KIN 205 – MUSCLE PHYSIOLOGY IN EXERCISE AND WORK

Course Outline Winter 2015

Department of Kinesiology, University of Waterloo

Lecture Times:	Tues & Thurs		2:30 pm – 3:50pm	EIT 1015
Lab Times:	Lab 101	Mon (2nd week)	2:30 pm - 5:20 pm	BMH 2402
	Lab 102	Wed (1st week)	2:30 pm - 5:20 pm	BMH 2402
	Lab 103	Fri (1st week)	8:30 am - 11:20 am	BMH 2402
	Lab 104	Mon (2nd week)	11:30 am - 2:20 pm	BMH 2402
	Lab 105	Wed (2nd week)	2:30 pm - 5:20 pm	BMH 2402
	Lab 106	Mon (1st week)	2:30 pm - 5:20 pm	BMH 2402
	Lab 107	Fri (2nd week)	8:30 am - 11:20 am	BMH 2402

Course Instructor:

Dr. Marina Mourtzakis
Office: BMH 1117
X38459
e-mail: mmourtza@uwaterloo.ca

Lab Instructor:

Chris Vigna
Office: BMH 0612
X32971
e-mail: cvigna@uwaterloo.ca
@UWKIN205

Course Description:

The purpose of this course is to examine various physiological processes that are used by skeletal muscle to produce energy. This energy is essential for carrying out daily activities and exercise. This course will provide information that will form the foundation for future physiology courses including skills and resources. The content of the lectures and laboratories are complementary. All students are required to enroll and participate in the laboratories. Advance preparation for each laboratory is essential.

Course Objectives:

1. To provide an understanding of the principles of muscle physiology.

2. To provide hands-on laboratory experience in understanding the concepts of muscle physiology covered in lecture.

3. To provide you with foundational knowledge and skills so that you can read and evaluate the scientific literature. This area of research is rapidly evolving and it is important, as a student and as a professional, to stay abreast of the recent research developments. Here are a few of the Journals that can be consulted:

    - Medicine and Science in Sports and Exercise
    - Journal of Applied Physiology
    - American Journal of Physiology
    - Muscle and Nerve
    - Applied Physiology, Nutrition and Metabolism
    - Journal of Physiology (London)
    - Acta Physiologica Scandinavica
    - European Journal of Applied Physiology

COURSE SCHEDULE

Section#	Topics	Readings
Section 1 Muscle Structure & Function	• General overview of the muscle cell • Structure and function of skeletal muscle • Sliding Filament Theory • Thin Filament Regulation of Muscle Contraction • Cross-Bridge Cycle	Silverthorn Provided in class Powers Chapter #8
Section 2 Muscle Fibre Types	• Concept of muscle fibre types and muscle plasticity • Classification schemes used to categorize muscle fibre types • Muscle fibre types and performance • Contractile protein isoforms	Silverthorn Provided in class Powers Chapter #8
Section 3 Muscle Mechanical Properties	• Mechanical behavior of skeletal muscle • Measurement of muscle contractile properties • Muscular fatigue and weakness • Fibre type differences	Silverthorn Provided in class Powers Chapter #8
Section 4 Energy Systems in Muscle	• Energy systems in muscle • ATP homeostasis • Metabolic potentials and fibre types • Metabolic control	Silverthorn Provided in class Powers Chapter#3
Section 5 Exercise Muscle Metabolism	• Exercise Muscle Metabolism • Sources of energy for different types of activity • Progressive vs prolonged exercise • Concept of metabolic fatigue	Powers Chapter#4
Section 6 Training Adaptations in Muscle	• Skeletal muscle adaptations with altered activity • Prolonged endurance exercise • Short-term exercise • High intensity exercise • Resistance exercise	Powers Chapter#13 + p. 157-160
Section 7 Excitation Processes in Muscle and Sarcoplasmic Reticulum	• Excitation processes in muscle • Sarcolemma and T-tubule • Membrane Potential • Na+-K+-ATPase • Excitability and fatigue • Sarcoplasmic Reticulum • Control of cytosolic Ca^{2+} levels • Processes involved in Ca^{2+} release and uptake	Silverthorn Provided in class Powers Chapter #7

