CBMS732

Protein Discovery and Analysis

S1 Day 2019

Dept of Molecular Sciences

Contents

General Information

Unit convenor and teaching staff
Unit Convenor
Phani Rekha Potluri
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Contact via By email
14ER 306
Tuesday 11am-12pm

Coordinator
Bridget Mabbutt
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Credit points
4

Prerequisites
Admission to MRes

Corequisites

Co-badged status
CBMS832

Unit description
This unit outlines molecular principles underlying today's developments in protein science and biomedical research. As well as detailing modern separation technologies, the course addresses structural biology, protein analysis and bioinformatics. Practices common in the biotechnology and pharmaceutical industries to isolate recombinant proteins are emphasized. Analysis methods are introduced in relation to proteomics, genomics and biochemical research. Molecular properties leading to the 3D shape of proteins are detailed and contemporary structure methods outlined.

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:

Assimilate and interpret methods used today to isolate and handle proteins

Comprehend the molecular behaviour of proteins (gene products), both in vivo and in vitro

Develop presentation skills (written, oral) relevant in biomedical science

Experimentally analyse and purify a protein of interest and utilise contemporary web tools to predict common characteristics of this protein

Be able to describe biomolecular forms and architectures

Extract and interpret information from a variety of scientific sources concerning proteins

Develop a sound knowledge of protein structure and how it is encoded in a protein (or gene) sequence

General Assessment Information

Three modes of assessment are used to determine your progress in CBMS832.

Assignment Submission

- You will be required to submit the reports through iLearn via a Turnitin link. Turnitin is an online program that detects plagiarised pieces of work. It compares not only work between students in the current year but also across previous years, across institutions, with all published materials, and the internet. Should an other student plagiarise your work you both will be penalised.
- **ANY evidence of plagiarism WILL be dealt with according to University policy.** A full outline of the Universities policy on plagiarism is found at
- It is your responsibility to ensure all documents submitted or uploaded in ilearn are the correct file(s) and readable by the person marking your assignment. If files cannot be read, then late penalties will apply for un-readable work until re-submission of the work occurs.

Extensions and penalties

- A late penalty of 10% will be deducted for each day (up to and including any time in the 24 hr period) if an assignment is late. This includes each day of a weekend.
- If you are unable to submit the assignment by the due date then an extension must be sought **BEFORE** the due date unless this is absolutely impossible.
- To support your extension, you must submit a "Special Consideration Request" request via www.ask.mq.edu.au.
- See https://students.mq.edu.au/study/my-study-program/special-consideration for instructions on how to do this. Please note that evidence **must be given** to support your request for an extension. Applications must also be made within five working days of the assessment task due date.

- Decisions to approve/not approve a special consideration request are made by the university (and NOT the unit convenor).

Attendance

- Attendance at all the practicals is **compulsory**.

If you are absent from a practical, then a Special Consideration Request must be submitted (see above). An unexplained absence from a practical (ie your absence was not approved by special consideration) will result in ZERO marks for the missed practical and quiz.

Assessment Tasks

Name	Weighting	Hurdle	Due
Quizzes	40%	No	In class tests
Protein Purification Practical	15%	No	May 6
Molecular graphics	10%	No	Apr 29
“Pet Protein” A	15%	No	Mar 29
"Pet Protein" seminar, model	20%	No	June 7

Quizzes

Due: **In class tests**
Weighting: **40%**

- All the quizzes will be scheduled during your lectures in week 2, 4, 7, 10 and 12 class and will include the lecture material covered. They may incorporate problem-solving exercises or short assays concerning pet protein.
- If you are not able to sit for a quiz, you may consider applying for Special Consideration.

