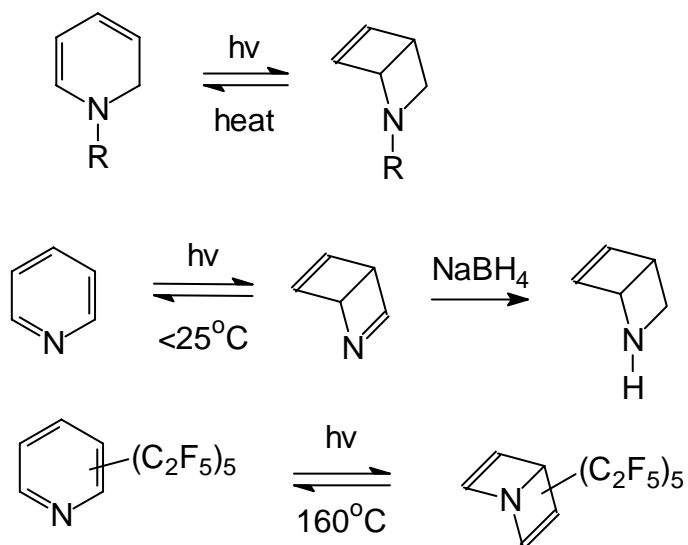
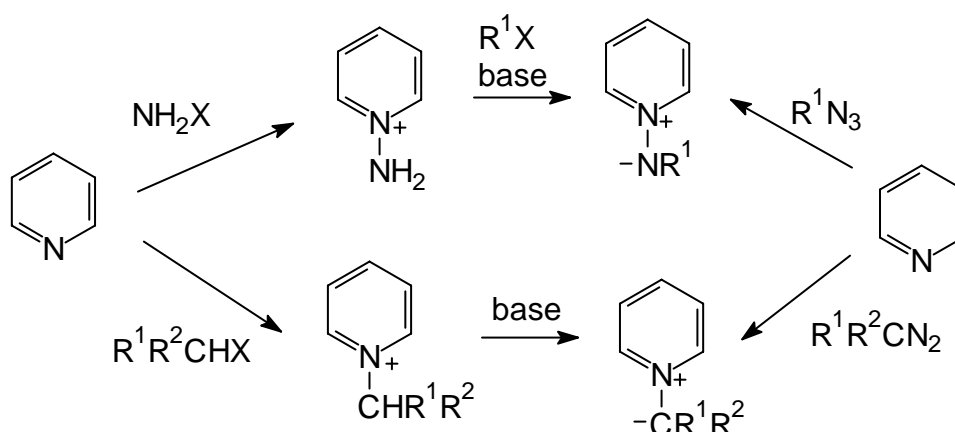


7.1.12 Photochemical isomerization

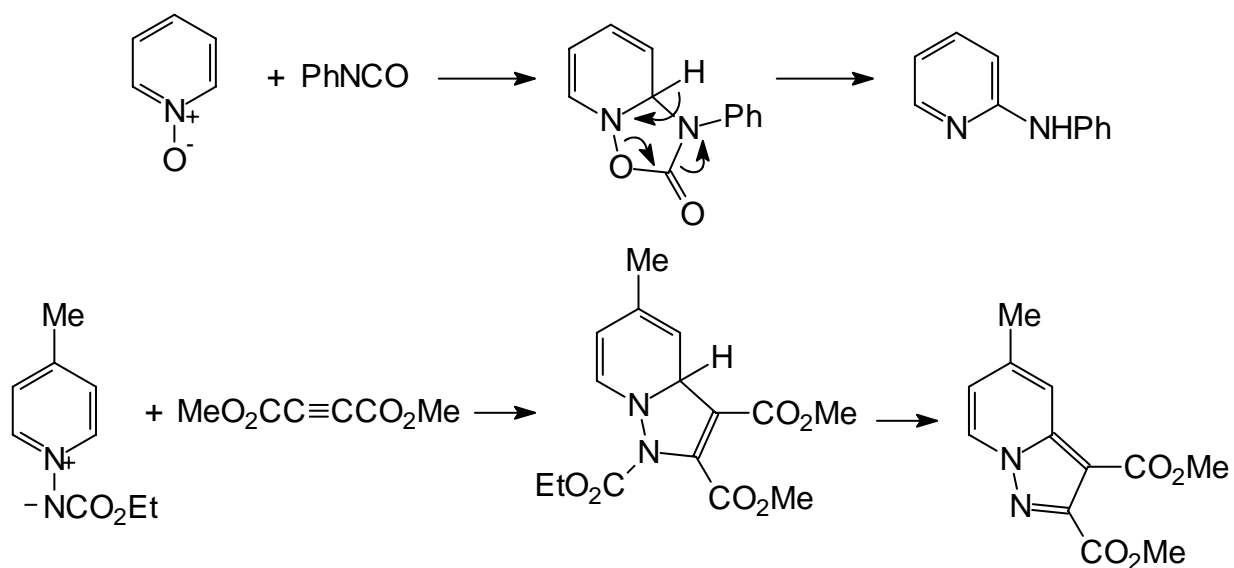


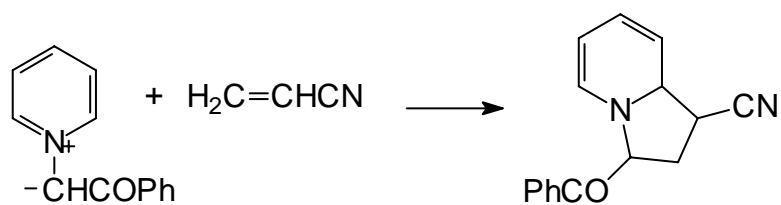
Photoisomerization of 1,2-dihydropyridines and pyridines

7.1.13 Pyridine N-oxides, N-imides and N-ylides

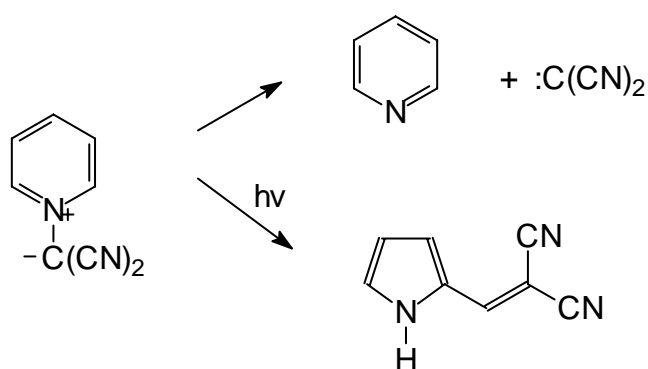
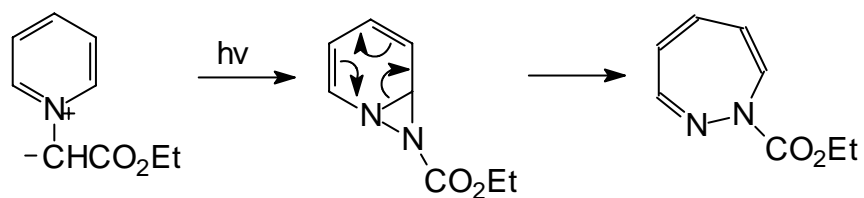


Formation of pyridinium imides and ylides

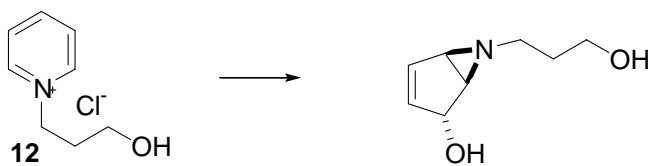
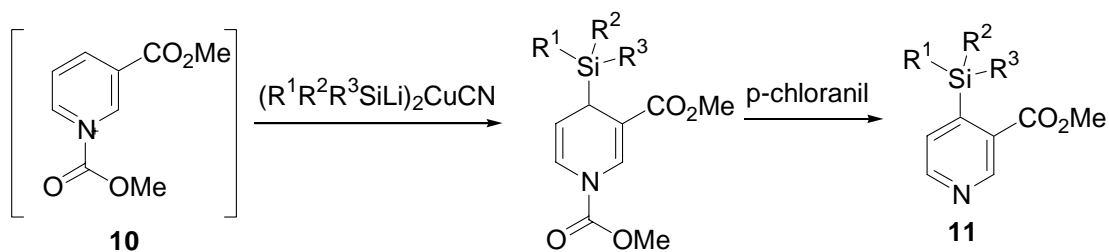




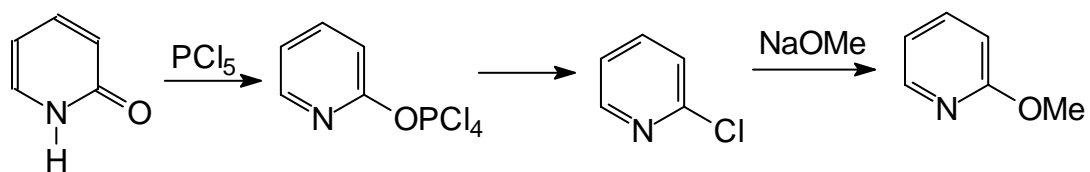
Cycloaddition reactions



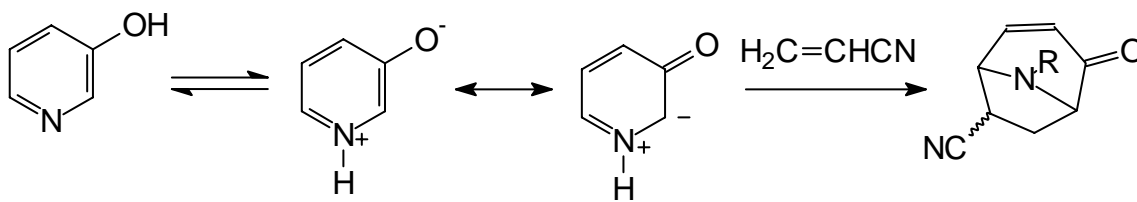
Photochemical reactions



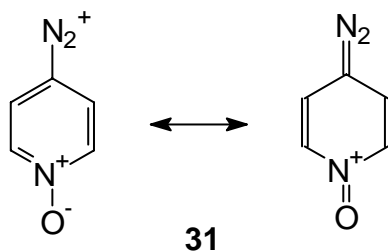
7.1.14 Hydroxy- and aminopyridines



2-Methoxypyridine from 2-pyridone.

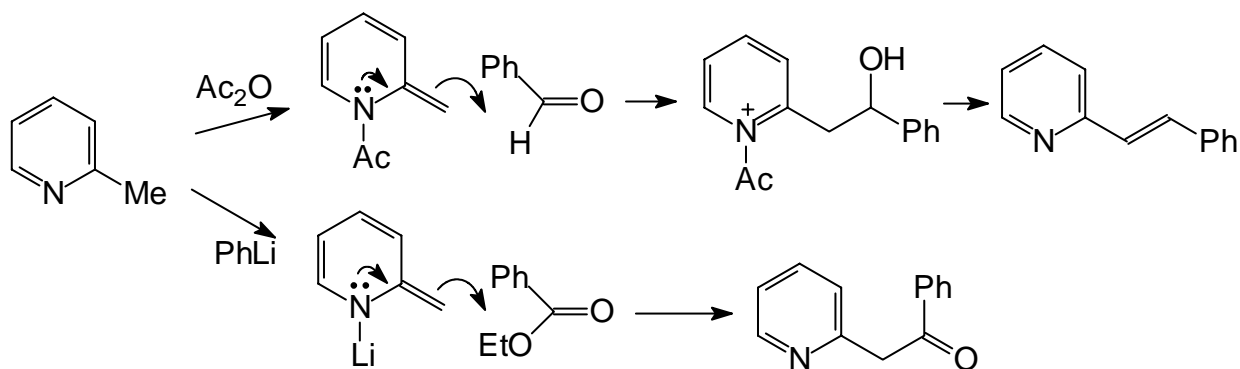


3-Hydroxypyridine as a 1,3-dipole.

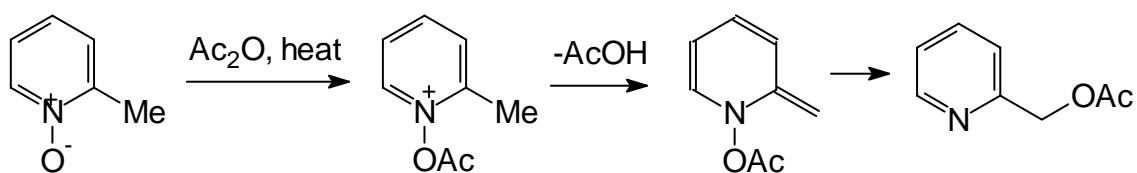


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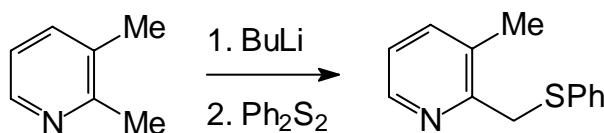
7.1.15. Alkyl- and alkenylpyridines



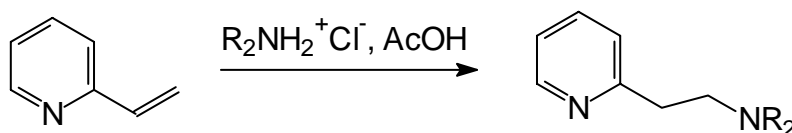
Substitution of the methyl group of 2-methylpyridine.



