The Role of the S-layer Lattice in Archaeal Cell Shape Plasticity

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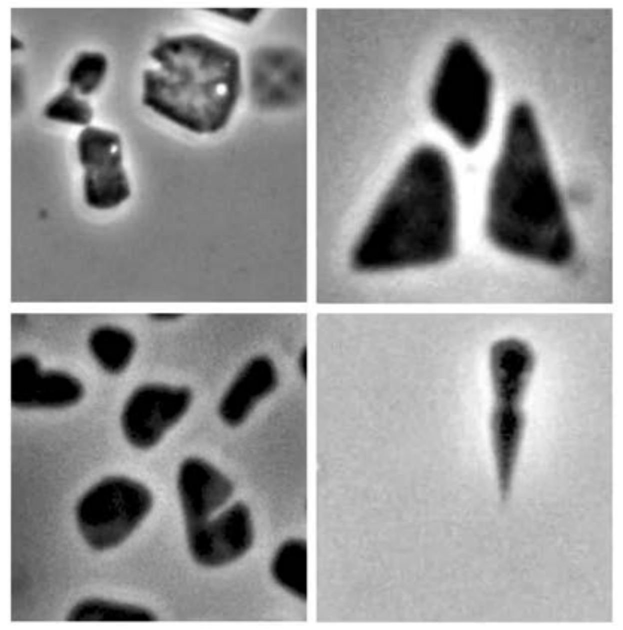
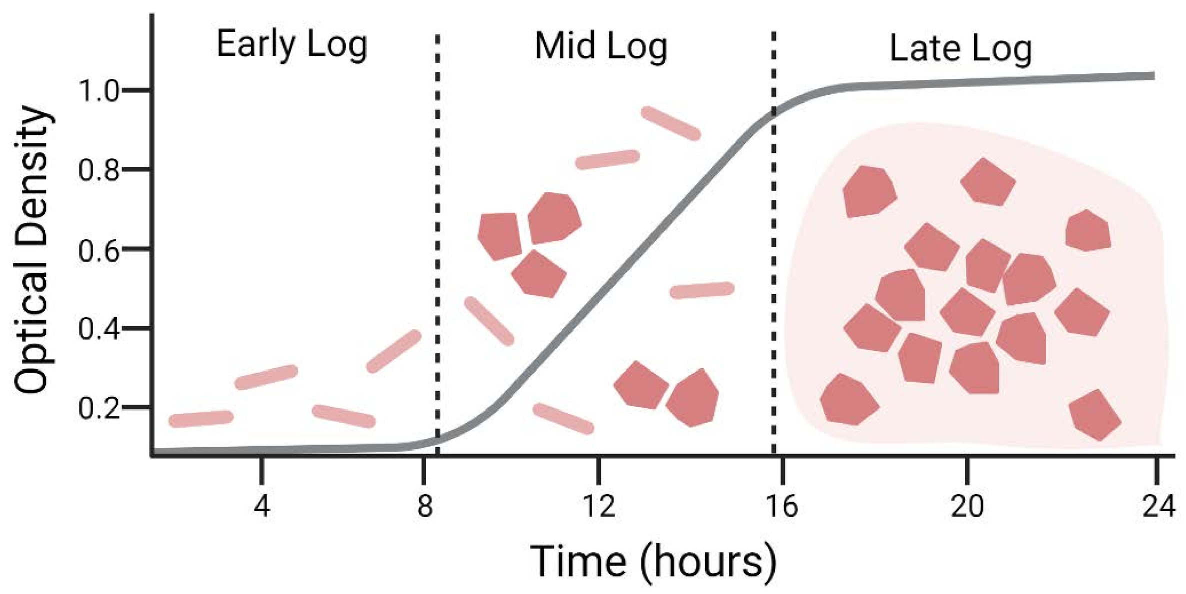
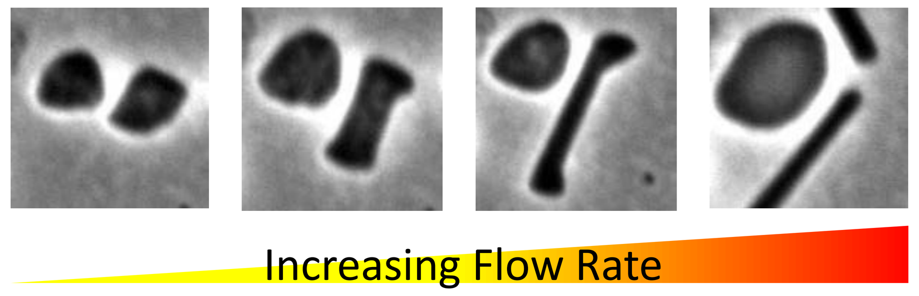
Transient and Diverse Morphologies in Haloarchaea

