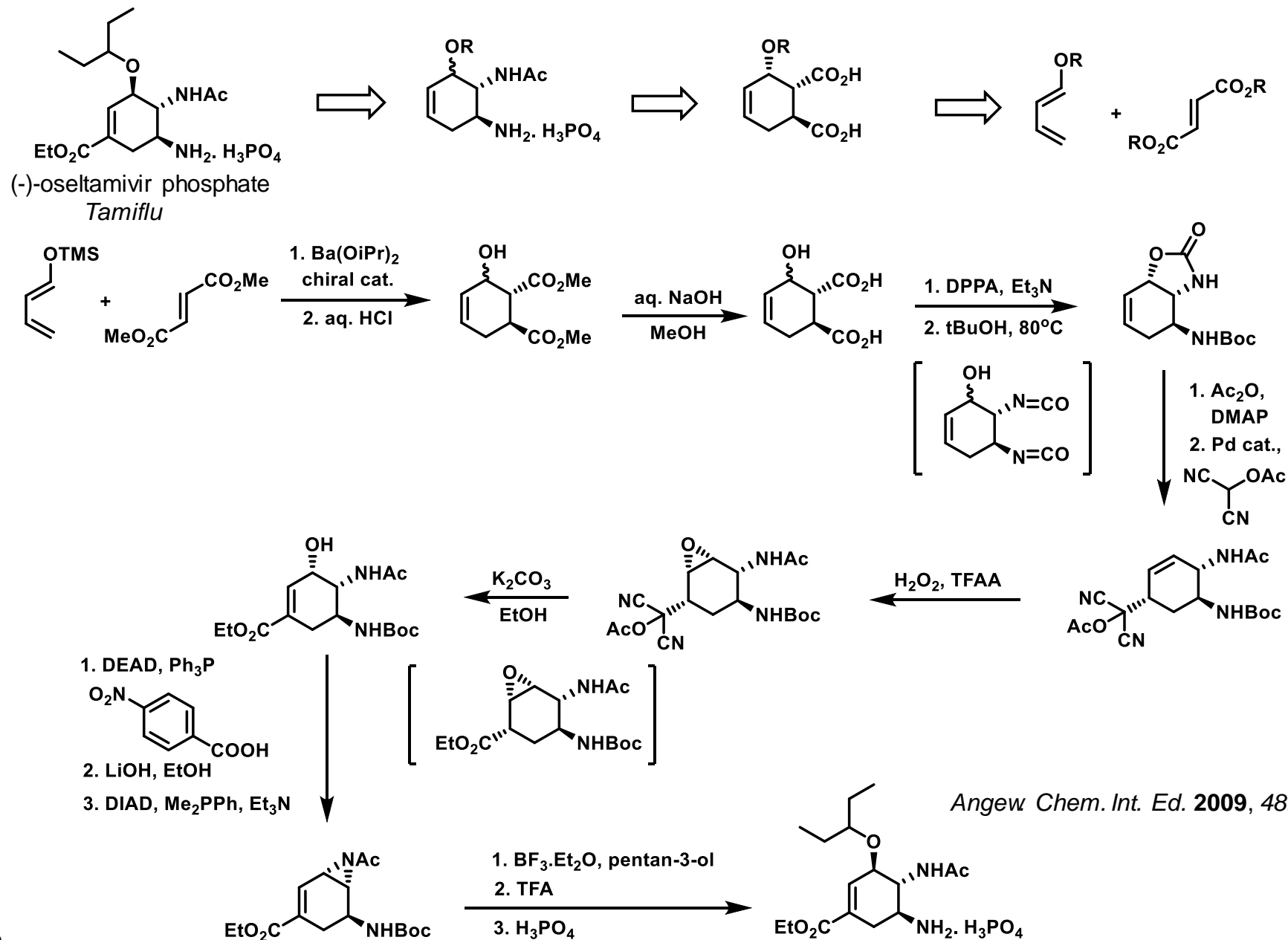
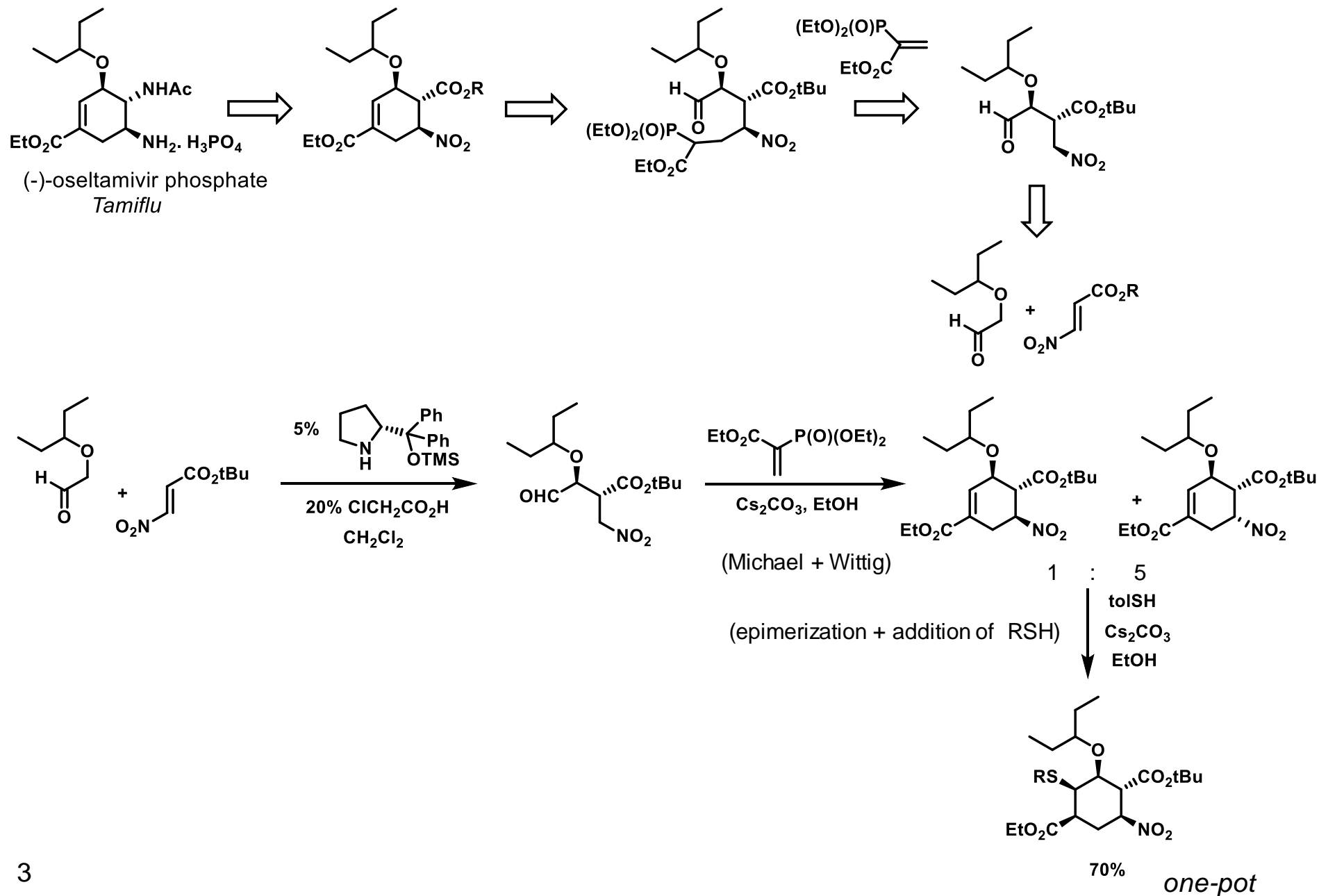


