We engineer biomaterials to explore the dynamic interplay between cells and their microenvironment. We apply these platforms to address fundamental human health challenges including: 1) Treatment of diseases such as fibrosis and cancer, 2) Repair and replacement of tissues and organs, 3) Improved understanding of how cells transduce microenvironmental signals.

Life is constantly evolving and happening in three dimensions, and yet most of what we know about how cells interact with their environment comes from work on flat and hard surfaces that do a poor job of recapitulating the architecture, mechanics, and biologics of tissues and organs. Therefore, the development of dynamic biomaterial tools that re-create the heterogeneous microenvironments of physiological and pathological conditions is essential to addressing challenges facing modern medicine.
Engineering Dynamic Hydrogels for Studying Fibrosis and Cancer
Nearly all synthetic biomaterials present an elastic, mechanically static environment to cells, despite tissues being viscoelastic and displaying dynamic stiffening during development and disease progression (e.g., liver fibrosis and cancer). The ability to fabricate more realistic, tissue-like materials will enable improved cell culture experiments. We are developing new classes of modular hydrogels that exhibit time-dependent mechanics (viscoelasticity) reminiscent of natural tissues while also displaying independently tunable crosslinking density and degradability. We use these materials to model liver disease and screen potential therapeutics using patient-derived cells.

Design of Clinically Translational Tissue Engineering Scaffolds
Muscle injuries and diseases are pervasively common in patients of many backgrounds ranging from elite athletes and soldiers to the elderly. While the vast majority of tissue engineering approaches focus on the healing of a single tissue many injuries, especially in orthopedics, happen at the interface between two distinct tissues. Indeed, the majority of muscle injuries occur at the fibers near the interface with tendon, known as the muscle-tendon junction (MTJ). Despite these facts, clinical and tissue engineering approaches to MTJ regeneration are lacking. We are engineering conductive collagen composites that should have a significant impact on not only the repair of skeletal muscle, but also other tissues including peripheral nerves and cardiac muscle.

Development of Hybrid Materials for Cell Delivery and Mechanosensing Studies
Fibrous hydrogels have recently emerged as useful substrates for a range of regenerative medicine applications. Unfortunately, many fibrous materials are limited by poor mechanics, inadequate cell infiltration, and/or do not support minimally invasive delivery strategies necessary for in vivo applications. We are harnessing the power of supramolecular chemistry to create self-assembled injectable fibrous materials that should be useful as both in vitro models of cellular mechanotransduction and as in vivo depots for therapeutic delivery.

RECENT RESEARCH DEVELOPMENTS
- Part of a collaborative effort to elucidate the role of N-cadherin in modulating stem cell mechanosensing, published in Nature Materials.
- Published an instructive guide to using hydrogels for cell culture in Nature Methods.
- Developed a class of stiffening hydrogels to probe the role of YAP/TAZ mechanical signaling in the progression of liver fibrosis.

RECENT GRANTS
- Part of a team establishing SIF-funded Center for Advanced Biomanufacturing. This center will provide tools for the design, fabrication, and characterization of (bio) materials for diverse applications in tissue engineering and soft matter.

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