Cells Embedded in Cytoskeleton Composites for Living Materials

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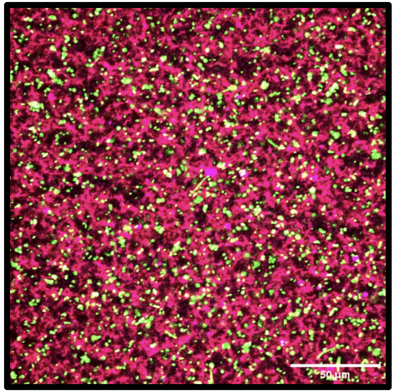
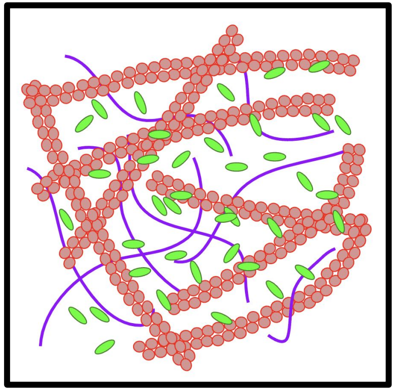
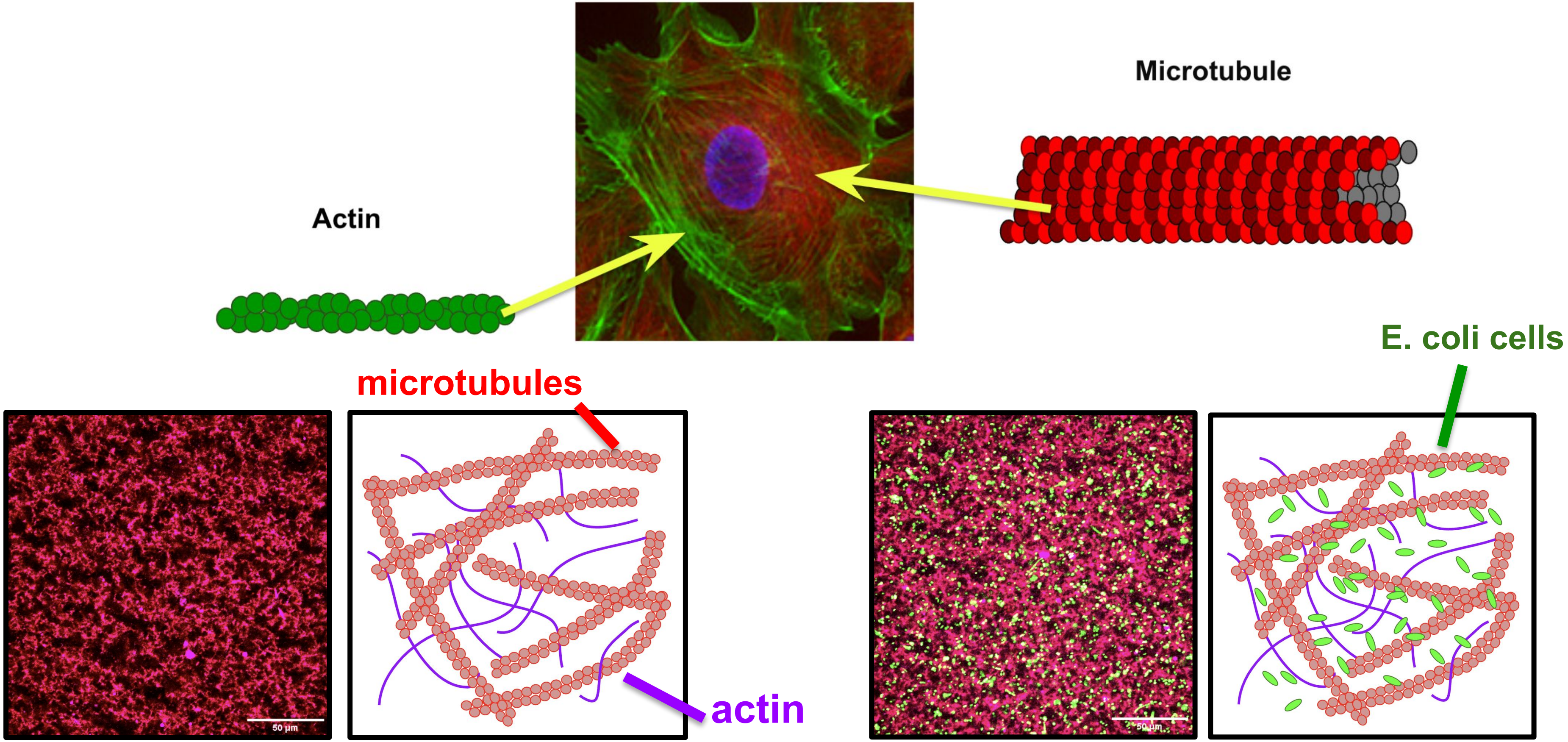
Project Abstract:

