Our group is interested in a) the total synthesis of biologically important natural products, b) the invention of new reactions and strategies in organic synthesis, and c) green chemistry.

Green Chemistry: Central to our research is the development of efficient and environmentally benign reactions and strategies. The Pharmaceutical Roundtable of the American Chemical Society’s Green Chemistry Institute deemed cross-couplings that avoid halogenaromatics as their top aspirational reaction. In collaboration with Professor Mitch Smith, we are inventing such reactions. Specifically, we are using catalytic C–H activation/borylation, often combined with subsequent chemical events, to generate pharmaceutically relevant building blocks for organic synthesis and the late stage functionalization of drugs and drug candidates.

Another of our green chemistry ventures aims to minimizing the need for tin in various processes. For example, we have developed an allylation/hydrostannation sequence where the tin waste from the allylation is recycled in situ so as to allow its use in the hydrostannation. This chemistry employs polymethylhydroisiloxane (PMHS), which is an oligomeric non-toxic waste product of the silicon industry, as the stoichiometric reductant.

Invention of New Reactions: The principles of green chemistry also motivate us to create new synthetic methods. Here we have been focusing on the employment of organosilanes as both reagents and substrates in chemical transformations ranging from Wittig rearrangements to new approaches to double-decker silsesquioxanes (DDSQ’s) for polymer applications. As part of a collaboration with Dow Chemical, we have also used PMHS in conjunction with our borylation chemistry to regioselectively generate building blocks of interest to the agrochemical industry. Here the combination of Pd(OAc)₂ and PMHS generates siloxane encapsulated Pd(O) nanoclusters.

Total Synthesis: The unifying thesis behind all of our methodological and mechanistic studies is that the chemistry to emerge from such studies should be applicable to real synthetic problems. We view target synthesis as the best proof of this concept. For example, as part of our green chemistry program, we look to make TMC-95A and autolytimycin by the strategic application of our own synthetic methods.

Selected Publications