CBMS793

Research Topic: Advanced Biomolecular Analysis

S2 Day 2018

Dept of Chemistry & Biomolecular Sciences

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General Information

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Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status

Unit description
This unit addresses some advanced methods of analysis utilised in the 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 specialized 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. This unit will provided a background to the data acquisition methods, quality control of the datasets, and analysis methods within a number of these areas. Most importantly it will provide hands-on experience in the analysis of real large-scale datasets and the correct use of appropriate analysis tools.

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:

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

Analyze 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.

General Assessment Information

- All written work must be submitted via Turnitin on the CBMS793 iLearn website, or as otherwise advised by the unit convenor.
- Late submissions **will** be penalised with 20% loss of the maximum mark for each day past the deadline. More than 2 days late will result in zero marks awarded unless **Special Consideration** has been requested.
- If there is any medical reason why you cannot submit work on time you should lodge a **Special Consideration application**, otherwise your mark will be penalized for lateness.

Assessment Tasks

Name	Weighting	Hurdle	Due
Take home examination	10%	No	25th August
Proteomics Data AnalysisReport	25%	No	6th October
Genomics quiz	10%	No	12th October
Genomics Data Presentation	25%	No	2rd November
Final Examination	30%	No	Examination Period

Take home examination

Due: **25th August**

Weighting: **10%**

Exam assessing some of the fundamental principles and concepts important in the application of protein mass spectrometry and proteomics, including peptide fragmentation, targeted mass spectrometry and principles of experimental design Content from Week 1-3 will be assessed in the form of short answer questions. There will be 5 questions of equal weighting.

On successful completion you will be able to:

- 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

Proteomics Data AnalysisReport

Due: **6th October**
Weighting: **25%**

Students will be given a dataset containing information from a large scale quantitation LC/MS experiment. The dataset needs to be evaluated using Perseus, and a report containing information about quantitative changes presented. The report should present visual statistical analysis providing an overview of the experiment and illustrating differences in samples (e.g. Hierarchical Clustering, Principle-Component-Analysis), and an evaluation of key proteins and the pathways they are associated with. The report should contain sufficient methodological detail appropriate for publication purposes in quality proteomics journals.

On successful completion you will be able to:

- 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
- Analyze 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.

Genomics quiz

Due: **12th October**
Weighting: **10%**

Students will be given raw paired-end next generation 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 preceding sessions. 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.

On successful completion you will be able to:

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

Genomics Data Presentation

Due: **2rd November**
Weighting: **25%**

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 of these results are to be given as an Oral Presentation of 12min plus 3min question time.

On successful completion you will be able to:

- 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
- Analyze 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.

Final Examination

Due: **Examination Period**
Weighting: **30%**

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

and short essays.

On successful completion you will be able to:

- 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
- Analyze 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.

Delivery and Resources

This unit uses team-based teaching in the form of 'lectorials' that encompass both lectures and hands-on experiences in using various data analysis software programs and tools. The tutors are actively involved in research activities to bring knowledge from real-world experiences in their respective fields. All class sessions take place on Friday 9am-1pm in F7B433 unless otherwise instructed. Tutorials will NOT be recorded. You must attend these tutorials to gain practical experience with data analysis. As some of the assessment is based on your practical use of specific software it is essential that you attend these classes.

It is expected 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

Proteomics software used in this module can be installed in weeks 1 or 2 and will be available for use during the software sessions starting week 3.

- Skyline (https://skyline.gs.washington.edu/labkey/project/home/begin.view?)
- Perseus (http://www.coxdocs.org/doku.php?id=perseus:start)

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.

- 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 is to be made using the CBMS793 iLearn website.

Unit Schedule

Week	Date	Title	Lecturer
Proteomics			
1	3 Aug	Unit overview Introduction to protein mass spectrometry (detecting ions - instruments, scan types, peptide fragmentation and common proteomic workflows) - Introduction to quantitative mass spectrometry techniques	MO MMcKay
2	10 Aug	Principles of protein identification: peptide fragmentation and the automation of spectral assignment - Targeted Mass Spectrometry (From SRM to DIA: Using Area Under the Curve (AUC) approaches for quantitation via SWATH)	MMcKay
3	17 Aug	Principles of experiment design and statistical analysis in proteomics Quantitation of Large DIA Proteomic Datasets	MMcKay
4	24 Aug	Tools for the quantitation of peptides and proteins PeakView and Perseus	MMcKay
5	31 Aug	Combining experimental design with statistical power in DIA experiments	McKay
6	7 Sept	DIA data analysis	McKay
7	14 Sept	Pathway mapping and data mining	McKay
Mid-Semester Break 17 Sept-2 Oct			
Core skills for 'Omics			
8	5 Oct	Genomics Introduction Introduction to the shell and useful tools	IP, MO

9	12 Oct	Introduction to sequencing data quality control, assembly and annotation Genomics Quiz	MO
10	19 Oct	Metagenomic analysis 1 Introduction to R	MO
11	26 Oct	Metagenomic analysis 2 Transcriptome analysis tools	MO
12	2 Nov	Genomics - Oral Presentations	MO
13	9 Nov	Revision	McKay MO

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

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

Assessment tasks

- Take home examination
- Proteomics Data AnalysisReport
- Genomics quiz
- Genomics Data 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 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
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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

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

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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

- Process datasets using specific software, providing a broad overview of data in terms of size, quality and utility for further analysis
- Analyze large datasets and compare it with established information about the system under investigation

Assessment tasks

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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

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

- Demonstrate knowledge of appropriate techniques used in acquiring large biomolecular datasets and the limitations of the use of these methods
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- Final Examination

Changes from Previous Offering

No changes from the unit offered in S2, 2016