# The quest for sustainable *N*-heterocycle synthesis powered by electricity and light

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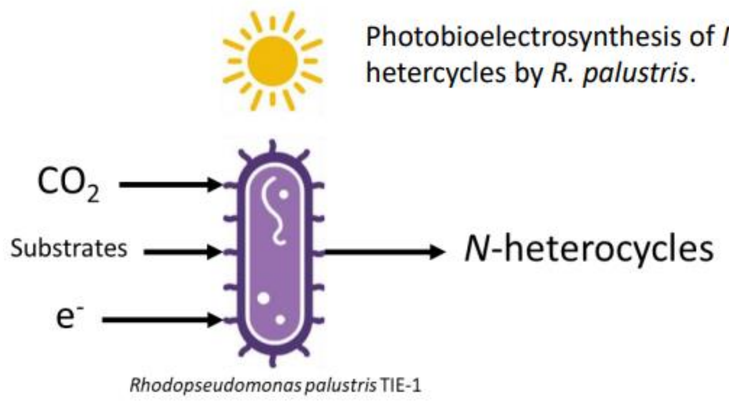
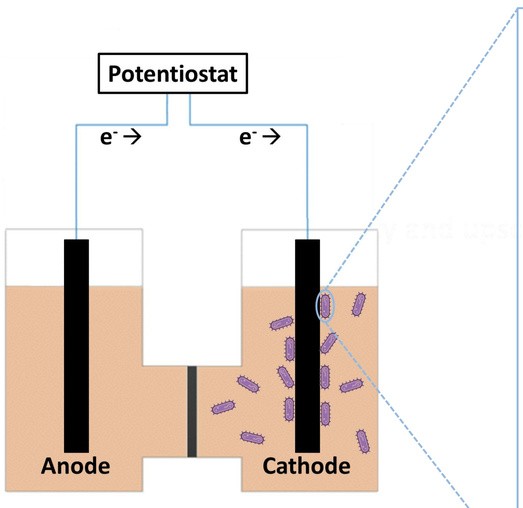
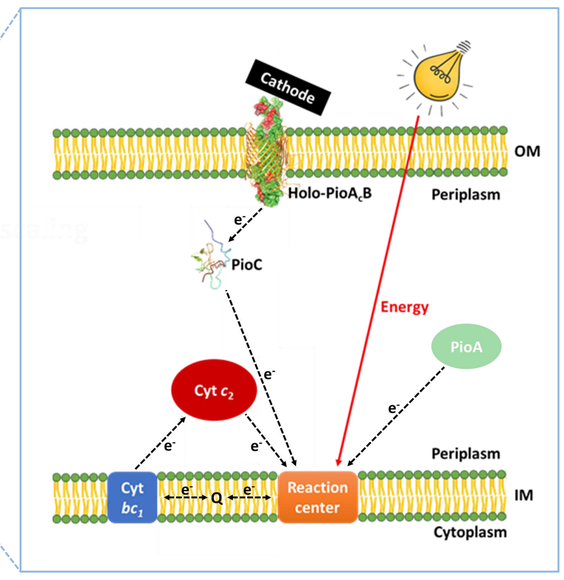
## Introduction

Photobioelectrosynthesis is a promising approach for fine chemicals synthesis. In this process, organisms like ***Rhodopseudomonas palustris* TIE-1** can utilize **light** and **electrons** to **fix $CO_2$** and to grow autotrophically.[1,2] This harnessed energy can be used to power the production of valuable ***N*-heterocycles** via **imine reductases (IRED)**.[3] This study aims to investigate the pathway that allows TIE-1 to gather reducing power and use this to drive imine reductase in catalyzing *N*-heterocycle synthesis from diamines and dicarbonyls.[3]

