketones

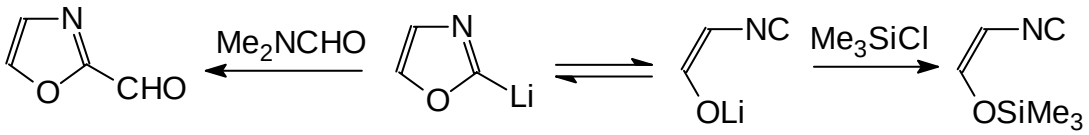


Methods of synthesis of oxazole- and thiazole-4-carboxylic esters

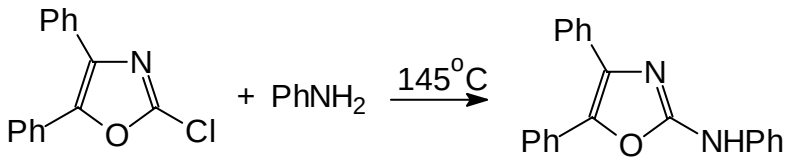
6.7.5.3 Chemical properties

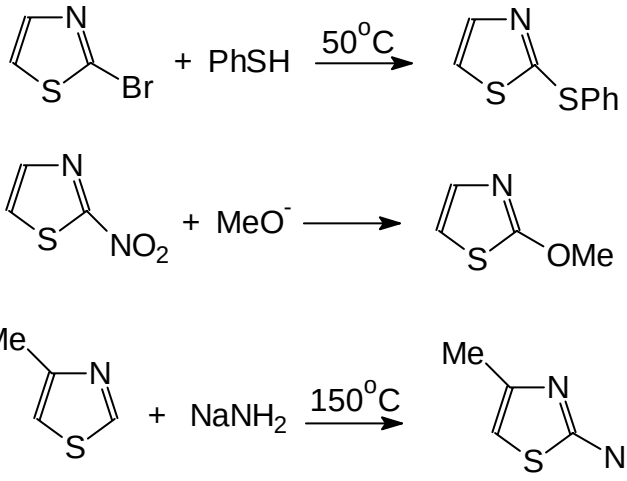


45 **46**

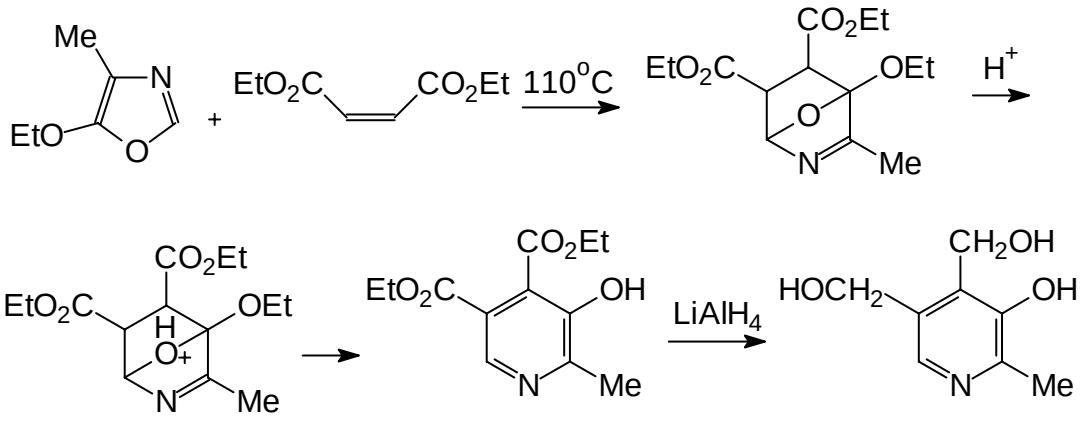


Reversible ring opening of 2-oxazolyllithium

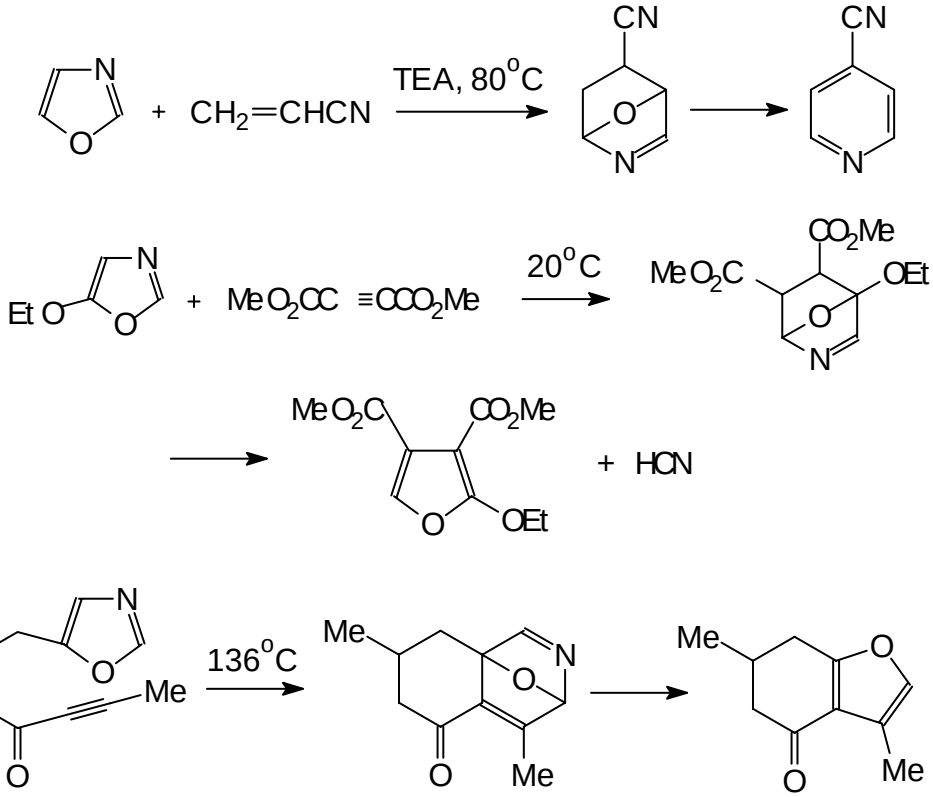




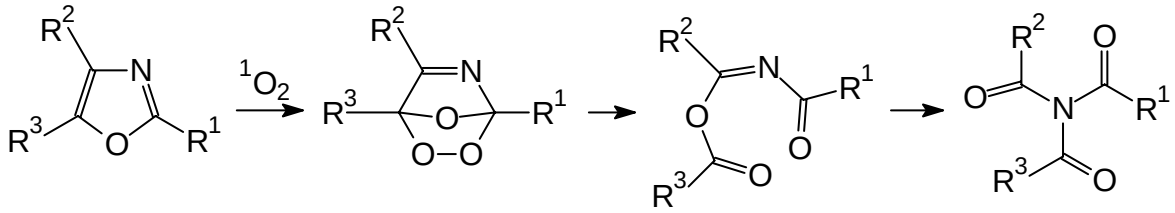
Nucleophilic substitution in oxazoles and thiazoles