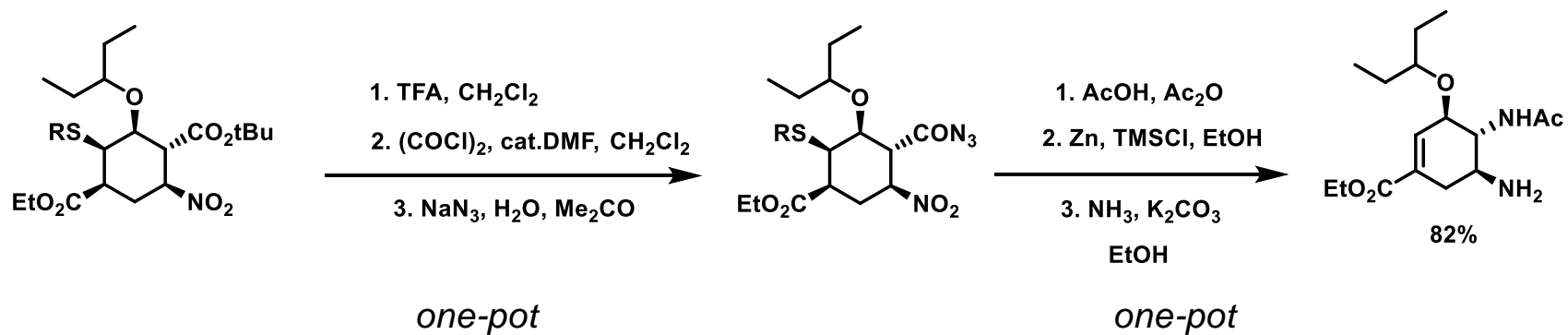
Organic synthesis

Kamil Paruch

Masaryk University, Brno



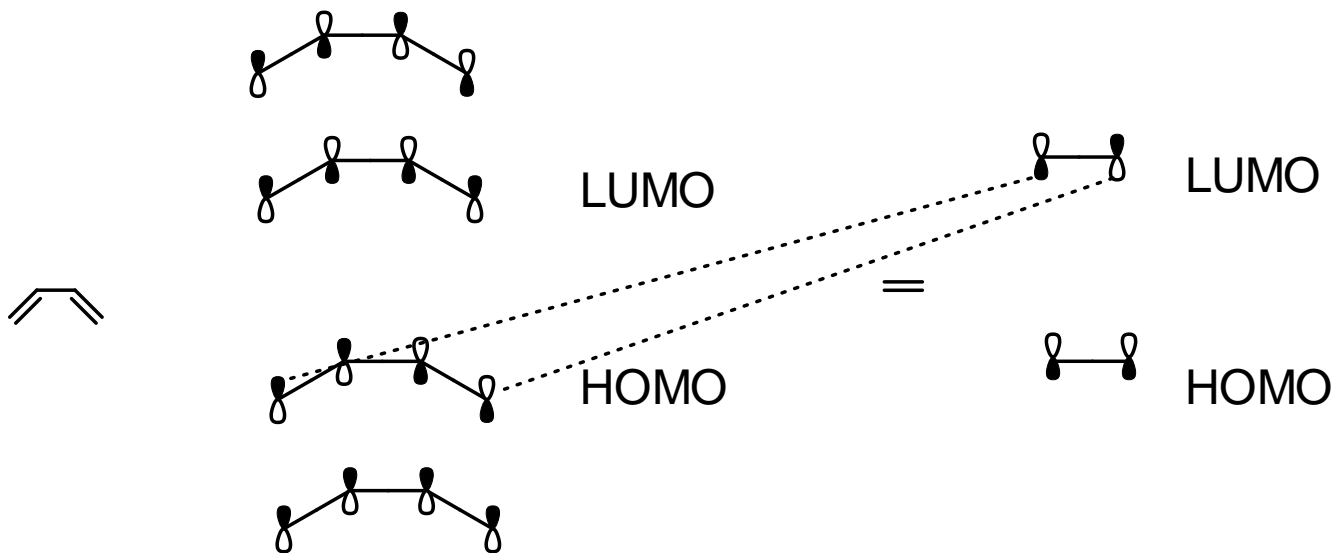




overall yield: 57%

Angew Chem. Int. Ed. 2009, 48, 1304..

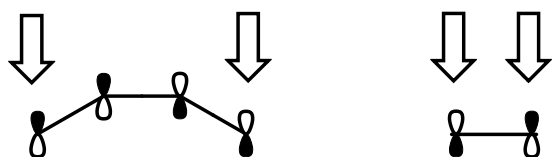
- Highest Occupied Molecular Orbital (HOMO)
Lowest Unoccupied Molecular Orbital (LUMO)
- bonding interactions: overlap of MO parts with the same sign of the wave function



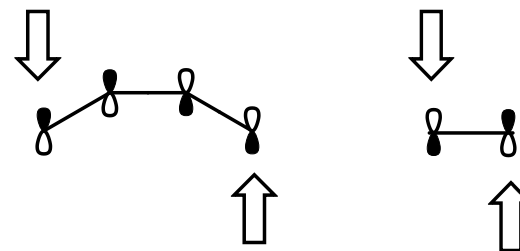
Woodward-Hoffmann rules

- describe the course of pericyclic reactions, based on the symmetry of molecular orbitals

suprafacial interactions:
same side of the π system



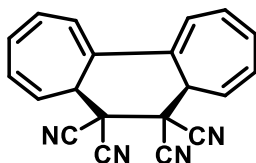
antarafacial interactions:
opposite sides of the π system



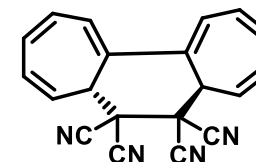
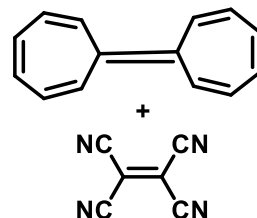
allowed reactions: *thermal*: number of components $(4m+2)_s + (4n)_a$: odd number
photochemical: number of components $(4m+2)_s + (4n)_a$: even number

Diels-Alder reaction: $(4\pi+2\pi)_s + (0)_a$: 1
(6): $4m+2$

thermal reaction:



$(14\pi+2\pi)_s + (0)_a$: 0
(16): $4m$

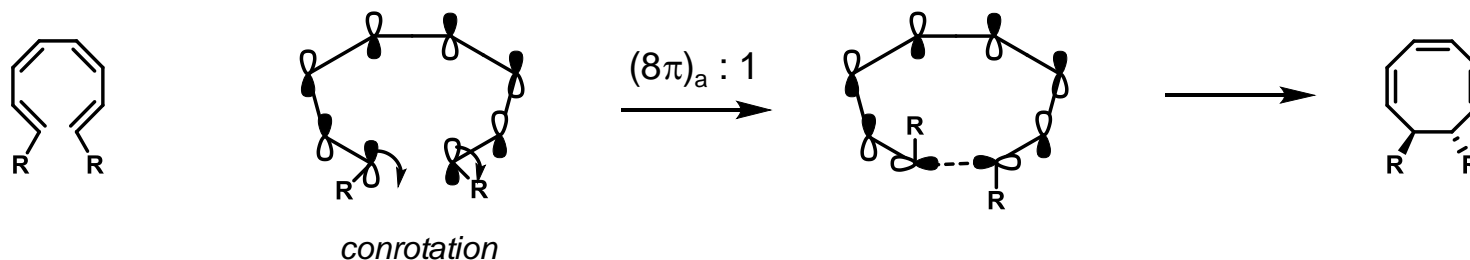
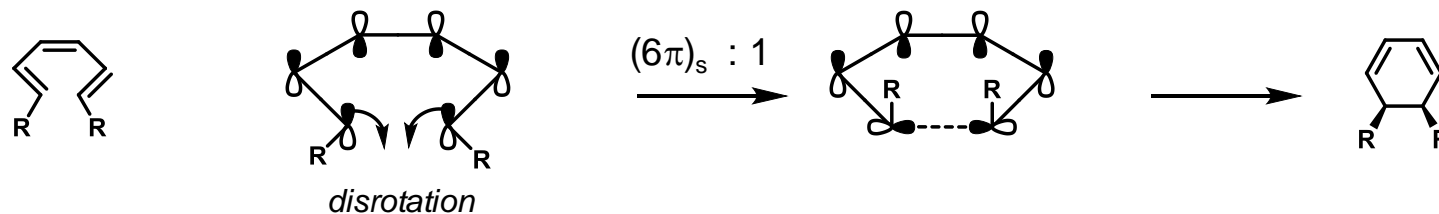
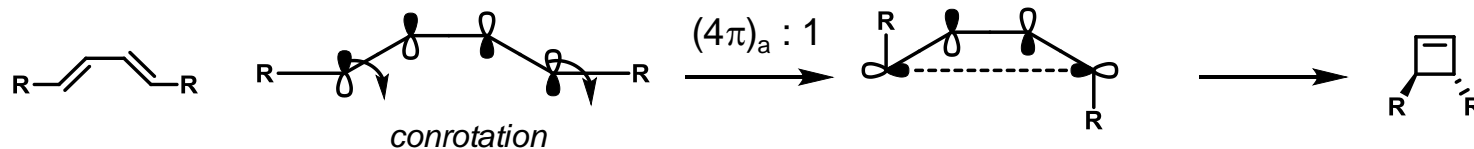


