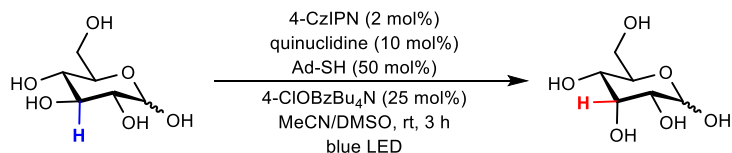


Carbohydrate Epimerization:



- Proceeds under kinetic control
- Gives C3 selectivity
- Hydrogen atom abstraction and donation mediated via co-catalysis
- Quinuclidinium radical cation mediates irreversible H-atom abstraction with a homolytic bond dissociation enthalpy = 100 kcal mol⁻¹
- Thiol acidity promotes irreversible HAT for epimerization at 87 kcal mol⁻¹

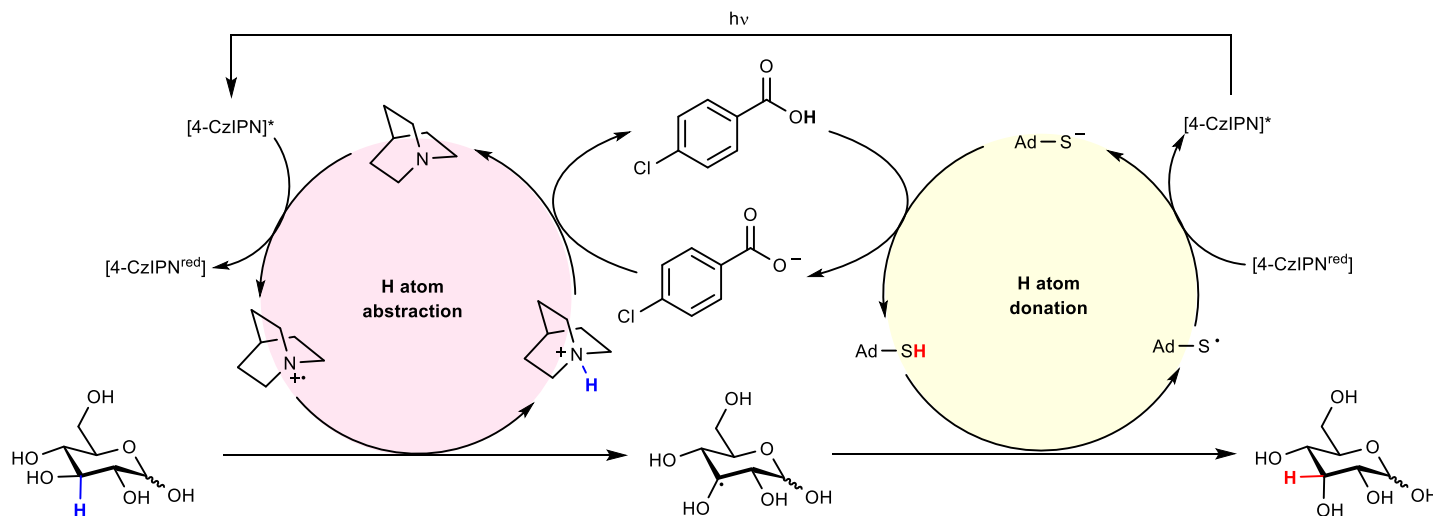
Benefits:

- Quick method to prepare rare sugar isomers
- Distinguishes nearly identical C-H bonds of unprotected, densely functionalized, polar compounds
- Doesn't require use of iridium
- Can run gram scale reactions (3-6 mmol)