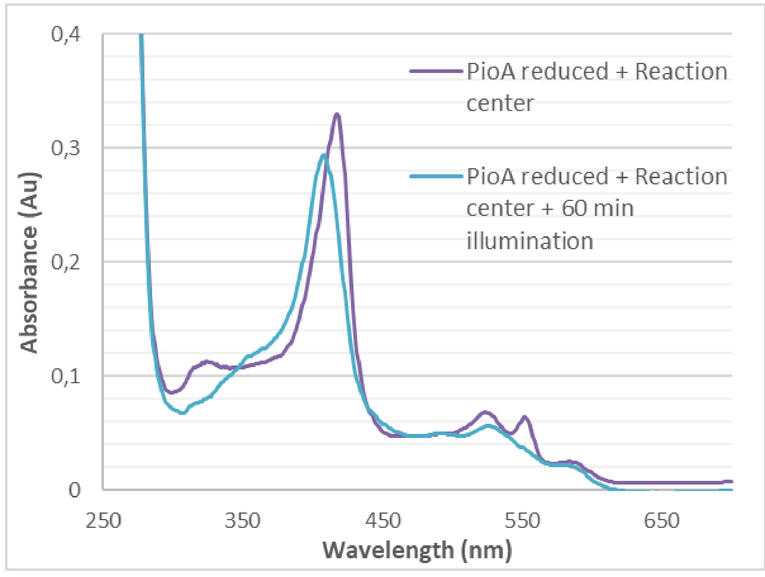



## A new step discovered on how *R. palustris* gathers reducing power




Overview of the bioelectrochemical reactor for microbial electrosynthesis (left) and a proposed model for extracellular electron transfer by *R. palustris* (right, blow-up diagram).[4-6]

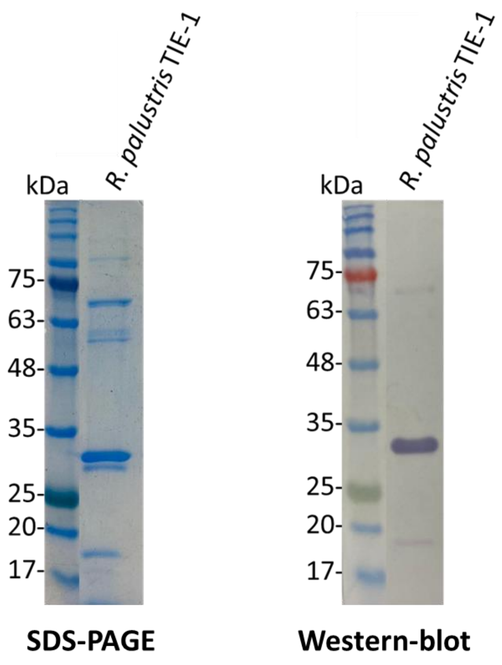



UV-VIS spectra of PioA (decaheme cytochrome) before (purple) and after oxidation (blue) by the photosynthetic reaction center.

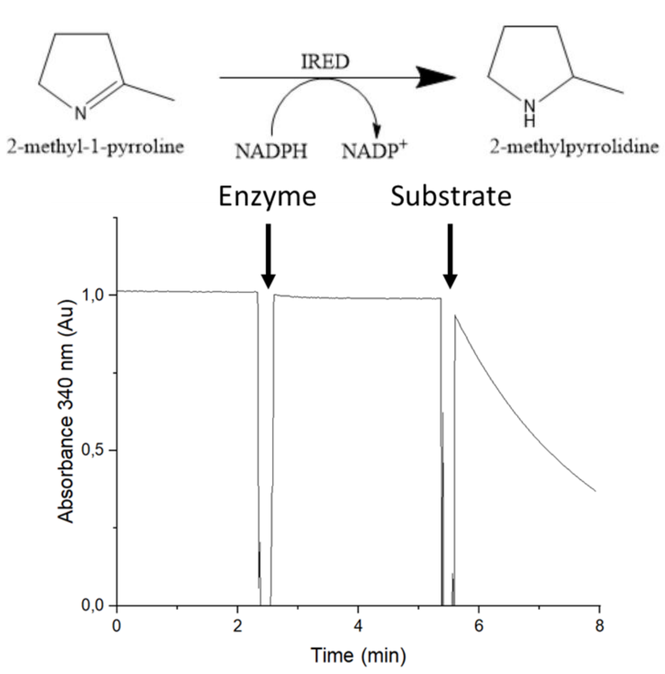
*R. palustris* can take up electrons from a cathode

