CBMS810

Application of Nuclear Science to Medicine

S1 Evening 2018

Dept of Chemistry & Biomolecular Sciences

Contents

General Information

Unit convenor and teaching staff
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Credit points
4

Prerequisites
Admission to MRadiopharmSc or MSc and permission by special approval

Corequisites

Co-badged status

Unit description
This unit focuses on imaging, including positron emission tomography (PET) and single photon emission computer tomography (SPECT) but other medical applications of radiopharmaceuticals are also covered in detail. It encompasses pharmaceutical and medicinal chemistry, nuclear science, pharmacology, biology and radiation safety. It is particularly relevant to drug design and the radiolabelling of drugs and biological macromolecules for use in non-invasive imaging. The unit also contains a component of laboratory management, quality assurance and regulatory affairs associated with ionising radiation. With access to the world class research expertise and facilities of the Australian School of Advanced Medicine and the Australian Nuclear Science and Technology Organisation, it will provide highly relevant contemporary and hands-on training for students.

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:

By the end of this unit students should be able to identify the different types of radiation, and describe terms applicable to radiochemistry, nuclear physics and radiobiology.
By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
By the end of this unit students should be able to describe the types of chemical reactions and radiochemical processes associated with the incorporation of Carbon-11, the radiohalogens and various radiometals to produce biologically and clinically useful radiopharmaceuticals.
By the end of this unit students should be able to present calculations and an analysis of experimental results applicable to the practice of radiopharmaceutical science.
By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

General Assessment Information

Assessment will be a mixture of exam (50%), progressive assessment in the form of quizzes (on-line and in-class, total 10%), two assignments (10 and 20% respectively), and a mark assigned for quality of participation in class tutorials and site vists (10%).

Final exam: The final exam (/50%) will be 3 hours in length with 10 minutes reading time. It is designed to address specific understanding of all the topics presented within the course and to show that the knowledge obtained can be applied to new problems.

Your marks (assignments, on-line quizzes, final exam and mark for participation) will be placed on the CBMS810 ilearn site. The **minimum requirement** to achieve a passing grade for CBMS810 is an **aggregate mark for all the assessment tasks of 50% or greater**.

Final Examination Details: The examination timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in final form approximately four weeks before the commencement of the examinations. You are expected to present yourself for examination at the time and place designated by the University in the Examination Timetable. This could be any day after the final week of semester and up until the

final day of the official examination period. It is Macquarie University policy to **not set early examinations** for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period. **NOTE: If you apply for a supplementary examination, you must make yourself available for 2 weeks after the formal examination period. If you are not available at that time, there is no guarantee an additional examination time will be offered. Specific examination dates and times will be determined at a later date.**

The only exception to sitting an examination at the designated time is because of documented illness or unavoidable disruption. Absence from the final exam will result in a grade of F except in the case of a genuine medical emergency or misadventure as defined by the University (see below). In these circumstances you should apply for a supplementary exam at ask.mq.edu.au.

Assessment Tasks

Name	Weighting	Hurdle	Due
Quizzes (on-line and in-class)	10%	No	wk 4, 6, 10, 12
Assignment 1	20%	No	wk 8, wk 9-11
Assignment 2	10%	No	wk 10
Site visits and tutorials	10%	No	throughout unit
Final exam	50%	No	Univ examination period

Quizzes (on-line and in-class)

Due: **wk 4, 6, 10, 12**
Weighting: **10%**

You will find that these quizzes assist you in revising the course material as the course progresses.

They offer **progressive review** of your understanding of the course material, and the material set for self-learning.

On successful completion you will be able to:

- By the end of this unit students should be able to identify the different types of radiation, and describe terms applicable to radiochemistry, nuclear physics and radiobiology.
- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.

Assignment 1

Due: **wk 8, wk 9-11**
Weighting: **20%**

The assignment requires a literature search, and findings are to be presented in both written form, and as an oral presentation. The purpose of the assignment is to develop research skills, and scientific communication - both written and oral. The written report is due week 8 and the oral will be scheduled in consultation with each student over weeks 9-11.

