CBMS306

Medicinal Chemistry

S1 Day 2015

Dept of Chemistry & Biomolecular Sciences

Contents

General Information

Unit convenor and teaching staff
Unit Convenor, lecturer and lab demonstrator
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F7B231
Have an open door policy, but students are encouraged to arrange a meeting via email.

Lecturer and lab demonstrator
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F7B232
Have an open door policy, but students are encouraged to arrange a meeting via email.

Credit points
3

Prerequisites
CBMS204 and (3cp from CBMS200-CBMS203 or CBMS205-CBMS234)

Corequisites

Co-badged status
This unit is co-badged with CBMS706 and CBMS842 Medicinal Chemistry

Unit description
Medicinal chemistry is the application of chemistry to the discovery, design and synthesis of new drugs. This unit is of value to all chemistry, biomolecular sciences and medical sciences students. The central core of the unit is the description of methods used for the discovery of new drugs, how these are modified to produce more active compounds, transportation to and from their points of action and how they are cleared from the body. Topics include: the structure and function of biological targets (proteins and DNA); sources of new drugs from nature; and lead generation and methods of lead modification to make more active, selective or less toxic drugs. This is followed by a study of structure – activity relationship methods; pharmacokinetics, drug metabolism and prodrugs, and chemical genetics. Case studies are also provided, including antibacterial and anticancer agents, and nucleic acid therapies. The theory is complemented by a discovery-based laboratory project incorporating synthetic chemistry, spectroscopic methods, bioassays and computational chemistry to elucidate the essential structural features necessary for the sulfonamide class of antibacterial agents.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

Define medicinal chemistry and what medicinal chemists know

Define the major biological targets for drugs and how these drugs achieve their pharmacological effect

Define where new drugs come from

Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs

Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism

Be able to design experiments to determine the structure-activity relationship within a class of drugs

Use the chemical literature to find suitable methods to make new compounds

Use analytical techniques to determine the molecular composition of reaction products

Analyse experimental results to solve related problems

Accurately record your laboratory observations in an appropriate scientific manner

Work with colleagues to undertake experiments in a safe and harmonious way

Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Assessment Tasks

Name	Weighting	Due
Practical Reports	25%	March 5, April 2, June 9
Mid-semester test	10%	May 7, 2pm
Quizzes	5%	in lectures and online
Assignment	10%	April 22, 9am, Student Centre
Final exam	50%	TBA

Practical Reports

Due: **March 5, April 2, June 9**
Weighting: **25%**

The practical work (synthesis and antibacterial structure activity relationship of sulfonamides) will be conducted in groups, with ~4-6 people per group. For each group a report in the style of a journal article will be produced at the end of the semester. Following your week 1 laboratory preparation session (**Feb 27**), in **week 2** in the **Thurs March 5** lecture/tutorial class, each group will be asked to present a short oral presentation on the justification of your group's choice of final target compounds and possible synthetic procedures. In **week 6** (**April 2**), each of you will submit your laboratory notebook and each group will present a formal write up of the experimental procedure for the synthesis of one of your sulfonyl chloride-amine condensation products, including spectral data by 9am to the Science Student Centre E7A. Feedback will be provided to help you improve your scientific writing skills and laboratory practices and for general understanding of the practical work. The combined week 2 and week 6 assessment tasks will be worth **7.5%** (5% individual mark, 2.5% group mark). At the end of the semester (by **Week 14, Tuesday June 9, 9am, Science Student Centre, E7A**), each group will hand in the final report written in journal format and each student will hand in their laboratory notebook. The whole group will get the same mark for the report (/**10%**), but each student will be given an individual mark for their laboratory notebook, general safety and participation in the laboratory (/**7.5**%). Proper recording of experimental procedures and spectral data, analysis of results and discussion and conclusion of these will all be taken into account in the marking. Full details on what is expected for assessment of the practical component is provided in the laboratory manual and on the web site (see under "Laboratory Notes").