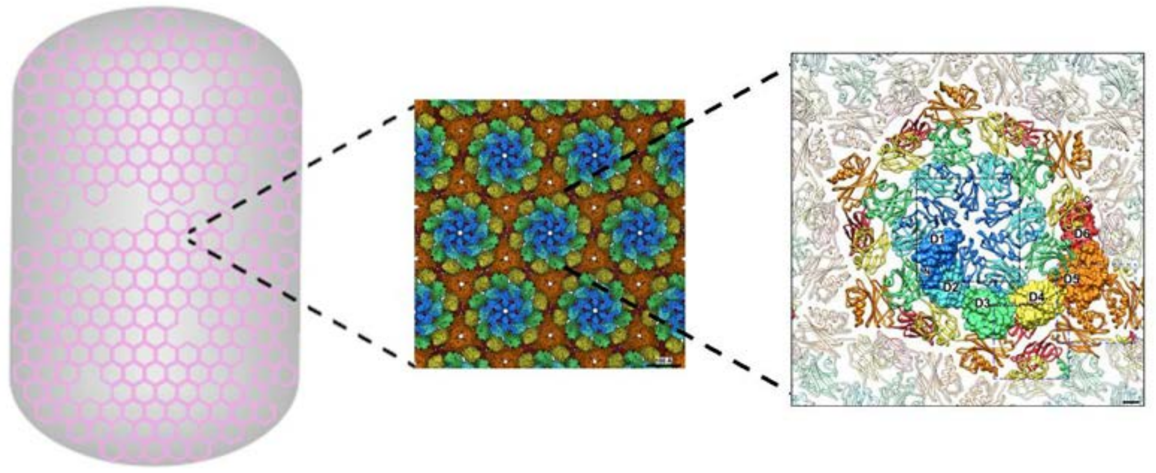






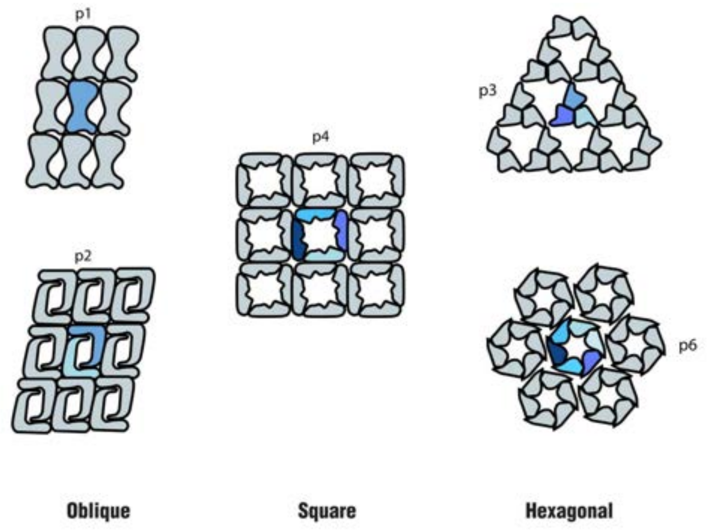
Haloarchaea are remarkable for their extremely diverse morphology across species (Left). *Haloferax volcanii* is notable for a consistent transition from motile rods to stationary disks as the density of a culture increases (Center). The reverse transition has also been observed within microfluidic devices as the flow rate of media increases (Above).

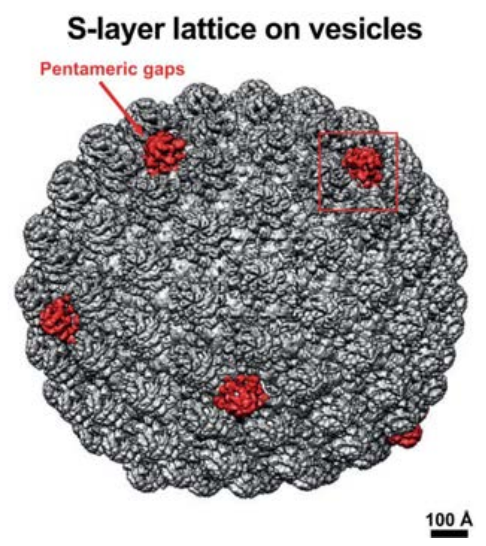
What Controls Cell Morphology?

