LF244-15 Protein Structure and Function

20/21

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

Description

Introductory description

The module introduces students to the complexity of protein structure and how these link to the activity and function of proteins. The emphasis is on the understanding of the molecular basis for how structure determines proteins and fits into the core aims for the Biochemistry degree. The determinants of specificity for ligand binding and catalysis are dissected.

Module web page

Module aims

Most of the properties of living organisms are ultimately due to the properties of the proteins they contain. Proteins are the most diverse and sophisticated molecules known, and their polymeric but non-repetitive structure permits the use of one cellular mechanism to generate a vast range of different structures serving all the functions that cells require to survive, grow and multiply. In recent years there has been an explosion in both the determination of the three-dimensional structures of proteins at atomic resolution, and the ability to alter these structures in precisely defined ways. The aim of this module is to build at an intermediate level on the basic concepts of protein structure and function introduced in Year 1, students having by this stage a firm foundation

in molecular biology and a wider range of knowledge of cell biology. The module is based on the books 'Introduction to Protein Structure' by C. Branden and J. Tooze, published by Garland Publishing Co. and 'Protein Structure and Function' by G. A. Petsko and D. Ringe, published by New Science Press Ltd.

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.

Protein Structure (Dr David Roper)

1-2 The basic facts and principles: The importance of proteins as the executive agents of genes; the basics of protein structure as polymers of amino acids; representations of protein structures to show end results of protein folding and the dimensions involved. 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 The peptide bond; chirality and planarity; phi and psi angles and the Ramachandran plot.

4 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.

5 Protein super secondary structures; motifs and super secondary structures; domains built from structural motifs. Alpha, alpha/beta and beta structures, intrinsically unstructured proteins.

6-7 Principles of protein engineering. Why engineer proteins? For functional study, to improve or change biological properties. E.g. addition of cysteines for disulphide bond thermostability of lysozyme; site directed mutagenesis; effects of adding glycine and proline residues to protein chains. The addition of tryptophan residues as fluorescent probes, incorporation of Aza-tryptophan in the study of protein-protein complexes. Methods to increase protein evolution by exon shuffling and error prone PCR. Biotechnology and industrial applications; applications of protein engineering, Biosteal and de-novo design.

From Structure to Function (Dr Yuriy Pankratov)

8-9 Protein folding; energetic and kinetic considerations; folding pathways, folding intermediates, roles and action of molecular chaperones, roles of protein disulphide isomerase and peptidyl-prolyl isomerase.

10-11 Overview of protein function and architecture: The many levels of protein function from ligand binding to catalysis; molecular switches and structural proteins. How structural features dictate the ability of proteins to bind a wide variety of ligands and catalyse the wide variety of chemical transformations on which life depends.

12 The molecular mechanism that control protein function in the cell. Regulation of protein function by pH, cellular location, redox environment and protein degradation. Structural/function relationships of phosphorylation, glycosilation lipid and other covalent protein modifications.

13-14 Illustrations of protein function from a protein structural level prospective. The structural

basis of mechanisms of protein switches based on nucleotide binding and hydrolysis. Case studies include activation mechanisms of different types of protein kinases, GTPases and ATPases.

Workshop in Pymol (VF)

15 Molecular Graphics program workshop with example files held in the ICL (see www.pymolwiki.org) and module page for details.

Learning outcomes

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

- Understand the utilisation of certain protein motifs and domains in functional situations.
- Understand the basic facts behind protein structure and its determination
- Discuss the importance of the basic chemical elements of protein structure from peptide bond to complex quaternary structures
- Understand with examples how proteins can be explored, changed or evolved to understand function and develop new properties
- Understand how to search for and visualise protein structures from the protein databank using bioinformatic tools

Indicative reading list

Branden, C. and Tooze, J. Introduction to Protein Structure, 2nd edn.
(Garland Publishing Co., 1999).

Petsko, G. A. and Ringe, D. Protein Structure and Function,
(New Science Press Ltd., 2004).

Subject specific skills

Understand the basic facts behind protein structure and its determination

Discuss the importance of the basic chemical elements of protein structure from peptide bond to complex quaternary structures

Understand with examples how proteins can be explored, changed or evolved to understand function and develop new properties

Understand the utilisation of certain protein motifs and domains in functional situations.

Understand how to search for and visualise protein structures from the protein databank using bioinformatic tools

Transferable skills

Self directed learning
Adult learning

Study

Study time

Type	Required
Lectures	15 sessions of 1 hour (7%)
Project supervision	1 session of 1 hour (0%)
Practical classes	3 sessions of 6 hours (8%)
Private study	116 hours (52%)
Assessment	75 hours (33%)
Total	225 hours

Private study description

Self directed learning and revision

Costs

No further costs have been identified for this module.

Assessment

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

Assessment group D

	Weighting	Study time
Computer Based Practical Assessment	30%	30 hours
Bioinformatics lab- students will compare mutations in DNA sequences and use pymol to model the changes in protein structure		
Online Examination	70%	45 hours
45 min short answer paper / 45 min essay paper		

- Online examination: No Answerbook required

Assessment group R

	Weighting	Study time
In-person Examination - Resit 45 min SAQ paper / 45 min essay paper	100%	

- Answerbook Green (8 page)

Feedback on assessment

Not required.\r\n

Past exam papers for LF244

Availability

Courses

This module is Core for:

- Year 2 of UBSA-C700 Undergraduate 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 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)