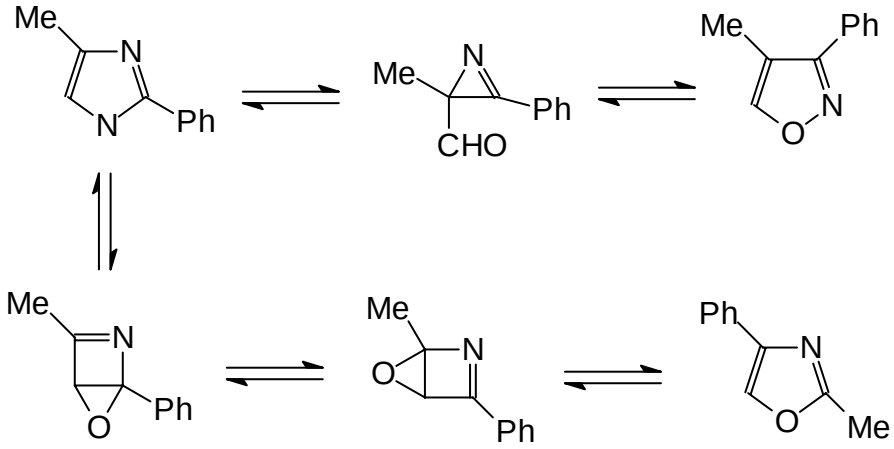
Synthesis of pyridoxol by Diels-Alder addition



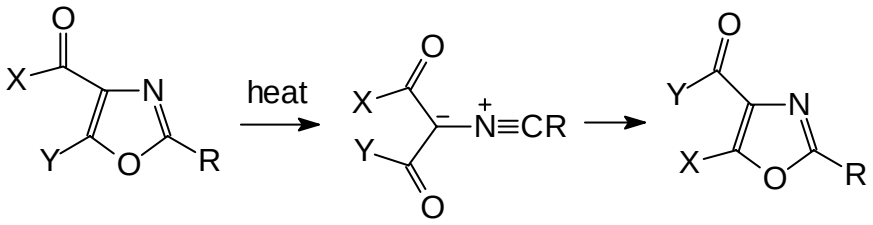
Oxazoles as dienes



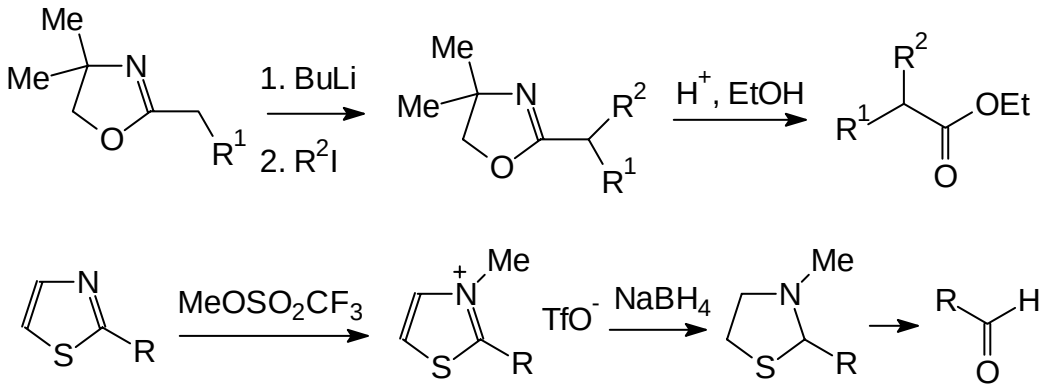
The addition of singlet oxygen to oxazoles



Photorearrangement of 4-methyl-2-phenyloxazole



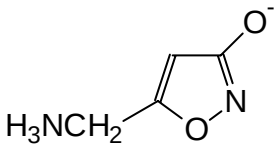
The Cornforth rearrangement (X = H, Cl, NR^2; Y = Cl, OR, O^-)



4,5-Dihydrooxazoles and thiazoles as protecting groups.

