Petition to the Graduate Committee

Name:

Email:

Advisor: Robin Shandas

Degree Seeking: MS or PhD (circle one)

Briefly describe what you are petitioning for:

Independent Study of the biology of the extracellular matrix.

Briefly explain why you are petitioning:

The subject if extracellular matrix (ECM) biology is essential to the understanding of connective tissue mechanics and disease pathology; however, as a subject of study, ECM biology lies outside the scope of a typical engineering curriculum. The proposed course is therefore a study of the biology, chemistry and physiology of the ECM in an effort to better explain the properties governing connective tissue mechanics.

Your Signature: _____ Date: 6/8/09

Advisor's Signature: _____ Date: 6/8/09

GRADUATE COMMITTEE DECISION

Approved ✓ **Declined** _____ **Date** _____ **Initials** _____

College of Engineering and Applied Science
Department of Mechanical Engineering

Independent Study Agreement

Name: _____ Student number: _____

Semester: Summer 09 Credit hours (1-3) 3

Circle one: MS ME (Ph.D.) Year in program: _____

Local phone # and email address: _____

Area of Specialization: _____ Overall GPA: _____

Previous number of Independent Study hours earned to date: _____

Faculty advisor: _____ Course #: _____

Description and goals of the proposed Independent Study: See Attached

_____

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_____
Signature of Supervision Faculty Member

Registered by _____ Date: _____
Graduate Advising Coordinator

A Mechanical Engineering faculty member normally supervises an Independent Study. An approved Independent Study supervised by a faculty member outside of Mechanical Engineering may also be applied to curriculum requirements as an out-of-department technical elective.

Independent Study Requirements

1. Submission of an Independent Study Agreement Form (which includes a written Statement of Work), to the ME Graduate Advising Coordinator. This paperwork must be submitted by the course Drop/Add deadline as specified in the Registration Handbook and Schedule of Courses.

2. Satisfactory completion of a significant portion of the initially defined project.

3. A written final report, including a copy for departmental files, must be submitted before a grade will be sent to the registrar's office for posting.

4. An independent study must be approved by petition PRIOR to the submission of the Independent Study Form. *Note: a copy of the previous approved Independent Study Form should be attached.*

5. **Under no circumstances will a third independent study be allowed.**

Note: Independent Study Forms may be obtained from the Graduate Advising Coordinator.

Author:

Advisor:

The subject if extracellular matrix (ECM) biology is essential to the understanding of connective tissue mechanics and disease pathology; however, as a subject of study, ECM biology lies outside the scope of a typical engineering curriculum. In fact, ECM biology is typically studied as part of a cell biology course and consists of an overview of ECM components and their functions (typically one book chapter and several lectures). I could find no ECM biology course offered by UCB, UCHSC or DU. An internet search resulted in only one dedicated ECM biology course, which is offered at Rice University (BIOE-464 Extracellular Matrix).

Although part of my doctoral thesis is focused on the mechanics of arterial elastin, the overlap between my thesis work and the proposed independent study is limited. The only real overlap would consist of the biochemistry, molecular arrangement, cross-linking and mechanical properties of elastin and the fact that there exists a locking stretch associated with collagen mechanics. I have therefore left these topics out of the proposed list of course topics, even though they would typically be covered in an ECM biology course. However, even with these eliminations, the field of ECM biology is so vast that the proposed study is still essentially a survey course on the subject.

Course title

Biology of the extracellular matrix

Duration

6/1/2009 – 8/1/2009

Description

This course is a graduate level study of the biochemistry, physiology, biosynthesis and degradation of connective tissue extracellular matrix (ECM). In most connective tissues, the ECM consists of the mechanically relevant, passive constituent materials: collagen, proteoglycans, elastin and glycoproteins. These materials act in concert to provide connective tissues with unique material properties required for their homeostatic function and are the subject of significant research on connective tissue disease pathology. The focus of this course is to provide engineering students with the fundamental understanding of ECM biology necessary for the further study of connective tissue mechanics. To this end, the course is split into two sub-topic studies. The first sub-topic focuses on the physiology, chemistry and microbiology of the major constituent matrix materials. The second sub-topic is focused on the biosynthesis, assembly, degradation, and regulation of the constituent materials. The second sub topic will also cover some of the more minor matrix constituent materials, many of which are important in assembly and intigrin binding of the ECM.

Organization

This is a self-instructed course focusing on the biology of the extracellular matrix of connective tissues. Course materials consist primarily of the two textbooks listed in the Textbook section of this syllabus. The subject material is divided into the two sub-topics described above. Each sub-topic will be studied for a 4-week duration culminating in a final paper. This paper will use the text material, supplemented with a literature review of relevant journal articles, to describe how extracellular matrix biology research is influencing our understanding of bioengineered and soft-tissue materials science.

Course objectives

By the end of this course, I will have a firm understanding of the physiology, biochemistry and microbiology of the major constituent ECM materials. I will learn the basic metabolic, physiologic and regulatory pathways responsible for ECM assembly, degradation and biosynthesis. And lastly, I will use this knowledge of ECM biology to further my understanding of the unique problems posed by the study of biological tissue materials science and mechanics. I will compile a report describing current thinking on the biochemistry, biology and structure-function relationships of the ECM.

Course topics

1. Extracellular matrix constituents
    a. Collagen
        i. Biochemistry
        ii. Posttranslational modification
        iii. Molecular arrangement
        iv. Genetic types
        v. Immunology
        vi. Mechanical properties
    b. Proteoglycans
        i. Biochemistry
        ii. GAG 's
        iii. Functions
        iv. Organizations
    c. Fibronectian
        i. Biochemistry
        ii. Types and locations
        iii. Functions
        iv. Organizations
2. Biosynthesis
    a. Proteoglycans
    b. Collagen
    c. Elastin
3. ECM assembly and degradation

   a. Collagen assembly mechanisms
   b. Ultrastructure
   c. Cellular regulation
   d. ECM proteinases
      i. MMP's and TIMP's
      ii. Collagenase
   e. Substrate enzyme specificity
   f. Collagenase regulation
4. Minor ECM molecules
   a. Fibulins
   b. Laminins
   c. Osteopontin
   d. Chondronectin

Textbooks

1. *Cell biology of extracellular matrix / edited by Elizabeth D. Hay*. New York :: Plenum Press, 1991.
2. *Guidebook to the extracellular matrix, anchor, and adhesion proteins / edited by Thomas Kreis and Ronald Vale*. Oxford ; New York :: Oxford University Press, 1999.

Materials for submission

Paper described in objectives section.