Engineering the meniscus to bone attachment by manipulating growth factor gradients.

The menisci are fibrocartilage disks in the knee that act as shock absorbers and provide stabilization and facilitation of load transmission. Meniscus injuries are one of the most common pathologies of the knee, and intrinsic repair is limited due to the lack of blood supply to the tissue. Therefore, a replacement option is needed. In the clinic, surgeons use a replacement meniscus that includes bone to be able to recapitulate the biomechanics of the native meniscus. The soft tissue-to-bone gradient comprises gradients in mineralization, cellular phenotypes, extracellular matrix (ECM) composition, and collagen architecture. Recapitulating the native structure and mechanical properties in tissue-engineered systems is an engineering challenge.

The Bonassar Lab (BME/MAE) is working on developing different techniques to improve the ECM structure and mechanical properties in tissue-engineered meniscus constructs. We collaborate with the Estroff Lab (MSE), Colbath Lab (Veterinary Medicine), and the Hospital for Special Surgery Biomechanics Lab in NYC. A variety of biomechanical and biochemical stimulants have been used to better mimic native meniscus. Hypertrophic chondrocytes are a specific cellular phenotype specifically found at the interface between soft tissue and bone and are involved in mineralizing their surrounding environment. Developing a systematic way to pattern hypertrophic fibrochondrocytes at the interface of tissue-engineered constructs could help mimic native tissue architecture and improve mechanical properties. Applying biochemical gradients of growth factors to tissue-engineered constructs can aid in patterning cell phenotypes.

Students who join the team will be tasked with 1) Optimizing a protocol to culture meniscal fibrochondrocytes in 3D culture of both collagen gels and bone, 2) Testing optimized culture conditions on tissue-engineered meniscus constructs, 3) Characterizing the ECM content and mechanical properties of the constructs using biochemical analysis and mechanical testing. Depending on the student's interests and background, additional opportunities may exist to further analyze these constructs using image analysis and histological staining. A student working on this project can expect to learn the fundamentals of tissue engineering including 1) Primary cell isolation and maintenance from dissection to 2D cell culture, 2) Scaffold selection for cell expansion and differentiation from seeding to encapsulation 3) Evaluation of tissue-engineered constructs performance from composition to mechanics.

This project is well suited for a sophomore/junior who is excited about tissue engineering and has a basic understanding of biology, the cell environment, and basic laboratory experience (e.g. General Chemistry 1 and 2 Lab). Interested students should forward a copy of a resume and unofficial transcript to:

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