32 Can bacteriophages be effective in controlling harmful biofilms?

Sanna Sillankorva, Diana P Pires, Luis D R Melo, Nuno Cerca and Joana Azeredo
Institute for Biotechnology and Bioengineering, Centre of Biological Engineering, Universidade do Minho, Campus de Gualtar, 4710-057 Braga, Portugal.

(Bacterio)phages are viruses that specifically infect bacteria, causing cell lysis and therefore can be considered a valuable strategy for bacterial control. Recent studies have demonstrated the potential of using phages to control bacterial biofilms. Phages are able to penetrate the extracellular matrix and can cause up to 90% of biofilm mass reduction even in old biofilms. However phage action can be impaired by components of the biofilm matrix, the slow growth of biofilm bacteria and the fast emergence of phage resistant phenotypes. We have conducted several studies of phage biofilm interaction and based on our experimental data, we have hypothesized that the general mechanisms of a virulent phage-biofilm infection, in a very simplistic model, can occur in four stages: 1) Transport of the phage particles through the biofilm matrix (by diffusion or convection mechanisms); 2) Settlement and/or attachment of phages onto bacterial cells embedded in the biofilm matrix, followed by adsorption and phage replication inside host cells; 3) Release of phage progeny to planktonic and biofilm phases, through host cell lysis and infection of neighbourhood biofilm cells resulting in biofilm biomass reduction; 4) Detachment of biofilm portions and phages into the planktonic phase. Nevertheless, the interaction between phage and biofilms is a rather complex process. Theoretically, a biofilm should be rapidly infected because cells are more close to each other and this fact can enhance phage replication, when compared to the less accessible bacteria of planktonic cultures. On the other hand, the structure and composition of the biofilm as well the physiology of the biofilm cells may impose some limitations to biofilm infection. Indeed, phage-biofilm interaction is greatly influenced by the biofilm age, biofilm structure, biofilm mode of growth and most importantly the host and phage characteristics. This work is a summary of all phage/biofilm interaction studies conducted by our team involving different phage types and host species.

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