BS348-15 Structural Molecular Biology

22/23

Department
Life Sciences
Level
Undergraduate Level 3
Module leader
Alexander Cameron
Credit value
15
Module duration
10 weeks
Assessment
100% coursework
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The aim of the course is to provide you with some in depth appreciation of current hot topics and recent advances in this fast moving and increasingly important field, whilst giving you some grounding in the experimental techniques that underpin these advances.
The lectures are arranged in specific fields of interest in Structural Biology. As with all university courses please remember that the lectures provide you with a scaffold on which your learning is built and additional reading from research papers in particular and text books to a lesser extent is required. The links below provide email and telephone contact numbers to the lecturers on the course but please remember that we lecturers are not just here to teach you and that we have administrative and research commitments that gets in the way of an instant answer to your question! That said we will endeavour to help you as much as possible.

Module web page

Module aims

From this module, aimed at correlating structure to biological properties of macromolecules, students should understand how this information is obtained. It covers research case studies in the current literature, from which students should learn how techniques are actively used to give structural insight into biological function. These lectures include information from structural biologists who participate on the module as guest lecturers. The module is broken into thematic

areas which include: Large Macromolecular structures and complexes; Membrane proteins; Infection and Computational Structural Biology

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1-2. Large Macromolecular Structures: (Dr. C. J. I. Smith) Principles and applications of protein structure determination by cryo-electron microscopy. The principles underlying protein structure determination by single particle analysis will be reviewed. Advanced concepts underlying recent improvements in technology and image processing that led to the ‘resolution revolution’ will be explained and examples of near-atomic resolution structures determined by single particle cryoEM will be discussed.

1. Large Macromolecular Structures 3: (Dr. C. J. I. Smith) Case study of the contribution of 3D cryo-electron microscopy to our understanding of the mechanism of action of GroEL. The bacterial chaperonin, GroEL has become a benchmark by which the development of 3D cryo-electron microscopy has been measured, due to the high-resolution structures which have been obtained via this technique. The information gained as a result has provided detailed knowledge of the precise conformational changes undergone by GroEL as it performs its function.

2. Large Macromolecular Structures 4: (Dr. C. J. I. Smith) How do cells choose what to eat? Structure and function of proteins involved in endocytosis. Introduction to endocytosis, structure of clathrin coats by cryo electron microscopy, proteins involved in clathrin coat formation, molecular basis of recruitment of receptors to the coated vesicle.

3. Membrane Proteins 1: (Prof. A. Cameron) Structural Biology of Membrane Proteins. This lectures will give an overview of some of the problems in obtaining structures of membrane proteins and will show how some of these problems are being addressed with current technology.

4. Membrane proteins 2: (Prof. A. Cameron) Primary transporters

5. Membrane proteins 3: (Prof. A. Cameron) Secondary transporters

These two lectures will introduce membrane transporters and the great advances that have been made recently into the structural basis for their mechanisms. Well-studied examples will show how these molecules transport molecules and ions from one side of the membrane to the other.

1. Membrane proteins 4: (Prof. A. Cameron) G protein-coupled receptors (GPCRs)
   GPCRs are the largest class of membrane proteins and are vital in signal transduction. There have been huge advances recently in understanding the structures, how they bind ligands and how this is transmitted to the associated G proteins. The lecture will discuss the structures, interactions and conformational changes that occur during activation of GPCRs.

2. Membrane proteins 5: (Dr. Y. Pankratov) Structure and function of neurotransmitter receptors I: Ligand-gated and Voltage-gated Ion Channels. Neurotransmitter receptors and voltage-gated ionic channels are two special classes of transmembrane proteins that are

vitally important for neuronal and many other types of cells. This lecture will address the fundamental principles of structural organization and its link to the functions of ion channels. We will explore the cases studies of most abundant glutamate and acetylcholine receptors and voltage-gate potassium and sodium channels.

3. Membrane proteins 6: (Dr. Y. Pankratov) Structure and function of neurotransmitter II: This lecture continues topic of membrane receptors structure and function.

4. Membrane proteins 7: (Dr P. Stansfeld) Outer Membrane Proteins This lecture will give an overview of the bacterial cell envelope, run through the roles of Outer Membrane Proteins (OMPs) and the Structural feature of OMP beta barrels. Finally, Mechanisms of Insertion of an OMP by BAM will be given.

5. Infection 1. (Dr. A. Crow) Protein secretion and antibiotic resistance mediated by tripartite efflux pumps. The tripartite efflux pumps of Gram-negative bacteria are large multi-protein complexes that span the entire cell envelope and drive secretion of proteins and small molecules. This lecture will provide an overview of the structure, function and mechanism of tripartite pumps with a particular focus on MacAB-TolC.

6. Infection 2. (Dr. A. Crow) Structural Biology of Covid19 This lecture will show some of the structures related to Covid19 including the Spike protein and its interaction with ACE2.

7. Infection 3. (Dr. A. Crow) Bacterial effectors This lecture will give case studies of how pathogens manipulate their hosts using injected proteins and discuss protein:protein interactions.

8. Infection 3. (Dr. A. Crow) Bacterial Cell Division Proteins. This will discuss the structural biology of proteins involved in bacterial cell division.

16-18. Computational Structural Biology (Dr P. Stansfeld). In this series of lectures the use of molecular dynamics and other computation techniques will be discussed. These techniques are useful to enhance the ‘static” structures that are obtained by crystallography and cryo-EM.

Learning outcomes

By the end of the module, students should be able to:

- LO1 Demonstrate an understanding of large macromolecular structures, including R&D techniques to study them
- LO2 Demonstrate an understanding of membrane protein structures, including R&D techniques to study them
- LO3 Demonstrate an understanding of structures involved in infection, including R&D techniques to study them
- LO4 Demonstrate an understanding of computational based structural biology approaches and their use in R&D

Subject specific skills

a. Demonstrate clear understanding of the scientific topic

b. Contain evidence of extended reading and lateral integration of material not covered in the lectures
c. Demonstrate independent thought and deep understanding
d. Specifically answer the set question using information from multiple lectures and sources
e. Be structured and formatted in a way that demonstrates understanding and logical flow

Transferable skills

1. Critical appraisal of source material
2. Self directed learning
3. Adult learning

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (13%)
Private study	130 hours (87%)
Total	150 hours

Private study description

130 hrs of self-study and directed reading to prepare for the open book assessment

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Students can register for this module without taking any assessment.

Assessment group A

	Weighting	Study time
Open Book Assessment	100%	20 hours

Final assessment for the module will be on open book assessment. This is an essay based assessment consisting of 4 questions- students need to answer 2. The essays cannot be answered using lecture notes alone- students will need to perform background research and

	Weighting	Study time
essays will need to be fully referenced.		

Feedback on assessment

Pastoral meetings with personal tutor

Availability

Courses

This module is Core for:

- UBSA-C700 Undergraduate Biochemistry
  - Year 3 of C700 Biochemistry
  - Year 3 of C700 Biochemistry
- ULFA-C1A2 Undergraduate Biochemistry (MBio)
  - Year 3 of C1A2 Biochemistry
  - Year 3 of C700 Biochemistry
- Year 4 of ULFA-C702 Undergraduate Biochemistry (with Placement Year)
- Year 3 of ULFA-C1A6 Undergraduate Biochemistry with Industrial Placement (MBio)

This module is Option list B for:

- Year 3 of UMDA-CF10 Undergraduate Integrated Natural Sciences (MSci)