

BIOC*3560

Structure and Function in Biochemistry

Summer 2015

Instructor:

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Lectures:

Tuesday & Thursday: 8:30 a.m. - 9:50 a.m. McKn 231.

Please note: Electronic recording of classes are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

Office hours:

Tuesday & Thursday: 11:30 – 12:30 or by **e-mail** (mbrauer@uoguelph.ca).
Other times can be arranged by appointment upon request.

Synopsis:

This is a course where biochemical structure and function are examined in an integrated fashion. An emphasis will be placed on the **regulation of protein function**. Topics covered include oxygen-binding proteins, regulatory enzymes, regulation of metabolism, membranes, membrane transport and biochemical signaling.

Prerequisite: BIOC*2580

Course Goals / Learning Outcomes:

1. Describe structure / function relationship 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 how 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.

Textbook:

Recommended but not required: "Lehninger Principles of Biochemistry" by Nelson and Cox, 5th **or** 6th Edition, Freeman Publishers; available at the bookstore. Several copies of the 5th and 6th Editions are on reserve (2 hour loan) at the Library Reserve Desk.

Or: Other excellent alternative textbooks: Voet and Voet (5th edition, 2010), Berg, Tymoczko and Stryer (7th edition, 2014) or Mathews, Van Holde, Appling and Anthony-Cahill (4th edition, 2013).

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.

Grade Assessment:

<u>Midterm Examination 1:</u>	33% (Tue. June 9)
<u>Midterm Examination 2:</u>	33% (Tue. July 7) (not cumulative)
<u>Final Examination:</u>	34% (set by Registrar) (not cumulative)

All 3 exams are required. If a mid-term is not written due to an illness, the student is required to provide appropriate documentation.

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). Program approval is only needed for drops and adds if your category is "Special" or "Provisional".

Course Evaluation:

As part of the faculty evaluation process in the Department of Molecular and Cellular Biology, students are reminded that written comments on instructors' teaching

performance may be sent to the Chair, Department of Molecular and Cellular Biology, at any time. Such letters must be signed; a copy will be made available to the instructor **after** submission of the final grade.

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 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: <http://www.csd.uoguelph.ca/csd/>

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. 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:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

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Suggested Reading

You are responsible for what is discussed in lecture (powerpoint, blackboard or verbal) and problem sets. You are not responsible for extra material in the text that was not mentioned in lecture. However, if you would like clarification or additional information, the textbook is useful. Chapter and page numbers below are from **Lehninger Principles of Biochemistry 5th and 6th Editions**. Purchase of the 6th Ed. is not required.

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

	6 th Ed.	5 th Ed.
<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 ₂ /H ⁺ /CO ₂ Transport	169-172 + Box 5-1	165-169 + Box 5-1
<u>Protein Interactions Modulated by Chemical Energy</u>	179-181 182-184	175-176 178-179
<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: Faustova, Loog and Jarv. Probing L-Pyruvate Kinase Regulatory Phosphorylation Site by Mutagenesis (2012) *The Protein Journal* 31, 592-597.

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

	6th Ed.	5th Ed.
<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 and Breakdown	620-627	602-609

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

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

Part D – Membranes, Transport and Biosignalling (Chapters 10-12)

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