CBMS810

Application of Nuclear Science to Medicine

S2 Day 2016

Dept of Chemistry & Biomolecular Sciences

Contents

General Information

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Credit points
4

Prerequisites
CBMS842

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 and name the types of radiation, and explain the definition of a range of terms applicable to nuclear physics and radiobiology. They will understand the characteristics of radionuclides suitable for diagnostic purposes, and differentiate between those and radionuclides suitable for therapy.

By the end of this unit students should be able to undertake measurements of radioactivity using specific apparatus, and apply techniques that ensure safe laboratory practices, and safe handling of radioactive materials.

By the end of this unit students should be able to describe and explain the different methods of radionuclide production and they should be able to understand the types of chemical reactions used in the production of molecules radiolabelled with carbon, halides, and radiometals.

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.

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.

General Assessment Information

Assessment will be a mixture of exam (50%), progressive assessment in the form of five short online quizzes (total 10%), two assignments (10 and 20% respectively), and a mark assigned for quality of participation in tutorials and practical assignments (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. However, it is advisable to be available the week beyond this just in case extenuating circumstances cause you to miss the exam and you need to do a supplementary exam.

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	Due
On-line quizzes	10%	Weeks 2,4,6,8,10
Assignment 1	10%	Due Week 11.
Assignment 2	20%	Due week 10.
Site visits & tutorials	10%	throughout unit
Final exam	50%	Univ examination period

On-line quizzes

Due: **Weeks 2,4,6,8,10**
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.

On successful completion you will be able to:

- By the end of this unit students should be able to identify and name the types of radiation, and explain the definition of a range of terms applicable to nuclear physics and radiobiology. They will understand the characteristics of radionuclides suitable for diagnostic purposes, and differentiate between those and radionuclides suitable for therapy.
- By the end of this unit students should be able to undertake measurements of

radioactivity using specific apparatus, and apply techniques that ensure safe laboratory practices, and safe handling of radioactive materials.

Assignment 1

Due: **Due Week 11.**
Weighting: **10%**

The assignment is issued in week 1 and due week 11. 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.

On successful completion you will be able to:

- By the end of this unit students should be able to describe and explain the different methods of radionuclide production and they should be able to understand the types of chemical reactions used in the production of molecules radiolabelled with carbon, halides, and radiometals.
- 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: **Due week 10.**
Weighting: **20%**

The assignment is issued in week 3 and due week 10. It 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.

On successful completion you will be able to:

- By the end of this unit students should be able to describe and explain the different methods of radionuclide production and they should be able to understand the types of chemical reactions used in the production of molecules radiolabelled with carbon, halides, and radiometals.
- 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 & tutorials

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

Participation in site visits, tutorial discussions. The objective is 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 undertake measurements of radioactivity using specific apparatus, and apply techniques that ensure safe laboratory practices, and safe handling of radioactive materials.
- By the end of this unit students should be able to describe and explain the different methods of radionuclide production and they should be able to understand the types of chemical reactions used in the production of molecules radiolabelled with carbon, halides, and radiometals.
- 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 and name the types of radiation, and explain the definition of a range of terms applicable to nuclear physics and radiobiology. They will understand the characteristics of radionuclides suitable for diagnostic purposes, and differentiate between those and radionuclides suitable for therapy.
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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.

- 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.

Delivery and Resources

CBMS 810 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 Practical component of the Unit aims to provide students with both 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 The nature of radioactivity
Week 2	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

Practical Outline

Topic	Related Lecture	To be covered
Working safely with radioactivity	2	Spill clean, hand monitoring, shielding, distance, ALARA.
Measuring radioactivity	2	Dose calibrator, Geiger counter etc, imaging devices
Radionuclide production - site visit	3	Reactor, cyclotron, generator
Medical application of RPS - site visit	4	Imaging examples in department

Pre-clinical imaging site visit	4	A pre-clinical imaging unit, the differences in equipment and the associated requirements.
Automated Synthesis	6	Ga-68, F-18 C-11 synthesis, including dispensing and QC of products
Clean room operations	12	Composition and function of a clean room, including entry, gowning, monitoring, cleaning and environmental monitoring.
Analytical chemistry application to product identification and/or release requirements	10, 11	Includes analysis of precursors and standards (HPLC, NMR); identification of formulated products for release (HPLC, ITLC, pH, Half-life, gamma spectroscopy)
Subject Matter Experts (SME) Tutorials	11	Sterility testing (JP) Pyrogen testing (PL), Environmental Monitoring
Site visits		Other potential career/ job opportunities

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

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/grading/policy.html

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

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.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://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 and name the types of radiation, and explain the definition of a range of terms applicable to nuclear physics and radiobiology. They will understand the characteristics of radionuclides suitable for diagnostic purposes, and differentiate between those and radionuclides suitable for therapy.
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Assessment tasks

- On-line quizzes
- Assignment 1
- Assignment 2
- Site visits & 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 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.
- 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.

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 undertake measurements of radioactivity using specific apparatus, and apply techniques that ensure safe laboratory

practices, and safe handling of radioactive materials.
- 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.

Assessment tasks

- Assignment 2
- Site visits & 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 describe and explain the different methods of radionuclide production and they should be able to understand the types of chemical reactions used in the production of molecules radiolabelled with carbon, halides, and radiometals.
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Assessment tasks

- Assignment 1
- Assignment 2
- Site visits & 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 outcomes

- By the end of this unit students should be able to undertake measurements of radioactivity using specific apparatus, and apply techniques that ensure safe laboratory practices, and safe handling of radioactive materials.
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Assessment tasks

- Assignment 1
- Assignment 2

Changes from Previous Offering

This unit has been modified to assist self-directed learning. It will have quizzes and resources to aid identifying strengths and weaknesses in knowledge of this unit content, along with resources, to assist self-directed study.

Non-attendance and Exemption

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

Practical sessions (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 assignment, and you will not receive a deduction of marks for the attendance to the lectures/tutorials/on-site visits.