Session: Tools & modelling

Multispecies phase diagram reveals biophysical principles of bacterial biofilm architectures

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Bacterial biofilms are among the most abundant multicellular communities on Earth and play essential roles in a wide range of ecological, medical, and industrial processes. Recently developed imaging techniques offer unprecedented insights into the three-dimensional internal structure and external morphology of growing biofilms, but general ordering principles that govern the emergence of biofilm architecture across species remain unknown. Here, we combine experiments and simulations to identify universal mechanical interaction properties that determine early-stage biofilm architectures of different bacterial species. Performing single-cell resolution imaging of *Vibrio cholerae, Escherichia coli, Salmonella enterica*, and *Pseudomonas aeruginosa* biofilms, we discovered that biofilm architectures up to a few thousand cells can be described by a two-dimensional phase diagram. Mechanistic simulations and experiments using single-species mutants for which the cell aspect ratio and the cell-cell adhesion are systematically varied, show that tuning these parameters reproduces biofilm architectures of different species. Early-stage biofilm architectures of different species therefore display a universal architectural structure, and their development is determined by conserved mechanical cell-cell interactions.