UNSW Course Outline

BIOM9311 Mass Transfer in Medicine - 2024

Published on the 26 Aug 2024

General Course Information

Course Code : BIOM9311
Year : 2024
Term : Term 3
Teaching Period : T3
Is a multi-term course? : No
Faculty : Faculty of Engineering
Academic Unit : Graduate School of Biomedical Engineering
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Undergraduate, Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

Mass transfer refers to the transportation of molecules from one location to another. In the human body, such transfer occurs mainly via diffusion and convection, and a thorough understanding of these mechanisms is fundamental to many applications in medicine and

biology. In this course, you will be introduced to mass transfer in medicine and biology, and learn how to computationally simulate these processes in a range of medical devices and physiological systems. Topics to be covered include the transfer of solutes across capillaries, mass transfer in haemodialysis, gas exchange in the lungs and membrane oxygenators, transfer of drugs and toxins across the skin, slow release of drugs from implants, as well as mass transfer considerations in biosensors and in tissue engineering.

Course Aims

The aim of this course is to introduce the various mass transfer processes of medical or physiological importance and teach the computational modelling of these. Mass transfer plays a crucial role in tissue engineering, biosensors, drug delivery systems, biomaterials, oxygenators and a range of other medical devices. A good understanding of these processes is fundamental for other courses in biomedical engineering, including physiology, tissue engineering, transducers and biosensors, as well as the computational modelling of organs, tissues and medical devices.

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.
CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.
CLO3 : Analyse the relative importance of convection and diffusion in a given system.
CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.
CLO5 : Explain the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.

Course Learning Outcomes	Assessment Item
CLO1 : Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.	• Final Examination • Laboratory Report • Weekly Quizzes
CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.	• Major Assignment • Final Examination • Laboratory Report • Weekly Quizzes
CLO3 : Analyse the relative importance of convection and diffusion in a given system.	• Final Examination • Laboratory Report • Weekly Quizzes
CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.	• Major Assignment • Final Examination • Laboratory Report • Weekly Quizzes
CLO5 : Explain the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.	• Final Examination • Laboratory Report • Weekly Quizzes

Learning and Teaching Technologies

Moodle - Learning Management System

Additional Course Information

For each hour of contact, it is expected that you will put in at least 1.5 hours of private study. You will need to spend substantial time implementing computer-based assignments in COMSOL. The following describes the learning approaches recommended for this course:

Private Study

- Watch the pre-recorded lecture and review the lecture notes each week (Moodle).
- Revise the previous week's laboratory exercises (Intedashboard and Moodle)
- Attend the optional online consultation session each week (Mondays 3-4 pm). Ask questions.
- Join/start Moodle discussions of problems.
- Learn COMSOL by working through example problems.

Computer Laboratory Sessions

- Work through the weekly team-based learning activities, both the individual and group-based assessments.
- Work through the remaining exercises in class.
- Ask questions.

Laboratory Report and Major Assignment

- Carefully read the detailed laboratory and assignment instructions.
- Process, present and interpret any experimental data.
- Perform any necessary simulations in COMSOL.

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Major Assignment Assessment Format: Individual	20%	Due Date: 15/11/2024 11:55 PM Post Date: 14/10/2024 12:00 AM
Final Examination Assessment Format: Individual	45%	Start Date: TBA Due Date: TBA
Laboratory Report Assessment Format: Individual	20%	Due Date: 28/10/2024 11:55 PM Post Date: 07/10/2024 12:00 AM
Weekly Quizzes Assessment Format: Individual	15%	Start Date: Every week during class Due Date: During class

Assessment Details

Major Assignment

Assessment Overview

Students are required to simulate a mass transfer system in medicine or biology, submitting a detailed report describing methods, assumptions, results and significance of findings. Model implementation, simulations, analysis of results, and write-up of the report should take around 20 hours, and feedback to students will be provided in Moodle around 1 week after submission.

Course Learning Outcomes

- CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.
- CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.

Assignment submission Turnitin type

This is not a Turnitin assignment

Generative AI Permission Level

Simple Editing Assistance

In completing this assessment, you are permitted to use standard editing and referencing functions in the software you use to complete your assessment. These functions are described below. You must not use any functions that generate or paraphrase passages of text or other media, whether based on your own work or not.
If your Convenor has concerns that your submission contains passages of AI-generated text or media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
For more information on Generative AI and permitted use please see here.

