Course description
This course develops the understanding of biochemical processes by examining the molecular mechanisms underlying the regulation of specific cellular and physiological systems. Examples may include: oxygen binding and transport; regulation of enzyme function; carbohydrate and lipid metabolic pathways and metabolic integration; structure of membranes and membrane proteins; and membrane transport and signaling.

Prerequisite(s): BIOC*2580

Lectures:
Mon., Wed., Fri., 9:30 a.m. - 10:20 a.m.; WMEM

Teaching team
Dr. Matthew Kimber; SSC 2254, ext. 52568
Dr. Manfred Brauer; SSC 3520, ext. 53795

Email
bioc356w@uoguelph.ca
Please do not send course related emails to the instructors’ personal email addresses.

Office hours:
Dr. Kimber: Wednesdays: 1:00 - 2:30 pm, Fridays: 10:30 am - noon
Dr. Brauer: TBD
Other times may be arranged by email appointment upon request.
**Intended Learning outcomes**

By the end of this course, successful students will be able to:

1. Describe structure/function relationships of proteins at the amino acid level, and how this contributes to ligand-binding and enzyme activity.
2. Describe the regulation of proteins by post-translational modifications and allosteric effectors.
3. Explain how regulatory enzymes are controlled in the regulation of pathways of carbohydrate and fatty acid metabolism in mammals. Explain the biochemical mechanisms that mediate signaling of these pathways at the tissue, organ and organismal level.
4. Describe how proteins and lipids define the structure and function of biological membranes. Explain the ways in which substances can be transported across membranes and the energy requirements for such transport.
5. Describe the biochemical mechanisms by which signals are propagated across the membrane and within a cell.

**Course Resources**

There is a Courselink site for this course.

**Textbook**


**Problem sets**

Periodically throughout the semester, problem sets will be posted. These exercises are for review/practice purposes; answers will be posted, no marks will be assigned.

**Course Reading**

A reading list for the lectures is provided at the end of this course outline.

**Methods of Assessment**

Students will find details of all Assessments on CourseLink.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Weight of Assessment</th>
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<tbody>
<tr>
<td>Online Quiz #1</td>
<td>2.5%</td>
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<tr>
<td>Online Quiz #2</td>
<td>2.5%</td>
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<tr>
<td>Midterm Examination</td>
<td>35%</td>
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<tr>
<td>Online Quiz #3</td>
<td>2.5%</td>
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<tr>
<td>Online Quiz #4</td>
<td>2.5%</td>
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<tr>
<td>Final Examination</td>
<td>55%</td>
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All assessments are required. If the mid-term or online assignment is not written due to an illness, the student is required to provide appropriate documentation. In this case, the final will be reweighted appropriately.
Examination Schedule:

Midterm Examination: **Tuesday February 28th, 2017, 5:45 – 6:45 p.m.** Persons with a scheduled academic conflict should inform the instructor by e-mail, stating the conflicting course, by **Monday, January 30th**. Alternative midterm exams will be arranged where appropriate and possible.

Final Examination: **April 24th, 2017, 8:30 am – 10:30 am** (location to be determined). The final exam is cumulative. Students who score a significantly higher grade on the Final Exam, compared with the midterm, may receive a higher weighting of the final exam (midterm: 20%, final: 70%), at our discretion. A significantly higher grade is one that is 25 percentage points or more higher.

Re-grading
Midterm papers may be returned to us for correction of addition or grading errors, only within one week of the return of the paper to the student. Note that a regrade entails a complete regrade, which may possibly result in a lower grade. We may refuse to re-grade a paper at our discretion.

Exam aids
No materials may be brought to the exam except for pencils, pens and an eraser. No calculators, electronic devices (including cell phones), pencil cases, purses, bags, tissue boxes or other containers may be present. All materials are subject to inspection.

Drop and Add
Notification is **not** needed for dropping the course before the **DROP** deadline (40th class day; Friday March 11th, 2017). Program approval is only needed for drops and adds if your category is "Special" or "Provisional".

Important Dates
A list of important dates is available in the [Undergraduate Calendar](#).
Course and 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. See the undergraduate calendar for information on regulations and procedures for Academic Consideration.

Accessibility
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 Student Accessibility Services (formerly the Centre for Students with Disabilities) as soon as possible.

For more information, contact Student Accessibility Services at 519-824-4120 ext. 56208 or email csd@uoguelph.ca.

