Playing by the Rules: Structural and Spatial Organization of Biofilm Communities

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Abstract:

Bacterial biofilms are a ubiquitous form of bacterial growth. Biofilms consisting of bacterial, viruses, and protozoa exist in the environment and our gastrointestinal tract. Robust bacterial biofilms surviving off light and fixing carbon exist in deserts and on marble monuments. Biofilms can be a medical challenge when composed of a single pathogenic species or promote human health as a highly evolved microbiome ecology composed of hundreds of species. Regardless of their location, certain patterns emerge. Biofilms can behave as viscous liquids or rigid structures. The rigid structures can provide protection to more viscous biofilms. These structures can be intricately organized structures ready to respond to changes in environmental conditions at a moment's notice. Within complex multi-species communities, bacteria organize themselves into smaller communities, which are often interdependent of each other. Understanding the rules that govern their structural and spatial arrangements supporting their functions and interactions is a complex challenge best approached by a multidisciplinary approach of computational mathematics, mathematical modeling, machine learning, and engineering.

In this talk, we will review biofilm basics defining what is a bacterial biofilm, their ubiquitous nature, and their roles in promoting health and producing difficult to treat diseases. Then we will explore processes shared by biofilms independent of their environment and specific bacterial species composition and the methods to study them. Studying these processes may reveal underlying principles driving the structural and spatial arrangements of most biofilms. Topics will include the composition and material properties of biofilms and how ordered matrix molecules, and possibly aggregation, contribute to rigid structure development.

The next part of the talk will review the function of rigid structures. Rigid structures form when bacteria are under stress, including antibiotic stress, to provide protection to the community allowing survival and even continued growth. This suggests multicellular behavior with parts of the community providing protection to other regions that are actively growing to replace the dying cells resulting in steady state survival of a community including the formation of regions of viscous biofilm behind rigid structures under flow. This will include a discussion on how mobile genetic elements can reshape biofilms and possibly make commensal microbiota bacteria more pathogenic (able to cause disease).

Finally, the use of simple interdependent communities in extreme environments will be discussed as a model for spatial organization of biofilms communities, which may have implications for establishment of interdependent smaller communities within the context of larger multi-kingdom species.

Biography:

Bettina Buttaro is an Associate Professor in the Departments of Microbiology, Immunology, and Inflammation and Medical Education and Data Science at Temple University Lewis Katz School of Medicine as well as a member of the Sol Sherry Thrombosis Research Center. She is a bacteriologist with broad expertise in Gram-positive biofilms, metabolism, and genetics. Current interests are using multidisciplinary approaches to understand structure and spatial arrangements of bacterial biofilms and using *Enterococcus faecalis* as a model bacterium for probing how changes in biofilm structures may contribute to disease. She received a Ph.D. in Microbiology from the University of Minnesota in 1993.