UNIT OUTLINE - GUIDE, SYLLABUS AND TIMETABLE

CBMS389 – ADVANCED CHEMISTRY III

THREE (3) CREDIT POINTS

FULL-YEAR (D3) 2014

UNIT CONVENOR – PROF PETER KARUSO

F7B232, PH 9850 8290, E-MAIL peter.karuso@mq.edu.au

ADMISSION TO ADVANCED SCIENCE PROGRAM OR PERMISSION OF

DEAN OF FACULTY

PRE-REQUISITES: CBMS188(P), and students must be in their third year of study

Classes: S1 C3B306, Wednesday 10-11 am
S2\(^1\) F7B322, Friday 1 - 2 pm

URL  http://ilearn.mq.edu.au

\(^1\) Day and Time to be confirmed at the beginning of S2 (Ignore what it says on the timetables web site)
**CBMS389 UNIT GUIDE**

<table>
<thead>
<tr>
<th>Year and Semester:</th>
<th>Full year, 2014</th>
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</thead>
<tbody>
<tr>
<td>Unit convenor:</td>
<td>Prof Peter Karuso</td>
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<tr>
<td>Prerequisite:</td>
<td>CBMS188, Admission to Advanced Science Program or permission of Dean of Faculty</td>
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<tr>
<td>Corequisite:</td>
<td>be in 3rd year of study, CBMS102/103(HD/D), GPA &gt;3.2</td>
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<tr>
<td>Assumed Knowledge:</td>
<td>This unit requires an inquisitive mind, the ability to think critically and a keen interest in chemistry wouldn’t hurt.</td>
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Students in this unit should read this unit outline carefully at the start of the year. It contains important information about the unit. If anything is unclear, please consult the unit convenor, Prof Peter Karuso.

**ABOUT THIS UNIT**

| Credit Points:               | 3 cp (equivalent to an average of 4-5 hours/week of contact hours and self-study) |
| Contact Hours:               | 1 hour/week (lecture/discussion session - some additional contact time may be requested to accommodate discussion and presentation sessions, following student consultation). Advanced Science students are also eligible for vacation scholarships, embedded within the department’s research groups. |
| When Offered:                | D3 - Day; Full-Year |
| Staff Contact:               | Prof Peter Karuso  
Department of Chemistry & Biomolecular Sciences  
Phone: 9850 8290  
Fax: 9850 8313  
E-mail: peter.karuso@mq.edu.au |

**CBMS389 - Advanced Chemistry III.** CBMS389 is the defining unit for the BAdvSc (Chem). CBMS389 is the 300-level version of CBMS188 and meets concurrently with CBMS188. The prerequisites are CBMS188(S) and CBMS102/103(D/HD) or GPA > 3.2. In addition to attending all coursework indicated for CBMS188, CBMS389 students will be expected to mentor at least three CBMS188 student and participate in at least one 4 week vacation “scholarship” (unpaid) after their second year of study (i.e. in Jan/Feb of their third year, the mid-year break (July) of end of third year (Dec-Jan) and to write up a report on their work. CBMS389 students will not submit assignments but help their mentored CBMS188 students complete their assignments. This will not involve helping CBMS188 students write the assignments (or whatever the task is), but guide the CBMS188 students through the process of collecting information, explaining new concepts and trying to get them enthused about science.

**TEACHING STAFF**

- Convenor Prof Peter Karuso, F7B232, ph 9850 8290, email mailto:peter.karuso@mq.edu.au
- Others – as appropriate for the research internship

You will be guided and instructed by world leaders in their respective research areas. Dr Louise Brown will facilitate the first four discussion groups, starting in week 2 of the semester on protein chemistry (weeks 2-5). This will be followed by Dr Danny Wong on adventures in electrochemistry (weeks 6-9).
and Dr Ian Jamie will facilitate the third topic on the growth of crystal gardens (weeks 10-13). In second semester, you will lead a workshop on chemoinformatics and introduce your CBMS188 students (mentor list) to literature searching in chemistry (SciFinder) in Week 16. Dr Liu will deliver the fourth topic on structural chemistry, molecular recognition, and their applications (weeks 17-20). Prof Karuso will deliver the fifth topic on combinatorial chemistry and chemical diversity (weeks 21-24). Prof Packer will deliver the last topic on sugar chemistry (weeks 25-28). There is no final exam so week 30 is free for study. You will also have to complete a 4 week full-time research project in your final year and write a report in the form of a research paper to complete CBMS389.