Final Examination

Assessment Overview

This assessment constitutes the final exam for the course. It will be an online exam consisting of multiple-choice and calculation-type questions. Students will need to prepare by studying the course lecture notes, weekly quizzes, and in-class weekly problems. Feedback will be provided to students in Moodle on completion of marking.

Course Learning Outcomes

- CLO1 : Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.
- CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.
- CLO3 : Analyse the relative importance of convection and diffusion in a given system.
- CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.
- CLO5 : Explain the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.

Assessment Length

2 hours exam duration

Assignment submission Turnitin type

This is not a Turnitin assignment

Generative AI Permission Level

No Assistance

This assessment is designed for you to complete without the use of any generative AI. You are not permitted to use any generative AI tools, software or service to search for or generate information or answers.
For more information on Generative AI and permitted use please see here.

Laboratory Report

Assessment Overview

This assessment involves the completion of a simple experiment, subsequent analysis of data generated, and presentation of findings in the form of a laboratory report. The experiment, analysis and write-up of the report should take around 20 hours, and feedback to students will be provided in Moodle around 1 week after submission.

Course Learning Outcomes

- CLO1 : Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.
- CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.
- CLO3 : Analyse the relative importance of convection and diffusion in a given system.
- CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.
- CLO5 : Explain the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.

Assignment submission Turnitin type

This is not a Turnitin assignment

Generative AI Permission Level

Simple Editing Assistance

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media, you may be asked to account for your work. If you are unable to satisfactorily demonstrate your understanding of your submission you may be referred to UNSW Conduct & Integrity Office for investigation for academic misconduct and possible penalties.
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Weekly Quizzes

Assessment Overview

This assessment consists of a series of quizzes, given during the weekly laboratory class. The quizzes will consist of online multiple-choice questions and are designed to encourage learning throughout the semester. Quizzes must be attempted during the laboratory class and will consist of an individual-based test (known as an individual readiness assurance test, or IRAT) and a team-based test (referred to as a team readiness assurance test, or TRAT). Students will need to prepare by revising the lecture for that week. Feedback will be immediately provided to students in class on completion of the TRAT component.

Course Learning Outcomes

- CLO1 : Explain the principles of diffusion and diffusive mass transport across synthetic and biological membranes.
- CLO2 : Solve biomedical problems in mass transport by analytical and/or numerical means.
- CLO3 : Analyse the relative importance of convection and diffusion in a given system.
- CLO4 : Formulate and use mathematical models of mass transfer in medical applications such as haemodialysis, drug release and biosensors.
- CLO5 : Explain the concepts of flow limitation and membrane limitation, distinguishing whether one or the other, or neither, is limiting in a particular medical application.

Assessment Length

30 minutes IRAT, 15 minutes TRAT during class time

Assignment submission Turnitin type

This is not a Turnitin assignment

Generative AI Permission Level

Not Applicable

Generative AI is not considered to be of assistance to you in completing this assessment. If you do use generative AI in completing this assessment, you should attribute its use.
For more information on Generative AI and permitted use please see here.

General Assessment Information

The assessment tasks for BIOM9311 Mass Transfer in Medicine have been designed to measure your achievement of the learning outcomes. The final grade for this course will normally be based on the sum of the scores from each of the assessment tasks. Quizzes will consist of online multiple-choice questions designed to encourage learning throughout the term and prepare students for the types of questions in the final exam. Quizzes must be attempted during the laboratory class and will consist of an individual-based test (known as an individual readiness assurance test, or IRAT) and a team-based test (referred to as a team readiness assurance test, or TRAT). Both quizzes are worth 7.5% each, comprising 15% of the course assessment. The major assignment is worth 20% of the total course assessment. A substantial problem of some complexity will be defined. The conceptual material required to solve it will have been covered in lectures but applying that material to this problem will not be trivial. It will not be a matter of simply finding the right equation. Clear thinking and working up from the basics will be required. In addition, values of some required material properties will have to be found in the literature. This will not be trivial either. It is expected that the report will detail the method of solution, including all simplifying assumptions. The laboratory report will be an opportunity for students to analyse experimental data and present findings in the form of a laboratory report. The laboratory report is worth 20% of the total course assessment. The final exam will be held during the formal exam period and is worth 45% of the total course assessment.

