The native extracellular microenvironment is dynamic, as cells synthesize, assemble, and remodel their surroundings during tissue development, injury, and repair. Hydrogels have evolved as valuable tools to both study mechanisms of cell-extracellular matrix (ECM) interactions (e.g., mechanobiology) and to guide desired cell behavior towards the development of new therapies (e.g., tissue repair/regeneration); however, the dynamic nature of the cell-ECM interface has been underappreciated. To address this, we are utilizing metabolic labeling techniques to visualize secreted matrix proteins to better understand how this nascent matrix influences cellular function and we are designing viscoelastic hydrogels that harness dynamic cell-hydrogel interactions. I have used these techniques to explore questions related to cellular mechanosensing in 3D, to better understand the evolution of matrix in modifying the cell-hydrogel interface in the engineering of tissues (e.g., cartilage), and to develop microengineered hydrogel platforms for the culture of organoids (e.g., lung) towards cellular therapies and as in vitro models of tissue repair. Our evolving understanding of this interface will not only open up new avenues for understanding biological mechanisms, but will allow us to design better systems for biomedical therapies.

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