

University of Guelph College of Biological Science
Department of Molecular and Cellular Biology
COURSE OUTLINE

Analytical Biochemistry BIOC*3570 Fall 2016

Course description (Calendar): BIOC*3570 Analytical Biochemistry S,F (3-4) [0.75]

This course covers the tools and techniques by which biological molecules are isolated, separated, identified, and analyzed. Detailed discussion of experimental methods for macromolecule purification and characterization is included. Prerequisites: (CHEM*2400 or CHEM*2480), BIOC*2580

Teaching team

Instructor: Dr. David Josephy Office: SC2253 ext 53833 djosephy@uoguelph.ca

Office hours: Wednesday, 9:00-10:30 a.m. If that time slot doesn't work for you, please send me an e-mail and we can arrange a mutually convenient time. I welcome receiving your comments and questions by e-mail, and I try to answer queries within one working day.

Laboratory Instructor: Ms. Paula Russell; SC3502 ext. 58763 prussell@uoguelph.ca

Course schedule

Lectures: Tues. and Thurs., 11:30 am-12:50 pm, Crop Sci. Room 116

The lecture PowerPoint presentations are posted on Courselink.

Laboratories: Mon. to Fri.; SSC 3101, 13:30-17:20 Attendance for the full time period of each laboratory is compulsory. Laboratory sessions start **during the week of Sept. 12.**

Please be prepared. Please see Ms. Russell if you have questions concerning the laboratory.

Learning goals and rationale; course goals and philosophy

Understanding the experimental methods by which biological molecules (especially proteins) are isolated, identified, quantified, and characterized, including some of the underlying theory. Spectroscopic methods and separations science (*e.g.*, chromatography, electrophoresis, centrifugation) are emphasized. We will focus on techniques used in contemporary biochemical research laboratories, and the theory will be profusely illustrated with examples from the scientific literature. The laboratory forms an important component of the learning experience for the course.

Adhering to the *University of Guelph Learning Outcomes*, the course will help particularly to develop the student's "Critical and Creative Thinking", "Literacy" (especially through a term-paper assignment, and encompassing "Information Literacy", "Quantitative Literacy", and "Technological Literacy"), and "Communicating". "Global Understanding" will be enhanced as we consider the historical development of the science and the relationship of biochemistry to other physical and biological sciences.

Learning outcomes

- * understand the theory and practice of protein purification, chromatography, electrophoresis, centrifugation, mass spectrometry, and other essential methods in modern molecular bioscience;
- * learn how to read and analyze the methods sections of primary research articles in biochemistry

- * become familiar with the use of biochemical instrumentation, including spectrophotometer, centrifuge, electrophoresis apparatus;
- * develop and improve fundamental science laboratory skills, including planning, group work, record-keeping, and trouble-shooting.

Course Resources

Laboratory: **Manual:** can be purchased in room SC3115; see hours posted in SC. **You must provide your own goggles and laboratory notebook.**

Recommended textbook: Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., K. Wilson and J. Walker (Eds), Cambridge Univ. Press, 2010; ISBN 978-0-521-73167-6 (Paperback, 744 pages). Specific readings from the textbook are given on the lecture schedule.

The textbook is a multi-author work, with chapters covering a wide range of techniques, including almost all of the topics that we will be discussing. There are also many chapters that we will not be looking at, *e.g.*, cell culture, microscopy, molecular biology and bioinformatics; but these may be useful to you in some other courses. Overall, the depth of coverage is somewhat limited - the book tends to be broad rather than deep.

You will want to refer to a comprehensive biochemistry textbook. I recommend Nelson and Cox, Lehninger's Principles of Biochemistry, 6th ed, 2012, or Berg, Tymoczko, and Stryer, Biochemistry, 8th ed, 2015.

Several sections of the course require familiarity with basic concepts from physics, including electrical circuits; atomic and nuclear structure; fluid mechanics (Archimedes' Principle; buoyancy; viscous drag). Most of these topics were covered in PHYS*1070 and 1080, but you will probably need to consult a physics textbook from time to time.

Some other useful books are listed below:

Laboratory-oriented textbooks

R.F. Boyer, *Biochemistry Laboratory: Modern Theory and Techniques*, Benjamin-Cummings, 2006 (QD415.5.B69)

R.R. Burgess and M.P. Deutscher (Eds), *Guide to Protein Purification*, 2nd ed, Methods in Enzymology, vol. 463, Academic Press, 2009. An authoritative collection of review articles on all aspects of the title subject. ISBN 978-0123749789

J.-C.Janson (Ed), *Protein Purification: Principles, High Resolution Methods, and Applications*, 3rd ed., Wiley, 2011 ISBN 978-0471746614

D.J. Holme and H. Peck, *Analytical Biochemistry*, 3rd ed., Longman, 1998 (QP 519.7.H64). This book has some good practical information on laboratory techniques, but the theoretical coverage is weak.

A.J. Ninfa, D.P. Ballou, and M. Benore, *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*, 2nd ed. Wiley, 2008. ISBN 978-047008766-4

R. Reed, D. Holmes, J. Weyers, and A. Jones, *Practical Skills in Biomolecular Sciences*, 3rd ed., Pearson, 2007; 568 pages. ISBN 978-0132391153

J.F. Robyt and B.J. White, *Biochemical Techniques: Theory and Practice*, Waveland Press, 1990 (QP519.7) Good coverage of chemical-analytical techniques for specific classes of biomolecules, including topics that we won't discuss, such as lipid analysis.

R. Switzer and L. Garrity, *Experimental Biochemistry*, 3rd ed., W.H. Freeman, 1999 (QP519.S95) Good coverage of protein purification, radioisotopes, electrophoresis, immunological methods. Nothing on fluorescence or centrifugation.