The teaching staff will not have set office hours for this course. Rather, you are expected to use the e-mail facility on the iLearn web pages to send questions and contribute to the on-line discussion (Q&A forum). We will, of course, also be available for consultations on topics best dealt with in person. While we have an open door policy, it may be best to make an appointment first to see us.

**CHANGES TO THE UNIT SINCE LAST OFFERING**

CBMS389 material is the same as the last offering but the order of lectures has been changed in S1. Access to the CBMS188 material is made through the CBMS188 iLearn page. CBMS389 is only available to students who have completed CBMS188(S) and have a GPA >3.2 or D/HD grades in 100-level chemistry units.

**FEEDBACK**

We are always open to suggestions for improving the content and delivery of this course. We are very happy to receive any constructive criticism that you may wish to provide. This unit gives you access to current cutting-edge science and the best research minds in the department.

**CLASSES**

CBMS389 is comprised of weekly one-hour interactive discussion sessions based around recent advances in chemistry. The one-hour discussion sessions commence in week 2 and run till week 26. Meetings times will initially be at 1 pm in Rm F7B322 in S1 and may be at a different time and place in second semester depending of clashes with other classes. Please ignore the “timetable” website for S2 classes. In addition, CBMS389 students are required to undertake a vacation scholarship in one of the research groups in CBMS and write a report on their work. As this is done for credit, no remuneration is associated with the assessed “vacation scholarship”.

**REQUIRED AND RECOMMENDED TEXTS AND/OR MATERIALS**

There are no required texts but for background reading use 200/300 level chemistry text books.

**UNIT WEB PAGE**

Please go to iLearn and select CBMS188/389

**TECHNOLOGY USED**

SciFinder Scholar is available on campus to assist in searching the literature. This is available in the library and, following requesting permission from the unit convenor, specific computers in Chemistry. You will also be expected to access the journal finder site from the library [http://www.lib.mq.edu.au/research/journal-finder.php](http://www.lib.mq.edu.au/research/journal-finder.php).

Please note information may also be sent by e-mail to your student e-mail account so please look at your student account regularly or have your e-mail forwarded to your preferred account.
EXPECTED LEARNING OUTCOMES

The general aim of this unit is to give students a deeper and more holistic appreciation of chemistry and what some of the current directions of the science are.

By the conclusion of this unit, students should be able to:

• Carry out a lab-based a research project with minimal supervision;
• Be able to gather, organise and interpret experimental results;
• Be able to use the primary literature to design and carry out lab-based experiments in a real research lab;
• communicate concepts of chemistry in manner accessible to other 100-level advanced students;
• show the ability to use the chemical database SciFinder Scholar to retrieve information on specific chemicals, find methods for the synthesis of specific chemicals and find literature on chemistry topics generally;
• mentor junior advanced sciences students in laboratory and literature-based projects

In addition to the discipline-based learning outcomes above, this unit will also help develop the graduate capabilities that “University’s graduates need to develop to address the challenges, and to be effective, engaged participants in their world”. Graduate capabilities are viewed as essential for all graduates, irrespective of their course of study. Thus, they are the building blocks for developing the attributes valued in a university graduate. Some of the attributes and skills that CBMS389 can help you develop are:

• Problem Solving and Research Capability, Critical, Analytical and Integrative Thinking and being Creative and Innovative: Within this unit you will have the opportunity to develop your problem solving and research skills and show your creativity and innovation through the “vacation scholarship” research project and written report. The problem solving will include situations where there are no clear solutions demanding critical, analytical and integrative thinking and consultation of the primary literature. In some cases you will be using specialised technologies in the labs that will require analytical and integrative thinking.

• Effective Communication: CBMS389 will help equip you with both oral and written communication skills, through participation and leading of discussions you will be engaged in with your lecturers and mentored class-mates. Part of your assessment will be concerned with your ability to communicate in clear, concise and appropriate, context-dependent modes (formal and informal team discussions, etc).