The cytoskeleton is a network of interconnected polymers that underlies many mechanical processes of cells including cell division, motility, signaling, and growth. The cytoskeleton's adaptability stems from the mechanical properties of its biopolymers, including rigid microtubules and semiflexible actin filaments. Understanding how embedded bacterial cells modify the fibrous scaffold's structure and mechanics, and how embedded cells are distributed within the scaffold, is critical to engineering tissue and living materials. Here, we examine the spatial distribution of embedded cells in networks of actin and microtubules; and, in turn, the impact of the embedded cells on the network structure. Using multi-spectral confocal microscopy and spatial image autocorrelation we quantify the characteristic structural correlation length-scales of both the cells and the filamentous network and map the relationship between cell concentration, filament rigidity, and network mesh size. Our preliminary results suggest that both rigidity and cell concentration play important roles in network mesh size and in the spatial distribution of cells. Our future work will investigate how the presence of the network influences cell growth, which is critical to tissue regeneration technologies and engineering adaptable materials that employ these composite scaffolds.

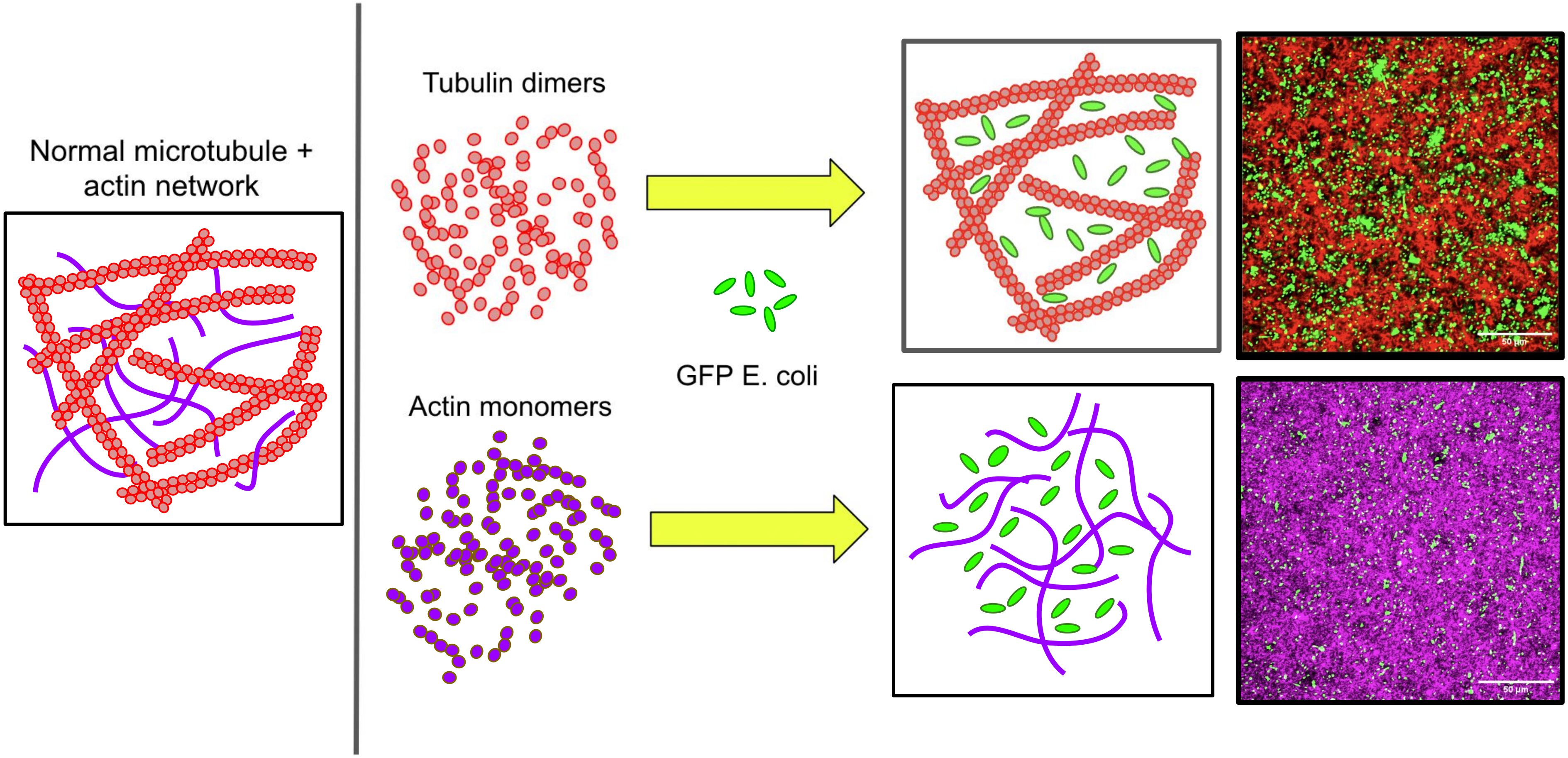




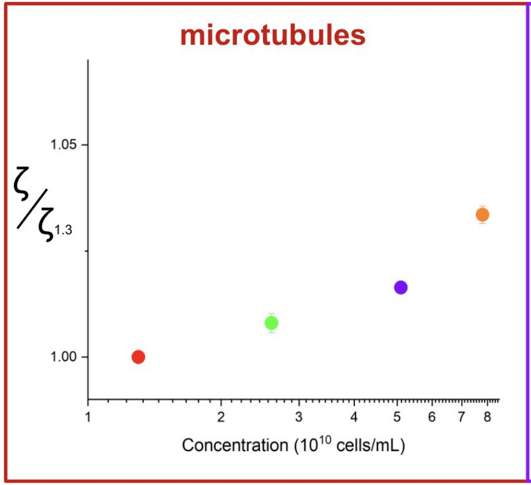
Restructuring effects of cytoskeleton biopolymers in response to embedded cells are studied for material engineering

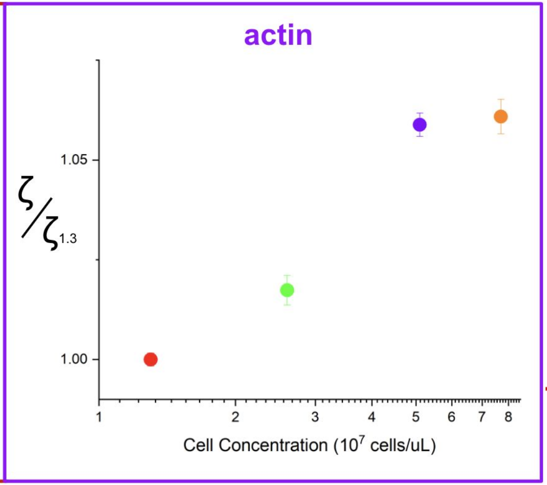


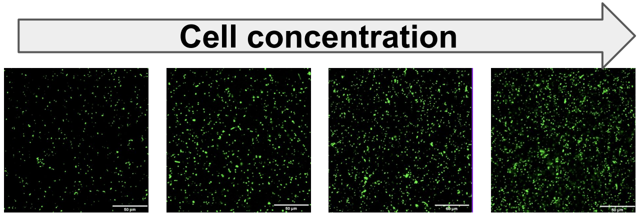
Microtubule and actin networks are polymerized around GFP E. coli cells



In single filament networks, actin increases in mesh size at greater rate than microtubules, and cell clumping has non-monotonic dependence on concentration

