CBMS224

Molecular Biology

S2 Day 2014

Chemistry and Biomolecular Sciences

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
Robert Willows
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Credit points
3

Prerequisites
(BIOL115 and CBMS103) or admission to GCertBiotech

Corequisites

Co-badged status

Unit description
The combination of CBMS223 Biochemistry with this unit provides an essential core of biochemistry and molecular biology. This unit aims to provide students with further insights into the molecular processes of the living cell, and at the same time help students to understand the complex 'language' of molecular biology. Topics covered include: molecular biological techniques, prokaryotic and eukaryotic gene regulation and genome organisation, transcription of RNA, translation of RNA to proteins, replication of DNA, bacterial and animal viruses, photosynthesis, and proteomics. The practical program is designed to give students a broad introduction to modern molecular biology techniques including extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide-gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products. As such it is highly recommended for all biomolecular sciences 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:

Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis,

cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.
Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.
Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
Describe the properties and functions of key enzymes used in molecular biology. Including: DNA ligase, restriction endonucleases, exonucleases, RNase, DNase, RNA polymerase, DNA polymerase I, thermostable DNA polyermerases such as Taq polymerase, reverse transcriptase.
Describe how protein is synthesized by ribosomes. Describe the key elements of initiation, elongation and termination. Describe the different types of protein expression systems in prokaryotes and eukaryotes and be able to discuss the advantages and disadvantages of each system. Describe what factors are important in choosing a protein expression system for producing a recombinant protein.
Describe the concept of transformation. This includes the different methods used to introduce foreign DNA into different organisms. Chemical methods, viral methods, electroporation, conjugation and biolistic methods. Describe the concept of a DNA library

in the context of molecular biology. This includes the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS. Describe how bacterial viruses replicate and can be harnessed in molecular biology.
Describe the differences and similarities in DNA and RNA synthesis within eukaryotic organelles such as mitochondria and chloroplasts compared to these processes in the nucleus of the host organism and to prokaryotes. Describe the endosymbiotic theory of organelles. Describe how proteins are transported out of the cell in eukaryotes and what happens to those proteins during transport. Describe how proteins are transported from the cytoplasm/cytosol into mitochondria and chloroplasts. Describe the different classes of hormones found in humans. Describe the distinct mechanisms of how lipophilic hormones cause changes in gene expression in eukaryotic cells. Describe the distinct mechanisms and how hydrophilic hormones cause changes in gene expression in eukaryotic cells.
Students must be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They must also be able to describe: 1. The differences between photosystem I and II; 2. The different strategies plants use to concentrate carbon dioxide; 3. The properties of the enzyme Rubisco.
Be capable of reading and summarizing the key points in molecular biological literature. Also use scientific papers as starting points to obtain further information on topics in the molecular biology field. Use trusted sources of information to extend their knowledge of a particular topic in the discipline.

Assessment Tasks

Name	Weighting	Due
Mid-semester test	10%	Tuesday 2nd of September
Practical report outline	5%	11th September
Student seminar	10%	October 29-30
Practical examination	10%	5th-6th November
Practical Report	10%	5th-6th November
Final Exam	55%	TBA

Mid-semester test

Due: **Tuesday 2nd of September**

Weighting: **10%**

The Mid-semester Test will cover lecture material and give you an idea of the types of questions that will be asked in the final examination. Held during lecture time.

On successful completion you will be able to:

- Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
- Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- Describe the properties and functions of key enzymes used in molecular biology. Including: DNA ligase, restriction endonucleases, exonucleases, RNase, DNase, RNA polymerase, DNA polymerase I, thermostable DNA polyermerases such as Taq polymerase, reverse transcriptase.
- Describe how protein is synthesized by ribosomes. Describe the key elements of initiation, elongation and termination. Describe the different types of protein expression systems in prokaryotes and eukaryotes and be able to discuss the advantages and disadvantages of each system. Describe what factors are important in choosing a protein expression system for producing a recombinant protein.
- Describe the concept of transformation. This includes the different methods used to introduce foreign DNA into different organisms. Chemical methods, viral methods, electroporation, conjugation and biolistic methods. Describe the concept of a DNA library in the context of molecular biology. This includes the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS. Describe how bacterial viruses replicate and

can be harnessed in molecular biology.

