Session 14: Biotechnology and Application of Viruses III

The use of bacteriophages to control infectious biofilms

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Biofilm formation occurs spontaneously on both inert and living systems and is an important bacterial survival strategy. Within biofilms, bacteria are organised in complex microcolonies embedded in a matrix composed by extracellular polymeric substances (EPS). These 3-D structures are often associated with several chronic and acute infections and are usually very tolerant to antibiotherapy. We 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. 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.

Phage/biofilm interaction 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. Some phages have developed specialized mechanisms to infect their hosts within biofilms. Phages able to infect stationary growth phase cells and displaying structural depolymerases have advantages for biofilm control. On the other hand, the biofilm phenotype in some species confers protection to phage predation, mostly due to the polymeric matrix that retains phages from interacting with their hosts . This talk is a summary of several phage/biofilm interaction studies conducted by our team involving different phage types and host species. A special attention will be given to the role of the EPS matrix in phage/biofilm interaction and the strategies used by phages to overcome the diffusional barrier imposed by it.