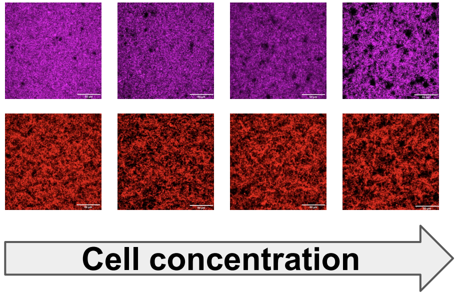


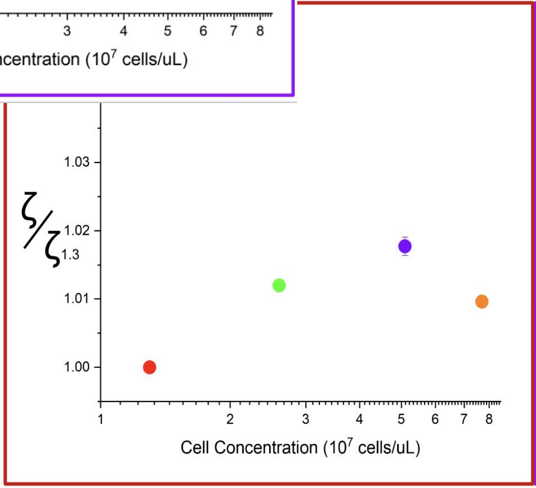


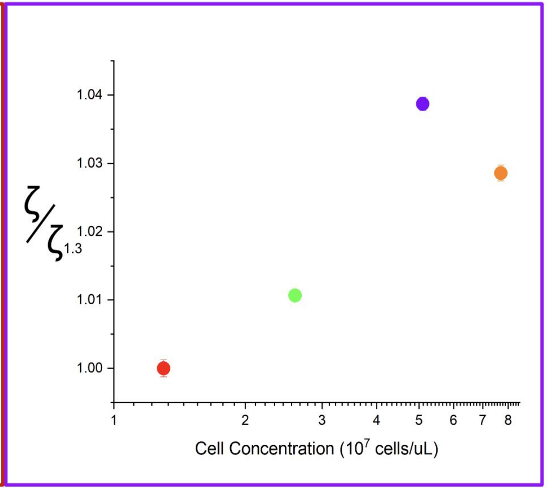


Cells in single filament scaffolds

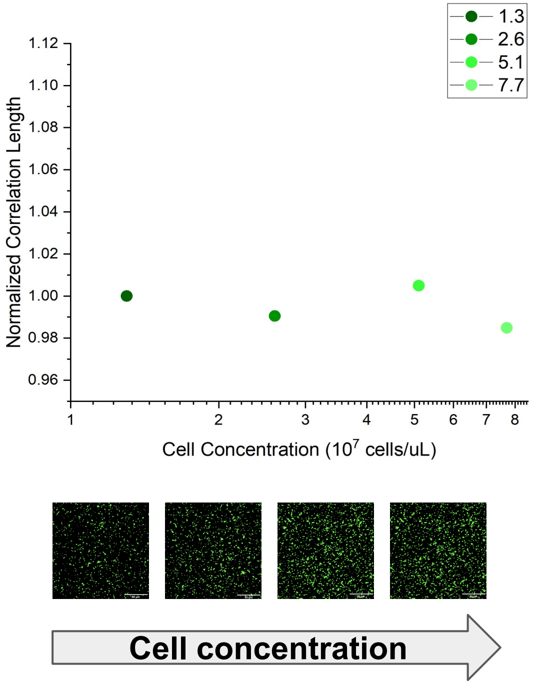
Single filament scaffolds

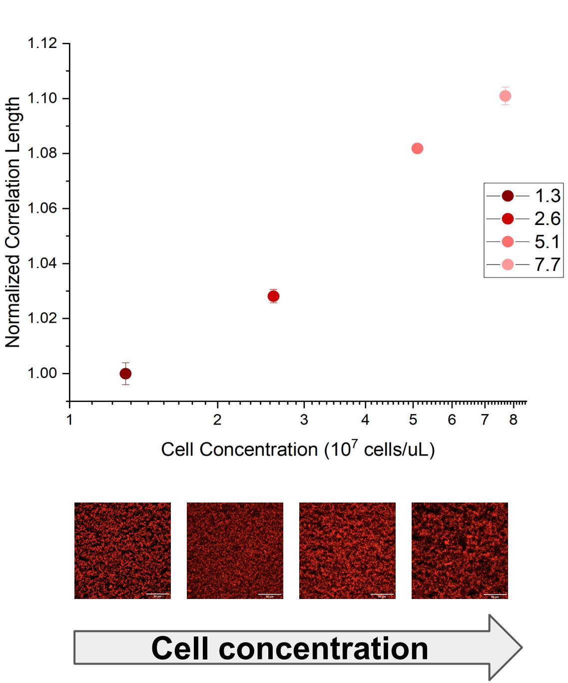


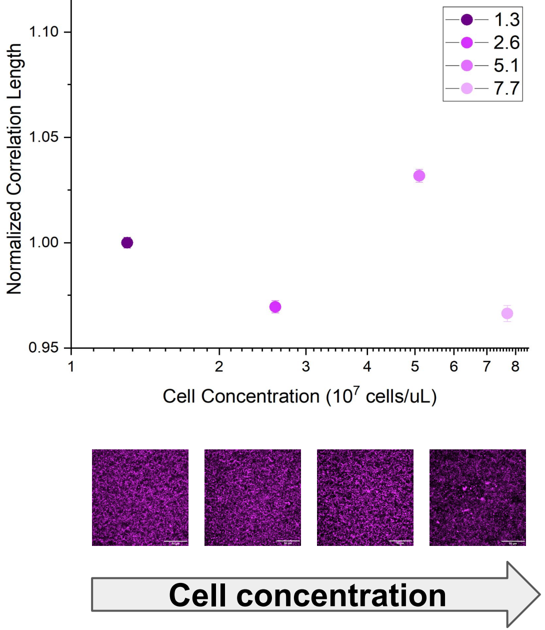




