Carnegie Mellon
Materials Science and Engineering Seminar Series

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"*Hydrogels for Cell Encapsulation and Injectable Delivery via Peptide Folding and Consequent Self-assembly*"

Wednesday, January 24, 2007
10:45 A.M. Seminar in Doherty Hall A310

The local nano- and overall network structure, and resultant viscoelastic and cell-level biological properties, of hydrogels that are formed via β-hairpin self-assembly will be presented. These peptide hydrogels are potentially ideal scaffolds for tissue repair and regeneration due to their ability to mimic natural extra cellular matrix. The 20 amino acid peptide MAX1 (H_2N-VKVKVKVKV^{D}PPTKVKVKVKV-$CONH_2$), has been shown to fold and self-assemble into a rigid hydrogel based on environmental cues such as pH, salt, and temperature including physiological conditions. The hydrogel is composed of a network of short fibrils that are 3 nm wide and up to several hundred nm long with no covalent crosslinking required for gel stiffness. In addition, slight design variations of the MAX1 sequence allow for tunability of the self-assembly/hydrogelation kinetics. In turn, by controlling hydrogel self-assembly kinetics, one dictates the ultimate stiffness of the resultant network and the kinetics through which gelation occurs. Importantly, once formed into a solid, self-supporting gel the network can be disrupted by the introduction of a shear stress. The system can shear thin but immediately reheal to preshear stiffness on the cessation of the shear stress. This shear thinning, or thixotropic, behavior of these physical networks makes them interesting candidates for injectable delivery *in vivo* where no post injection chemistry is required to set up the network. Initially, 2D cultures of several cell lines (including progenitor osteoblasts, fibroblosts, and mesenchymal stem celles) proved that the hydrogel is nontoxic and sustains cellular attachment with or without serum proteins without altering the physical properties of the hydrogel. The cell-material interaction is normal in 2-D and so was extended into 3D by cell encapsulation. The ability to control the kinetics of assembly afforded the control of homogeneous cell encapsulation in 3-D. Cells were observed to remain viable in 3-D culture for extended periods of time. Peptide design for folding and self-assembly, self-assembly characterization, gel material properties, and cell-level biological properties of these peptide hydrogels will be discussed.

Darrin Pochan is currently an associate professor in the Materials Science and Engineering Department as well as the Delaware Biotechnology Institute at the University of Delaware. Since joining the department in 1999 after a Ph.D. in Polymer Science and Engineering at the University of Massachusetts-Amherst and a National Research Council Post-doctoral fellowship at the National Institute of Standards and Technology in Gaithersburg, MD he has developed a research program around the contruction of new materials and nanostructures via molecular self-assembly mechanisms. The specific collaboration with the group of Prof. Joel Schneider in Chemistry/Biochemistry at UD concerning the design and self-assembly of b-hairpins into hydrogels for tissue engineering applications has, to date, led to over 10 publications and several patents and current funding from the National Institutes of Health. Recent honors for Darrin include an NSF Career Award, the DuPont Young Faculty Award, and the Dillon medal from the American Physical Society. Currently, Darrin also serves as Associate Editor for North America of Soft Matter, a new interdisciplinary journal from the Royal Society of Chemistry in the United Kingdom.