Theoretically-oriented textbooks

D. Freifelder, *Physical Biochemistry*, 2nd ed., W.H. Freeman, 1982 (QH 345.F72) This is an excellent reference text, especially with respect to the theory of spectroscopy, centrifugation, electrophoresis, and other biophysical techniques. The text provides detailed coverage of specialized topics that are rarely found in other books, such as the determination of partial molar volumes of proteins; but it is now badly out-of-date.

A. Hofmann, A. Simon, T. Grkovic, and M. Jones, *Methods of Molecular Analysis in the Life Sciences*, Cambridge Univ. Press, 2014. Clear, concise introductions to theory and physical principles; strong on spectroscopy.

S.R. Mikkelsen and E. Cortón, *Bioanalytical Chemistry*, 2nd ed, Wiley, 2016 (QP519.7.M54) Mikkelsen is a chemistry professor at Univ. of Waterloo. Good coverage of electrophoresis, but little spectroscopy.

K.E. van Holde, W.C. Johnson, P.S. Ho, *Principles of Physical Biochemistry*, 2nd ed., Pearson/Prentice-Hall, 2006 (QP 517.P49) Strong on spectroscopic methods and thermodynamics.

Course Content: A detailed lecture plan for the course is given at the end of this document.

Course Prerequisites: Introductory Biochemistry is a prerequisite for this course. The following aspects of the subject are important background; familiarity with them will be *assumed* and may be examined: basic aspects of protein and nucleic acid structure, **including the structures of the amino acids (and their one-letter codes)**; basic enzymology. Please review this material carefully, especially if some time has passed since you took BIOC*2580.

Method of Assessment:

Lecture component		Lab component	
Quiz 1 Oct. 20	15	Notebook	7
Quiz 2 Nov. 17	15	Report 1	14
Term paper Nov. 29	10	Report 2	14
Final exam Dec. 8	25	<i>sub-total</i>	35
<i>sub-total</i>	65	total	100

Students must pass (mark of 50% or better) both the laboratory component (35%) and the lecture component (65%) to obtain a final passing mark in the course. In cases where this standard is not reached, the final mark assigned will be either the mark calculated as given above or 47%, whichever is less. The quizzes will be held in class - see Lecture Schedule for dates. The final exam will cover the entire course, with emphasis on the material covered after the second quiz. Exercises (problem assignments) will be posted on Courselink, but will not be graded. Detailed instructions regarding the term paper, which will be a critical review of a recent journal article, will be distributed separately.

Course and University Policies

Students are expected to attend the lectures and labs. Only valid excuses (medical or compassionate) will prevent a grade of zero for any missed lab., lab. quiz, or examination. Documentation may be required. There will be no “make-up” exams. College policy precludes changes to the grading scheme for individual students, except in case of illness. Every student must bring his/ her identification card to the quizzes and exam. All exams must be written in ink. No additions must be made after return of the paper. Papers may be returned to the instructor for correction of grading errors, only within one week of the return of the graded papers. The instructor may refuse to re-grade a paper, at his discretion. The use of stored programs or stored alphanumeric information on calculators, during examinations or tests, is not allowed.

Signed written comments on the teaching performance of the lecturer may be sent to the Chair, Department of Molecular and Cellular Biology, at any time (a copy will be made available to the instructor after submission of final grades).

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 undergraduate calendar for information on regulations and procedures for Academic Consideration:
www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

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 as soon as possible. For more information: 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: 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. 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:

www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

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:

www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

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 express written permission, obtained in advance, 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.

Campus Resources

The Academic Calendar is the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:

www.uoguelph.ca/registrar/calendars/index.cfm?index

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

- make an appointment with a program counsellor in your degree program:

www.bsc.uoguelph.ca/index.shtml

www.uoguelph.ca/uaic/programcounsellors

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.

www.learningcommons.uoguelph.ca/

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.

www.uoguelph.ca/counselling/

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

www.uoguelph.ca/studenthealthservices/clinic

- 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.

www.uoguelph.ca/~ksomers/

If you have a documented disability or think you may have a disability: Student Accessibility Services provides 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:

www.uoguelph.ca/csd/

Class	Date	Topic	readings
1	2016-09-08	Introduction. Protein quantitation methods	16-20
2	2016-09-13	Protein quantitation methods (cont'd)	306-311
3	2016-09-15	Protein purification principles	"
4	2016-09-20	Mass transport; diffusion; chromatography principles	433-437
5	2016-09-22	Ion-exchange chromatography	459-461
6	2016-09-27	Gel-filtration chromatography	462-465
7	2016-09-29	Affinity chromatography	465-470
8	2016-10-04	Electrophoresis: theory	399-411
9	2016-10-06	Electrophoresis: techniques; detection of proteins	417-418
	2016-10-11	<i>(study break)</i>	
10	2016-10-13	Antibodies	263-279
11	2016-10-18	Immuno- ("western") blotting	419-422
12	2016-10-20	Class test #1	
13	2016-10-25	Electrophoresis: 2D gels; proteomics	411-415; 341-345
14	2016-10-27	Centrifugation: theory	73-95
15	2016-11-01	Centrifugation: techniques	"
16	2016-11-03	Analytical ultracentrifugation	95-99
17	2016-11-08	UV-visible spectroscopy: theory	477-487
18	2016-11-10	UV-vis.: instrumentation and applications	487-493
19	2016-11-15	Fluorescence spectroscopy: theory	493-501
20	2016-11-17	Class test #2	
21	2016-11-22	Fluorescence spectroscopy instrumentation and applications	493-501
22	2016-11-24	Analysis of protein folding and denaturation	-
23	2016-11-29	Mass spectrometry; term paper due	chapter 9
24	2016-12-01	Protein mass spectrometry; proteomics	"
	2016-12-08	Final exam.	