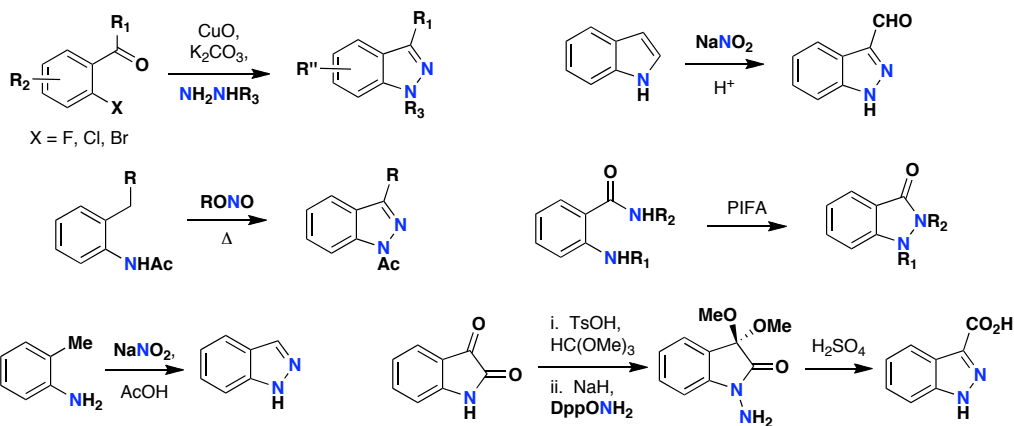
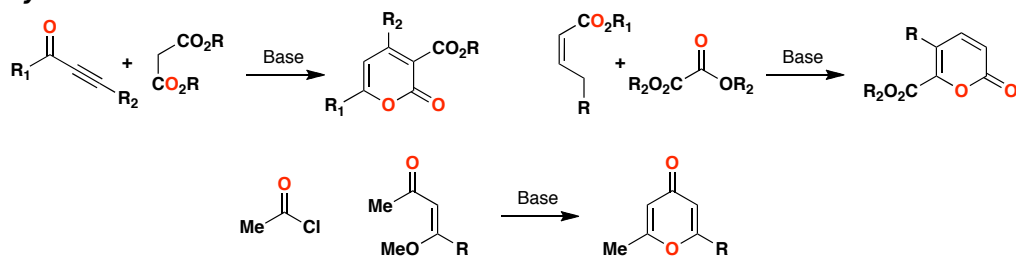
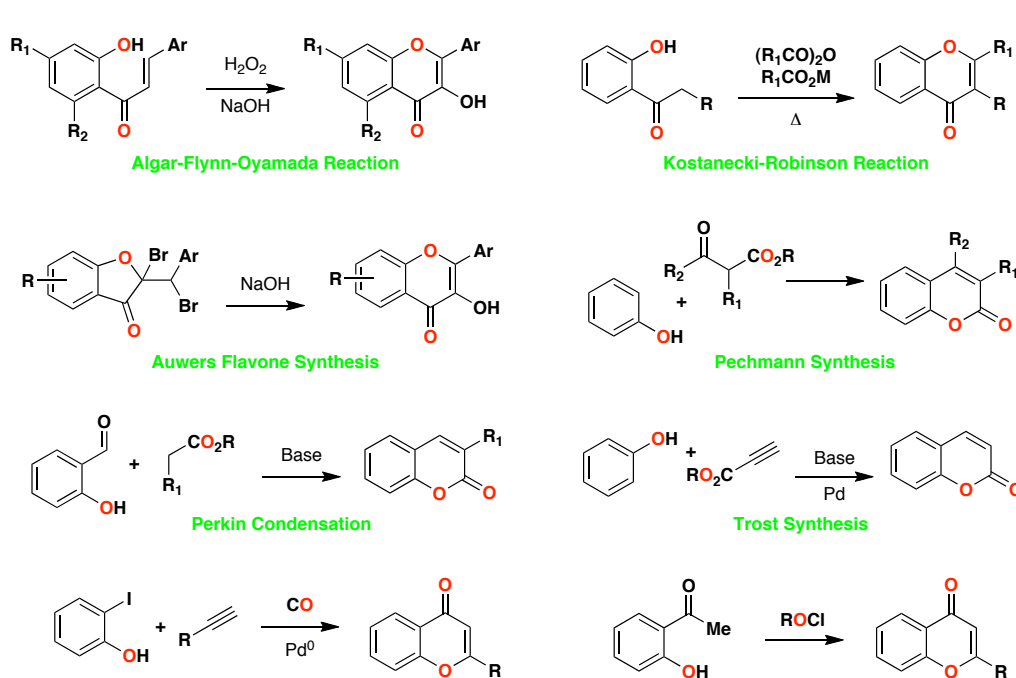
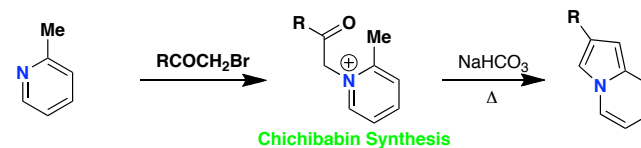
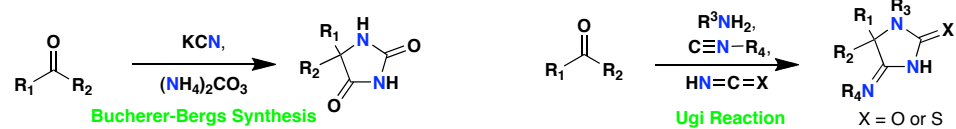