On successful completion you will be able to:

- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
- By the end of this unit students should be able to describe the types of chemical reactions and radiochemical processes associated with the incorporation of Carbon-11, the radiohalogens and various radiometals to produce biologically and clinically useful radiopharmaceuticals.
- By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Assignment 2

Due: **wk 10**
Weighting: **10%**

This assignment involves the construction of a personal portfolio of information about the commonly used (and some less common) radiopharmaceuticals. It will be developed progressively over the duration of the course, adding information from weekly lectures and tutorials. It is due in week 10.

A review of progress will be undertaken in week 7, as a class workshop session. The purpose of this is to correct any misconceptions about the detail and presentation of this assignment.

On successful completion you will be able to:

- By the end of this unit students should be able to describe the types of chemical reactions and radiochemical processes associated with the incorporation of Carbon-11, the radiohalogens and various radiometals to produce biologically and clinically useful radiopharmaceuticals.
- By the end of this unit students should be able to research the literature on a relevant

topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Site visits and tutorials

Due: **throughout unit**
Weighting: **10%**

Participation in site visits and discussions during class tutorials will be marked; with the objective being to encourage active participation in learning activities and discussions.

On successful completion you will be able to:

- By the end of this unit students should be able to present calculations and an analysis of experimental results applicable to the practice of radiopharmaceutical science.

Final exam

Due: **Univ examination period**
Weighting: **50%**

Final exam

On successful completion you will be able to:

- By the end of this unit students should be able to identify the different types of radiation, and describe terms applicable to radiochemistry, nuclear physics and radiobiology.
- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
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Delivery and Resources

CBMS810 delivers the knowledge and some of the skills required to work as a clinical Radiopharmaceutical Scientist (RPSS). The role of the RPSS is to prepare radiopharmaceuticals (RPs) for the clinic. This can include radionuclide production, labelling of the biologically active molecule, performing all of the quality control processes and maintaining the documentation required. Additionally the RPSS can be involved in the research and development of new RPs and clinical trials. In this Unit the student will learn about the processes and techniques involved in the preparation and quality control of RPs as well as how a new RP may be introduced into the clinic, its evaluation and biological and clinical assessment. A significant outcome is how this improves clinical management.

An important aspect of this Unit is that it is mapped to the Training, Education and Assessment Program (TEAP), which leads to Certification as a RPSS through the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM).

The Unit demonstrates the multidisciplinary nature of radiopharmaceutical science. The student will gain knowledge and skills that enable the application of pharmaceutical and medicinal chemistry, nuclear science, pharmacology, biology and radiation safety to the production of radiolabelled drugs and biological macromolecules for use in non-invasive imaging, and in therapy. The Unit demonstrates the application of drug design.

The student will also gain knowledge and skills relevant to laboratory management, in particular the quality assurance and regulatory affairs requirements that govern both the use of ionising radiation and the manufacture of radiopharmaceuticals.

The student will also gain access to a number of institutions and departments, such as public hospitals, ANSTO, and some private entities to see the application of the knowledge and skills gained from the Unit.

The Curriculum will be delivered so as to encourage directed self-learning, a skill essential to functioning as a proactive scientist in the workplace. The two hour weekly session on-campus will be run as a combination of lectures and tutorials (lectorials). Lectures will be delivered as outlined in the Unit Schedule. Additionally, specific topics will be nominated for self-study. The student is expected to come to the weekly classes prepared to participate in robust discussion on these topics.

The site visits are aimed to provide students with exposure to practical experience of working with radioactivity, and exposure to its use, clinically and pre-clinically. To best facilitate this process, visits to various institutions that employ radiopharmaceutical scientists have been organised, thus also offering the students insight into potential career options available. Times for these will be determined in consultation with all students in the unit.

