CBMS224

Molecular Biology

S2 Day 2016

Dept of Chemistry & Biomolecular Sciences

Contents

General Information

Unit convenor and teaching staff
Robert Willows
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Credit points
3

Prerequisites
BIOL115 and CBMS103

Corequisites

Co-badged status
CBMS624

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:

1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to

DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.
3. Students will be able utilise appropriate enzymes for handling, extracting and modifying DNA in vitro and be able to relate the different methods for introducing DNA into cells. To address this learning outcome students will be able to relate 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. Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and critically evaluate both the raw data and the results of the database searches.
6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.
7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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.

General Assessment Information

All practical assessment items must be submitted BOTH as a hard copy and online via turnitin.

Assessments conform to the current assessment policy: http://www.mq.edu.au/policy/docs/assessment/policy_2016.html

10% penalty per day for late assessments. Assessment items submitted more than 1 week late will not be marked, except for serious and unavoidable disruptions (See http://mq.edu.au/policy/docs/disruption_studies/policy.html)

Assessment Tasks

Name	Weighting	Due
Practical report outline	5%	25th August
Mid-semester test	10%	Week 6
Student seminar	10%	Week 11
Practical examination	10%	Week 12

Name	Weighting	Due
Practical Report	10%	Week 12
Final Exam	55%	TBA

Practical report outline

Due: **25th August**
Weighting: **5%**

The title, abstract and introduction will need to be submitted on 20th of August (week 4) together with a flow diagram of the practical. It is expected that you will know the name of your *Chlamydomonas* gene and have done some literature searching together with searching http://www.ncbi.nlm.nih.gov/ pub med and protein databanks to work out what is known about your gene and gene product from *Chlamydomonas*. You will also have read ALL of the practical notes and worked out a flow diagram of the practical components placed in a logical order for cloning, expressing and analysing your gene and gene product.

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:

- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms

of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.

- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
- 6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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.

Mid-semester test

Due: **Week 6**
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:

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA

transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.

- 3. Students will be able utilise appropriate enzymes for handling, extracting and modifying DNA in vitro and be able to relate the different methods for introducing DNA into cells. To address this learning outcome students will be able to relate 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. Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

Student seminar

Due: **Week 11**
Weighting: **10%**

The seminar will provide you with the opportunity to research the current literature 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:

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.
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endonucleases, exonucleases, RNase, DNase, RNA polymerase, DNA polymerase I, thermostable DNA polyermerases such as Taq polymerase, reverse transcriptase. Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

- 6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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: **Week 12**
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:

- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
- 5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and critically evaluate both the raw data and the results of the database searches.

Practical Report

Due: **Week 12**
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:

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
- 5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and critically evaluate both the raw data and the results of the database searches.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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/long or extended answer question, 20% of exam. You will get a choice of three or

four question for this section and are expected to write 1-3 pages.

On successful completion you will be able to:

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.
- 3. Students will be able utilise appropriate enzymes for handling, extracting and modifying DNA in vitro and be able to relate the different methods for introducing DNA into cells. To address this learning outcome students will be able to relate 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.

Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

- 5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and critically evaluate both the raw data and the results of the database searches.
- 6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.

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
P3/T2	Week 4	**C1** Growth of transformant *E. coli* cells and inducible expression of proteins Recombinant DNA, Introduction to physical mapping **Practical Outline: Due Thursday at science centre. Turnitin submission required.**
P4 (2hr) T3 (1hr)	Week 5	**D1** Analysis of RNA, plasmid and PCR product by agarose gel electrophoresis **D2** Set up of DNA sequencing reaction **T3: *Translation and protein synthesis***
No lab or tut	Week 6	**Midsemester test**
P5(2hr) T4(1hr)	Week 7	**E1** SDS-PAGE of total protein from induced and uninduced transformant cells **E2** Bioinformatics: Analysis of sequencing results **Tutorial:**More genetic engineering, cloning strategies
		Mid-semester break

