Being e-connected: a common way of life in microbial biofilms?

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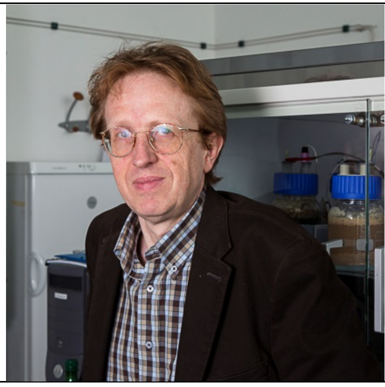

Around 10 years ago was discovered the capability of microbial biofilms to use solid electrodes as electron acceptor (microbial anodes) [1]. Very soon, the first studies have shown that some bacteria were able to plug onto electrode surfaces and to transfer electrons to the electrode material via a sophisticated chain of membrane-bound redox compounds. This mechanism requires direct contact between the cell and the electrode and can consequently explain electron transfer only from the first layer of adsorbed cells. In complement, two other pathways have been discovered that allow long-range electron transport inside thick biofilms. Some bacteria produce extracellular redox proteins, which diffuse in the biofilm and play the role of electron shuttle between the cells and the electrode. Pili have also been postulated to be involved in electron transport [2]. Some authors claim that pili are electrically conductive, being able to transport electrons like conductive nanowires [3], while others state that electron transport is achieved by a succession of electrochemical reactions between c-type cytochromes aligned along pilus-like filaments [4]. In light of these discoveries, biofilms should now be thought as electron transport networks that offer to the bacteria the possibility of long-range respiration.

The mechanisms of electron transfer from biofilms to anodes will be illustrated with a couple of studies that deal with the electron transport capabilities observed in biofilms formed around microelectrodes [5] and recent results dealing with high-salinity tolerant biofilms [6].

The mechanisms of electron transfer from electrodes to biofilms (microbial cathodes) are less studied and still poorly understood although they represent key challenges, mainly with the view to develop oxygen-reducing cathodes [7] and, most recently, innovative synthesis-routes for CO2 reduction [8].

Finally, a short review will be done of the various new technologies that the concept of electroactive biofilms may bring out, including production of electricity (microbial fuel cells), generation of hydrogen (microbial electrolysis cells) and synthesis of organic compounds from CO2 reduction (microbial electrosynthesis cells).

References

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