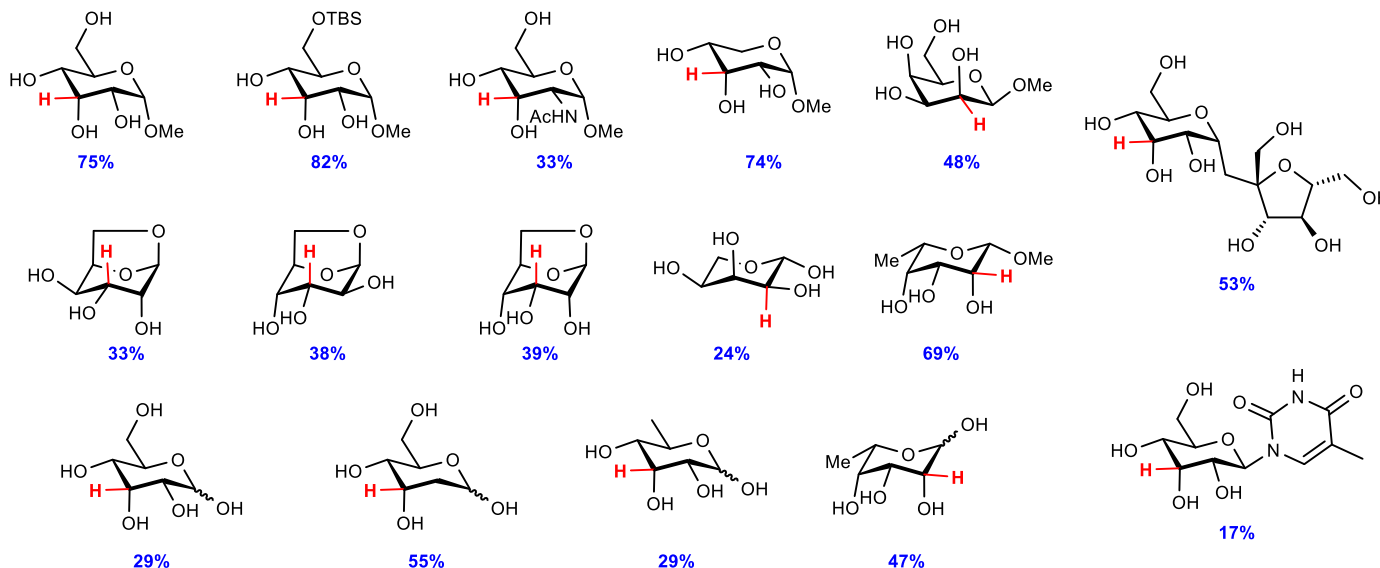
Limitations:

- Only shown to work on unprotected carbohydrates
- Basis of site-selectivity not fully understood
- Significant yield reduction when no C4 oxygen isn't trans to C3
- Significant yield reduction if O is replaced by a NHAc
- Significant yield reduction if C2 oxygen free

Mechanism:



Substrate Scope:

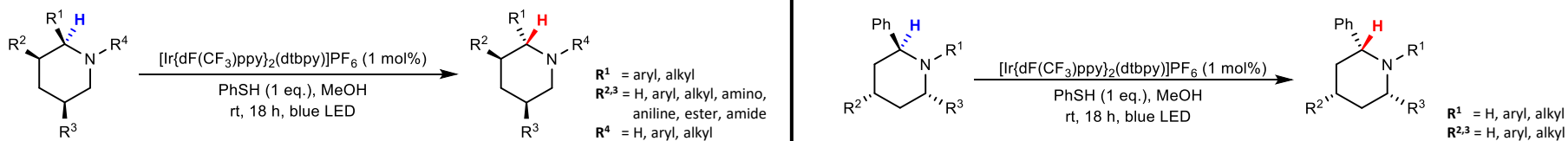


Reaction Set-up:



Wendlandt. *Nature*, 2020, 578, 403. <https://doi.org/10.1038/s41586-020-1937-1>

Piperidine Epimerization:



- Proceeds under thermodynamic control
- Observed diastereomer ratios in agreement with calculated relative stability of the two
- Thiophenyl radical undergoes reversible polarity matched HAT made possible by both bond dissociation energies being approximately 79 kcal mol^{-1}

Mayer, Ellman, and Houk. *JACS*, 2021, 143, 126. <https://doi.org/10.1021/jacs.0c11911>

