



Connection to UN SDGs

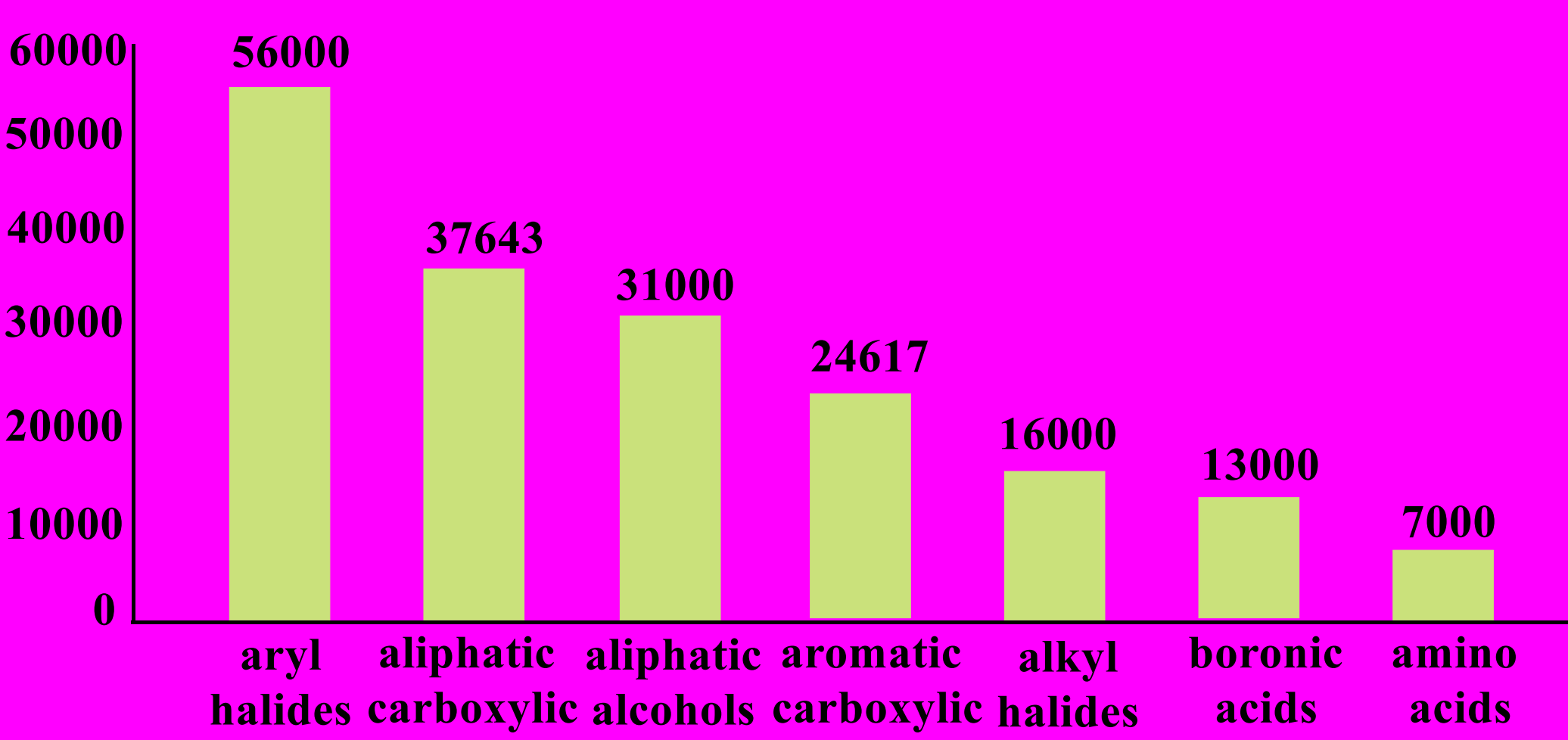
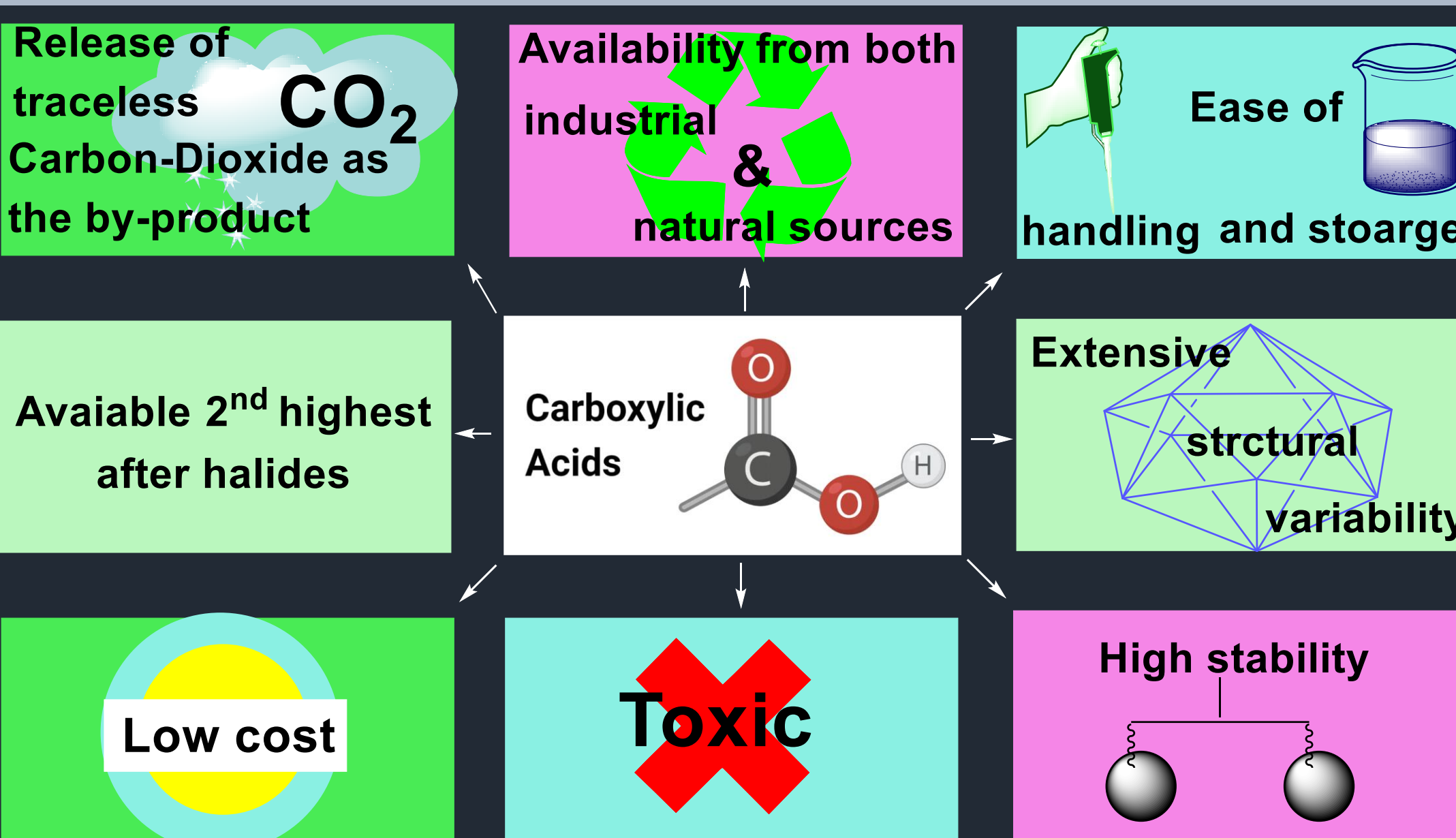


