CBMS188 – ADVANCED CHEMISTRY I

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-/CO-REQUISITES: CBMS102 & CBMS103

Classes:  S1 F7B322, Thursday 1 - 2 pm
          S2¹ F7B322, Wednesday 1 - 2 pm

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

(login and follow prompts to Advanced Chemistry)

¹ Day and Time to be confirmed at the beginning of S2 (please ignore timetable website)
CBMS188 UNIT GUIDE

Year and Semester: Full year, 2014
Unit convenor: Prof Peter Karuso
Prerequisite: Admission to Advanced Science Program or permission of Dean of Faculty
Corequisite: CBMS102 & CBMS103
Assumed Knowledge: This unit requires an inquisitive mind, the ability to think critically and a keen interest in things molecular wouldn’t hurt.

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

CBMS188 - Advanced Chemistry I. CBMS188 is a unit reserved for students with a strong interest in chemistry/biological chemistry, especially those who wish to undertake further Chemistry & Biomolecular Sciences units. It comprises a weekly one-hour discussion session based around new chemistry concepts and recent advances in the chemical sciences in the fields of physical, analytical, organic and biological chemistry. It is an extension course to CBMS102 and CBMS103 and will not duplicate other CBMS units but introduce you to new concepts and topics not covered in other units. Completing CBMS188 to a high standard also gives you the opportunity for entry into summer vacation scholarships (currently $275/week tax free) with an academic staff member of your choice within the Department of Chemistry & Biomolecular Sciences. You will also be assigned a third year Advanced Science mentor who will help you with your assignments.

TEACHING STAFF
• Unit Convenor and Lecturer Prof Peter Karuso, F7B232, ph 9850 8290, email mailto:peter.karuso@mq.edu.au
• Lecturer Dr Ian Jamie, F7B236, ph 98508293 , e-mail mailto:ian.jamie@mq.edu.au
• Lecturer Dr Danny Wong, F7B235, ph 98508300 , e-mail mailto:danny.wong@mq.edu.au
• Lecturer Dr Fei Liu, F7B330, ph 9850 8313, e-mail mailto:fei.liu@mq.edu.au
• Lecturer Dr Louise Brown, F7B335, ph 98508294 , e-mail mailto:louise.brown@mq.edu.au
• Lecturer Prof Nicki Packer, E8C307, ph 9850 8176, e-mail mailto:nicki.packer@mq.edu.au
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 biological molecules (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 crystal gardens (weeks 10-13). In second semester, your 3rd year mentors will introduce you 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). The final written assignment is due in week 29 and there is no final exam so week 30 is free for study.

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**

CBMS188 is structurally the same as last year but there is some new content compared to previous years. The unit is now run through iLearn instead of the Chemistry web server. CBMS188 is open to students outside the BAdvSc program, by permission and with an equivalent ATAR (>95) or with HD grade(s) in CBMS101, 102 and/or 103.

**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**

CBMS188 is comprised of weekly one-hour interactive discussion sessions based around recent advances in chemistry and biomolecular sciences. The one-hour discussion sessions commence in week 2 and run till week 26. Meetings times will initially be at 10 am (Wednesday) in Rm C3B306 in S1 and may be at a different time and place in second semester depending of clashes with other classes but please check [https://timetables.mq.edu.au](https://timetables.mq.edu.au) for the official timetable of the unit for semester 1. For semester 2, ignore the timetable as meeting will most likely be in F7B322.

**Required and Recommended Texts and/or Materials**

There are no required texts but for background reading use the CBMS012 & 103 text books.

**Unit Web Page**

The web page for this unit can be found at [http://ilearn.mq.edu.au/](http://ilearn.mq.edu.au/). Just login and follow the prompts to CBMS188 Advanced Chemistry. For those who are interested in looking at the unit guide but are not formally enrolled, go to [http://www.cbms.mq.edu.au/ugrad/units.html](http://www.cbms.mq.edu.au/ugrad/units.html) and click on “[PDF]” next to CBMS188. You can use any web browser to login. iLearn Macquarie University’s default Learning Management System (LMS). The iLearn online learning environment is aimed to enables learning,
teaching, communication and collaboration. We use it to create and share lecture notes, laboratory notes, discussions, digital lecture recordings and other learning resources online. See http://www.mq.edu.au/iLearn/studentinfo.htm for more information. You will be asked for a username and password. Your User Name is your Macquarie Student ID Number, which is an 8-digit number found on your Campus Card. The password is your myMQ Student Portal password. This will be the original MQID password (2 random characters followed by your date of birth in ddmmyy format) that was sent to you on enrolment, unless you have already changed your password in the myMQ Student Portal. If you have any problems with iLearn log a ticket with OneHelp at http://onehelp.mq.edu.au/. More information about OneHelp can be found at: http://informatics.mq.edu.au/help/

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.

Internet access is required to view the unit web site and download pdf files. To view pdf files you will require Adobe Acrobat Reader version 7 (or later) to be installed on your computer. The latest version of Acrobat Reader can be downloaded from the Adobe website http://get.adobe.com/uk/reader/. If you are using the computers in the library, then Acrobat has already been installed.

