Tapping into cyanobacteria electron transfer for higher exoelectrogenic activity by imposing iron limited growth

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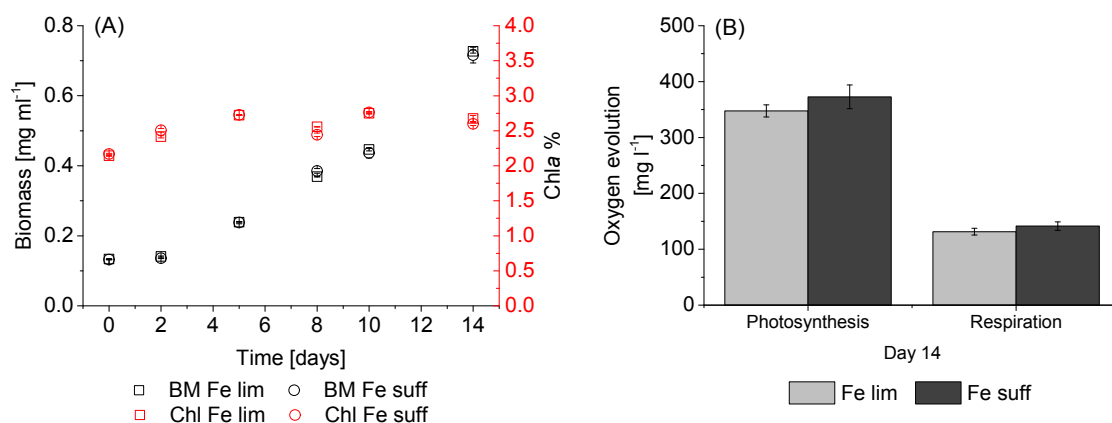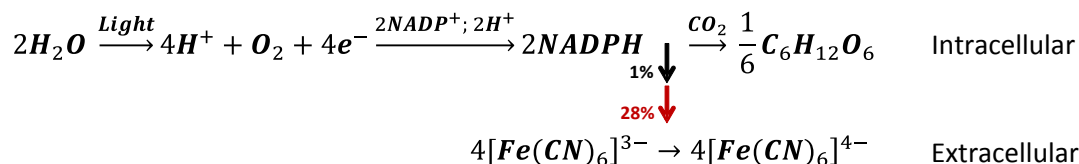* acf42@cam.ac.uk

Supplementary Information

Figure 1. (A) Growth curve of PCC7942 in iron limited and iron sufficient conditions at 30 °C and 120 rpm, under light intensity of 90 μmol m^{-2} s^{-2} in a 12 hour light/dark cycle. From the graph, exponential growth rates calculated as ln(Day 8 – Day 2)/3, equal to 0.138 day^{-1}, equivalent to 5 days doubling time. (B) Photosynthetic and respiration rates at Day 14 of cultures of PCC7942 in iron limited and iron sufficient conditions as oxygen evolution in the light (photosynthesis) and in dark immediately after (respiration). (n=3 ±1SE).

$$2H_2O \xrightarrow{Light} 4H^+ + O_2 + 4e^- \xrightarrow{2NADP^+; 2H^+} 2NADPH \xrightarrow[\text{1\%}]{CO_2} \frac{1}{6}C_6H_{12}O_6 \quad \text{Intracellular}$$

$$\text{28\%} \quad 4[Fe(CN)_6]^{3-} \rightarrow 4[Fe(CN)_6]^{4-} \quad \text{Extracellular}$$

