BIOTRANS
LA ROCHELLE 2023

N°731 / OC
TOPIC(s) : Synthetic biology, metabolic engineering / Biocatalytic cascade reactions

In vivo redox and multistep biocatalysis coupled to hetero- and/or phototrophic metabolism

AUTHORS

Bruno BÜHLER / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Lisa BRETSCHNEIDER / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Carolin BERTELMANN / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Adrian TÜLLINGHOFF / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Anna HOSCHEK / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Sara LUPACCHINI / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG
Jörg TOEPEL / HELMHOLTZ CENTRE FOR ENVIRONMENTAL RESEARCH - UFZ, PERMOSERSTR. 15, LEIPZIG

PURPOSE OF THE ABSTRACT

In the past three decades, efficient oxygenase biocatalysis concepts have been developed relying on the metabolism of living cells of heterotrophic organisms (e.g. E. coli or Pseudomonas) [1, 2]. These organisms utilize organic compounds such as glucose as source of carbon, energy, and reduction equivalents which implies that carbon and energy metabolism are coupled. As examples, in vivo cascades for monomer production and efficient steroid hydroxylation in engineered Pseudomonads and E. coli, respectively, will be presented [3-7].

Phototrophic organisms on the other hand acquire high-energy reduction equivalents from water as highly attractive electron donner, i.e., via photosynthetic water oxidation, and thus gained interest as host systems for redox biocatalysis [8, 9]. The photosynthetic light reaction provides both co-substrates of oxygenases, i.e., electrons and O2, via a path orthogonal to the carbon metabolism. The fast photosynthetic water oxidation thus augurs well for resource-efficient oxygenation and redox biocatalysis in general (Figure 1). We present results on photosynthesis-driven redox reactions catalyzed by recombinant Synechocystis sp. PCC 6803, on their dependency on the phototrophic metabolism in terms of electron and O2 supply, as well as on reaction engineering options. Light-driven biocatalysis based on a CYP450 monooxygenase [10, 11], a BVMO [12], and an oxygen-tolerant hydrogenase will be highlighted. The latter recently has successfully been introduced into Synechocystis with the perspective to enable photosynthetic H2 production [13].

FIGURES

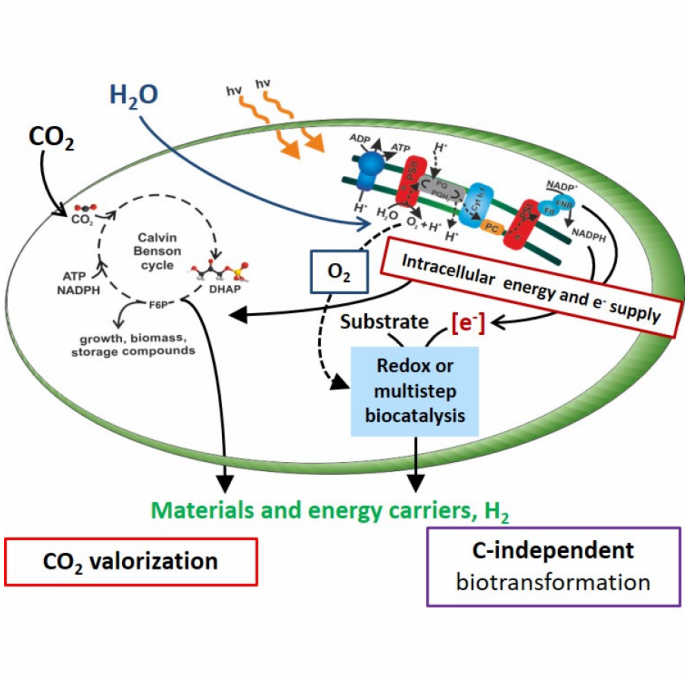

FIGURE 1

FIGURE 2

Figure 1

Light-driven biocatalysis based on cyanobacteria.

KEYWORDS

in vivo redox biocatalysis | oxygenases | cofactor recycling | light-driven biocatalysis

BIBLIOGRAPHY

[1] e. theodosiou et al., front. bioeng. biotechnol. 2022, 10, 855715.
[2] m. schrewe et al., chem. soc. rev. 2013, 42, 6346-6377.
[3] c. bertelmann et al., front. catal. 2022, 2, 887458.
[4] l. bretschneider et al., metab. eng. 2022, 79, 206-217.
[5] l. bretschneider et al., front. catal. 2021, 1, 683248.
[6] l. bretschneider et al., microb. biotechnol 2021, 14, 1011-1025.
[7] l. schaefer et al., biotechnol. j. 2020, 15, 2000091.
[8] j. toepel et al., curr. opin. biotechnol. 2023, 80, 102892.
[9] a. hoschek et al., chemcatchem 2018, 10, 5366-5371.
[10] a. hoschek et al., biotechnol. j. 2019, 14, 1800724.
[11] a. hoschek et al., bioresour. technol. 2019, 282, 171-178.
[12] a. tuellinghoff et al., front. catal. 1, 2022, 780474.
[13] s. lupacchini et al., metab. eng. 2021, 68, 199 - 209.