Practical report outline

Due: **11th September**
Weighting: **5%**

The title, abstract and introduction will need to be submitted on Thursday the 11th of September (week 7) together with a flow diagram of the practical. This is worth 5%. It is expected that you will revise and update the abstract and introduction to include in the final report.

On successful completion you will be able to:

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.
- Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
- Students must be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They must also be able to describe: 1. The differences between photosystem I and II; 2. The different strategies plants use to concentrate carbon dioxide; 3. The properties of the enzyme Rubisco.
- Be capable of reading and summarizing the key points in molecular biological literature. Also use scientific papers as starting points to obtain further information on topics in the molecular biology field. Use trusted sources of information to extend their knowledge of a particular topic in the discipline.

Student seminar

Due: **October 29-30**
Weighting: **10%**

The seminar will provide you with the opportunity to research the currentliterature and to begin to understand the formal writing style of scientific papers. You will present the overview of a specific topic in the biomolecular science area to the class, thus gaining experience in presentation techniques and public speaking.

The review topic will be assigned to you through iLearn during the mid semester break. To help you start a review article on that topic will be supplied but you may use additional published reviews. Note that the topics are broad and you should check the detailed information on the iLearn web site as to what is expected for this seminar.

You must also submit a single sheet of 5 key points on your topic area.

On successful completion you will be able to:

- Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
- Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- Describe the properties and functions of key enzymes used in molecular biology. Including: DNA ligase, restriction endonucleases, exonucleases, RNase, DNase, RNA polymerase, DNA polymerase I, thermostable DNA polyermerases such as Taq polymerase, reverse transcriptase.
- Describe how protein is synthesized by ribosomes. Describe the key elements of initiation, elongation and termination. Describe the different types of protein expression systems in prokaryotes and eukaryotes and be able to discuss the advantages and disadvantages of each system. Describe what factors are important in choosing a protein expression system for producing a recombinant protein.
- Describe the concept of transformation. This includes the different methods used to introduce foreign DNA into different organisms. Chemical methods, viral methods, electroporation, conjugation and biolistic methods. Describe the concept of a DNA library in the context of molecular biology. This includes the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS. Describe how bacterial viruses replicate and can be harnessed in molecular biology.
- Describe the differences and similarities in DNA and RNA synthesis within eukaryotic

organelles such as mitochondria and chloroplasts compared to these processes in the nucleus of the host organism and to prokaryotes. Describe the endosymbiotic theory of organelles. Describe how proteins are transported out of the cell in eukaryotes and what happens to those proteins during transport. Describe how proteins are transported from the cytoplasm/cytosol into mitochondria and chloroplasts. Describe the different classes of hormones found in humans. Describe the distinct mechanisms of how lipophilic hormones cause changes in gene expression in eukaryotic cells. Describe the distinct mechanisms and how hydrophilic hormones cause changes in gene expression in eukaryotic cells.

- Students must be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They must also be able to describe: 1. The differences between photosystem I and II; 2. The different strategies plants use to concentrate carbon dioxide; 3. The properties of the enzyme Rubisco.
- Be capable of reading and summarizing the key points in molecular biological literature. Also use scientific papers as starting points to obtain further information on topics in the molecular biology field. Use trusted sources of information to extend their knowledge of a particular topic in the discipline.

Practical examination

Due: **5th-6th November**
Weighting: **10%**

The practical exam is designed to test your practical skills. It will consist of two parts.

A practical theory component where you will be given data to analyze and interpret. This data is of a similar type that you have generated in the laboratory sessions during semester.

