BIOCHEMISTRY AND BIOMEDICAL SCIENCES 3X03
Structure and Function of Macromolecules

Calendar description
Through relevant examples, we will learn how the structure of proteins and macromolecular assemblies are elucidated and how structure determines protein function.

Description
In this course, we will discuss the potential and applicability of various structural biology techniques. From the structure of the DNA duplex in the early fifties to the design of sophisticated antibiotics, X-ray crystallography has played an instrumental role in our current understanding of protein function at the molecular level. We will learn how crystal structures are solved and how the structural information is translated into functional information. Since proteins do not work on isolation, we will also learn how the structure and function of proteins can be studied within the context of macromolecular assemblies or even the whole cell using electron microscopy techniques. Lectures will be combined with hands-on sessions on both crystallography and electron microscopy.

Instructors
Alba Guarné  guarnea@mcmaster.ca  (Course coordinator)
Joaquin Ortega  ortegaj@mcmaster.ca
(Instructors will not have set office hours, but students can make appointments via e-mail).

Teaching Assistants
Monica Pillon  pillonmc@mcmaster.ca  (crystallography section and projects)
Ahmad Jomaa  jomaaah@mcmaster.ca  (electron microscopy section and projects)

Lectures
Tuesday, Thursday and Friday  8:30-9:20 pm   BSB-117

Evaluation
Test 1  35%  (This test will be on the material taught by Dr. Guarné)
Test 2  35%  (This test will be on the material taught by Dr. Ortega)
Project  30%  (20% presentation + 10% written report)

➢ Grades will be posted on Learnlink via the last five digits of your student number. By attending class the student is agreeing to this method of disclosure of grades.
➢ See “Responsibilities of the students – TESTS” on page 3 for academic work missed.

Academic Ethics
Students are required to reread the Senate Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty. Students should be aware of the expectations the University has of its scholars and of the consequences when these expectations are not met.

Academic Dishonesty
Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: “Grade of F assigned for academic dishonesty”), and/or suspension or
expulsion from the university. It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy at [www.mcmaster.ca/univsec/policy/AcademicIntegrity.pdf](http://www.mcmaster.ca/univsec/policy/AcademicIntegrity.pdf)

**Lectures**

#1 (Sep 8) Course Description: Different questions, different methodologies
#2 (Sep 9) Projects Description

**Part I: X-ray crystallography**

#3 (Sep 13) X-ray diffraction fundamentals I  
#4 (Sep 15) X-ray diffraction fundamentals II  
#5 (Sep 16) X-ray Diffraction: Ewald sphere  
#6 (Sep 20) Crystallization techniques  
#7 (Sep 22) Crystal symmetry and data collection  
#8 (Sep 23) Data processing  
#9 (Sep 27) Structure determination I  
#10 (Sep 29) Structure determination II  
#11 (Sep 30) Model Building/ Refinement  
#12 (Oct 4) TEST #1 (Material covered by Dr. Guarné)

**Part II: Electron microscopy**

#13 (Oct 6) What do you do if you do not have a crystal?  
#14 (Oct 7) Fourier theory  
#15 (Oct 11) Theory image formation in electron microscopy. Electron scattering  
#16 (Oct 13) Theory image formation in electron microscopy. Mechanisms of contrast  
#17 (Oct 14) Sample preparation in electron microscopy  
#18 (Oct 18) Obtaining three-dimensional reconstructions of macromolecular machines I  
#19 (Oct 20) Obtaining three-dimensional reconstructions of macromolecular machines II  
#20 (Oct 21) Four-dimensional cryo-electron microscopy. Image classification strategies  
#22 (Oct 27) No Class.  
#23 (Oct 28) TEST #2 (Material covered by Dr. Ortega)