P6(2hr) T5(1hr)	Week 8	**F1** Preparation of induced SDS-PAGE gel band for MS analysis **Tutorial:** Review mid-semester test; Eukaryotic genomes
P7(3hr)	Week 9	**G1** Extraction and MS analysis of induced protein from gel plug
P8(2hr)	Week 10	**H1** Bioinformatics: Analysis of MS results
T6	Week 11	**Student seminars**: Wonders of the biomolecular world
Prac Test	Week 12	· **Practical Test** · **Hand in hard copy of Practical Report: Turnitin submission also required.**
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

New Assessment Policy in effect from Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy_2016.html. For more information visit http://students.mq.edu.au/events/2016/07/19/new_assessment_policy_in_place_from_session_2/

Assessment Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/assessment/policy.html

Grading Policy prior to Session 2 2016 http://mq.edu.au/policy/docs/grading/policy.html

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

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.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/

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

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 outcomes

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA

transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.

- 5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and 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

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

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.
- 3. Students will be able utilise appropriate enzymes for handling, extracting and modifying DNA in vitro and be able to relate the different methods for introducing DNA into cells. To address this learning outcome students will be able to relate 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. Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
- 6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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

- Practical report outline
- Mid-semester test
- 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

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- 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

- 1. Students will be able to use the appropriate abbreviations and scientific conventions for describing DNA, RNA and protein sequences. They will be able to utilise their knowledge of the chemical and physical properties of DNA to deduce what happens to DNA under different physical and chemical conditions. These are key requirements in understanding and utilising recombinant DNA technologies.
- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.

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

Assessment tasks

- Practical report outline
- Mid-semester test
- 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

- 3. Students will be able utilise appropriate enzymes for handling, extracting and

modifying DNA in vitro and be able to relate the different methods for introducing DNA into cells. To address this learning outcome students will be able to relate 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. Students will be able to relate the concept of transformation, using examples of various methods used to introduce foreign DNA into different organisms including; chemical methods, viral methods, electroporation, conjugation and biolistic methods. Students should understand the concept of a DNA library in the context of molecular biology and the use of: plasmids, cosmids, bacteriophage lambda, BACS and YACS.

- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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.
- 5. Students will be able to to analyse and interpret gel electrophoresis data, DNA sequencing data and basic proteomic data. They will be able to analyse this data using the appropriate biomolecular databases and searching methods and critically evaluate both the raw data and the results of the database searches.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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 task

- Practical report outline

Learning and teaching activity

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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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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:

Learning outcomes

- 2. Students will be able to compare and contrast the processes of transcription, translation and replication in eukaryotes and prokaryotes. Examples of this learning outcome in the context of transcription would be the ability to: Discuss the different types of RNA within cells and their uses within prokaryotic and eukaryotic cells. Relate the differences between prokaryotic and eukaryotic transcription in regards; location of RNA synthesis , processing of RNA, the number of proteins encoded by a single RNA transcript, the modification of the RNA, how RNA polymerases from prokaryotes and eukaryotes recognise a promoter, and how RNA polyermerase knows when to terminate RNA synthesis. Outline the distinct mechanisms of how lipophilic hormones and hydrophilic hormones cause changes in gene expression in eukaryotic cells. Examples of this learning outcome in the context of translation would be: Discuss how protein is synthesized by ribosomes with the key elements of initiation, elongation and termination. Describe how the different ways in which proteins are transported across membranes, including out of the cell in eukaryotes and from the cytoplasm/cytosol into mitochondria and chloroplasts. 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. Examples of this learning outcome in terms of the complexity of these processes in eukaryotes and the evolution of eukaryotes from prokaryotes would be: Understanding the endosymbiotic theory of organelles like chloroplasts and mitochondria and the molecular evidence for this based on similarities

in DNA and RNA and protein synthesis in these organelles to that of prokaryotes.

- 6. Students will be able to describe the “light” reactions and carbon fixation reactions of photosynthesis and the products of these reactions. They will 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.
- 7. Be able to summarise and present in oral form key points from the molecular biological literature, using 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

- Practical report outline
- Mid-semester test
- 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
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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

- 4. Building on generic practical skills, such as pipetting learnt in prerequisite units, students will be able to conduct experiments using 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

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Changes from Previous Offering

Rephrasing and clarification of the learning outcomes

Changes since First Published

Date	Description
16/08/2016	Change of date 20th to 25th of August for Practical Outline