COURSE EVALUATION

	Evaluation
Lab Material	
Laboratory Reports	15%
Laboratory Test (Thursday April 2, 2015 – last lecture)	15%
Lecture Material	
Midterm (Thursday February 26 2015)	25%
Final Exam (Scheduled by registrar)	45%

Student Responsibilities:

- Attendance at all lectures is important. Although individual notes are available for purchase, it is imperative that you attend each lecture as you will want to take additional notes and in greater detail than what is provided in your course notes. All material that is discussed in class can be examined on the midterm or final exam.

- Participation in laboratory activities and related assignments is also essential. All material discussed in class and lab will be examined. Attendance at the lab, mid-term and final exam is mandatory.

- All lab report must be submitted by the deadlines outlined. Late submissions will not be accepted, unless arrangements have been made with the instructor in advance.

- This course is registered with UW Learn and all registered students in this course will have online access to course material such as the course syllabus, additional course notes, and important announcements. Be sure to check UW Learn for additional resources.

- **It is expected that you know and understand the University's policies with respect to academic dishonesty. Please read the information on these links carefully.**

    - **Academic Integrity:** In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check www.uwaterloo.ca/academicintegrity/ for more information.]

    - **Grievance:** A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read *Policy 70 - Student Petitions and Grievances*, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

    - **Discipline:** A student is expected to know what constitutes academic integrity

[check www.uwaterloo.ca/academicintegrity/] to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the Undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline, www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm .

- **Appeals:** A decision made or penalty imposed under *Policy 70 - Student Petitions and Grievances* (other than a petition) or *Policy 71 - Student Discipline* may be appealed if there is a ground for an appeal. A student who believes he/she has a ground for an appeal should refer to *Policy 72 - Student Appeals*, www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

- Note for Students with Disabilities: The Office for Persons with Disabilities (OPD; *http://www.studentservices.uwaterloo.ca/disabilities/*), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

Recommended Texts:
The recommended texts for this course are the same as the texts that were used in BIOL 273 and KIN 105. You will be evaluated on the material that is covered in lectures. The suggested reading will act as an additional resource to help you learn the lecture material more thoroughly. There are several texts and sources that were used to develop the lecture material. The figures that appear in your course notes have been redrawn with permission from the various journal articles listed below.

Recommended Texts:
Silverthorn DU. Human Physiology: An Integrated Approach (6th edition).

Powers SK and ET Howley. Exercise Physiology. Theory and Application to Fitness and Performance (8th edition). New York: McGraw-Hill, 2012.

Reference Texts:
1. Jones D, Round J, and A. de Haan. Skeletal Muscles: From Molecules to Movement. Churchill Livingstone, 2004.
2. Plowman SA and DL Smith. Exercise Physiology. For Health Fitness, and Performance. MA. Allyn and Bacon, 1996.
3. Astrand PO and K Rodahl. Textbook of Work Physiology. New York: McGraw-Hill Book Company, 1986.
4. Brooks GA, Fahey TD, and White TP. Exercise Physiology: Human Bioenergetics and Its Applications. Mountain View, California: Mayfield Publishing Co., 1996.

5. Hochachka PW. Muscles as Molecular and Metabolic Machines. London: CRC Press, 1994.
6. Salway JG. Metabolism at a Glance. Oxford: Blackwell Scientific Publications, 1994.
7. Wilmore JH and DL Costill. Physiology of Sport and Exercise. Champaign, IL: Human Kinetics, 1994.
8. Vander AJ, Sherman JH, and DS Luciano. Human Physiology. The Mechanics of Body Function. New York: McGraw-Hill Publishing Co., 1990.
9. MacIntosh BR, Gardiner PF, and AJ McComas. Skeletal Muscle: Form and Function. (2nd edition). Champaign, IL: Human Kinetics, 2006.
10. Mooren FC and K Völker. Molecular and Cellular Exercise Physiology. Champaign, IL: Human Kinetics, 2005.
11. Mougios V. Exercise Biochemistry. Champaign, IL: Human Kinetics, 2006.

Reference Journal Articles:

Allen DG and H Westerblad (2001). Role of phosphate and calcium stores in muscle fatigue. *J Physiol* **536**:657-665.

Bottinelli R et al. (1999). Specific contributions of various muscle fibre types to human muscle performance: an in vitro study. *J Electromyog Kinesiol* **9**: 87-95.

Clausen T (2003). Na+-K+ pump regulation and skeletal muscle contractility. *Physiol Rev* **83**:1269-324.

Dröge W (2002). Free radicals in the physiological control of cell function. *Physiol Rev* **82**:47-95.

Goldspink G. (1999). Changes in muscle mass and phenotype and the expression of sutocrine and systemic growth factors by muscle in response to stretch and overload. *Anat* **194**:323-34.

Goodyear L and BB Kahn (1998). Exercise, glucose transport, and insulin sensitivity. *Ann Rev Med* **49**:235-261.

Jones DA et al (1989). Physiological changes in skeletal muscle as a result of strength training. *Quart J Exp Physiol* **74**:233-56.

Kiang JG and GC Tsokos (1998). Heat shock protein 70 kDa: molecular biology, biochemistry and physiology. *Pharmacol Ther* **80**:183-201.

Lamb G and MA Cellini (1999). High intracellular [Ca^{2+}] alters sarcoplasmic reticulum function in skinned skeletal muscle fibres of rat. *J Physiol* **519**:815-27.

Lazarides E (1980). Intermediate filaments as mechanical integrators of cellular space. *Nature* **283**: 249-256.

Lin J. et al. (2002). Transcriptional co-activator PGC-1 alpha drives the formation of slow-twitch muscle fibres. *Nature* **418**:797-801.

Lunde PK et al (2001). Contraction and intracellular Ca(2+) handling in isolated skeletal muscle of rats with congestive heart failure. *Circ Res* **88**:1299-305.

MacLennan DH and MS Phillips (1992). Malignant hyperthermia. *Science* **256**:789-94.

MacLennan DH et al (1998). Structure-function relationships in the Ca(2+)-binding and translocation domain of SERCA1: physiological correlates in Brody disease. *Acta Physiol Scand* **163**:Suppl (643), 55-67.

Meyer RA et al (1980). Ammonia and IMP in different skeletal muscle fibres after exercise in rats. *J Appl Physiol* **49**:1037-41.

Nakatani A et al (1997). Effect of endurance exercise training on muscle glycogen supercompensation in rats. *J Appl Physiol* **82**:711-5.

Phillips SM (2004). Protein requirements and supplementation in strength sports. *Nutrition* **20**:689-95.

Protasi F (2002). Structural interaction between RYRs and DHPRs in calcium release units in cardiac and skeletal muscle cells. *Front Biosci* **7**:d650-8.

Rommel C et al (2001). Mediation of IGF-1-induced skeletal muscle myotube hypertrophy by PI(3)K/Akt/mTOR and PI(3)K/Akt/GSK3 pathways. *Nat Cell Biol* **3**:1009-13.

Tupling R et al (2000). Postcontractile force depression in humans is associated with an impairment in SR Ca(2+) pump function. *Am J Physiol* **278**:R87-R94.

Tupling AR et al (2003). Paradoxical effects of prior activity on human sarcoplasmic reticulum Ca^{2+}-ATPase response to exercise. *J Appl Physiol* **95**:138-144.

Westerblad H et al (2002). Muscle fatigue: lactic acid or inorganic phosphate the major cause? *News Physiol Sci* **17**:17-21.