$(14\pi+0\pi)_s + (2\pi)_a$: 1
(14): $4m+2$

Electrocyclic reactions

- pericyclic closure and opening of rings

thermal: HOMO (corresponds to double bonds in the structure)

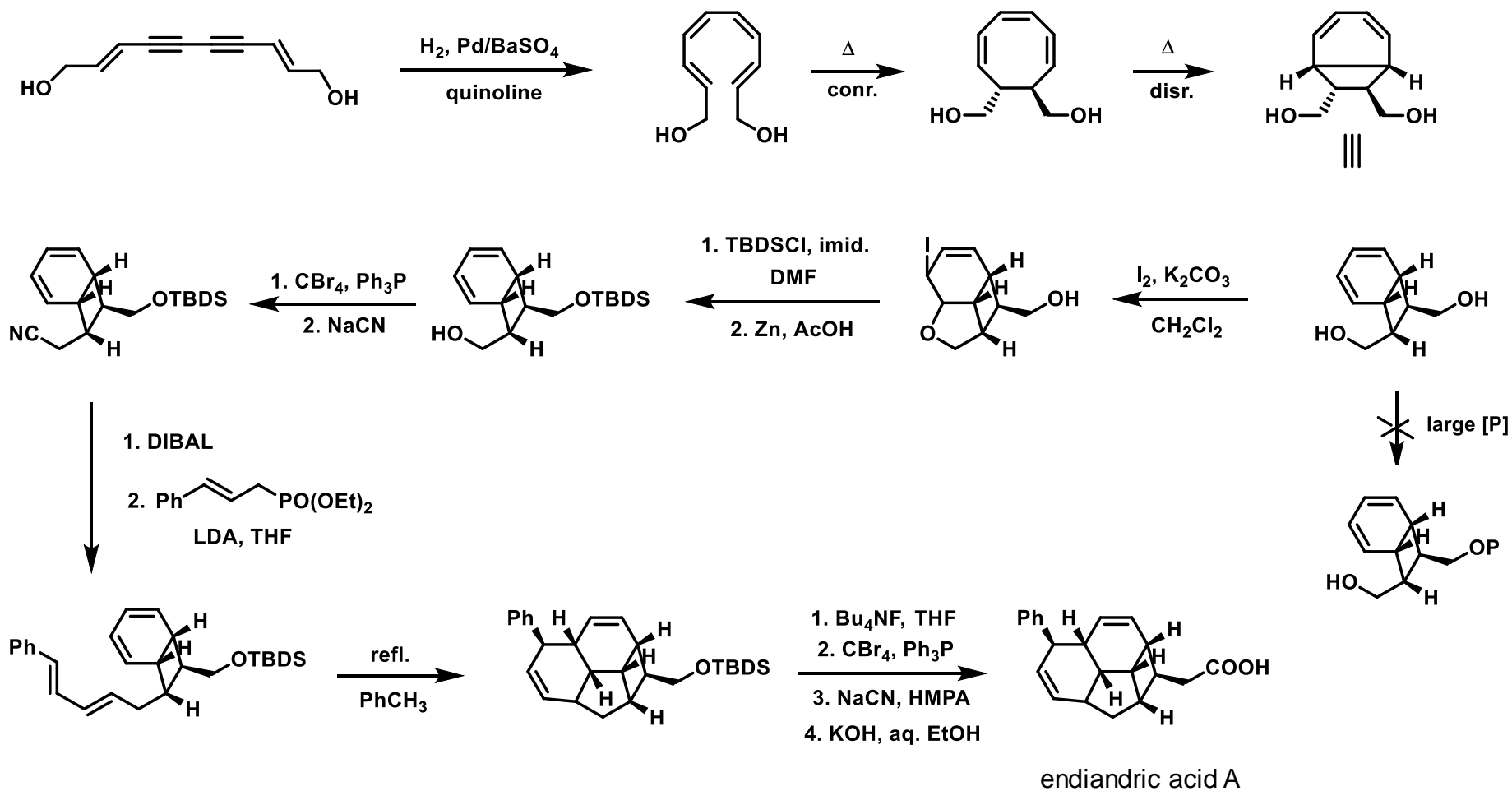


photochemical:

4π
disrotation

6π
conrotation

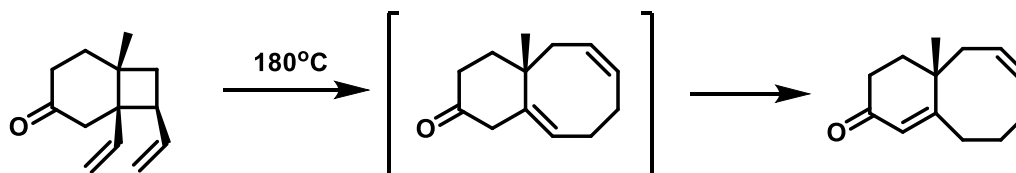
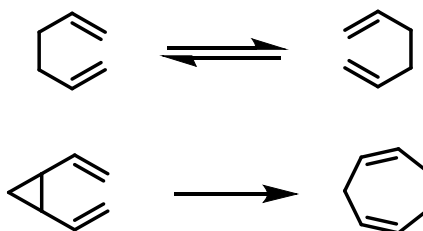
8π
disrotation



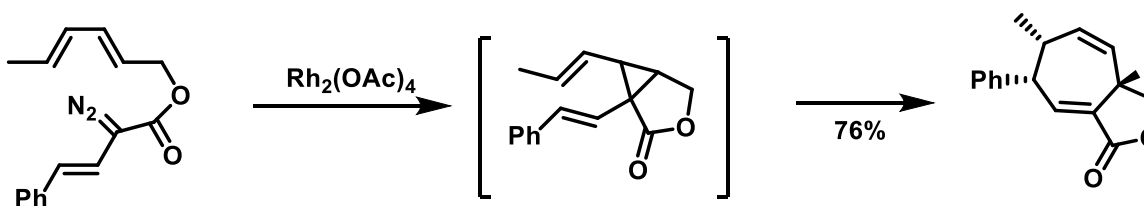
J. Am. Chem. Soc. **1982**, *104*, 5560.

Cope rearrangement

- equilibrium reaction
- in some cases, the equilibrium is significantly shifted to the more stable isomer
(or the isomer that is converted to more stable product)



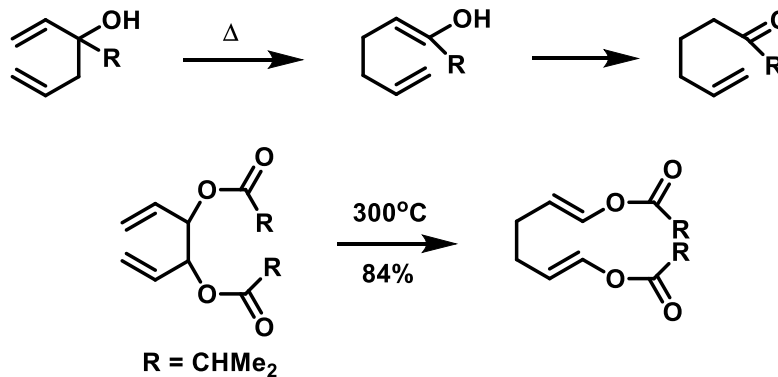
Tetrahedron Lett. **1988**, 29, 2773.



