Title:	Strategies for improving the electroactivity and specific metabolic functionality of microorganisms for various microbial electrochemical technologies1
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Keywords:	Bioelectrochemical systems Microorganism-electrode interactions Electroactive microorganisms
Issue Date:	2020
Publisher:	Elsevier
Citation:	Biotechnology Advances 39.
Abstract:	Electroactive microorganisms, which possess extracellular electron transfer (EET) capabilities, are the basis of microbial electrochemical technologies (METs) such as microbial fuel and electrolysis cells. These are considered for several applications ranging from the energy-efficient treatment of waste streams to the production of value-added chemicals and fuels, bioremediation, and biosensing. Various aspects related to the microorganisms, electrodes, separators, reactor design, and operational or process parameters influence the overall functioning of METs. The most fundamental and critical performance-determining factor is, however, the microorganism-electrode interactions. Modification of the electrode surfaces and microorganisms for optimizing their interactions has therefore been the major MET research focus area over the last decade. In the case of microorganisms, primarily their EET mechanisms and efficiencies along with the biofilm formation capabilities, collectively considered as microbial electroactivity, affect their interactions with the electrodes. In addition to electroactivity, the specific metabolic or biochemical functionality of microorganisms is equally crucial to the target MET application. In this article, we present the major strategies that are used to enhance the electroactivity and specific functionality of microorganisms pertaining to both anodic and cathodic processes of METs. These include simple physical methods based on the use of heat and magnetic field along with chemical, electrochemical, and growth media amendment approaches to the complex procedure-based microbial bioaugmentation, co-culture, and cell immobilization or entrapment, and advanced toolkit-based biofilm engineering, genetic modifications, and synthetic biology strategies. We further discuss the applicability and limitations of these strategies and possible future research directions for advancing the highly promising microbial electrochemistry-driven biotechnology.
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