6.7.6 Isoxazoles, isothiazoles, and their benzo derivatives

6.7.6.1 Introduction



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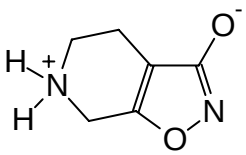

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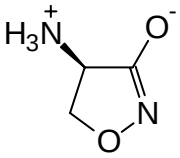

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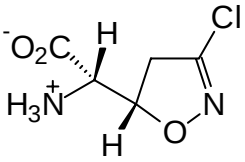

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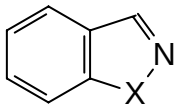

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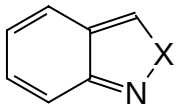
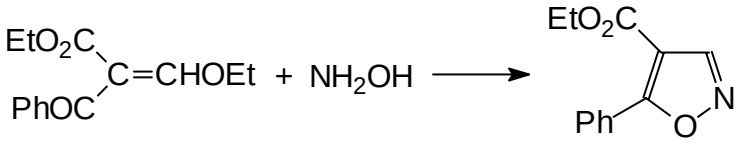
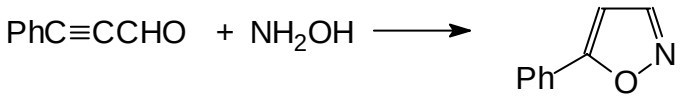
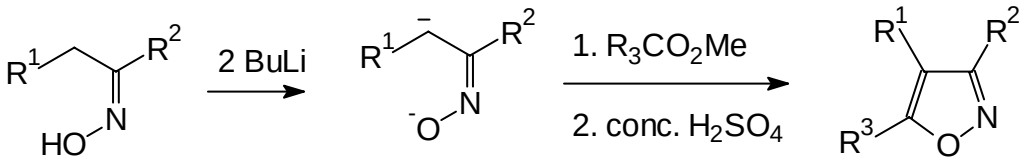


54

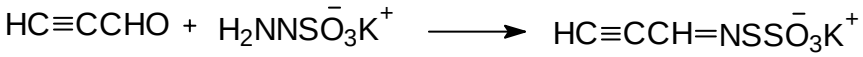
6.7.6.2 Ring synthesis



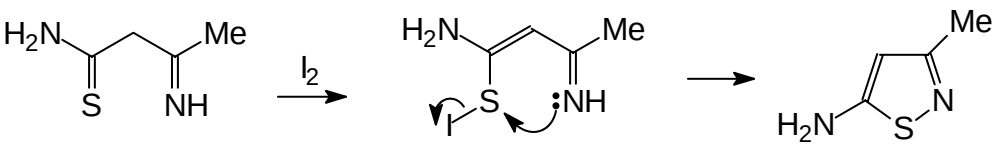


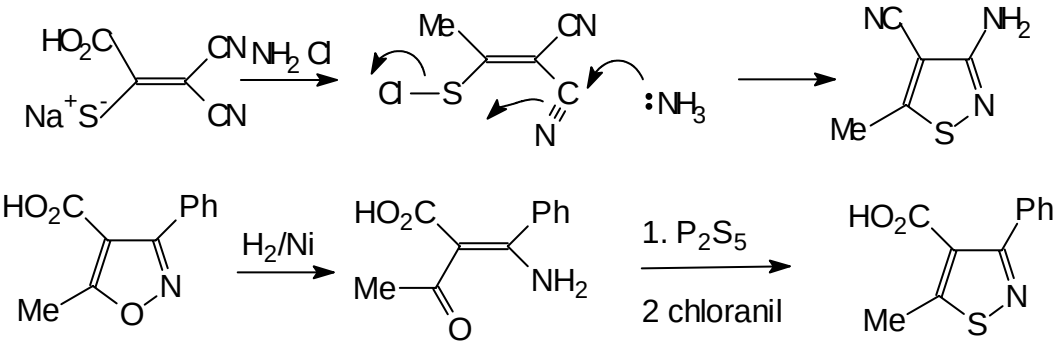


Isoxazoles by cyclization reactions

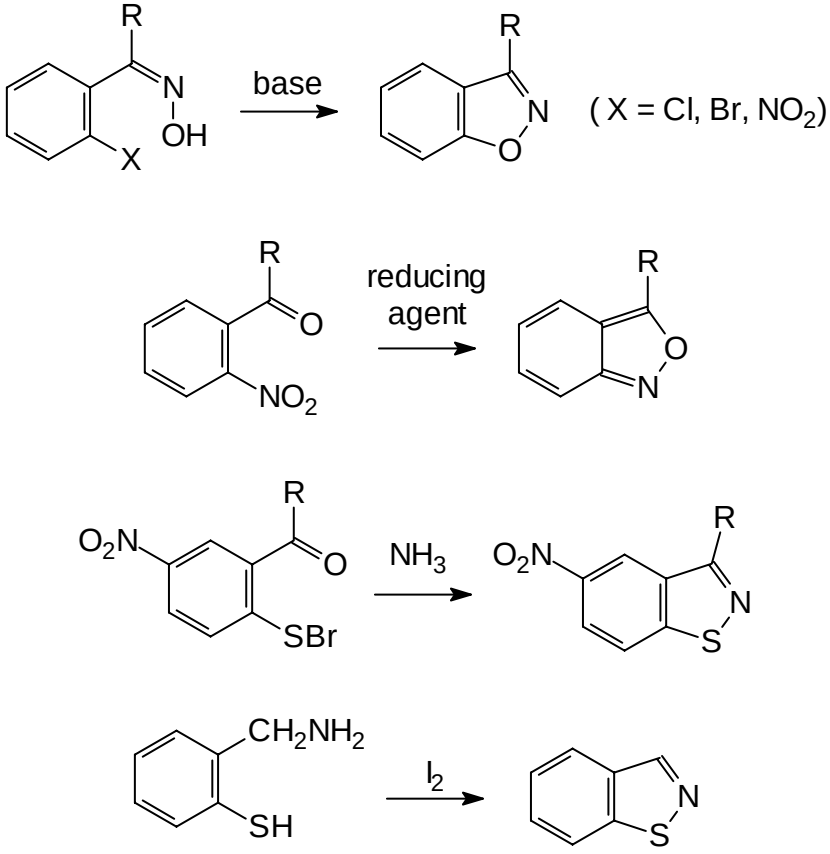


A route to isothiazole

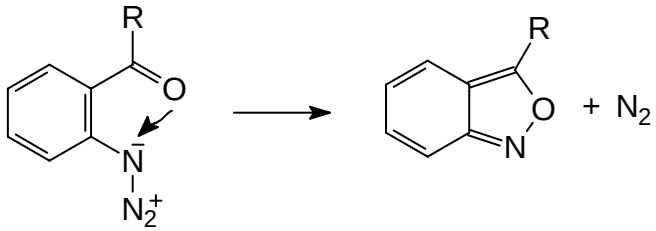




Isothiazole synthesis by formation of the N-S bond.