J. Org. Chem. **1989**, 54, 930.

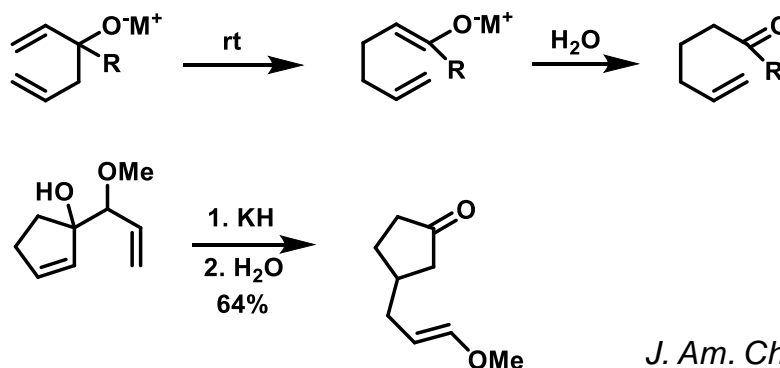
oxy-Cope rearrangement

- newly formed enol tautomerizes to ketone (irreversible process)

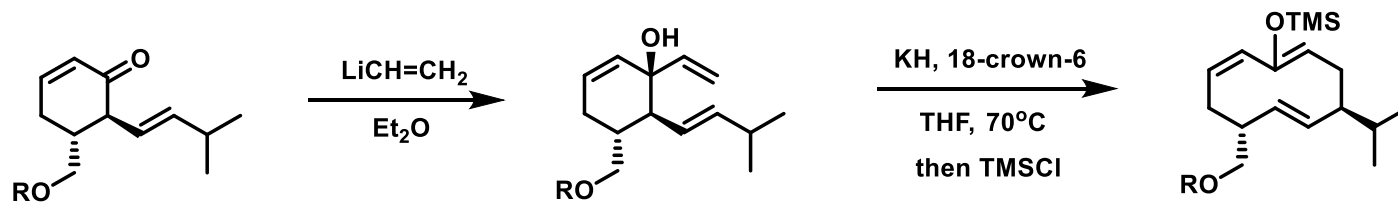


anionic oxy-Cope rearrangement

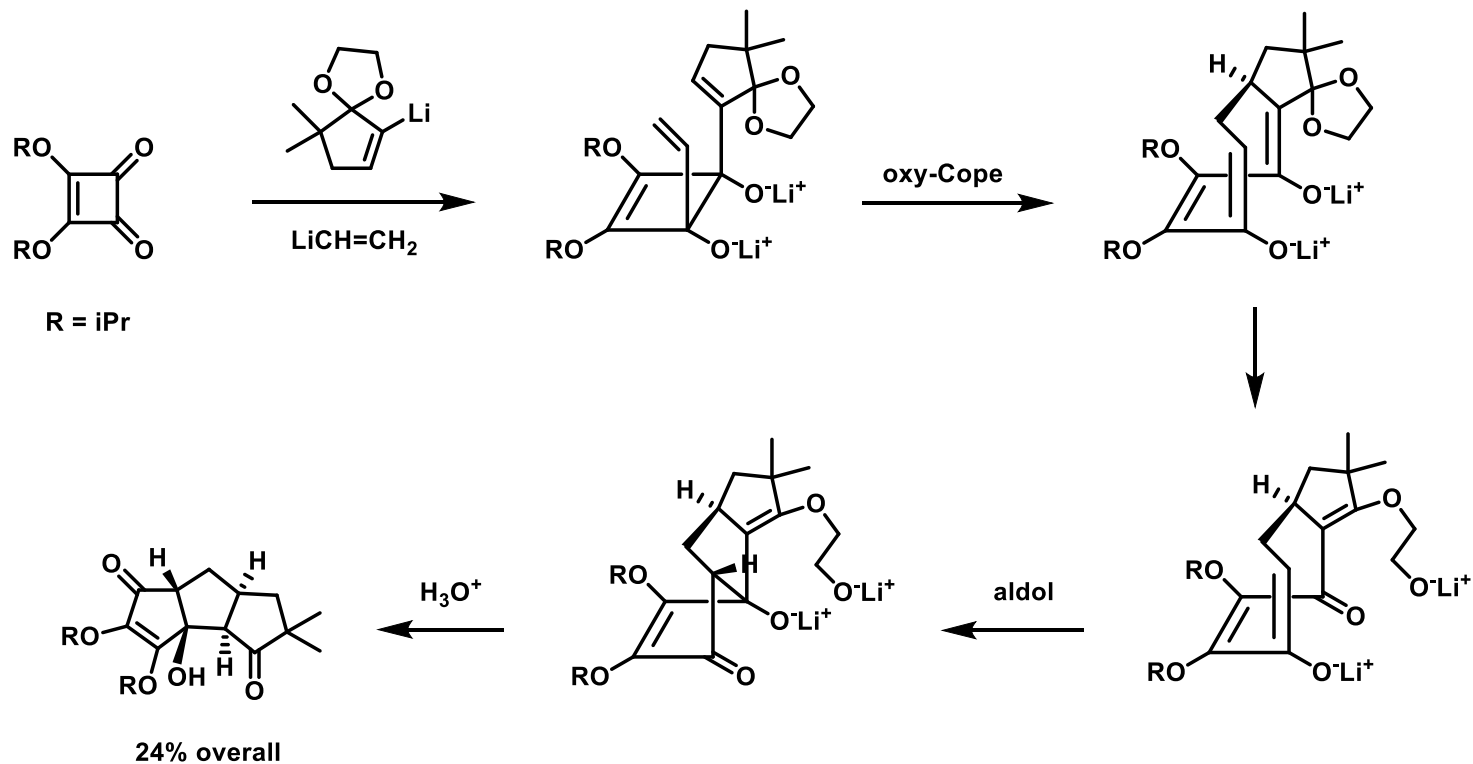
- substrate: 1,5-diene alkoxide
- fast reactions, often at 25 °C



J. Am. Chem. Soc. **1980**, 102, 774.

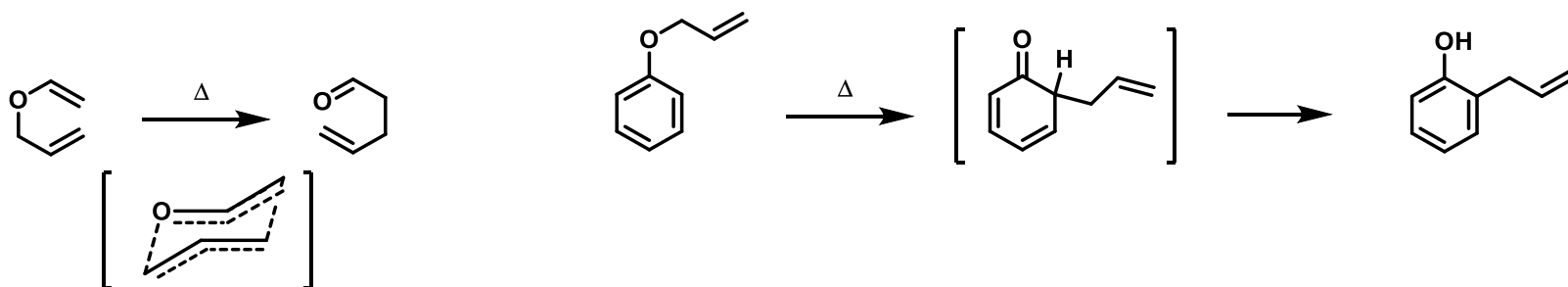


J. Am. Chem. Soc. **1979**, 101, 2493.

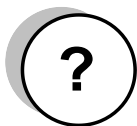
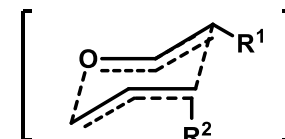
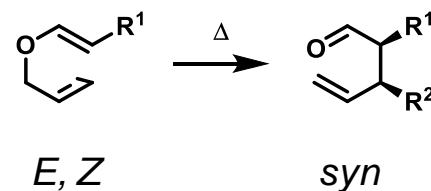
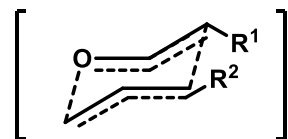
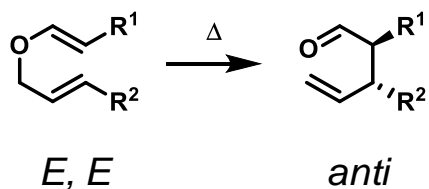


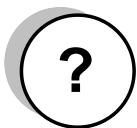
J. Am. Chem. Soc. **2002**, 124, 9199.

