RECOVERY, REGENERATION, & ADAPTATION COURSE

(Nikos C. Apostolopoulos PhD)

COURSE DESCRIPTION:

Depending on the intensity and duration of exposure to a mechanical stimulus (i.e. weights, running, etc.) morphological and physiological changes occur responsible for the adaptation of the body. Recovery and regeneration is an adaptation process integrating numerous mechanical signals arising in response to a physical perturbation. This response is coordinated both spatially and temporally relative to the dynamic processes of the cytoskeleton, regulation of signal transduction and the adhesion and detachment of cells to each other resulting in a biochemical feedback. Literature will be used to explore the concept of recovery, regeneration, and adaptation providing students with comprehensive knowledge that is fundamental to this process. Students will be introduced to such concepts as mechanotransduction, tensegrity, and the inflammatory response, itself a complex interaction of soluble factors within cells. The format of the course will be lectures and student-led presentations.

EVALUATION:

Grades are a measure of the performance of a student in individual courses. Each student shall be judged on the basis of how well they have command of the course materials.

EXAM and ASSIGNMENT	**VALUE**
Midterm 1 – Introduction & Mechanotransduction	20%
Midterm 2 – Inflammation	20%
Student-led Presentation	35%
Final Exam	25%
Total	100%

Evaluation Components:

Midterm 1 & 2
Mixed Format with approximately 30% Multiple Choice and True and False Questions*; 30% Short Answer; and 40% Long Answer
Student-led Presentation
Groups of students (n = x per group) will choose a seminar topic from those listed in the course handout (Section 3) and prepare a PowerPoint presentation. Each presentation will briefly discuss the subject chosen and how it relates to the concepts discussed in Sections 1 & 2 of the course. The presentation shall be 20 minutes in length followed by 5 minutes of questions. One should err on the side of being short rather than too long to keep within the allotted time to be fair to those following. (NOTE: each seminar will be timed, and those exceeding the 20-minute time frame will be marked down one grade). Grading of the seminar will be done on a peer basis using an evaluation tool provided by the course instructor – attached below. In addition, students need to do a literature review for their topic and provide a list of readings (3 – 5) for the other students one week prior to their presentation. They should consult several search engines such as PUBMED, Google Scholar, MEDLINE, EMBASE etc.

The student-led presentation will be evaluated as follows: 25% for the PPT presentation and 10% for the literature review.	
Final Exam	
Includes all course material as well as student-led presentations	During class time. This will be administered in 2 parts. Part A – Multiple Choice, True & False, and Short Answers (D-35) Part B – Essay Question (D-36)

*****For True and False Questions – True = 1 mark, False = 1 mark + 1 mark for giving the correct answer)

LEARNING OUTCOMES:

LEARNING OUTCOME	PROCESS BY WHICH THESE SKILLS WILL BE DEVELOPED
I. Subject-Specific Content. After completing this course each student will demonstrate: 1. Working knowledge of the concepts of recovery, regeneration, and adaptation. 2. Theoretical perspective of mechanotransduction, inflammatory response, and other topics presented and discussed (see course outline) 3. Knowledge of physical changes occurring from the macro to the micro regarding the body's response to a mechanical perturbation	Midterms Student-led Presentation Final Examination
II. Transferable Skills. By the end of this course, students will have enhanced the following skills: 1. Presentation skills 2. Critical thinking skills 3. Research/inquiry skills 4. Independent and collaborative learning 5. Professional responsibility	These skills will be achieved through the student-led presentations, which will be evaluated by the students themselves thereby gaining valuable skills of assessing and properly critiquing others work. The presentation will challenge the ability of students to work collaboratively, as well as help to foster a development of their research skills.

CLASS SCHEDULE and READING OUTLINE:

SECTION 1 – Introduction & Mechanotransduction			
Week	Day	Topic	Readings
01	01	Introduction	See Reference List Below
	02	Systems Biology	
	03	Mechanobiology	
02	04	Mechanotransduction & Tensegrity	
	05	Macromolecules	
	06	Cells & Mitochondria	
03	07	Integrins & Focal Adhesions	
	08	Extracellular Matrix	
	09	Tissues	
04	10	Muscles, Tendons, Myotendon Junction	
04	11	Review & Study Group	
	12	Midterm 1 – Introduction & Mechanotransduction	
SECTION 2 - Inflammation			
Week	Day	Topic	Readings
05	13	Delayed Onset Muscle Soreness (DOMS)	See Reference List Below
	14	Inflammation	
	15	Inflammation – Habitual Exercise	
06	16	Inflammation – Muscle Damage	
	17	Calpains	
	18	Endothelium (Endothelial Cells)	
07	19	Cytokines	
	20	Neutrophils	
	21	Macrophages	
08	22	Acute Phase Response (APR)	
08	23	Review & Study Group	
	24	Midterm 2 - Inflammation	