On successful completion you will be able to:

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- Be able to describe biomolecular forms and architectures

Protein Purification Practical

Due: **May 6**
Weighting: **15%**

- Although you worked in a team, each report should be written up individually.
- A full report must be made of your experimental data and **discussion and analysis** of your findings.
- Submit the report via the assignment box located in the FSE student centre (14 Sir Christopher Ondaatje Avenue, Ground, 14 SCOA, Ground Floor) including a completed and signed cover sheet stapled to the front cover.
- Electronic submission to the Turnitin program (see iLearn site) is also required for this task by the due date.
- Bibliography listings must conform to an acceptable style (for guidance, see http://libguides.mq.edu.au/Referencing
- Marking rubric can be found on ilearn. Expected sections are outlined below:
  Introduction (15%)
    - address the goals and aims of the segments of the practical.
    - overview the methods used

  Results (40%)
    - summarize laboratory experience and data obtained.
    - Do not reproduce details of the instructions given in the practical notes.

  Discussion (40%)
    - this is the most detailed and important section
    - interpret data and relate laboratory observations concerning purity, mass measurements and melting temperature range.
    - Conclude with a summary of properties of your protein sample.

  References (5%)
    - correctly formatted (author list, full title, journal, page numbers).
    - Web url addresses are to be avoided.

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Molecular graphics

Due: **Apr 29**
Weighting: **10%**

- Hand in the worksheet.
- In addition to filling in the worksheets issued on the day of the practical, a specific 3-D structure essay will be assigned. A reflective essay, 2000-3000 words (maximum) i.e. approximately 2-3 printed pages of 12 point font single line spaced.
- Work must be submitted via the assignment box located in the FSE student centre (14 Sir Christopher Ondaatje Avenue, Ground, 14 SCOA, Ground Floor) including a completed and signed cover sheet stapled to the front cover.
- Electronic submission of the essay on the Turnitin program (see iLearn site) is also required by the due date.
- The marking rubric will be available on ilearn. The report should be written up individually, and should contain the information as outlined below
  Reflective essay (60%)
    - The essay should present a molecular description of the protein, its structure fold, and some relationship to its function as a GTPase (and maybe even oncogenicity).
    - The data (xray coordinates) used should be described, including how the structure was determined and by whom?
    - Should also give a brief description about the structure solving mechanism.

  A good report will note binding characteristics of the protein and discuss conserved features of the sequences.

  Completed worksheet (30%)
    - should present all lab records created and AS OBSERVED ON THE DAY.

  Bibliography (10%)
    - appropriate bibliography style and use of references

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“Pet Protein” A

Due: **Mar 29**
Weighting: **15%**

- This is assessment of your research and analytical skills, and continues throughout the semester to enhance each topic area.
- Your individual protein for your own “Pet Protein” project will be distributed during week1 of the tutorial.
- There are two parts to this assessment task. Details are given below.

  As well as presenting analysis of your own case study in written form, you will transmit your understanding of the individual protein to fellow students via seminars and presentation of your own constructed three-dimensional protein model:
  - **Pet Protein A**: Purification, written report: **due Mar 29 -** 15%
  - **Pet Protein B**: Structure, Seminar and Model, **due Jun 7**-20%

This assignment will require extensive literature searching to locate prime sources in books and journals. You will be given the name of a protein of industrial/medical importance. In addition, each student will be given a journal/research paper related to your pet proteins to be used for writing the purification sections in the report as below. The given paper will describe the initial purification steps of your protein and may also include the description of a medical or industrial purification. The marking rubric will be made available online:

-
  - 1. The primary structure (amino acid sequence).

    20%

    - Prepare your own figure (not a journal extract) of the protein sequence, clearly showing the numbering relevant to the mature sequence.
    - Outline and label any sub-regions or domain units important in this protein. Indicate on this figure the disulfide connections (if any), as well as any amino acids known to be glycosylated.

    2. The physico-chemical properties of the protein such as the

- pI,
- MW,
- GRAVY value of the protein

that are important for determining a purification protocol.

