

Feature Review Papers in Biocatalysis and Enzyme Engineering

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Biocatalysis and enzyme engineering continue to stand at the forefront of sustainable chemical innovation, providing powerful solutions for green manufacturing, environmental protection, and the circular bioeconomy. The integration of modern protein engineering, synthetic biology, and nanotechnology has rapidly expanded the possibilities for designing efficient biocatalysts with tailored properties. This Special Issue of Catalysts—Feature Review Papers in Biocatalysis and Enzyme Engineering—brings together five comprehensive review contributions that collectively highlight the breadth and transformative potential of current research in this dynamic field.

The featured reviews illustrate diverse aspects of enzyme science and its industrial applications. Topics include the exploration of non-conventional yeast species for biotransformations, the use of non-natural cofactors such as nicotinamide mononucleotide (NMN) to expand biocatalytic reaction scope, and the design of functionalized nanomaterials as advanced enzyme carriers for biodegradation and biotransformation processes. Equally, advances in protein engineering for industrial enzymes, with emphasis on the lessons learned from engineered PETases, underscore the role of rational and directed evolution approaches in enhancing enzyme robustness and specificity. Finally, the review on cellulosome systems in digestive tract microorganisms provides a fresh perspective on nature's multienzyme complexes and their underexploited potential in lignocellulose valorization.

Collectively, these contributions address key challenges in modern biocatalysis—from enzyme discovery and stabilization to reaction design and process integration. They not only survey the state of the art but also identify persistent knowledge gaps, including the limited understanding of enzyme–material interactions, the need for cofactor regeneration strategies compatible with non-natural cofactors, and the complex regulation of multienzyme systems such as cellulosomes. The authors provide valuable guidance toward overcoming these barriers through interdisciplinary approaches that merge computational design, metabolic engineering, and advanced materials science.

Looking ahead, the field will be benefitted from AI-assisted enzyme design, integration of biocatalysts into hybrid chemo-enzymatic cascades, and bioprocess intensification through continuous flow systems and nanostructured supports. Furthermore, the convergence of enzyme engineering with waste valorization and bioplastic degradation aligns biocatalysis with global sustainability goals, fostering the transition to a circular bio-based economy.

This Special Issue thus captures both the maturity and the future promise of biocatalysis and enzyme engineering as enabling technologies for a sustainable industrial future. We hope that these feature reviews will serve as a valuable resource for researchers, stimulate new collaborations, and inspire innovative solutions to both longstanding and emerging challenges.



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