**Part III: Group Project (Nov 1 - Dec 2)**

<table>
<thead>
<tr>
<th>Project #</th>
<th>Topic Covered</th>
<th>TA</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Crystallization, data collection and processing of lysozyme</td>
<td>Pillon</td>
</tr>
<tr>
<td>II</td>
<td>Structure Determination and Refinement</td>
<td>Pillon</td>
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<tr>
<td>III</td>
<td>Structure Validation</td>
<td>Pillon</td>
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<tr>
<td>IV</td>
<td>3-D reconstruction of macromolecules</td>
<td>Jomaa</td>
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<tr>
<td>V</td>
<td>Sample preparation for cryo-electron microscopy</td>
<td>Jomaa</td>
</tr>
<tr>
<td>VI</td>
<td>Dealing with heterogeneous specimens in electron microscopy</td>
<td>Jomaa</td>
</tr>
</tbody>
</table>

#24 (Nov 1) Groups I and IV meet with TAs
#25 (Nov 3) Groups II and V meet with TAs
#26 (Nov 4) Group III and VI meet with TAs
#27 (Nov 8) Groups I and IV meet with TAs
#28 (Nov 10) Groups II and V meet with TAs
#29 (Nov 11) Groups III and VI meet with TAs
#30 (Nov 15) Groups I and IV meet with TAs
#31 (Nov 17) Groups II and V meet with TAs
#32 (Nov 18) Groups III and VI meet with TAs

*this meeting may run long
Responsibilities of the students

COURSE CONTENT:

The instructor and university reserve the right to modify elements of the course during the term. The university may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes. It is the responsibility of the student to check their McMaster email and course websites weekly during the term and to note any changes.

TESTS:

Since the course does not have a final exam, every student MUST write both tests. Extenuating circumstances, preventing students from writing any of the tests, should be discussed and properly justified to the course instructors beforehand and an individual oral exam will be arranged. Otherwise, the mark for the missed test will be zero. If you miss a test due to illness or compassionate reasons, the proper forms must be submitted to the Associate Dean of Science (Studies) for approval. Discretionary notes from the Associate Dean’s office will not be accommodated. Information on Missed Academic Work and Appropriate Medical Certificates can be found at www.science.mcmaster.ca/~associatedean/services/exemptions.html

McMASTER STUDENT ABSENT FORM

Please note that the MSAF may not be used for term work worth 30% or more (i.e. midterm exams or projects). If you are absent from the university for a minor medical reason, lasting fewer than 5 days, you may report your absence, once per term, without documentation, using the McMaster Student Absence Form. Absences for a longer duration or for other reasons must be reported to your Associate Dean of Science (Studies) for approval, with documentation, and relief from term work may not necessarily be granted. When using the MSAF, report your absence to Dr. Guarne or Dr. Ortega (normally within 2 working days) by email to learn what relief may be granted for the work you have missed.

GROUP PROJECT:

Please sign up for your preferred group project between October 12th (10 pm Learnlink time, signups before that time will be disregarded) and October 14th (10 pm Learnlink time, late signups will be penalized with a 1% off your final mark). Projects will be assigned on a first-come first-served basis. Therefore, please list all the projects in order of preference when signing on Learnlink. Each group will work together during three weeks to develop the mini-research project and their contributions will be evaluated from both the oral presentation and the written report.

CLASS PRESENTATIONS:

Presentations should be 15 minutes and will be evaluated on the basis of clarity, accuracy and overall quality. Electronic files of the presentations (PowerPoint format) must be submitted to the course coordinator 24 hours before the presentation. Any person of the group can present (we encourage 2-3 people). The presentation will be followed by a short question and answer period to ALL the members of the group. Absolutely no re-scheduling will be done once the groups are set.

WRITTEN REPORTS:

Written reports (one per group) should be submitted to your TA by 2 pm the day after your presentation. An electronic copy of the document MUST be sent to the course coordinator at the
same time. Reports should have a maximum length of 10 pages (double-space and 1 inch margins all around) including figures but excluding references. Only reliable scientific sources should be used as references. Reports should be written using publication style including four sections (introduction, methods, results and discussion). The documents will be screened for plagiarism using the Turnitin software and marked based on clarity, accuracy, scientific content and style. Late submissions will be assessed with a 1% penalty on the final mark.

ATTENDANCE:

Attendance to ALL group presentations is mandatory. Attendance will be randomly monitored and absences will be assessed with a 1% penalty on the final mark.