2-Acetoxymethylpyridine from 2-methylpyridine N-oxide

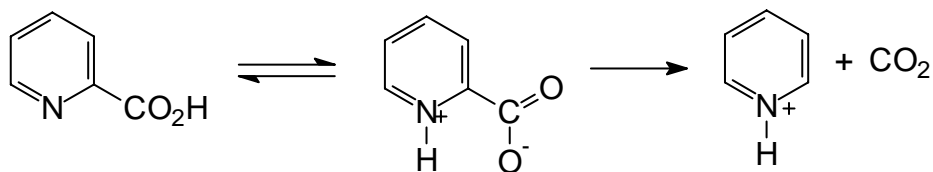


Selective attack at the 2-methyl group of 2,3-dimethylpyridine.



Conjugate addition to 2-vinylpyridine.

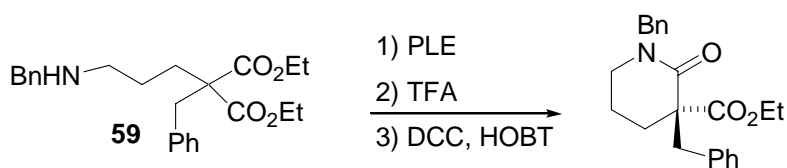
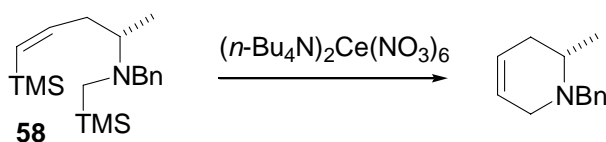
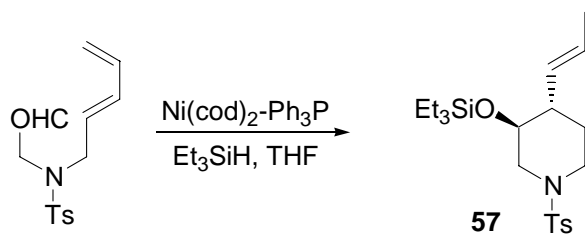
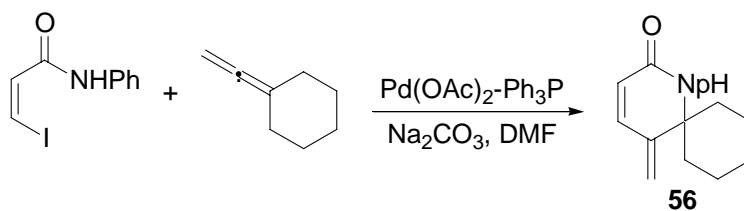
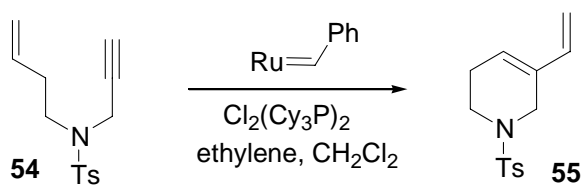
7.1.16. Pyridinecarboxylic acids

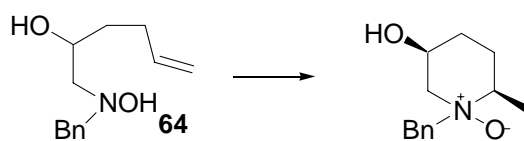
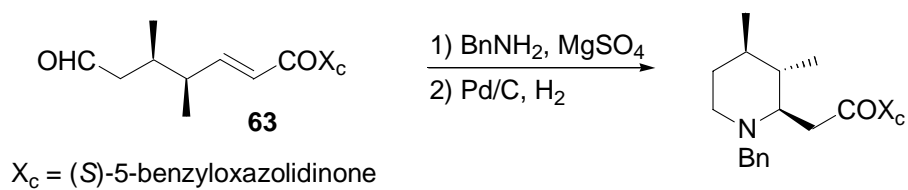
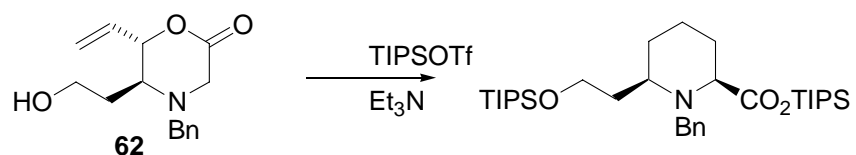
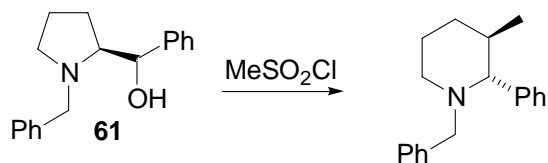
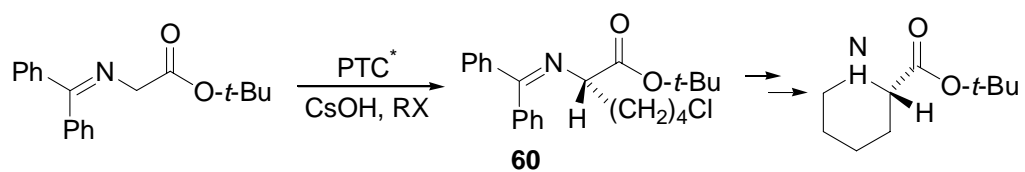


Mechanism of decarboxylation of pyridine-2-carboxylic acid.

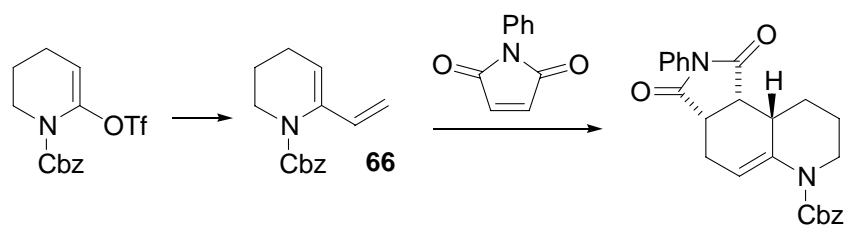
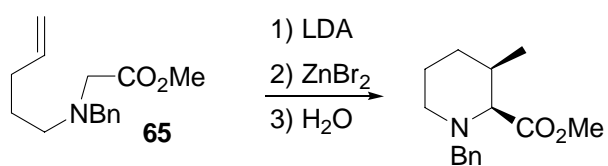
7.1.17. Piperidines

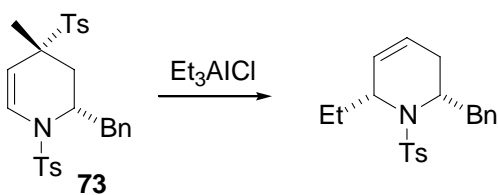
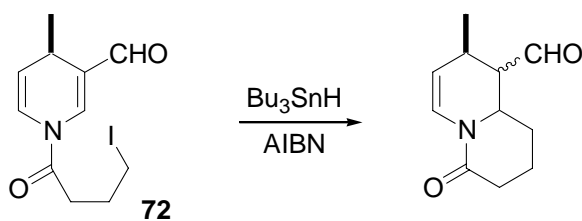
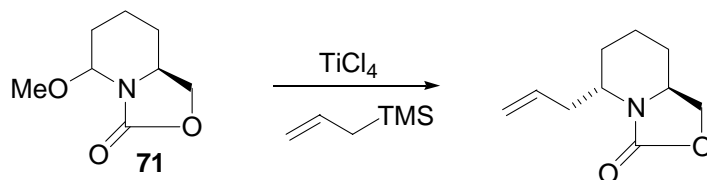
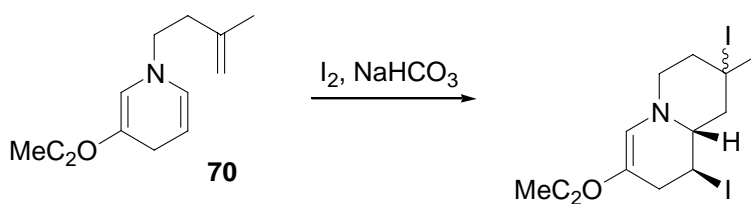
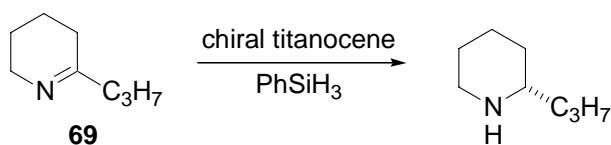
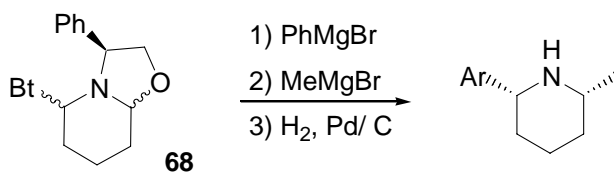
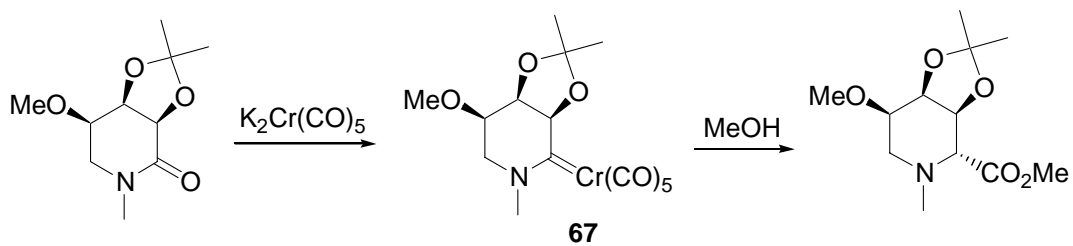
Synthesis of piperidines





