CBMS836

Molecular Biology and Genomics

S1 Day 2019

Dept of Molecular Sciences

Contents

General Information

Unit convenor and teaching staff
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Credit points
4

Prerequisites
Admission to MBiotech or MBiotechMCom or MRadiopharmSc or MSc or MBioBus or MMarScMgt or GradDipConsBiol or MScInnovation

Corequisites

Co-badged status

Unit description
This unit provides an introduction to synthetic biology and hands-on practise in the analysis of large datasets gathered when working in the broad field of biomolecular sciences. Biomolecular sciences spans the study of individual molecular structures and biochemical reactions to also encompass the 'omics' sciences of genomics, proteomics, metabolomics and glycomics. These sciences all generate large and complex datasets that require specialised software and methods to assemble and analyse. The analyses are challenging, as they not only require a good knowledge of biochemistry, molecular biology, and cell and developmental biology, but also an understanding of limitations of both the software and the data quality. The lectures on synthetic biology start with a brief overview of the field and then delves into more challenging yet exciting concepts. You will learn about current techniques and approaches used in synthetic biology and design a molecular switch using these principles. The lectures also discuss applications, limitations and future potential of synthetic biology to produce new solutions to global challenges.

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:

1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Assessment Tasks

Name	Weighting	Hurdle	Due
Genomic quiz	10%	No	Week 4
Genomic data presentation	20%	No	Week 7
Design of SynBio	10%	No	Week 10
Oral presentation	20%	No	Weeks 12-13
Final Examination	40%	No	Examination period

Genomic quiz

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

Students will be given raw sequencing data equivalent to a complete bacterial genome. Students will be tasked with assembling the data following the necessary pre-processing steps, and then annotating the genes and features on the assembled DNA using tools covered in the workshops. The task will be assessed by 1. producing a fasta file of assembled dna contigs, 2. a file of gene/ORF annotations, 3. filling in the summary table (provided) and answering 3 short questions about their data.

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Genomic data presentation

Due: **Week 7**
Weighting: **20%**

Students to be given raw next generation sequencing reads from an unknown dataset. These are to be analysed following guidelines presented in the tutorials. The outcomes will be reported in a Poster Presentation on the Data Festival day on Week 7.

This Assessment Task relates to the following Learning Outcomes:

• Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods.

• Demonstrate understanding of experiment design and ability to critically assess the

quality of large biomolecular datasets prior to in-depth analysis.

• Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis.

• Analyse large datasets and compare results with established information about the system under investigation.

• Demonstrate ability to effectively report, communicate and draw new conclusions about

a biomolecular system from large analytical datasets.

On successful completion you will be able to:

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Design of SynBio

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

Plan and justify how to design synthetic switch

This Assessment Task relates to the following Learning Outcomes:

• Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field.

• Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

• Synthesise diverse primary synthetic biology literature sources and present in an accessible way suitable for a general audience

On successful completion you will be able to:

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large

biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Oral presentation

Due: **Weeks 12-13**
Weighting: **20%**

Oral presentation on a new tool/approach in synthetic biology.

This Assessment Task relates to the following Learning Outcomes:

• Summarise and discuss engineering principles and the relationship to synthetic biology. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.).

• Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest trends in the field.

On successful completion you will be able to:

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large

analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Final Examination

Due: **Examination period**
Weighting: **40%**

This will be a 2h exam consisting of a series of problem solving, data interpretation questions and short essays.

This Assessment Task relates to the following Learning Outcomes:

• Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods.

• Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis.

• Analyse large datasets and compare it with established information about the system

under investigation.

• Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets.

• Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field.

• Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

On successful completion you will be able to:

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information

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Delivery and Resources

This unit uses team-based teaching and workshops. The material relating to data analysis and synthetic biology encompasses both lectures and hands-on experience in the use of various data analysis software programs and tools. Lectures will be presented formally, although quizzes and general questions may be asked in class, to strengthen and increase understanding of the concepts. Most lecture material will be available on the unit web site, while other material will be provided in the lecture class. You are expected to download the lecture material and bring it into the lecture class so you can spend most of the time listening to the lecturer rather than transcribing. Do not assume these notes or recordings/video capture are a suitable substitute to attending the lectures.

