Sarah Heilshorn
Assistant Professor
Materials Science and Engineering
Stanford University

Engineering protein-based hydrogels to improve stem cell transplantation

Stem cell transplantation is a promising therapy for a myriad of debilitating diseases and injuries; however, current delivery protocols are inadequate. Transplantation by direct injection, which is clinically preferred for its minimal invasiveness, commonly results in less than 5% cell viability, greatly inhibiting clinical outcomes. We demonstrate that mechanical membrane disruption results in significant acute loss of viability at clinically relevant injection rates. As a strategy to protect cells from these damaging forces, we show that cell encapsulation within hydrogels of specific mechanical properties will significantly improve viability. Building on these fundamental studies, we have designed a reproducible, bio-resorbable, customizable hydrogel using protein-engineering technology. In our Mixing-Induced Two-Component Hydrogel (MITCH), network assembly is driven by specific and stoichiometric peptide-peptide binding interactions. By integrating protein science methodologies with simple polymer physics models, we manipulate the polypeptide chain interactions and demonstrate the direct ability to tune the network crosslinking density, sol-gel phase behavior, and gel mechanics. This is in contrast to many other physical hydrogels, where predictable tuning of bulk mechanics from the molecular level remains elusive due to the reliance on non-specific and non-stoichiometric chain interactions for network formation. Furthermore, our MITCH materials enable stem cell and growth factor encapsulation at constant physiological conditions – a significant advantage over other commonly used hydrogels such as collagen and Matrigel. Through a series of *in vitro* and *in vivo* studies, we demonstrate that these materials may significantly improve transplanted stem cell retention.

Sarah Heilshorn Biography

Sarah Heilshorn is Assistant Professor at Stanford University in the Departments of Materials Science and Engineering, Bioengineering (by courtesy), and Chemical Engineering (by courtesy). Prior to joining Stanford in 2006, Prof. Heilshorn was a postdoctoral scholar in the Department of Molecular and Cell Biology at the University of California, Berkeley. She completed her Ph.D. and M.S. studies in Chemical Engineering at Caltech in 2004 and 2000, respectively. She earned a B.S. in Chemical Engineering at Georgia Tech in 1998. She combines these diverse fields to design new materials that mimic those found in our own bodies for applications in tissue engineering and regenerative medicine. Recent recognitions include the NSF CAREER Award and the NIH New Innovator Award.