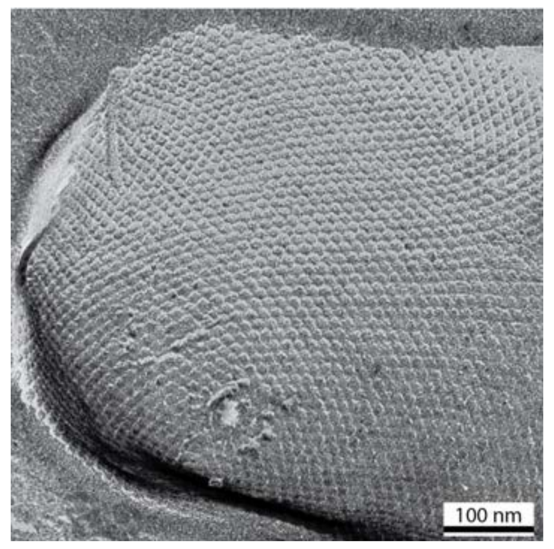


Archaea are encased by a proteinaceous semi-crystalline lattice called the S-layer[2]. The above figure shows how the main S-layer protein appears on *H. volcanii*[1]. I hypothesize this lattice is what controls archaeal cell morphology.

S-layer Lattice Structure





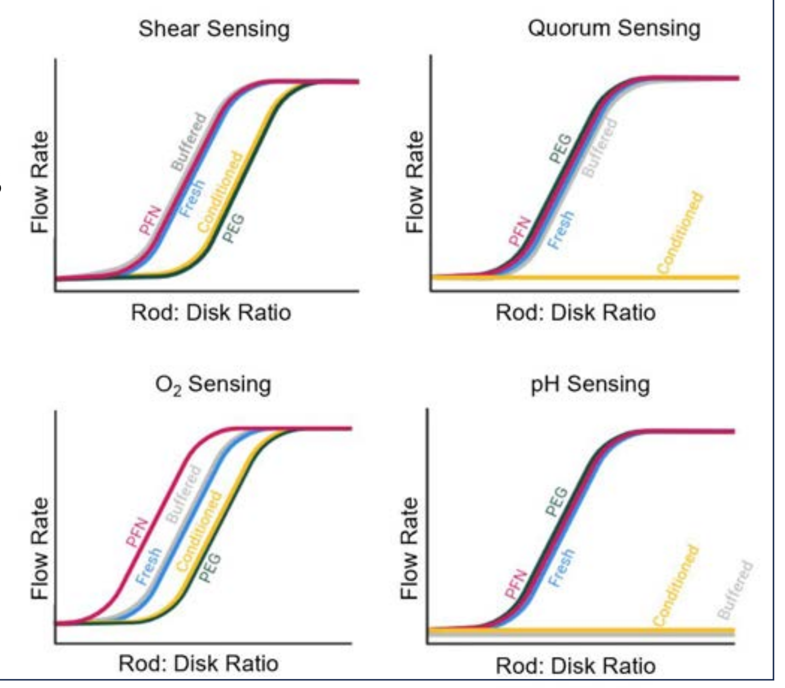


The lattice structure of the S-layer varies substantially across prokaryotic species[3] (Top Left). There have also been observations of imperfections at areas of high curvature in S-layer lattices, where hexameric subunits take on a pentameric form[1] (Top Center). TEM can be used to resolve the structure of the lattice[3] (Top Right).

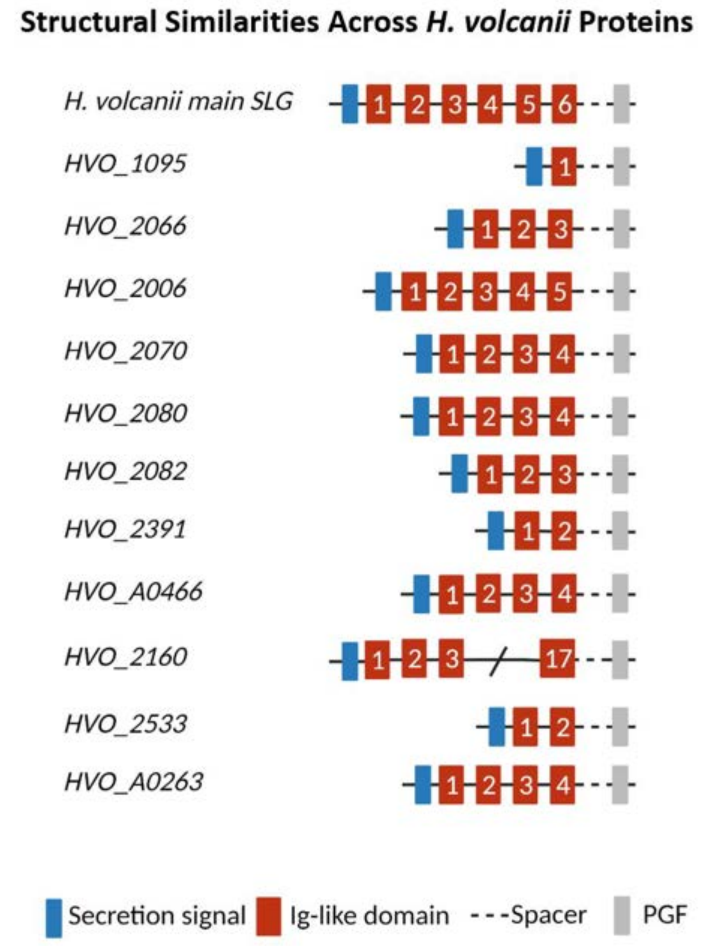
What Drives this Transition?

