C-C Bond Formation via SET Decarboxylative Coupling

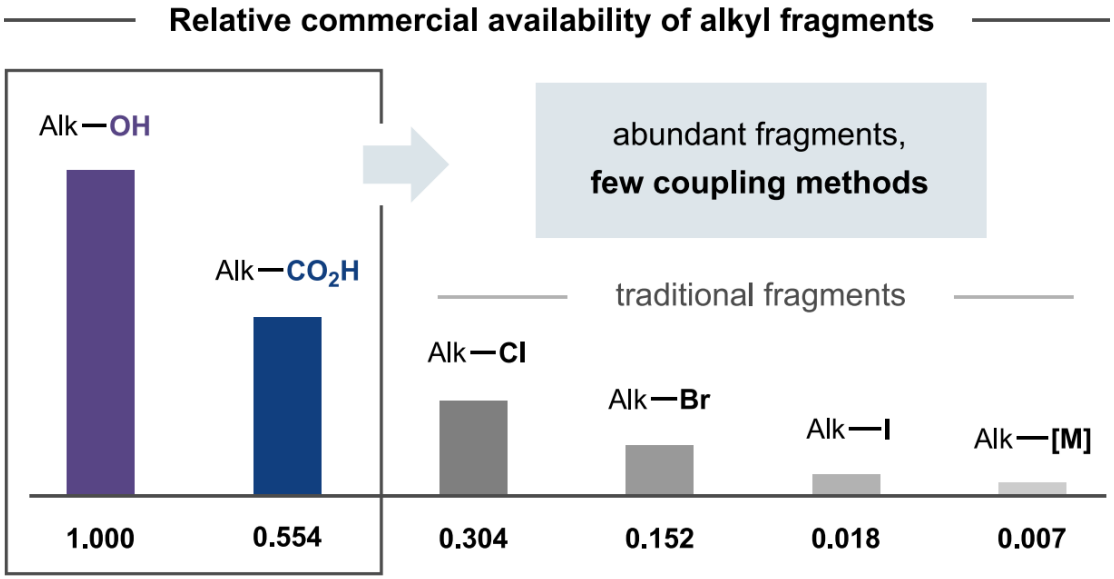
Outline

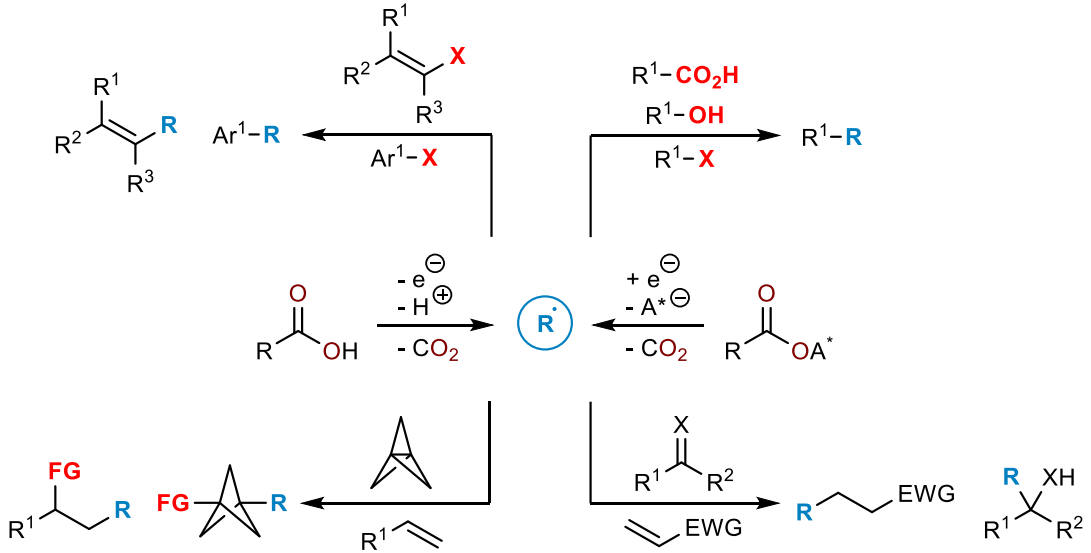
1. **Introduction**
2. **Alkenylation & Arylation**
3. **sp³ C-C Coupling**
4. **Difunctionalization**
5. **Addition to C=X Bond**
6. **Miscellaneous Examples**

Not included:

Transition metal catalyzed CO_2 extrusion of ester & metal carboxylate

Introduction

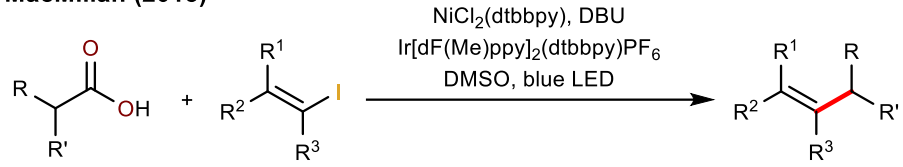


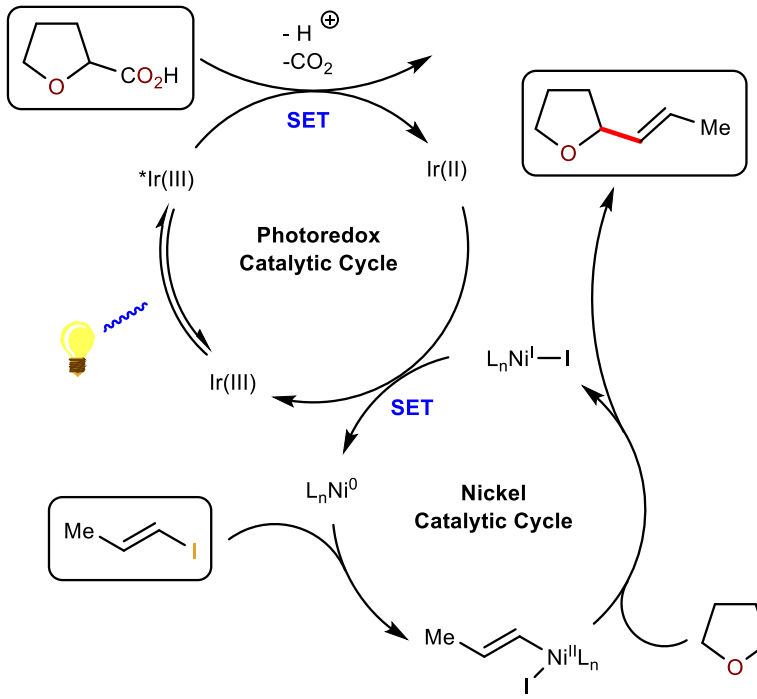


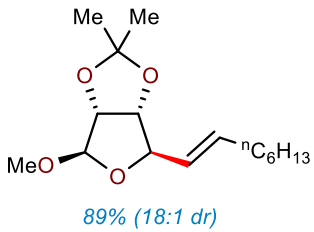
MacMillan, D. W. C. *J. Am. Chem. Soc.* **2022**, *144*, 6185. https://doi.org/10.1021/jacs.2c02062

Alkenylation & Arylation

MacMillan (2015)



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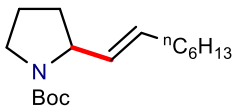
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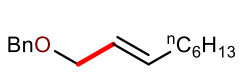
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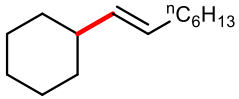
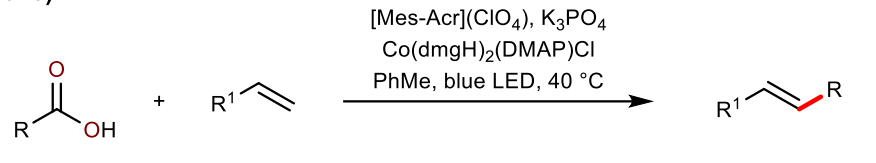
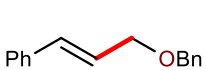

78%

MacMillan, D. W. C. *J. Am. Chem. Soc.* **2015**, *137*, 624. https://dx.doi.org/10.1021/ja511913h

Wu (2018)

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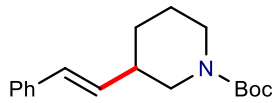
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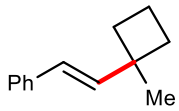
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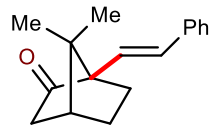
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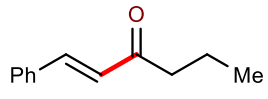
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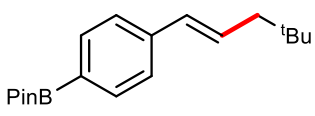
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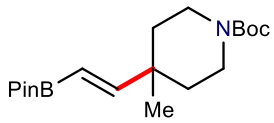
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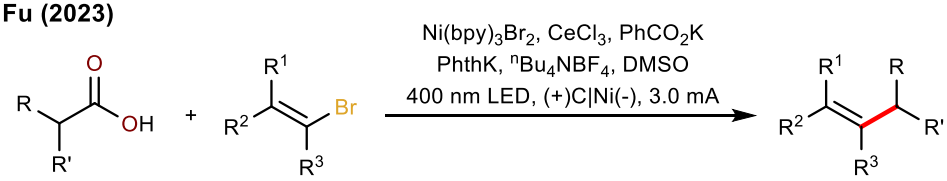
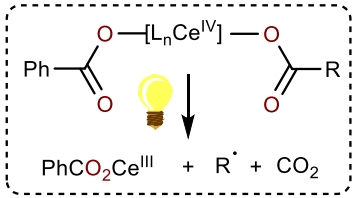
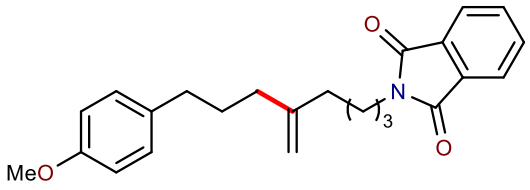
Wu, J. *J. Am. Chem. Soc.* **2018**, *140*, 16360. https://doi.org/10.1021/jacs.8b11218

Fu (2023)