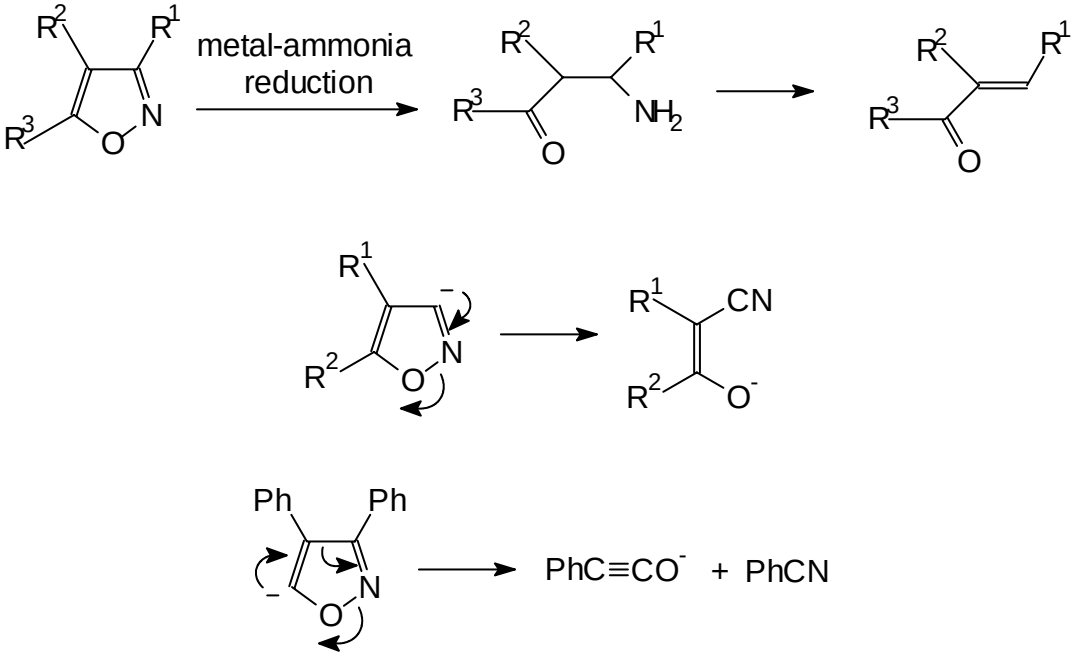


Routes to benzisoxazoles and benzisothiazoles

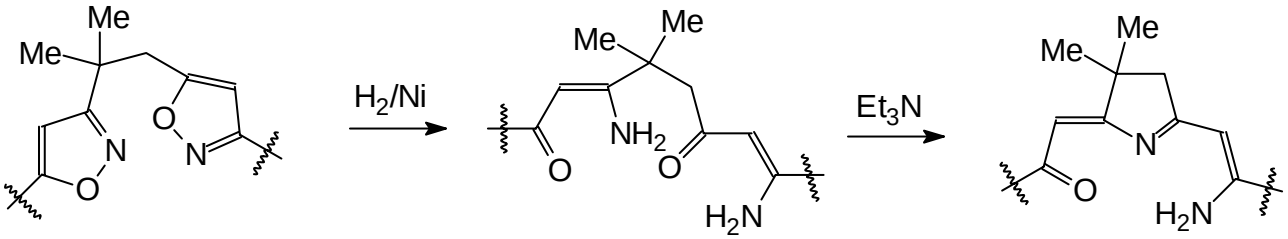


2,1-Benzisoxazoles from 2-azidozryl ketones

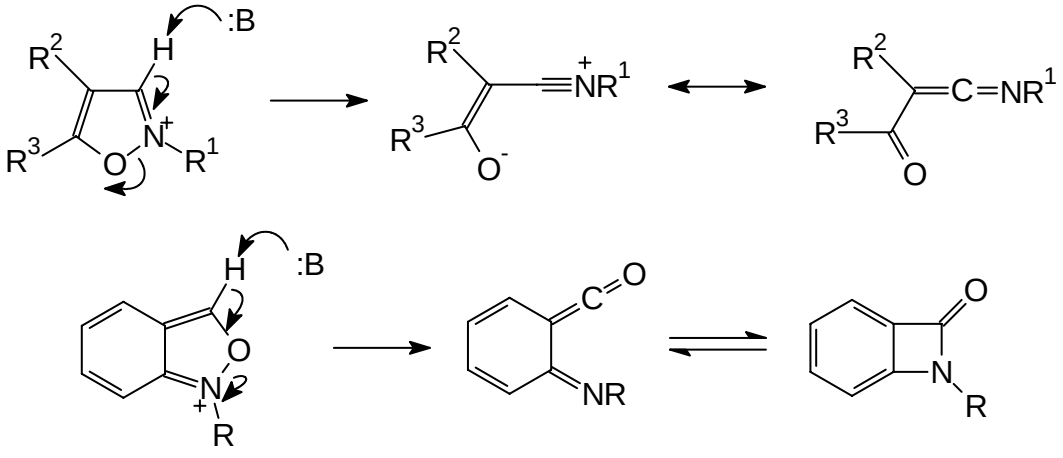
6.7.6.3 Chemical properties



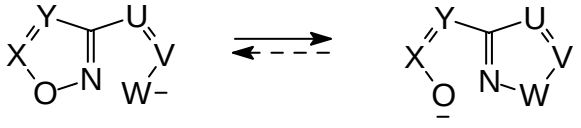
Cleavage of isoxazoles



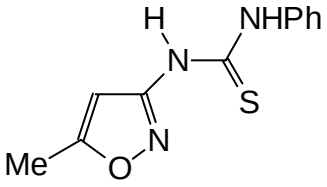
Reductive cleavage of isoxazoles in corrin synthesis.