• Socially and Environmentally Active and Responsible: You will be working with 1-5 first year students as part of CBMS389, giving you the opportunity to develop your ability to work with others as a leader and mentor and to have a sense of connectedness and mutual obligation with your class mates.

• Engaged and Ethical Local and Global citizens: Engaged and ethical behaviour will be addressed in the context of being a professional chemist, that is, you will be concerned with collecting information with appropriate acknowledgement of sources. You will be working with people from a variety of cultural, social and economic backgrounds and you will be expected to be able to form cohesive and effective teams and show leadership of students in your class.

Commitment to Continuous Learning: As a result of its discussion mode, some of the coursework in this unit is open ended allowing you to demonstrate commitment to learning well beyond the defined tasks and you will have the opportunity to influence some of the topics covered. The coursework is
specifically designed to stimulate curiosity and fascination for chemistry and lead you to continue to pursue knowledge for its own sake.

**TEACHING AND LEARNING STRATEGY**

CBMS188/389 is run in discussion mode (1 hour per week) to enhance understanding of contemporary topics in chemistry. All students will be expected to attend every session and actively participate in discussions throughout the year. Do not be afraid to ask questions – everyone benefits from a robust and open discussion of the topics and remember, there are no stupid questions about chemistry (only stupid answers).

Vacation Scholarships are an invaluable opportunity to experience real research embedded in an internationally recognised group. Students are expected to attend group meetings, seminars and participate in all aspects of the research group. Attendance is for a minimum of 4 weeks, 9-5 weekdays.

**RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES**

**Assessment** is based on participation in the weekly discussions/lectures (total of 6 major topics) and your mentoring of CBMS188 students. These assessment tasks are marked by your lecturers, based on your participation, interactions and support of your CBMS188 students. This forms 15% of your final mark. Alternatively, students can apply to mentor Hornsby Girls High year 12 students in chemistry in preparation for their HSC exams. This will entail travelling to the School (train from MQ) and participating in workshops and lunchtimes and/or 3-5pm afternoons. In addition, CBMS389 involves a vacation scholarship with an assessable report. This involves 4 weeks of research work, for which you will write a report, marked by the unit coordinator (40%) and a report from your research mentor (35%). For your final vacation scholarship, you should not work in a lab that you have worked in before. **There is no final exam for this unit.**

A satisfactory/unsatisfactory grade is obtained overall. You must perform satisfactorily in all parts of the assessment to achieve an overall satisfactory mark (i.e. in the mentoring and the vacation scholarship). Mentoring will be marked with a HD/D/Cr, etc or similar marking scheme and you are encouraged to perform at the best of your abilities. An unsatisfactory grade may result from a student not attending all sessions.

Assessment details for CBMS389 are provided below. More detailed information will be provided directly by the teaching staff.

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<thead>
<tr>
<th>Assessment Task</th>
<th>Percentage</th>
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<tr>
<td>Slomation feature mentoring</td>
<td>5%</td>
</tr>
<tr>
<td>Redox Laboratory Report Mentoring</td>
<td>5%</td>
</tr>
<tr>
<td>Protein structure and thermodynamics mentoring</td>
<td>5%</td>
</tr>
<tr>
<td>(or Hornsby Girls High student mentoring)</td>
<td>15%</td>
</tr>
<tr>
<td>Research Internship report²</td>
<td>40%</td>
</tr>
<tr>
<td>Supervisor’s report</td>
<td>35%</td>
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If an absence is **anticipated** (perhaps for a mandatory religious or University-associated sporting event etc) you must lodge a special consideration request on-line at: [http://web.science.mq.edu.au/new_and_current_students/undergrad/admin_central/special_consideration/](http://web.science.mq.edu.au/new_and_current_students/undergrad/admin_central/special_consideration/). It is your responsibility to undertake this. Notification after the event of an anticipatable absence will not be looked upon favourably. Late submission will incur a 10%/day penalty.

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² Your report should be in the style of a research paper. Use the Tetrahedron template provided on iLearn or something similar. The report is due before the beginning of the semester AFTER your vacation project.
UNIT SYLLABUS AND TIMETABLE

Wk 1: No Lecture. Download unit guide, familiarise yourself with the curriculum and expectation.