Claisen rearrangement

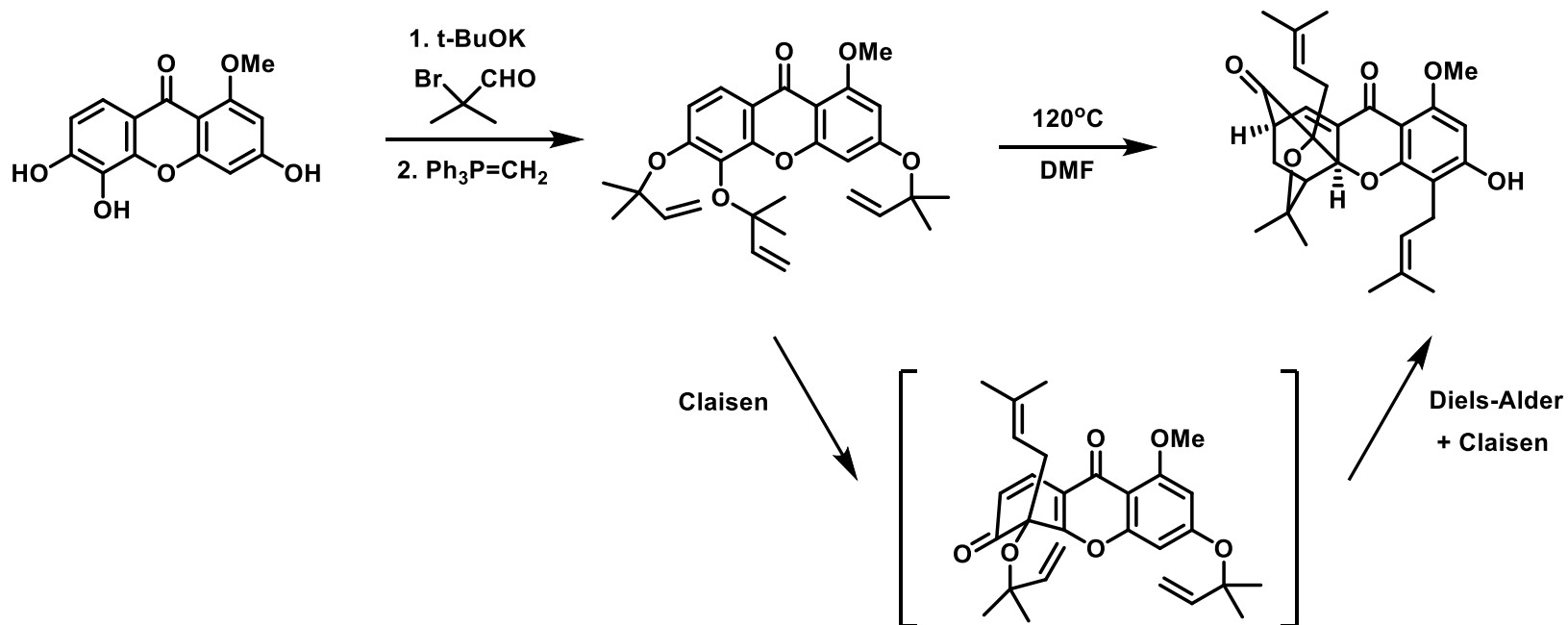


- reliable method for introduction of double bond in combination *with defined stereochemistry* at C atoms bearing R¹ and R²

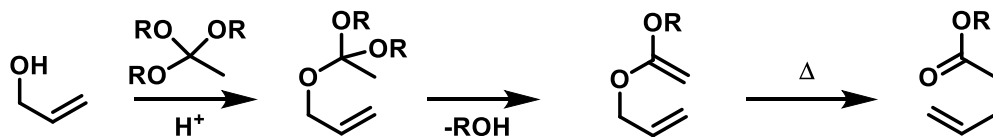
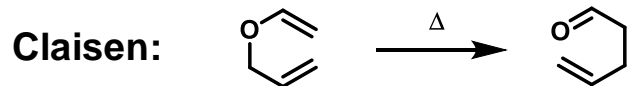




biomimetic synthesis of 1-O-methylforbesione:

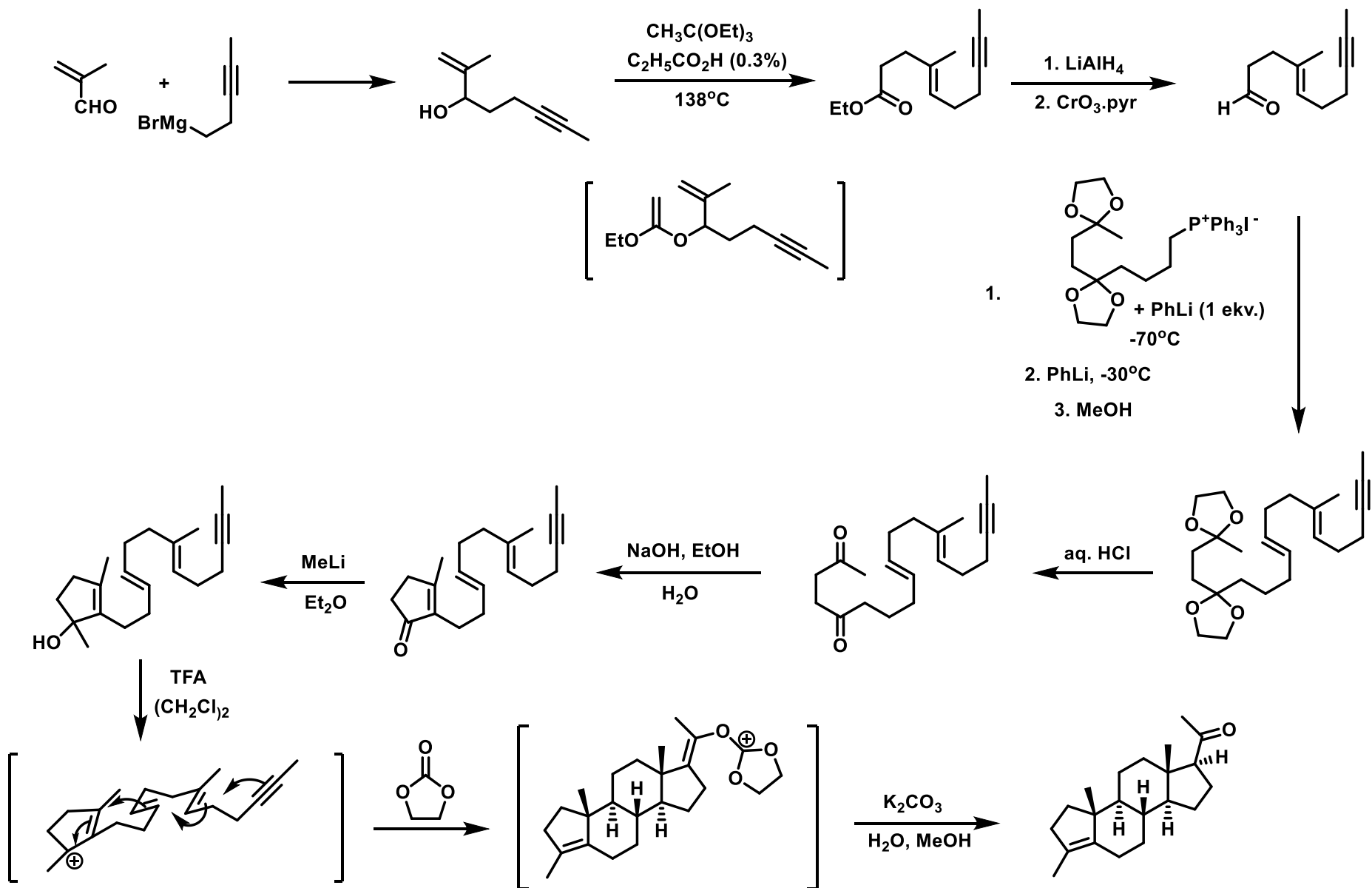


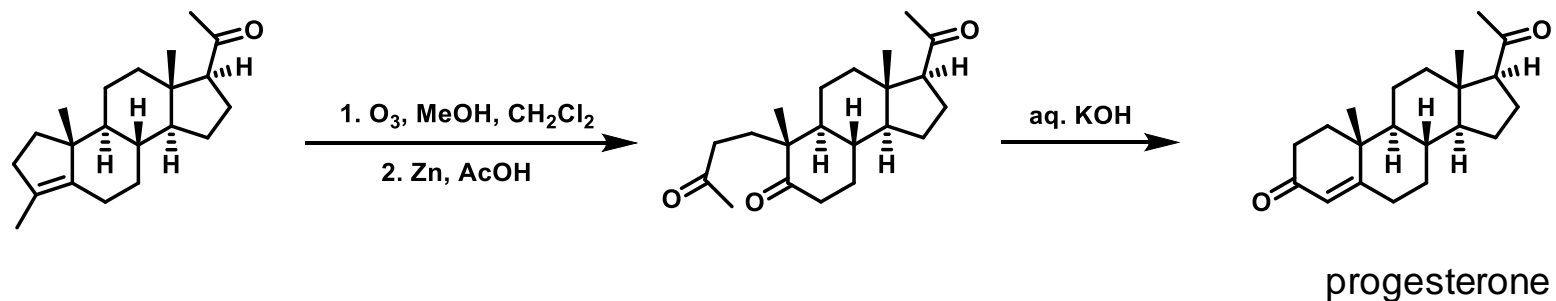
Johnson-Claisen rearrangement (of ketene acetals)



- preparation of γ,δ -unsaturated esters

?

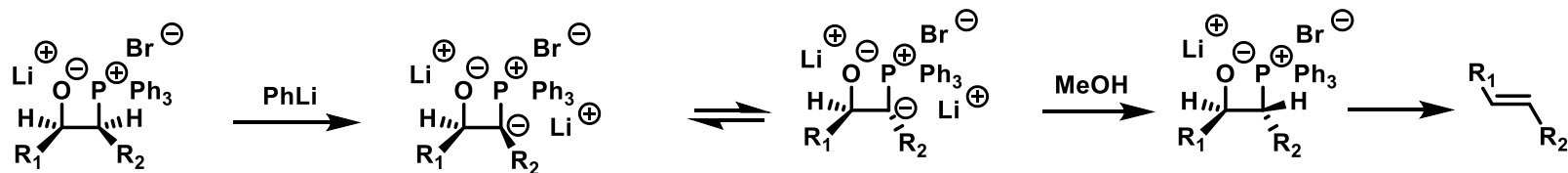




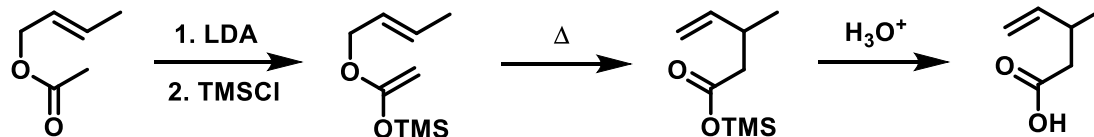
J. Am. Chem. Soc. **1978**, *100*, 4274.

Note: Schlosser modification of Wittig reaction

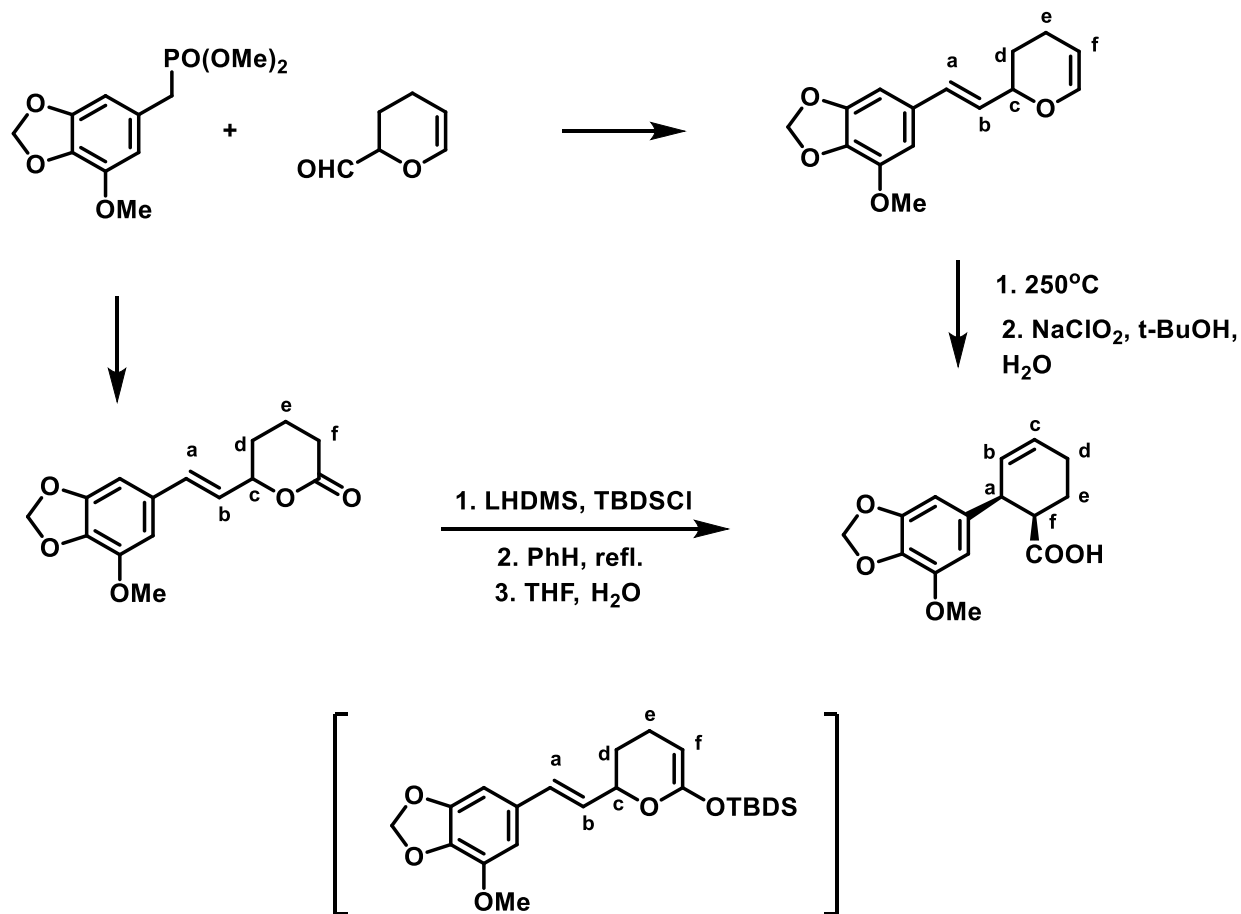
- preparation of (*E*)-olefins using *nonstabilized* ylides



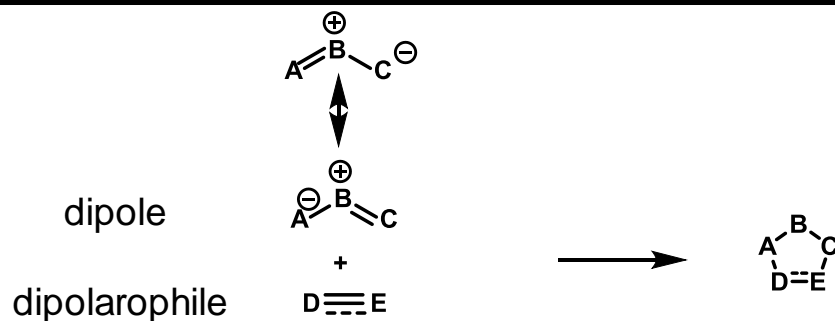
Ireland-Claisen rearrangement (of allyl ester enolates)



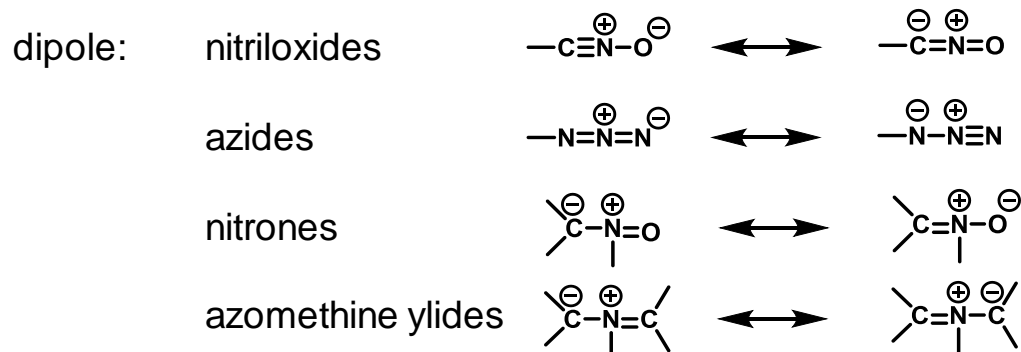
?



