



## Higher National Unit specification

### General information for centres

**Unit title:** Protein Structure and Function

**Unit code:** DG6X 35

**Unit purpose:** This Unit is designed to provide candidates with a detailed understanding of the relationship between structure and functioning of proteins as well as a working knowledge of the techniques used in analysing this relationship. This Unit is suitable for candidates who are studying for an HN Biotechnology or other science related qualification.

On completion of the Unit the candidate should be able to:

1. Outline key aspects of proteomics.
2. Describe the principles involved in keeping proteins in their native states.
3. Outline the basic principles of specific binding.
4. Outline the key principles of the regulation of protein activity.

**Credit value:** 1 HN credit at SCQF level 8: (8 SCQF credit points at SCQF level 8\*)

*\*SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from Access 1 to Doctorates.*

**Recommended prior knowledge and skills:** Access to this Unit will be at the discretion of the centre, however it is recommended that candidates should have a good knowledge of biochemistry and biochemical techniques at SCQF level 7.

**Core Skills:** There may be opportunities to gather evidence towards Core Skills in Problem Solving and Working with others at Higher level in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

**Context for delivery:** This Unit is included in the framework of the Group Award, HND Biotechnology. It is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

**Assessment:** This Unit should be assessed using a holistic, closed-book, supervised test with a cut off score of 60%. The test should incorporate either a case study or problem solving materials.

## **Higher National Unit specification: statement of standards**

**Unit title:** Protein Structure and Function

**Unit code:** DG6X 35

The sections of the Unit stating the Outcomes, knowledge and/or skills, and Evidence Requirements are mandatory.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the knowledge and/or skills section must be taught and available for assessment. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

### **Outcome 1**

Outline key aspects of proteomics

#### **Knowledge and/or Skills**

- ◆ Use of two-dimensional gel electrophoresis
- ◆ Interpretation of 2D gels
- ◆ Sequencing of peptides
- ◆ Protein-protein interactions

#### **Evidence Requirements**

Evidence for the knowledge and skills in this Outcome will be gathered using a written assessment employing case study and/or problem-solving materials, in which candidates must obtain at least 60% of the marks available in order to pass.

A candidate's response will be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ outline the principles of 2D gel electrophoresis
- ◆ identify 2D gel spots from the molecular weights of tryptic peptides
- ◆ outline the sequencing of peptides by mass spectrometry
- ◆ summarise the approaches used to investigate protein — protein interactions

#### **Assessment Guidelines**

Please see Assessment Guidelines for the Unit.

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Protein Structure and Function

### **Outcome 2**

Describe the principles involved in keeping proteins in their native states

#### **Knowledge and/or Skills**

- General principles of protein denaturation
- Inactivation of functional sites
- Prevention of proteolysis
- Protein storage

#### **Evidence Requirements**

Evidence for the knowledge and skills in this Outcome will be gathered using a written assessment employing case study and/or problem-solving materials, in which candidates must obtain at least 60% of the marks available in order to pass.

A candidate's response will be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ outline the general principles of protein denaturation
- ◆ outline conditions which can inactivate functional sites
- ◆ describe methods employed to prevent proteolysis
- ◆ outline a common method of protein storage

#### **Assessment Guidelines**

Please see Assessment Guidelines for the Unit.

### **Outcome 3**

Outline the basic principles of specific binding

#### **Knowledge and/or Skills**

- ◆ General characteristics of binding sites
- ◆ Interactions involved in protein-ligand binding
- ◆ Structural methods for locating the amino acid residues in binding sites
- ◆ Chemical methods for locating the amino acid residues in binding sites

## **Higher National Unit specification: statement of standards (cont)**

**Unit title:** Protein Structure and Function

### **Evidence Requirements**

Evidence for the knowledge and skills in this Outcome will be gathered using a written assessment employing case study and/or problem-solving materials, in which candidates must obtain at least 60% of the marks available in order to pass.

