



National Science Foundation Research Experiences for Undergraduates (NSF REU)

Integrated Bioengineering Research, Education, and Outreach Opportunities for Females and Underrepresented Minorities at Worcester Polytechnic Institute (WPI)

Proposed* projects for summer 2009

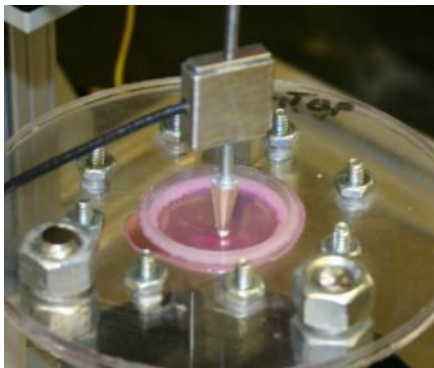
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*by the time the summer rolls around, the projects may change somewhat

Using mechanical cues to develop functional engineered tissues

Advisor: Prof. Kristen L. Billiar, Biomedical Engineering Department

[Tissue Mechanics and Mechanobiology Laboratory](#)



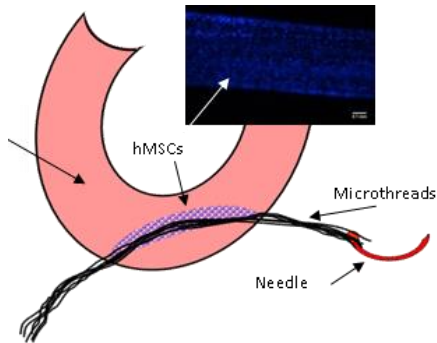
Tissue engineering is a promising new approach for creating living replacements for soft connective tissues (e.g., skin, tendons, and blood vessels). A thorough understanding of the factors that stimulate and guide tissue development is necessary for engineering viable tissues; however, many of the processes involved in tissue growth are unclear. Our goal is to decipher how the cells within tissues sense and respond to their mechanical environment. Due to the broad nature of this project, two REU students with different but symbiotic skills will work together (e.g., one student interested in biomechanics and one focused on tissue engineering). Experience with cell culture, Labview, and CAD/machining is desired but not essential.



Delivery of Stem Cells to the Heart

Advisor: Prof. Glenn R. Gaudette, Biomedical Engineering Department

Myocardial Regeneration Lab

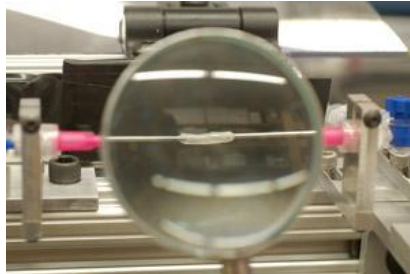


Recent evidence suggests that the delivery of human mesenchymal stem cells (hMSCs) to the infarcted heart improves mechanical function in both clinical and experimental animal studies. However, a major limitation of cell delivery systems for cardiac repair has been ineffective localization. Recently, we have developed new methods for producing fibrin microthreads for delivery of hMSCs to the heart. UGs will be asked to consider microthread characteristics for delivery of cells to the heart. These characteristics may include mechanical properties needed to pull threads through the heart and biological properties of the threads that may aid in cell retention by the heart.

Analysis of mechanical properties of tissue engineered blood vessels.

Advisor: Prof. Marsha Rolle, Biomedical Engineering Department

Our lab is testing cell culture and genetic engineering approaches to augment extracellular matrix (ECM)



synthesis in smooth muscle cells, toward the generation of cell-based vascular grafts with functional and structural properties that mimic normal blood vessels. REU students will seed cells onto mandrels to form cellular tubes, which will be cultured in the presence of soluble factors that have been shown to promote ECM synthesis in vascular smooth muscle cells, such as transforming growth factor- β (TGF- β) and ascorbate. Biochemical, histochemical, and mechanical analysis (burst pressure testing; see image, left) of cellular tubes will be performed to assess the effects of ECM composition on blood vessel mechanical function.

Role of Cranberry on Adhesion of Uropathogenic *E. coli*

Advisor: Prof. Terri Camesano, Department of Chemical Engineering

Bacterial Adhesion and Interaction Forces Laboratory



E. coli are the main culprit in the development of urinary tract infections (UTI) in the body. The consumption of cranberry juice is often recommended to help prevent UTIs from developing, and the mechanism of this action is believed to be due to cranberry compounds causing *E. coli* to be unable to attach to urinary tract cells. We are performing clinical studies in collaboration with Rutgers University, to investigate whether cranberry compounds turn into anti-adhesive metabolites in the body. After a volunteer consumes cranberry juice cocktail or a placebo beverage, we use atomic force microscopy to measure whether nanoscale adhesion forces are altered for the pathogenic *E. coli*.



WPI-NSF REU in Bioengineering



Fighting Food-Borne Pathogens with Antimicrobial Peptides

Advisor: *Prof. Terri Camesano, Department of Chemical Engineering*

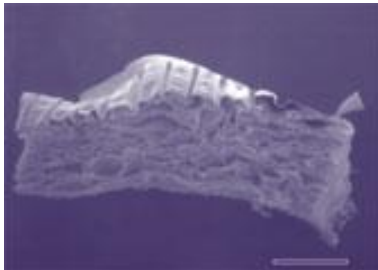
[Bacterial Adhesion and Interaction Forces Laboratory](#)



E. coli O157:H7 is a common pathogen associated with contaminated beef, lettuce, spinach, and other foods. We are exploring the use of antimicrobial peptides (AMPs) for their abilities to selectively bind to and inactivate pathogenic *E. coli*. Over 150 AMPs have been found in nature, and while they generally work against bacteria, viruses, and fungi, most are non-toxic to human cells. For example, cecropin P1 is a small peptide produced by the Cecropia moth, and our lab demonstrated that it binds with *E. coli* O157:H7, but not with non-pathogenic strains of *E. coli*. We will study the mechanisms by which peptides can inactivate bacteria, in order to develop strategies for reducing foodborne bacterial contamination.

Engineering of Microtextured Basal Lamina Analogs to Control Keratinocyte Function and Enhance the Performance of Bioengineered Skin Substitutes

Advisor: *Professor George Pins, Department of Biomedical Engineering*



Engineered tissue analogs have achieved some clinical success as substitutes for damaged skin. However, prolonged healing times for regenerated skin and mechanically induced graft failure remain persistent problems. The rational design of bioengineered skin substitutes requires an understanding of the mechanisms by which the three-dimensional microarchitecture and the biochemical composition of tissue scaffolds modulate keratinocyte adhesion, proliferation and differentiation, as well as the morphogenesis of cells into analogs of functional skin. With funding from the Whitaker Foundation, we are quantitatively analyzing keratinocyte function on microtextured basal lamina analogs and identifying parameters that will improve the design and performance of bioengineered skin substitutes used to treat skin injuries.

Development of Chemical Methods for Modifying the Surfaces of Surgical Implants to Prevent Biofilm Formation

Advisor: *Prof. Chris Lambert, Department of Chemistry and Biochemistry*



Biofilms are complex matrices of proteins, polysaccharides and bacteria that form on the surfaces of surgically implanted devices such as catheters. Biofilms lead to post-operative infections that lengthen recovery times and hospital stays, increased healthcare costs and greater risk of complications. This project will involve the deposition of chemical coatings on implant materials and the determination of the effectiveness of these coatings in preventing biofilm formation and bacterial growth.