Anionic cleavage of isoxazolium



Rearrangement of isoxazoles and related heterocycles



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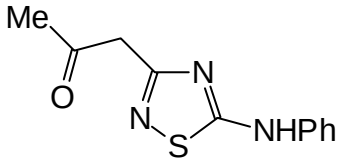

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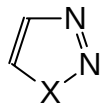
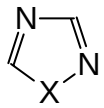
6.7.7 Oxadiazoles, thiadizoles and related systems

6.7.7.1 Introduction



1,2,3-



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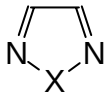

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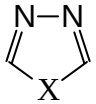
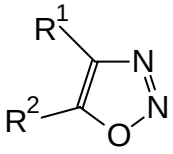


1,3,4-

Isomeric oxadiazoles and thiadiazoles



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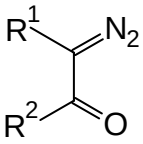

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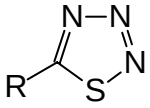

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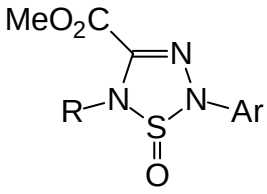

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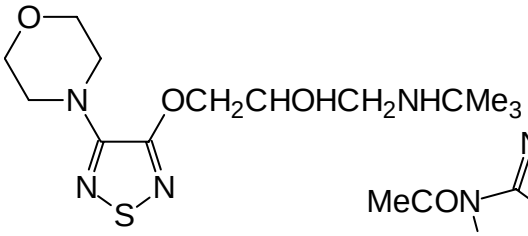

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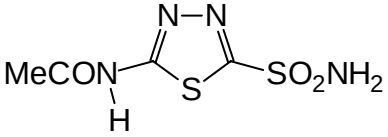

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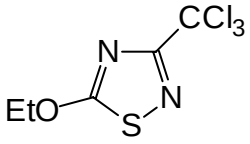

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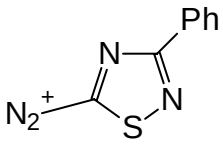
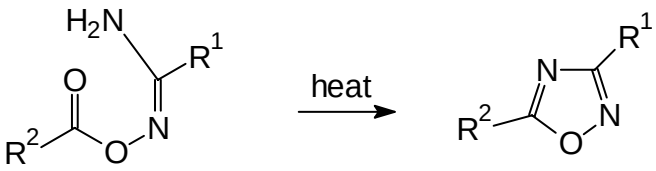
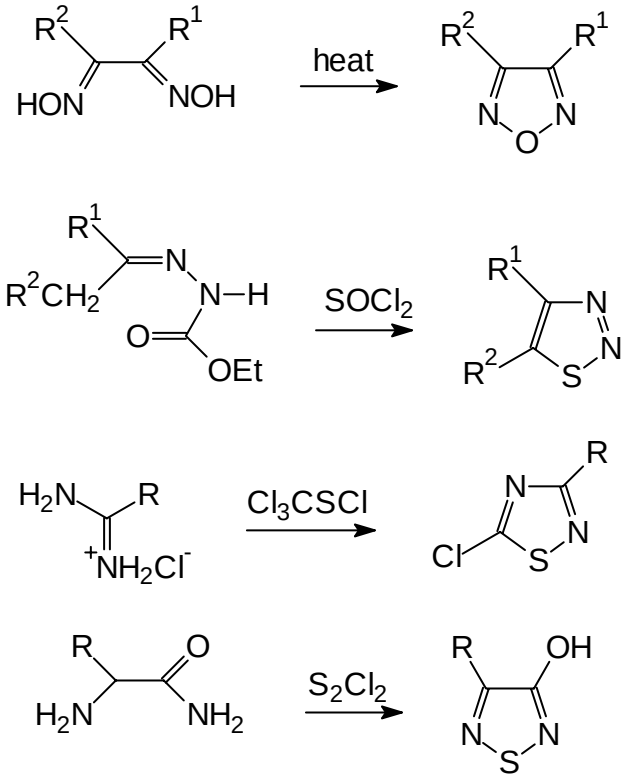


66

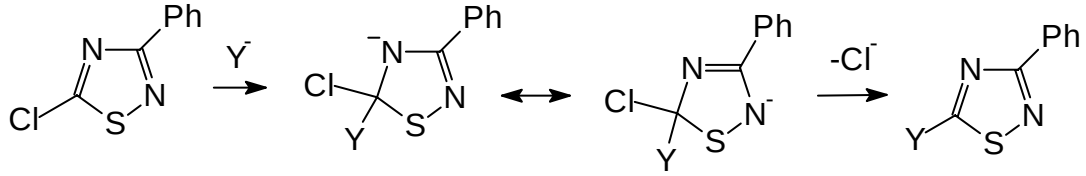
6.7.7.2 Ring synthesis



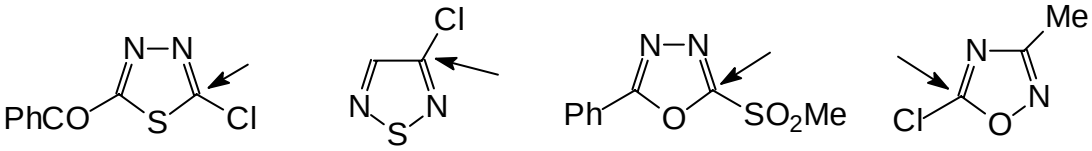


Some general methods for preparing oxadiazoles and thiadiazoles.

