HK*6130 Advanced Skeletal Muscle Metabolism [0.50] Winter 2017

Course Goal

The objective of this course is to solidify, and expand upon, skeletal muscle metabolism taught at the Undergraduate level. This course is designed to examine selected areas and topics in contemporary human skeletal muscle metabolism at an advanced level. It is expected that the student is familiar with skeletal muscle metabolism to the depth provided by Newsholme and Leech's 1983 Biochemistry for the Medical Sciences. The majority of learning will occur during discussions of state of the art research papers.

While Undergraduate courses are focused on learning the rate-limiting enzymes/control points regulating metabolism, this course is designed to force the student to apply this information, and to critically think about research design and interpretation. The course will focus on skeletal muscle but other organs/systems will be discussed when relevant (liver, adipose tissue, circulation etc.). The emphasis will be on catabolic processes, but selected anabolic processes will also be addressed. Throughout the course we attempt to determine how the energy provision pathways meet the energy demands of the muscle cell during varying situations, and how the body handles the various by-products of metabolism. Many of these topics will not be specifically addressed but are discussed during several of the weeks. We will focus primarily on the rate-limiting enzymes involved in fatty acid and carbohydrate metabolism and how these are regulated at rest, during the onset of exercise, during steady-state exercise, as well as how these processes are affected by training/detraining and obesity/diabetes. The students will be introduced to the underlying concepts in a short informal lecture, and strengthened through journal club discussions and a critical evaluation of the scientific. This course therefore represents a unique opportunity to merge many facets of your previous University training, including molecular biology, physiology, cell biology and lifestyle genomics, to understand the regulation of exercise metabolism, and to apply this knowledge to conditions (e.g. training and disease).

The goal for this course is to ensure that the student will emerge with a greater understanding of skeletal muscle metabolism, as well as fully appreciate the notion of the 'specificity of training', as different training regimes will be discussed in the context of genetic adaptations. In addition, students will explore the metabolic alterations that occur with common diseases (examples include obesity, insulin resistance, type 2 diabetes) and how exercise can recover health of the individual by altering skeletal muscle metabolism.

SPECIFIC COURSE OBJECTIVES

Upon completion of this course, students should have:

- An understanding of the classical exercise training literature
- An understanding of fuel interaction/regulating in skeletal muscle
- An extensive understanding of the rate-limiting enzymes/processes in both carbohydrate and fatty acid metabolism
- A thorough appreciation of exercise physiology, with a particular emphasis on skeletal muscle
- An understanding of mechanisms thought to improve exercise capacity following training
- A full appreciation of the power of exercise at combating many diseases
- Improved small group work and self-directed learning skills
- Improved scientific writing and oral presentation skills

Instructor:

Dr. Graham Holloway – Office: ANNU 332 x53688 ghollowa@uoguelph.ca

Lectures:

Lectures will be Wednesday mornings from 8:30-11:20 in ROZH 107.
Prerequisite(s): None
Co-requisite(s): None
Restriction(s): None.

Course Learning Outcomes:

By the end of the course, students should be able to:

- Possess an extensive understanding of the current state of knowledge regarding the regulation of skeletal muscle metabolism
- Fully understand mechanisms that influence the interaction between carbohydrate and fatty acid catabolism
- Understand mechanisms thought to cause various diseases
- Possess an extensive understanding of the current state of knowledge regarding how exercise training affects gene regulation
- Have a thorough appreciation of exercise physiology, with a particular emphasis on skeletal muscle
- Understand how exercise combats many diseases at the molecular level in muscle
- Successfully work in small groups
- Improve scientific writing and oral presentation skills
- Critically evaluate scientific reports

Textbook: There is no required textbook, but a list of recommended texts is listed at the end of this document.

Courselink: This course will make use of the University of Guelph's course website on D2L (via Courselink). Consequently, you are responsible for all information posted on the Courselink page for HK*6130. Please check it regularly.

Graduate Calendar: is the source of information about the University of Guelph's procedures, policies and regulations, which apply to undergraduate programs.

Course Teaching / Learning Approach

The course comprises a combination of lectures, journal club discussion and small group presentations. The weekly format will consist of a discussion examining the 4-5 articles that have been assigned for the topic of the day. In most cases the instructor will take the final 30 minutes of a class to prepare for the discussion of the following week's topic. If required, the instructors will also distribute a 1-2 page handout at the end of a class to set the stage for the next class. This should make the readings more meaningful. All students are expected to read all papers each week and any background reading they feel is necessary.

In addition, students will be asked to lead the discussions of the papers each week. Therefore, 4-5 students will be involved in leading the discussions each week. Depending on the number of students in the course, you can expect to lead a discussion every week or every other week, as historically the class size ranges between 5-10 students. The discussions are meant to be informal and do not require formal presentations. In the discussions we will examine points regarding the rationale, purpose and hypotheses of the study, the methods used, the obtained results and the interpretation of the findings. I would also ask that you prepare a one-page synopsis of the paper you will discuss to be distributed to the other students (this will help during the exam).