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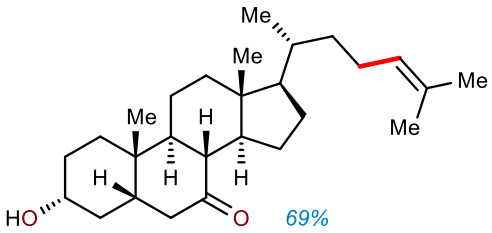
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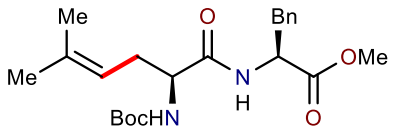
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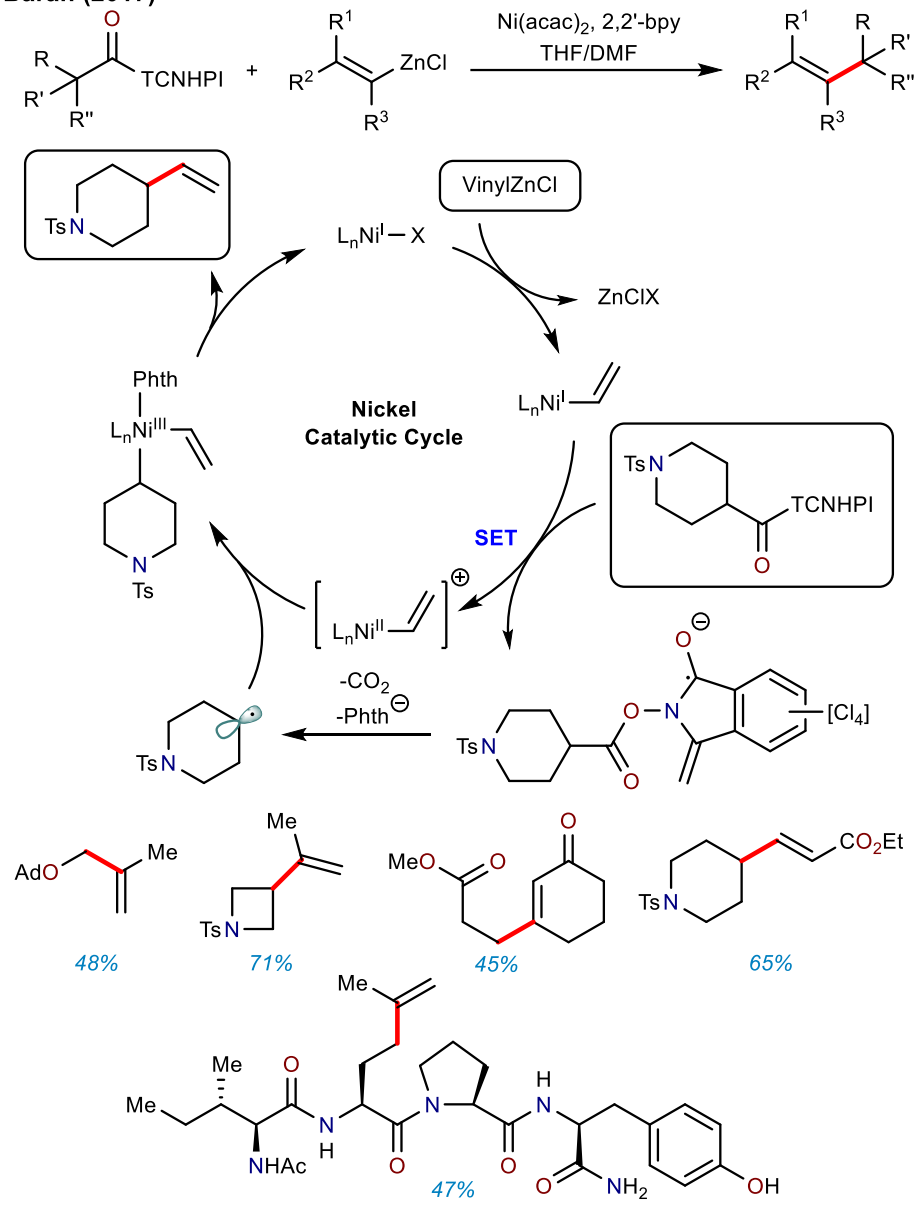
Fu, N, -K, J. *J. Am. Chem. Soc.* **2023**, *145*, 26774. https://doi.org/10.1021/jacs.3c08839

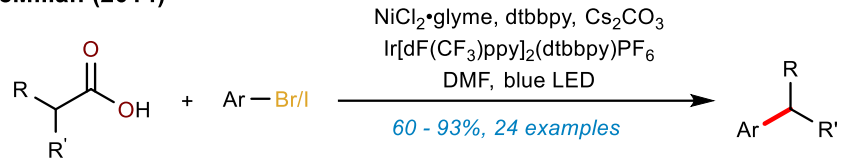
Alkenylation & Arylation

Baran (2017)



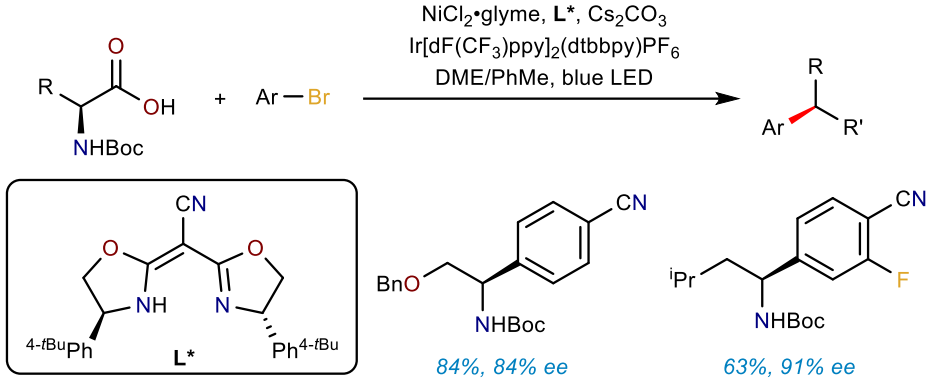
Baran, P. S. *Nature.* **2017**, *545*, 213. https://doi.org/10.1038/nature22307

MacMillan (2014)



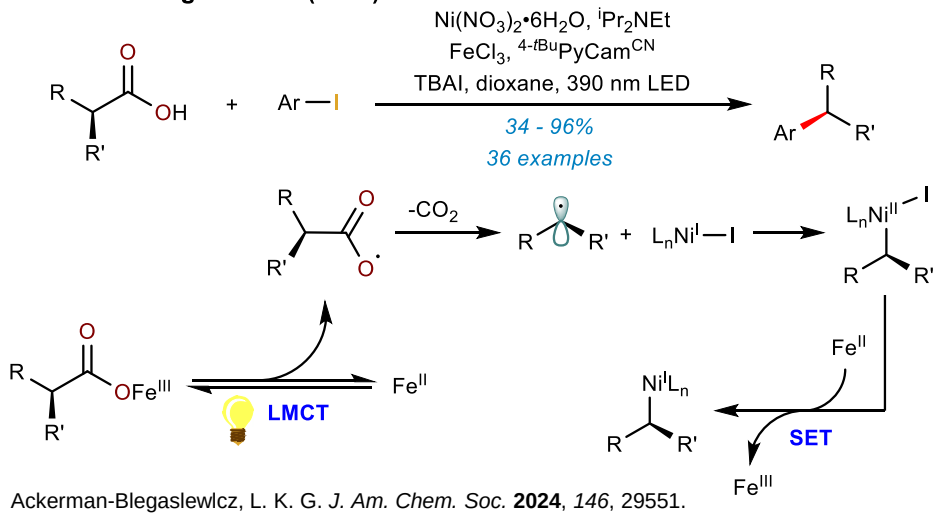
MacMillan, D. W. C. *Science.* **2014**, *345*, 437. https://doi.org/10.1126/science.1255525

MacMillan (2016) -- Asymmetric Version



MacMillan, D. W. C. *J. Am. Chem. Soc.* **2016**, *138*, 1832. https://doi.org/10.1021/jacs.5b13211

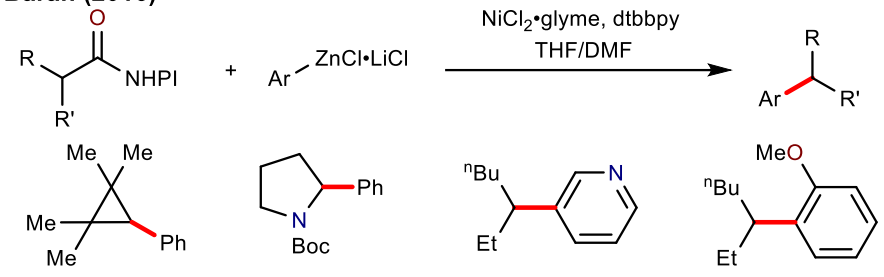
Ackerman-Biegasiewicz (2024)



Ackerman-Blegaslewlcz, L. K. G. *J. Am. Chem. Soc.* **2024**, *146*, 29551. https://doi.org/10.1021/jacs.5b13211

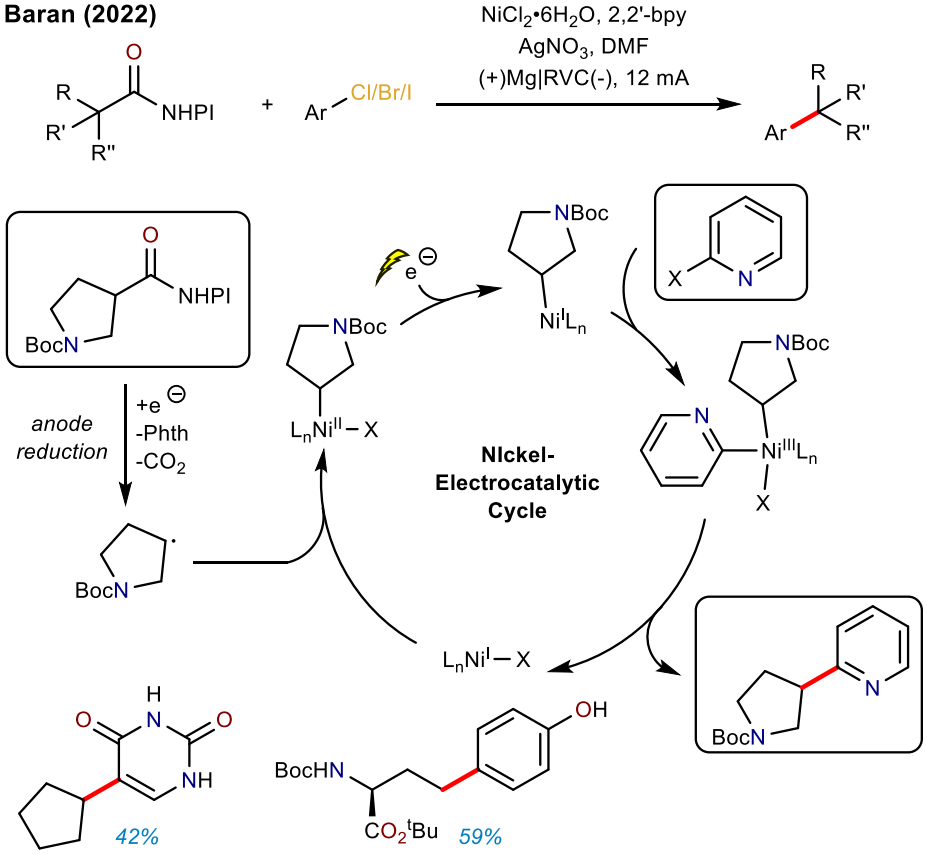
Alkenylation & Arylation

Baran (2016)



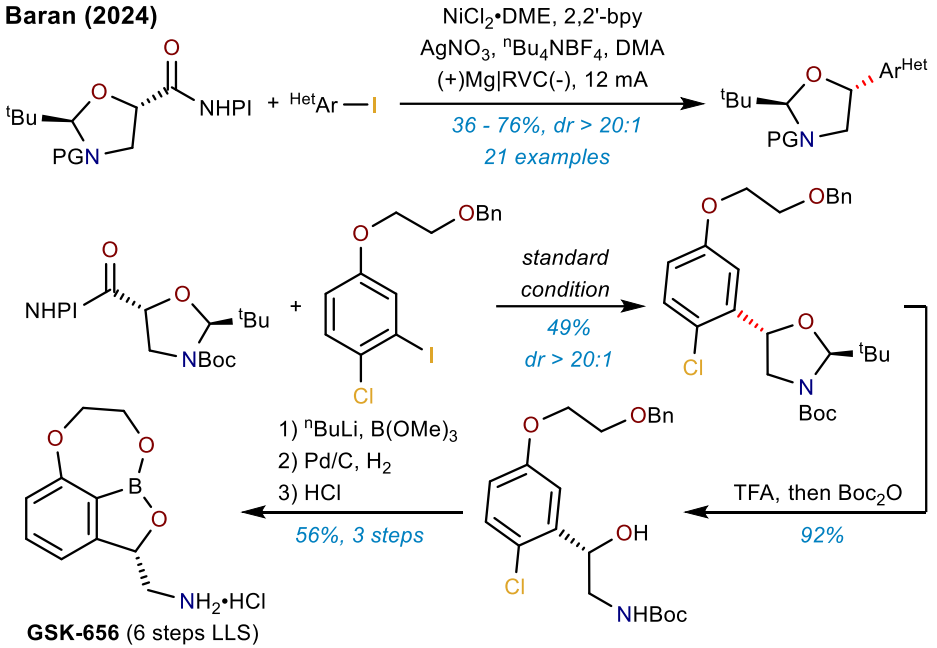
Baran, P. S. *J. Am. Chem. Soc.* **2016**, *138*, 2174. https://doi.org/10.1021/jacs.6b00250