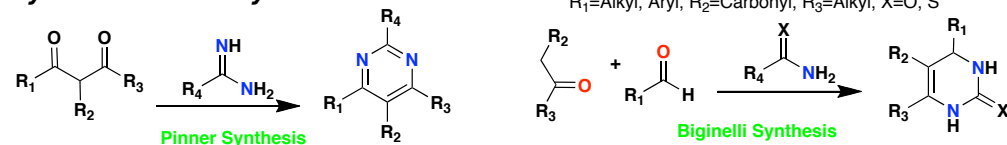
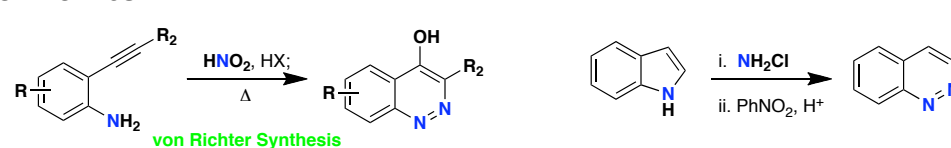
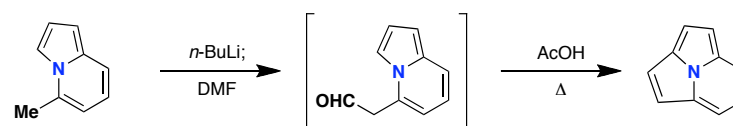
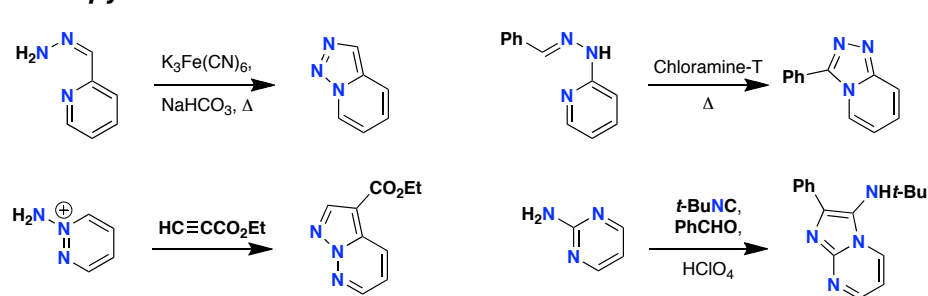
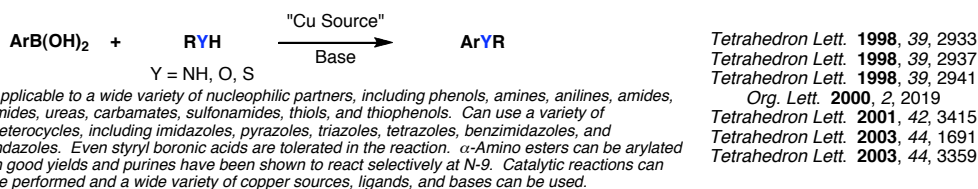