However, a formal presentation in small groups will be required on the final day of class. The instructor will choose the topics to be discussed, and in groups of 2 or 3 (depending on class size) you will be required to provide a 30-40 lecture on a given topic. The information covered during these lectures will also be included on the final exam, however you will not be permitted to answer a question pertaining to the topic you presented on the exam.

It is expected that once *Research Presentation* groups are established students arrange meetings outside of class time in which to organize and plan their presentations. Students are given a minimum of 6 weeks to prepare for their presentation. You can contact the instructor by email if you have any questions pertaining to the presentation. It is highly encouraged that groups meet weekly to discuss progress and to interact on the presentation. Meeting on a regular basis will be evident in the quality of the final presentation. Note that content presented in the *Research Presentation*s will be included in the final exam. This will be an invaluable opportunity for small group discussion and interaction and is critical to achieving the learner-centered objective of this course as outlined above.

METHODS OF ASSESSMENT

Form of Assessment	**Weight (% final grade)**
Midterm (take home)	40%
Final Exam (take home)	40%
Research Presentation (April 5th)	20 or 30%

The workload will be heavy each week given the articles to read and the occasional need for background reading. Therefore, there are only three evaluations;

1. **Take-home Exam** (40%) - Exam will be picked up after the last class preceding the winter break week. The exam could is to be done in 48 hr. The exam will have 6-8 questions covering the topics from the first half of the course and you will be required to answer 2 questions. Only 1 question per section (week) can be answered.
2. **Final Exam** (40%) - Exam will be take home and returned in 48 hr. Pick up after the final class or during the following week. The exam will require you to answer two questions from 6-8 options covering the topics from the last half of the course.

Please note that these are take home examinations, however the ***MUST be completed independently!*** Any indication that you completed this examination with the assistance of others will result in a grade of zero.

3. **Group lecture** (20%) – These will occur on the final day of class. You will be expected to provide rationale and background information on a given topic, and then accurately summarize the literature provided to you by the instructor.

Research Presentation: Presentation topics will be selected by the instructor. It is expected that topics relate to the general focus of the course, however, student groups will be required to use journal articles, books, etc to further develop each topic. Groups will consist of 3-4 students. PowerPoint presentations will be 25-30 minutes in length, and it is obligatory that each student in the group present material related to the topic. Each presentation will be followed by 5 minutes of questions. Student attendance at these presentations is mandatory and content presented by student groups will be incorporated into the final exam. Students will be required to meet and work as a group outside of scheduled lecture times.

TEXTBOOK AND READINGS

There is no required text for this class. Background readings (e.g. review articles from the scientific literature) will be provided as PDF files on the course website. Students are responsible for any additional background reading they think is necessary – instructors will provide suggestions of reading material. For the *Research Presentation* students are expected to search and read current scientific literature, including original research papers, relevant to their topic. The instructor can provide students with a short list of recommended readings as required to aid in the learning process.

ATTENDANCE EXPECTATIONS

Since lecture and *Research Presentation* content will be assessed in the final exam, it is strongly encouraged that students attend all lectures. The structural overview of lectures will be made available on the website and students who have missed classes will need to interact with their fellow students to obtain the material. While appointments can be made to discuss course content with the instructor, you will not be able to answer questions on the exams pertaining to lectures missed (i.e. you will have fewer questions to select from).

COURSE WEBSITE: Can be found on D2L entitled: HK*6130 Advanced skeletal muscle metabolism

Course & University Policies

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in---course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact, and be prepared to provide supporting documentation. See the graduate calendar for information on regulations and procedures for Academic Consideration.

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact the Centre for Students with Disabilities as soon as possible. For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: Centre for Students with Disabilities

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the graduate Calendar:

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

Drop Date

The last date to drop one-semester Winter 2017 courses, without academic penalty, is **Friday March 10th.** For regulations and procedures for Dropping Courses, see the Graduate Calendar.

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded in any electronic media without the permission of the presenter, whether the instructor, a classmate or guest lecturer.

Grading

If you are absent from classes during the semester, you will be expected to make up missed lecture material on your own. Assignments handed in late will be penalized 10% for every day that it is late.

General Campus Resources

If you are concerned about any aspect of your academic program:

• make an appointment with your Graduate Chair (Dr. David Wright).

If you are struggling to succeed academically:

• There are numerous academic resources offered by the Learning Commons including, Supported Learning Groups for a variety of courses, workshops related to time management, taking multiple choice exams, and general study skills. You can also set up individualized appointments with a learning specialist. The Learning Commons

If you are struggling with personal or health issues:

- Counselling services offers individualized appointments to help students work through personal struggles that may be impacting their academic performance. Counselling Services
- Student Health Services is located on campus and is available to provide medical attention. Student Health Services
- For support related to stress and anxiety, besides Health Services and Counselling Services, Kathy Somers runs training workshops and one---on---one sessions related to stress management and high performance situations. Stress Management and High Performance Clinic

If you have a documented disability or think you may have a disability:

• The Centre for Students with Disabilities (CSD) can provide services and support for students with a documented learning or physical disability. They can also provide information about how to be tested for a learning disability. For more information, including how to register with the centre please see: Centre for Students with Disabilities