Baran (2022)



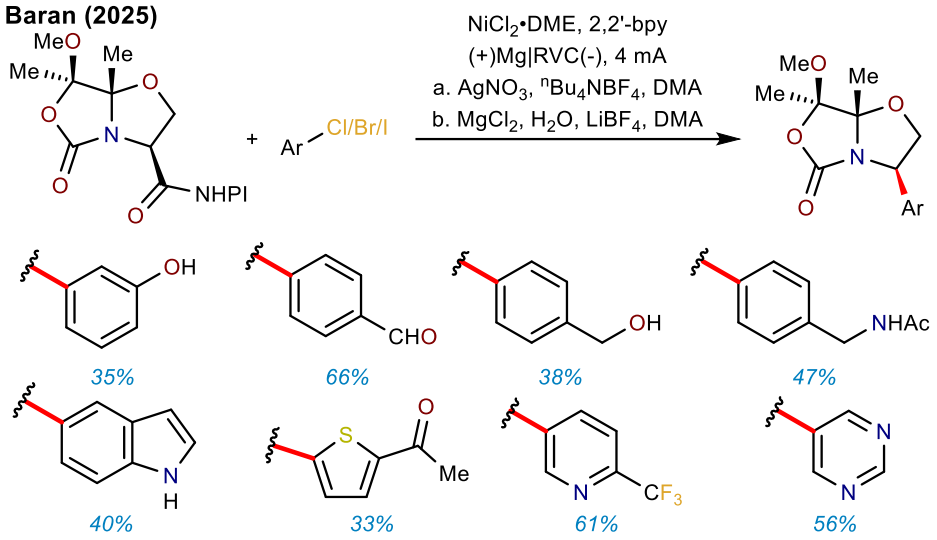
Baran, P. S. *J. Am. Chem. Soc.* **2022**, *144*, 17709. https://doi.org/10.1021/jacs.2c08006

Baran (2024)



Baran, P. S. *J. Am. Chem. Soc.* **2024**, *146*, 6209. https://doi.org/10.1021/jacs.3c14119

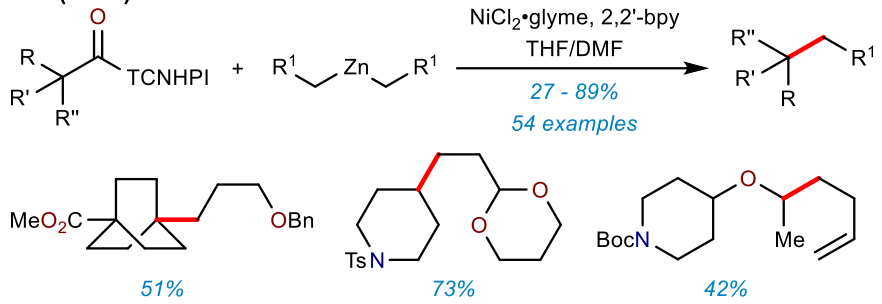
Baran (2025)



Baran, P. S. *Nat. Chem.* **2025**, *17*, 44. https://doi.org/10.1038/s41557-024-01695-7

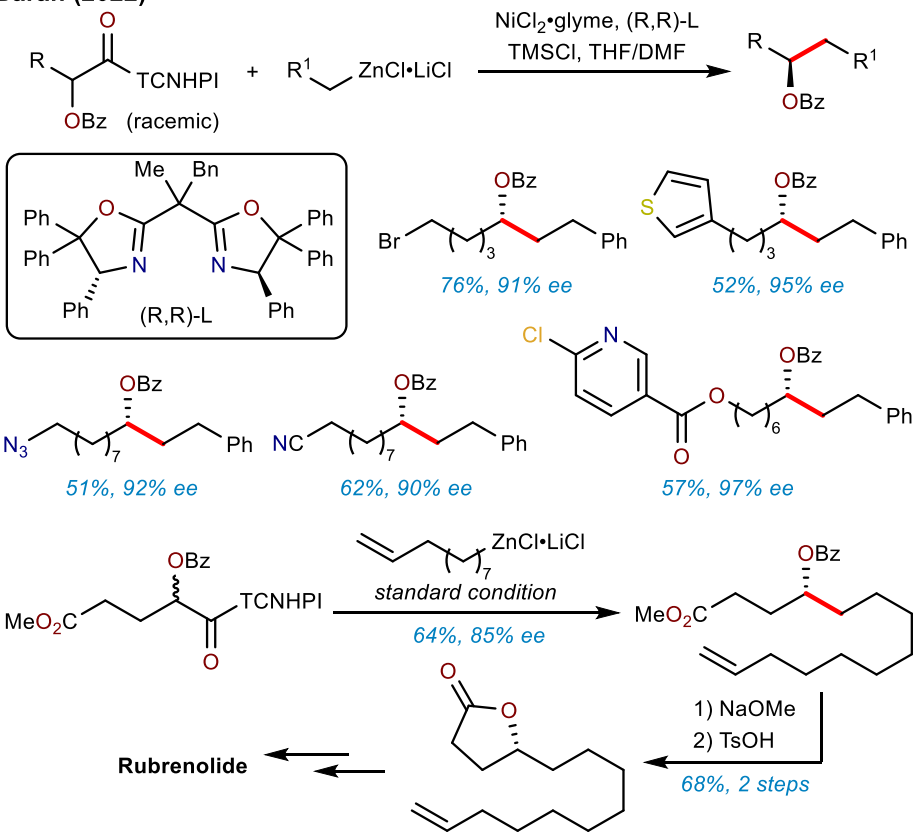
sp³ C-C Coupling

Baran (2016)



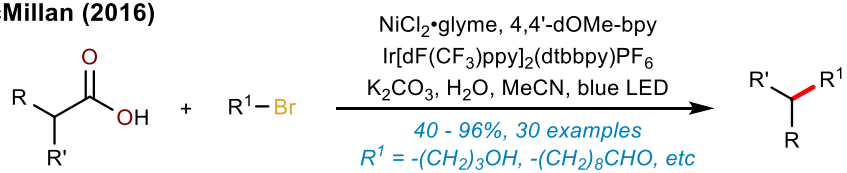
Baran, P. S. *Science.* **2016**, *352*, 801. https://doi.org/10.1126/science.aaf6123

Baran (2022)



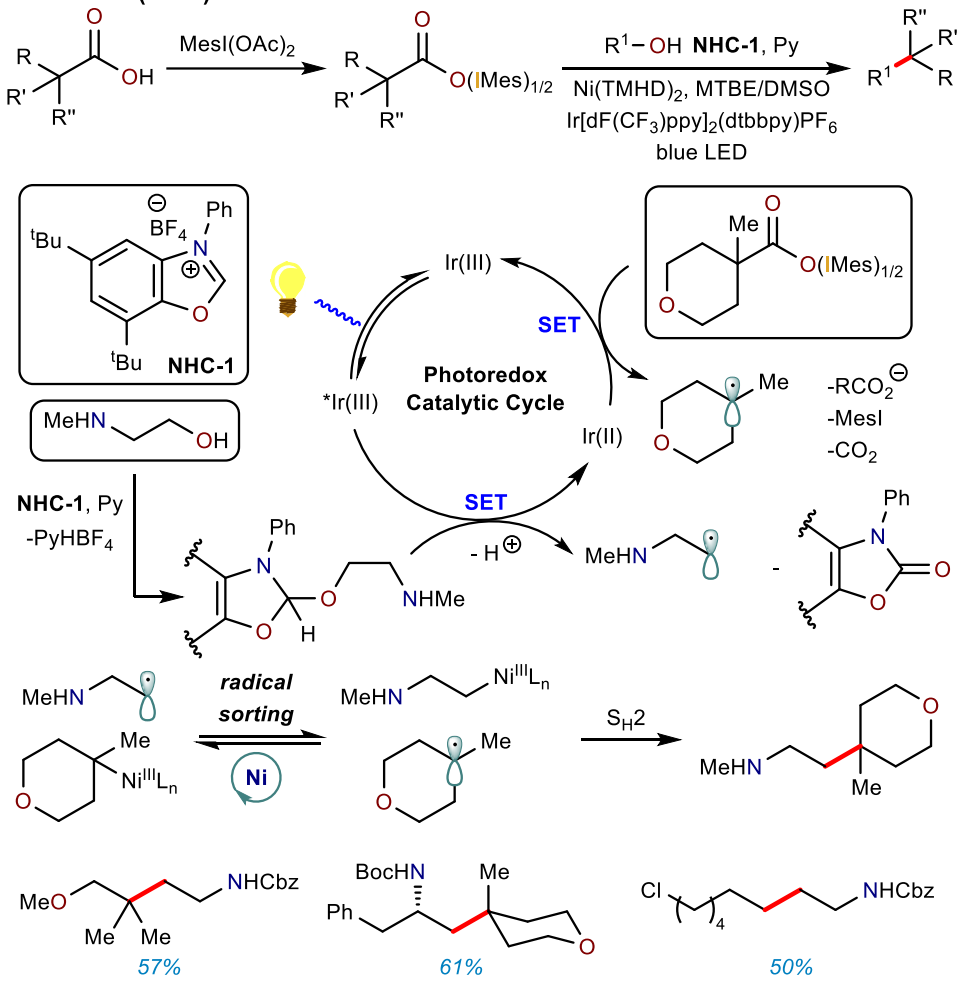
Baran, P. S. *J. Am. Chem. Soc.* **2022**, *144*, 10992. https://doi.org/10.1021/jacs.2c04358

MacMillan (2016)



MacMillan, D. W. C. *Nature.* **2016**, *536*, 322. https://doi.org/10.1038/nature19056

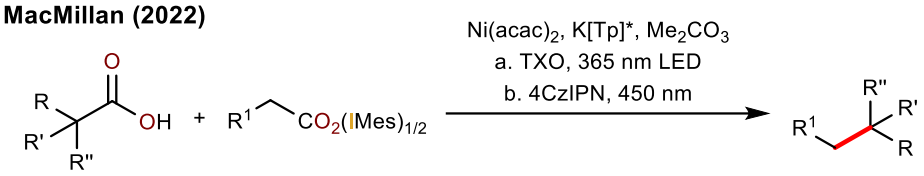
MacMillan (2022)

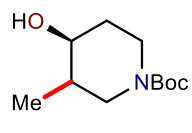


MacMillan, D. W. C. *J. Am. Chem. Soc.* **2022**, *144*, 6185. https://doi.org/10.1021/jacs.2c02062

sp^3 C-C Coupling

MacMillan (2022)





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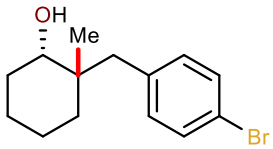
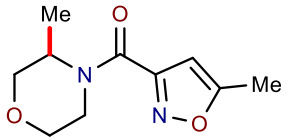