SECTION 3 – Student-Led Presentations			
Week	Day	Topic	Readings
09	25	Massage	Provided by Students
	26	Physiotherapy	
	27	Chiropractic	
10	28	Ice Baths/Whole Body Cryotherapy (WBC)	Provided by Students
	29	Acupuncture/Intermuscular Stimulation (IMS)	
	30	Various Stretching Techniques	
11	31	Sleep & Electro-Magnetic Fields (EMF)	Provided by Students
	32	Meditation	
	33	Relaxation Response	
12	34	Review & Study Group	
	35	Final Exam Part A – Multiple Choice, True & False, and Short Answers	
	36	Final Exam Part B – Essay Question	

Required Readings

SECTION ONE – Introduction & Mechanotransduction		
Week	Day	Required Reading
01	02	SPIVEY, A. (2004) Systems Biology the Big Picture, *Environmental Health Perspectives,* 112 (6): A 938-43.
01	03	PEDERSEN, J.A. & SWARTZ, M.A. (2005). Mechanobiology in the Third Dimension. *Ann Biomed Eng*, 33 (11): 1469-90.
02	04	KHAN, K.M. & SCOTT, A. (2009). Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair. *Br J Sports Med,* 43: 247-51. INGBER, D.E. (1993). Cellular tensegrity: defining new rules of biological design that govern cytoskeleton. *J Cell Sci,* 104: 613-27.
02	05	KURUNCZI, L. & OPREA, T. (2003). *Structure of Biological Macromolecules. Proteins and Nucleic Acids* in Quantum Biochemistry and Specific Interactions. Second Edition, Chapter 4.
02	06	DUGUEZ, S. ET AL (2002). Mitochondrial biogenesis during skeletal muscle regeneration, *Amer J Physiol Endocr Metab,* 282 (4): E802-9.
03	07	CUI, Y. ET AL (2015). Cyclic stretching of soft substrate induces spreading and growth. *Nature Communications,* 6(6333): 1-8.

03	08	KJAER, M. (2004). Role of Extracellular Matrix in Adaptation of Tendon and Skeletal Muscle to Mechanical loading. *Physiol Rev,* 84: 649-98.
03	09	COWIN, S.C. (2000). How Is a Tissue Built? *J Biomech Eng,* 122(6): 553-69.
04	10	SCHWEITZER, R. ET AL. (2010). Connecting Muscles to Tendons: Tendons and Musculoskeletal Development in Flies and Vertebrates. *Development,* 137: 2807-17.
SECTION TWO - Inflammation		
Week	Day	Required Reading
05	13	CLEAK, M.J. & ESTON, R.G. (1992). Delayed Onset Muscle Soreness: Mechanisms and Management. J Sports Sci, 10(4): 325-41.
05	14	NATHAN, C. (2002). Points of Control of Inflammation. *Nature,* 420: 846-52.
06	16	PEAKE, J.M. (2017). Muscle Damage and Inflammation During Recovery from Exercise. *J Appl Physiol,* 122: 559-70.
06	17	MURPHY, R.M. (2009). Calpains, Skeletal Muscle Function and Exercise. *Proceedings Australian Physiol Society*, 40: 95-102.
06	18	ANDO, J. & YAMAMORO, K. (2009). Vascular Mechanobiology – Endothelial Cell Responses to Fluid Shear Stress. *Circ J*, 73: 1983-92.
07	19	PHILIPPOU, A. ET AL. (2012). Cytokines in Muscle Damage. *Adv Clin Chem*, 58: 49-74.
07	20	PYNE, D.B. (1994). Regulation of Neutrophil Function During Exercise. Sports Med, 17(4): 245-58.
07	21	MINUTTI, C.M. (2017) – Tissue-specific contribution of macrophages to wound healing. *Sem Cell Develop Biol*, 61 (2017): 3-11.
08	22	GRUYS, E. ET AL. (2005). Acute Phase Reaction and Acute Phase Proteins. *J Zhejiang Uni Sci*, 6B (11): 1045-56.

STUDENT-LED PRESENTATION SCORING SHEET

SPEAKERS: _____ DATE: _____20XX

TITLE OF PRESENTATION**:** _____

EVALUATION CRITERIA	RATING	REMARKS & COMMENTS
Development of Topic (20): • originality • organization, adequate background • clarity, concise • Command of topic area, completements, topic explored in some depth, not just descriptive or only scratching the surface		
Language & Body Language (10): • Grammar, pronunciation, use of jargon • Other language mannerisms (“ok, ah, um, etc.”) • Distracting body mannerisms		
Style (15): • Enthusiasm, confidence, projection of voice • Distracting mannerisms and posture		
Effectiveness (15): • Achievement of purpose, interesting, provocative, informative • Increased your interest in the topic		
Audiovisual Aids (15): • Clarity, colours scheme, font legible, pitch size, organization, too cluttered, adequate number, appropriate time spent on each		
Adherence To Time (5): • 5 for being $\pm$ 1 minute of allotted time, subtract 1 point for every minute(s) in excess to, or short of, the allotted time		
Response To Questions (10): • Ability to answer questions on presentation		
Overall Impression (10):		
TOTAL SCORE (100)		

EVALUATORS NAME: _____

SIGNATURE: _____