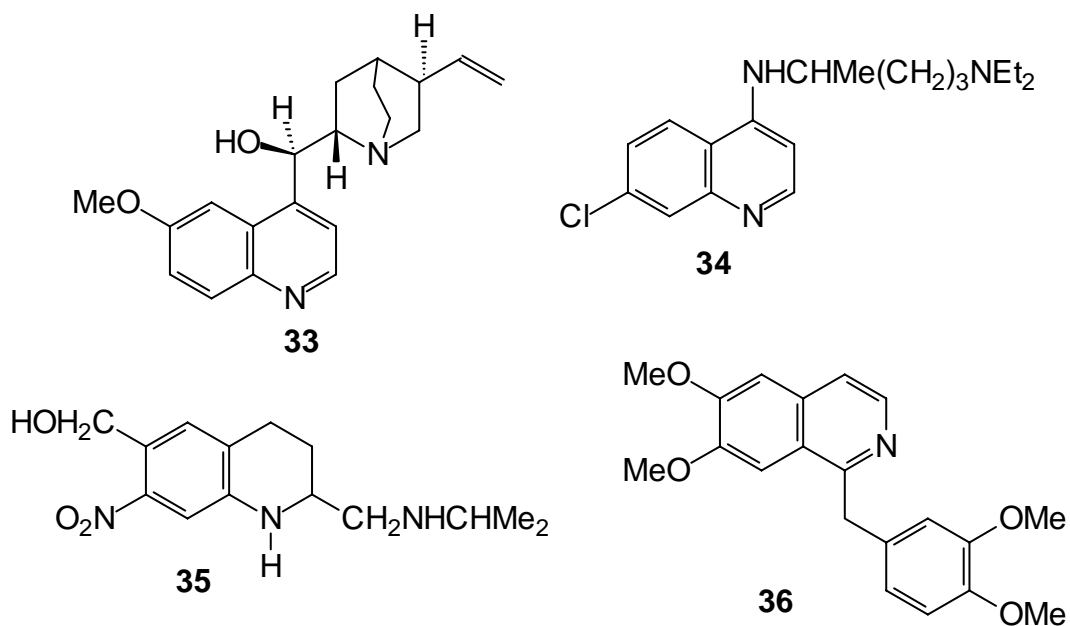
Reaction of piperidines



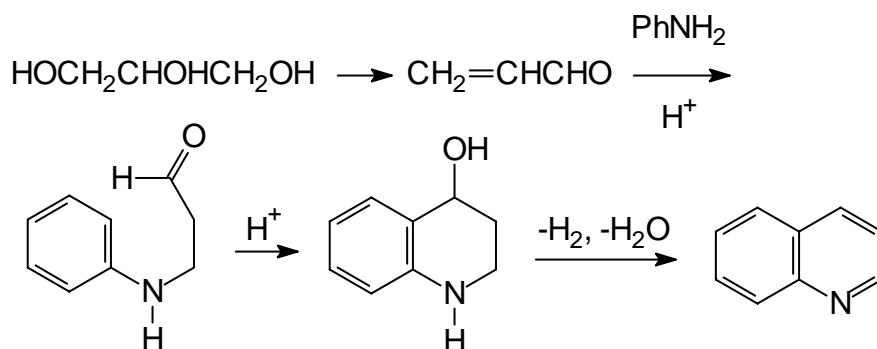


7.2. Quinolines and isoquinolines

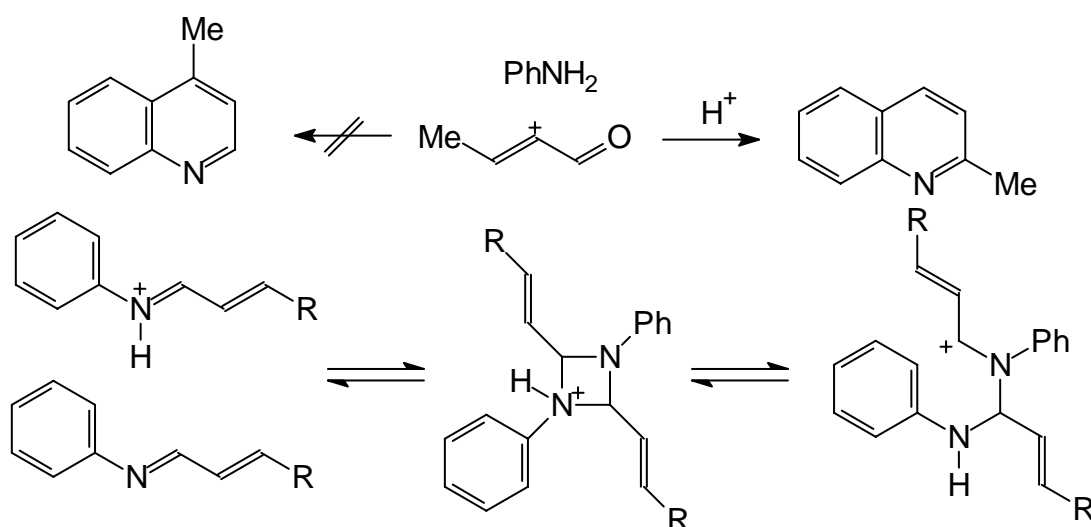
7.2.1. Introduction

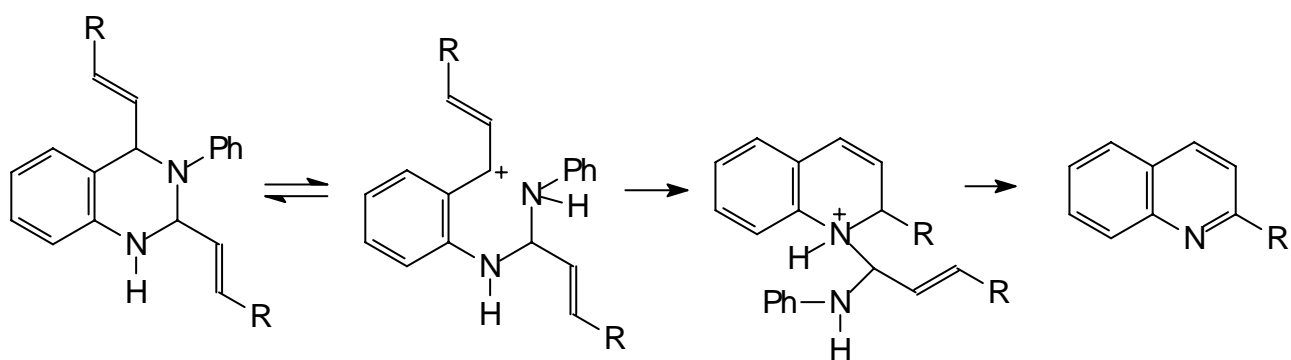


7.2.2 Synthesis of quinolines

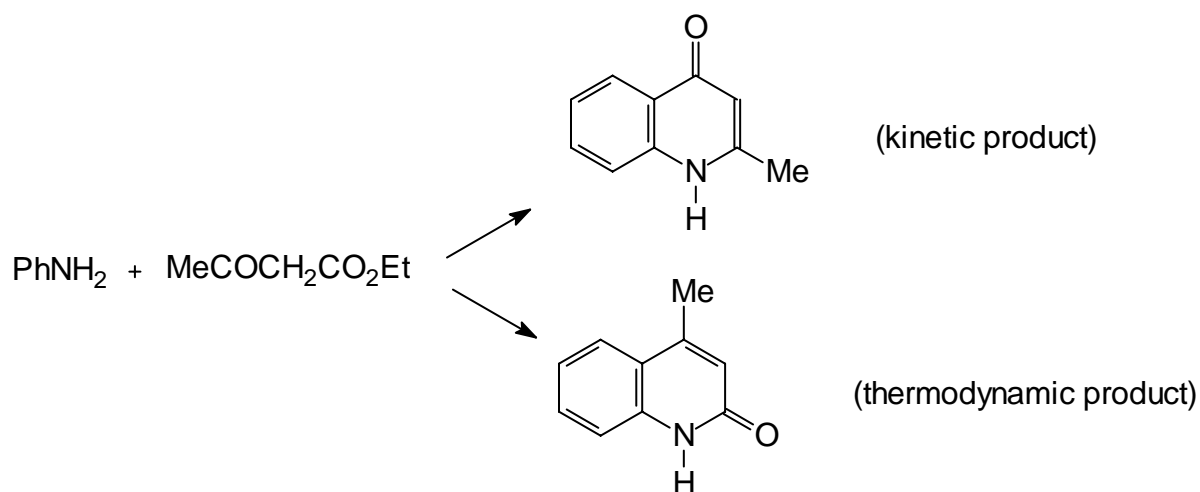


The Skraup synthesis

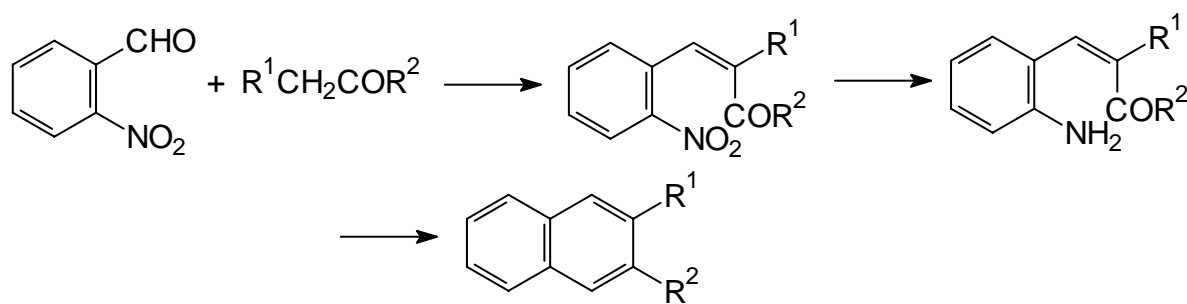




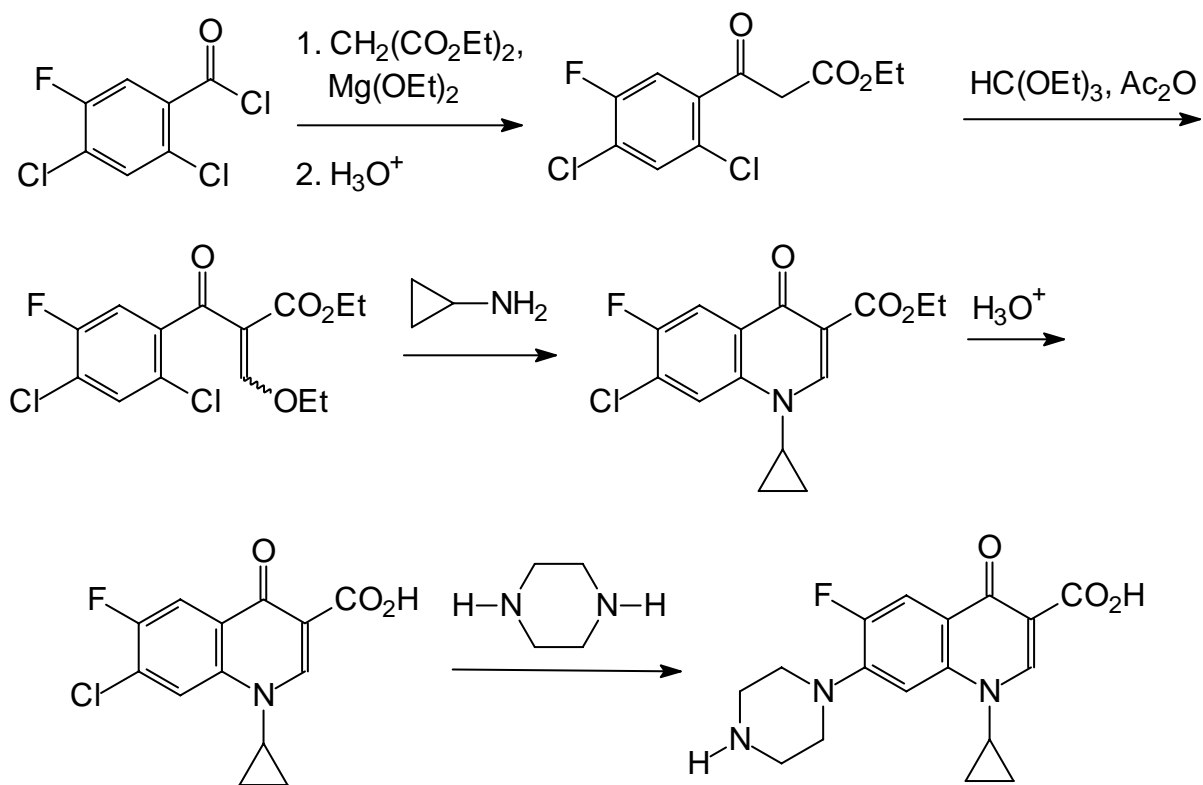
Doebner-von Miller synthesis of 2-methylquinoline from aniline and crotonaldehyde



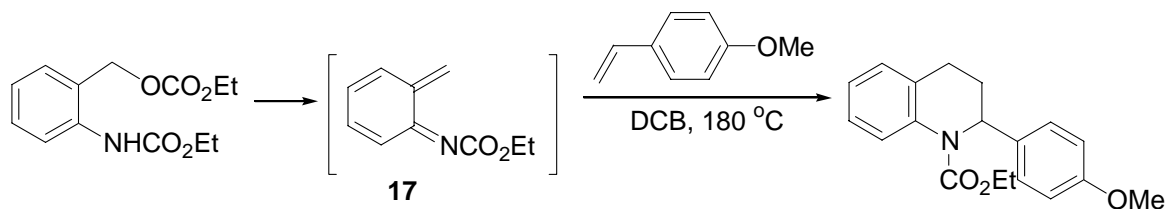
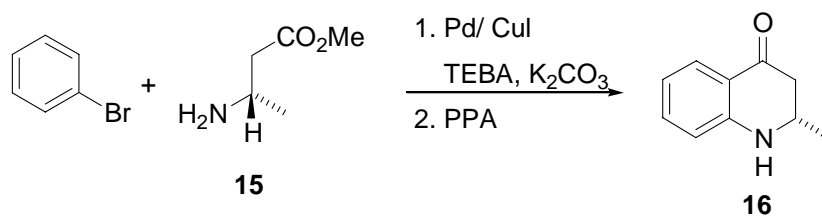
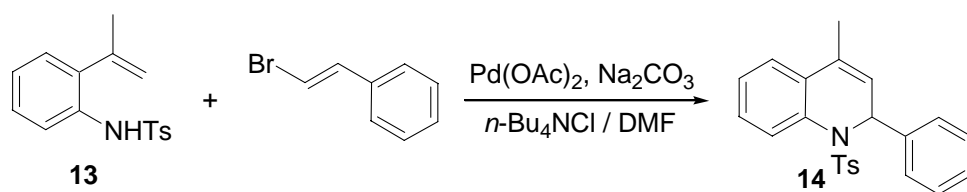
A Combes synthesis from aniline and ethyl acetoacetate

