

**University of Guelph**  
**College of Biological Science**  
**Department of Molecular and Cellular Biology**  
**COURSE OUTLINE**  
**BIOC\*3560 Structure and Function in Biochemistry**  
**Winter 2016**

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**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

**Teaching team**

Dr. Steffen Graether; SSC 2255, ext. 56457

Dr. John Dawson, SSC 2248, ext. 53867

**Email**

bioc356w@uoguelph.ca

Please do not send course related emails to the instructors' personal email addresses.

**Lectures:**

Mon., Wed., Fri., 9:30 a.m. - 10:20 a.m.; RozH104

**Office hours:**

Dr. Graether: Mondays 1-2:30 pm, Thursdays 10:30 am - noon

Dr. Dawson: TBD

Other times may be arranged by 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

Recommended: “Lehninger Principles of Biochemistry” by Nelson and Cox, 6<sup>th</sup> **or** 5<sup>th</sup> Edition, Freeman Publishers; available at the bookstore. Several copies of the 5<sup>th</sup> and 6<sup>th</sup> Editions are on reserve (2 hour loan) at the Library Reserve Desk.

### 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.

### Assessment

| Form of Assessment  | Weight of Assessment |
|---------------------|----------------------|
| Online Quiz #1      | 2.5%                 |
| Online Quiz #2      | 2.5%                 |
| Midterm Examination | 35%                  |
| Online Quiz #3      | 2.5%                 |
| Online Quiz #4      | 2.5%                 |
| Final Examination   | 55%                  |

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: March 2, 2016, 5:45 pm – 6:45 pm, Alex 100 & 200** . Persons with a scheduled academic conflict should inform the instructor by e-mail, stating the conflicting course, by **Monday, January 25th**. Alternative midterm exams will be arranged where appropriate and possible.

**Final Examination: April 21, 2016, 7 pm – 9 pm** (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 grading errors, only within one week of the return of the paper to the student. 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 (40<sup>th</sup> class day; March 11<sup>th</sup>,2016). 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

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### **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](mailto: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 40<sup>th</sup> 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.

## **Campus Resources**

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### **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 6<sup>th</sup> Ed.; however, the material covered by the course is similar in both, and purchase of the 6<sup>th</sup> Ed. is not required.

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

|  | <b>6th Ed.</b>       | <b>5th Ed.</b>       |
|--|----------------------|----------------------|
| <u>The Oxygen-binding Proteins</u>                                       |                      |                      |
| 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 <sub>2</sub> /H <sup>+</sup> /CO <sub>2</sub> Transport | 169-172 +<br>Box 5-1 | 165-169 +<br>Box 5-1 |
| <br>   |                      |                      |
| <u>Protein Interactions Modulated by Chemical Energy</u>                 |                      |                      |
|  | 179-181              | 175-176              |
|  | 182-184              | 178-179              |
| <br>   |                      |                      |
| <u>Regulatory Enzymes</u>  |                      |                      |
| 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:                                      | 231-232              | 226-228              |
| chymotrypsin   | 214-218              | 205-209              |
| caspases   | 492-494              | 477-478              |
| Complex Regulation of Enzyme Activity                                    | 235-236              | 227                  |
| cyclin-dependent kinases   | 484-488              | 469-473              |

**Research article:** Stieglitz *et al.* Structure of the E. coli Aspartate Transcarbamoylase Trapped in the Middle of the Catalytic Cycle (2005) *Journal of Molecular Biology* 352, 478-486.

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

|   | <b>6th Ed.</b> | <b>5th Ed.</b> |
|---|----------------|----------------|
| <u>Carbohydrate Metabolism</u>                                |                |                |
| 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<br>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,<br>951-959 | 605-609,<br>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,<br>Box 12-1 | 419-423,<br>Box 12-1 |
| Gated Ion Channels; Synaptic Transmission                  | 410-470,             | 449-455              |
| Receptor Enzymes   | 453-459              | 439-445              |
| G Protein-coupled Receptors and 2 <sup>nd</sup> Messengers | 437-447              | 423-432              |
| Steroid Hormone Receptors                                  | 471-472,             | 456-457,             |
| 1182-1184 1143-1144  |                      |                      |