The demonstrators are actively involved in research activities to bring knowledge from real-world experiences in their respective fields. Workshops will NOT be recorded. You must attend these workshops to gain practical experience with data analysis and designing of the switch. As some of the assessment is based on your practical use of specific software it is essential that you attend these workshops.

It is recommended that each student will bring to class a laptop PC computer to install data analysis software, or prior arrangements must be made with the convenor.

Software Requirements

Genomics, data analysis and programming software used in this module can either be installed onto the students' laptop or will be made available via access to a university Linux server. Local installation of up-to-date versions of the following software will be required.

• Qiime2 (Installed for lab computers)

• R (https://www.r-project.org)

• RStudio (https://www.rstudio.com/products/rstudio/download/)

• Mobaxterm (Windows) (https://mobaxterm.mobatek.net)

All official correspondence with lecturers and tutors will be carried out using the CBMS836 iLearn website.

Class Times:

This Session 1 unit comprises a 4-hour block each week. Please consult the iLearn site for updated timetable. This unit will be taught in hands-on workshops. In addition there is one recorded lecture per week. Workshops will NOT be recorded and attendance is essential to fullfil the course requirement.

Unit Text:

The following text is recommended to help with your learning in this unit.

WEB sites for tools:

https://www.youtube.com/watch?v=FvHRio1yyhQ

“Synthetic Biology : Tools and Applications” (2013) Huimin Zhao.

The ebook can be downloaded from the library using this link: http://mqu.eblib.com.au/patron/FullRecord.aspx?p=1160900

There is a hardcopy of the book in the Macquarie Library. It is **NOT** recommended that you purchase this text.

Other required learning material (e.g. journal articles, book chapters) will be made available on **iLearn** as this unit progresses.

Unit Schedule

Week/Date (Mon)	Lecture Mon 3-4 pm
Week 1	Unit overview and Introduction to DNA sequencing
Week 2	Sequencing techniques and applications
Week 3	An introduction to Metabarcoding
Week 4	Transcriptomics and transposon sequencing for gene function identification
Week 5	Decoding the microbiome: A roadmap
Week 6	Functional metagenomics
Week 7	Basics of Synthetic Biology

Mid-Semester break	
Week 8	Design in SynBio
Week 9	Engineering Speciation in Sexually Reproductive Organisms
Week 10	Yeast 2.0
Week 11	Synbio approaches to understand how cells function
Week 12	Bioengineering enzyme production
Week 13	Engineering protein-based nanoparticles for biotechnology and biomedicine

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 published on platform other than eStudent, (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA student contact globalmba.support@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

If you are a Global MBA student contact globalmba.support@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:

Assessment tasks

- Design of SynBio
- Oral presentation
- Final Examination

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 outcome

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Assessment tasks

- Genomic quiz
- Genomic data presentation
- Design of SynBio
- Oral presentation
- Final Examination

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 outcome

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Assessment tasks

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- Final Examination

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 outcome

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their relationship to synthetic biology. 7. Gain familiarity with a common vocabulary useful for synthetic biology (e.g. standard part, chassis, switches, oscillators, etc.). 8. Summarise current and future application spaces for synthetic biology and have a sound knowledge of the latest published literature in the field. 9. Define the culture, safety practices, and organisational community of the synthetic biology field to evaluate how emerging and future synthetic biology technologies may benefit and/or potentially endanger humanity and the natural environment.

Assessment tasks

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- Final Examination

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 outcome

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large

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Assessment tasks

- Genomic data presentation
- Design of SynBio
- Oral presentation
- Final Examination

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

- 1. Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods. 2. Demonstrate understanding of experiment design and ability to critically assess the quality of large biomolecular datasets prior to in-depth analysis. 3. Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis. 4. Analyse large datasets and compare results with established information about the system under investigation. 5. Demonstrate ability to effectively report, communicate and draw new conclusions about a biomolecular system from large analytical datasets. 6. Summarise and discuss engineering principles and their

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