Wk 2-5 LB
This four-week section will introduce you to the chemistry of biological macromolecules, particularly proteins (Brown Ch 29). You will gain an understanding for why the bigger a molecule becomes, the more difficult it is to determine its structure. We will look at several novel approaches at the forefront of determining structures of biological macromolecules. We will also focus on several classes of proteins including molecular motors, light receptors and channels. We will dissect mechanisms behind how and why proteins can move and change shapes to perform their required functions.

Wk 2: Introduction to properties of amino acids and protein folding (Thermodynamics, Brown Ch 14). Explore conventional structural methods, including X-ray crystallography and NMR spectroscopy. Discussion on several notable biomacromolecules including examples of molecular motors, fluorescent proteins, membrane proteins Pick your own ‘biomacromolecule’.

Wk 3: Introduction to primary literature for researching your chosen biomacromolecule. Group Task - Plan your YouTube video for filming in week 4.

Wk 4: Group task – film your YouTube video in small groups

Wk 5: Group presentations of your YouTube videos of your selected biomacromolecule. Discussion/Debate of the definition of chemistry and whether ‘structural biology’ really is chemistry. Hand in your individual written report.

Wk 6-9 DW
In this section, we will firstly extend principles of redox reactions already developed in high school chemistry, followed by their applications to analytical detection. More specifically, we will direct our attention to how electrochemistry is applied to modern development of sensitive and selective sensing technologies. This section build on Blackman Ch 12 and involves some theory and a laboratory experiment will be conducted, led by your third year mentor, to enhance understanding of principles presented in this section, as well as to gain hands-on experience of some advanced electroanalytical detection techniques. Students will then be required to deliver a verbal presentation of their independent research on selected sensor development and a formal lab report, which is graded.

Wk 6: Review of basic electrochemistry
Wk 7: Laboratory work
Wk 8: Discussion of results
Wk 9: Oral presentation and hand in lab report

Wk 10-13 IJ

Chemical gardens are the plant-like structures formed when a soluble metal salt in the form of a seed crystal is placed in an aqueous solution, typically, sodium silicate. Tubular structures form, rising up from the seed crystal. This process has some parallels with other precipitation processes, such as the huge black “smokers” that grow up to 30 m tall at hydrothermal vents on the ocean’s floor. At smaller length scales, it causes the growth of beautiful “soda-straw” stalactites in limestone caves. We will
explore the chemistry of the formation of these crystal gardens and use the technique of “slowmation” to document the process.

**Wk 10:** Introductory remarks and overview of the unit. Introduction to precipitation in the lab and in the field

**Wk 11:** Growing a Crystal Garden in the Laboratory

**Wk 12:** Discussion of Crystal Field Theory

**Wk 13:** Construction of the Web Page

**Wk 14:** study period

**Wk 15:** Examination week (CBMS188 has no mid-year exam)

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**Semester 2**

**Wk 16:** introduction to SciFinder Scholar by your 3rd year mentors (and Joanne Jamie)

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**Week 2-5 FL**

This section of the course will provide you with an overview of more advanced concepts in chemical bonding and structure, chemical and physical principles behind molecular recognition, and their applications in fundamental discoveries. This section is an extension of CBMS103 as it deals with more advanced theories on bonding, structures, conformations, H-bonds, and reaction energy controls. These are extensions of McMurry Ch. 1, 2, and 3 (Structure and bonding, nature of organic molecules, and nature of organic reactions). Specific topics include:

**Wk 17:** Localised and delocalised bonding: From Lewis to Schrödinger

**Wk 18:** Weak bonding interactions behind strong networks

**Wk 19:** Recognition motifs of the molecular world

**Wk 20:** Time-dependent chemical complexity + hand in take-home exam in Wk 21

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**Week 6-9 PK**

This section of the course will provide you with an overview of Chemical Diversity, Combinatorial Chemistry and more advanced aspects of organic chemistry mechanisms that can lead to Diversity Orientated Synthesis. Topics covered are extension of McMurry Ch. 1 (structure and bonding), 2 (the nature of organic molecules) and Ch. 3 (the nature of organic reactions)

**Wk 21:** Introduction and history of chemical synthesis, chemical space, medicinal chemistry, natural products and combinatorial chemistry