Grading Basis

Standard

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 9 September - 15 September	Lecture	Fundamentals of Mass Transfer & Introduction to COMSOL
	Tut-Lab	In-Class Quiz 1 (IRAT & TRAT) - Practice only: not assessable this week
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 2 : 16 September - 22 September	Lecture	Mass Transfer Across Membranes
	Tut-Lab	In-Class Quiz 2 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 3 : 23 September - 29 September	Lecture	Biosensors
	Tut-Lab	In-Class Quiz 3 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 4 : 30 September - 6 October	Lecture	Haemodialysis
	Tut-Lab	In-Class Quiz 4 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 5 : 7 October - 13 October	Lecture	Drug Delivery
	Tut-Lab	In-Class Quiz 5 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session, Tuesday 10-11 am. Note the change from the usual weekly time, due to the public holiday on Monday 7th October.
Week 6 : 14 October - 20 October	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 7 : 21 October - 27 October	Lecture	Fluid Dynamics and Convection
	Tut-Lab	In-Class Quiz 6 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 8 : 28 October - 3 November	Lecture	Mass Transfer in the Cardiovascular System
	Tut-Lab	In-Class Quiz 7 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
	Assessment	Laboratory Report (due Monday 28th October, 11:55 pm)
Week 9 : 4 November - 10 November	Lecture	Tissue Engineering and Bioreactors
	Tut-Lab	In-Class Quiz 8 (IRAT & TRAT)
	Online Activity	Optional Online Consultation Session (Monday 3-4 pm)
Week 10 : 11 November - 17 November	Lecture	Artificial Lung and Blood Gas Exchange
	Tut-Lab	In-Class Quiz 9 (IRAT & TRAT)
	Online Activity	Week 10 Optional Online Consultation Sessions: • Monday 3-4 pm • Thursday 3-4 pm
	Assessment	Major Assignment (due Friday 15th November, 11:55 pm)

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Online lectures will be released every week in Moodle. These will be prerecorded and can be viewed at any time, but please ensure you have done so before the computer laboratory class each week.

Every week in the latter half of the scheduled weekly lecture slot (i.e. Mondays 3-4 pm), there will be a 1-hour online consultancy session where students can ask questions related to lectures, assignments, or other course content. Attendance is optional.

For the weekly computer laboratory class, please come to the class you have been enrolled in, otherwise, you will not be able to access the in-class online materials required. Classes will be held in the Computer Laboratory, Samuels building room 518. In each weekly lab class, you will be undertaking a set of online quizzes (both individual and team-based), for which you are required to submit answers by the end of each class session. There will be eight such quizzes in total, forming 15% of the overall course assessment.

Course Resources

Prescribed Resources

Basic Transport Phenomena in Biomedical Engineering (3rd Edition) by Fournier, Ronald A. L. CRC Press 2012. (Available from the Library: 571.64/3A, 571.64/3B, plus one copy of an earlier edition).

Recommended Resources

The lecture recordings and slides posted on Moodle will be the primary source of information. Additional optional resources are given below:

A text which provides useful case studies in biomedical engineering mass transfer phenomena, as well as a useful resource in COMSOL modelling is:

- Datta A, Rakesh V: An Introduction to Modeling of Transport Processes: Applications to Biomedical Systems, Cambridge University Press (2010).

A text which is organised quite differently from the course but which might be helpful on selected topics:

- Trusky GA, Yuan FaBIOM93331297n, Katz DF: Transport Phenomena in Biological Systems, Pearson Prentice Hall (2004). GSBME library. [Level 7, Main Library (571.64/26)]

A basic mass transfer reference:

- Cussler EL: Diffusion: Mass transfer in fluid systems. Cambridge, Cambridge University Press (1984). [Level 9, Main Library (P 660.28423/23)]

A reference that gives a simple discussion of diffusion as well as the problem of diffusion to a

receptor (as on a cell):

- Berg HC: Random walks in Biology. Princeton, Princeton University Press (1993). [Library Level 7 MB 574.01519282/1]

A relatively simple reference on fluid flow and dialysis:

- Keller KH: Fluid mechanics and mass transfer in artificial organs (1973).

