PHYS704

Nanobiophotonics

S2 Day 2018

Dept of Physics and Astronomy

Contents

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General Information

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Lecturer
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Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status

Unit description
This unit covers the current research directions at the interface of nanotechnology and biophotonics, addressing a common gap in the physics/engineering undergraduate curriculum. You will learn about the principal types of nanomaterials and nanostructures with the underpinning physics and chemistry. You will gain familiarity with photonics techniques that relate to biological applications such as advanced microscopy and image analysis. There is an emphasis on applications and significance of nanomaterials in the life sciences. We will discuss various Nanosafety, instrumentation and core measurement techniques which are applicable in nanotechnology and biophotonics will also be discussed.

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:

Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
Understand the key role that nanoparticles and nanostructures play in the life sciences.
Apply nano-biophysics concepts to characterise nanoparticle interactions with cells and biological tissue, measure nanomaterial impacts, and remedy hazards.
Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.
Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Assessment Tasks

Name	Weighting	Hurdle	Due
Microscopy Assignment	15%	No	Week 3
Experimental Planning	10%	No	Week 4
Major Research Report	25%	No	Week 8
BioPhotonics Assignment	10%	No	week 9
Literature Review	15%	No	Week 10
Lab Report	15%	No	Week 12
NanoBio Assignment	10%	No	Week 13

Microscopy Assignment

Due: **Week 3**
Weighting: **15%**

Assignments will be set based on lecture content and are designed to test the student's understanding of course concepts.

On successful completion you will be able to:

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Experimental Planning

Due: **Week 4**
Weighting: **10%**

The student is expected to write an experimental plan in consultation with the lecturer, detailing a short research project to be carried out in weeks 5-7 using the optical surface profiler. This experimental plan must contain a proposed research question along with detailed methodology, including any extra equipment or resources that may be required.

On successful completion you will be able to:

- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Major Research Report

Due: **Week 8**
Weighting: **25%**

The student is expected to conduct a short (pre-planned) research project using the optical surface profiler, and submit a lab report detailing the aims and motivation of the experiment (including reference to appropriate background literature), experimental methodology, the results of the measurement and analysis, as well as a discussion and concluding remarks. Detailed records of lab work must also be retained in a lab book, and submitted along with the report.

On successful completion you will be able to:

- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
- Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.
- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

BioPhotonics Assignment

Due: **week 9**
Weighting: **10%**

Assignments will be set based on lecture content and are designed to test the student's understanding of course concepts.

On successful completion you will be able to:

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Understand the key role that nanoparticles and nanostructures play in the life sciences.
- Apply nano-biophysics concepts to characterise nanoparticle interactions with cells and biological tissue, measure nanomaterial impacts, and remedy hazards.

Literature Review

Due: **Week 10**
Weighting: **15%**

The student will write a short (1500 word) essay discussing a recent scientific study published in a high-impact research journal (Science, Nature), or ensemble of research papers describing the development of a (nano)biophotonics technique. The student will communicate their understanding of what the study/studies was/were aiming to do, what was found, and why the findings are significant in the context of nano-biophotonics.

On successful completion you will be able to:

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applications.
- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
- Understand the key role that nanoparticles and nanostructures play in the life sciences.
- Apply nano-biophysics concepts to characterise nanoparticle interactions with cells and biological tissue, measure nanomaterial impacts, and remedy hazards.
- Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.

Lab Report

Due: **Week 12**
Weighting: **15%**

The student will perform a supervised experiment to obtain functional information from biomedical tissues using advanced imaging technologies. The student will be expected to write up a lab report on this experiment. The student's lab book will also be submitted as part of this assessment.

On successful completion you will be able to:
- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
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- Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.
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NanoBio Assignment

Due: **Week 13**
Weighting: **10%**

Assignments will be set based on lecture content and are designed to test the student's

understanding of course concepts.

On successful completion you will be able to:

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Understand the key role that nanoparticles and nanostructures play in the life sciences.
- Apply nano-biophysics concepts to characterise nanoparticle interactions with cells and biological tissue, measure nanomaterial impacts, and remedy hazards.

Delivery and Resources

Microscopy - E. Hecht, Optics, 3rd edition (1998).

Nanobio - Tuan Vo Dinh, Biomedical Photonics Handbook, 3 Volume Set, Second Edition (selected chapters, will be electronically available)

Unit Schedule

Week 1-2 (Doug Little) - Lectures: Advanced microscopy, Fourier optics and interferometry.

Week 3-4 (Doug Little) - Lab: Optical surface profiler basics and fundamentals, and planning a research project.

Week 5-7 (Doug Little) - Lab: Short research project.

Weeks 8 - 9 (Annemarie Nadort) - Lectures: Functional biophotonics, nanobiophotonics

Weeks 9 - 10 (Annemarie Nadort) - Literature study: in consultation with students, functional biophotonics or bio-nanotechnology

Weeks 11 - 12 (Annemarie Nadort) - Lab: short research project

Week 13 (Annemarie Nadort) - concluding lecture and assignment

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-central). 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 outcomes

- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
- Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.
- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Assessment tasks

- Microscopy Assignment
- Experimental Planning
- Major Research Report
- Literature Review
- Lab Report

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

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
- Understand the key role that nanoparticles and nanostructures play in the life sciences.
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Assessment tasks

- Microscopy Assignment
- Experimental Planning
- Major Research Report
- BioPhotonics Assignment
- Literature Review
- Lab Report
- NanoBio Assignment

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

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.

- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
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- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Assessment tasks

- Microscopy Assignment
- Experimental Planning
- Major Research Report
- BioPhotonics Assignment
- Literature Review
- Lab Report
- NanoBio Assignment

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

- Understand basic light - tissue interactions, study examples of functional optical tissue imaging and the role of nanotechnology therein, gain knowledge about the characterisation of nanoparticles and nanostructures in the context of biological applications.
- Apply advanced microscopy and related theoretical concepts to the characterisation of nanoparticles and nanostructures used in biological applications.
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Assessment tasks

- Microscopy Assignment
- Experimental Planning
- Major Research Report
- BioPhotonics Assignment
- Literature Review
- Lab Report
- NanoBio Assignment

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

- Understand the key role that nanoparticles and nanostructures play in the life sciences.
- Communicate understanding of one or more topics in modern nano-biophotonics to an expert audience.
- Apply advanced microscopy concepts in a laboratory environment, including detailed planning of experiments, understanding and detailing advanced experimental methods, performing the requisite analysis to provide tangible answers to posed research questions, and the preparation of reports to communicate these results.

Assessment tasks

- Microscopy Assignment
- Experimental Planning
- Major Research Report
- BioPhotonics Assignment
- Literature Review
- Lab Report
- NanoBio Assignment

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

- Understand the key role that nanoparticles and nanostructures play in the life sciences.
- Apply nano-biophysics concepts to characterise nanoparticle interactions with cells and biological tissue, measure nanomaterial impacts, and remedy hazards.

Assessment tasks

- BioPhotonics Assignment
- Literature Review
- Lab Report
- NanoBio Assignment

Changes from Previous Offering

Unit has been significantly restructured from previous years. There will be no final exam, instead a large portion of assessments will be concentrated around laboratory work, research planning and experimental skills.