SDG 7: Decarboxylative cross-coupling strategies promote Sustainable Development Goal (SDG) 7 by enabling energy-efficient chemical transformations using renewable inputs like photochemistry and electrochemistry.
SDG 12: They also support SDG 12 by utilizing renewable carboxylic acids, reducing waste and hazardous byproducts, and minimizing reliance on unsustainable reagents, thereby fostering greener production practices.

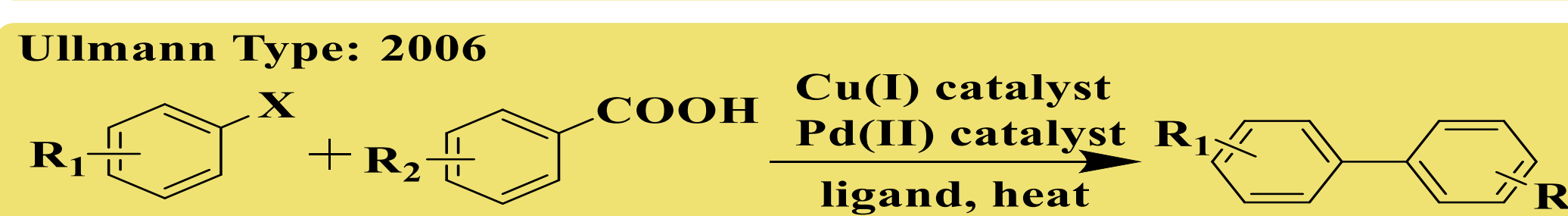
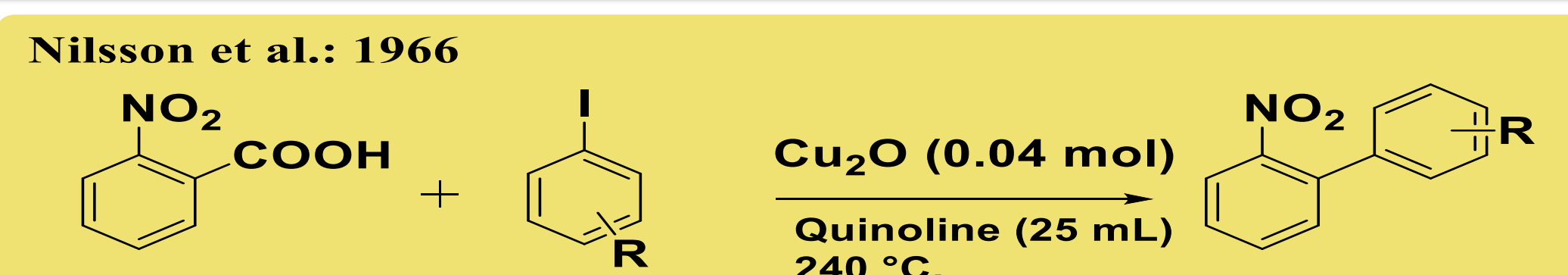
Abstract:

The selection of materials and catalysts is crucial for achieving sustainable processes. Carboxylic acids, which are abundant, stable, and ideally biobased feedstocks, can be considered as attractive platforms towards a range of functionalized molecules. Decarboxylative cross-coupling reactions have emerged as a powerful and sustainable strategy in modern synthetic organic chemistry, enabling efficient and sustainable formation of C–C and C–X bonds through the extrusion of carbon-dioxide from carboxylic acids. This method offers a green alternative to traditional cross-coupling reactions by avoiding the use of prefunctionalized substrates such as halides or organometallic reagents. Recent advances in transition-metal catalysis, photoredox and electrochemical approaches has significantly expanded the scope of decarboxylative couplings reactions, allowing for the efficient construction of complex molecules under mild conditions.

Why Carboxylic acids?



Transition metal-catalyzed Decarboxylation



Some Selected Examples:

Transition metal catalysed decarboxylation :

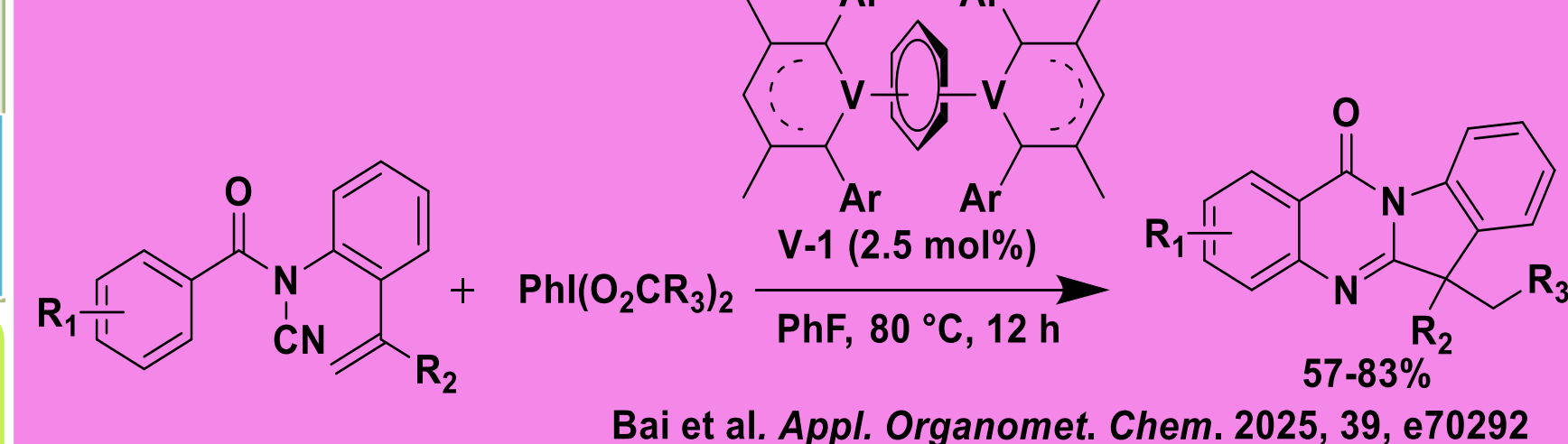
Scandium catalysed decarboxylation:



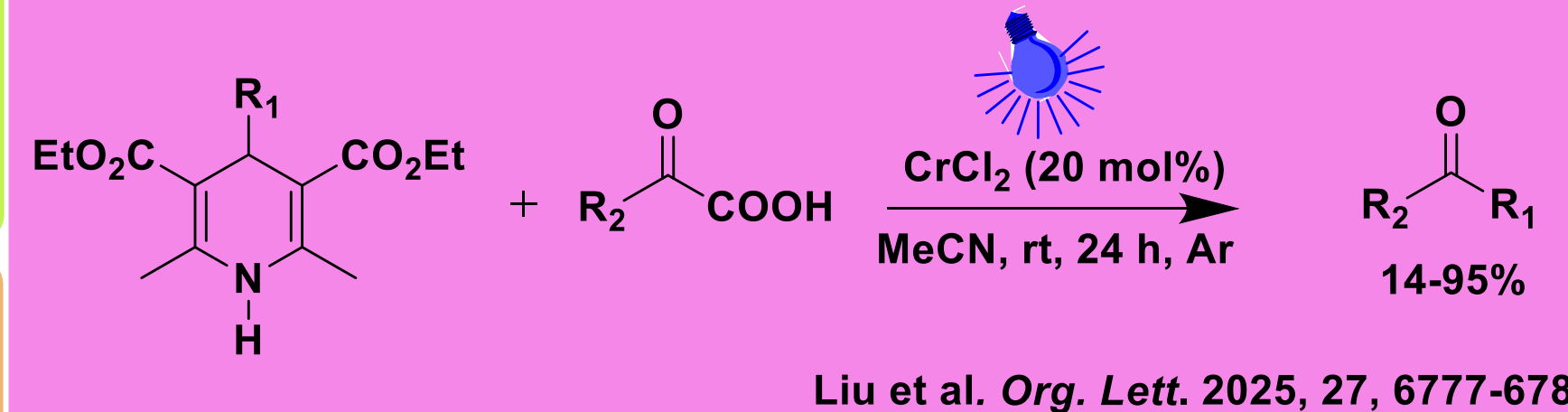
Titanium catalysed decarboxylation:



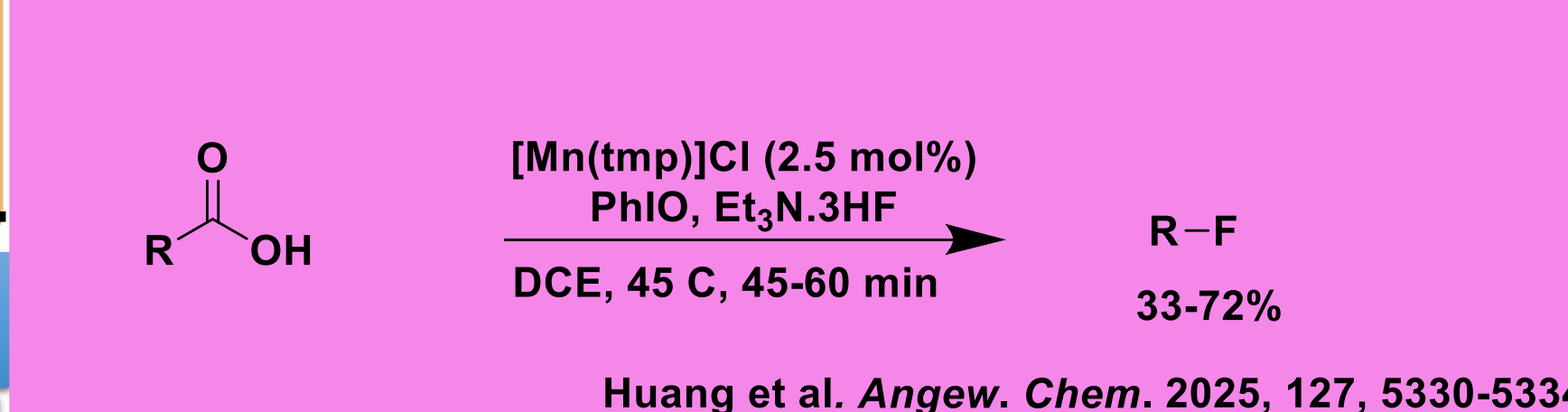
Vanadium catalysed decarboxylation:



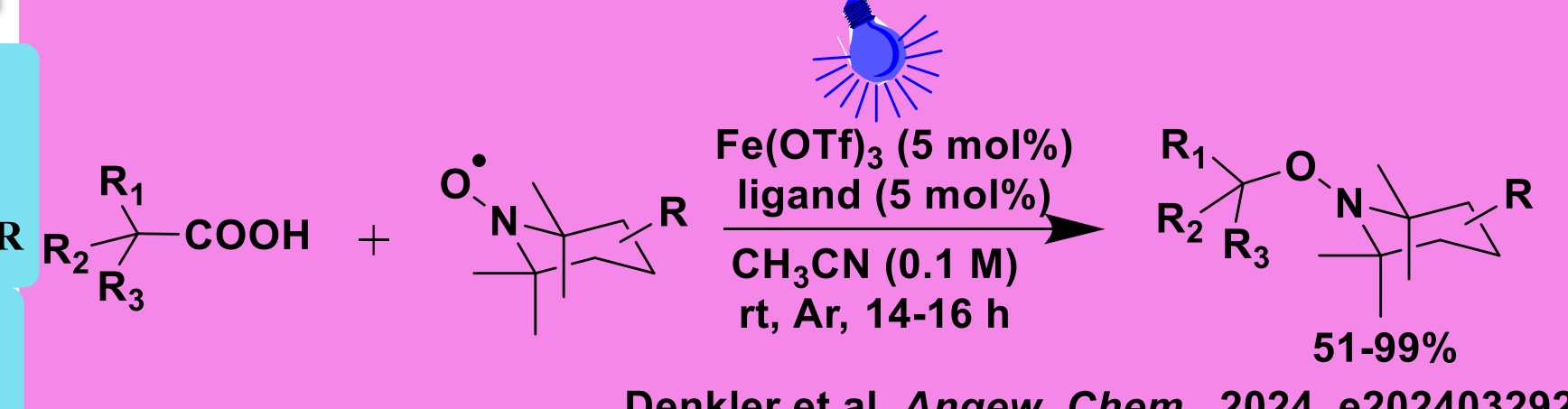
Chromium catalysed decarboxylation:



Manganese catalysed decarboxylation:



Iron catalysed decarboxylation:



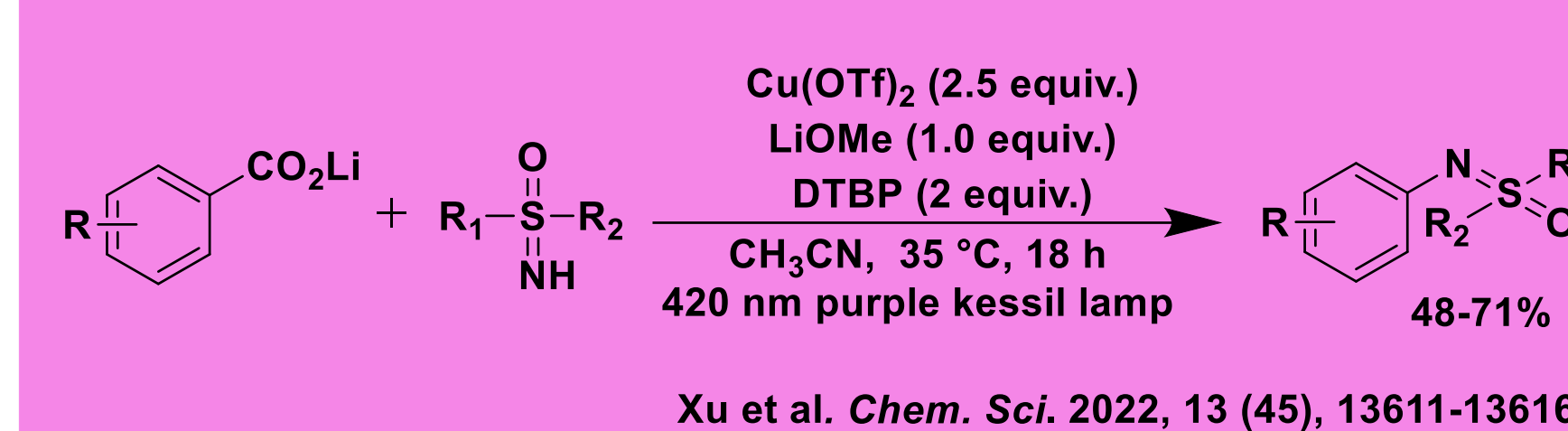
Cobalt catalysed decarboxylation:



Nickel catalysed decarboxylation:



Cooper catalysed decarboxylation:



Zinc catalysed decarboxylation:

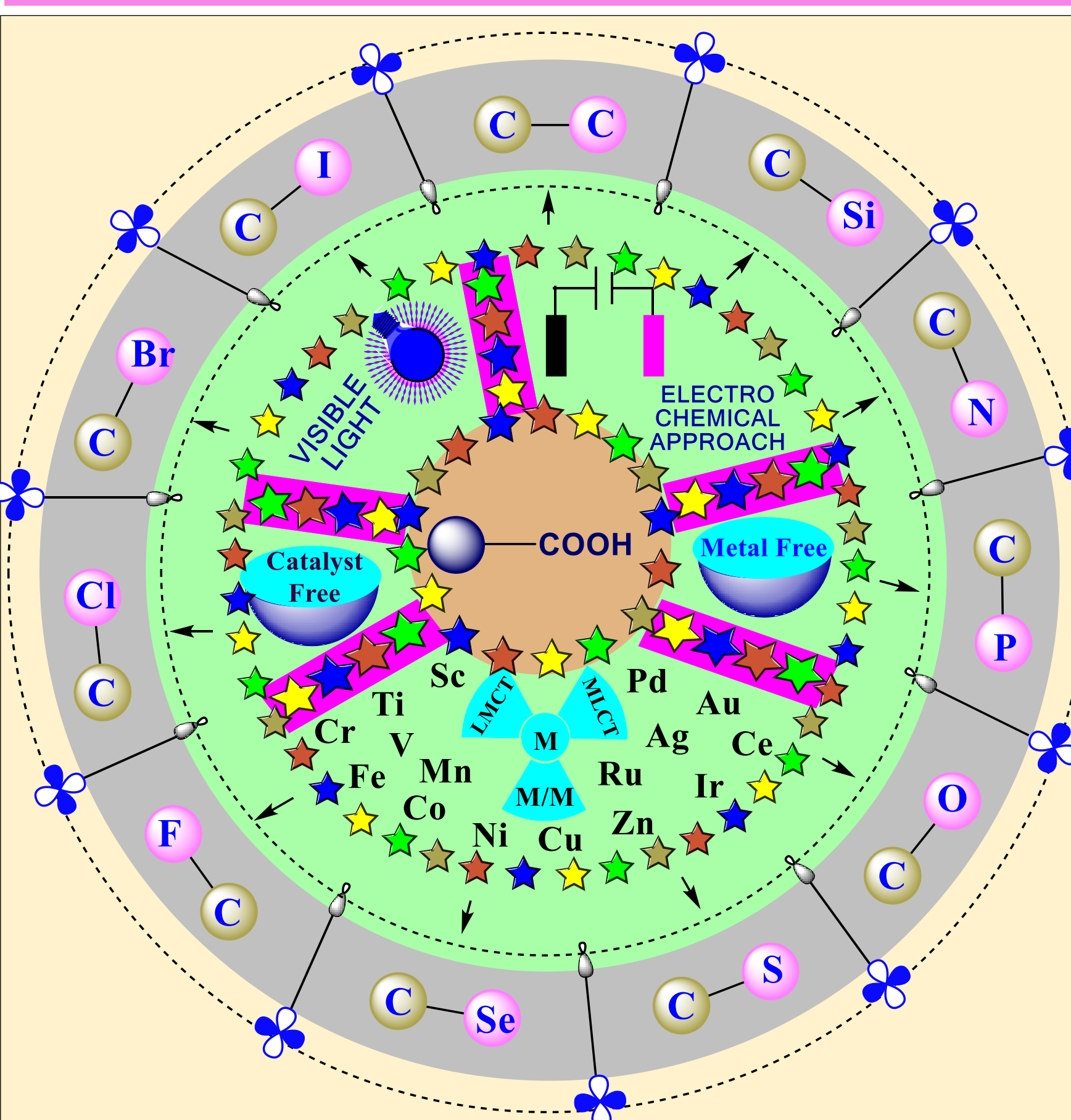
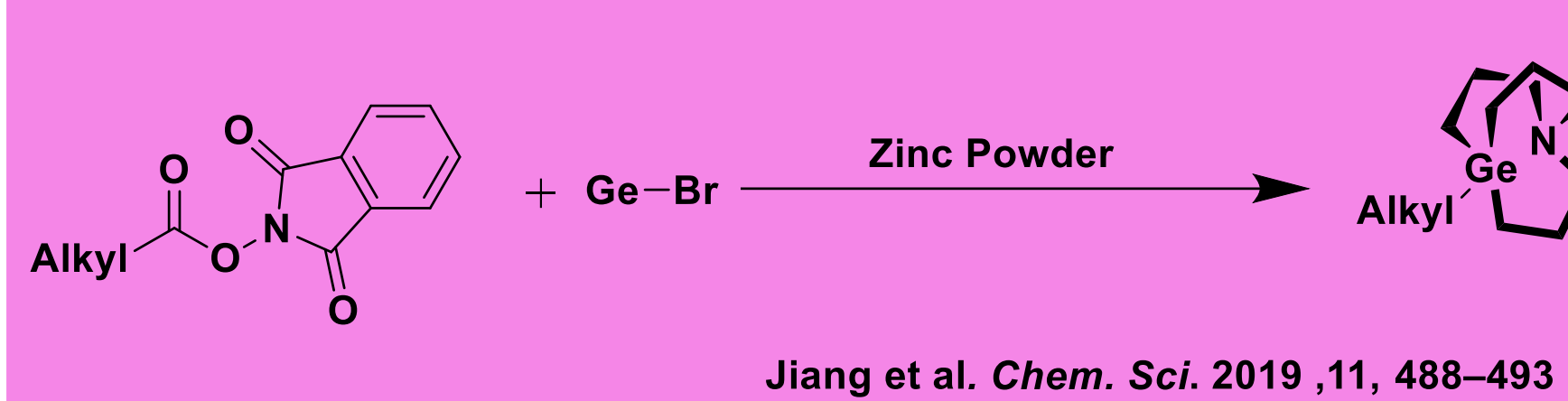
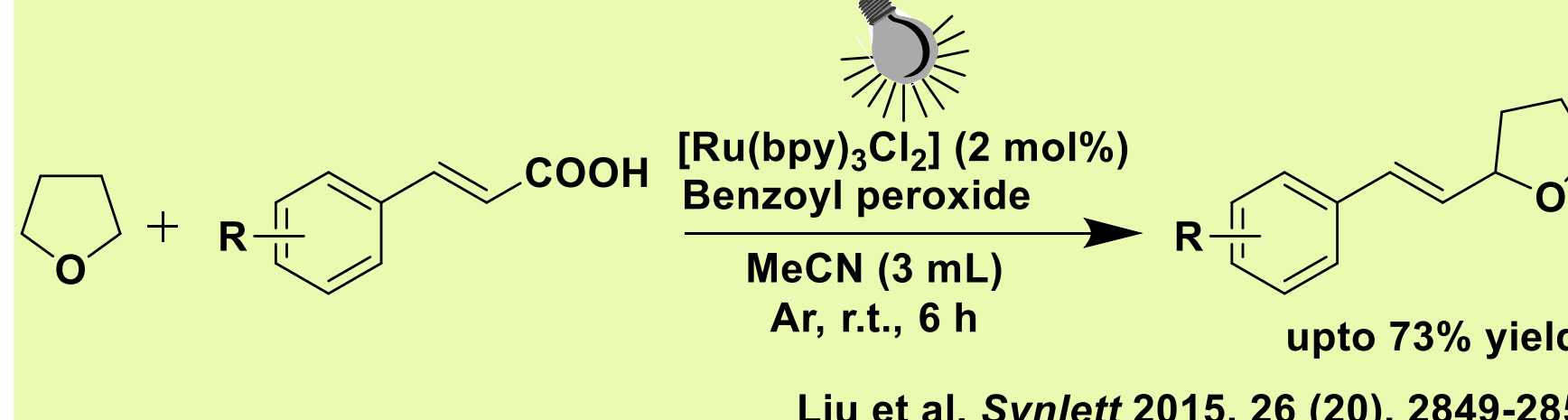
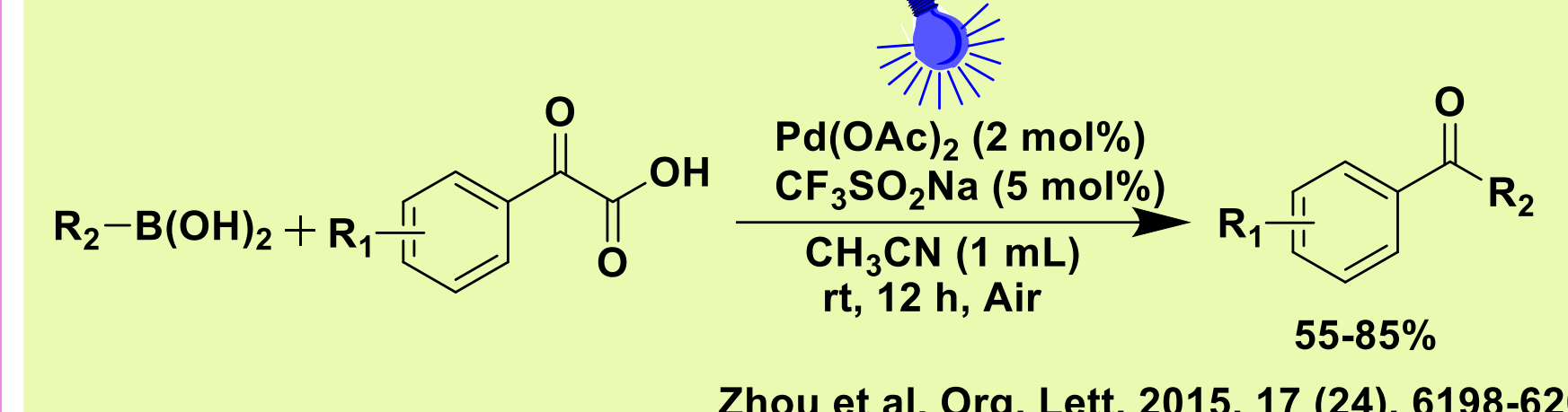