**Wk 22:** Advanced mechanistic chemistry + pick your research topic related to combichem

**Wk 23:** Combinatorial Chemistry and Diversity Orientated Synthesis + prepare for your presentation

**Wk 24:** Group talks and final summaries and hand in your report in Wk 25.
**Week 10-13 NP**

This section of the course will provide an overview of the modifications that occur to a protein between the translation of a gene and the functional gene product. These "post-translational modifications" will be related to the functional groups you learn about in CBMS103 and the mechanisms of functional group transformations. For example, serine phosphorylation can be related to reaction of acid anhydrides (or esters) with alcohols, ATP being a phosphoric acid anhydride or "phosphodiester". Alkylation with SAM can be related to the reaction of alkyl-halides (eg MeI, which you learnt about from a chemical perspective in Ch 7 and Ch 8 and Ch 12). Acetylation with acetylCoA can be related to esterification (Ch 10) and amide bond formation (Ch 12). Emphasis will be on sugar chemistry (see Blackman, Ch22; McMurry Ch14 & 15), the addition of the many types of different carbohydrate structures to the proteins, and how their chemical properties modify the behaviour of the protein.

*Wk 25: Discussion of the known modifications that occur to proteins and how their chemical properties may affect the behaviour, structure and localisation of the proteins.*

*Wk 26: Introduction to the types of oligosaccharide modifications that are found on proteins, with examples of the many different isomeric sugar structures found. Choice of a particular glycoprotein to review.*

*Wk 27: Exploration of the methods used to characterise glycoproteins and the basis behind the methods used.*

*Wk 28: Oral (10 min. + 5 min for questions) and hand in written report*

*Wk 29: study break*

*Wk 30: Examination week (CBMS188 has no final exam)*

We hope you find this course both educational and inspiring!

Peter Karuso
The small print:

EXTENSION AND SPECIAL CONSIDERATION REQUESTS

Extension requests for the assignments must be made through the Faculty Science link. [http://web.science.mq.edu.au/new_and_current_students/undergrad/admin_central/special_consideration/]

The University recognises that there may be circumstances where a student is prevented by unavoidable disruption from performing in accordance with their ability. The University has a policy on special consideration request that may be found at [http://www.mq.edu.au/policy/docs/special_consideration/policy.html].

UNIVERSITY POLICY ON ASSESSMENT AND EXAMINATIONS

To articulate the principles that underpin the Macquarie University approach to assessment of student learning and feedback. These principles guide the procedures to be used in the conduct and management of assessment and feedback practices in all coursework units. [http://www.mq.edu.au/policy/docs/assessment/policy.html]

The examination period following week 13 of every semester is part of the academic year and all students are required to make themselves available during this period. The University policy of examinations can be found at: [http://www.mq.edu.au/policy/docs/examination/policy.html]

ACADEMIC HONESTY

The University declares that it is a “fundamental principle” that “all staff and students act with integrity in the creation, development, application and use of ideas and information”. This means that:

• all academic work claimed as original is the work of the author making the claim
• all academic collaborations are acknowledged
• academic work is not falsified in any way
• when the ideas of others are used, these ideas are acknowledged appropriately

You should be familiar with the University’s Policy on Academic Honesty practices and its Statement on Ethics. These can be found in the Handbook of Undergraduate Studies or on the web at:


Academic Honesty Policy: [http://www.mq.edu.au/policy/docs/academic_honesty/policy.htm]


The policies and procedures explain what academic dishonesty is, how to avoid it, the procedures that will be taken in cases of suspected dishonesty, and the penalties if you are found guilty.

FEEDBACK

We value your feedback to improve our unit and reflect on our practices. The University policy on feedback can be found here: [http://www.mq.edu.au/policy/docs/student_feedback/policy.html]

OTHER UNIVERSITY POLICIES

Macquarie University is developing a number of policies in the area of learning and teaching. Approved policies and associated guidelines can be found at Policy Central: [http://www.mq.edu.au/policy].

STUDENT SUPPORT SERVICES

Macquarie University provides a range of Student Support Services. Details of these services can be obtained at: [http://www.futurestudent.mq.edu.au/undergraduate/information_about/accessing_student_support.jsp]