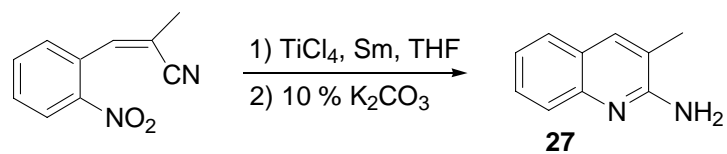
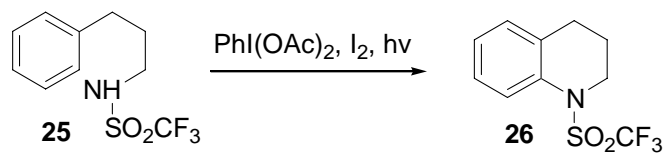
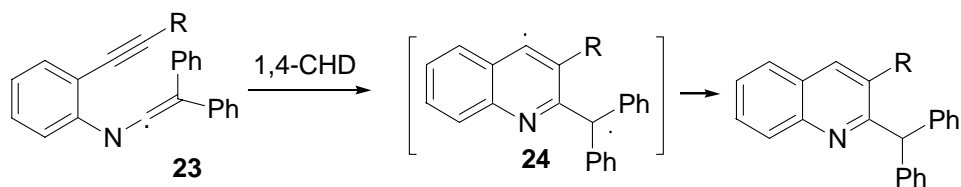
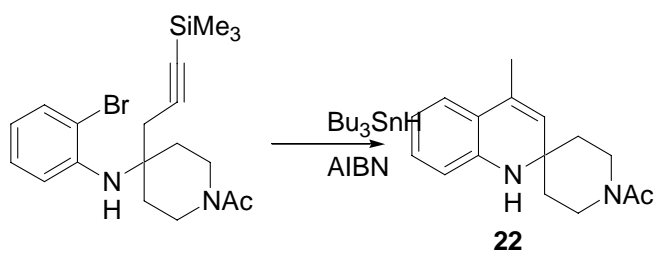
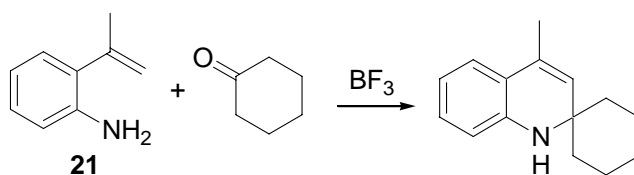
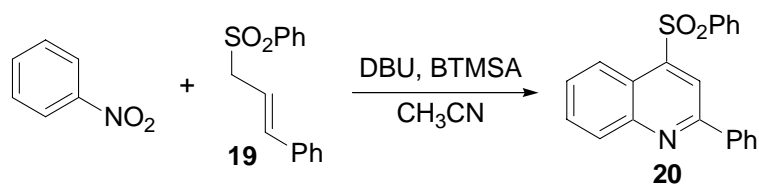
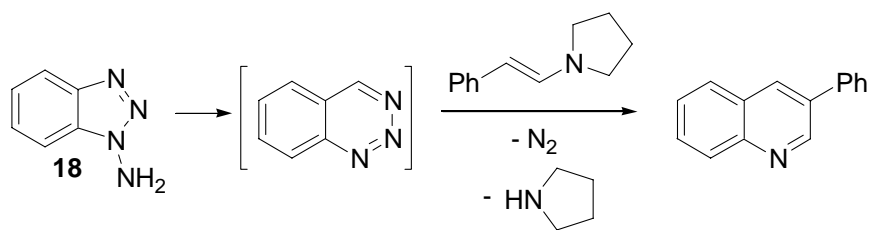


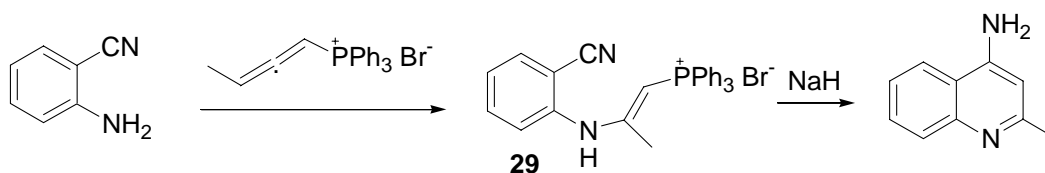
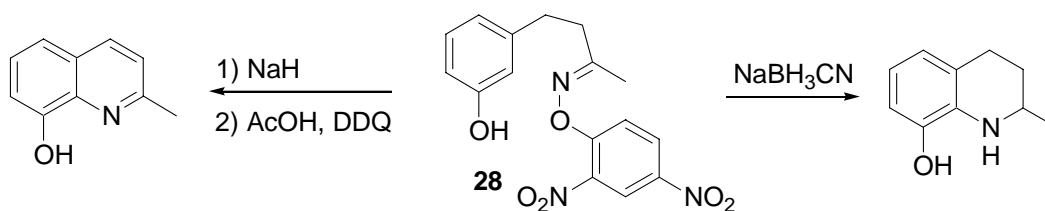
A modified Friedlander synthesis



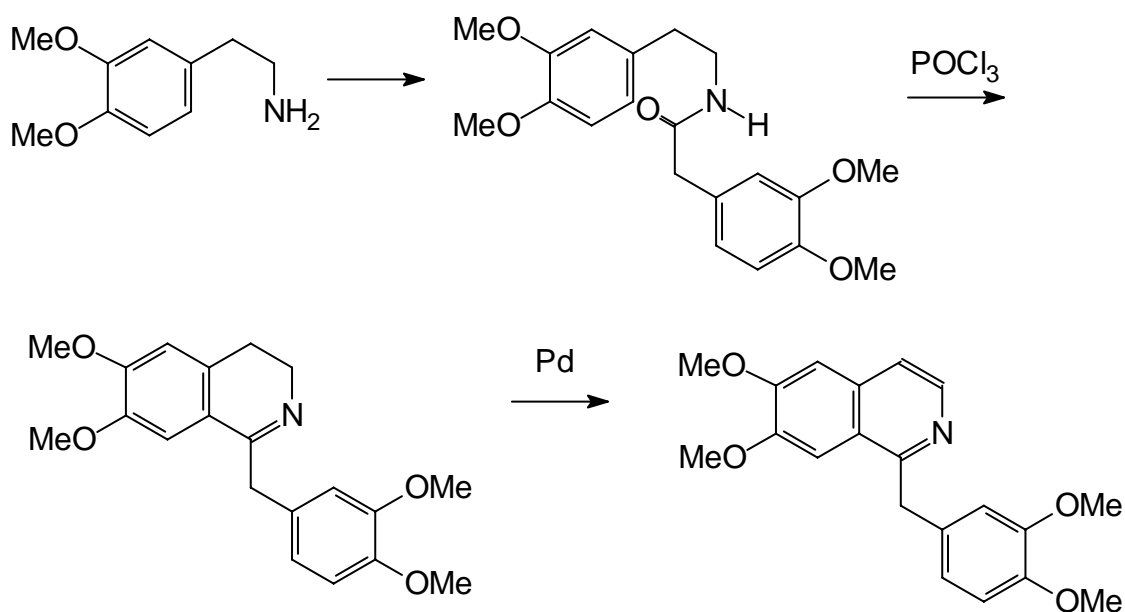
A synthesis of ciprofloxacin



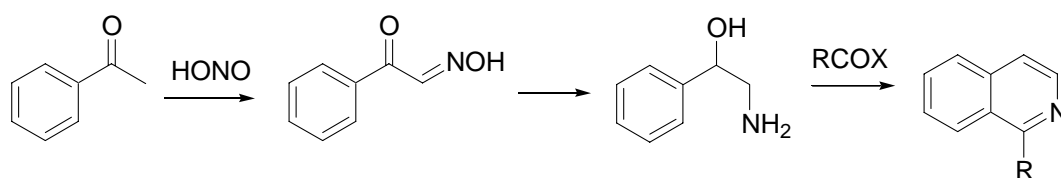




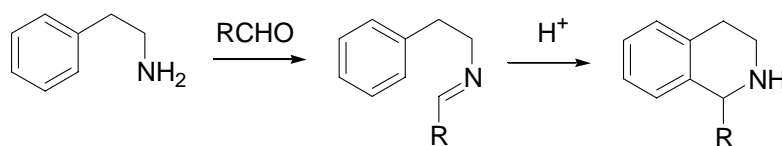
7.2.3 Synthesis of isoquinolines



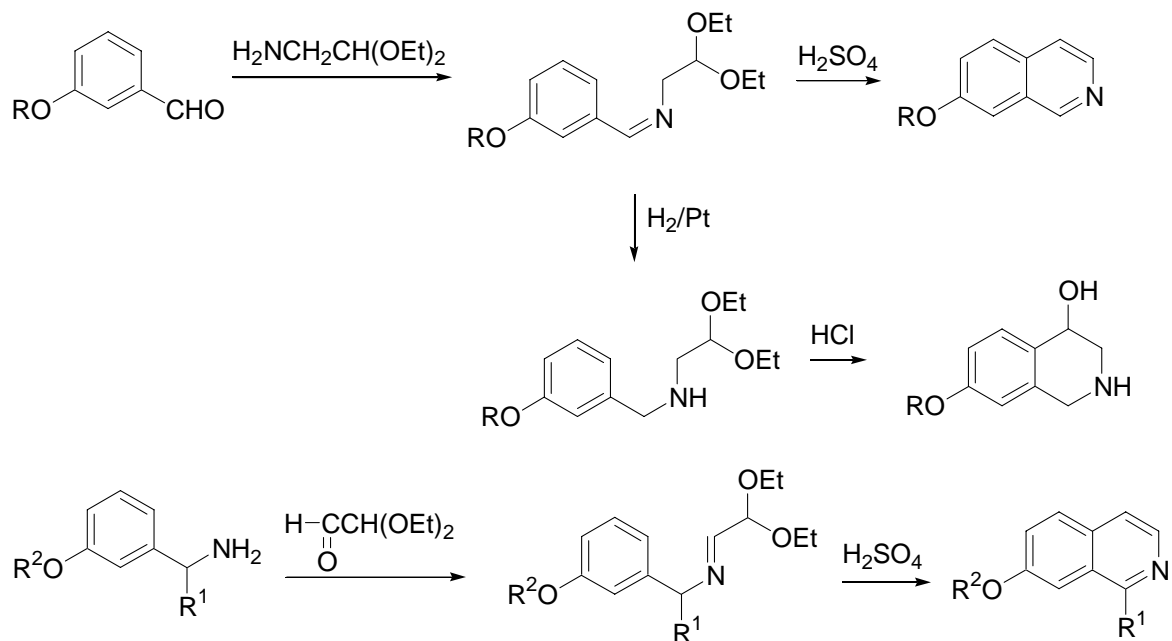
Synthesis of papaverine by the Bischler-Napieralski method



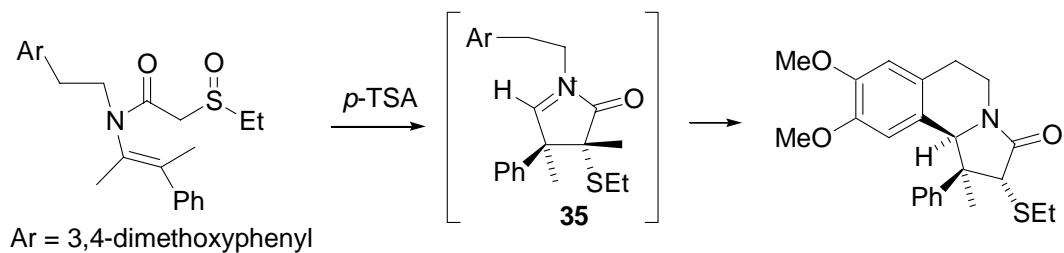
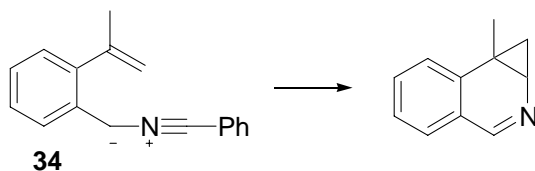
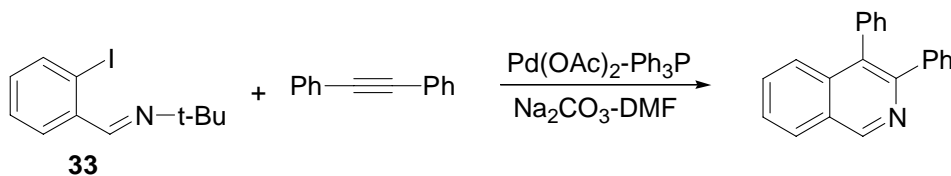
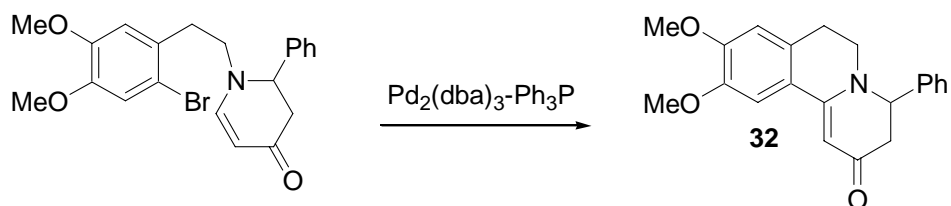
The Pictet-Gams synthesis