Equation 1. Photo-biocatalysis in electron transfer from water to extracellular ferricyanide by PCC7942 at Day 14. Iron limited cells present an enhanced redirection of electrons (red arrow) over iron sufficient cells (black arrow) at neutral pH. Estimated percentages are calculated as moles of electrons reducing ferricyanide over moles of electrons generated in O$_2$ evolution (photosynthetic rates), 4 mol of ferricyanide require 1 mol of O$_2$. FeCN-R rates in the dark were subtracted previous to calculating the percentages of photo-biocatalysis. Ferrocyanide can be reoxidised in the anode of an electrochemical cell for generation of photo-bioelectricity.
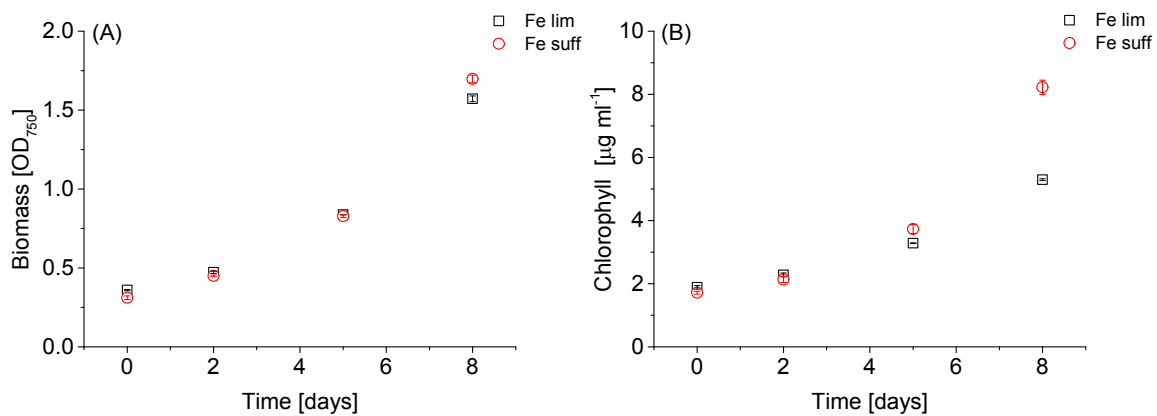
Figure 2. (A) Growth curve and (B) chlorophyll content of *C. vulgaris* cultures in iron sufficient and iron limited condition at 30 °C and 120 rpm, under light intensity of 90 μmol m^{-2} s^{-2} in a 12 hour light/dark cycle. From the graph, exponential growth rates calculated as ln(Day 8 – Day 2)/3, equal to 0.20 day^{-1} and 0.22 day-1 for iron limited and iron sufficient cultures respectively, equivalent to 3.5 and 3.1 days doubling time. (n=3 ±1SE).
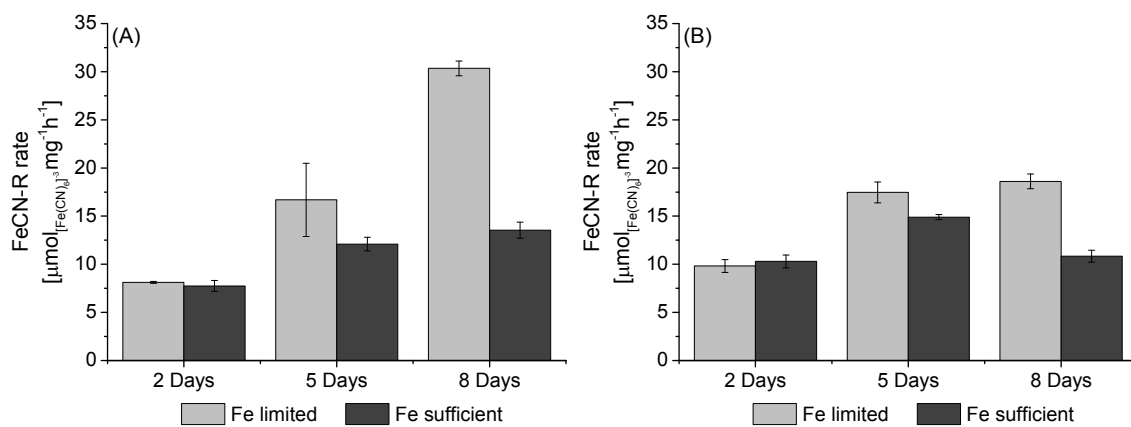

Figure 3. Ferricyanide reduction rates of *C. vulgaris* cultures conditioned by iron availability (A) in the light and (B) in darkness. (n=3±1SE).