Construction of artificially structured microbial consortia (ASMC) using dielectrophoresis: Examining bacterial interactions via metabolic intermediates within environmental biofilms


Abstract
The construction of artificial biofilms with defined internal architectures is described. Bacterial cells are suspended in a low conductivity medium, guided to specific areas in a microelectrode array by dielectrophoresis (DEP), and then immobilised using the flocculating agent poly(ethyleneimine). Multispecies biofilms can be constructed by introducing different species at different times. The rapid construction of such biofilms with defined internal architectures provides, when combined with visual reporters of gene activity, a powerful new method for the investigation of the effects of the spatial organisation on interactions between bacterial species in biofilms. To demonstrate the utility of the technique as a method for investigating metabolic interactions in biofilms, aggregates were constructed from Acinetobacter sp. C6 and Pseudomonas putida::gfp. The Acinetobacter degrades benzyl alcohol, overproducing benzoate, which in turn is consumed by the Pseudomonas strain. The P. putida has a chromosomally expressed cassette encoding a gfp downstream of the promoter which controls degradation of benzoate, making the interaction between the two strains in the metabolism of benzyl alcohol visible by the production of green fluorescent protein (GFP). Microscopic observation of the biofilms, including the use of confocal laser scanning microscopy (CLSM), confirmed that metabolic exchange occurred. In addition, it was observed that the bacteria appear to have a preferred biofilm architecture, with P. putida in the bottom layer, and Acinetobacter at the top.