

## ENGINEERED INDUSTRIAL BIOCATALYSTS - DELIVERING ON THE PROMISE OF DIRECTED ENZYME EVOLUTION

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Biocatalysis and directed enzyme evolution offer a vision and a path to greener, more sustainable processes and products. Building on three decades of exploration, innovation and development in protein engineering, this promise has been realized today as reflected in the growing number of industrial applications involving engineered high-performance biocatalysts

Beyond traditional applications of enzymes in commodity products such as proteases in laundry detergents, early developments of engineered high-performance biocatalysts have been driven by the pharmaceutical industry. Here, directed evolution delivered highly active and selective enzymes at scale, replacing expensive and potentially toxic chemical catalysts and reagents, reducing the number of process steps, and enabling operation under environmentally benign conditions for the manufacturing of life-saving drugs including antivirals against COVID and HIV [1-3]. These successes have undoubtedly contributed to recent, broader utilization of engineered biocatalysts in other markets including food and beverage ingredients, as well as advanced diagnostic and genomics applications [4,5]. Finally, protein engineering is delivering promising solutions to global environmental challenges, offering novel industrial biocatalysts for plastic recycling and carbon dioxide capture [6,7].

Despite significant progress and success, the integration of biocatalysis throughout industry is still in its infancy. Directed enzyme evolution presents a powerful approach to harness and exploit the tremendous versatility and functional diversity of proteins, a potential that we have barely tapped today. Its solutions will enable society to not only benefit from greener, more sustainable manufacturing processes, but also to successfully tackle growing political, economic, and environmental challenges. Critical to the continuation of this success story are investments in education of a highly skilled and innovative workforce and technological advances to accelerate protein engineering, but also engineering solutions to biomanufacturing.

### References

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