A hands on practical component. This is designed to test you laboratory skills such as pippeting acuracy and ability to interpret and follow a written method. The test is open book and you WILL require your laboratory manual to find and use the appropriate method.

On successful completion you will be able to:

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.
- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular

databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.

Practical Report

Due: **5th-6th November**
Weighting: **10%**

The Practical Report will provide you with the opportunity write a scientific paper using ALL of the experimental results obtained over the course of the semester. You will be primarily assessed on your data analysis and interpretation. Detailed marking criteria and an example report are available on the iLearn web site. This is to be handed in at the completion of the practical exam and can be used during the exam.

On successful completion you will be able to:

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.
- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.
- Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
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- Describe the concept of transformation. This includes the different methods used to introduce foreign DNA into different organisms. Chemical methods, viral methods, electroporation, conjugation and biolistic methods. Describe the concept of a DNA library in the context of molecular biology. This includes the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS. Describe how bacterial viruses replicate and can be harnessed in molecular biology.
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- Be capable of reading and summarizing the key points in molecular biological literature. Also use scientific papers as starting points to obtain further information on topics in the molecular biology field. Use trusted sources of information to extend their knowledge of a particular topic in the discipline.

Final Exam

Due: **TBA**
Weighting: **55%**

The final exam has three sections:

Multiple choice section (50 questions), 50% of the exam.

A short answer section similar to the midsemester exam, 30 % of exam.

One essay question, 20% of exam. You will get a choice of three or four question for the essay and are expected to write 1-3 pages.

On successful completion you will be able to:

- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and

basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.

- Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
- Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
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- Students must be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They must also be able to describe: 1. The differences between photosystem I and II; 2. The different strategies plants use to concentrate carbon dioxide; 3. The properties of the enzyme Rubisco.

Delivery and Resources

Technology used and required

It is important that you have a scientific calculator as hand-held calculators will be used in tutorials, practicals, for assignments, tests and in the final examination. Note that text retrieval calculators are not allowed in the in-semester tests or final examination.

Use will be made of Excel and other data processing and display software. Computers carrying this software are available in the teaching laboratories. Items of interest, links to other on-line material and iLectures will be placed on the unit iLearn website.

General use computers are provided by the University, but it would be advantageous to have your own computer and internet access.

Lecture and Tutorial times

The timetable for classes can be found on the University web site at: http://www.timetables.mq.edu.au/

• 2 x 1 hr lectures per week

• 3 hr Practical classes are interspersed with 2 hr tutorials/discussions of the practicals.

Teaching and Learning Strategy

• CBMS224 will comprise 2 lectures (or equivalent) per week, with practical (usually 3 hours) sessions interspersed with tutorials (1 to 2 hours). Live lecture recordings, ECHO will be available through a link to iLectures.

• Students are expected to attend all practical and tutorial classes. You will be required to submit

a formal lab report and keep an up to date laboratory book. In addition you will be required to give a seminar on a seminar topic related to the lecture topics.

• Satisfactory performance in BOTH the final exam and in the practical component is required to pass CBMS224.

The assessment tasks are designed to give you feedback as well as to assess your progress within the unit. More specifically:

o The Mid-semester Test will cover lecture material and give you an idea of the types of questions that will be asked in the final examination.

o The seminar will provide you with the opportunity to research the current literature and to begin to understand the formal writing style of scientific manuscripts. You will present the results of a published paper to the class, thus gaining experience in presentation techniques and public speaking.

o The Practical Test is designed to test your practical skills.

o The Practical Report will provide you with the opportunity write a scientific paper using all of the experimental results obtained over the course of the semester

· Marked work and midsemester and practical exam results should be returned within 2 weeks of being submitted.

· Students are to hand in their assignments after the practical test in week 12. The practical test is open book and students may need their practical report results to complete the practical exam.

· The seminar presentation will be discussed with students during semester.

