

Undergraduate Project #1

Morphometric Analysis of Bony Variation in Modern Humans
Biomechanics Laboratory
Department of Biomedical Engineering
Tulane University

An emerging area of research with application to many scientific disciplines is 'morphometrics', or the study of shape and shape change. As a first step within biomechanics, this project is intended to examine bony variation in multiple locations within the human skeleton, and determine if the observed anatomical variation is uniform across the skeleton. Given the interaction between form and function at different locations within the skeleton, it seems reasonable to expect some differences. A digitizing arm is available to collect landmark data on bones (e.g. knee joints and crania), but several challenges present themselves, such as: what landmarks to measure? How to extract meaningful information and visually represent changes in shape? Should shape comparisons be 'rigid' (best-fit) or allow 'deformation' (exact fit)? To do this, the student will investigate morphometrics and then seek out existing codes for morphometric analysis (there are a few) and their application. Given the specialized nature of the problem, it is expected that the student will develop/modify (with assistance) a computer program for morphometric analysis.

If you enjoy mechanics and are interested in how they relate to shape analysis - and therefore to diverse areas of research in human functional morphology - then maybe you are the right person for this project. The student engaged in this project will work closely with graduate student Missy Banitt, as well as Dr. Livesay and Dr. Holliday (Department of Anthropology). If you are interested in this project, please send a letter of application (including your future educational/employment plans/goals), and a resume to Dr. Livesay.

Undergraduate Project #2

Regional Variation in the Viscoelastic Response of Knee Ligaments
Biomechanics Laboratory
Department of Biomedical Engineering
Tulane University

One important aspect of both normal and tissue-engineered ligaments is their time-dependent (or viscoelastic) response under loading/stretching. In addition to providing an additional design parameter for matching engineered tissues to normal tissues, these phenomenon affect the overall function of the joint in which they are implanted. For example, the fixation of a graft to replace the normal anterior cruciate ligament will be performed under some 'initial' tension to account for the stretching out of the graft over time in the knee joint. Also, although knee ligaments have been shown to deform more near their insertions to bone in tensile (elastic) tests, no studies have examined whether this behavior is also observed in viscoelastic tests. Therefore, the overall goal of this proposed project will be to experimentally determine the (potential) variation in viscoelastic response of isolated knee

ligaments. The student undertaking this project will utilize an existing device (certainly with some modifications!) to test both the creep (constant load) and stress-relaxation (constant elongation) of knee ligaments. In addition, the student will track surface deformation of the tissues to assess potential regional variation in the viscoelastic response. Initial validation work will be performed on prototype 'tissues' (non-biologic, viscoelastic gels) - then moving on to the biological tissues. If you are interested in this project, please send a letter of application (including your future educational/employment plans/goals), and a resume to Dr. Livesay.

Undergraduate Project #3

Development of a Laser-Based System for Characterization of Knee Ligaments
Biomechanics Laboratory
Department of Biomedical Engineering
Tulane University

Determination of the material properties and ultrastructural organization of biological soft tissues remains an important area of research in biomechanics. The material properties of normal ligaments provide macroscopic design parameters for engineered tissue replacements, while the ultrastructural arrangement provides more 'local' information with which to evaluate successful construction. A major experimental challenge associated with determination of the material properties of both normal ligaments and engineered tissues is the accurate measurement of cross-sectional area. In addition, as these soft tissues are composed of collagen fibers, being able to determine the distribution of fiber angles within a tissue (the ultrastructural organization) would enable improved understanding of structure-function relationships. Methods have been developed using laser-based systems to assess both cross-sectional area and fiber orientation in a non-destructive manner, and the student on this project will undertake development of a system to perform one of these tasks (not both). The overall goal of this project is to review the state of the field at this time (for either cross-sectional measurement of fiber orientation), and develop a measurement system applicable to both normal and tissue-engineered ligaments. Both contact and non-contact techniques will be explored, particularly in view of technical developments in measurement techniques during the last decade. Finally, comparisons of performance/error of various techniques will be made on created, non-biologic 'tissues' (with known cross-sectional shape/area, and/or fiber distribution), before moving to evaluate tissues such as the anterior cruciate ligament, etc. The student involved in this project will be engaged in multiple aspects of the design process for the selected system, including machining (and machine drawings), programming, parameter sensitivity, etc. If you are interested in this exciting, rather open-ended project, please send a letter of application (including your future educational/employment plans/goals), and a resume to Dr. Livesay.