20%

- Use the tools in ExPASy to analyse your sequence. Check you have the mature sequence of your protein (i.e. remove any signal peptide)
- If a glycoprotein, detail the full chemical nature of the carbohydrate portion.
- Present a hydropathy plot of the marure seqeunce of your protein (see ProtScale: web.expasy.org/protscale/).
- Discuss (i) the features of this plot with relation to the specific amino acid sequence and (ii) how it can be used to determine the GRAVY (grand average hydropathy) value.
- Comment on the link between the pI, GRAVY value and amino acid composition.

3. How the protein was initially purified from its natural source when it was first discovered.

50%

- Present a summary for this first purification **as a simplified flow chart.** It must present a summary overview of the chemical partitioning events, not detailed methods & reagents. Clearly label discarded and retained fractions at each partition.
- Within your report, give a detailed description of the molecular events

and chemistry of each separation step in the specific procedure, at the same detailed level as theory from lectures**.**

- Where possible, include and discuss column traces or stained gel images that indicate the purification achieved at specific steps.
- consistent bibliography style and use of references

Note: your flowchart must include branch points to clearly show how the mixture is successively partitioned to remove unwanted components and achieve purification.

4. References

10%

- consistent bibliography style and use of references

On successful completion you will be able to:

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"Pet Protein" seminar, model

Due: **June 7**
Weighting: **20%**

This is a continuation of the pet protein case study

Pet Protein B: Structure, model, seminar & questions: **due June 7,** model - 10% and presentation - 10%

- Overall, project work will be assessed according to:
  - the quality and extent of your research
  - the depth and **molecular detail** of your analysis
  - appropriate use of internet tools

- the clarity of your communication (verbal and written) and molecular analysis
- the extent to which your model successfully shows the shape and form of your protein **in three-dimensions**
- correct bibliography layout (i.e. alphabetical or numbered listing), with reference to all primary source material (i.e. journal articles, not web-based information)

Seminar

Transmit understanding of the individual protein structure to your fellow students in a 10 minute powerpoint presentation. You are required to:

Research the literature concerning the three-dimensional structure and structure determination method relevant to your protein. The percentages given are for reference only and can be split around based on your presentation.

- Locate the coordinate file in the Protein data Bank (www.rcsb.org/pdb/) and pertinent paper
- Outline the method(s) used to derive its structure
- Outline the fold features and spatial organization of the molecule
- Describe the structural features that relate to the function of your protein
- In addition to your presentation, addressing the questions asked by your reviewer will also count towards the total marks

Model

- Construct a model (hint: wire, tape, kitchen utensils...) that shows the three-dimensional shape of this macromolecule.
- If your protein is particularly large, with two or more distinct domains, only select one of these for your model.

Advanced work for bonus mark:

Use the BLAST tool available through ncbi (/blast.ncbi.nlm.nih.gov) to locate some interesting sequence homologues to your selected Pet Protein sequence. Align these in CLUSTAL (/www.clustal.org/).

- Present these aligned sequences and indicate the location of secondary structure (helices, sheets) important in the 3D structure of your Pet Protein.

- Note any relationship between sequence varation in this protein family and 2^{o} (and 3^{o}) structure.

On successful completion you will be able to:

- Develop presentation skills (written, oral) relevant in biomedical science

Delivery and Resources

Teaching Staff:

- The Unit will be administered by Dr Phani Rekha Potluri. Lectures in this Unit will be delivered by Assoc. Professor Bridget Mabbutt, and tutorials by Dr Potluri.
- For administrative matters, the Unit Convenor (Dr Potluri) can be contacted by email within the online iLearn interface (ilearn.mq.edu.au). You are welcome to arrange personal meeting times by appointment (Office hrs, Tuesdays, 11- 12pm).
- The following guests will deliver individual lectures in their areas of research speciality: Dr. Sophie Goodchild, Dr Alastair Stewart, and Dr. Morten Andersen.

