LF244-15 Protein Structure and Function

26/27

Department
Life Sciences
Level
Undergraduate Level 2
Module leader
Allister Crow
Credit value
15
Module duration
5 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

LF244 introduces students to the beauty and complexity of protein structures and the remarkable diversity of their biological functions. The course explores topics such as protein folding, DNA binding, electron transfer, protein engineering and membrane proteins. Students will also learn how to view and analyse protein structures with computational tools.

Module aims

The course aims to provide a solid understanding of how protein structure determines protein function.
LF244 serves as a core module for the Warwick Biochemistry degree stream.

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. The basic facts and principles.
   The importance of proteins as the executive agents of genes; protein structure as polymers of amino acids; representations of protein structures to show end results of protein folding and the dimensions involved.

2. Amino acids.
   Structure and properties of the 20 protein amino acids, including dissociation of charged groups, the hydrophobic interaction and the importance of side chain variation for the properties of proteins.

3. Peptide bonds and secondary structure.
   Amino acids chirality and planarity; phi and psi angles, Ramachandran plot, alpha helices, beta sheets. Loops.

4. Protein motifs, domains and beyond.
   Secondary structure elements in proteins and the forces that drive proteins to fold. Regular structures in proteins; secondary structures; the alpha helix and beta strand and their characteristics, loops and their importance. Protein super secondary structures; motifs and super secondary structures; domains built from structural motifs. Alpha, alpha/beta and beta structures.

5. Protein engineering.
   Why engineer proteins? Rational design of proteins for study and application. Site directed mutagenesis, Fusion proteins, Directed evolution, Lysozyme heat stability by addition of cysteines for disulphide bond thermostability of lysozyme; Noble prize 2018. Self study requirements.

6. Protein engineering: Lecture content on Green and other colours florescent proteins, Phage display to humanised antibodies.

7. Protein Folding - Part I.
   Properties of the folded and unfolded states; Levinthal's paradox; Folding landscapes.

8. Protein Folding - Part II.
   Anfinsen's Dogma; Predicting structure from sequence.

9. Chaperones.
   How do chaperones assist folding? The Anfinsen Cage mechanism; Iterative annealing mechanism.

10. DNA binding proteins.
    How do proteins recognise DNA? Sequence recognition in the DNA minor and major groove; Specific and non specific binding; Engineered DNA binding proteins (zinc fingers and Tal effectors)

11. Electron transfer proteins.
    Redox centres; Molecular wires; thiol-disulfiude interchange

12. Structure and mechanism of the SARS CoV 2 Spike protein.
    Structure of the coronavirus spike; Receptor recognition (protein-protein interaction);

membrane fusion (protein conformational change).

13. Membrane proteins.
    Transmembrane helices; Beta barrels; Membrane protein functions.

14. Membrane protein insertion and transport.
    Assembling/inserting membrane proteins (SEC); Membrane proteins in the bacterial outer membrane (BAM)

In silico practical
Use of computational tools for viewing and analysing 3D protein structures.
Analysing nucleotide sequences. Linking genetic mutation to protein structure and function.

Learning outcomes

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

- Discuss the relationship between a protein's structural features and its function.
- Discuss molecular mechanisms with reference to a protein's 3D structure.
- Discuss the forces that drive protein folding.
- Apply knowledge of secondary structure elements, ligands and motifs to identify and describe protein structures.
- Assess and evaluate recent advances in protein structure prediction.
- Use molecular visualisation software to inspect and analyse 3D protein structures and create structural images.

Subject specific skills

Knowledge of protein structure and function.
Use of computational tools for visualising proteins.
Use of bioinformatics programmes for nucleotide sequence analysis
Producing scientific figures.

Transferable skills

Self-directed learning.
Computer skills.

Study

Study time

Type	Required	Optional
Lectures	14 sessions of 1 hour (9%)	1 session of 1 hour
Project supervision	(0%)	
Practical classes	2 sessions of 3 hours 30 minutes (5%)	
Private study	97 hours 30 minutes (65%)	
Assessment	31 hours 30 minutes (21%)	
Total	150 hours	

Private study description

General reading around the subject. Students will be given suggested reading to accompany lectures.
A 1 hour revision session will be provided as exam season approaches.

Costs

Category	Description	Funded by	Cost to student
IT and software	Computers are required to visualise 3D protein structures using software (such as Pymol).	Department	£0.00

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D2

	Weighting	Study time	Eligible for self-certification
In-class assignment	30%	30 hours	No
In silico practical on protein structure and function. Students will analyse protein structures using computational software and present their findings in a written report.			
Closed-book end-of-year examination	70%	1 hour 30 minutes	No
In-person locally-timetabled closed-book end-of-year examination			

Assessment group R2

	Weighting	Study time	Eligible for self-certification
Closed-book examination	100%		No

In-person locally-timetabled closed-book examination

Feedback on assessment

Written report feedback:
Individual feedback on written reports given by markers (via Tabula).
Cohort-level feedback given on the written report (via Moodle).

Exam feedback:
Individual exam marks returned to students.
Cohort-level feedback given on the examination (via Moodle).

Past exam papers for LF244

Availability

Courses

This module is Core for:

- UBSA-C700 Undergraduate Biochemistry
  - Year 2 of C700 Biochemistry
  - Year 2 of C700 Biochemistry
- ULFA-C1A2 Undergraduate Biochemistry (MBio)
  - Year 2 of C1A2 Biochemistry
  - Year 2 of C700 Biochemistry
- Year 2 of ULFA-C702 Undergraduate Biochemistry (with Placement Year)
- Year 2 of ULFA-C1A6 Undergraduate Biochemistry with Industrial Placement (MBio)

This module is Optional for:

- UBSA-3 Undergraduate Biological Sciences
  - Year 2 of C100 Biological Sciences
  - Year 2 of C100 Biological Sciences
  - Year 2 of C102 Biological Sciences with Cell Biology
  - Year 2 of C103 Biological Sciences with Environmental Resources
  - Year 2 of C104 Biological Sciences with Microbiology
  - Year 2 of C105 Biological Sciences with Molecular Genetics
  - Year 2 of C107 Biological Sciences with Virology
- Year 2 of ULFA-C1A1 Undergraduate Biological Sciences (MBio)
- Year 2 of ULFA-C113 Undergraduate Biological Sciences (with Placement Year)
- Year 2 of ULFA-C1A5 Undergraduate Biological Sciences with Industrial Placement (MBio)
- UBSA-C1B9 Undergraduate Biomedical Science

    - Year 2 of C1B9 Biomedical Science
    - Year 2 of C1B9 Biomedical Science
    - Year 2 of C1B9 Biomedical Science
- ULFA-C1A3 Undergraduate Biomedical Science (MBio)
    - Year 2 of C1A3 Biomedical Science
    - Year 2 of C1B9 Biomedical Science
- Year 2 of ULFA-C1A7 Undergraduate Biomedical Science with Industrial Placement (MBio)
- ULFA-CB18 Undergraduate Biomedical Science with Placement Year
    - Year 2 of CB18 Biomedical Science with Placement Year
    - Year 2 of CB18 Biomedical Science with Placement Year
    - Year 2 of CB18 Biomedical Science with Placement Year
- Year 2 of ULFA-B140 Undergraduate Neuroscience (BSc)
- Year 2 of ULFA-B142 Undergraduate Neuroscience (MBio)
- Year 2 of ULFA-B143 Undergraduate Neuroscience (with Industrial Placement) (MBio)
- Year 2 of ULFA-B141 Undergraduate Neuroscience (with Placement Year) (BSc)