91%, 2.3:1 dr



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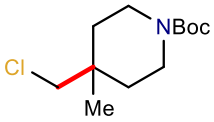

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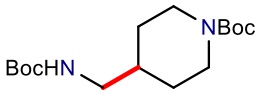

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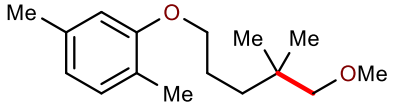

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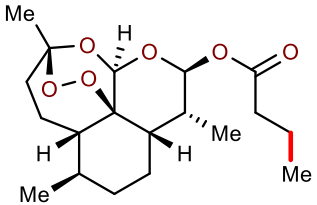
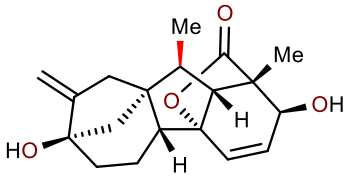


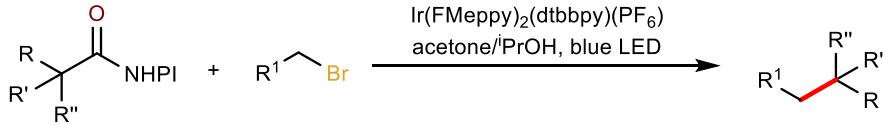
44%, from *Artesunate*



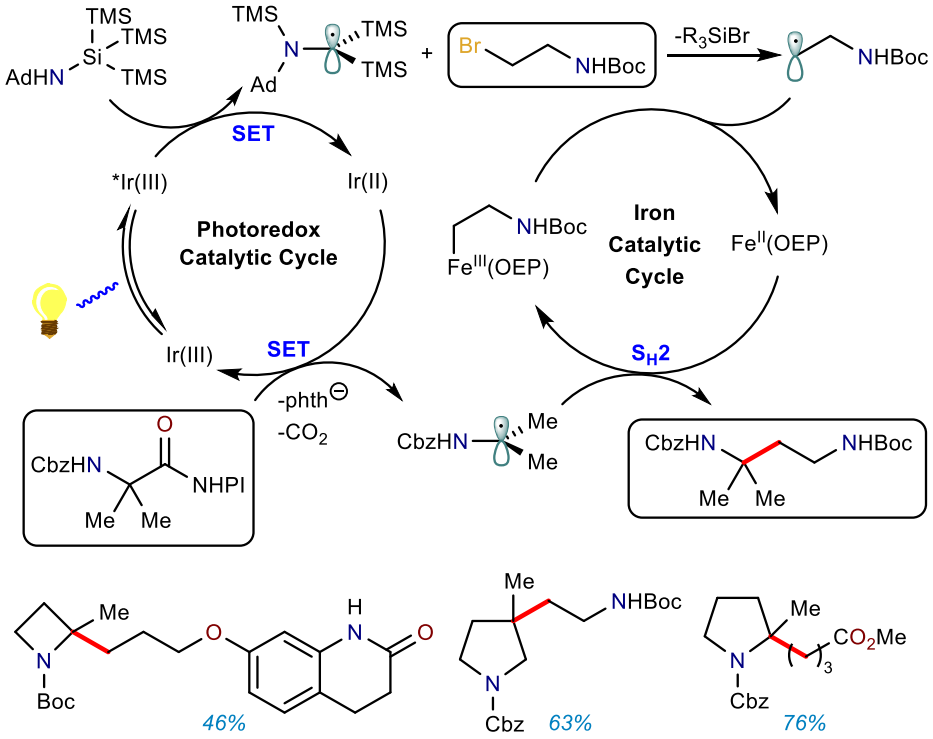
76%, 19:1 dr, from *Gibberellin A3*

MacMillan, D. W. C. *J. Am. Chem. Soc.* **2022**, *144*, 21278. https://doi.org/10.1021/jacs.2c08989

MacMillan (2021)



MacMillan, D. W. C. *Science.* **2021**, *374*, 1258. https://doi.org/10.1126/science.abl4322



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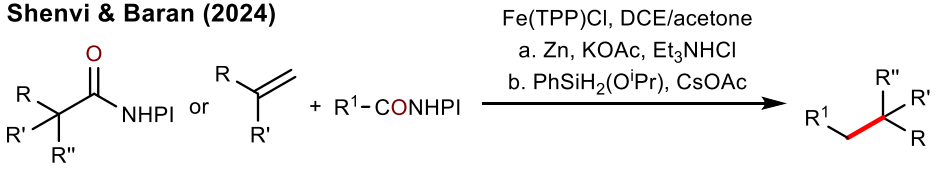
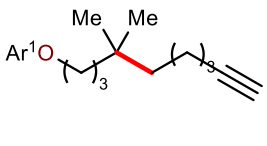
Shenvi & Baran (2024)





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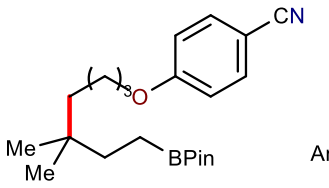

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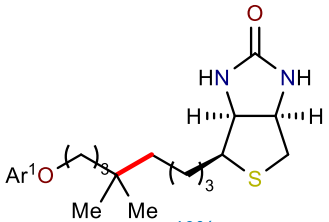

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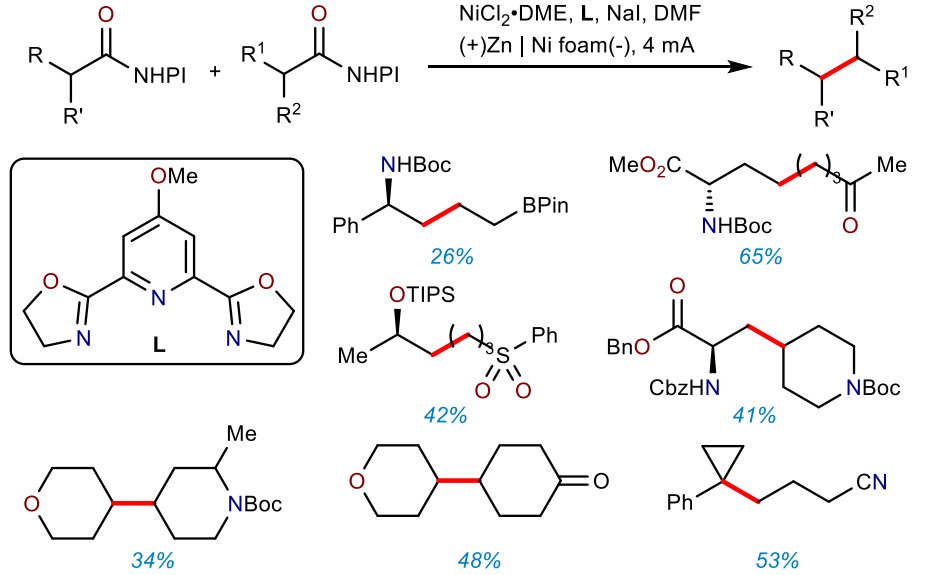
Shenvi, R.; Baran, P. S. *Science.* **2024**, *384*, 118. https://doi.org/10.1126/science.adn5619

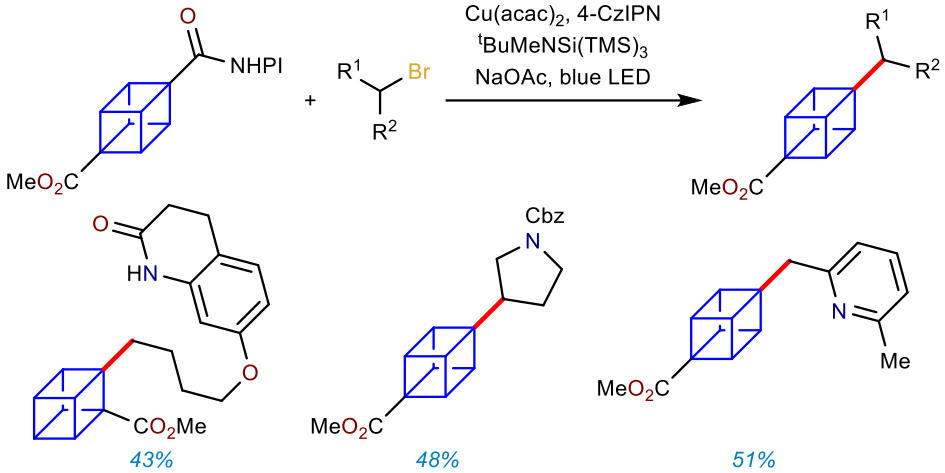
sp³ C-C Coupling

Baran (2022)



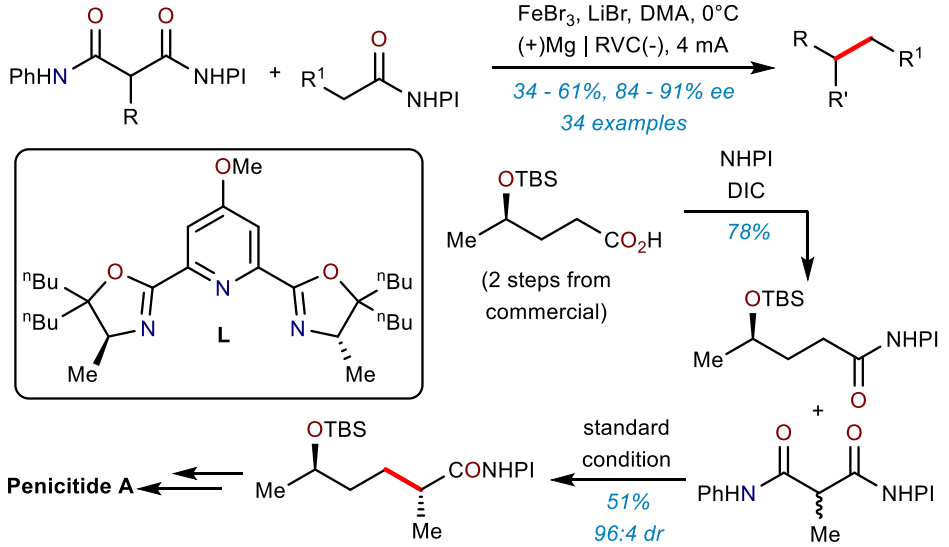
Baran, P. S. *Nature.* **2022**, *606*, 313. https://doi.org/10.1038/s41586-022-04691-4

MacMillan (2023) -- bioisosteres synthesis



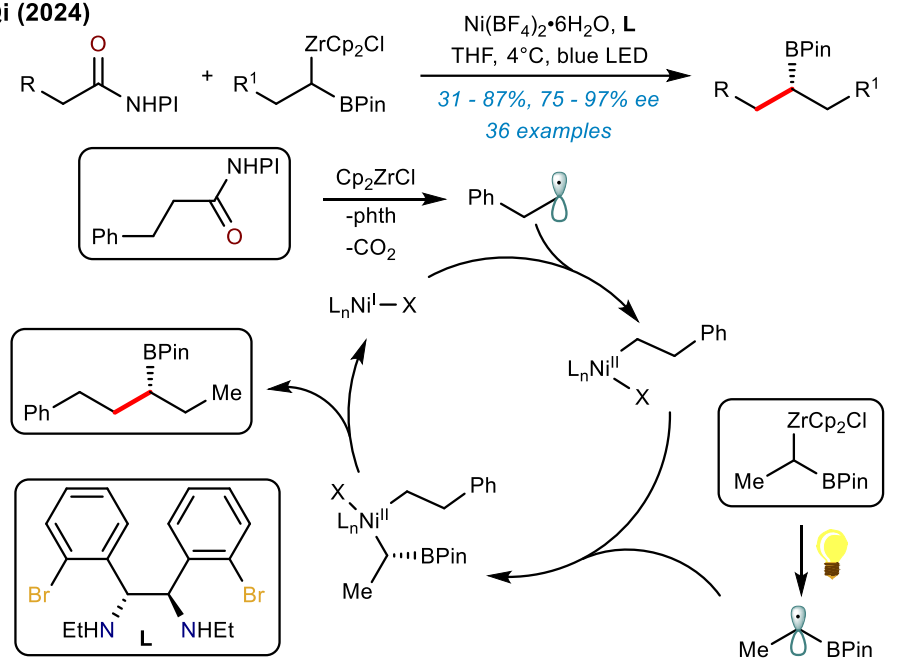
MacMillan, D. W. C. *Nature.* **2023**, *618*, 513. https://doi.org/10.1038/s41586-023-06021-8