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:

• explain the chemistry behind the synthesis and metabolism of biological macromolecules
• describe the chemistry that drives protein folding;
• be able to describe the major techniques for determining structures of biological macromolecules. describe the significance of analytical chemistry to modern society;
• explain the role of electrochemistry in analytical chemistry;
• describe the fundamental principles of electrochemistry, particularly how electrochemistry is related to analytical detection;
• apply electrochemistry to simple chemical analysis, clinical diagnostics and environmental detection;
• relate "crystal garden" growth to the chemical processes of precipitation, diffusion and osmosis;
• relate "crystal garden" colours to molecular electronic configuration;
• communicate concepts of chemistry in manner accessible to a non-technical audience;
• describe the role small organic molecules can play in probing biological systems;
• explain the theoretical models behind bonding and molecular structure
• explain experimental observations of chemical reactivities properties governed by structure
• recognise and rationalise the molecular forces that control how molecules interact
• explain how a diverse range of molecules can be synthesised using combinatorial methods;
• compare and contrast different methods used in combinatorial chemistry and diversity orientated synthesis;
• be able to explain the differences between combinatorial libraries and natural products;
• have the capability 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;
• be able to draw and assign the stereochemistry of the eight monosaccharides found on mammalian glycoproteins
• be able to list the range of modifications that occur to a protein after translation;
• compare and contrast the approaches to the analysis of carbohydrate modifications to proteins;
• describe the limits to the heterogeneity found in oligosaccharide structures.

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 CBMS188 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 written assignments and an oral presentation. The problem solving will include situations where there are clear solutions as well as situations demanding critical, analytical and integrative thinking. In some cases you will be using specialised technology for the retrieval of information, the analysis of data and the presentation of results.

• **Effective Communication**: CBMS188 will help equip you with both oral and written communication skills, through assignments and oral presentations, and through the communications you will be engaged in with your lecturers and your class-mates. Part of your assessment will be concerned with your ability to communicate in clear, concise and appropriate, context-dependent modes (formal reports, informal team discussions, etc). You will also be assessed on your ability to use appropriate technologies including PowerPoint presentations, use of the white-board and overhead projector to assist oral communications.

• **Socially and Environmentally Active and Responsible**: You will be working in small teams for part of CBMS188, giving you the opportunity to develop your ability to work with others as a leader and a team player and to have a sense of connectedness and mutual obligation with others.

• **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 share the workload with other 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 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). Group presentations in written and oral form are also expected.

Some lecture/discussion material will be available on the unit web site, while other material will be provided in the class. The staff in this unit will regularly update the web site to provide further information relevant to the unit. All students are expected to visit the web site on a regular basis and enter into web-based discussions with their peers and your third year mentors.

**RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES**

**Assessment** is based on assignments/workshops (total of 6 major topics) and short orals (group presentation). These assessment tasks are provided so that you will have the opportunity to use the information gained in the discussion session to test your degree of understanding of those topics and to gain discipline specific knowledge and skills as well as develop your graduate capabilities attributes.

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. Assignments 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. A high standard of performance will allow entry into summer vacation scholarships. An unsatisfactory grade may result from a student not submitting all assignment tasks or showing a partial, superficial or faulty understanding of the topics.

Assessment details* for CBMS188 are provided below. More detailed information will be provided directly by the teaching staff. The assessment consists of assignments, essays, lab reports, posters and/or oral presentation requiring reviews of current literature in the six topic areas.

Assignment on biological macromolecules
(due Friday 5 pm week 5) 1/6 unit mark

Laboratory Report
(due Friday 5pm week 10) 1/6 unit mark

Production of a Web Page on Crystal Gardens
(due Friday 5 pm week 14) 1/6 unit mark

Takehome exam on structure and bonding
(due Friday 5pm week 6, S2) 1/6 unit mark

Essay on combinatorial chemistry and oral presentation of your topic
(due Friday 5pm week 10, S2) 1/6 unit mark

Protein modification assignment
(due Friday 5pm week 13, S2) 1/6 unit mark

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* More detailed information will be provided directly by the teaching staff.

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**Prof Peter Karuso**

**Advanced Chemistry I, Chemistry & Biomolecular Sciences, 2014**
*Receipts must be filled in and signed for all essays and assignments handed in. See the unit web site under printed notes for the receipts. Receipts are available from the science website: http://web.science.mq.edu.au/intranet/lt/barcode/coversheet.php

Late submission of assignments will incur a penalty of 10% for each late day unless a valid reason is provided. 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/. It is your responsibility to undertake this. Notification after the event of an anticipatable absence will not be looked upon favourably.

UNIT SYLLABUS AND TIMETABLE

Wk 1: No Lecture. Download unit guide, familiarise yourself with the curriculum and expectations and participate in virtual meeting on the CBMS188 web site.

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 setion build on Blackman Ch 12 and involves some thoery 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)

Semester 2
Wk 16: introduction to SciFinder Scholar by your 3rd year mentors (and Joanne Jamie)

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

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/](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](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](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](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:


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](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/](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](http://www.futurestudent.mq.edu.au/undergraduate/information_about/accessing_student_support.jsp)