On successful completion you will be able to:

- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism
- Be able to design experiments to determine the structure-activity relationship within a class of drugs
- Use the chemical literature to find suitable methods to make new compounds
- Use analytical techniques to determine the molecular composition of reaction products
- Analyse experimental results to solve related problems
- Accurately record your laboratory observations in an appropriate scientific manner
- Work with colleagues to undertake experiments in a safe and harmonious way
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Mid-semester test

Due: **May 7, 2pm**
Weighting: **10%**

There will be a 50 minute test (**/10%**) in **Week 9, Thursday May 7, 2 pm sharp**. This will cover up to the end of prodrugs. This is designed to give you specific feedback on your understanding of the topics up to this stage to assist you in your further study of the unit.

On successful completion you will be able to:

- Define medicinal chemistry and what medicinal chemists know
- Define the major biological targets for drugs and how these drugs achieve their pharmacological effect
- Define where new drugs come from
- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Quizzes

Due: **in lectures and online**
Weighting: **5%**

Quizzes (/**5%)** may be conducted at any stage within the lectures. Quizzes are also combined online after core topics. They are to encourage continuous learning of the lecture material without the stress of a significant assessment component. They are compulsory.

On successful completion you will be able to:

- Define the major biological targets for drugs and how these drugs achieve their pharmacological effect
- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Assignment

Due: **April 22, 9am, Student Centre**
Weighting: **10%**

The assignment consists of a report (10%) that summarises the chemical and biological properties of a pharmaceutical agent in current use and how these relate to its function and properties in the body, along with general historical importance of the drug. This assignment is designed to provide skills in searching the literature and understanding the properties of the pharmaceutical agent from a molecular point of view. The assignment is due **Week 7, Wednesday, April 22, 9am, Science Student Centre, E7A**. It must be accompanied with the assignment cover sheet provided on the web site.

On successful completion you will be able to:

- Define the major biological targets for drugs and how these drugs achieve their pharmacological effect
- Define where new drugs come from
- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism
- Use the chemical literature to find suitable methods to make new compounds
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Final exam

Due: **TBA**
Weighting: **50%**

The final exam (/50%) will be 3 hours in length with 10 minutes reading time. It is designed to assess specific understanding and holistic concepts of all the topics presented within the course and an opportunity for you to show what knowledge you have obtained and how you can be apply this to new problems.

On successful completion you will be able to:

- Define medicinal chemistry and what medicinal chemists know
- Define the major biological targets for drugs and how these drugs achieve their pharmacological effect
- Define where new drugs come from
- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution

and metabolism
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Delivery and Resources

Unit Web Page

The web page for this unit can be found at ilearn.mq.edu.au.

Just login and follow the prompts to CBMS306 Medicinal Chemistry.

You can use any web browser such as Firefox, Internet Explorer or Safari to login.

iLearn is the name for Macquarie University's new Learning Management System (LMS). The iLearn online learning environment enables learning, teaching, communication and collaboration. It is used to make lecture notes, laboratory notes, discussion forums, digital lecture recordings and other learning resources available to students online.

CBMS306 is a 3 credit point unit and will require an average of 10 hours of work (contact and self study time) per week over the 15 weeks. For students with weak chemistry backgrounds, more time per week will probably be necessary to perform satisfactorily in this unit. CBMS306 is run with three hours of lectures/tutorials per week, along with 4 hour blocks of laboratories/ workshops. Students are required to attend all lectures, tutorials and laboratory classes. Active participation by the students in all of these fora is expected.

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions. Some lecture material will be available on the unit web site, while other material will be provided in the lecture class. Learning is an active process, and as such, you must engage with the material. This means reading the textbook (and beyond) before and after lectures, attempting the assignment questions and other questions, discussing the concepts with your classmates and lecturers. Do not be afraid to ask questions – everyone benefits from a robust and open discussion of the topics.
- Assignment questions are issued so that you will have the opportunity to use the information provided in the lectures and textbook and to test your degree of understanding of those topics.
- Quizzes and a mid session test will also be run in the lecture session. The in class quizzes will cover any material prior to that day's lecture, therefore all students are expected to keep up to date with lecture material through revision each week. Online quizzes are also provided, with accompanying resources. The quizzes and mid session test are designed to allow you to continuously learn and to identify what you understand and the areas that you need to spend more time on, with minimal assessment penalty.
- All laboratory experiments will be conducted in groups. These have a highly

collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity. This laboratory work is designed to give real life experiences in research by involving students in the design of the experiments, using literature procedures as a guide, and trouble shooting to identify the best experimental conditions. It will emphasise the importance of being highly prepared for all experiments and being fully aware of all safety procedures, proper recording and reporting of all data and interpreting of all results, and having an analytical and inquisitive approach.

Further information on technology used: You are expected to access the unit web site frequently This contains important information including notes on the topics to be covered; the laboratory manual; What You Need to Know Sheets; your marks for practicals, quizzes and the mid-session exam; and past exam papers, including with answers. Additionally, the web site will also be used to post important messages and links to internet facilities and sites of relevance to the course, downloadable software, and lots of other interesting material.

If you do not have your own computer you may wish to access the Medicinal Chemistry web resources on campus using the PC computers in the Library or in the C5C computer laboratories. To view notes on all the topics and past exams on the unit web site, you will require Adobe Acrobat Reader Version 9 or later to be installed on your computer. Acrobat Reader can be downloaded from the Adobe web site http://get.adobe.com/uk/reader/. If you are using the computers in the library, then Acrobat has already been installed. Please note information will also be sent by email to your student email account so please look at your email account on a frequent basis.

You are expected to access SciFinder Scholar and Reaxys to assist in searching the literature. These are available through the library web site.

Hand-held calculators will be occasionally used in tutorials and practicals, for tests and in the final examination. Note that text-retrieval calculators are not allowed in the in-semester tests or final examination.

Unit Schedule

Lectures/tutorials:

The first 3/4 of CBMS306 will provide an overview of the important concepts in medicinal chemistry and the last 1/4 will concentrate on case studies. CBMS306 has three hours/week allocated to lectures/tutorials. While formal lectures will be presented, discussion sessions will also form a major part of the classes. This will be supplemented by practical classes utilising synthetic chemistry, spectroscopic methods and bioassays.

The laboratory classes will be run in groups and students are required to, in part, design the experiments, using literature procedures as a guide. Considerable preparation is therefore needed. Past students have found this a valuable experience as it gives them a realistic

approach to conducting research. The laboratory classes will run every week, Friday 2-6 pm except the mid-session break and week 13. The week 13 lab class time will be used for the final laboratory report preparation.

In week 1, the laboratory class will be a preparative session, in which the groups will discuss structure-activity relationships and use this to rationally choose their target sulfonamides, learn how to use SciFinder Scholar and Reaxys for literature searching and start to identify key preparative methods for the sulfonamides, and prepare flow diagram and risk assessment forms for commencement of the wet laboratory classes (beginning week 2).

This week 1 preparative session will be run in the write-up room E7B346 (unless otherwise indicated), and commence at 2pm. The laboratory classes will run from week 2 in laboratory E7B350. The 2-6pm session of week 13 will be used for finalising the laboratory report and the write-up room will be available for this.

Topics Lect/Tut Lecturer

- Overview of Medicinal Chemistry wk 1-2 JJ
- Cellular targets ('receptors') for drug action
- Binding of drugs to 'receptors'
- Interaction of 'receptors' with agonists and antagonists
- Protein structure and function wk 2-3 JJ
- Enzyme kinetics
- Interaction of enzymes with inhibitors (competitive, non-competitive)
- Nucleic acids wk 4 JJ
- Drug discovery from nature wk 4-6 JJ
- Drugs from synthesis
- Optimisation of lead compound, structure-activity relationships
- Physicochemical properties of drugs
- Drug absorption, distribution, metabolism and excretion
- Prodrugs
- Quantitative structure-activity relationships wk 7-10 PK
- Combinatorial synthesis
- Chemical biology
- Case studies (e.g. G-coupled protein receptor agonists and antagonists) wk 10-12
- Case studies (e.g. antibacterial agents) wk 10-12 JJ
- Chemoinformatics (Guest lecture, Shoba Ranganathan)
- Discussion of sulfonamide antibacterial assays and lab report wk 12/13 JJ/PK
- Revision wk 13 JJ/PK

Learning and Teaching Activities

Lectures/tutorials

Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.