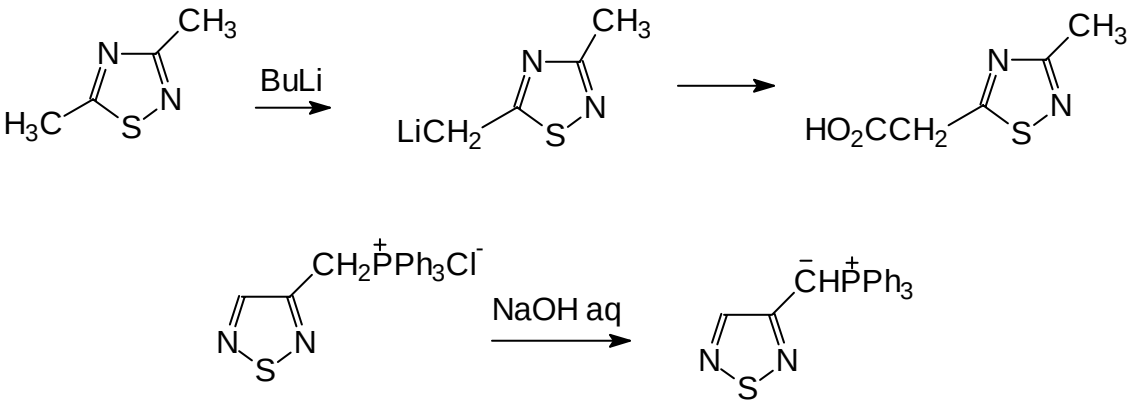
6.7.7.3 Chemical properties



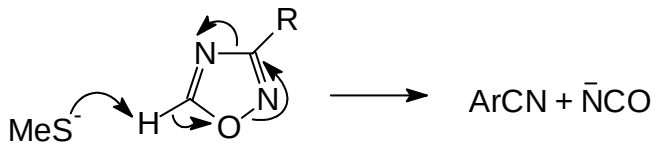
Nucleophilic displacement of chloride in 5-chloro-3-phenyl-1,2,4-thiadiazole

