

# Photovoltaics in synthetic biology

Synthetic biology. Synthetic biology is a bioengineering discipline using standardized genetic engineering tools to control cellular behaviour and enhance biochemical processes, including PETCs 85 ...

This article discusses an emerging technology that uses synthetic biology to express extracellular electron transport pathways in cyanobacteria to conductively link the photosynthetic ...

Photovoltaic-driven electrolysis is the more efficient process when measured on an annual basis, yet short-term yields for photosynthetic conversion under optimal conditions come within a factor of 2 or 3 of the photovoltaic benchmark. ... We consider opportunities in which the frontiers of synthetic biology might be used to enhance natural ...

Synthetic biology was founded as a biophysical discipline that sought explanations for the origins of life from chemical and physical first principles. Modern synthetic biology has been reinvented as an engineering discipline to design new organisms as well as to better understand fundamental biological mechanisms. However, success is still largely limited to the laboratory ...

Living photovoltaics are microbial electrochemical devices that use whole cell-electrode interactions to convert solar energy to electricity. The bottleneck in these technologies is the limited electron transfer between the microbe and the electrode surface. This study focuses on enhancing this transfer by engineering a polydopamine (PDA) coating on the ...

The basic idea is the conversion of light energy into electrical energy using photosynthetic microorganisms. The microbes will use their photosynthetic apparatus and the incoming light to split the water molecule. ...

A fundamental understanding and targeted optimization of the microbes might help to achieve higher power outputs. Possible solutions in the future might include synthetic biology approaches to improve the electron ...

Synthetic biology is a multidisciplinary field of research that aims to develop new biological components, devices, and systems, as well as redesign existing natural systems [] is a field of study that includes a wide range of approaches from other disciplines, including biotechnology, genetic engineering, molecular biology, molecular engineering, systems ...

Photosynthetic organisms use solar energy to generate high-energy electrons through their photosynthetic electron transport chains. Electrons from different photosynthetic electron transport chains can be rewired to new-to-nature pathways, creating biotechnologies for solar-powered electricity generation and chemical synthesis.

In this review, we highlight underlying principles and advancements in using synthetic biology approaches to engineer living photovoltaics, focusing on the ability of vital ...

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A fundamental understanding and targeted optimization of the microbes might help to achieve higher power outputs. Possible solutions in the future might include synthetic biology approaches to improve the electron transfer efficiency, such as introducing alternative electron transfer routes (Sekar et al., 2016; Schuergers et al., 2017 ...

You have full access to this article via your institution. Photosynthetic organisms have evolved versatile electron transport chains that efficiently convert solar energy into chemical energy.

Here, we discuss recent advances and current challenges of engineering improved photosynthesis in the era of synthetic biology toward optimized utilization of solar energy and ...

This review provides a materials science perspective on applying a complementary, synthetic biology approach to engineering membrane-electrode interfaces. It focuses on the technical challenges behind the introduction of foreign extracellular electron transfer pathways in bacterial host cells and the past and future efforts to engineer ...

Synthetic biology offers a promising interdisciplinary approach to integrate the principles of molecular biology with biochemical engineering in conjunction with computational tools to modify an existent ... Comparing photosynthetic and photovoltaic efficiencies and recognizing the potential for improvement. *Science*. 2011; 332:805-809. Crossref.

Photosynthetic biofilms in pure culture harness solar energy in a mediatorless bio-photovoltaic cell (BPV) system. *Energy Environ. Sci.* 4, 4699-4709. doi: 10.1039/C1EE01965A

The feasibility of employing rhodopsins in photovoltaic systems has been extensively demonstrated (Espinoza-Araya et al., 2023; Kanekar et al., 2020; Krivenkov et al., 2019). These devices can be classified into two primary categories: bio-sensitised solar cells (BSSCs) and Bio-enhanced photovoltaics (BEPVs).

The redox potentials of the hemes are affected by the surrounding environment<sup>40</sup>, and interactions such as menaquinone (MQ) binding to CymA may change the protein potential in a manner that favors electron transfer<sup>41,42</sup>. Approximate potentials are shown. - "A Synthetic Biology Approach to Engineering Living Photovoltaics."

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Commercial silicon-based photovoltaic cells customarily reach 20% solar-to-electricity conversion rates even securing profitability<sup>9</sup>. Additionally, photovoltaic-driven electrolysis could achieve at least 10-12% solar

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energy to water splitting efficiency 10, 11.

Synthetic biology applies genetic tools to engineer living cells and organisms analogous to the programming of machines. ... Biological photovoltaics derived from microbial fuel cells use ...

Synthetic biology faces major challenges in the rational design of complex living systems, necessitating a quantitative understanding of the principles that guide the emergence of functions from ...

The article highlights advances in engineering protein-based, electron-exporting conduits in a model host organism, *E. coli*, before reviewing state-of-the-art biophotovoltaic technologies that use both unmodified and bioengineered photosynthetic bacteria with improved electron transport.

produce hydrogen. Photovoltaic-driven electrolysis is the more efficient process when measured on an annual basis, yet short-term yields for photosynthetic conversion under optimal conditions come within a factor of 2 or 3 of the photovoltaic benchmark. We consider opportunities in which the frontiers of synthetic biology might be used

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Although both processes harvest the energy in sunlight, they operate in distinctly different ways and produce different types of products: biomass or chemical fuels in the case of natural photosynthesis and nonstored electrical current in the case of photovoltaics.

Biomimetics is formed by the words biology and mimesis (imitation). It also called as bionics. Technical biology analyses the form, structure and function relationship in living organisms by physical, chemical or engineering sciences (Purkait et al., 2018). Technical biology forms the basis for biomimetic research which allows the understanding of quantitative and ...

Natural photosynthesis is compared with present technologies for photovoltaic-driven electrolysis of water to produce hydrogen and opportunities in which the frontiers of synthetic biology might be used to enhance natural photosynthesis for improved solar energy conversion efficiency are considered. Comparing photosynthetic and photovoltaic efficiencies is not a simple issue. ...

ACS Synthetic Biology has been certified as a transformative journal by cOAlition S, committing to a transition to 100% open access in the future. If your research funder has signed Plan S, your open access charges may be covered by your funder through December 31, 2024. ... Photovoltaics (1) Electrochemical detection (1) Ultrasound (1) ...

Biology does this via photosynthesis, which is of course how crude oil was formed in the first place. The

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downside is that photosynthesis is rather inefficient in its use of photons. On the other hand, there have been huge strides in the development of photovoltaics (PVs) and electricity generation via PV's is rapidly coming down in price.

Key points. Photosynthetic organisms use solar energy to generate high-energy electrons through their photosynthetic electron transport chains. Electrons from different ...

We have sought here to make the most consistent comparison possible between the fundamental solar energy storage efficiencies of photovoltaic and photosynthetic systems. In this context, the efficiency advantage clearly goes to photovoltaic systems.

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