Practicals

All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.html

Disruption to Studies Policy http://www.mq.edu.au/policy/docs/disruption_studies/policy.html *The Disruption to Studies Policy is effective from March 3 2014 and replaces the Special Consideration Policy.*

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcomes

- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism
- Be able to design experiments to determine the structure-activity relationship within a class of drugs
- Analyse experimental results to solve related problems

Assessment task

- Practical Reports

Learning and teaching activity

- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning outcome

- Work with colleagues to undertake experiments in a safe and harmonious way

Assessment task

- Practical Reports

Learning and teaching activity

- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning and teaching activities

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Define medicinal chemistry and what medicinal chemists know
- Define the major biological targets for drugs and how these drugs achieve their pharmacological effect
- Define where new drugs come from
- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Describe qualitatively and quantitatively the factors affecting drug absorption, distribution and metabolism
- Be able to design experiments to determine the structure-activity relationship within a class of drugs
- Use the chemical literature to find suitable methods to make new compounds
- Use analytical techniques to determine the molecular composition of reaction products
- Analyse experimental results to solve related problems
- Accurately record your laboratory observations in an appropriate scientific manner

Assessment tasks

- Practical Reports
- Mid-semester test
- Quizzes
- Assignment
- Final exam

Learning and teaching activities

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.
- All laboratory experiments will be conducted in groups using a highly collaborative and

investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Describe qualitatively and quantitatively the relationship between structure and biological activity of drugs
- Be able to design experiments to determine the structure-activity relationship within a class of drugs
- Analyse experimental results to solve related problems

Assessment tasks

- Practical Reports
- Final exam

Learning and teaching activities

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.
- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Be able to design experiments to determine the structure-activity relationship within a class of drugs
- Use the chemical literature to find suitable methods to make new compounds
- Use analytical techniques to determine the molecular composition of reaction products
- Analyse experimental results to solve related problems

Assessment tasks

- Practical Reports
- Mid-semester test
- Final exam

Learning and teaching activities

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.
- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Learning outcomes

- Accurately record your laboratory observations in an appropriate scientific manner
- Explain medicinal chemistry concepts clearly in the classes and in written format in exams, tests and laboratory reports

Assessment tasks

- Practical Reports
- Mid-semester test
- Assignment

Learning and teaching activities

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.
- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

Learning outcomes

- Accurately record your laboratory observations in an appropriate scientific manner
- Work with colleagues to undertake experiments in a safe and harmonious way

Assessment task

- Practical Reports

Learning and teaching activity

- Lectures will be presented as a combination of formal lectures and interactive tutorial sessions.
- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcomes

- Accurately record your laboratory observations in an appropriate scientific manner
- Work with colleagues to undertake experiments in a safe and harmonious way

Assessment task

- Practical Reports

Learning and teaching activity

- All laboratory experiments will be conducted in groups using a highly collaborative and investigative approach, where you will be designing and synthesising a series of sulfonamides and subsequently testing them for antibacterial activity to determine the important features for their antibacterial activity.

Changes from Previous Offering

The unit is being run similarly to 2014. Additional online quizzes, both right at the start of the unit and throughout, have also been added to aid understanding of core topics. Self and peer learning resources are also being used in the lab to help develop good lab practices.

Other Teaching Staff

Along with Joanne Jamie and Peter Karuso, Prof Shoba Ranganathan, F7B121, shoba.ranganathan@mq.edu.au will provide a guest lecture.

There are no formal office hours for the teaching staff, however, you are expected to contact them on any questions you have with their topics and the unit convenor on any administrative questions as soon as your concern arises. You are encouraged to phone or email to organise a meeting. You may also wish to ask questions using the discussion board on the website.