Unit Schedule

Weekly Lecture Topics

Week 1	An introduction to radiopharmaceutical science Chemical reactions essential for CBMS810
Week 2	The nature of radioactivity Radiation detection methods Radiation safety Radiobiology
Week 3	Radionuclide production
Week 4	An Introduction to imaging modalities and choice of radiopharmaceuticals
Week 5	Carbon-11: Radiopharmaceutical chemistry and radiolabelling methods
Week 6	Fluorine-18: Radiopharmaceutical chemistry and radiolabelling methods
Week 7	Radiolabelling with other halides
Week 8	Chemistry of the radiometals (Tc-99m and Ga-68)
Week 9	Radiolabelling with other metals (In-111, Tl-201, Cu-64, Zr-89, Lu-177,Y-90)
Week 10	Radiochemical measurement, instrumentation and analytical chemistry methods
Week 11	Quality control, the use of monographs and regulatory control
Week 12	Production for clinical use
Week 13	Review and student presentations

Site visits (dates to be confirmed)

ANSTO guided tour
FMHS radioactive materials handling
Camperdown tour of cyclotron facility

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-centr

al). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/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/study/getting-started/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://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

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

Graduate Capabilities

PG - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcome

- By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Assessment tasks

- Assignment 1
- Assignment 2
- Final exam

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- By the end of this unit students should be able to identify the different types of radiation, and describe terms applicable to radiochemistry, nuclear physics and radiobiology.
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Assessment tasks

- Quizzes (on-line and in-class)
- Assignment 1
- Assignment 2
- Site visits and tutorials
- Final exam

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
- By the end of this unit students should be able to describe the types of chemical

reactions and radiochemical processes associated with the incorporation of Carbon-11, the radiohalogens and various radiometals to produce biologically and clinically useful radiopharmaceuticals.
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Assessment tasks

- Assignment 1
- Assignment 2
- Final exam

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
- By the end of this unit students should be able to present calculations and an analysis of experimental results applicable to the practice of radiopharmaceutical science.
- By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Assessment tasks

- Assignment 2
- Site visits and tutorials
- Final exam

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcomes

- By the end of this unit students should be able to compare and contrast the physical and chemical properties and methods of production of key radionuclides suitable for diagnostic purposes and therapy.
- By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Assessment tasks

- Assignment 1
- Assignment 2
- Site visits and tutorials
- Final exam

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcome

- By the end of this unit students should be able to research the literature on a relevant topic, and present a point of view in written and oral format. They should also be able to explain nuclear science concepts more broadly in tutorials and in written format in a report and exam.

Assessment tasks

- Assignment 1

- Assignment 2
- Site visits and tutorials

Changes from Previous Offering

There are no significant changes to the 2018 offering. We will continue to encourage directed self-learning and continue to have quizzes and resources to aid identifying strengths and weaknesses in knowledge of this unit content. There will be an even greater emphasis on in-class participation then previous years.

Non-attendance and Exemption

Attendance at the class session (combined lectures and tutorials) is expected. Less than 80% attendance (10/13 class sessions) will result in a deduction of marks (0.5 marks per lecture missed) from the Active Participation mark.

Site visits will be organised to best fit the availability of the majority of students. It is anticipated this will be organised as a workshop during the mid-semester break. Every effort will be made to accommodate all students. Attempts will be made to accommodate students unable to attend for valid reasons. Failure to attend without valid reason will result in a deduction of marks from the Active Participation mark assigned.

Exemptions to above:

Medical certificates or official documents must be lodged as part of a disruption to studies request at ask.mq.edu.au as soon as possible if you are absent for any of the lectures/tutorials or site visits or miss the due date for any of the on-line quizzes or assignments. If your reason is regarded as valid and the disruption to studies request is approved, an extension of time will be provided for the quizzes or assignments, and you will not receive a deduction of marks for the attendance to the lectures/tutorials/on-site visits.