Living Cells with Biosynthesized Nanomaterials – Can We Generate a Cyborg Organism?

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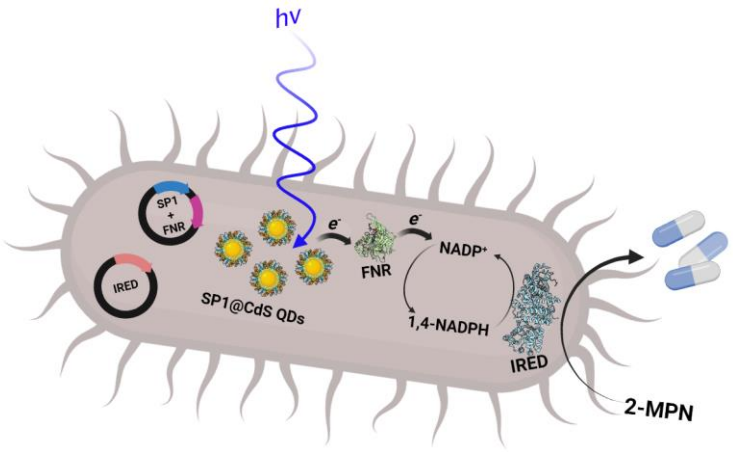
We suggest a new concept for a self-sustained biotic-abiotic cyborg organism, which comprises a biological system with an add-on nano-based organelle. In this whole-cell biohybrid system, I plan to use the distinctive structure of stable protein 1 (SP1) for the biosynthesis of various size-constrained inorganic nanomaterials in living systems. These nanomaterials are optically and electronically active NPs that can be utilized for various catalytic or photocatalytic processes.[1,2]

Here we show the biosynthesis of CdS NPs stabilized by a predesigned SP1 variant at ambient conditions.[3] The size controlled crystalline NPs were utilized for NADPH regeneration which was subsequently used for the activation of the imine reductase (IRED) enzyme (as depicted in the scheme). The system enabled the generation a vital product for the pharmaceutical industry. We extended this platform to a fully integrated photocatalytic NADPH regeneration system in a whole living bacterium. In our recent results, we demonstrate the exclusive ability of SP1-expressing cells to biosynthesize photo-catalytically active CdS NPs. Finally, we demonstrate the use of the generated photo-active NPs in activating a solar driven cascade within a whole organism to produce fine chemicals. We attempt to investigate this new concept in a broader evolutionary perspective. The incorporation of biosynthetic capabilities of nanomaterials in living cells could allow new properties not only for the enhancement of a single enzymatic reaction, but also in the level of the whole organism.



References

[1] O. Bachar *et al.*, *Chem. Commun.,* 56, 11211–14, 2020.

[2] O. Bachar *et al.*, *COBIOT*, 81:102943, 2023.

[3] O. Bachar *et al*., *Angew. Chem. Int. Ed*., 61, e202202457, 2022.