A candidate's response will be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ outline the general characteristics of binding sites
- ◆ outline the role of weak, non-covalent interactions in protein-ligand binding
- ◆ describe methods, based on structure, which are employed to locate amino acid residues in binding sites
- ◆ describe methods, based on chemical treatments, which are employed to locate amino acid residues in binding sites

### **Assessment Guidelines**

Please see Assessment Guidelines for the Unit

## **Outcome 4**

Outline the key principles of the regulation of protein activity

### **Knowledge and/or Skills**

- ◆ Role of conformational changes
- ◆ Phosphorylation and dephosphorylation
- ◆ Activation by proteolysis
- ◆ Regulation by binding proteins

### **Evidence Requirements**

Evidence for the knowledge and skills in this Outcome will be gathered using a written assessment employing case study and/or problem-solving materials, in which candidates must obtain at least 60% of the marks available in order to pass.

## **Higher National Unit specification: statement of standards (cont)**

### **Unit title:** Protein Structure and Function

A candidate's response will be judged to be satisfactory where the evidence provided is sufficient to meet the requirements for each item by showing that the candidate is able to:

- ◆ outline the role of conformational changes (in the context of multiple binding sites) in regulating protein activity
- ◆ outline role of kinases and phosphatases
- ◆ outline the process of proteolytic activation
- ◆ outline the principles involved in regulation by binding proteins

### **Assessment Guidelines**

This Unit should be assessed using a holistic, closed-book, supervised test with a cut off score of 60%. The test should incorporate either a case study or problem solving materials.

## Administrative Information

**Unit code:** DG6X 35

**Unit title:** Protein Structure and Function

**Superclass category:** RH

**Original date of publication:** August 2004

**Version:** 03 (June 2009)

### History of changes:

Version	Description of change	Date
02	Previous versions were made before the introduction of the History of Changes table.	04/06
03	Changes made to standardise assessment guidelines.	03/06/09

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## Higher National Unit specification: support notes

### Unit title: Protein Structure and Function

This part of the Unit specification is offered as guidance. The support notes are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 40 hours.

### Guidance on the content and context for this Unit

This Unit is primarily intended to provide the candidate with a detailed knowledge of the relationship between the structure of a protein and its function. In biotechnological processes the role of proteins is paramount and as such it is essential that scientists can understand and manipulate the factors which contribute to their functioning. Hence, the Unit concentrates on the ability to identify how a protein functions and to maintain it in a functional state. The essential underpinning knowledge and skills gained here will be invaluable during employment or further study.

**Outcome 1** looks at the key aspects of proteomics. Candidates should become familiar with the following features:

- ◆ 2D gel electrophoresis: SDS-PAGE; isoelectric focusing; automated comparison of gels.
- ◆ Interpretation: trypsin specificity; mass spectrometry; database searches.
- ◆ Sequencing: fragmentation of amide linkages; mass differences between peaks.
- ◆ Interactions: techniques used to identify and analyse proteins bound by the target protein.

This Outcome could include an activity which lets candidates use data to locate the exact site of tryptic cleavage in the full structure of an oligopeptide.

**Outcome 2** concentrates on the principles involved in keeping proteins in their native states. The knowledge and skills which should be covered are:

- ◆ Denaturation: temperature; pH; detergents; urea.
- ◆ Inactivation: oxidation; protection by use of reducing agents; loss of cofactors (emphasis on metal ions).
- ◆ Proteolysis prevention: speed; cold; protease inhibitors.
- ◆ Storage: 50% glycerol at  $-20^{\circ}\text{C}$ .

This Outcome could include an activity which lets candidates interpret data from urea gradient gels.

## Higher National Unit specification: support notes (cont)

### Unit title: Protein Structure and Function

**Outcome 3** concentrates on enabling candidates to understand the principle of specificity in the context of protein binding. The knowledge and skills which should be covered are:

- ◆ General characteristics: lock and key; induced fit; evolutionary conservation of crucial residues.
- ◆ Non-covalent interactions: ionic, hydrophobic; hydrogen bonds; van der Waals interactions; discrimination between similar molecules.
- ◆ Structural methods: data from 3D structures of complexes (without covering how the data are obtained); stable substrate analogues for enzymes.
- ◆ Chemical methods: chemical modification; pH dependence of activity.

This Outcome could include an activity which lets candidates identify crucial residues (based on evolutionary conservation) by alignment of amino acid sequences.

Alternatively data from the crystal structure of a complex between RNaseA and a non-hydrolysable substrate analogue could be analysed to identify residues involved in the reaction mechanism.