Possible mechanisms that could be driving this morphological transition include:

- Shear Sensing
- Quorum Sensing
- O_2 Sensing
- pH Sensing



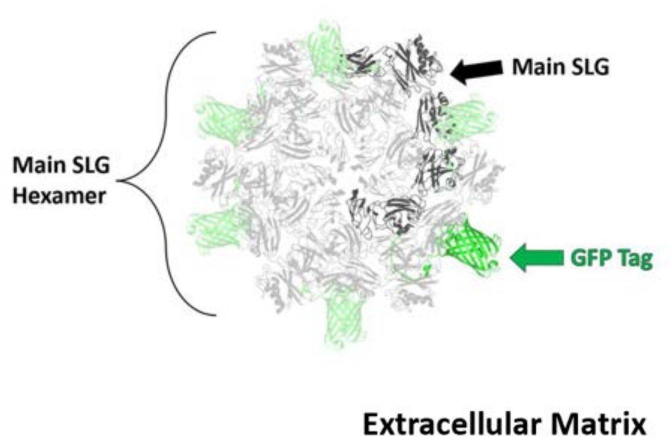
Putative S-layer Proteins



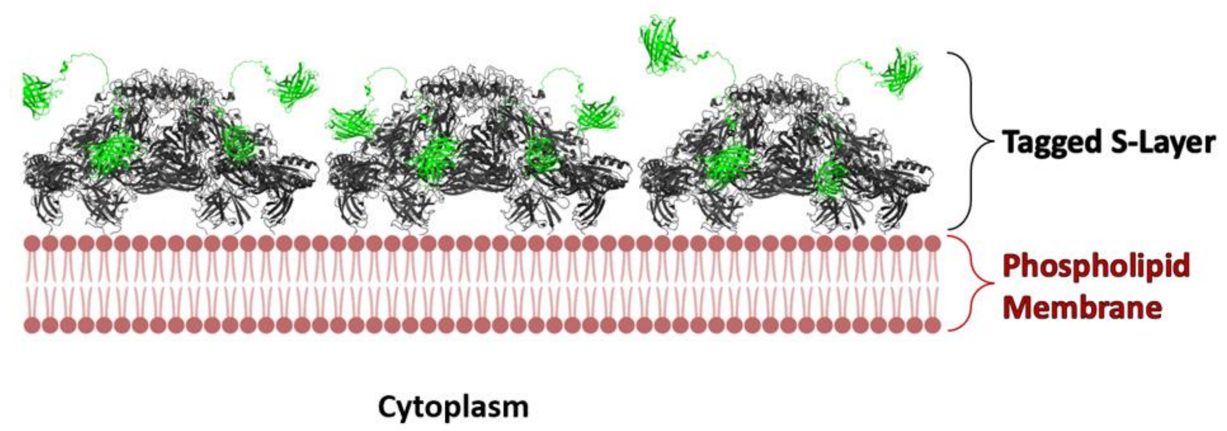
In addition to the main S-layer protein, there are 11 putative S-layer proteins with a similar structure in *H. volcanii's* genome (Left).

