Multicellular systems, from bacterial biofilms to human organs, form spatial patterns and interfaces to achieve complex functionality with implications for various applications. Our ability to rationally engineer such active matter is still limited. My lab recently developed the first synthetic and optogenetic approaches to control cell-cell and cell-surface adhesion for bacterial self-assembly and patterning (‘Biofilm Lithography’). I will discuss the biophysical characterization of these tools and their applications to investigate cooperative antibiotic responses in biofilms. I will then demonstrate a synthetic 4-bit cell-cell adhesin logic to experimentally program and mathematically model universal two-dimensional interface patterns. These interfaces are generated through a swarming adhesion mechanism that enables precise control over interface geometry as well as adhesion-mediated analogs of developmental organizers and morphogen fields. Utilizing tiling and four-color mapping concepts, I present algorithms for creating versatile target patterns. Remarkably, a minimal set of four adhesins suffices to program arbitrary tessellation patterns, implying a low critical threshold for the engineering and evolution of complex multicellular systems. Finally, I will discuss applications for material sciences, health, biochemical synthesis, and greenhouse gas mitigation.

Thursday, 10.11.2022, 11:00 am

Hosts: Jochen Rink & Melina Schuh