The reaction center can take electrons from PioA

## Evaluation the recombinant strain



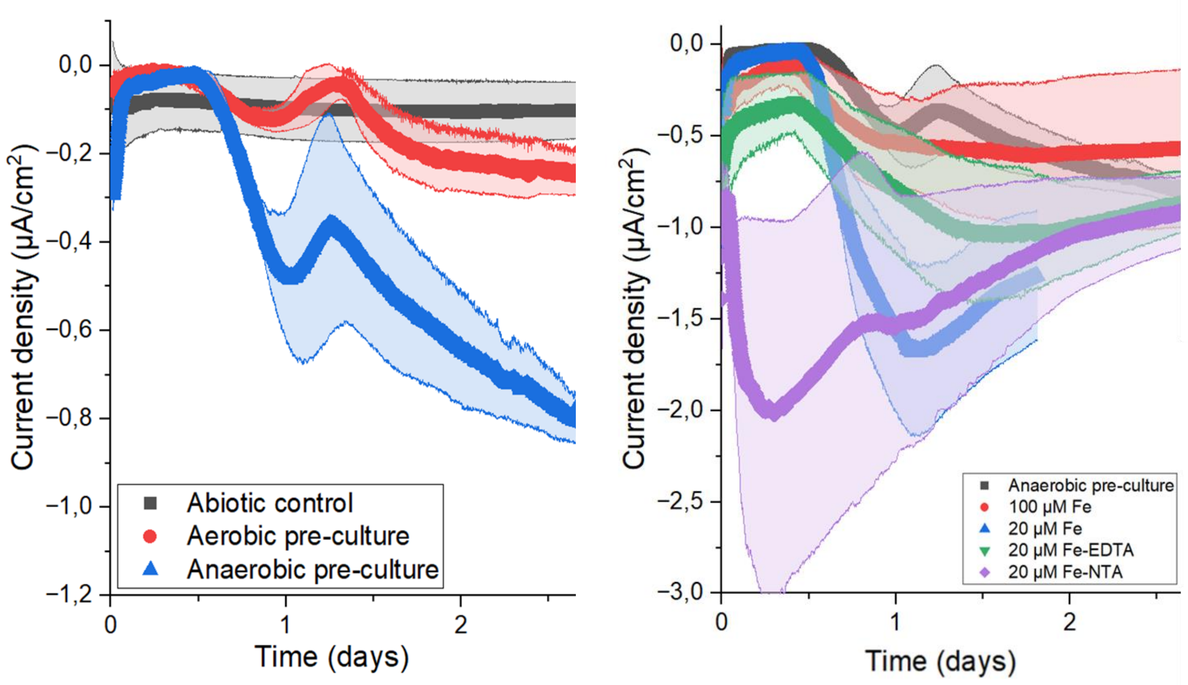

SDS-PAGE (left) and Western-blot (right) anaylsis of IRED purified *via* its *N*-terminal streptag from recombinant *R. palustris*.




Evaluation of IRED (produced by recombinant *R. palustris*) activity *in vitro* by following NADPH consumption of the IRED catalyzed imine reduction at 340 nm in a cuvette.[7]

Successful IRED production and activity were shown in recombinant *R. palustris* in an *in vitro* activity assay

## Optimizing the reactor setup




Optimization of the reactor setup by maximizing current consumption by *R. palustris* TIE-1 wildtype. Current density measured with a potentiostat with a set potential of 100 mV versus SHE.

Anaerobically preculturing *R. palustris* TIE-1 wildtype in combination with 20 µM Fe resulted in increased and reproducible current consumption

## Conclusion & outlook

This study showed that **PioA** and the **reaction center** are capable of direct electron transfer, thus expanding our understanding of extracellular electron transfer pathway performed by *R. palustris*. Furthermore, successful **IRED** production was shown in **recombinant *R. palustris***. Also, the bioelectrochemical reactor setup was optimized for **increased current consumption**. Overall, these steps together pave the way for *N*-heterocycle synthesis with *R. palustris* by microbial photo-electrosynthesis.

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