Baran (2023)



Baran, P. S. *J. Am. Chem. Soc.* **2023**, *145*, 11518. https://doi.org/10.1021/jacs.3c03337

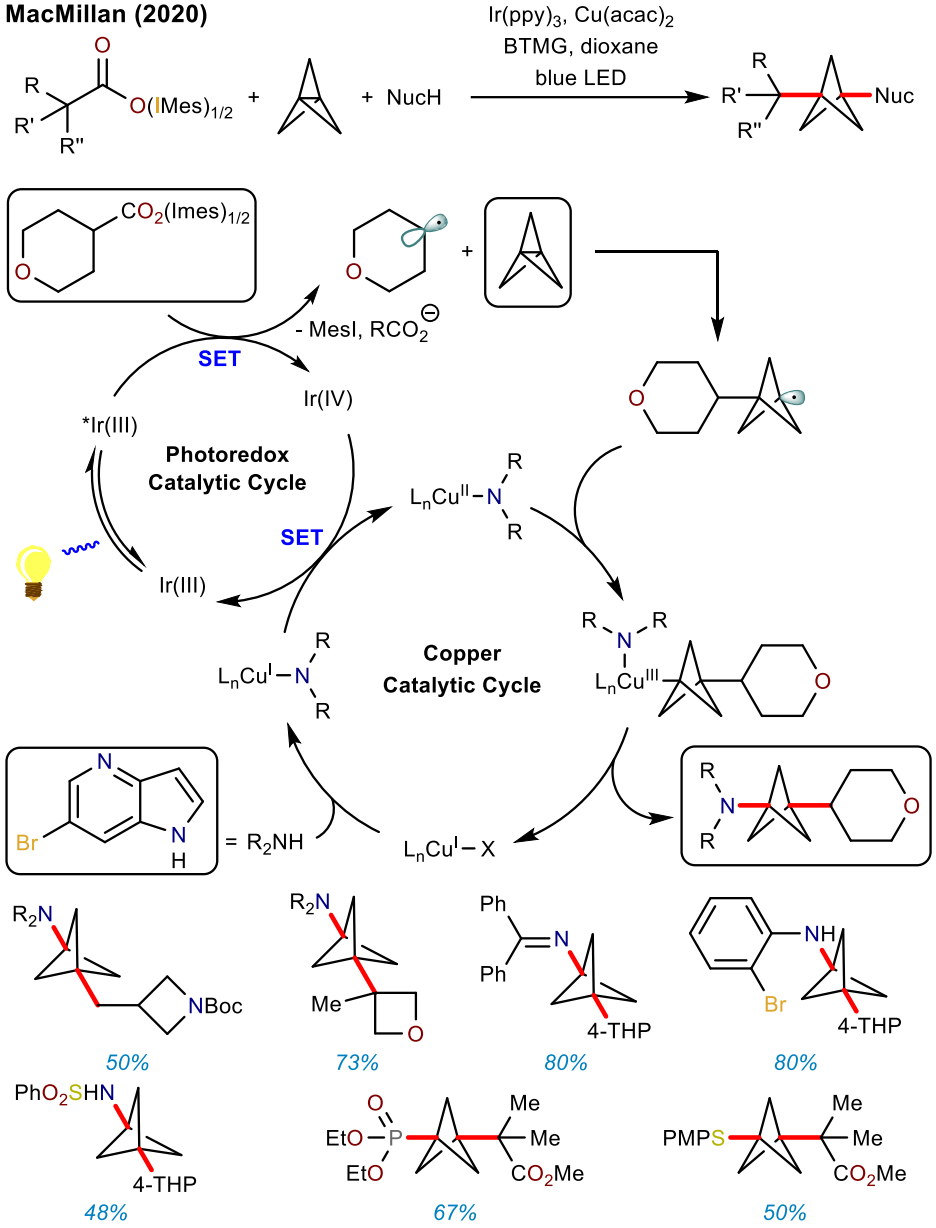
Qi (2024)



Qi, X. B. *J. Am. Chem. Soc.* **2024**, *146*, 27070. https://doi.org/10.1021/jacs.4c09245

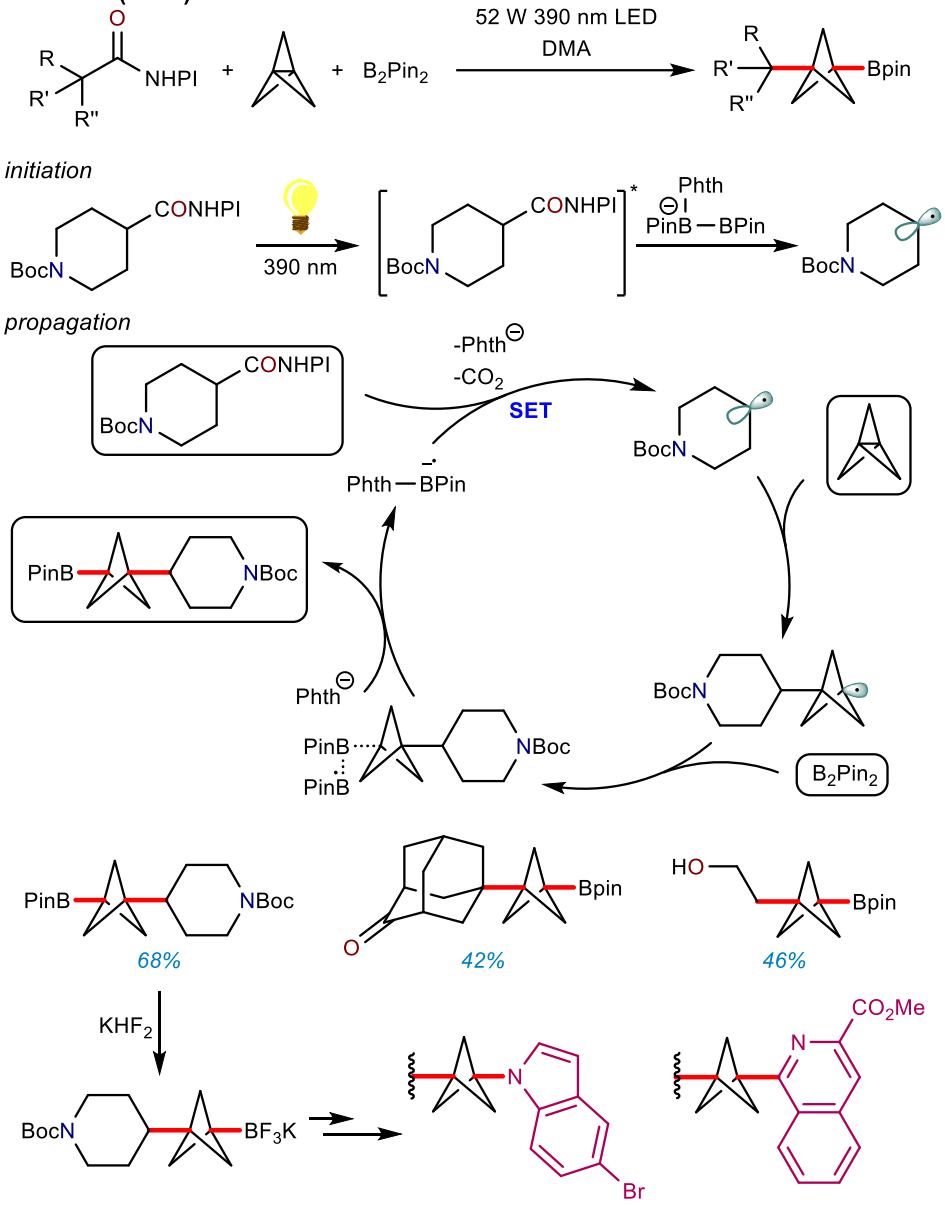
Difunctionalization

MacMillan (2020)



MacMillan, D. W. C. *Nature.* **2020**, *580*, 220. https://doi.org/10.1038/s41586-020-2060-z

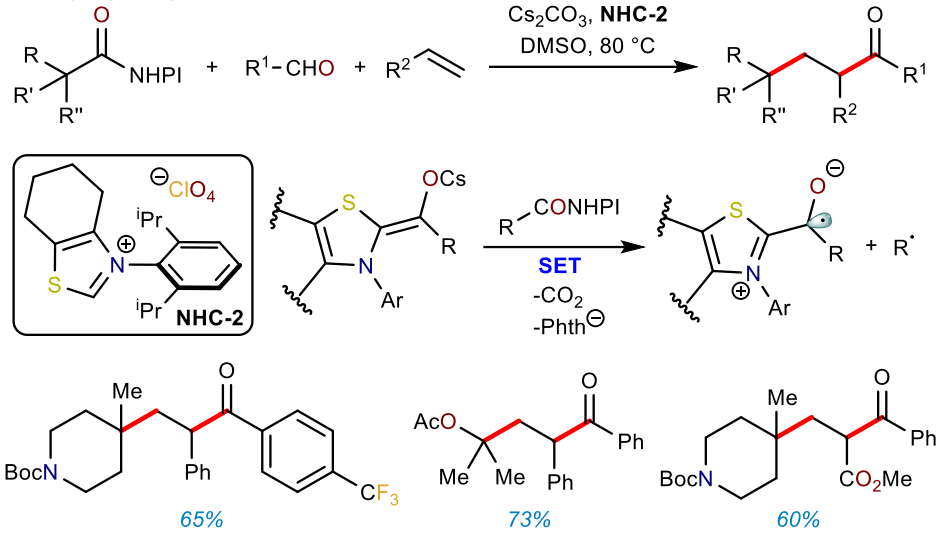
Molander(2022)



Molander, G. A. *Nat. Chem.* **2022**, *14*, 1068. https://doi.org/10.1038/s41557-022-00979-0

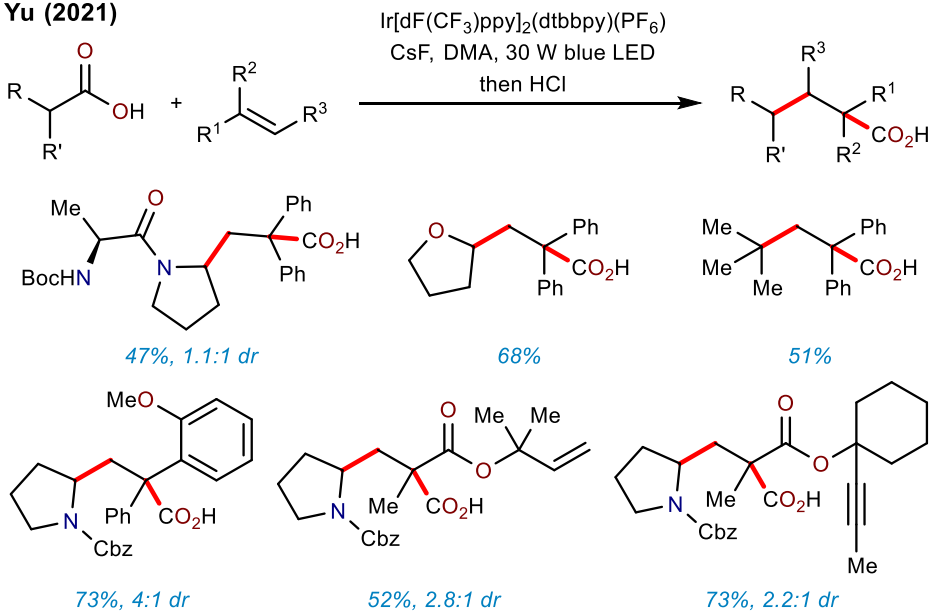
Difunctionalization

Ohmiya (2019)



