BS348-12 Structural Molecular Biology

20/21

Department
Life Sciences
Level
Undergraduate Level 3
Module leader
David Roper
Credit value
12
Module duration
10 weeks
Assessment
100% exam
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. We hope that the course will spark further interest in your studies overall and we welcome students who wish to discuss the subject areas covered. Please also be aware that each year there a number of undergraduate projects available in the group. We will advertise these positions as they become available and you are advised to make enquires ASAP if interested.

The lectures are arranged in specific fields of interest in Structural Biology including

Macromolecular structures
Protein-nucleic acid interactions
Protein-ligand interactions
Membrane proteins
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, Structure and Function of Membrane Proteins, Protein Folding and Structure, Protein-Nucleic Acid Interactions, Protein-Ligand Interactions, Biophysics and 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 Each topic will examine current research interests that demonstrate how structural biology methods have been employed to study biological functions.

1. Large Macromolecular Structures: (Dr. Michael Baker) Introduction to the principles of protein structure determination by cryo-electron microscopy. An overview of negative stain and cryo-electron microscopy methods will be provided.
2. Large Macromolecular Structures: (Dr. Michael Baker) The principles underlying protein structure will be explained using the 2D images obtained via electron microscopy of a frozen protein, and single particle analysis.
3. Large Macromolecular Structures 4: (Dr. Michael Baker) 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.
4. Large Macromolecular Structures 3: (Dr. Michael Baker) 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.
5. Protein-Nucleic Acid Interactions 1: (Dr. D. I. Roper) DNA topoisomerases, their structure mechanisms and drug interactions. How is the hydrolysis of ATP linked to the movement of DNA through the Gyrase protein complex? The similarities in mechanism between Human Topoisomerase Ib and lambda family site specific recombinases as revealed by X-ray crystallography.
6. Protein Nucleic Acid Interactions 2. (Dr D. I. Roper) DNA gyrase and antimicrobial drugs

7. Protein-Nucleic Acid Interactions 3: (Dr. D. I. Roper) The ribosome, part 1. General introduction to the structure of the ribosome as revealed by recent advances in the field and a historical perspective.

8. Protein-Nucleic Acid Interactions 4: (Dr. D. I. Roper) The ribosome, part 2. The interaction of antibiotics and ribotoxins with the ribosome, and their effects on protein synthesis. Peptidyl bond formation and how the ribosome can differentiate between cognate and near cognate aminoacyl-tRNAs.

9. Protein-Ligand Interactions 1: (Dr. D. I. Roper) Molecular basis of antibiotic action: vancomycin: general antibiotic strategies, bacterial cell wall and peptidoglycan biosynthesis, vancomycin resistance mechanism and structural elucidation of factors contributing, general factors in vancomycin resistance, molecular events leading to vancomycin resistance.

10. Protein-Ligand Interactions 2: (Dr. D. I. Roper) The structure and mechanism of lysosyme. Hen egg-white lysozyme was the first enzyme to have its three-dimensional structure determined by X-ray diffraction techniques. A catalytic mechanism, proposed by Sir David Philips was proposed on the basis of model-building studies and became the “paradigm” for the catalytic mechanism of beta-glycosidases that cleave glycosidic linkages with net retention of configuration of the anomeric centre. Studies with other retaining beta-glycosidases, however, provide strong evidence pointing to a common mechanism for these enzymes that involves a covalent glycosyl-enzyme intermediate, as previously postulated. A recent study combining X-ray crystallography and mass spectrometry has redefined this mechanism.

11. Protein-Ligand Interactions 3: (Dr D.I. Roper)

12. Protein-Ligand Interactions 3: (Professor V. Fülöp) -propellers in enzyme catalysis and regulation. The beta-propeller fold has been found in and is predicted to be in many different structures from a variety of organisms. Recently solved structures and proposed models have helped to reveal the structural characteristics of the beta-propeller fold, as well as the features that contribute to its high rigidity and stability. These structural features together with their functional diversity will be discussed.

13. Membrane proteins 1: (Dr. A. Cameron) Introduction to membrane proteins. Membrane proteins are extremely important with 30% of genes encoding membrane proteins and up to 50% of pharmaceutical drugs targeting them. They are notoriously difficult to work with. This lecture will introduce some of the methods that are used to isolate and crystallise membrane proteins. A case study will show how a combination of X-ray crystallography and EM can lead to important structural information.

14. Membrane proteins 2: (Dr. A. Cameron) Primary 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.

15. Membrane proteins 3: (Dr. 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.

16. Membrane proteins 4: (Dr. 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.
17. 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.
18. Membrane proteins 6: (Dr. Y. Pankratov) Structure and function of neurotransmitter II: This lecture continues topic of membrane receptors structure and function.

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 protein-nucleic acid interactions structures, including R&D techniques to study them
- LO3 Demonstrate an understanding of protein-ligand interactions structures, including R&D techniques to study them
- LO4 Demonstrate an understanding of membrane structure, components and function, including R&D techniques to study them

Indicative reading list

Reading lists can be found in Talis

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	19 sessions of 1 hour (16%)
Private study	101 hours (84%)
Total	120 hours

Private study description

101 hrs of self-study and directed reading

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 B1

Assessment component	Weighting	Study time	Eligible for self-certification
Written Examination	100%		No

Reassessment component is the same

Feedback on assessment

Pastoral meetings with personal tutor

Past exam papers for BS348

Availability

Courses

This module is Core for:

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