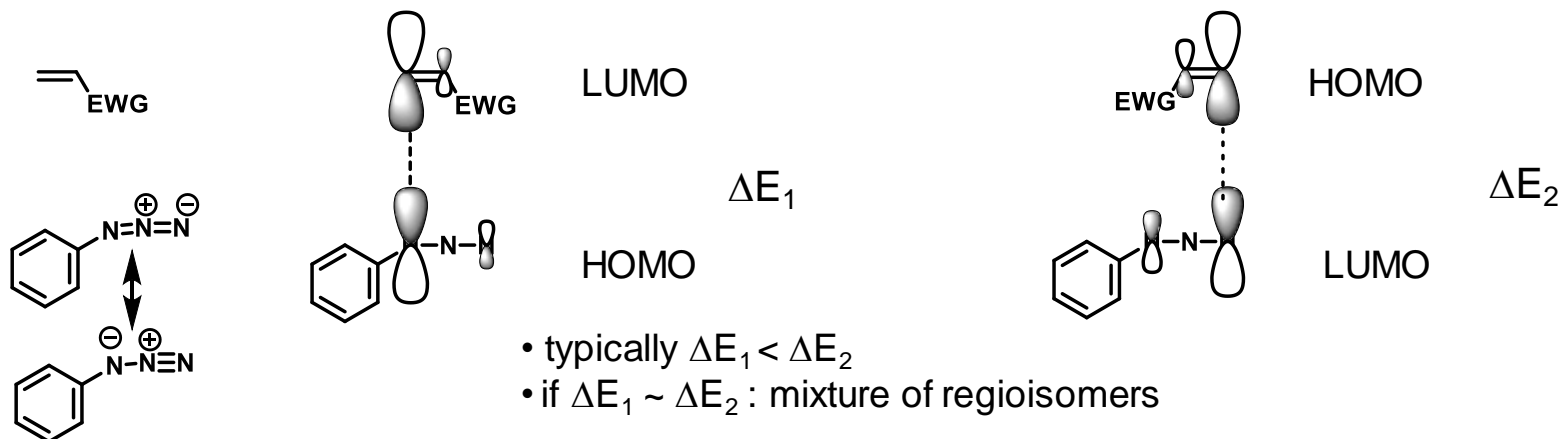
J. Org. Chem. **2004**, *69*, 112.

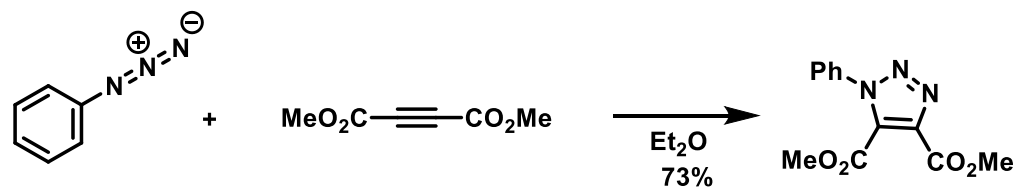


dipolarophile: essentially any double/triple bond



regioselectivity: HOMO – LUMO interaction (overlap of MO parts on atoms with larger coefficients)