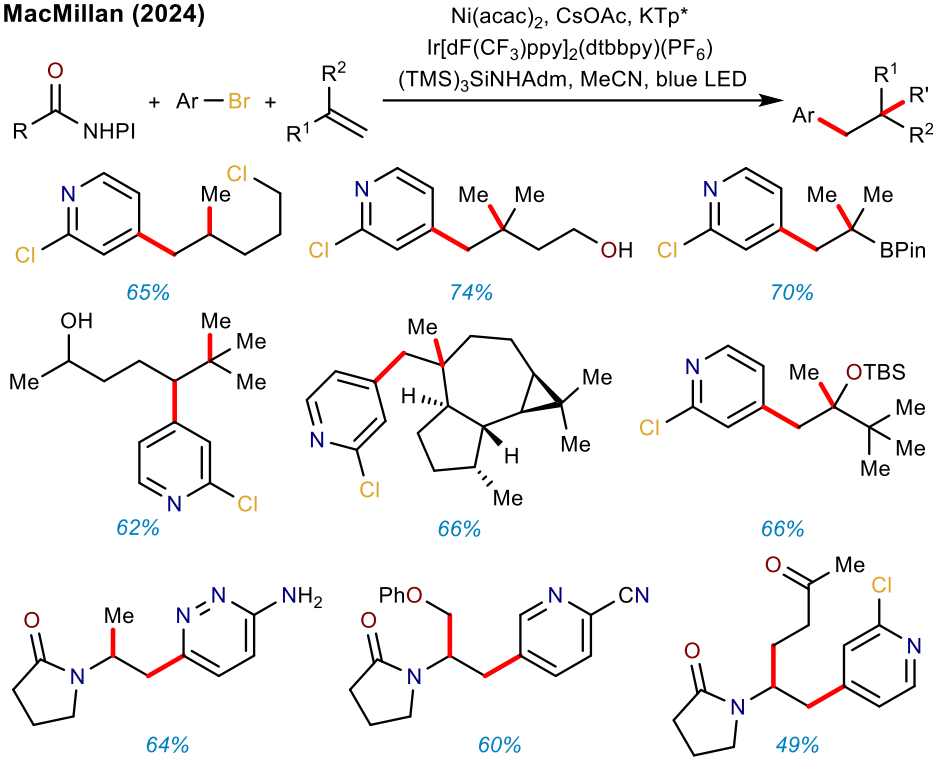
Ohmiya, H. *J. Am. Chem. Soc.* **2019**, *141*, 14073. https://doi.org/10.1021/jacs.9b07194

Yu (2021)



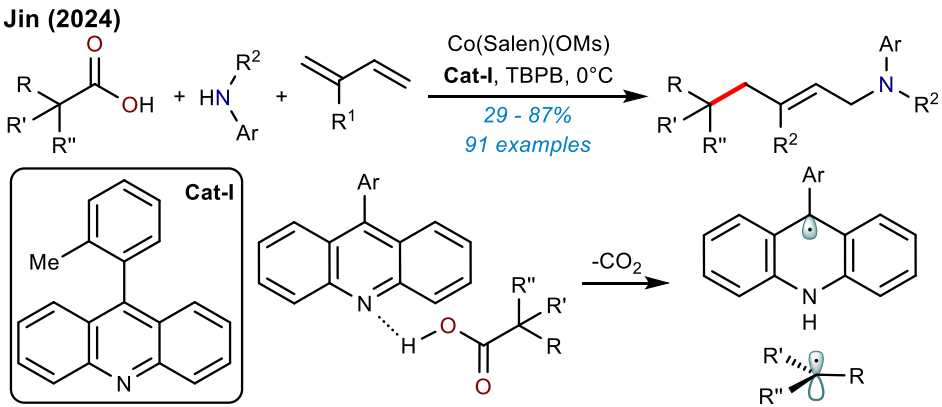
Yu, D. -G. *J. Am. Chem. Soc.* **2021**, *143*, 2812. https://dx.doi.org/10.1021/jacs.0c11896

MacMillan (2024)



Macmillan, D. W. C. *J. Am. Chem. Soc.* **2024**, *146*, 15693. https://doi.org/10.1021/jacs.4c05744

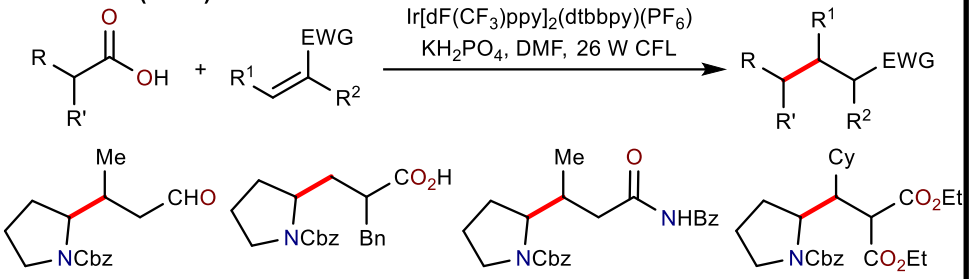
Jin (2024)



Jin, S. F. *J. Am. Chem. Soc.* **2024**, *146*, 8508. https://doi.org/10.1021/jacs.3c14828

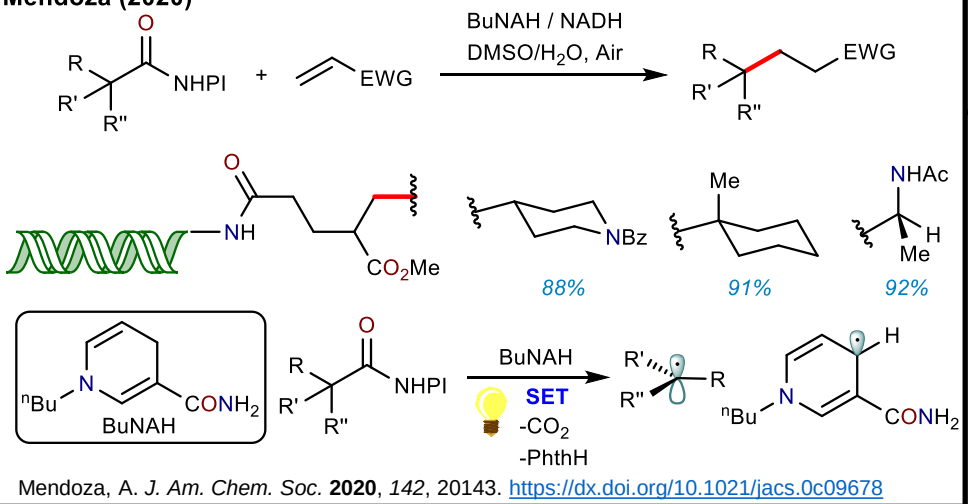
Addition to C=X Bond

MacMillan (2014)



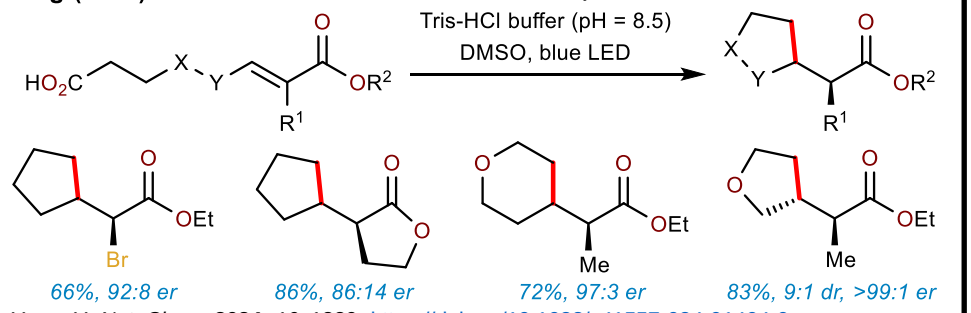
MacMillan, D. W. C. *J. Am. Chem. Soc.* **2014**, *136*, 10886. https://dx.doi.org/10.1021/ja505964r

Mendoza (2020)



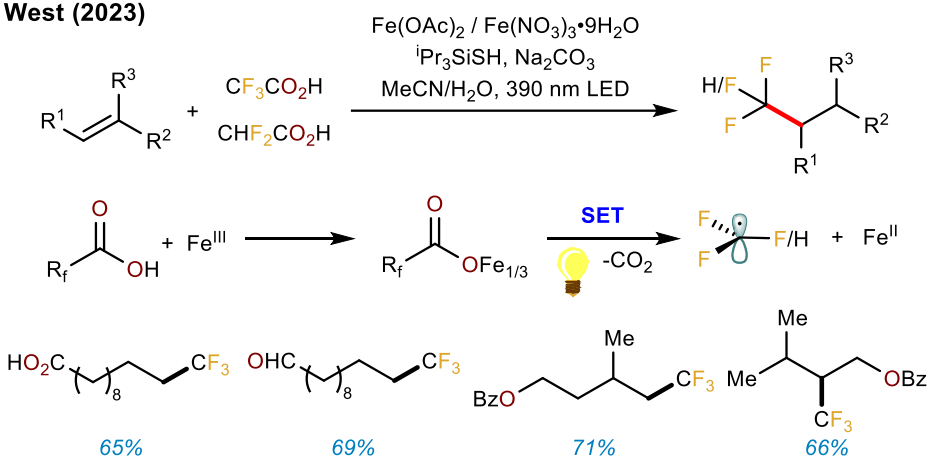
Mendoza, A. *J. Am. Chem. Soc.* **2020**, *142*, 20143. https://dx.doi.org/10.1021/jacs.0c09678

Yang (2024)