Indazoles:**Pyrones:****Chromanones and Coumarins:****Purines:****Indolizidines:****Hydantoins:****Pyrimidines and Pyrimidones:****Cinnolines:****Cyclazines:****Triazolopyridines:**

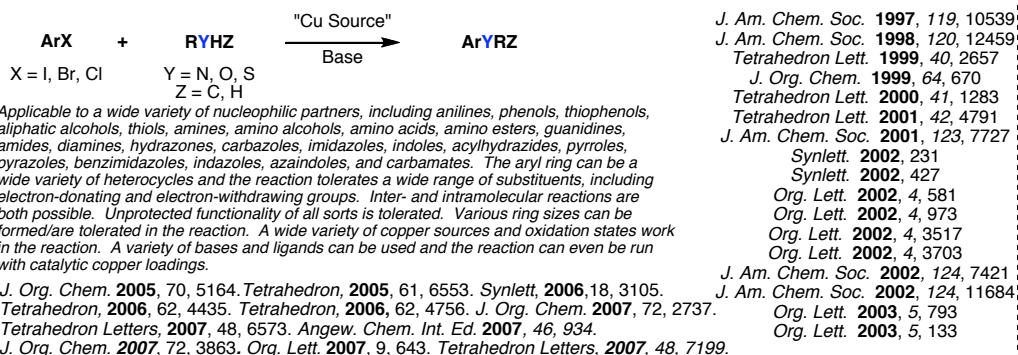
Useful Methods of Forming Aryl C–N and C–O Bonds:



Electron-donating and electron-withdrawing functional groups are tolerated on both coupling partners.



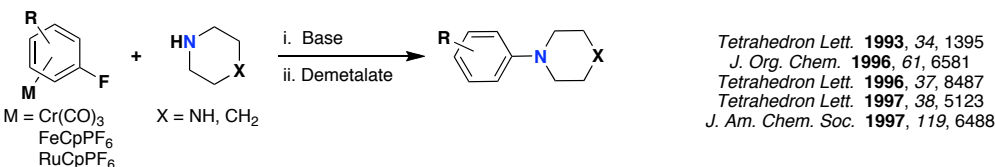
A wide variety of boronic acids are tolerated and hydrazinolysis reveals the O-arylhydroxylamine. Requires two equivalents of the boronic acid.



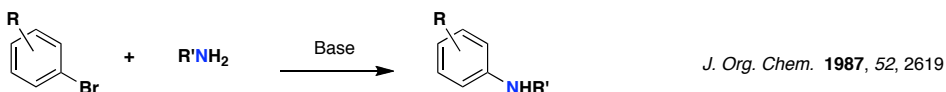
Applicable to a wide variety of aryl stannanes. Nucleophilic partners include amines, anilines, indazoles, benzimidazolones, pyridones, and aryl amides.



Various nucleophilic partners can be used, specifically alkoxides, silyloxides, anilines, and amines. A variety of electron-withdrawing and electron-donating groups are tolerated on the aromatic ring.



For chromium: will tolerate electron-donating groups on the aromatic ring and a variety (lack of) protecting groups on the piperazine. For iron: a range of amine nucleophiles can be used and some substitution on the aromatic ring is tolerable.