Classes:

- Lectures will be twice weekly: **Thursday (12 pm)** and **Friday (9 am)** in **9 Wally's Walk (9WW) 131.**
- The course syllabus is defined by the subject material presented in all lectures (including guest lectures) and practicals, much of which is beyond standard textbooks.
- From week 1, tutorials run for all students at the following times: **Thursday (1 pm and 2 pm)** in 14 Eastern Road (14ER) 188. These are structured as problem-solving workshops. You are required to attend *one* of the two sessions. Attendance is compulsory.

Laboratory Sessions:

A Protein Purification Practical is scheduled in the mid-semester break.

*All students are required to attend practicals scheduled for **Apr 15th-17th**, (Mon-Wed).*

- Throughout the semester, **workshops** (named Practical_1 and Practical_2 in the University timetable) are scheduled on four selected **Fridays (10am-2pm)**. You will attend according to dates and time (detailed in the table below) allocated to your laboratory group.
- You will be allocated a lab group (Group 1 or Group 2 or Group 3) by the Unit convenor and communicated via the iLearn interface. You are not permitted to change groups

during semester. Each of you need to attend for 2 hrs in these sessions.

- Please carefully check the location of each activity, as classes start promptly. **Latecomers may be excluded from class.**
- Participation is compulsory on the allocated days of class. If you are absent through illness, medical certificates are required. Please consult with the Unit Convenor to ensure all laboratory and project work is completed.

Required and Recommended texts

- **The textbook to which you are expected to have access is: "Physical Biochemistry: Principles and Applications", David Sheehan, John Wiley (2nd ed, 2002).** Copies are available for purchase in the bookshop**.**
- The library has an excellent collection of up-to-date reference material to cover the course and laboratory subjects - explore it!!
- Strongly recommended **reference texts** available in the library (short-term loan only):
    - "Proteins: Structure and Function", D. Whitford, John Wiley, 2005
    - "Protein Structure and Function", Petsko & Ringe, New Science Press, 2009
    - "Introduction to Protein Structure", Branden & Tooze, Garland, 1999
- Other **general references** that you may find useful are:
    - Dagmar Klostermieier & Markus G.Rudolph "Biophysical Chemistry:"
    - R. Scopes, "Protein purification: principles and practice", New York, Springer-Verlag, 1994
    - Garrett & Grisham, "Biochemistry" (esp. Chs 4 – 6), Harcourt Brace, 2013
    - T. Creighton, "Proteins: Structures and Molecular Properties", Freeman, 1993

Web resources

The Unit will run as an online unit within iLearn (http://learn.mq.edu.au). Within this Unit, you will be introduced to Web-based tools, search engines and graphics software that are commonly used today in protein science.

It is an expectation that you will become familiar with the following sites during the course:

- www.uniprot.org/
- www.expasy.org/proteomics
- www.ncbi.nlm.nih.gov/pubmed
- www.rcsb.org/pdb

Technology Requirements

- You will require access to the internet and a computer available for accessing the iLearn site, web browsing, preparation of your reports and presentations (Word and PowerPoint software), molecular viewing and case study analysis. Printer access is required to generate hard copy of reports.
- Your project and laboratory reports will be electronically submitted via the online Turnitin program within the CBMS 732/832 iLearn portal.
- Your practical reports will require you to carry out minor arithematical tasks, for which a calculator and access to basic statistical software will be required.
- We place a strong emphasis on correct referencing style in all your reports. Use of the program EndNote (http://libguides.mq.edu.au/EndNoteMac, http://libguides.mq.edu.au/EndNotePC) is encouraged, but not essential.
- Your model-building assessment task can be carried out with very simple materials; it is not an expectation that expensive art supplies need be purchased.