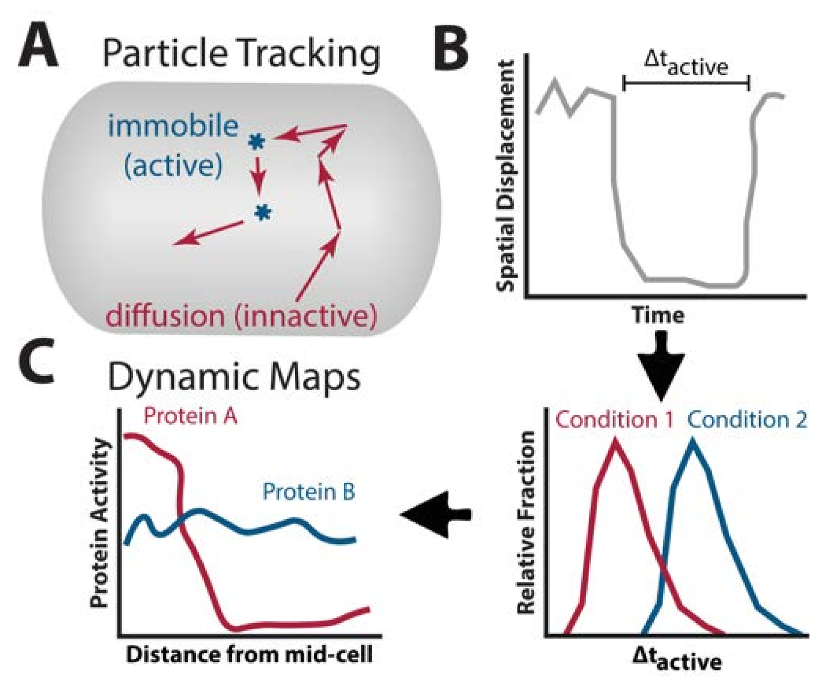
Using CRISPRi, these proteins can be knocked down and their effect on cell morphology can be observed.

S-Layer Dynamics



A tagged S-layer hexamer from above, with a single monomer highlighted (Left). A side view of the S-layer lattice as it appears on the cell membrane (Below).

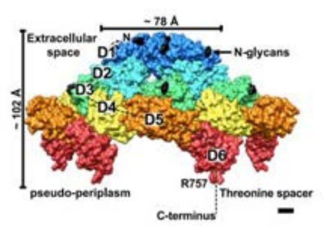


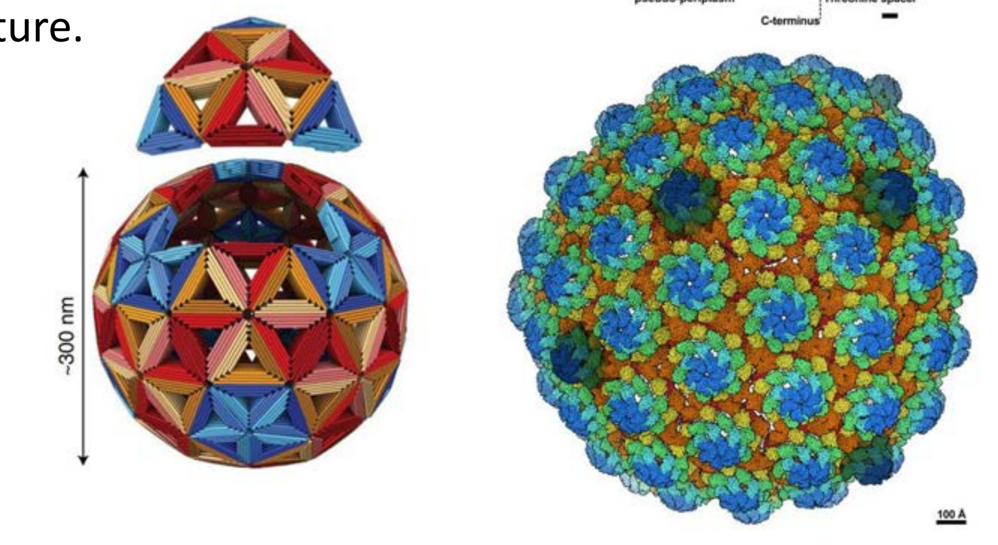


Single particle tagging can be used to create dynamic maps of the SLGs (Above).

Protein Origami in IRG1

To expand the limits of programmable self-limiting assembly, its vital to improve our understanding of these kinds of self-limiting structures found in nature.





An icosahedral DNA origami shell[4] (Left) and the S-layer lattice on a spherical vesicle with pentamers colored darker[1] (Right)

Acknowledgments

Thank you to Dr. Ben Rogers and everyone from the Bisson lab for the constant support and guidance, the Han Lab for their collaboration with creating a method for single-molecule particle tracking in the S-layer and Dr. Elad Stolovicki for his help in the design and manufacture of the microfluidic devices.

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