Fig 2. Decarboxylative Functionalization

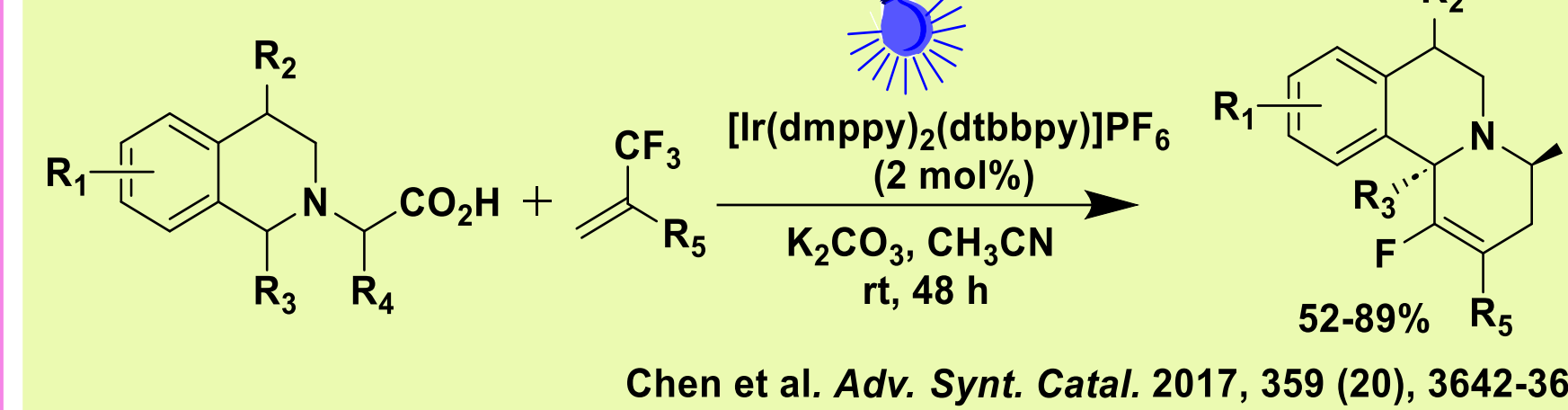
Ruthenium catalysed decarboxylation:



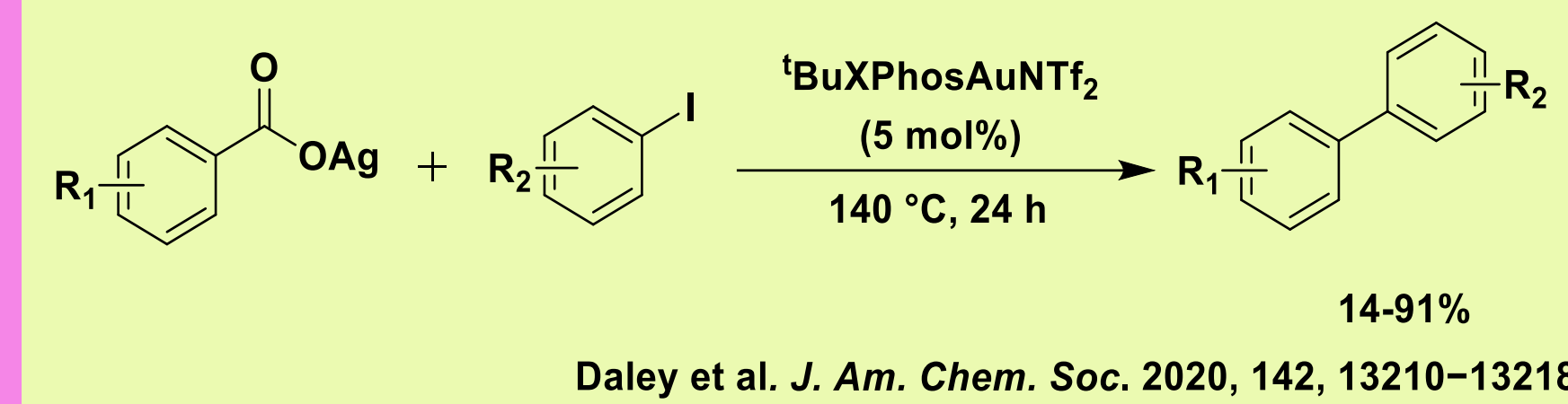
Paladium catalysed decarboxylation:



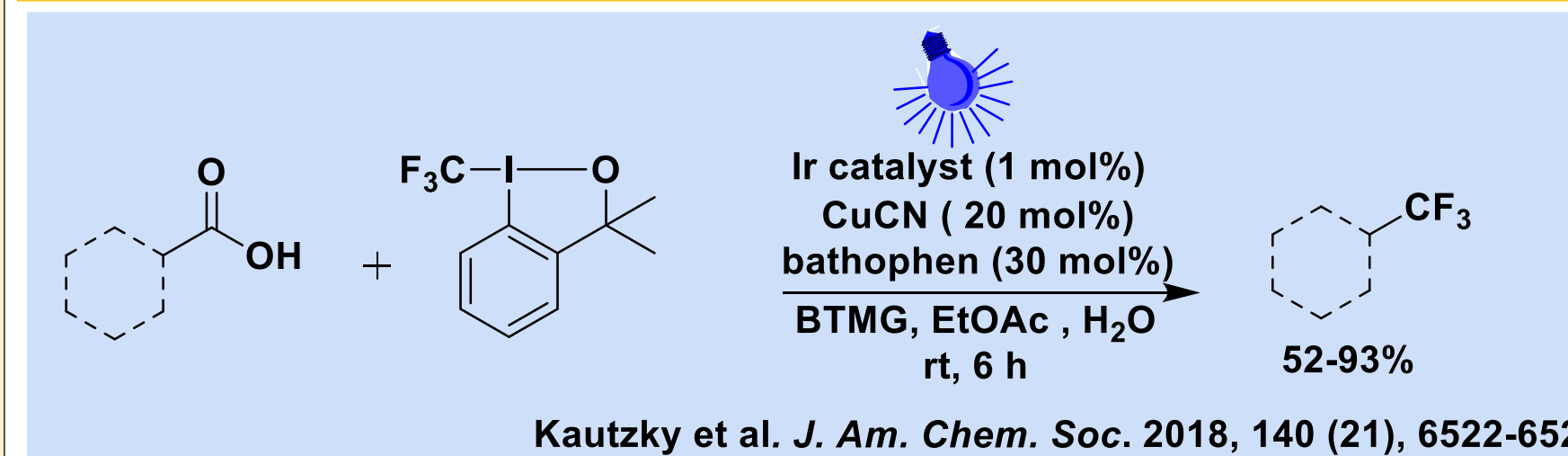
Iridium catalysed decarboxylation:



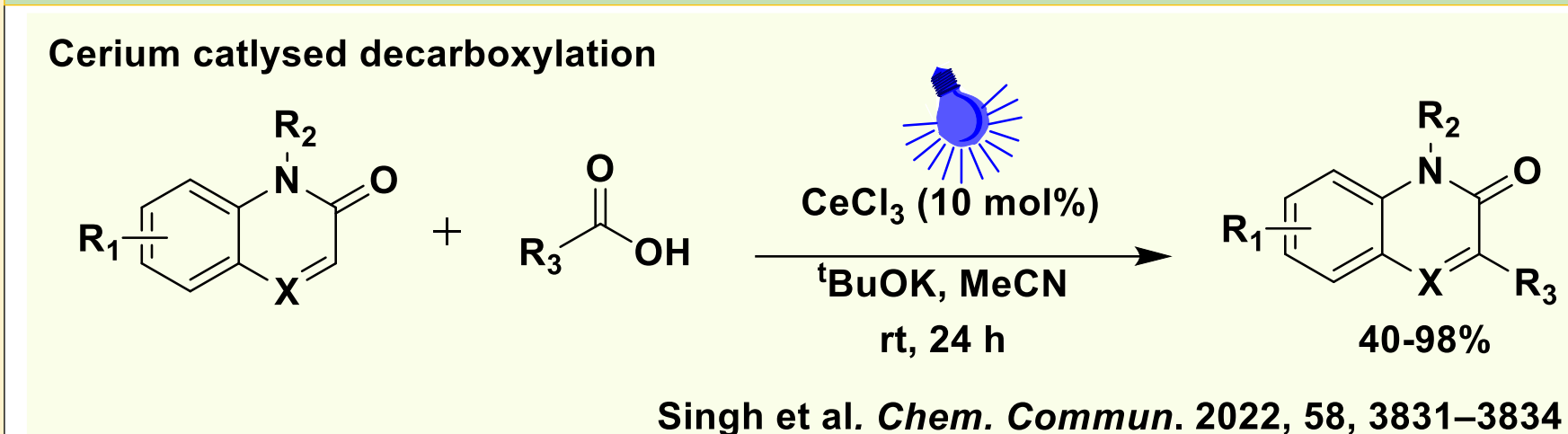
Gold catalysed decarboxylation:



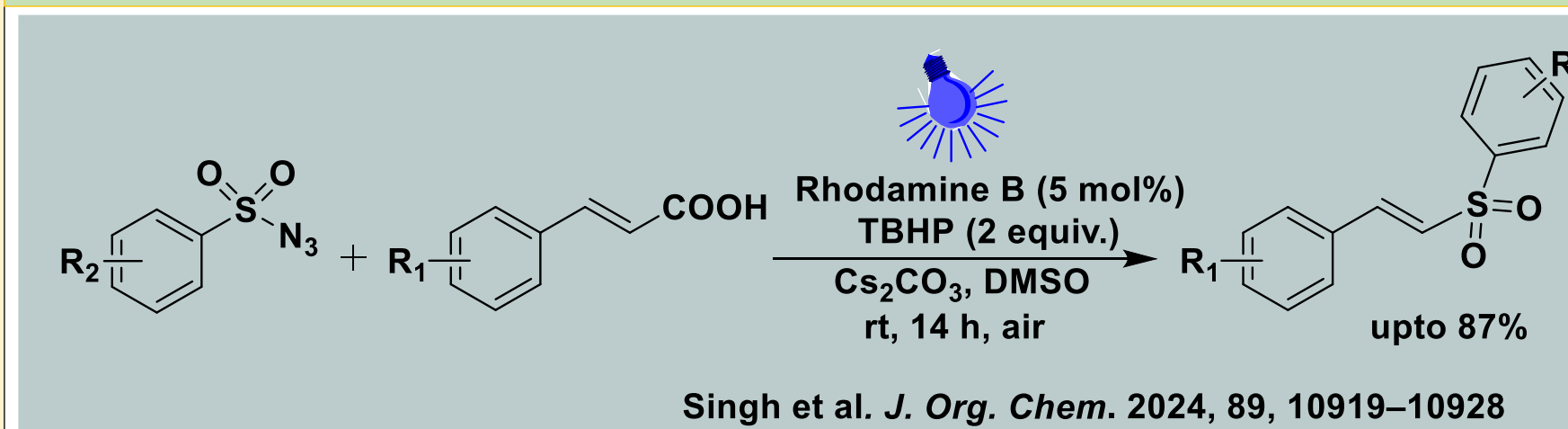
Dual metal catalysed decarboxylation :



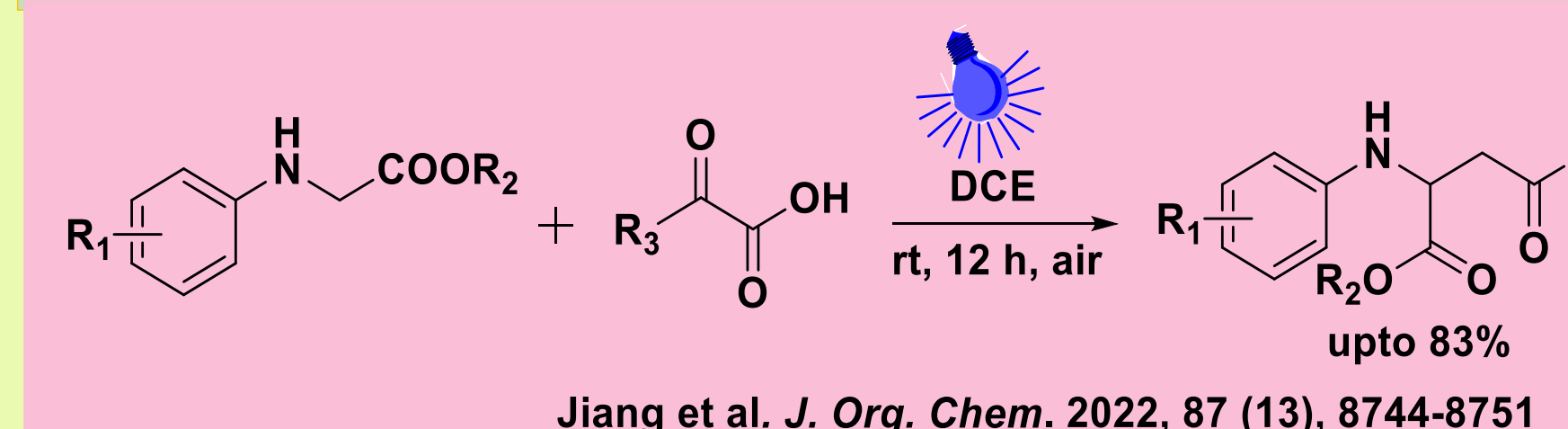
Inner-transition metal catalysed decarboxylation



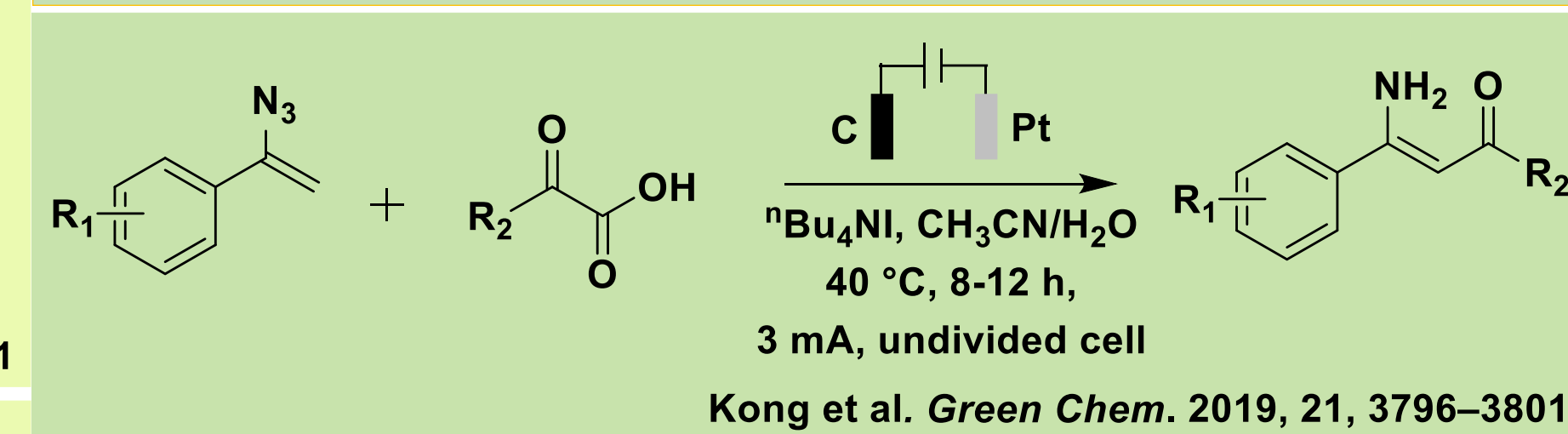
Metal-free decarboxylative coupling reactions



Catalyst-free decarboxylative coupling reactions



Electrochemical decarboxylation



Mechanochemical-assisted decarboxylation

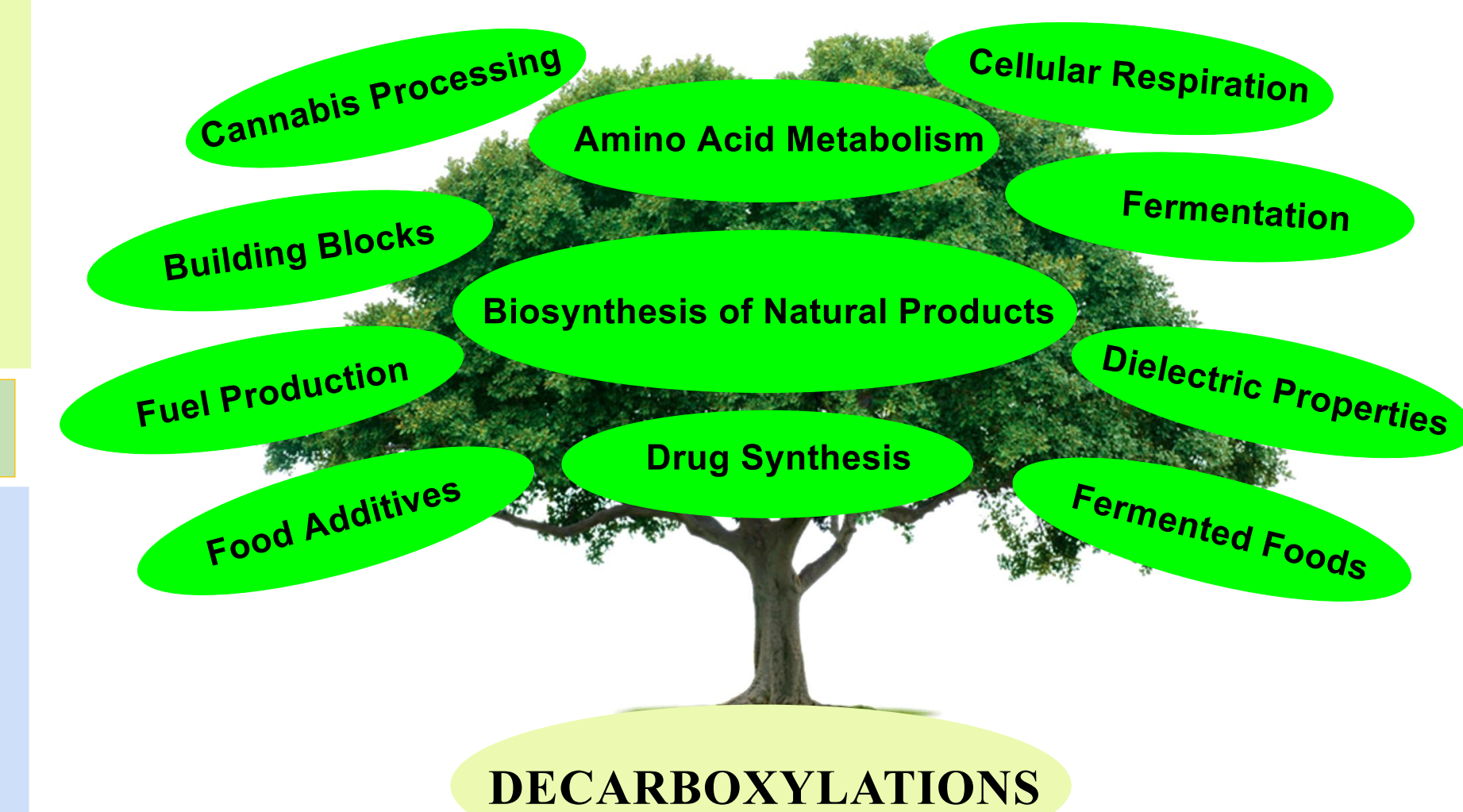


Fig 3. Applications

Current status and Challenges

Despite the remarkable progress of decarboxylative cross-coupling reactions, many more challenging reactions still await further investigation. Many of the newly developed decarboxylative cross-coupling reactions still require the use of a precious metal catalyst paired with the use of a large excess of specially designed ligands, longer reaction times, and the use of an inert atmosphere. Moreover, some of the coupling partners, catalysts, additives, and oxidants are air and moisture-sensitive. These shortcomings limit the practicality of these methods and their potential industrial applications. Future efforts should prioritize the design of catalytic systems that are not only cost-effective and air/moisture-stable but also capable of operating under mild, scalable, and environmentally friendly conditions. By embracing these innovations, decarboxylative cross-coupling reaction is poised to evolve into a more versatile, sustainable, and industry-relevant tool, guiding future breakthroughs across synthetic and medicinal chemistry.

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Conclusions: In conclusion, we have observed an explosive development of decarboxylative cross-coupling reactions under transition metal catalysis to photo-redox, electrochemical and mechanochemical assisted approaches. Of particular importance is that the coupling reactions of a broad range of electrophiles and nucleophiles have been achieved using visible-light induced decarboxylative cross-coupling reactions. A variety of biologically active compounds have been synthesized using these coupling reactions. By offering a comprehensive overview of established and novel synthetic techniques, this is a valuable resource for researchers, aiding in the rational design of decarboxylative cross-coupling reactions and fostering the development of more sustainable, efficient, and selective functionalization protocols. Ultimately, it bridges gaps in literature, stimulates interdisciplinary collaboration, and identifies unexplored avenues for future research.