Week	Topic	Date
1	Introduction to Advanced Skeletal Muscle Metabolism	Jan 11
2.	Classical training literature	Jan 18
3.	Excitation contraction coupling and Ca^{2+} homeostasis	Jan 25
4.	Glucose Transport & Signalling	Feb 1
5.	Fatty Acid Transport & Signalling	Feb 8
6.	CHO Metabolism – Reg. of Glycogenolysis & Glycolysis (including PHOS, PFK and PDH)	Feb 15
	Pick up TAKE-HOME I exam after WEEK 6 class	
	WINTER BREAK WEEK - Feb 20-24, no class Feb 22	
7.	Fat Metabolism – Regulation of IMTG Lipolysis	Mar 1
8.	Fat Metabolism – Regulation of mitochondrial lipid transport	Mar 8
9.	Mitochondrial Bioenergetics	Mar 15
10.	Mitochondrial dysfunction with obesity/insulin resistance	Mar 22
11.	Control of mitochondrial biogenesis	Mar 29
12.	Group presentations	April 5

Pick up TAKE-HOME II exam after WEEK 12 class

Background Texts:

Newsholme, E.A., and C. Start. Regulation in Metabolism. Wiley, Toronto, 1973.

Houston, M.E. Biochemistry Primer for Exercise Science. 2nd Edition, Human Kinetics, Windsor, Ontario, 2001

Freinkel, N. (ed.). Contemporary Metabolism. Vol. 2. Plenum, New York, 1982.

Newsholme, E.A., and A.R. Leech. Biochemistry for the Medical Sciences. Wiley, Toronto, 1983.

Peachey, L.D. (ed.) Skeletal Muscle. In: Handbook of Physiology, American Physiological Society, Williams and Wilkins, Baltimore, MD, 1984.

Wolfe, R.R. Tracers in Metabolic Research. Radioisotopes and Stable Isotope/Mass Spectrometry Methods. Alan R. Liss Inc., New York, 1984.

Beitner, R. Regulation of Carbohydrate Metabolism. Vol. I and II. CRC Press Inc., Boca Raton, 1985.

Horton, E.S., and R.L. Terjung (eds.) Exercise, Nutrition, and Energy Metabolism. Collier Macmillan, Toronto, 1988.

Lehninger, A.L., D.L. Nelson, and M.M. Cox. Principles of Biochemistry. 2nd Edition, Worth Publishing, New York, 1993.

Hargreaves, M. Exercise Metabolism. Human Kinetics, Champaign, IL, 1995.

Rowell, L.B., and J.T. Shepherd (eds) Handbook of Physiology, American Physiological Society, Section 12: Exercise: Regulation and Integration of Multiple Systems. Oxford University Press, New York, 1996.

McGilvery, R.W. Biochemical Concepts. W.B. Saunders, Toronto,

Biochemistry of Exercise Series, Human Kinetics Publishers. Champaign, IL, Meetings V (Knuttgen, Vogel, and Poortmans, 1983), VI (Saltin, 1986), VII (Taylor, Gollnick, Green, Ianuzzo, Noble, Metivier, and Sutton, 1988), IX (Maughan and Shirreffs, 1996), and X (Hargreaves and Thompson, 1998).

Maughan, R., M. Gleeson, and P.L. Greenhaff. Biochemistry of Exercise & Training. Oxford Univ. Press, Oxford, 1997.

International Symposium on "Signalling in Muscle Metabolism". Acta Physiologica Scandinavica 178:285-452, 2003.

Richter, E.A., B. Kiens, H. Galbo, and B. Saltin. Skeletal Muscle Metabolism in Exercise and Diabetes. In: Volume 441: Advances in Experimental Medicine and Biology. Plenum Press, New York, 1998.

D.R. Lamb and R. Murray (eds). The Metabolic Bases of Performance in Sport and Exercise. Human Kinetics, Windsor, Ontario, 1999. p. 1-51.

Journals with Articles Relevant to Substrate Metabolism

Acta Endocrinol.
Am. J. Clin. Nutr.
Am. J. Physiol. (Endocrinology & Metabolism; Cell Physiology; and Regulatory, Integrative & Comparative Sections)
Acta Physiol. Scand.
Applied Physiology, Nutrition and Metabolism (formerly Can. J. Appl. Physiol).
Biochim. Biophys. Acta
Biochem. J.
Can. J. Physiol. Pharmacol.
Can. J. Zoology
Cell
Diabetes
Diabetologica
Endocrinology
Eur. J. Appl. Physiol.
FASEB J.
Horm. Met. Res.
Int. J. Sports Med.
J. Appl. Physiol.
J. Biol. Chem.
J. Clin. Endocrin. Metab.
J. Clin. Invest.
J. Physiol. (London)
Metabolism
Med. Sci. Sports Exerc.
Pflugers Archiv.
Scand. J. Clin. Lab. Invest.

Reviews

Advances in Enzyme Regulation
Annual Review of Biochemistry
Annual Review of Physiology
Essays in Biochemistry
News in Physiological Sciences
Physiological Reviews
Recent Progress in Hormone Research
Trends in Biochemical Sciences