The matrix reloaded: how a self-produced extracellular matrix controls the development of multicellular microbial communities

In nature, many bacteria live in multicellular communities called biofilms. Biofilms offer their resident bacterial cells protection from environmental insults and assaults, and better attachment to hosts. For humans, they have medical and industrial costs, but also benef?ts, in the root-associated biof?lms that are essential for many commercial crops.

In biofilms, bacterial cells are covered by a self-produced extracellular matrix, which glues them to surfaces and to each other. Importantly, the extracellular matrix and provides a chemical and mechanical barrier that protects the cells from environmental insults, such as antibiotics and antibacterial substances.

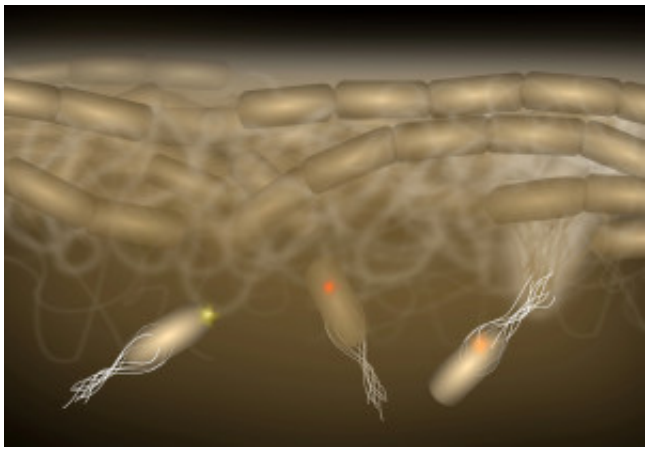

Fig. 1. Illustration of bacterial cell-extracellular matrix interactions leading to activation of signaling cascades.

Bacterial biofilm formation is a developmental process, in which various genetic programs are activated in a specific order in different subpopulations of cells. This organized, collective behavior is essential for the proper establishment of a functional structure, similar to the case of higher organisms, such as animals and plants. In animals and plants, multiple processes in the developing cells, such as cell proliferation, cell migration, tissue morphogenesis and homeostasis, are all controlled through signals from the extracellular matrix. These signals are perceived by specialized receptors on the cell surface, which then trigger specific responses. Those cell-extracellular matrix interactions were researched in great detail in high organisms. In bacteria, however, so far only a limited number of studies have addressed the role of bacterial extracellular matrix as a signaling platform during biofilm development.

In this review article, for the first time, we collected recent studies that demonstrate the involvement of the bacterial extracellular matrix in controlling cell behavior during different stages of biof?lm formation. Our review shows that biofilm formation is intricate, and that the bacterial extracellular matrix is surprisingly complex in its structure and function.

The studies presented in our review give a new perspective into the extracellular matrix as a pivotal player in signaling during the development of bacterial biof?lms. So far the extracellular matrix was found to regulate several important bacterial behaviors, such as bacterial capability to migrate (motility), to form especially resistant cell types (sporulation) and it was shown to positively regulate the production of additional extracellular matrix building blocks via positive feedback loops.

Understanding the internal processes that control biofilm development can lead to the development of new antimicrobial and antibiofilm agents against pathogenic bacteria, or to facilitate the colonization of beneficial bacteria on roots of commercial crops.

Steinberg Nitai *and* ***Kolodkin-Gal Ilana***
Department of Molecular Genetics
Weizmann Institute of Science
Rehovot, Israel

Publication

The Matrix Reloaded: Probing the Extracellular Matrix Synchronizes Bacterial Communities.
Steinberg N, Kolodkin-Gal I.
J Bacteriol. 2015 Mar 30