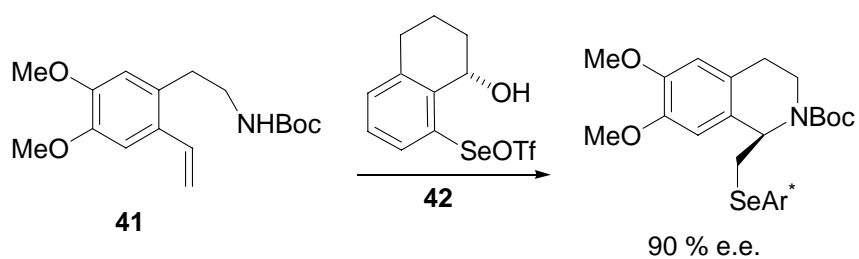
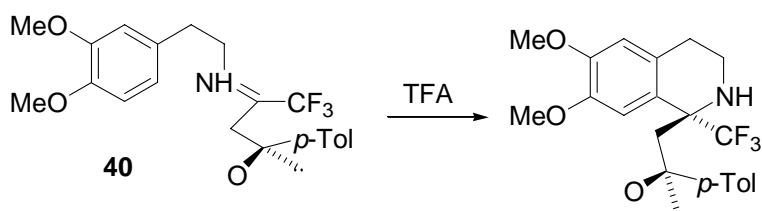
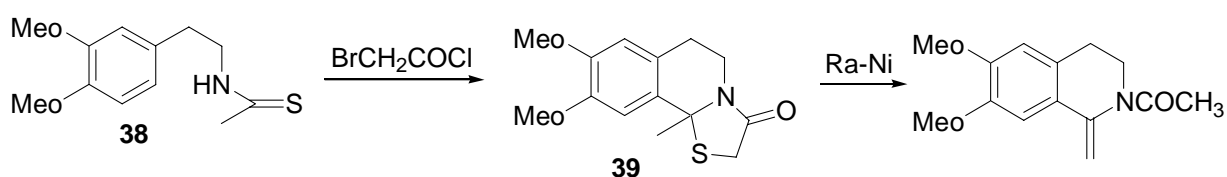
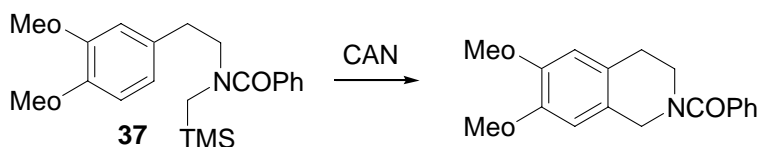
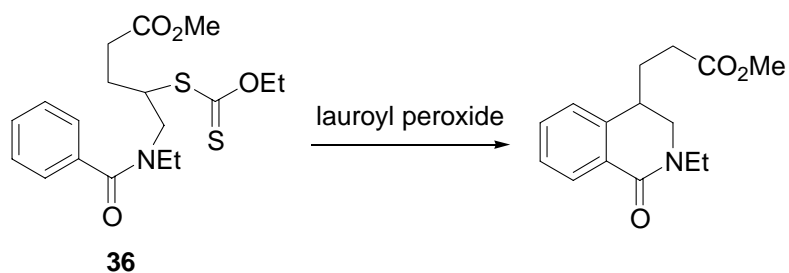


The Pictet-Spengler synthesis

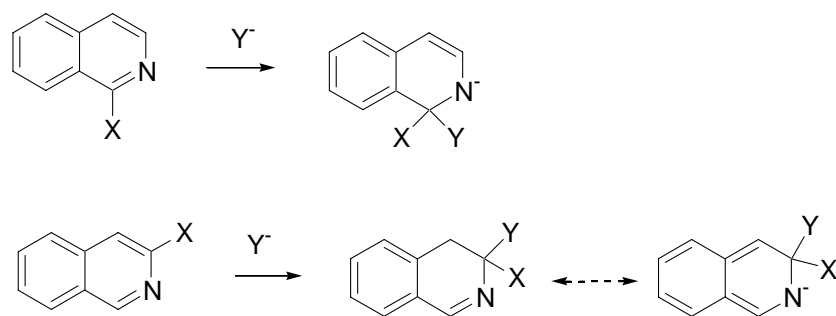


The Pomeranz-Fritsch synthesis and related methods

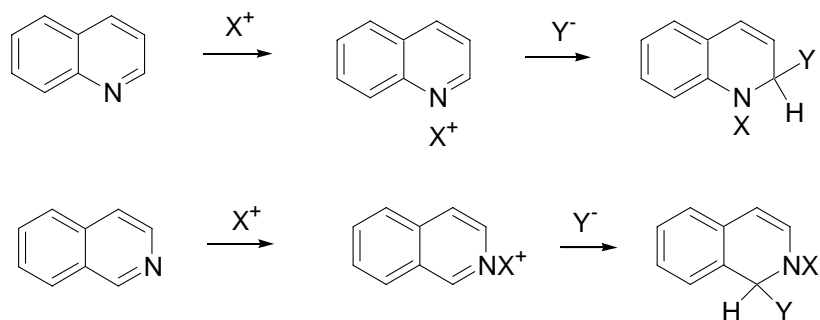




7.2.4 General features of the chemistry of quinolines and isoquinolines



Intermediates in nucleophilic substitution of isoquinoline

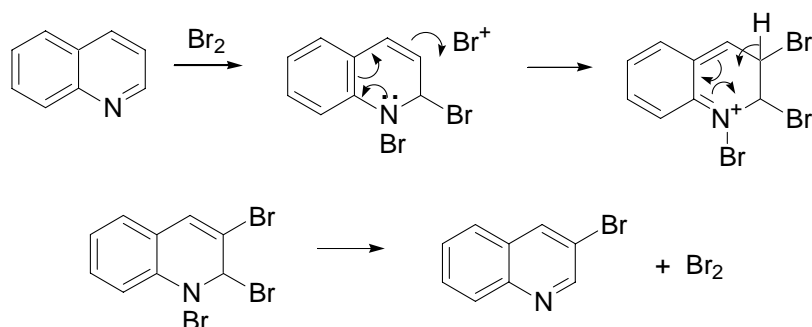


Addition reactions initiated by electrophilic attack at nitrogen

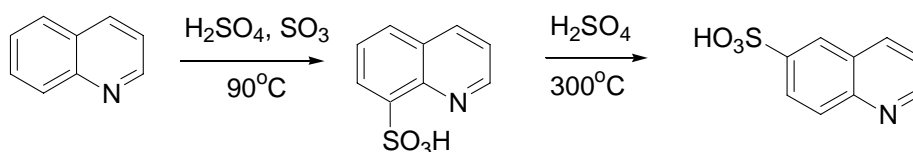
7.2.5 Electrophilic substitution

Table 7.4. Electrophilic substitution of quinolines and isoquinolines

Electrophile	Reagents and conditions	Major products
Quinoline		
D ⁺	70% D ₂ SO ₄ , 150°C	8-
NO ₂ ⁺	H ₂ SO ₄ , HNO ₃ , 0°C	5- and 8- (1:1)
Br ⁺	Br ₃ , AlCl ₃ , 80°C	5-
SO ₃ H ⁺	H ₂ SO ₄ , SO ₃ , 90°C	8-
Isoquinoline		
D ⁺	70% D ₂ SO ₄ , 150°C	5-
NO ₂ ⁺	H ₂ SO ₄ , HNO ₃ , 0°C	5- and 8- (9:1)
Br ⁺	Br ₂ , AlCl ₃ , 80°C	5-

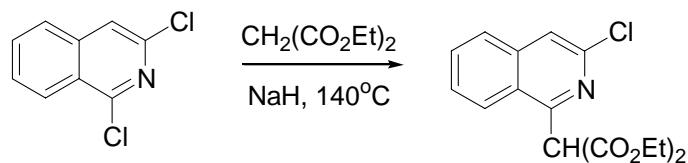
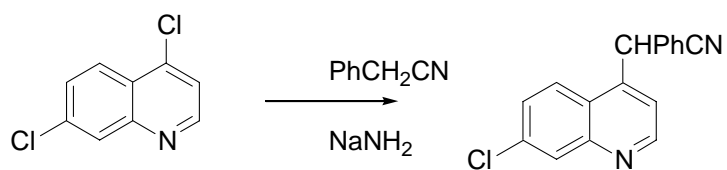