Unit Schedule

Lectures, assessments and Practical schedule

1 - 3	PROTEIN ENGINEERING -Functional groups in proteins
4	DETECTION OF BIOMOLECULES
5 - 8	SEPARATION OF PROTEINS -Separation by SEC -Ion exchange -Affinity chromatography
9	Glycomics (MA)
10-12	PROTEIN FOLDS AND DOMAINS -all alpha-structures (globin fold, helix bundles); -all beta structures (antiparallel barrels, the beta helix); -mixed alpha/beta folds
14	MEMBRANE PROTEINS
15-18	TERTIARY STRUCTURE DETERMINATION -X-ray crystallography; -Electron microscopy -NMR spectroscopy

19-21	HOW PROTEINS FOLD IN SOLUTION -thermodynamics of protein folds; -circular dichroism; -Fluoroscence based methods
22-23	BIOINFORMATICS -structure prediction methods; -the CASP project
24	SINGLE MOLECULE DETECTION METHODS
25-26	PET PROTEIN PRESENTATIONS

Teaching week	**Date**	**Activity**	**Assignment due**	**Student group**
Weeks 2	Mar-8	**Revision Quiz**		All students
Week 3	Mar-15	PRACTICAL: Searching the primary literature		11 WW- 260 10am-12pm, **group 1**, 12pm-2pm, **group 2**, 11 WW- 270 10am-12pm, **group 3**.
Week 4	Mar-22	**Quiz (Topics 4-8)**		All students
Week 5	Mar-29		*Pet Protein (A) report due, 5p.m.*	All students
Week 6	Apr-5	**Quiz (Topics 9-11)**		All students
Week 7	Apr-12	Workshop: Molecular graphics		14 SCOA 346 10am-12pm, **group 1** 12pm-2pm, **group 2&3**
Mid-semester break	Apr-15th-17th	Practical: Protein Purification		14 ER 130 AND 150: 9am-5pm **All groups**
Week 8	Apr-29		*Molecular Graphics Report due, 5p.m*	All students
Week 9	May-6		*Protein Purification: Chromatography report due, 5p.m*	All students

Week 9	May-10	FILM: "DNA: Life story"		11am-1pm (venue tba), all students
Week 10	May-17	**Quiz (Topics 12-19)**		All students
Week 11				
Week 12	May-31	**Quiz (Topics 20-23)**		All students
Week 13	Jun-6th	Presentations: pet protein B (Tertiary structure)		**12pm-3pm, groups 1, venue tba**
Week 13	Jun-7th	Presentations: pet protein B (Tertiary structure)		**10am-2pm, groups 2 and 3, venue tba**

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results published on platform other than eStudent, (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au or if you are a Global MBA student contact globalmba.support@mq.edu.au

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

If you are a Global MBA student contact globalmba.support@mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

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

Graduate Capabilities

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- Assimilate and interpret methods used today to isolate and handle proteins
- Comprehend the molecular behaviour of proteins (gene products), both in vivo and in vitro
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- Experimentally analyse and purify a protein of interest and utilise contemporary web tools to predict common characteristics of this protein
- Develop a sound knowledge of protein structure and how it is encoded in a protein (or gene) sequence

Assessment tasks

- Quizzes
- Protein Purification Practical
- Molecular graphics
- “Pet Protein” A

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- Assimilate and interpret methods used today to isolate and handle proteins
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- Experimentally analyse and purify a protein of interest and utilise contemporary web tools to predict common characteristics of this protein
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Assessment tasks

- Quizzes
- Protein Purification Practical
- Molecular graphics
- “Pet Protein” A

- "Pet Protein" seminar, model

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- Experimentally analyse and purify a protein of interest and utilise contemporary web tools to predict common characteristics of this protein
- Extract and interpret information from a variety of scientific sources concerning proteins

Assessment tasks

- Protein Purification Practical
- Molecular graphics
- “Pet Protein” A
- "Pet Protein" seminar, model

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcome

- Be able to describe biomolecular forms and architectures

Assessment tasks

- Quizzes
- “Pet Protein” A
- "Pet Protein" seminar, model

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcomes

- Be able to describe biomolecular forms and architectures
- Develop a sound knowledge of protein structure and how it is encoded in a protein (or gene) sequence

Assessment tasks

- Quizzes
- Protein Purification Practical
- Molecular graphics
- “Pet Protein” A