Development of microfluidic devices for bacterial communication and biofilm formation

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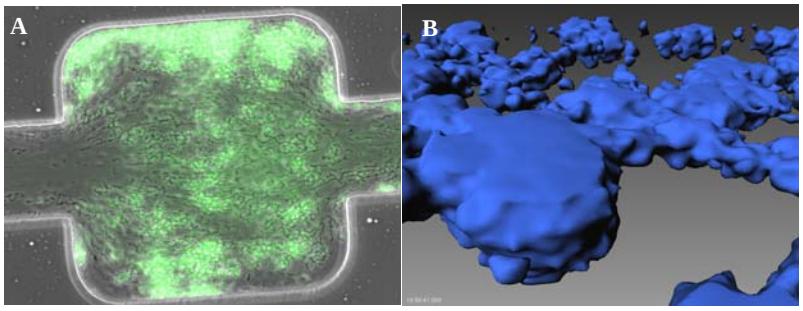
The overall goal of this project is to develop a fundamental understanding of bacterial cell communication and quorum sensing (QS) that is involved in multi-species biofilm formation. The propensity of bacteria to form highly-structured, multi-species biofilms in an exopolysaccharide matrix is well established. Biofilm formation has serious economic and biomedical implications, ranging from corrosion of pipelines to contamination of implants and prosthetic devices and infections. Conventional approaches to biofilm eradication such as application of antimicrobials and biocides have not been entirely successful. An understanding of the mechanisms belying biofilm formation is important for developing new strategies for biofilm control. Several reports have now shown that QS molecules are involved in biofilm formation, and that the different bacterial species in a biofilm uniquely recognize only QS molecules produced by their species. However, it is also becoming evident that multiple QS systems are present in bacteria and since, the number of bacteria is much greater than the number of known QS molecules, it is inevitable that the same QS molecule may be used in different bacteria. In this REU project, students will work on building different microfluidic devices for growing bacteria and investigating cell-cell communication and QS. Different QS molecules and inhibitors of biofilm formation (individually and in combination) will also be introduced into these microfluidic devices and their effect on biofilms determined using microscopy. The Figure below shows the development of a biofilm in a microfluidic device and reconstruction of the structure using fluorescence microscopy and image analysis.



(A) Bacterial biofilm developed in a 300 x 300 micron microfluidc device. Green indicates live bacteria. (B) IMARIS visualization of a bacterial biofilm.