Late assignments will receive a 10% per day penalty. Assignments handed in more than 1 week late will not be marked. Extensions will only be given in extenuating circumstances and must be discussed with the unit convenor BEFORE the due date.

Information about iLearn or other resources for this unit.

• There is no web page for this unit.

• The unit will utilise iLearn (https://ilearn.mq.edu.au). Select the CBMS224 link and log on with your student id and password.

Changes since the last offering of this unit.

None

Other material

• Prescribed or recommended text(s):

Garrett and Grisham BIOCHEMISTRY (Third edition, Saunders). Another suitable contemporary biochemistry text is BIOCHEMISTRY (Berg, Tymoczko, Stryer, 5th edition, 2002, Freeman Press).

Genuine molecular biology texts are a bit harder to find, but there is a new edition of the MOLECULAR BIOLOGY OF THE GENE (5th edition) by Watson and others (Benjamin-Cummings Publishers). Useful molecular biology can be found also in Lewin GENES VIII (Pearson Education) 2003) and in MOLECULAR BIOLOGY OF THE CELL (Alberts et al., Garland Science, 2002). Other information may be obtained from Prescott, Harley, Klein: MICROBIOLOGY (McGraw-Hill 1999) or other microbiology texts. Several of these books are also recommended for other Units so this will influence decisions as to whether to invest in them.

• Prescribed unit materials:

Practical notes are available from the bookshop

Unit Schedule

Tutorial (T) /Practical (P)	Wed or Thurs	Experiment no. and topic
P1/T1	Week 1	**P1- Lab induction. Compulsory.** T1 Introductory Tutorial/Workshop on: Gene control, *lac* operon, transcription, DNA replication
P1	Week 2	**A1** Preparation of *E. coli* competent cells **A2** **'**Miniprep' extraction of plasmid DNA from *E. coli* **A3** Transformation of *E. coli* competent cells with plasmid DNA
P2	Week 3	**B1** Extraction of RNA from *Chlamydomonas* **B2** RT-PCR of RNA with a primer set to amplify a *Chlamydomonas* cDNA **B3** Growth of transformant *E. coli* cells and inducible expression of proteins
T2	Week 4	Recombinant DNA, Introduction to physical mapping

P3 (2hr) T3 (1hr)	Week 5	**C1** Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis **C2** Set up of DNA sequencing reaction **T3:** ***Translation and protein synthesis***
No lab or tut	Week 6	**Midsemester test: Held during the normal Monday lecture)**
P4(2hr) T4(1hr)	Week 7	**D1** SDS-PAGE of total protein from induced and uninduced transformant cells **D2** Bioinformatics: Analysis of sequencing results **Tutorial:**More genetic engineering, cloning strategies **Practical Outline: Due Thursday at science center.**
		Mid-semester break
P5(2hr) T5(1hr)	Week 8	**E1** Preparation of induced SDS-PAGE gel band for MS analysis **Tutorial:** Review mid-semester test; Eukaryotic genomes
P6(3hr)	Week 9	**F1** Extraction and MS analysis of induced protein from gel plug **F2** Bioinformatics: Analysis of MS results
P7(2hr)	Week 10	**G1** Bioinformatics: Analysis of MS results
T6	Week 11	**Student seminars**: Wonders of the biomolecular world
Prac Test	Week 12	· **Practical Test** · **Hand in Practical Report**

T7	Week 13	Revision tutorial; trial exam questions

Learning and Teaching Activities

Lectures

Lecture topics (note some topics run for more than a single lecture): 1. Introduction: DNA and RNA: Structure and function. 2. DNA replication 3. DNA replication II: DNA polymerases, sequencing and PCR 4. Transcription; RNA from DNA (example of the lac operon) 5. The genetic code: Translating mRNA into protein 6. Translation: ribosome structure, mechanism and function 7. Recombinant DNA techniques and systems 8. Recombinant DNA Expression systems 9. Proteomics 10. Molecular biology of bacterial viruses (phage T4, phiX, lambda phage) 11. Mutation and DNA repair 12. Organization and function of eukaryotic genomes 13. Mitochondrial and chloroplast genomes 14. Lipoproteins and steroid hormones 15. Second messengers and hormone action 16. Photosynthesis