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 Undergraduate 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 courses, without academic penalty, is the 40th class day. To confirm the actual date please see the schedule of dates in the Undergraduate Calendar. For
regulations and procedures for Dropping Courses, see the Undergraduate Calendar.

**Copies of out-of-class assignments**
Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

**Recording of Materials**
Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

**Grading**
Indicate all course policies regarding in-semester tests and assignment submissions, including time and place for submission of assignments and explicit penalties for late submissions.

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**Campus Resources**

**If you are concerned about any aspect of your academic program:**
Make an appointment with a Program Counsellor in your degree program.

**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.

**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. 
Student Health Services is located on campus and is available to provide medical attention. 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.

**If you have a documented disability or think you may have a disability:**
Student Accessibility Services (SAS) formerly Centre for Students with Disabilities 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.
Course Content: BIOC*3560 – Winter 2016
Assigned Reading

Chapter and page numbers below are from Lehninger Principles of Biochemistry 6th and 5th Editions. We will be using figures mainly from the 6th Ed.; however, the material covered by the course is similar in both, and purchase of the 6th Ed. is not required.

Part A - Regulation of Protein Function (Chapters 5, 6 and 12)

The Oxygen-binding Proteins
Protein-ligand Interactions I  157-158  153-154
Myoglobin Structure/Function  158-159  154-155
Protein-ligand Interactions II  159-163  155-158
Hemoglobin  163-167  158-162
Cooperative Ligand Binding, Hill Equation  167-169  162-165
Hemoglobin and O$_2$/H$^+$/CO$_2$ Transport  169-172 +  165-169 +
Box 5-1  Box 5-1

Protein Interactions Modulated by Chemical Energy  179-181  175-176
182-184  178-179

Regulatory Enzymes
Review Enzyme Function  189-203  183-198
Regulatory Enzymes:  226-228  220-222
Enzyme Regulation by Reversible Covalent Modification  228-229  223-224
Phosphorylation
   glycogen phosphorylase, glycogen synthase:  229-231  224-226
Modulation by Proteolytic Cleavage:
   chymotrypsin  231-232  226-228
   caspases  214-218  205-209
   492-494  477-478
Complex Regulation of Enzyme Activity
   cyclin-dependent kinases  235-236  227
   484-488  469-473


Part B - Regulation and Integration of Carbohydrate Metabolism (Chapters 14, 15)

Carbohydrate Metabolism
Regulation of Metabolic Pathways  501-504  485-488
Review of Glycolysis  543-555  527-539
Gluconeogenesis  568-575  551-558
Pentose Phosphate Pathway  575-580  558-563
Reciprocal Regulation of Glycolysis and Gluconeogenesis 601-608 582-590
Glycogen Metabolism 612-619 594-601
Coordinated Regulation of Glycogen Synthesis and Breakdown 620-627 602-609

Part C - Regulation and Integration of Lipid Metabolism (Chapters 17, 21, 23)

Lipid Metabolism
Fatty Acid Catabolism 667-672 647-652
Mobilization and Oxidation of Fatty Acids 672-682 652-661
Ketone Bodies 686-688 666-668
Fatty Acid Biosynthesis 833-848 805-820
Triacylglycerol Metabolism 848-850 820-822

Integration of Metabolism
Tissue-specific Metabolism 939-951 912-922
Hormonal Regulation of Fuel Metabolism 623-627, 605-609, 951-959 922-929
Diabetes 959-960 929-930

Part D – Membranes, Transport and Biosignalling (Chapters 10-12)
6th Ed. 5th Ed.

Membranes and Transport
Review of Lipids 357-362 343-349
Membrane Lipids 362-370 349-357
Membrane Structure and Function 385-389 371-374
Membrane Proteins 389-395 374-381
Membrane Dynamics and Fusion 395-402 381-389
Transport Across Membranes; ATPase Ion Pumps 402-420 389-406
Ion Selectivity 420-427 406-413

Biochemical Signaling
Introduction to Biosignaling 433-437, 419-423, Box 12-1 Box 12-1
Gated Ion Channels; Synaptic Transmission 410-470, 449-455
Receptor Enzymes 453-459 439-445
G Protein-coupled Receptors and 2nd Messengers 437-447 423-432
Steroid Hormone Receptors 471-472, 456-457, 1182-1184 1143-1144