**Outcome 4** looks at the basic principles underlying the regulation of protein activity. The knowledge and skills which should be covered are:

- ◆ Conformational change: allosteric enzymes; repressor proteins; membrane receptors.
- ◆ Phosphorylation/dephosphorylation: protein kinases; phosphoprotein phosphatases; residues phosphorylated; consensus motifs.
- ◆ Proteolytic activation: specificity; pepsinogen.
- ◆ Binding proteins: cAMP dependent protein kinase.

An ideal opportunity exists in this Outcome to engage candidates in data-handling activities. This could be through the use of calculations to allow the determination of  $K_d$  for repressor proteins in the presence and absence of effectors.

### Guidance on the delivery and assessment of this Unit

This Unit forms part of the Group Award, HND Biotechnology, which is primarily designed to prepare candidates for employment in a biological science related post. The Unit requires the candidate to be able to identify chemical groups and bonds as well as having some familiarity with biological molecules and biochemical techniques. Hence it is expected to be delivered subsequent to Units in chemistry and biochemistry in the second year of a full-time HND Biotechnology programme. Where possible during the delivery, links should be drawn with other relevant areas of the course.

## **Higher National Unit specification: support notes (cont)**

### **Unit title:** Protein Structure and Function

The use of candidate-centred, resource-based methodologies should be as extensive as possible to promote independent study.

Assessment of the underlying theory in Outcomes 1-4 is by production of appropriate written evidence. It is recommended that this evidence should be generated by case studies and/or problem-solving activities and that, where possible, knowledge and/or skills should be assessed in an integrated manner. Where evidence is found to be unsatisfactory, candidates may be questioned in order to identify particular problems with specific area(s). Support tutorials may prove to be useful in scaffolding a solution to these problems.

In delivery of this Unit an ideal opportunity exists to engage students in utilising the accessible protein databases on the Internet, as well as computer graphics of structures of proteins and protein-ligand complexes. This approach is strongly encouraged given the high level of use of ITA in biotechnology industries.

### **Open learning**

If this Unit is delivered by open or distance learning methods, additional planning resources may be required for candidate support, assessment and quality assurance.

A combination of new and traditional authentication tools may have to be devised for assessment and re-assessment purposes.

### **Disabled candidates and/or those with additional support needs**

The additional support needs of individual candidates should be taken into account when planning learning experiences, selecting assessment instruments, or considering whether any reasonable adjustments may be required. Further advice can be found on our website [www.sqa.org.uk/assessmentarrangements](http://www.sqa.org.uk/assessmentarrangements)

## **General information for candidates**

### **Unit title:** Protein Structure and Function

This is a 1 credit HN Unit at SCQF level 8 intended for candidates undertaking a biological science related qualification. It is designed to provide you with an understanding of, and appreciation for, the link between a protein's structure and its ability to function in a specific way.

On completion of this Unit you should be able to:

1. Outline key aspects of proteomics.
2. Describe the principles involved in keeping proteins in their native states.
3. Outline the basic principles of specific binding.
4. Outline the key principles of the regulation of protein activity.

The four Outcomes that make up the Unit are described below;

#### **Outcome 1**

You will be introduced to the concept of proteomics. The lectures/tutorials for this Outcome will focus on particular aspects such as the various biochemical techniques involved as well as how to interpret the data produced.

#### **Outcome 2**

In this Outcome you will be introduced to the principles involved in keeping proteins in their natural state. You will learn about environmental conditions which may lead to denaturation, protection methods to prevent denaturation, and effective storage methods.

#### **Outcome 3**

This Outcome focuses on the concept of specific binding. The characteristics shared by protein binding sites will be outlined here. You will also be taught about chemical and structural methods which are utilised in trying to identify the actual amino acid residues which contribute to a binding site.

#### **Outcome 4**

In this Outcome you will look at regulation of protein activity. In lectures/tutorials you will learn about such principles, namely: conformational changes, reversible phosphorylation, proteolysis and the role of binding proteins.

Your knowledge of the topics covered in this Unit will be assessed by case studies or problem solving activities. In order to pass this Unit, you will have to obtain at least 60% of the marks available.

To succeed in this Unit you must achieve a satisfactory level of performance in all assessments.