Substitution by way of dihydro intermediates

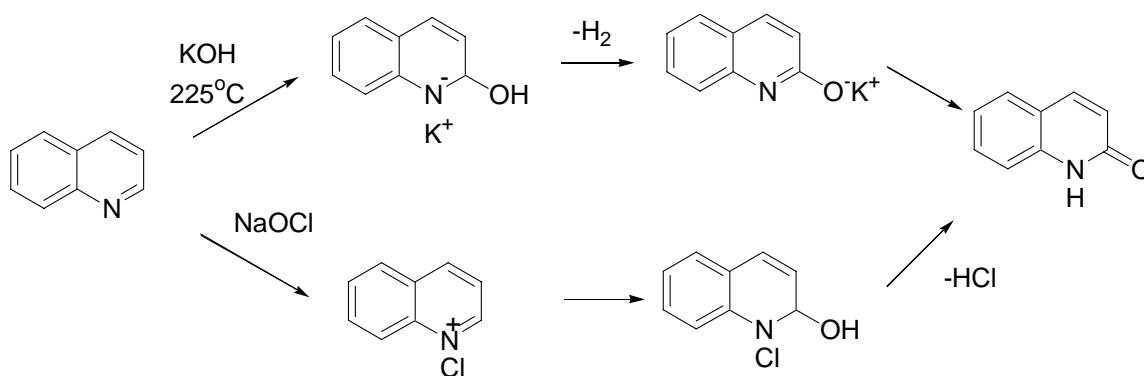


Sulfonation of quinoline

7.2.6 Nucleophilic substitution

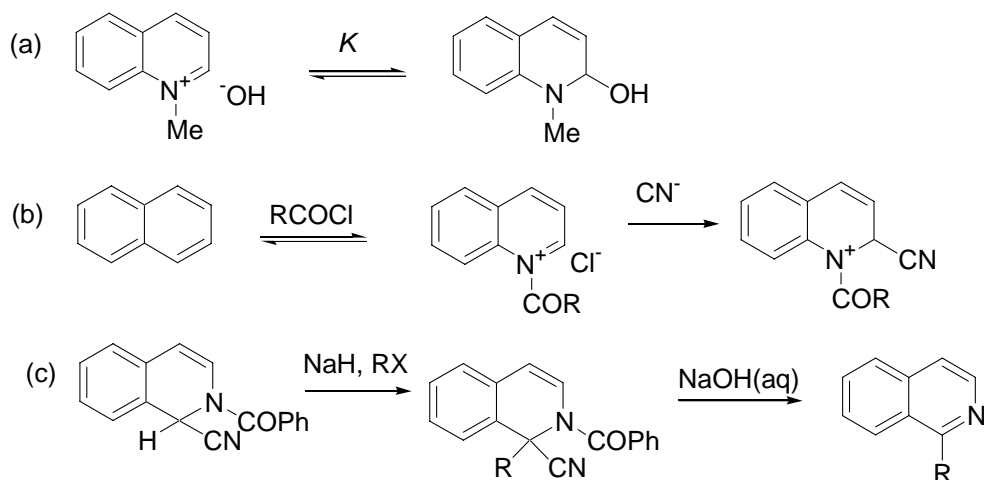


Selective displacement of chloride

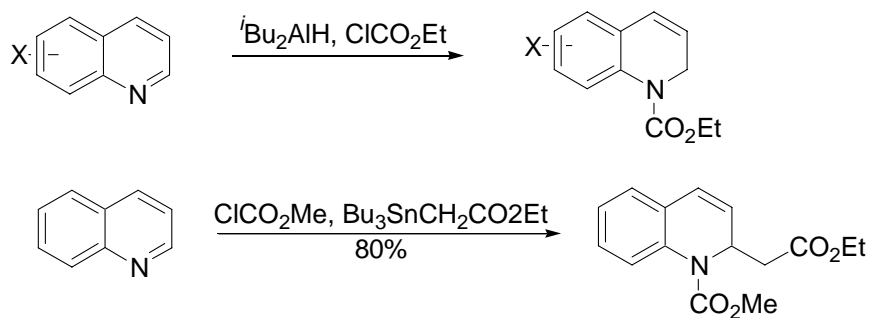


Routes to 2-quinoline from quinoline

7.2.7 Nucleophilic addition

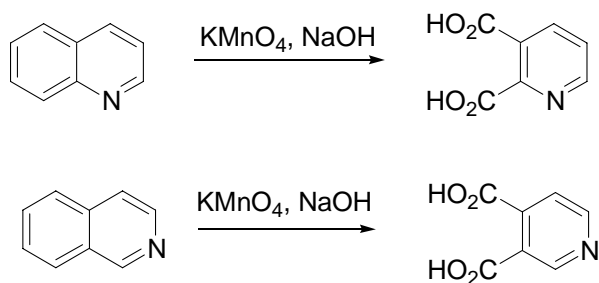


(a) Pseudobase formation; (b) and (c) Reissert compounds

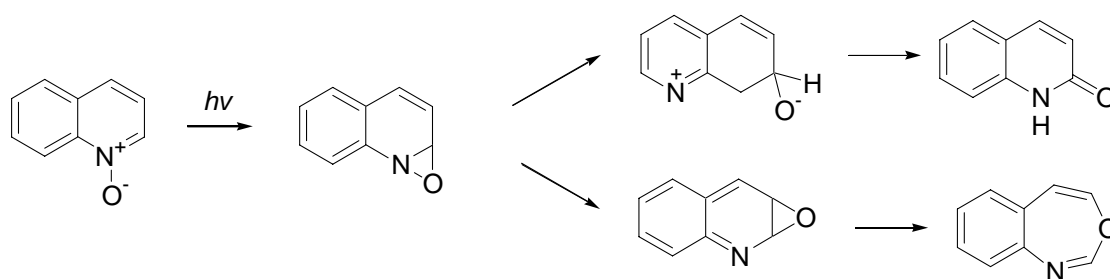


1,2-Dihydroquinolines from quinolines

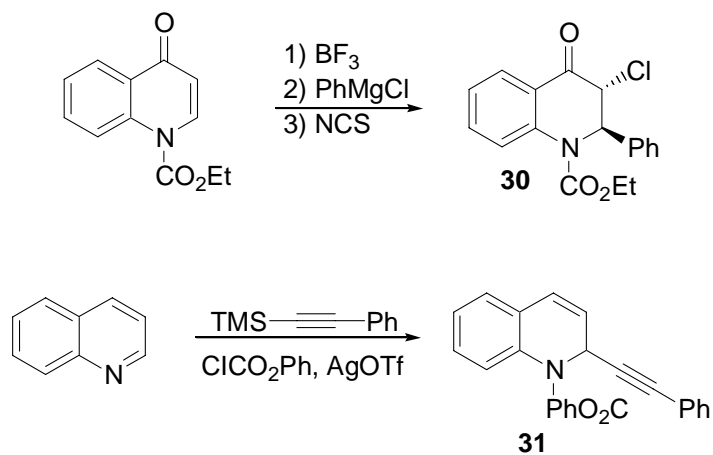
7.2.8 Oxidative cleavage

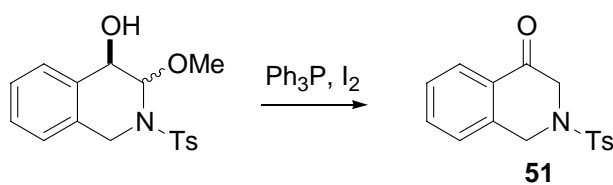
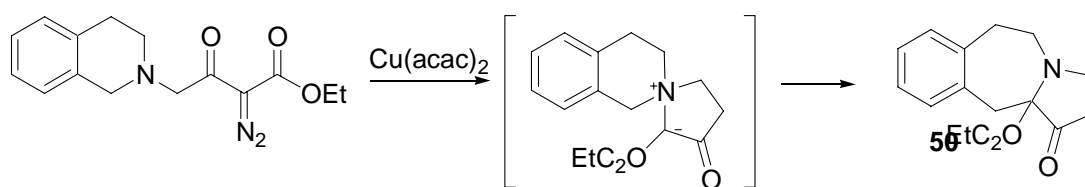
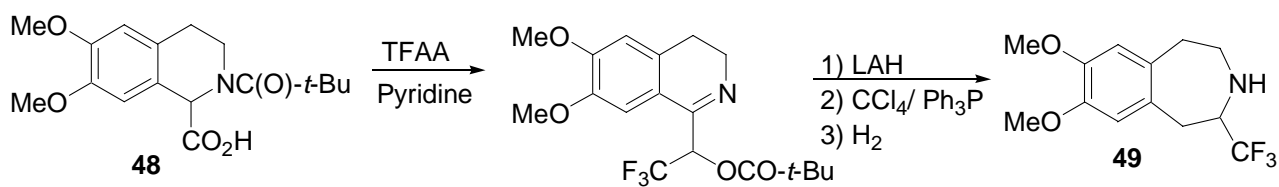
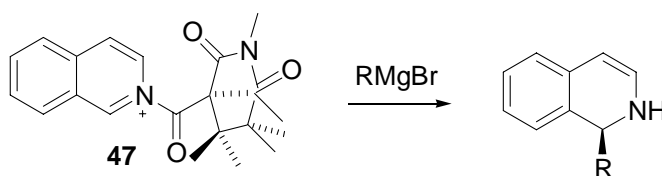
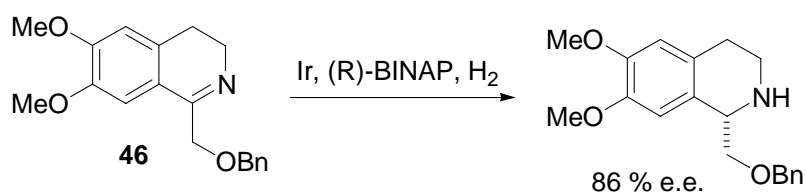
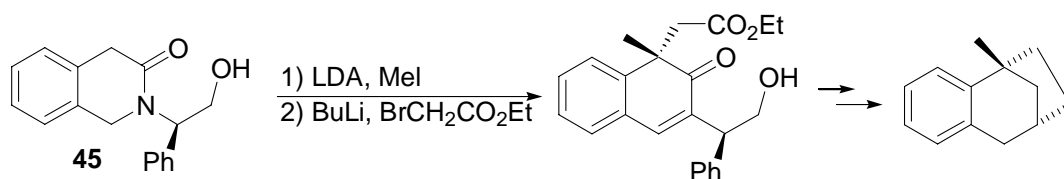
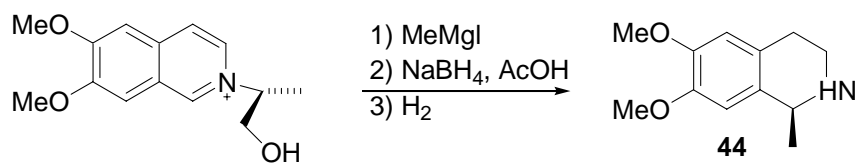
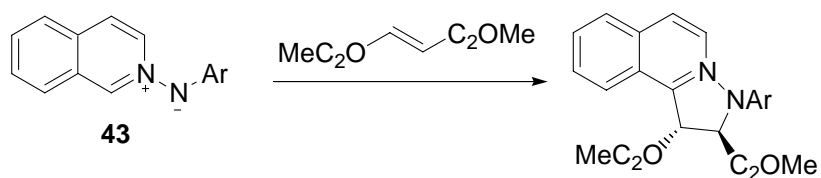


7.2.9 N-Oxides and N-imides

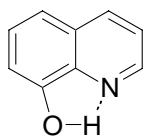
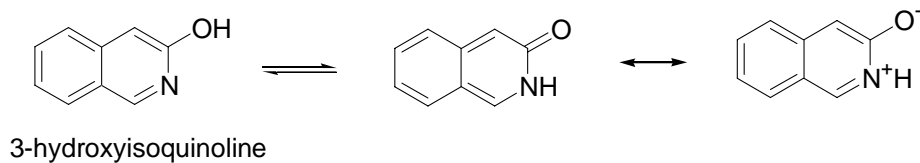


Photoisomerization of quinoline N-oxide



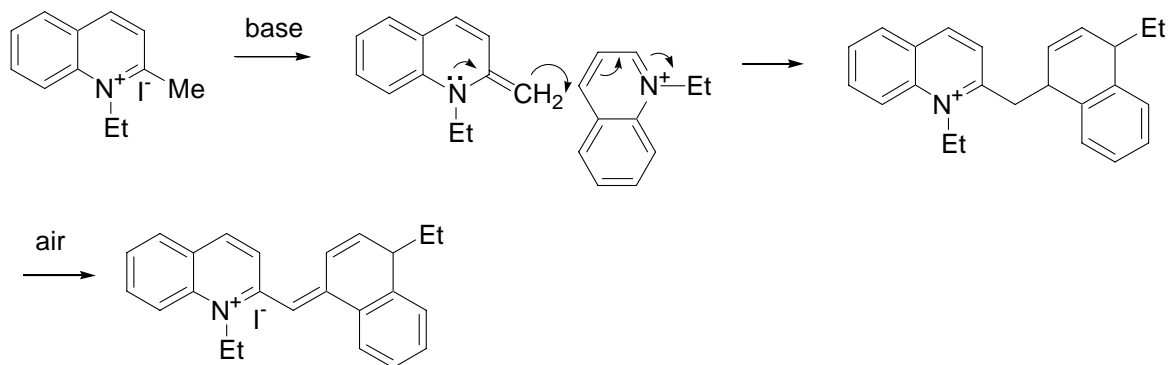


7.2.10 Properties of substituents

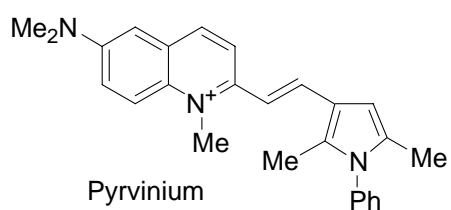


Hydroxyquinoline can form an intramolecular hydrogen bond. It is also a good chelating agent for metals.

7.2.11 Cyanine dyes



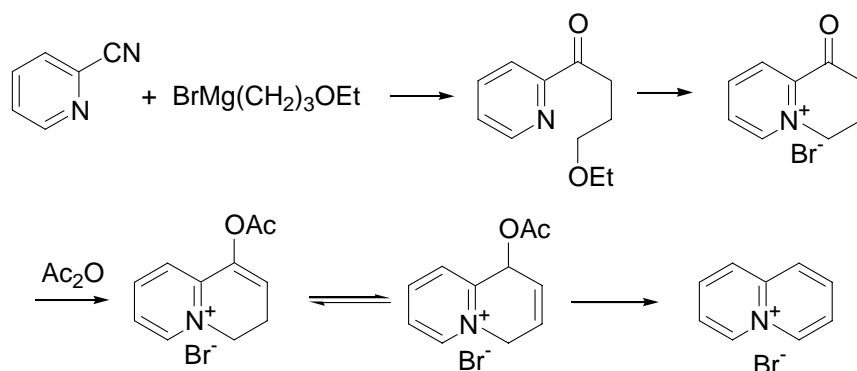
Formation of a cyanine dye



A mixed dye, use in the control of pinworm infection

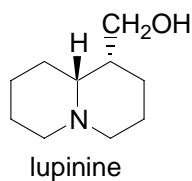
7.3 Other fused pyridines

7.3.1 Quinolizines

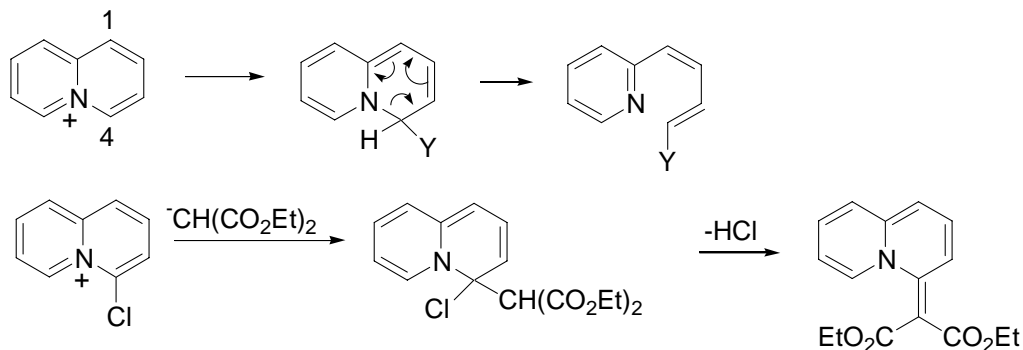


A route to quinolizinium salts

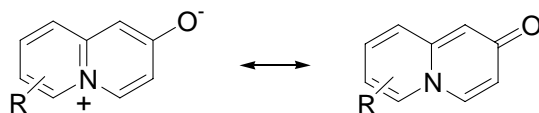
The ring system occurs naturally, usually in a partially or fully reduced form. Lupinine is one of the quinolizidine alkaloids which are present plants of the lupin genus.



Quinolizinium salts are resistant to electrophilic attack but are susceptible to nucleophilic attack, particularly at the 4-position.

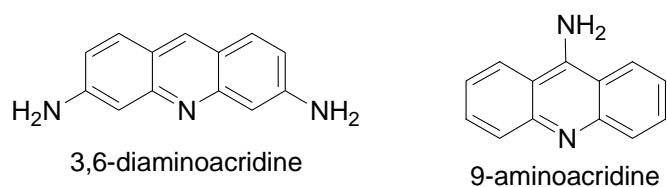


2-Hydroxyquinolizinium salts are easily deprotonated to 2-quinolizones.

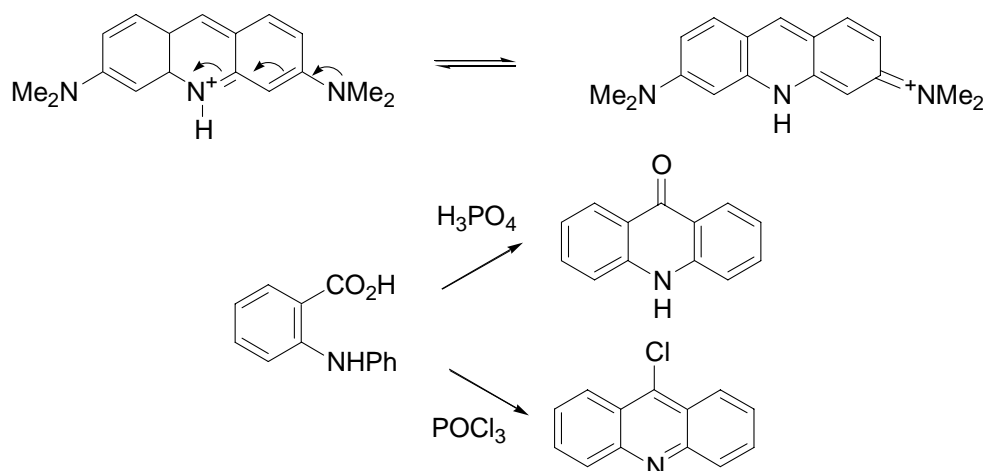


7.3.2 Acridines

9-Aminoacridine and 3,6-diaminoacridine, have antiseptic properties.