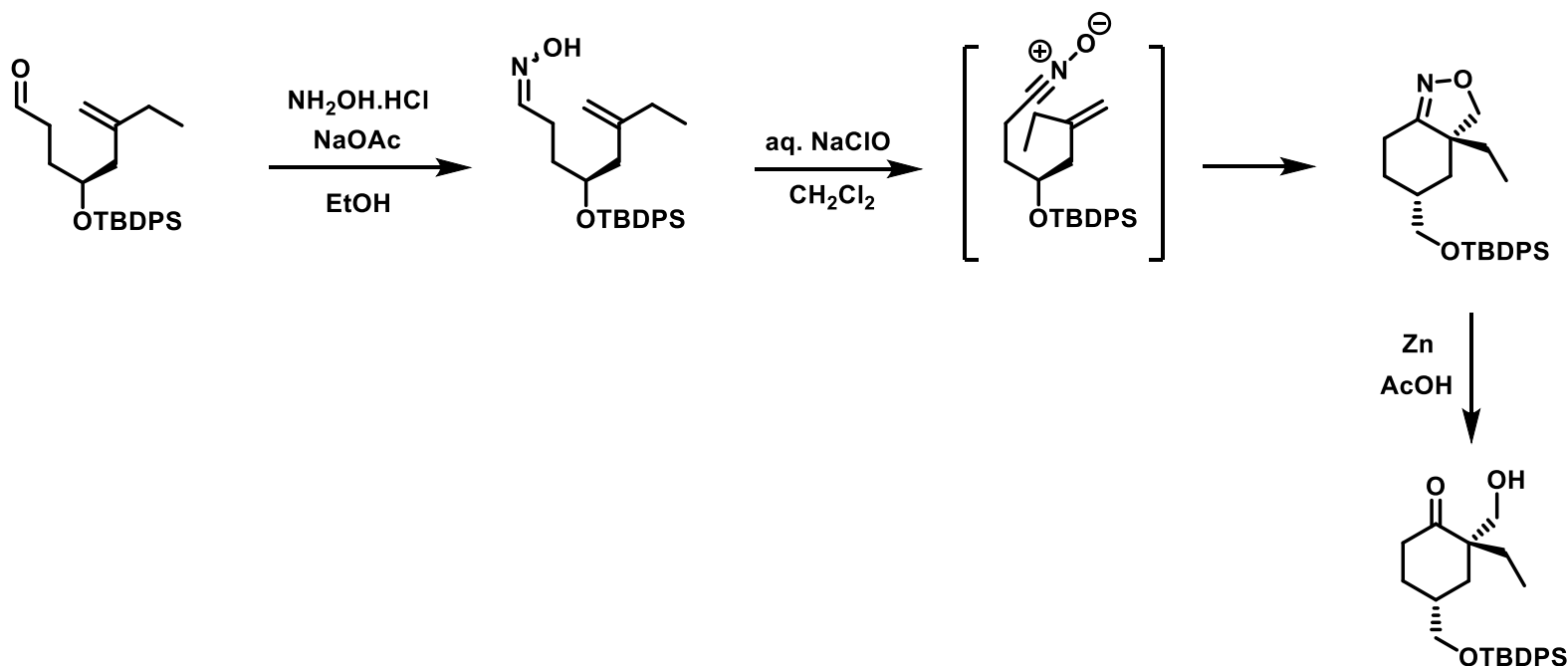


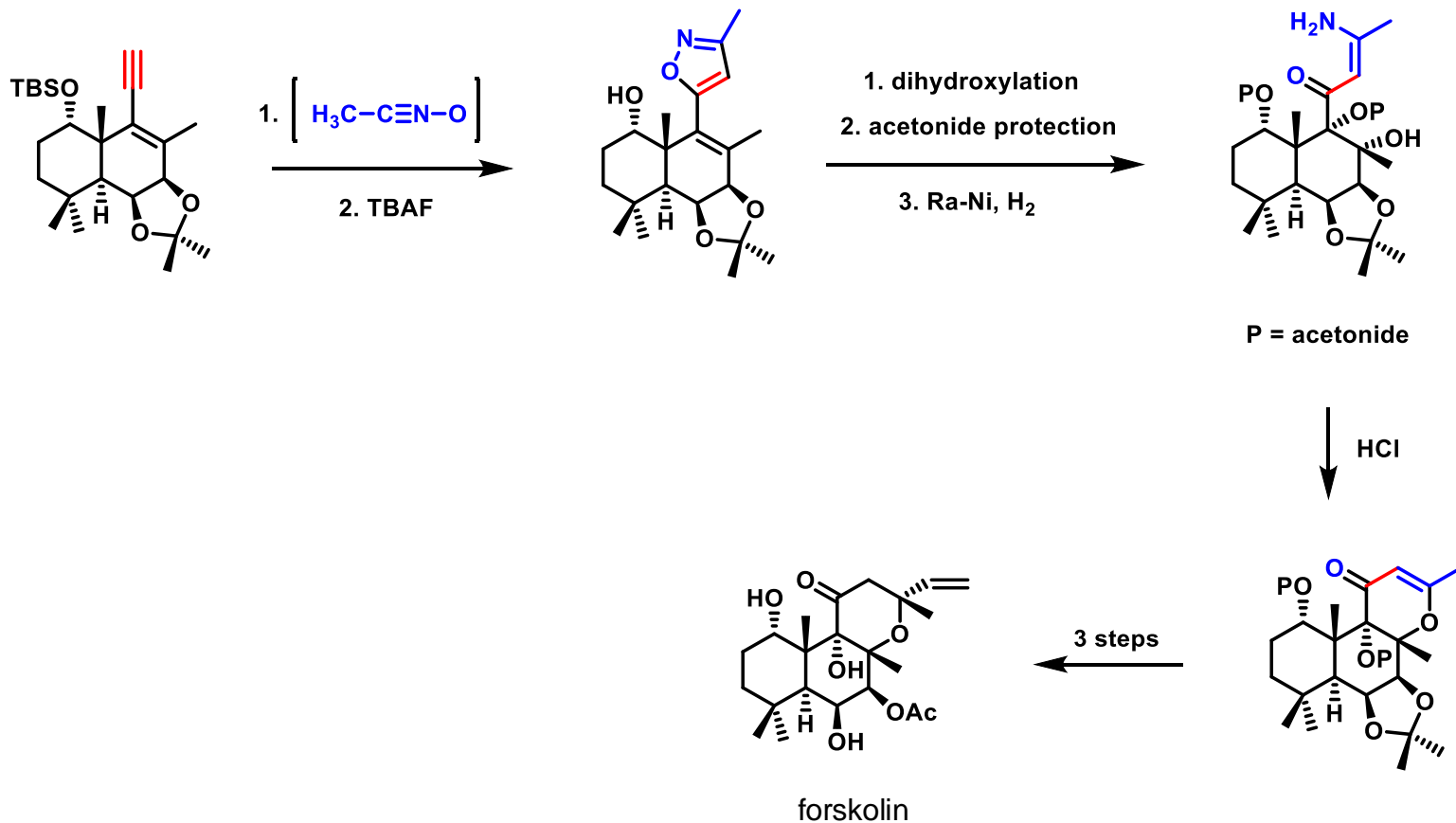


click reaction: Cu(I) catalyzed triazole formation

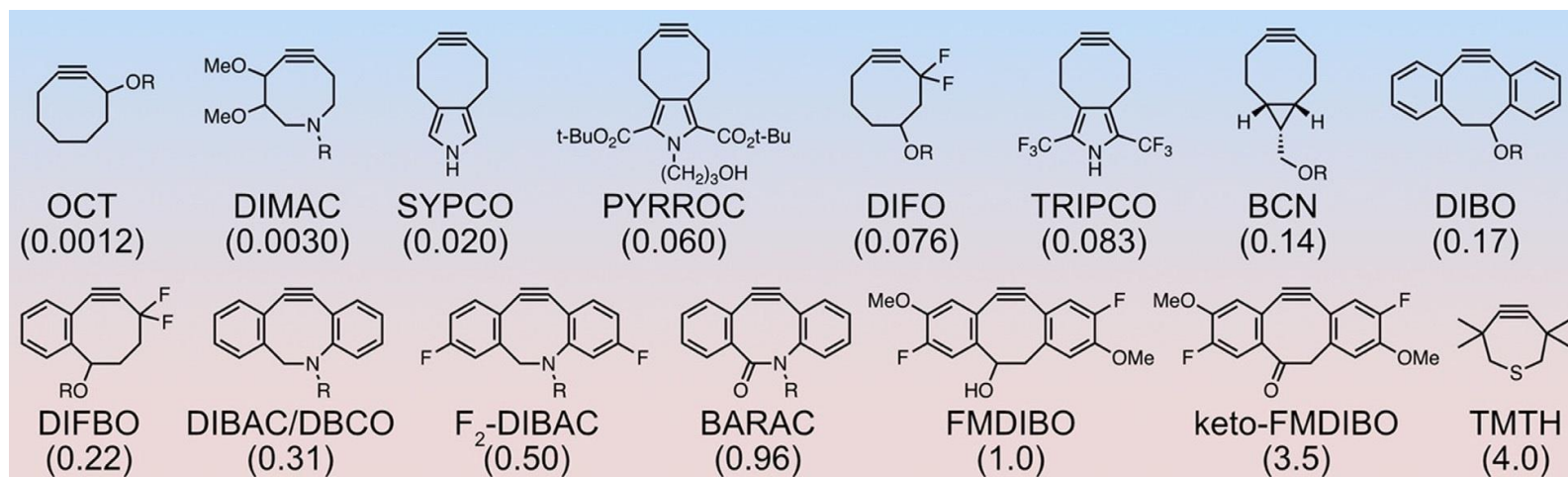
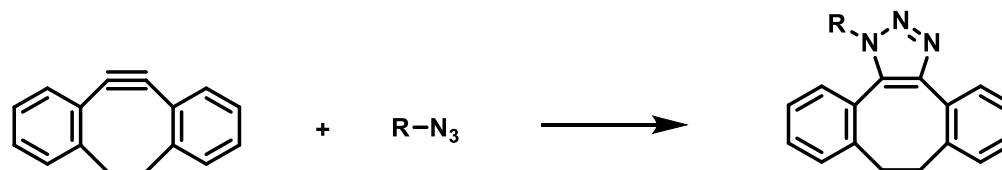
frequently used in biology; can be done in the cell (in vivo)

nitrile oxides: frequently used dipoles





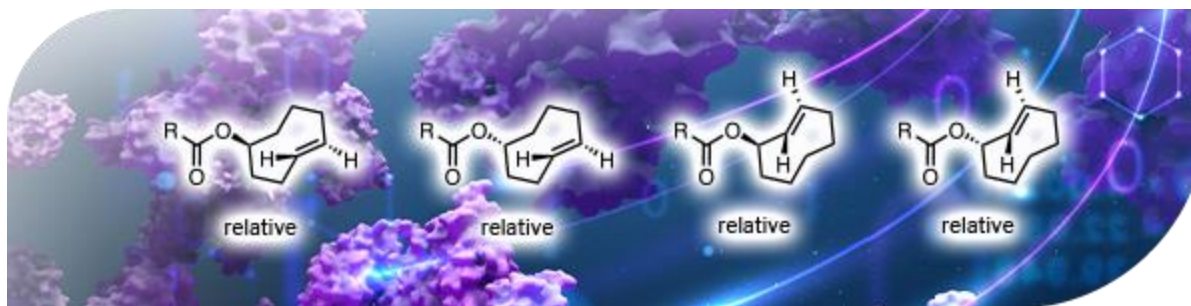
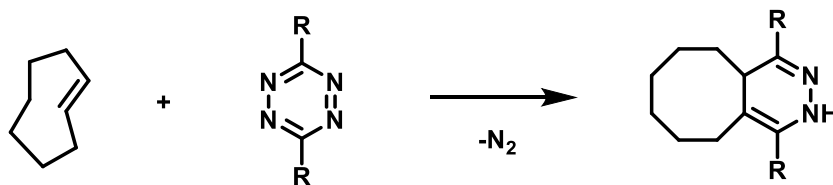
Strain-promoted azide-alkyne cycloadditions



Chem. Eur. J. **2021**, *27*, 5057.

Inverse electron-demand Diels-Alder reaction

- click reactions with trans-cyclooctene
- widely used in chemical biology (protein labelling and imaging)



Chem. Soc. Rev. **2017**, 46, 4895.