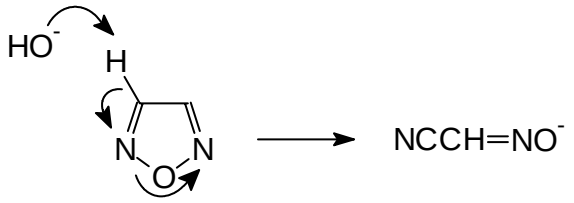


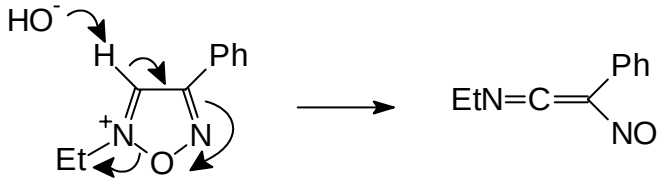
67 **68** **69** **70**

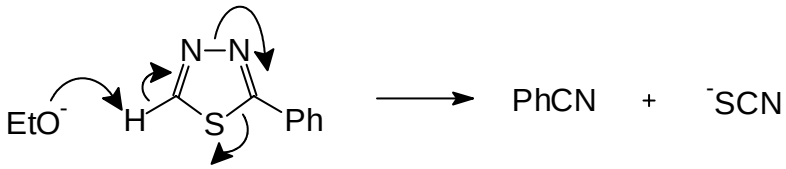


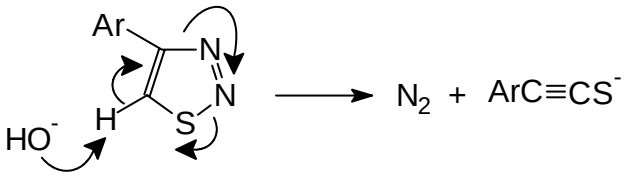
Acidity of α-hydrogen atoms



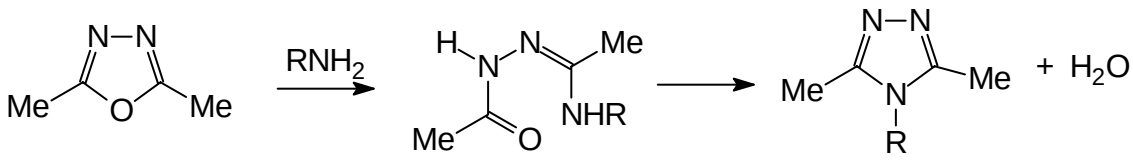




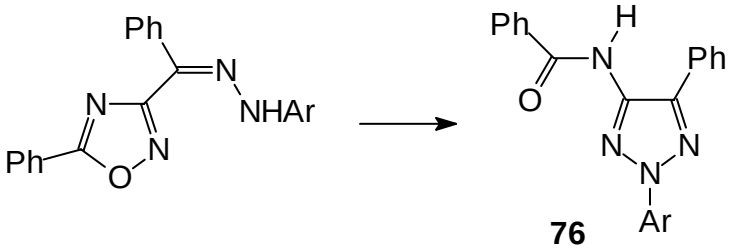




Examples of anionic cleavage



Ring opening of 2,5-dimethyl-1,3,4-xoadiazole and recyclization



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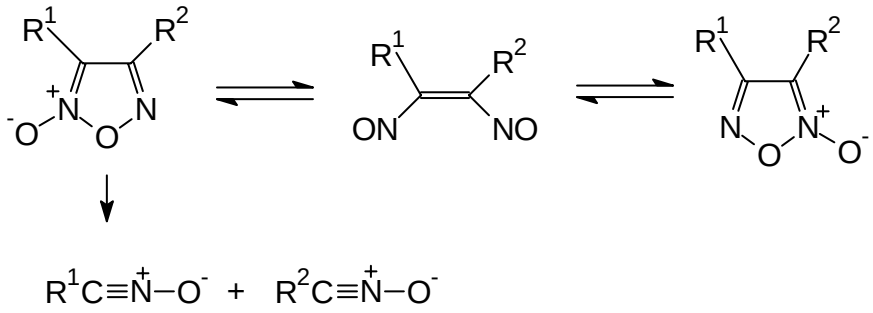
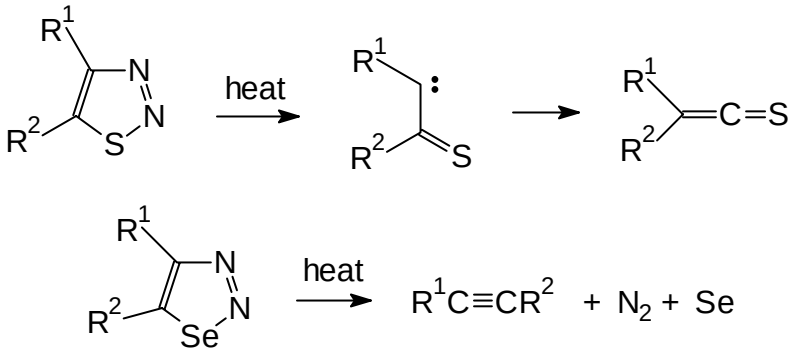
An example of ring interconversion.



Thermal reactions of 1,2,5-oxadiazole 2-oxides

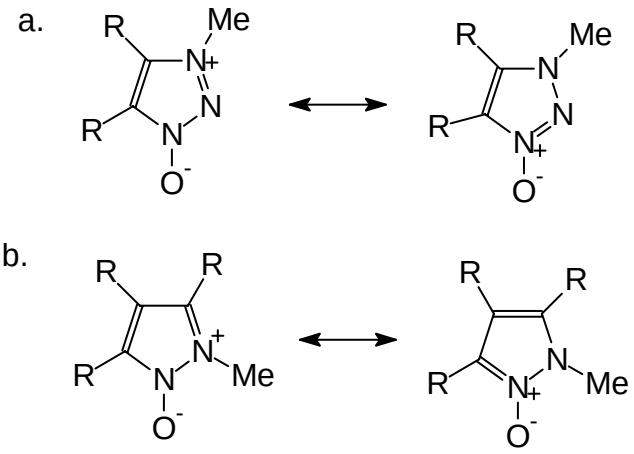


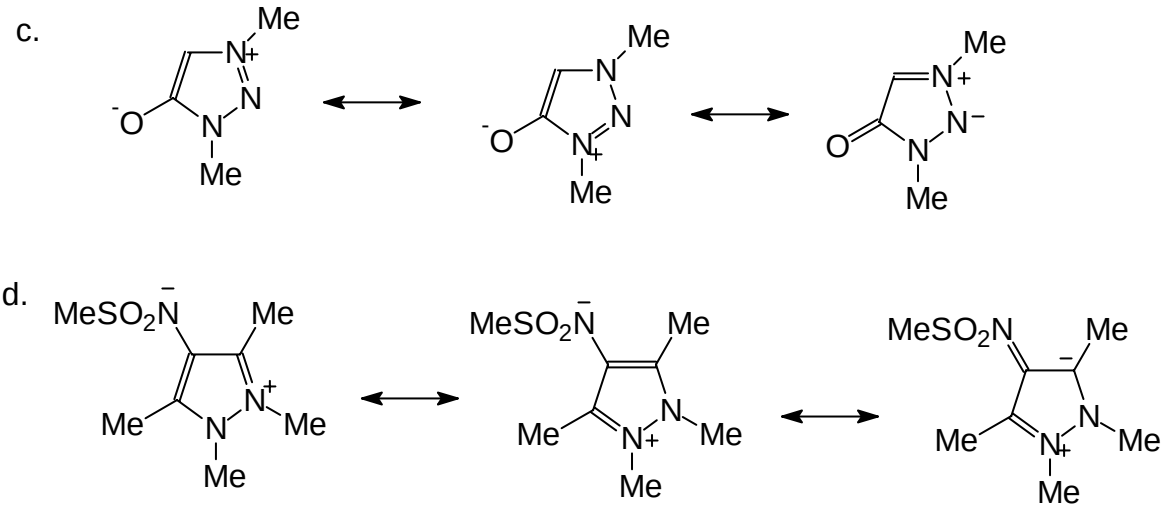
Thermolysis of 1,2,3-thiadiazoles and 1,2,3-selenadiazoles

6.7.8 Betaines and mesoionic compounds

Betaine: dipolar structure

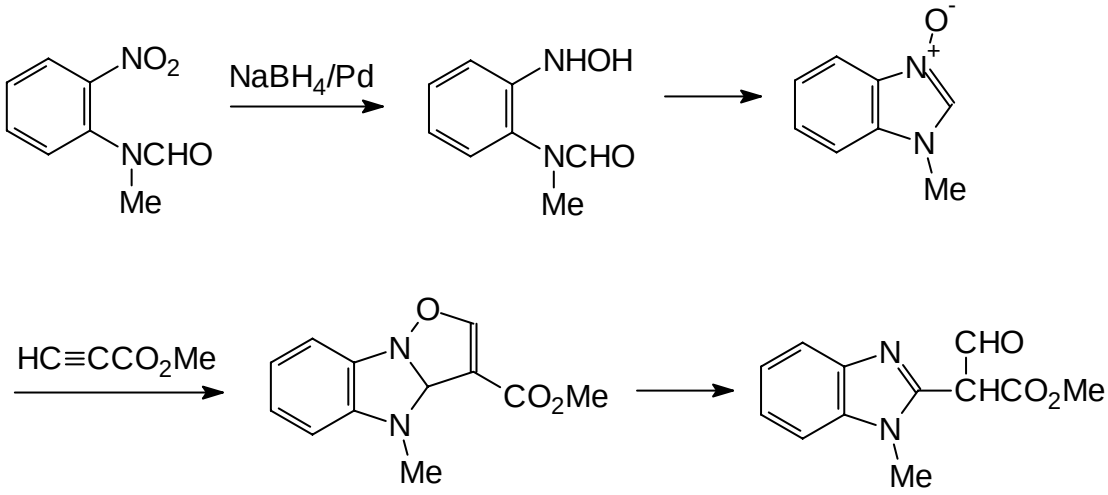
Mesoionic compounds: cannot satisfactorily be represented by a single covalent or dipolar structure.



