

Enzymes in Action: Finding the Right Enzyme for a Given Reaction. Application to CO₂ and C1 Compound Conversion.

Carine Vergne-Vaxelaire

Génomique Métabolique, Genoscope, Institut François Jacob, CEA, CNRS, Univ Evry,
Université Paris-Saclay
91057 Evry, France
carine.vergne@genoscope.cns.fr

Abstract

Biocatalysis has become a key pillar of sustainable chemistry, offering highly selective transformations under mild conditions while supporting the transition toward greener and more resource-efficient manufacturing. Its success relies on the remarkable catalytic efficiency and substrate promiscuity of enzymes, enabling applications ranging from pharmaceutical synthesis to bulk chemical production, in a rapidly expanding global market.[1] Yet, expanding the scope of biocatalysis relies on our ability to identify enzymes capable of catalyzing new reactions and accepting new substrates. The presentation will review the main strategies for discovering and optimizing biocatalysts, from genome mining and biodiversity exploration to directed evolution and de novo enzyme design.[2] Recent examples from our laboratory will illustrate the potential of genome mining to uncover novel enzymatic activities.[3] The second part will focus on the growing role of biocatalysis in carbon valorization, with particular emphasis on CO₂-derived C1 compounds.[4] Finally, we will present our recent work on the reductive amination of C1 compounds using native amine dehydrogenases, highlighting how biodiversity exploration can unlock new biocatalysts for carbon-efficient synthesis and contribute to the development of future CO₂-based bioprocesses.

References

- [1] Buller, R. et al. From nature to industry: Harnessing enzymes for biocatalysis, *Science*, 2023, [10.1126/science.adh8615](https://doi.org/10.1126/science.adh8615).
- [2] N'Guyen, D.T. et al. Genome Mining for New Enzyme Chemistry, *ACS Catal.* 2024, [10.1021/acscatal.3c06322](https://doi.org/10.1021/acscatal.3c06322).
- [3] Elisée, E. et al. Refined Picture of the Native Amine Dehydrogenase Family Revealed by Extensive Biodiversity Screening. *Nat Commun* 2024, [10.1038/s41467-024-49009-2](https://doi.org/10.1038/s41467-024-49009-2).
- [4] Intasian, P. et al. Enzymes, In Vivo Biocatalysis, and Metabolic Engineering for Enabling a Circular Economy and Sustainability, *Chem. Rev.* 2021, [10.1021/acs.chemrev.1c00121](https://doi.org/10.1021/acs.chemrev.1c00121)

Keywords

Biocatalysis ; Genome mining ; CO₂-based bioprocesses ; CO₂-to-functionnalized C1