Ammonia, primary, and secondary amines can be used. Gives regioisomeric product mixtures if unsymmetrical.

Useful Methods of Forming Aryl C–N and C–O Bonds:



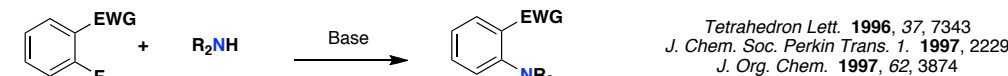
Applicable to a wide variety of nucleophilic partners, including amines, amides, silyloxides, sulfonamides, anilines, carbamates, ureas, alkoxides, vinylogous amides, phenoxides, cyclopropylamines, tert-butylcarbamates, sulfoximes, hydrazines, hydrazones, and imines. Various heterocycles can be N-arylated including indole, pyrrole, imidazole, carbazole, benzotriazole, and phenoxazole. A variety of aryl donors are tolerated, including electron-rich, electron-poor, hindered, unhindered, and heterocyclic. A tropone has even been aminated using this procedure. Five and six (not seven) membered heterocycles can routinely be formed via intramolecular cyclizations.

Tetrahedron Lett. 1995, 36, 3609
Angew. Chem. Int. Ed. 1995, 34, 1348
J. Org. Chem. 1996, 61, 1133
J. Am. Chem. Soc. 1996, 118, 7215, 7217
J. Org. Chem. 1996, 61, 7240
Tetrahedron 1996, 52, 7525
J. Org. Chem. 1997, 62, 1264, 1268
J. Am. Chem. Soc. 1997, 119, 3395
J. Org. Chem. 1997, 62, 5413
Tetrahedron Lett. 1997, 38, 6367
J. Am. Chem. Soc. 1998, 120, 827
Tetrahedron Lett. 1998, 39, 5731
J. Am. Chem. Soc. 1998, 120, 9722
J. Am. Chem. Soc. 1999, 121, 3224
Tetrahedron Lett. 1999, 40, 3543
J. Org. Chem. 1999, 64, 5575
Org. Lett. 2000, 2, 219
Tetrahedron. 2001, 57, 2953
Tetrahedron Lett. 2001, 42, 4381
Org. Lett. 2000, 2, 1109

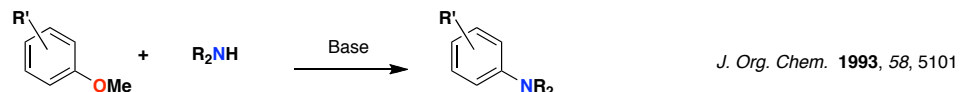


Can use with various substituted aryl groups, however phenyl is the most common. The nucleophilic partner can be an amide, aniline, alcohol, phenol, amine, or hydrazone.

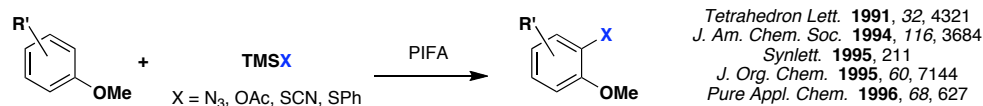
Tetrahedron Lett. 1986, 27, 3615
Synthesis. 1994, 775
Tetrahedron. 1997, 53, 4137
Tetrahedron. 1999, 55, 1341



Various amines and electron-withdrawing groups can be used.



A variety of amines can undergo the displacement. Electron-withdrawing groups are not required on the aromatic ring.



A variety of substitution can be tolerated on the aromatic ring. R can be either alkyl or methoxy. The reaction has even been performed in the absence of methoxy group.

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- Prim, D.; Campagnon, J.-M.; Joseph, D.; Andrioletti, B. "Palladium-catalysed reactions of aryl halides with soft, non-organometallic nucleophiles" *Tetrahedron.* 2002, 58, 2041 – 2075.