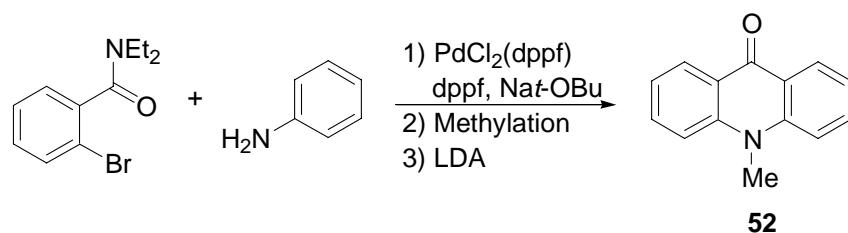
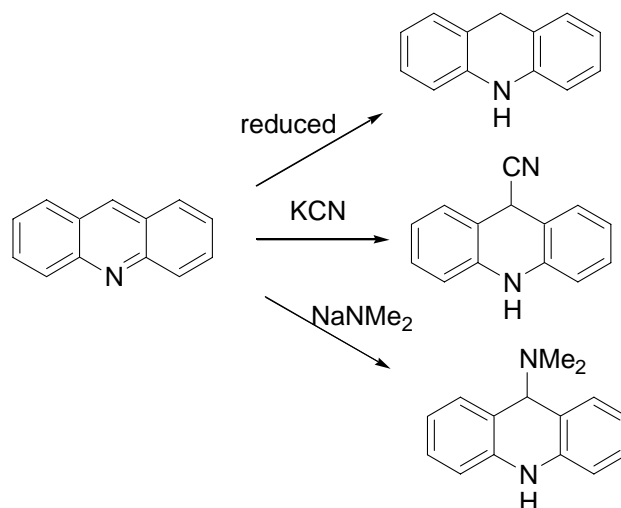


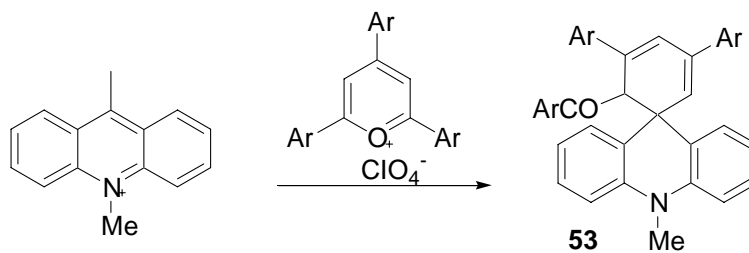
Acridine Orange L: Dye



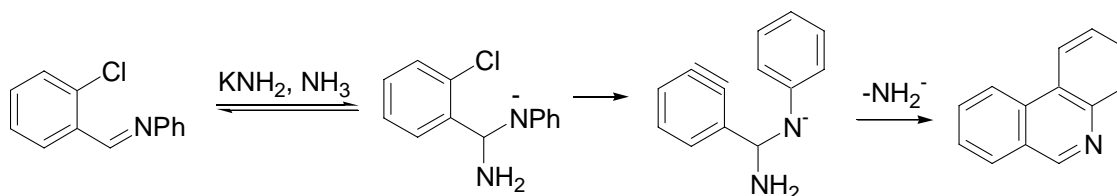
Synthesis of 9-acridone and 9-chloroacridine by cyclization.

Acridine is easily reduced to 9,10-dihydroacridine and with potassium cyanide it gives 9-cyano-9,10-dihydroacridine, etc.



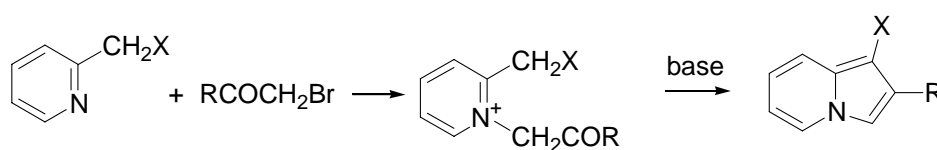


7.3.3 Phenanthridines



Phenanthridine by aryne cyclization.

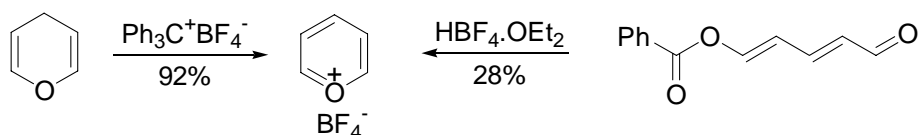
7.3.4 Indolizines



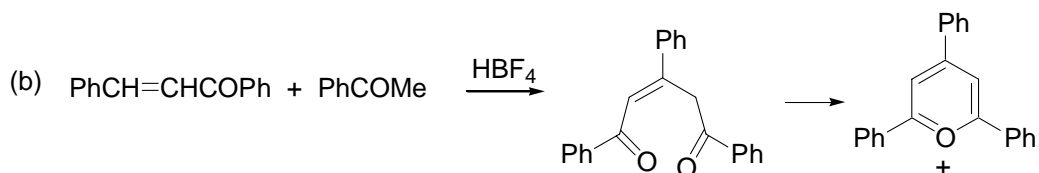
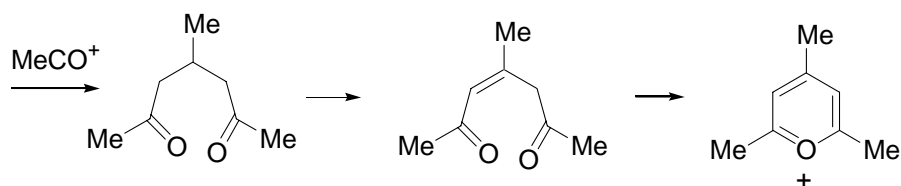
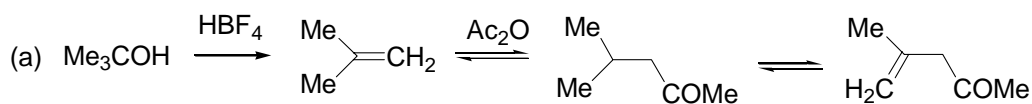
The Chichibabin synthesis of indolizines

7.4 Ring systems containing oxygen

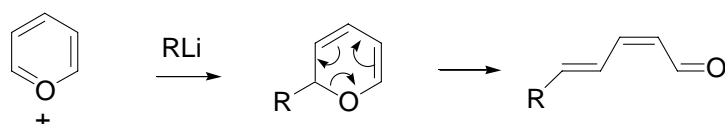
7.4.1 Pyrylium salts



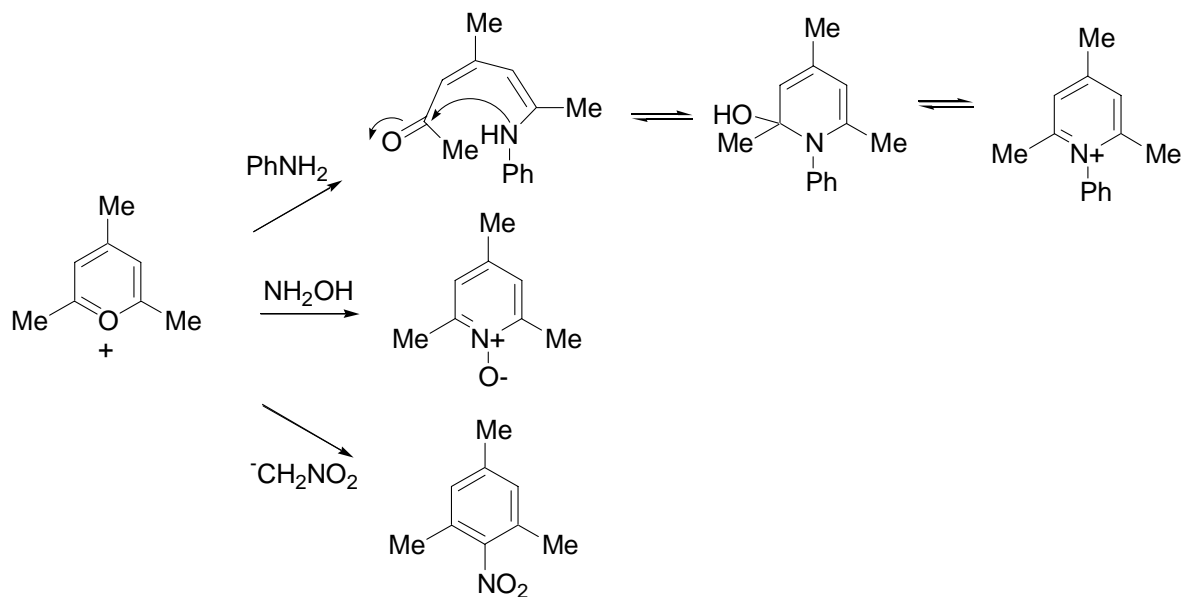
Preparation of pyrylium tetrafluoroborate



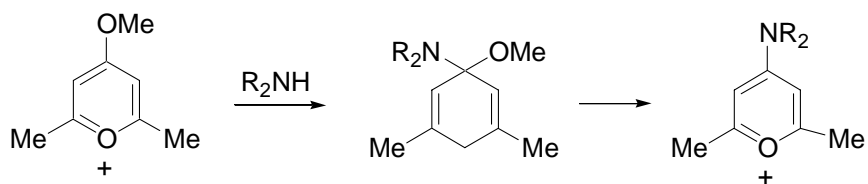
Routes to 2,4,6-trisubstituted pyrylium salts.



Ring opening of the pyrylium cation by organolithium reagents.



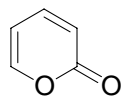
Reactions of trimethylpyrylium salts.



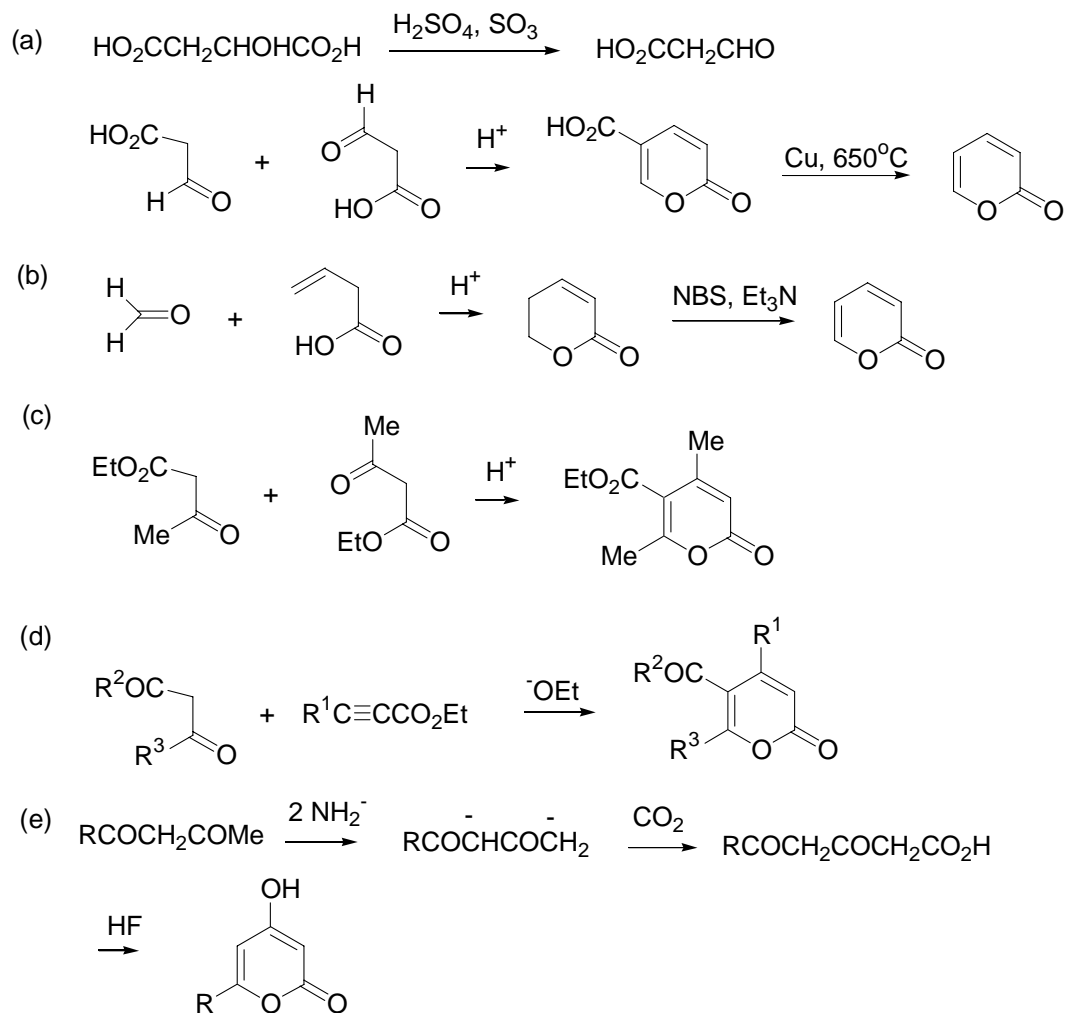
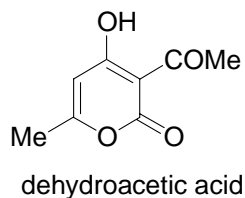
Nucleophilic substitution at C-4.