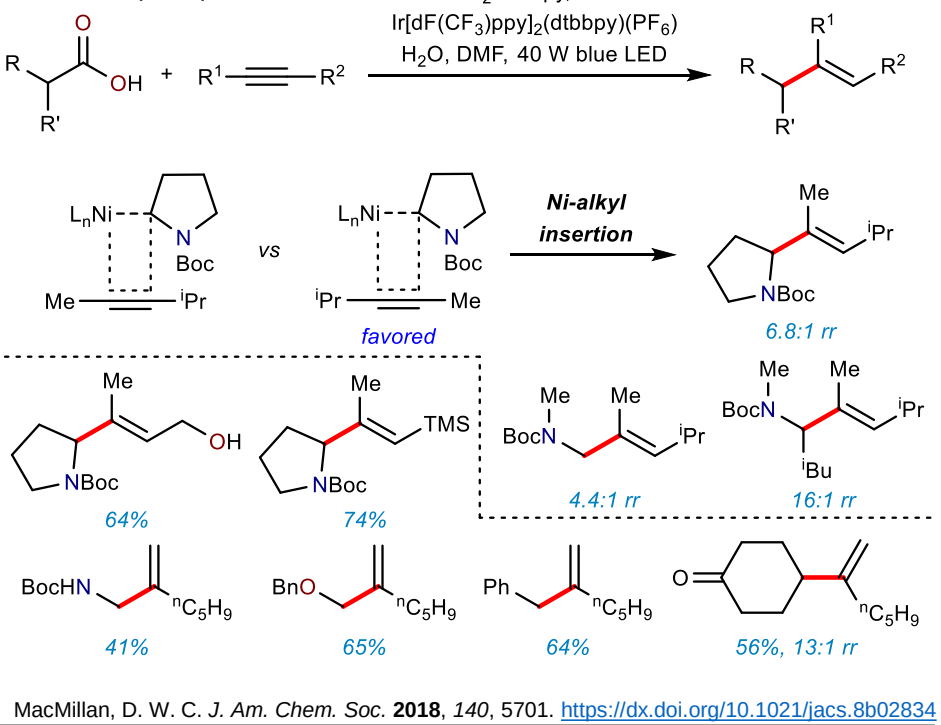
Yang, Y. *Nat. Chem.* **2024**, *16*, 1339. https://doi.org/10.1038/s41557-024-01494-0

West (2023)



West, J. G. *Nat. Chem.* **2023**, *15*, 1683. https://doi.org/10.1038/s41557-023-01365-0

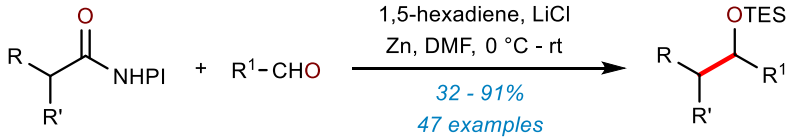
MacMillan (2018)



MacMillan, D. W. C. *J. Am. Chem. Soc.* **2018**, *140*, 5701. https://dx.doi.org/10.1021/jacs.8b02834

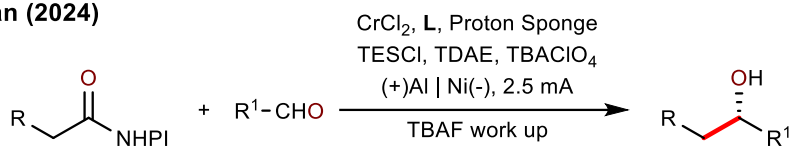
Addition to C=X Bond

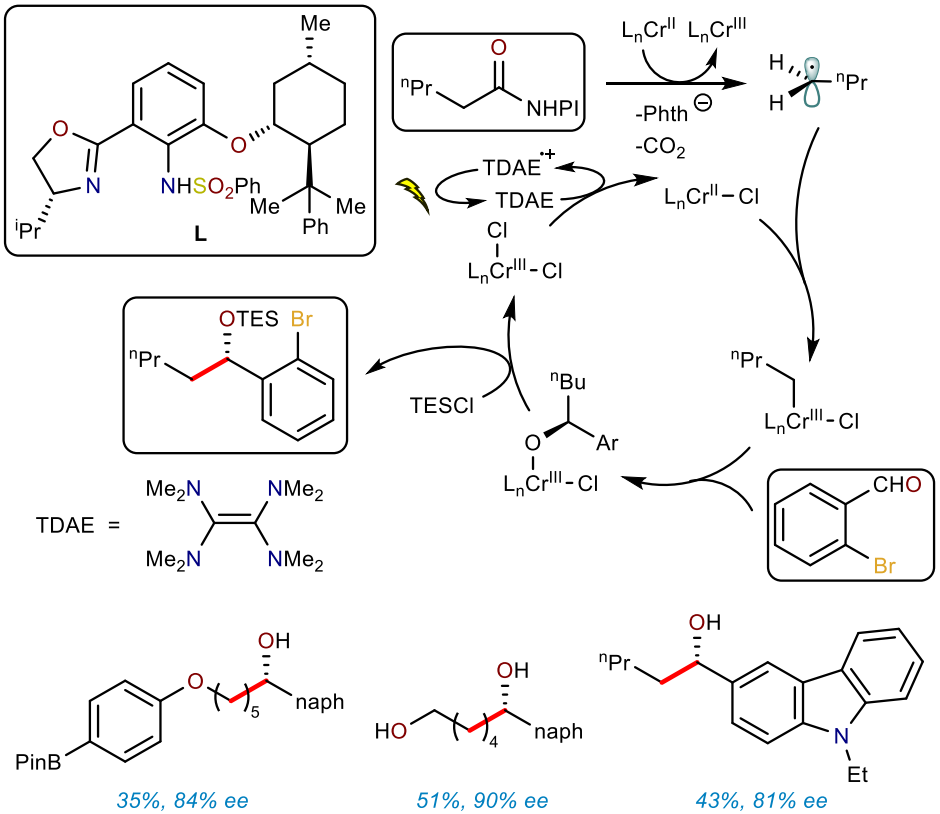
Montgomery (2021)



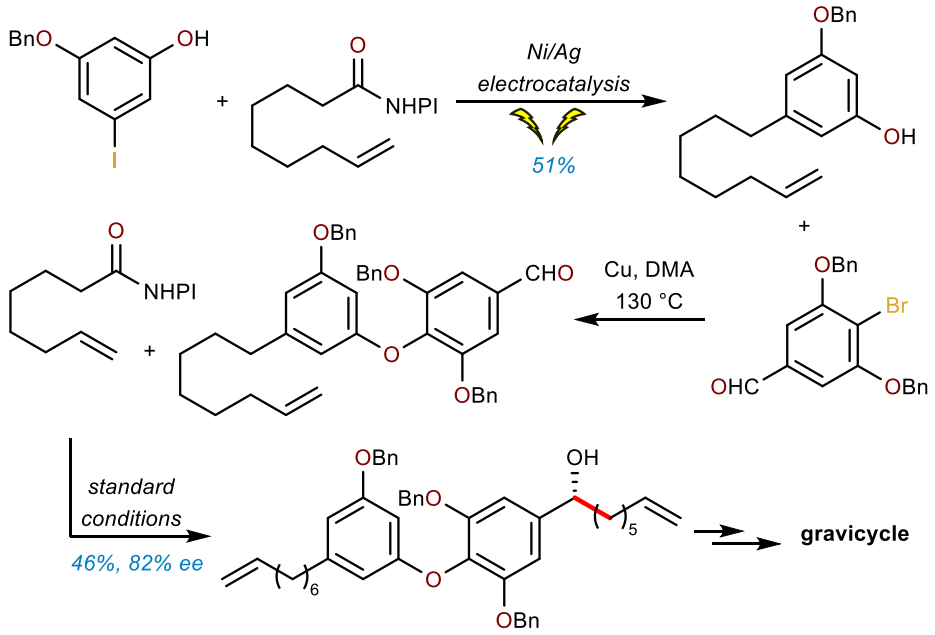
Montgomery, J. *J. Am. Chem. Soc.* **2021**, *143*, 21234. https://doi.org/10.1021/jacs.1c11170

Baran (2024)

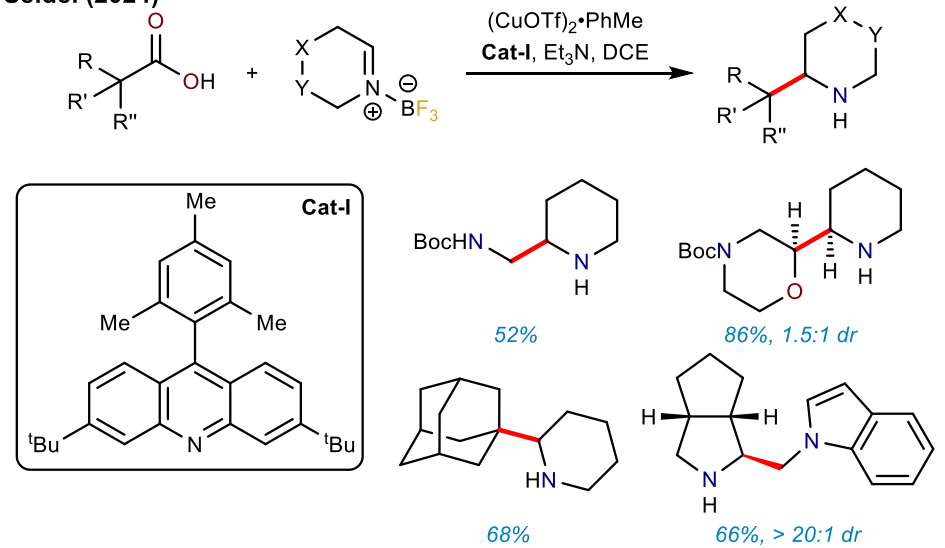




Baran, P. S. *J. Am. Chem. Soc.* **2024**, *146*, 4872. https://doi.org/10.1021/jacs.3c13442



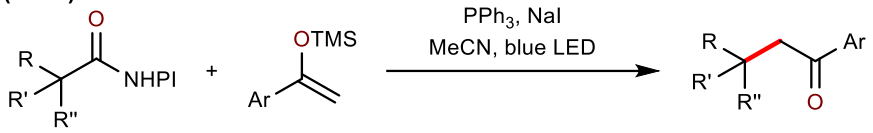
Seidel (2024)

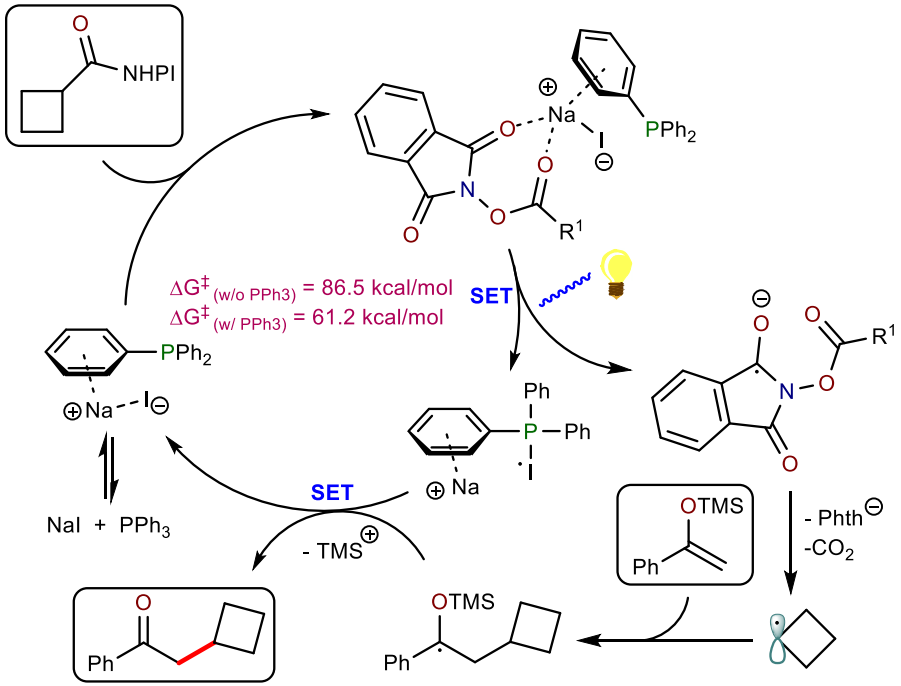


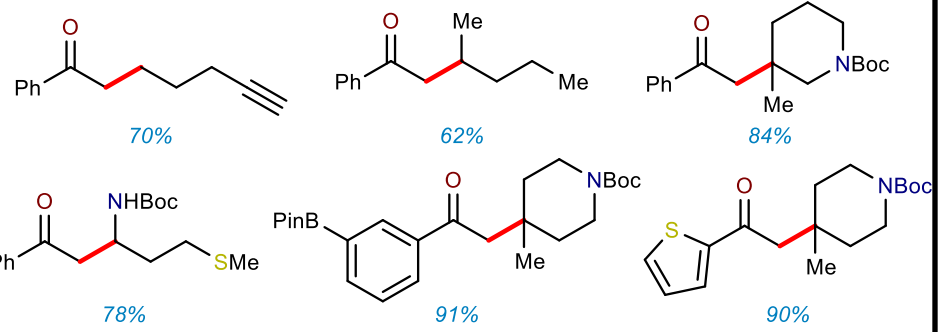
Seidel, D. *J. Am. Chem. Soc.* **2024**, *146*, 26331. https://doi.org/10.1021/jacs.4c08754