Practicals

A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results

Tutorials/Workshops

T1 Introductory Tutorial/Workshop on: Gene control, lac operon, transcription, DNA replication T2 Recombinant DNA, Introduction to physical mapping T3: Translation and protein synthesis T4: More genetic engineering, cloning strategies T5: Review mid-semester test; Eukaryotic genomes

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

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy http://mq.edu.au/policy/docs/grading/policy.html

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

Grievance Management Policy http://mq.edu.au/policy/docs/grievance_management/policy.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/

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://informatics.mq.edu.au/help/.

When using the University's IT, you must adhere to the Acceptable Use Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Capable of Professional and Personal Judgement and Initiative

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

Learning and teaching activities

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning and teaching activities

- Lecture topics (note some topics run for more than a single lecture): 1. Introduction: DNA and RNA: Structure and function. 2. DNA replication 3. DNA replication II: DNA polymerases, sequencing and PCR 4. Transcription; RNA from DNA (example of the lac operon) 5. The genetic code: Translating mRNA into protein 6. Translation: ribosome structure, mechanism and function 7. Recombinant DNA techniques and systems 8. Recombinant DNA Expression systems 9. Proteomics 10. Molecular biology of bacterial viruses (phage T4, phiX, lambda phage) 11. Mutation and DNA repair 12. Organization

and function of eukaryotic genomes 13. Mitochondrial and chloroplast genomes 14. Lipoproteins and steroid hormones 15. Second messengers and hormone action 16. Photosynthesis

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.
- Students will learn what basic molecular biology terms such as transcription, translation and replication mean and be able to explain these terms and processes. They will also be able to explain how these processes differ in eukaryotes and prokaryotes.
- Describe the biochemical basis of how DNA is modified, repaired, replicated and degraded within different types of cells and how these processes can be harnessed in the laboratory. Describe the chemical and physical differences between RNA and DNA. Describe the different types of RNA within cells and their uses within the cell. They should be able to use this information to compare and contrast the similarities and differences in how RNA is made within prokaryotes and eukaryotes. This includes but is not limited to: location of RNA synthesis, the processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, the differences between how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Students will learn the abbreviations and scientific conventions for describing DNA, RNA and protein sequences; the chemical and physical properties of DNA and use this information to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.

- Describe how protein is synthesized by ribosomes. Describe the key elements of initiation, elongation and termination. Describe the different types of protein expression systems in prokaryotes and eukaryotes and be able to discuss the advantages and disadvantages of each system. Describe what factors are important in choosing a protein expression system for producing a recombinant protein.
- Describe the concept of transformation. This includes the different methods used to introduce foreign DNA into different organisms. Chemical methods, viral methods, electroporation, conjugation and biolistic methods. Describe the concept of a DNA library in the context of molecular biology. This includes the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS. Describe how bacterial viruses replicate and can be harnessed in molecular biology.
- Describe the differences and similarities in DNA and RNA synthesis within eukaryotic organelles such as mitochondria and chloroplasts compared to these processes in the nucleus of the host organism and to prokaryotes. Describe the endosymbiotic theory of organelles. Describe how proteins are transported out of the cell in eukaryotes and what happens to those proteins during transport. Describe how proteins are transported from the cytoplasm/cytosol into mitochondria and chloroplasts. Describe the different classes of hormones found in humans. Describe the distinct mechanisms of how lipophilic hormones cause changes in gene expression in eukaryotic cells. Describe the distinct mechanisms and how hydrophilic hormones cause changes in gene expression in eukaryotic cells.
- Students must be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They must also be able to describe: 1. The differences between photosystem I and II; 2. The different strategies plants use to concentrate carbon dioxide; 3. The properties of the enzyme Rubisco.

