# Editorial Commentary

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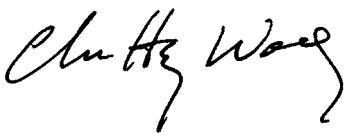
Synthetic organic chemistry has been one of the most important scientific disciplines, and has contributed significantly to the fundamental study of molecular sciences and the development of chemical and pharmaceutical industries. New synthetic reagents, catalysts, strategies, and processes have made possible the synthesis and processing of molecules with various degrees of complexity. While organic synthesis based on stoichiometric reactions and catalysis with acids, bases, and metals will continue to advance, new synthetic and catalytic methods are necessary to deal with the new classes of compounds that are becoming the emerging targets of molecular research and development.

Asymmetric catalysis based on transition metals complexed with chiral ligands has been progressed rapidly in the past decades, and numerous efficient and cost-effective syntheses and processes have been developed. Compounds with polyfunctional groups and multiple chiral centers, however, still pose particular challenges to the current chemical synthetic methods. In addition, the increasing constraints imposed by environmental concerns require the development of new synthetic methods that are environmentally benign. Transition metals, heavy elements, and toxic organic solvents are often used in chemical processes. When these materials are used with great care and efficiency, they may still be environmentally acceptable, but their handling and disposal may pose problems.



Enzymes are chiral catalysts, which catalyze most biological reactions *in vivo*, with remarkable rate acceleration and stereoselectivity. They also catalyze reactions involving both natural and unnatural substrates *in vitro*. The stereo- and regioselectivity, as well as substrate specificity of enzymes can range from being very narrow to very broad. They often operate at room temperature, under neutral aqueous conditions, and without substrate functional-group protection, but, in certain cases, also under unnatural or uncommon conditions. They can be used as the sole catalyst in a reaction or in combination with other enzymes to catalyze a multi-step synthesis, or with non-biological reagents to perform a mixed chemical-enzymatic synthesis. Furthermore, recent advances in molecular genetics have provided new tools to expand the scope of biocatalysis. Site-directed mutagenesis, directed evolution, and pathway engineering have been developed to alter the specificity, efficiency, and stability of enzymes. New forms of biocatalysts based on antibodies or RNA have been developed. The biocatalysis configuration has also been revolutionized; ranging from the use of a single enzyme in a free or immobilized form, to the whole cell or fermentation process, to multienzyme systems, and to modular biocatalysis. In addition, the complexity of the molecules prepared by biocatalysis or a combined chemo-enzymatic or chemo-biosynthetic process ranges from very simple chiral or achiral molecules, to polymeric and nanomaterials and to very complex structures such as carbohydrates, proteins, glyco- and lipidated proteins, nucleic acids (e.g., DNA and RNA), glycosylated natural products (e.g., polyketides and glycopeptide antibiotics), and their variants. The ability of using biocatalysis or the mixed biological and non-biological synthesis strategy to carry out environmentally acceptable synthetic transformations that are otherwise not feasible or impractical offers one of the best opportunities now available to research and development in chemical sciences and related interface disciplines and in industry.

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