Miscellaneous Examples

Fu (2019)

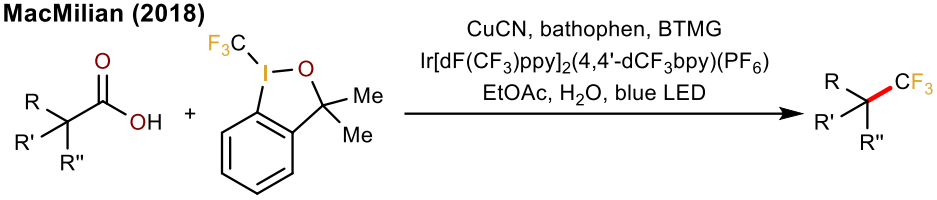


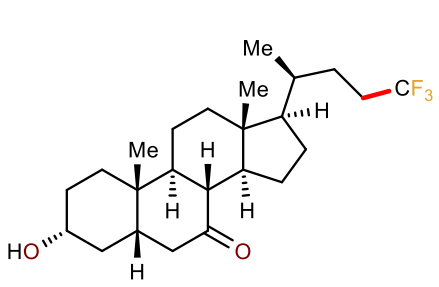




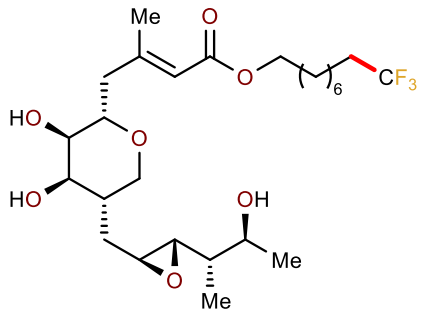
Fu, Y. *Science.* **2019**, *363*, 1429. https://doi.org/10.1126/science.aav3200

MacMilian (2018)





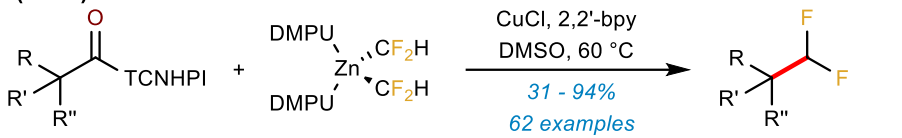
from nutriacholic acid, 71%



from mupirocin, 45%

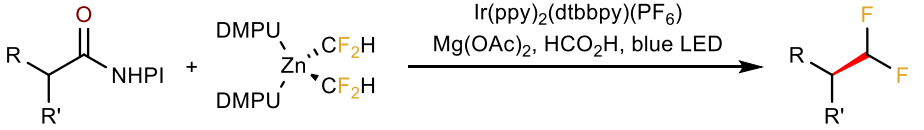
MacMillan, D. W. C. *J. Am. Chem. Soc.* **2018**, *140*, 6522. https://dx.doi.org/10.1021/jacs.8b02650

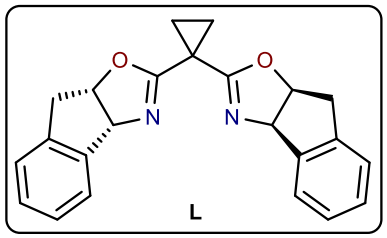
Liu (2019)

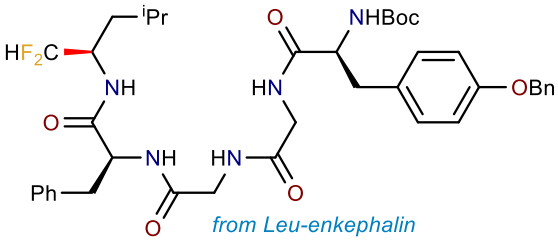


Liu, W. *J. Am. Chem. Soc.* **2019**, *141*, 11389. https://dx.doi.org/10.1021/jacs.9b05363

Liu (2024)







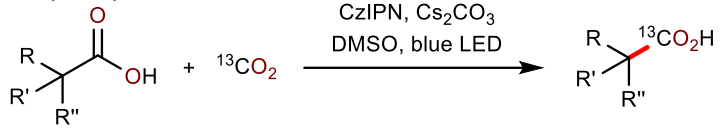
from Leu-enkephalin

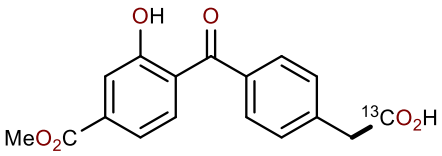
38%, 98:2 dr

Liu, W. *J. Am. Chem. Soc.* **2024**, *146*, 29297. https://dx.doi.org/10.1021/jacs.4c11257

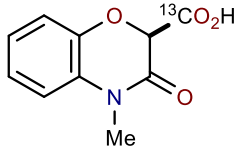
Miscellaneous Examples

Lundgren (2021)

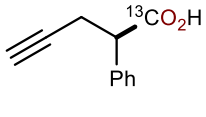




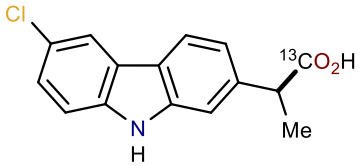
59%, 38% ^{13}C



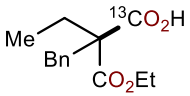
24%, 90% ^{13}C



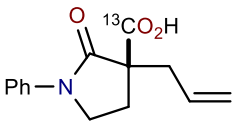
72%, 21% ^{13}C



60%, 71% ^{13}C



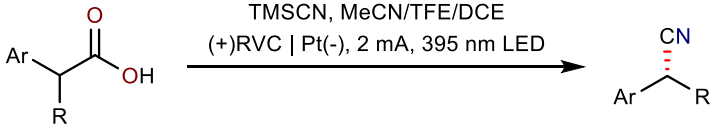
71%, 70% ^{13}C

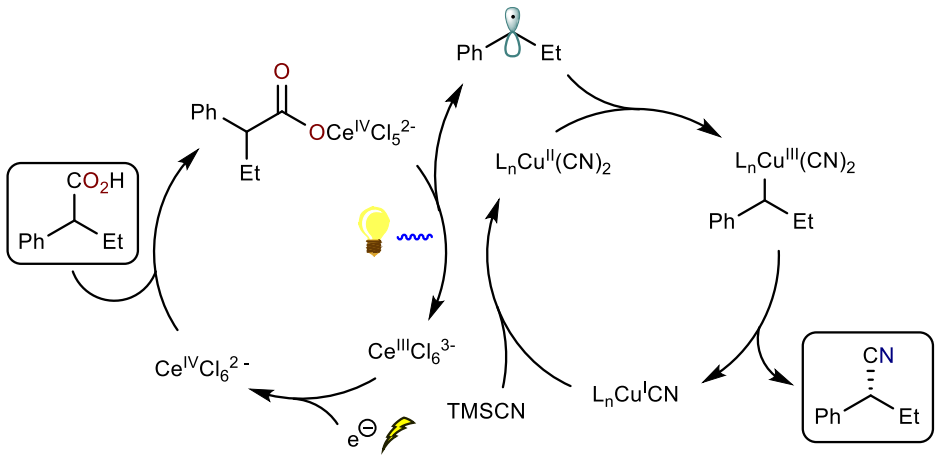


60%, 74% ^{13}C

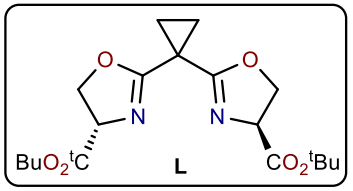
Lundgren, R. J. *J. Am. Chem. Soc.* **2021**, *143*, 2200. https://dx.doi.org/10.1021/jacs.0c12819

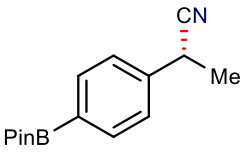
Xu (2022)



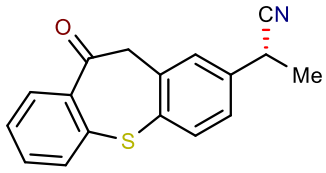


Xu, H. -C. *J. Am. Chem. Soc.* **2022**, *144*, 20201. https://doi.org/10.1021/jacs.2c09050

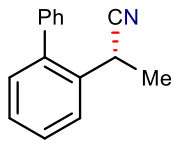




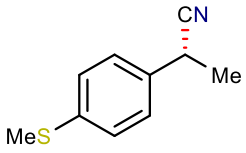
73%, 93% ee



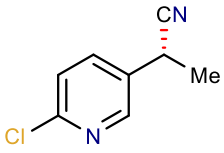
35%, 86% ee
from zaltoprofen



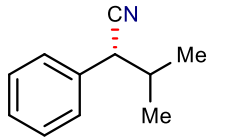
76%, 80% ee



61%, 90% ee

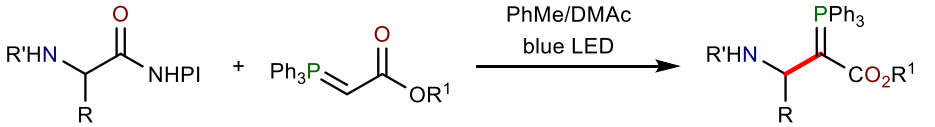


91%, 81% ee



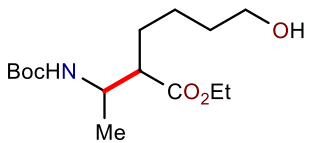
68%, 92% ee

Maruoka (2024)

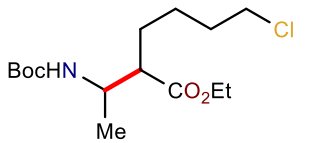


divergent transformations

alkylation
alkene, Ir(PPy)$_3$
C_6F_5SH, ascorbic acid
MeCN/H_2O, blue LED

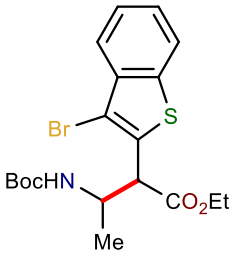


43%, 1.1:1 dr

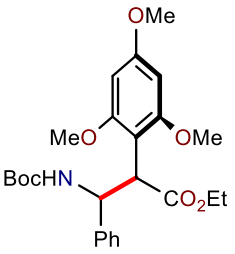


84%, 2.1:1 dr

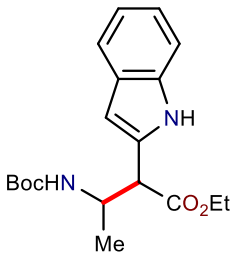
arylation
arene, Ir(PPy)$_3$, HBF_4
MeCN/H_2O, blue LED



81%, 1.1:1 dr



55%, 1.1:1 dr



63%, 1.2:1 dr

Maruoka, K. *J. Am. Chem. Soc.* **2024**, *146*, 35478. https://doi.org/10.1021/jacs.4c14860