Course Evaluation and Development

Student feedback has helped to shape and develop this course, including feedback obtained from on-line evaluations as part of UNSW's myExperience process. You are highly encouraged to complete such an on-line evaluation toward the end of Term. Feedback and suggestions provided will be important in improving the course for future students.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Socrates Do kos		Room 506, Samuels Bldg (F25)	9385 9406	By appointment (via e-mail)	No	Yes
Demonstrato r	Dhyey Shah					No	No
	Wenlu Duan					No	No

Other Useful Information

Academic Information

I. Special consideration and supplementary assessment

If you have experienced an illness or misadventure beyond your control that will interfere with your assessment performance, you are eligible to apply for Special Consideration prior to, or within 3 working days of, submitting an assessment or sitting an exam.

Please note that UNSW has a Fit to Sit rule, which means that if you sit an exam, you are declaring yourself fit enough to do so and cannot later apply for Special Consideration.

For details of applying for Special Consideration and conditions for the award of supplementary assessment, please see the information on UNSW's Special Consideration page.

II. Administrative matters and links

All students are expected to read and be familiar with UNSW guidelines and polices. In particular, students should be familiar with the following:

- Attendance
- UNSW Email Address
- Special Consideration
- Exams
- Approved Calculators
- Academic Honesty and Plagiarism
- Equitable Learning Services

III. Equity and diversity

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course convener prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equitable Learning Services. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

IV. Professional Outcomes and Program Design

Students are able to review the relevant professional outcomes and program designs for their streams by going to the following link: https://www.unsw.edu.au/engineering/student-life/student-resources/program-design.

Note: This course outline sets out the description of classes at the date the Course Outline is published. The nature of classes may change during the Term after the Course Outline is published. Moodle or your primary learning management system (LMS) should be consulted for the up-to-date class descriptions. If there is any inconsistency in the description of activities between the University timetable and the Course Outline/Moodle/LMS, the description in the Course Outline/Moodle/LMS applies.

Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW students have a responsibility to adhere to this principle of academic integrity. Plagiarism undermines academic integrity and is not tolerated at UNSW. *Plagiarism at*

UNSW is defined as using the words or ideas of others and passing them off as your own.

Plagiarism is a type of intellectual theft. It can take many forms, from deliberate cheating to accidentally copying from a source without acknowledgement. UNSW has produced a website with a wealth of resources to support students to understand and avoid plagiarism, visit: student.unsw.edu.au/plagiarism. The Learning Centre assists students with understanding academic integrity and how not to plagiarise. They also hold workshops and can help students one-on-one.

You are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting and the proper referencing of sources in preparing all assessment tasks.

Repeated plagiarism (even in first year), plagiarism after first year, or serious instances, may also be investigated under the Student Misconduct Procedures. The penalties under the procedures can include a reduction in marks, failing a course or for the most serious matters (like plagiarism in an honours thesis or contract cheating) even suspension from the university. The Student Misconduct Procedures are available here:

www.gs.unsw.edu.au/policy/documents/studentmisconductprocedures.pdf

Submission of Assessment Tasks

Work submitted late without an approved extension by the course coordinator or delegated authority is subject to a late penalty of five percent (5%) of the maximum mark possible for that assessment item, per calendar day.

The late penalty is applied per calendar day (including weekends and public holidays) that the assessment is overdue. There is no pro-rata of the late penalty for submissions made part way through a day. This is for all assessments where a penalty applies.

Work submitted after five days (120 hours) will not be accepted and a mark of zero will be awarded for that assessment item.

For some assessment items, a late penalty may not be appropriate. These will be clearly indicated in the course outline, and such assessments will receive a mark of zero if not completed by the specified date. Examples include:

- Weekly online tests or laboratory work worth a small proportion of the subject mark;
- Exams, peer feedback and team evaluation surveys;
- Online quizzes where answers are released to students on completion;
- Professional assessment tasks, where the intention is to create an authentic assessment that has an absolute submission date; and,
- Pass/Fail assessment tasks.

Faculty-specific Information

Engineering Student Support Services – The Nucleus - enrolment, progression checks, clash requests, course issues or program-related queries

Engineering Industrial Training – Industrial training questions

UNSW Study Abroad – study abroad student enquiries (for inbound students)

UNSW Exchange – student exchange enquiries (for inbound students)

UNSW Future Students – potential student enquiries e.g. admissions, fees, programs, credit transfer

Phone

(+61 2) 9385 8500 – Nucleus Student Hub

(+61 2) 9385 7661 – Engineering Industrial Training

(+61 2) 9385 3179 – UNSW Study Abroad and UNSW Exchange (for inbound students)

School Contact Information

Student Services can be contacted via unsw.to/webforms.