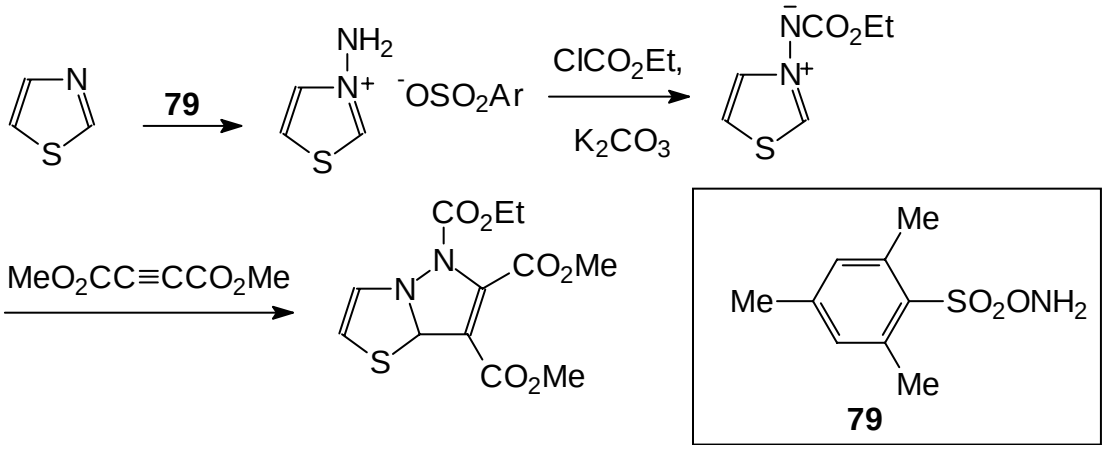


Betains and mesoionic azoles

6.7.8.1 N-Oxides and N-imides

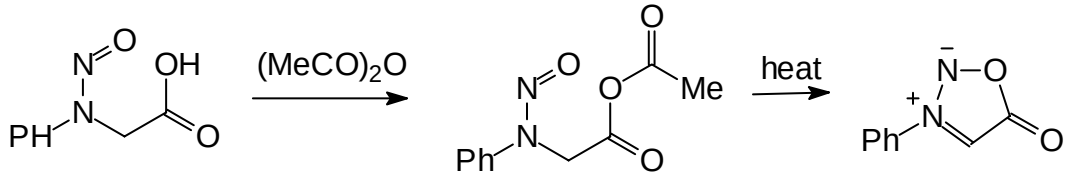


Formation and dipolar cycloaddition of 1-methylbenzimidazole 3-oxide



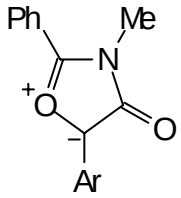
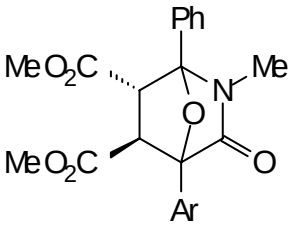
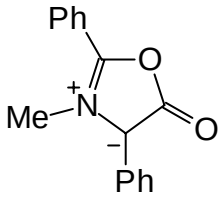
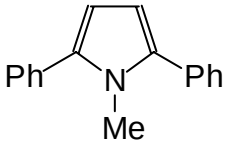
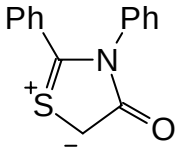
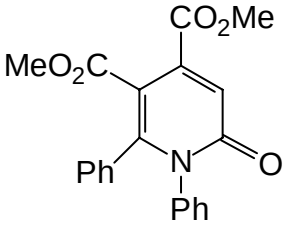
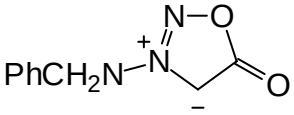
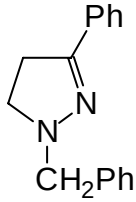
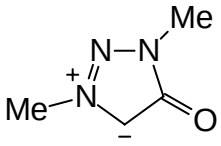
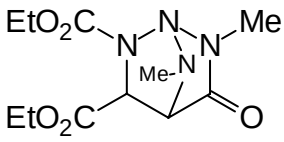
N-Amination of thiazole and generation of thiazolium N-imide

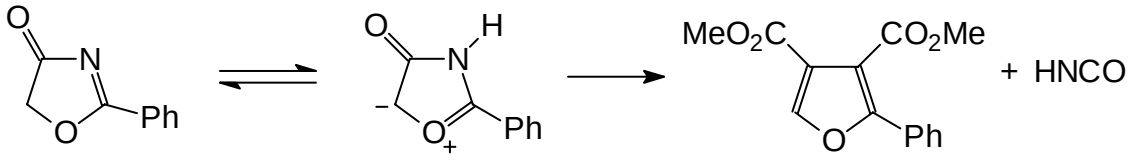
6.7.8.2 Mesoionic compounds



Formation of N-phenylsynone

Examples of 1,3-dipolar addition of mesoionic heterocycles

Mesoionic compound	Dipolarphile	Product
	(E)-$MeO_2CCH=CHCO_2Me$, 80°C	
	$HC\equiv CH$, 120-130°C	
	$MeO_2CC\equiv CCO_2Me$, 80°C	
	$PhCH=CH_2$, 140°C	
	$EtO_2CN=NCO_2Et$, 140°C	



Tautomerization of 2-phenyloxazol-4-one