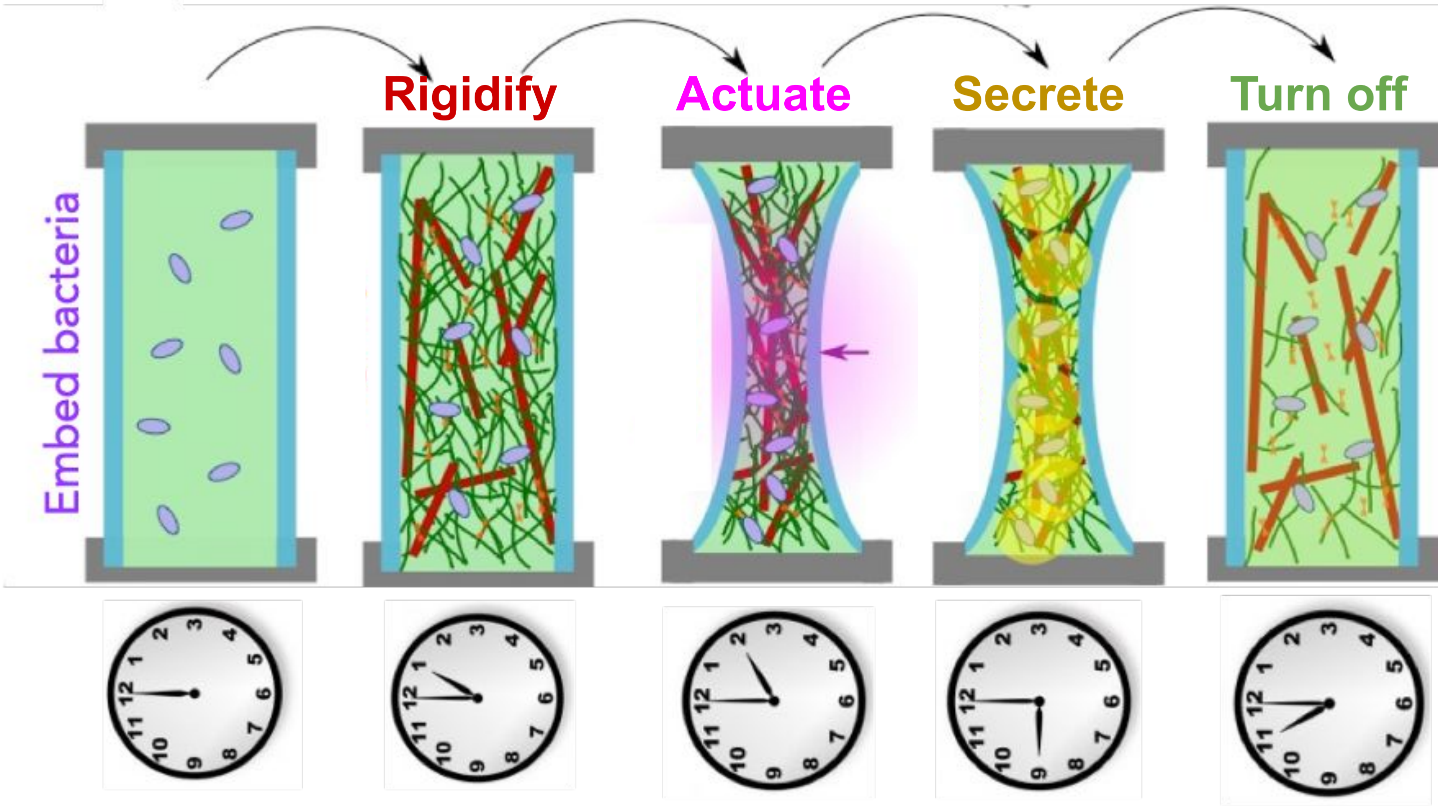
In two filament scaffolds, microtubule networks increase in mesh size, while actin networks and cells have non-monotonic relationship with cell concentration







Scaffolds with embedded cells can be used for living materials and tissue engineering



BioSPOT Lab, Dr. Rae Anderson