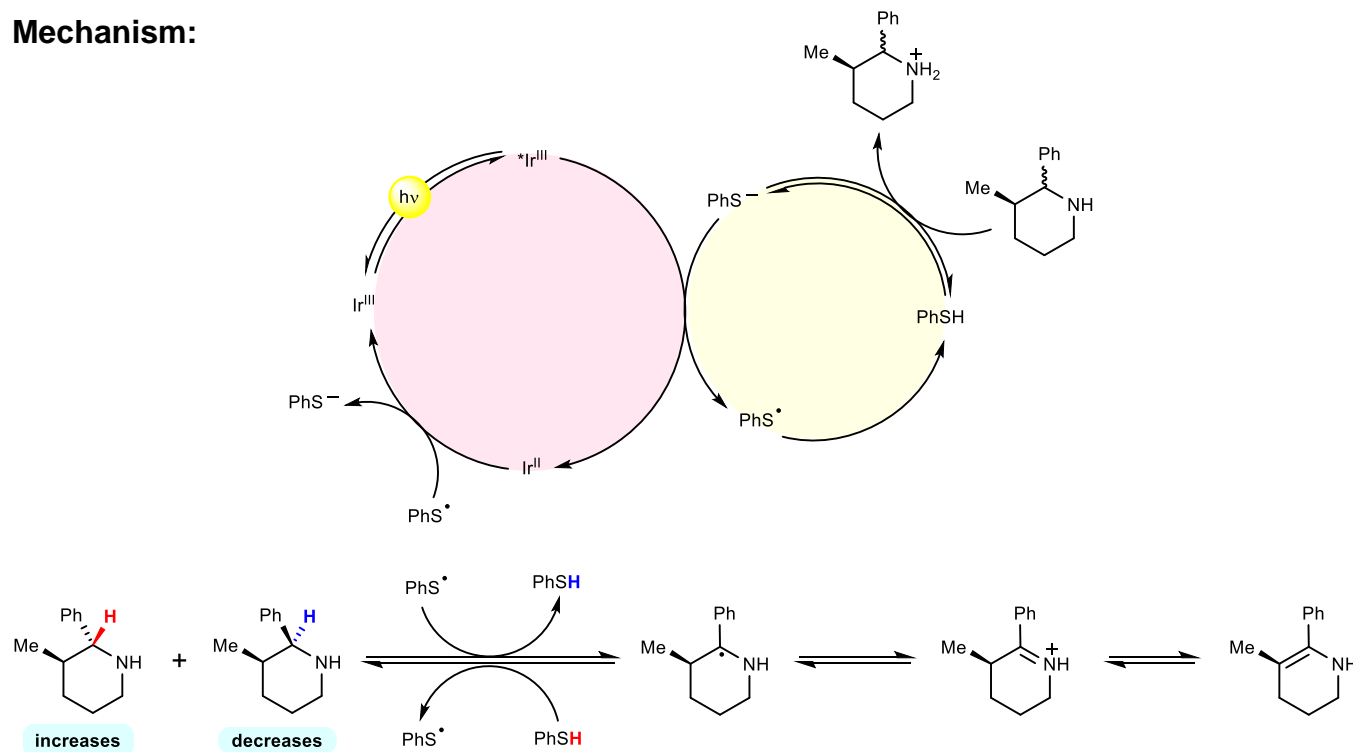
Benefits:

- Rapid access to more stable isomer
- Allows for use of electron rich and electron deficient aryl substituents
- α -epimerization works for 2,3-disubstituted and 2,5-disubstituted piperidines
- Displays epimerization of *syn* contra-thermodynamic piperidines

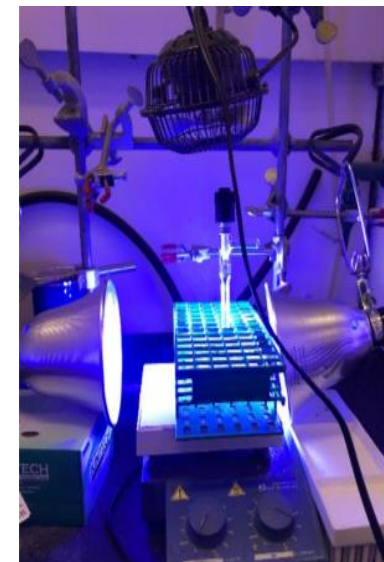
Limitations:

- Method specific for α -amino epimerization
- Uses iridium
- Only shown on mg scales (up to 1 mmol)

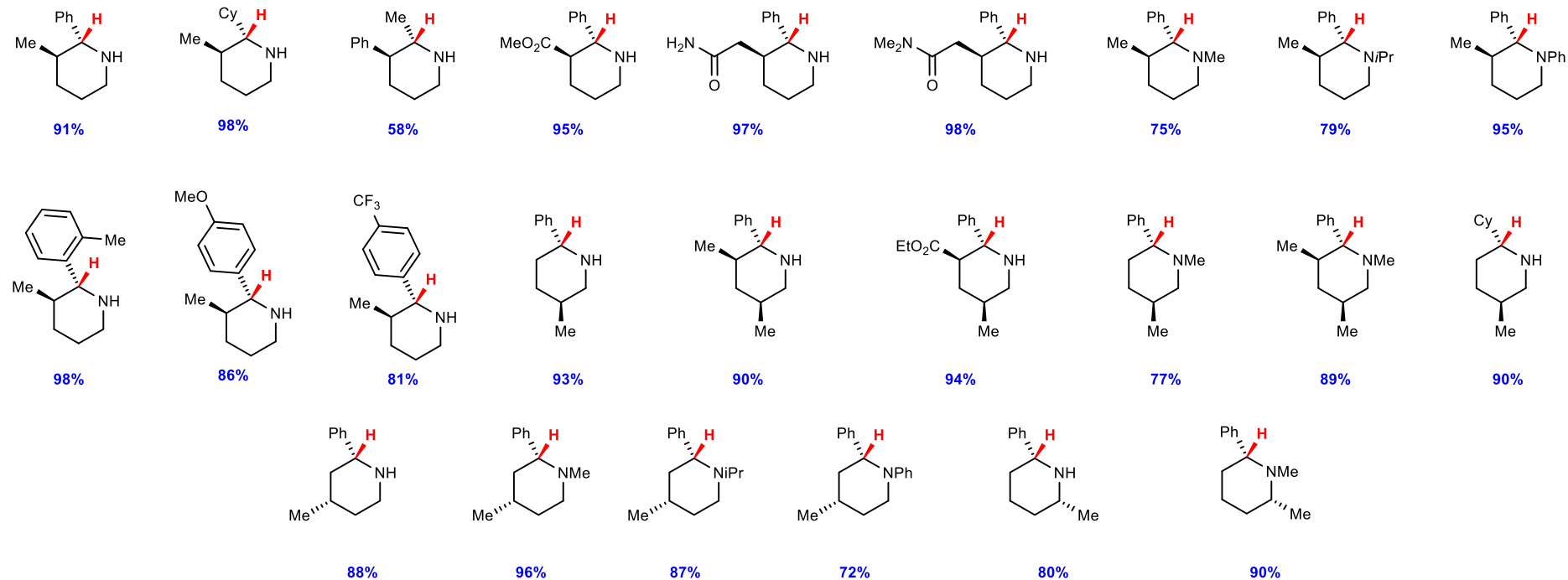
Mechanism:



Reaction Set-up:

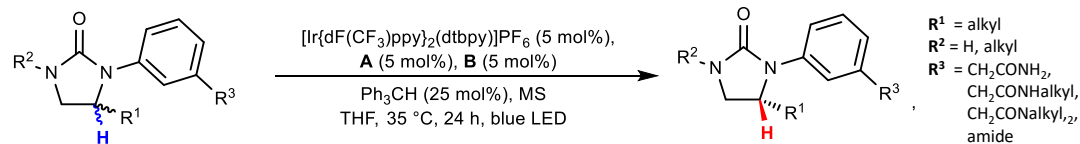


Substrate Scope:

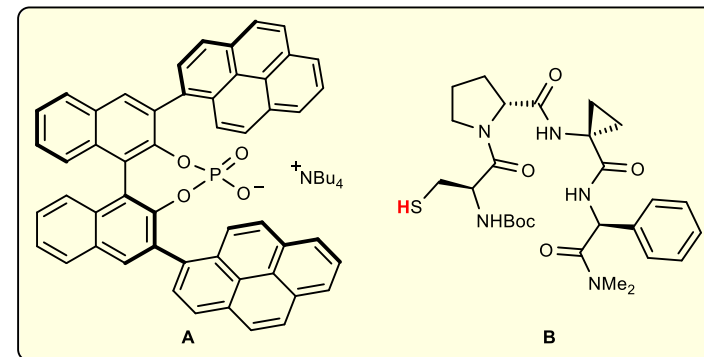


Mayer, Ellman, and Houk. *JACS*, **2021**, 143, 126. <https://doi.org/10.1021/jacs.0c11911>

Cyclic Urea Epimerization:



- Proceeds under thermodynamic control
- Observed stereoselectivity product of enantiomeric ratios of proton transfer and HAT steps



Miller and Knowles. *Science*, **2019** 366, 364. <https://doi.org/10.1126/science.aay2204>

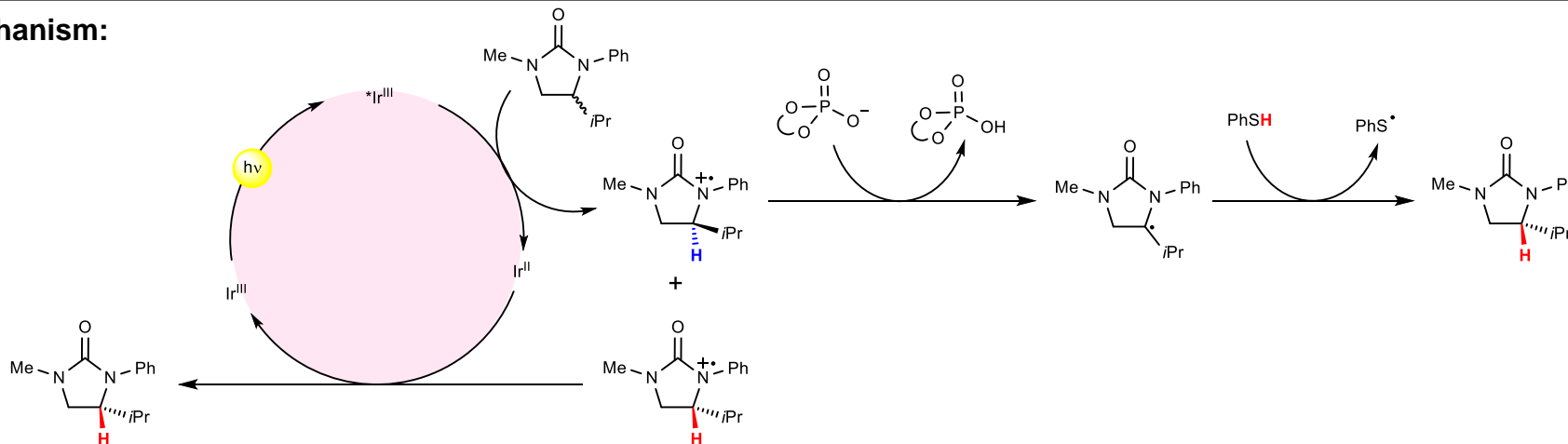
Benefits:

- Two independent stereoselective steps that occur in sequence gives composite selectivity that is higher than that of either step individually.
- Creates out-of-equilibrium product distributions between substrate enantiomers using excited-state redox events
- Deracemization made to be thermodynamically favorable

Limitations:

- Method only shown for cyclic ureas with a meta substitution
- Uses iridium
- Lengthy process to make both chiral catalysts
- Only shown on mg scales (up to 0.25 mmol)

Mechanism:



Substrate Scope:

