

**School of Kinesiology  
Faculty of Health Sciences  
Western University**

**EXERCISE BIOCHEMISTRY  
Kin 3360B  
Winter, 2019**

**Instructor:** J.M. Kowalchuk, PhD

**Office:** HSB 411C

**Location:** FIMS & Nursing Bldg, Rm 3220

**Office Hours:** by appointment  
(after first meeting with GTA)

**Lectures:** M, W, F; 12:30-1:30

**Email:** [jkowalch@uwo.ca](mailto:jkowalch@uwo.ca)

**GTA:** TBA  
(information posted on OWL course site when available)

**NOTE:** All course information including grades, assignment outlines, deadlines, etc. are available via OWL. Check the website regularly for course announcements.

**Calendar Description:** A study of human exercise biochemistry and metabolism with attention given to the major metabolic pathways and their control as they relate to acute and chronic responses and adaptations to exercise.

**Course Description:** This course will describe the major metabolic pathways associated with the transport and storage of substrate, and production of “energy equivalents” at rest and during different durations and intensities of exercise, as well as in other physiological or clinical conditions. In addition to describing individual steps in the pathways for carbohydrate and fat breakdown, utilization and synthesis, this course will examine regulation of these pathways in different tissues and in these various conditions, and how fuel use is integrated amongst tissues.

**Anti-requisite(s)/Pre-requisite(s)/Co-requisite(s) if applicable:**

Pre-requisites for this course are:

Physiology 1021 or equivalent; Kin 2230a/b or equivalent.

Be advised that a previous introductory background in chemistry/ biochemistry / metabolism is strongly recommended.

You are responsible for ensuring that you have successfully completed all course pre-requisites, and that you have not taken an anti-requisite course (if applicable). Lack of a pre-requisite or the completion of an anti-requisite cannot be used as a basis for appeal. If you are found ineligible for a course, you may be removed from it at any time and you will receive no adjustment to your fees. This decision cannot be appealed.

**Course Format:**

Lectures held on Monday, Wednesday and Friday from 12:30 p.m. – 1:30 p.m.

**Course Recommended Textbook(s):**

Required Textbook:

PM Tiidus, AR Tupling, ME Houston. Biochemistry Primer for Exercise Science (4th ed). Human Kinetics, 2012.

Because there is no single textbook that covers all material adequately, lecture material will be taken from many sources, including many other University-level textbooks in biochemistry (e.g., DL Nelson and MM Cox, Lehninger: Principles of Biochemistry, W.H. Freeman & Co.; or D Voet, JG Voet and CW Pratt, Fundamentals of Biochemistry - Life at the Molecular Level, John Wiley & Sons, Inc.), and published, peer-reviewed research and review articles.

**Learning Objectives:**

Upon completion of this course students will be able to:

1. describe and explain the role of enzymes in metabolic pathways, and the different mechanisms by which they are regulated
2. understand the mechanisms related to acid-base control during exercise
3. describe and explain the bioenergetic requirements of muscle
4. describe individual steps in each of the metabolic pathways studied, and identify key steps where pathway regulation occurs and how “regulation” is achieved
5. describe and explain the metabolic responses to exercise of different intensity and duration
6. understand metabolic interactions amongst muscle and other tissue and organ systems
7. use examples from the published literature to help in the understanding of metabolic responses to exercise
8. understand the relationship between metabolism and certain disease states
9. describe and explain the relationship between metabolism and exercise performance

Note that these learning objectives may modified depending on the time constraints and on the material covered during the term.

**Required Course Material:**

References for all required course readings will be posted on OWL.

**Course Evaluation Summary:**

Midterm #1 (TBD)	25%
Midterm #2 (TBD)	25%
Final Exam (scheduled by the Registrar’s office during the April examination period)	50%

Exams will be a combination of multiple choice and short answer questions. Midterm examinations normally will be held outside of the assigned lecture time and at a time agreed upon by the instructor and a majority of students (usually between 5:00 p.m. and 7:00 p.m.). The instructor will try to ensure that midterm exams do not conflict with students’ schedules, but it

may be necessary for the student to readjust/modify their personal schedule to accommodate the midterm. A missed midterm or final examination without appropriate documentation will result in a “zero” grade (note: attending athletic team practice is not an acceptable excuse to miss a scheduled examination). A “make-up” exam is not guaranteed. If a valid reason is provided, an alternate time may be considered but at the discretion of the course instructor. If a reasonable, alternate, time cannot be established, the final grade will be re-weighted at the discretion of the instructor in a manner that is fair to both the student and the other students in the class.

## **Course/University Policies**

### **1. Written documentation (Illness, Medical/Non-Medical):**

[https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_illness.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf)

The University recognizes that a student’s ability to meet his/her academic responsibilities may, on occasion, be impaired by medical illness. Illness may be acute (short term), or it may be chronic (long term), or chronic with acute episodes. The University further recognizes that medical situations are deeply personal and respects the need for privacy and confidentiality in these matters. However, in order to ensure fairness and consistency for all students, academic accommodation for work representing 10% or more of the student’s overall grade in the course shall be granted only in those cases where there is documentation indicating that the student was seriously affected by illness and could not reasonably be expected to meet his/her academic responsibilities.

A UWO Student Medical Certificate (SMC) is required where a student is seeking academic accommodation. This documentation should be obtained at the time of the initial consultation with the physician or walk-in clinic. An SMC can be downloaded under the Medical Documentation heading of the following website:

[http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf)

Documentation is required for non-medical absences where the course work missed is more than 10% of the overall grade. Students may contact their Faculty Academic Counselling Office for what documentation is needed.

Whenever possible, students who require academic accommodation should provide notification and documentation in advance of due dates, examinations, etc. stating specific reasons and dates. Students must follow up with their professors and their Academic Counselling office in a timely manner. Documentation for medical requests for accommodation must be submitted within two (2) business days after the end date on the documentation, to the appropriate Academic Counselling Office of the student’s Faculty of registration. For KIN students, you may go to the School of Kinesiology in 3M Centre room 2225 **NOT** to the instructor. It will be the Academic Counselling office that will determine if accommodation is warranted.\*

An “Accommodation Consideration Request Form” found online or in the Kinesiology Undergraduate Office” for ALL accommodation requests must be submitted into the appropriate Academic Counselling office of the student’s Faculty/School of registration. These documents will be retained in the student’s file, and will be held in confidence in accordance with the University’s Official Student Record Information Privacy Policy.

[https://www.uwo.ca/fhs/kin/undergrad/files/accommodation\\_request.pdf](https://www.uwo.ca/fhs/kin/undergrad/files/accommodation_request.pdf)

2. **Grades:** Where possible assignment objectives and rubrics will be posted on OWL. Assignments will be returned to students. The final examination will not be returned but students are able to view their exams by making an appointment with the GTA. Should you have a concern regarding the grade you received on an assignment or final examination or feel that it is unfair in any way, you must wait 24 hours from the receipt of the assignment to approach the instructor or TA. In doing so, please make an appointment and prepare in writing, with evidence, why you feel your grade is inappropriate. However, be aware that in requesting a grade reassessment, the entire assignment or examination could be re-evaluated and your grade could go up/down/or stay the same. Note that calculations errors (which do occur!) should be brought to the attention of the GTA immediately. At least **15% of course grades will be posted by the last day to drop a course.**

Course grade expectations:

A+	90-100	<i>One could scarcely expect better from a student at this</i>
A	80-89	<i>Superior work that is clearly above average</i>
B	70-79	<i>Good work, meeting all requirements and eminently</i>
C	60-69	<i>Competent work, meeting requirements</i>
D	50-59	<i>Fair work, minimally acceptable.</i>
F	below 50	<i>Fail</i>

3. **Scholastic offences:** They are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf).

A) Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar). All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between Western University and Turnitin.com (<http://www.turnitin.com>)

B) Computer marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

Plagiarism and the copying of other students' work are taken to be a serious offences. In addition to this Web site, information on plagiarism is provided at the end of the lab manual. Note that anyone caught plagiarising and/or copying will receive "zero" on the report or assignment.

4. **Examination Conflict Policy:** Please see the Office of the Registrar policy on Exam Conflict and Multiple Exam Situations [www.registrar.uwo.ca/examinations/exam\\_schedule.html](http://www.registrar.uwo.ca/examinations/exam_schedule.html)

5. **Classroom Behaviour:** Class will begin promptly at the time specified in this syllabus. In the event that you must arrive late, please enter the classroom with a minimal disturbance to the class. The course instructor or GTAs reserve the right to lock the classroom door and deny entrance if lateness becomes a common occurrence. Excessive talking during class time is disruptive, disrespectful, and will not be tolerated. Students engaging in such behaviour may be asked to leave the room. Cellular phones, pagers, and text-messaging devices are disruptive when they ring in class. If you must bring these with you, please place them on silent mode or turn them off during class. Failure to do so may result in your being asked to leave.

6. **Electronic Device Usage:**

**During Lectures and Tutorials:** Although you are welcome to use a computer during lecture and tutorial periods, you are expected to use the computer for scholastic purposes only, and refrain from engaging in any activities that may distract other students from learning. From time to time, your professor may ask the class to turn off all computers, to facilitate learning or discussion of the material presented in a particular class. **Unless explicitly noted otherwise, you may not make audio or video recordings of lectures – nor may you edit, re-use, distribute, or re-broadcast any of the material posted to the course website.**

**During Exams -** Unless you have medical accommodations that require you to do so, or explicit permission from the instructor of the course, you may not use any of the following electronic devices during ANY of the tests, quizzes, midterms, examinations, or other in-class evaluations: cellphones, smart phones, smart watches, smart glasses, audio players or recorders of any sort, video cameras, video games, DVD players, televisions, laptop/notebook/netbook computers, flashlights or laser pointers.

7. **Health and Wellness:** As part of a successful undergraduate experience at Western, we encourage you to make your health and wellness a priority. Western provides several on-campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your degree. For example, to support physical activity, all students receive membership in Western's Campus Recreation Centre as part of their registration fees. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page (<http://www.music.uwo.ca/>), or the McIntosh Gallery <http://www.mcintoshgallery.ca/>

Further information regarding health and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<http://www.health.uwo.ca/>) for a complete list of options about how to obtain help.

## **STUDENT CODE OF CONDUCT**

The purpose of the Code of Student Conduct is to define the general standard of conduct expected of students registered at Western University, provide examples of behaviour that constitutes a

breach of this standard of conduct, provide examples of sanctions that may be imposed, and set out the disciplinary procedures that the University will follow. For more information, visit <http://www.uwo.ca/univsec/board/code.pdf>

### **ENGLISH PROFICIENCY FOR THE ASSIGNMENT OF GRADES**

Visit the website <http://www.uwo.ca/univsec/handbook/exam/english.pdf>

### **SUPPORT SERVICES**

There are various support services around campus and these include, but are not limited to:

1. Student Development Centre -- <http://www.sdc.uwo.ca/ssd/>
2. Student Health & Wellness -- <http://www.health.uwo.ca/>
3. Registrar's Office -- <http://www.registrar.uwo.ca/>
4. Ombuds Office -- <http://www.uwo.ca/ombuds/>

**TENTATIVE Course Schedule (2018-2019)**  
**(tentative schedule only – topics subject to change)**

**Tentative Course Outline &/or Proposed Topics To Be Covered:**

1. Amino acid, peptides and proteins
  - The nature of amino acids
  - Characteristics of peptides
  - Structure of proteins
2. Water & acid-base balance
  - Properties of water
  - Acid-base dependent and independent variables
  - Strong and weak acids
  - Strong ions (and the strong ion difference); weak acids and proteins; and CO<sub>2</sub>
3. Enzymes
  - Enzymes as catalysts
  - Rates of enzymatic reactions
  - Enzyme inhibition
  - Regulation of enzyme activity
  - Provision of reactive groups by cofactors
  - Oxidations and reductions
4. Bioenergetics
  - Free Energy
  - Energy-rich phosphates
  - Energy systems
5. Carbohydrate metabolism
  - Carbohydrates
  - Cellular uptake of glucose
  - Phosphorylation of glucose
  - Glycolysis
  - Glycogen metabolism (glycogen synthesis; glycogenolysis)
  - Regulation of glycogen/glucose metabolism (in muscle and liver)
  - Pyruvate/Lactate metabolism and transport
  - Oxidation of cytoplasmic NADH and shuttle systems
  - Gluconeogenesis
    - Regulation of gluconeogenesis
    - Pentose Phosphate Pathway
6. Oxidative phosphorylation
  - Overview
  - Mitochondria

- Mechanism of oxidative phosphorylation
  - Role of the tricarboxylic acid cycle
  - Reactions of the tricarboxylic acid cycle
  - Electron transfers
  - Coupled phosphorylation
  - Mitochondrial transport of ATP, ADP and Pi
  - Regulation of oxidative phosphorylation
7. Lipid metabolism
- Types of lipids
  - Lipogenesis and lipogenolysis and their regulation
  - Oxidation of fatty acids
  - Oxidation of ketone bodies
  - Fatty acid synthesis and regulation
8. Metabolism in exercise: fat vs carbohydrate
9. Amino acid metabolism
- Overview
  - Degradation of amino acids
  - Urea cycle
  - Fate of amino acid carbon skeletons
  - Amino acid metabolism in exercise
10. Gene transcription and its control
- Types of RNA
  - The genetic code
  - Transcription and its regulation
11. Protein synthesis and degradation
- Post-transcriptional modifications of RNA
  - Translation and its regulation
  - Post-translational processing of polypeptides
  - Protein degradation

**Note: Course Content:**

Some “basic” course material may be covered only as assigned readings or via ancillary material provided on the OWL website. While it is hoped that many of the topics listed above will be covered to varying degrees during the term, it is likely that time constraints will not permit examination of all topics, and that the order of presentation might change, or that other topics may be added.

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