Optimizing Fabricated Collagen Fibers

Cell and Tissue Engineering Laboratory
Department of Biomedical Engineering
Tulane University

There are significant medical needs for engineered tissue constructs to replace tissue lost to burns, trauma, cancer surgery, birth defects, *etc.* The abundance and structural importance of collagen in the body make this biomaterial a logical choice for a broad spectrum of tissue engineering applications. We are therefore investigating composite biomaterials consisting of type I collagen fibers embedded in Type I collagen gels. The fibers can be fabricated with varying diameters and lengths. Long continuous fibers in the composites govern the tensile tangent modulus of the constructs; the gel phase of the constructs is hospitable to cell culture; and short embedded fibers limit contraction of the gel phase while maintaining high permeability throughout the gel phase. To date, we are unaware of any attempts by other groups to create similar collagen fiber/collagen gel composites for soft tissue reconstructions. The presence and properties of the collagen fibers are critical to the overall properties of the collagen composites, and our preliminary work has indicated that changes in select fiber formation protocol steps significantly affected the resulting fibers. Therefore the goal of this project is to analyze the fiber formation protocol, with the ultimate goal of strengthening the resulting fibers. Students who undertake this project will complete a fractional factorial experimental design to determine effects of collagen weight percent, mixing time, and buffer pH on resulting extruded fiber defects, diameter, and tensile strength. Students will develop their skills in experimental design and statistical analysis of data, light microscopy, and mechanical testing. This is an ideal project for students with positive attitudes who are interested in the 5^{th}-year M.S. program or other graduate school experience to study biomechanics/tissue engineering. To apply for this project, please send a resume and a cover letter, including your future educational/employment plans/goals, to Dr. Dee.

An Investigation of Collagen Composite Biodegradation

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The medical needs for engineered tissue constructs to replace tissue lost to burns, trauma, cancer surgery, birth defects, *etc.* have inspired us to investigate composite biomaterials consisting of type I collagen fibers embedded in Type I collagen gels. A series of well-regarded studies by Gentleman, *et al.*, demonstrated that collagen composites populated with living fibroblasts and maintained under standard culture conditions (for 25 days) displayed significantly higher tangent moduli and peak stresses when compared to composites maintained under similar conditions without cells. The data indicated that the

cell-free composites were losing mechanical strength over time, while the cell-populated composites were maintaining their mechanical strength. We therefore hypothesize that these collagen composites may degrade under standard culture conditions over time, and that this (hydrolytic) degradation outpaces any cell-based protease degradation (within the time frame of a typical cell culture experiment). The goal of this project is therefore to quantitatively measure the biodegradation of collagen composites *in vitro,* with and without incorporated cells, over selected time frames by measuring the hydroxyproline content in the culture media and by assaying for collagenase/protease activity of the cells. Students who undertake this project must possess fundamental cell culture skills, must be comfortable conducting independent literature searches, and should understand that optimizing a new assay often requires an iterative experimental approach. Students will develop their skills in colorimetric assay development and testing, cell culture, and histology. This is an ideal project for students with positive attitudes who enjoy working relatively independently, and who are interested in attending graduate school to study cell/tissue engineering or medical school. To apply for this project, please send a resume and a cover letter, including your future educational/employment plans/goals, to Dr. Dee.