Assessment tasks

- Mid-semester test
- Practical report outline
- Student seminar
- Practical examination
- Practical Report
- Final Exam

Learning and teaching activities

- Lecture topics (note some topics run for more than a single lecture): 1. Introduction: DNA

and RNA: Structure and function. 2. DNA replication 3. DNA replication II: DNA polymerases, sequencing and PCR 4. Transcription; RNA from DNA (example of the lac operon) 5. The genetic code: Translating mRNA into protein 6. Translation: ribosome structure, mechanism and function 7. Recombinant DNA techniques and systems 8. Recombinant DNA Expression systems 9. Proteomics 10. Molecular biology of bacterial viruses (phage T4, phiX, lambda phage) 11. Mutation and DNA repair 12. Organization and function of eukaryotic genomes 13. Mitochondrial and chloroplast genomes 14. Lipoproteins and steroid hormones 15. Second messengers and hormone action 16. Photosynthesis

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results
- T1 Introductory Tutorial/Workshop on: Gene control, lac operon, transcription, DNA replication T2 Recombinant DNA, Introduction to physical mapping T3: Translation and protein synthesis T4: More genetic engineering, cloning strategies T5: Review mid-semester test; Eukaryotic genomes

Critical, Analytical and Integrative Thinking

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

Learning outcomes

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and

analysis of the expressed protein products.

- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.

Assessment tasks

- Mid-semester test
- Practical report outline
- Practical examination
- Final Exam

Learning and teaching activities

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results
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Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students

will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.

- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data and the results of the database searches.

Assessment task

- Practical report outline

Learning and teaching activity

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results
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Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

Learning outcome

- Students will learn how to interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will analyse this data using the appropriate biomolecular databases and searching methods and learn how to critically evaluate both the raw data

and the results of the database searches.

Assessment task

- Student seminar

Learning and teaching activity

- T1 Introductory Tutorial/Workshop on: Gene control, lac operon, transcription, DNA replication T2 Recombinant DNA, Introduction to physical mapping T3: Translation and protein synthesis T4: More genetic engineering, cloning strategies T5: Review mid-semester test; Eukaryotic genomes

Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

Assessment tasks

- Mid-semester test
- Practical report outline
- Student seminar
- Practical examination
- Practical Report
- Final Exam

Learning and teaching activities

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results
- T1 Introductory Tutorial/Workshop on: Gene control, lac operon, transcription, DNA

replication T2 Recombinant DNA, Introduction to physical mapping T3: Translation and protein synthesis T4: More genetic engineering, cloning strategies T5: Review mid-semester test; Eukaryotic genomes

Socially and Environmentally Active and Responsible

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

Learning outcome

- Building on generic practical skills, such as pipetting learnt in prerequisite units, students will learn how to perform the following techniques: extraction of DNA and RNA from cells, reverse transcriptase PCR, agarose- and SDS-polyacrylamide gel electrophoresis, cloning of cDNA, DNA sequencing, and heterologous protein expression in E. coli and analysis of the expressed protein products.

Learning and teaching activities

- A1 Preparation of E. coli competent cells A2 ‘Miniprep’ extraction of plasmid DNA from E. coli A3 Transformation of E. coli competent cells with plasmid DNA B1 Extraction of RNA from Chlamydomonas B2 RT-PCR of RNA with a primer set to amplify a Chlamydomonas cDNA B3 Growth of transformant E. coli cells and inducible expression of proteins C1 Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis C2 Set up of DNA sequencing reaction D1 SDS-PAGE of total protein from induced and uninduced transformant cells D2 Bioinformatics: Analysis of sequencing results E1 Preparation of induced SDS-PAGE gel band for MS analysis F1 Extraction and MS analysis of induced protein from gel plug F2 Bioinformatics: Analysis of MS results G2 Bioinformatics: Analysis of MSMS results