7.4.2 2H-Pyran-2-ones

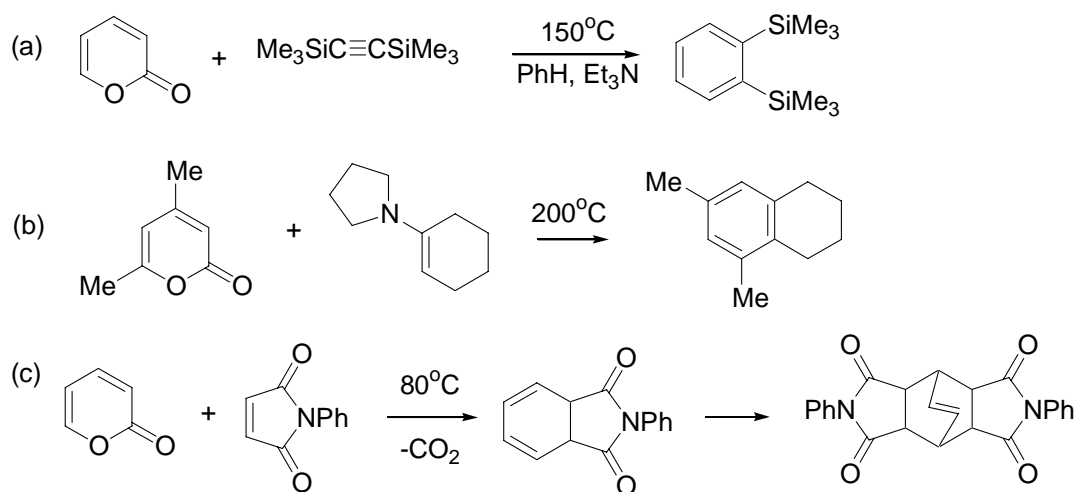
2H-Pyran-2-one (α -pyrone)



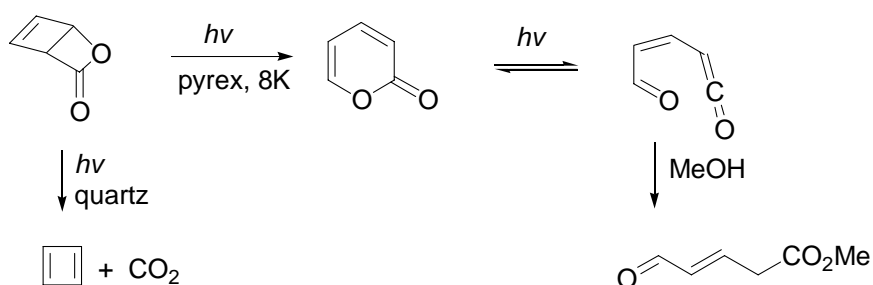
Dehydroacetic acid is obtained by the base-catalyzed condensation of 2 mol of ethyl acetoacetate, is used as a fungicide on fruit.



Routes to α -pyrones.

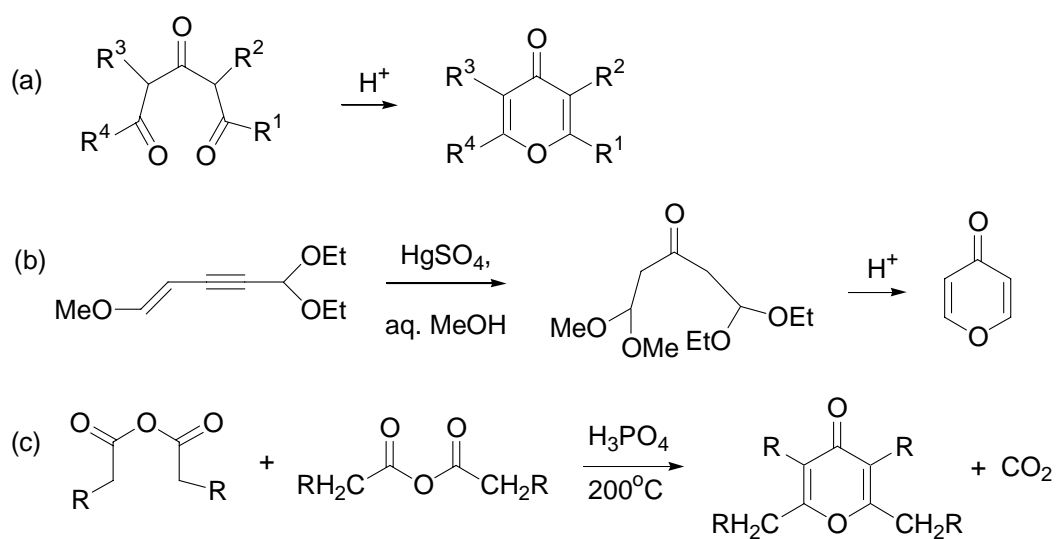


Diels-Alder reactions.

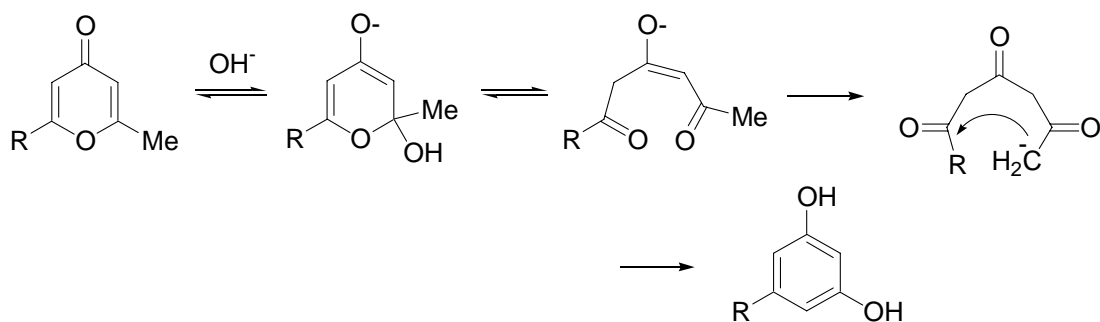


Photochemistry of α -pyrone

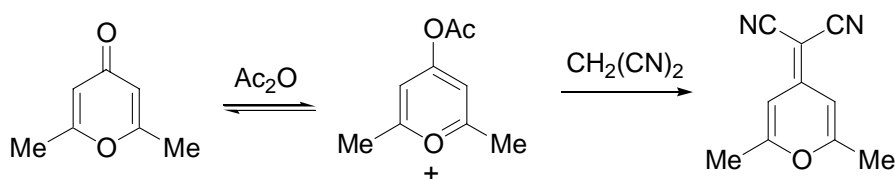
7.4.3 4H-Pyran-4-ones



Routes to γ -pyrones

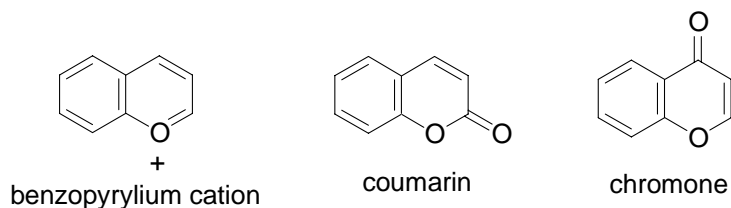


Base-catalyzed isomerization to a phenol.

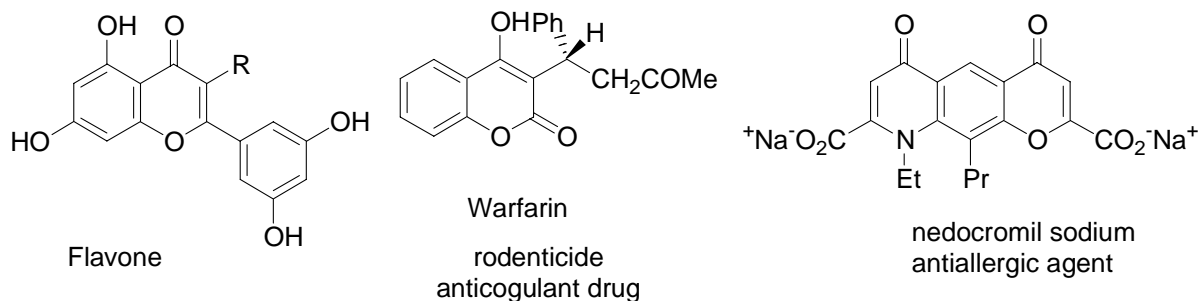


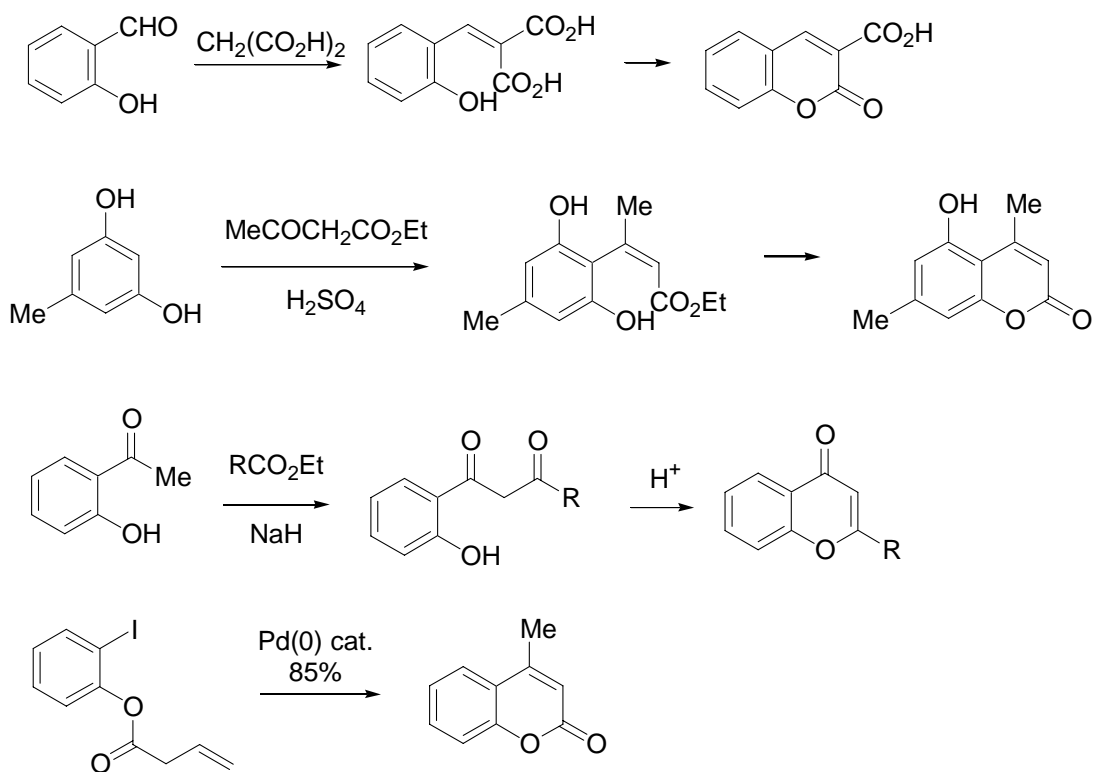
Reaction at the carbonyl group.

7.4.4 Benzo-fused systems

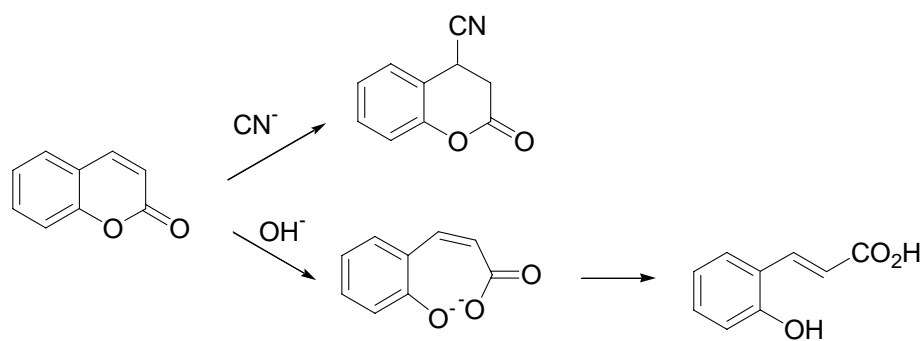


Benzopyrylium cations and chromones with a 2-phenyl substituent have the trivial names 'flavylium cations' and 'flavones', respectively. Flavylium cations occur widely in the plant kingdom as oxygenated derivatives, called anthocyanins, which are responsible for the red and blue colors of flowers and fruits.

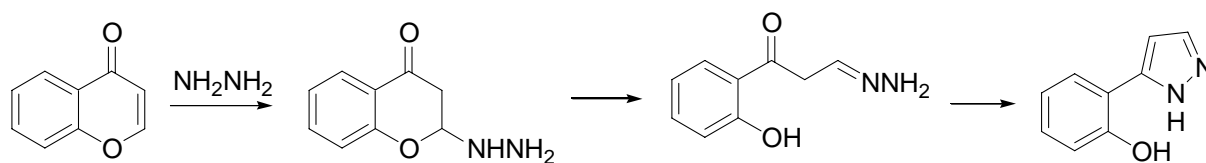




Some routes to coumarins and chromones



Nucleophilic attack on coumarin



Reaction of chromone with hydrazine.