TOWARDS NEW POLYMER MATERIALS FOR THE REGULATION OF QUORUM SENSING AS A BIOFILM CONTROL STRATEGY

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Abstract:

The formation of biofilm on surfaces in contact with liquid media is a major public health concern (medical and food industry sectors), and has also significant economic and environmental impacts (navigation, water treatment sectors, …). In biofilms, bacteria communicate and cooperate through quorum sensing, a system based on small signaling molecules called autoinducers that regulates the expression of genes involved in processes such as colonization. Polymers designed to sequester these autoinducers represent a promising and innovative strategy to control biofilm development [1]. Among these materials, molecularly imprinted polymers (MIPs) offer a particularly attractive approach. By creating highly specific binding sites complementary in shape, size, and functional groups to target autoinducers, MIPs can selectively capture and neutralize these signaling molecules (Fig.1). This biomimetic strategy provides both robustness and reusability, making MIPs a promising alternative to conventional antimicrobial treatments for efficient and sustainable biofilm control, with potential applications ranging from medical and industrial uses to the prevention of biofouling in environmental systems [2].

In this work, the target molecules are the autoinducers from the acylated homoserine lactone (AHL) family. Instead of using one AHL in particular as template molecule, an analog dummy template was used with the aim of recognizing the entire AHL family with only one tailor-made MIP (Fig.2). The rational design of the MIPs was first based on a NMR study of the strength of the interactions between the template and the functional monomers. Different polymerization conditions were tested (precipitation/bulk polymerization, thermal/photo initiation...) in order to optimize the MIPs performances. Testing these polymers in complex microbiological environments has confirmed their ability to sequester AHL, their anti-biofilm properties, and their non-cytotoxicity, showcasing their potential for biofilm control.

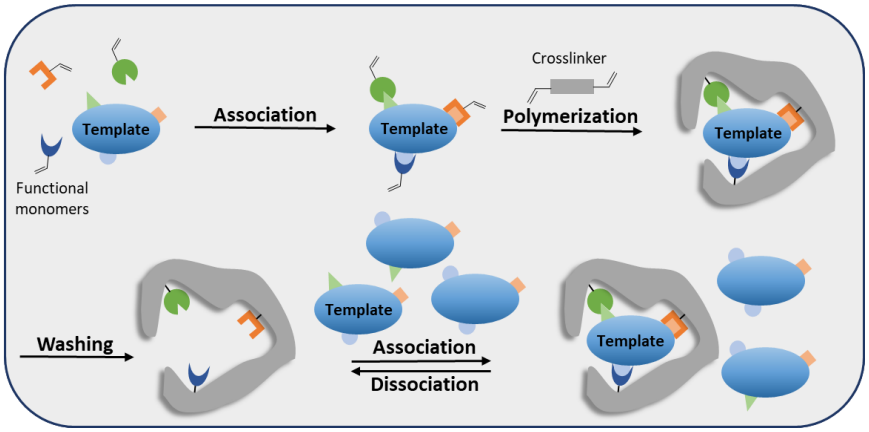

Figure 1. Synthesis of Molecularly Imprinted Polymer

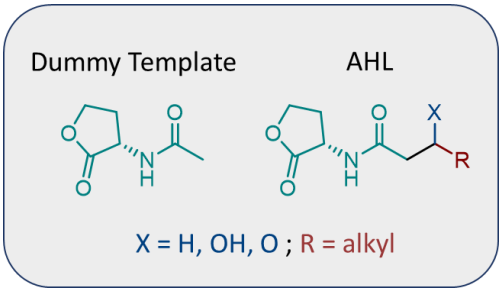

Figure 2. Dummy Template and AHL family

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